Seattle Public Utilities

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Green Stormwater Infrastructure in Seattle

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Working Together to Protect our Waterways

Green Stormwater Infrastructure Manual for Capital Improvement Projects

Volume III: Design Phase

MIG | SvR

February 2020

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This is the third of five volumes of the Green Stormwater Infrastructure (GSI) Manual for Capital Improvement Projects (GSI Manual). Please consult with other volumes for additional information:

VOLUME:

I	Project Initiation / Partnering Framework
II	Options Analysis
III	**Design Phase**
IV	Construction, On-Boarding & Commissioning
V	Operations & Maintenance

This GSI Manual supplements (not replaces) City and County project design guideline manuals.

This document and its content were developed and prepared by MIG|SvR for Seattle Public Utilities (SPU) and King County Wastewater Treatment Division (WTD) for the GSI Program (SPU Contract C12-004). Additional contributors to this document included representatives from SPU, WTD and results from the City's Interdepartmental Team Meetings in 2013 to 2019 and consultants. Input from PRR with SPU and WTD GSI Program communications team was provided for Section 6 – Public Engagement. Update to Section 10 Deep Infiltration was developed by joint SPU/WTD work group in 2019.

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Image: A series of bioretention cells (vegetated and grass lined) along a new Neighborhood Yield street in High Point neighborhood during heavy rainfall event on November 6, 2006.

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List of Abbreviations*

*See COS Standard Plan (COS Std Plan) 002 for other General Abbreviations used for Street Improvement Permitting plans in City's ROW.

Term	Abbreviation Definition
ADA	Americans with Disability Act
amsl	above mean sea level
AMP	Asset Management Plan
APWA	American Public Works Association
bgs	below ground surface
BMPs	best management practices
BOD	Basis of Design
BSM	bioretention soil media
BTP	bioretention tree planting details (see Appendix D)
CAD	computer-aided design
CB	catch basin
CEG	Cost Estimating Guide (SPU)
CIP	Capital Improvement Project
CMMS	Computerized Maintenance Manual System (WTD)
CO	cleanout
COS	City of Seattle
COS SWM	City of Seattle Stormwater Manual
CRZ	critical root zone
CSI	Construction Specification Institute
CSO	combined sewer overflow
CSECP	Construction Stormwater and Erosion Control Plan
CSS	combined sewer system (combined stormwater and sanitary sewer flows)
DSG	Seattle Public Utilities Design Standards & Guidelines
DSO	Design Services Office (SPU)
ECA	environmentally critical areas
Ecology	Washington State Department of Ecology
EOR	Engineer of Record
ESA	environmental site assessment
FAQ	frequently asked questions
FOM	Facilities Operations Manager (SPU)
ft	foot (or feet)
gpd	gallons per day
GDR	Geotechnical Design Report
GIS	geographic information system
GSI	green stormwater infrastructure
GV	gate valve

Term	Abbreviation Definition (Continued)
H&H	hydraulic and hydrologic
IDT	interdepartmental team
IP	Integrated Plan (SPU)
LEED	Leadership in Energy and Environmental Design
lf	linear feet
LID	Low Impact Development
LL	lesson learned from past SPU/WTD projects
LOB	Line of Business (SPU)
LTCP	Long-Term Control Plan
MAX.	maximum
MEF	maximum extent feasible
MEP	maximum extent practicable
MAXIMO	asset management tracking software (SPU)
MH	maintenance hole
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MUP	Master Use Permit
NDS	natural drainage system (SPU)
NG	Neighborhood Greenways
NPDES	National Pollutant Discharge Elimination System
O&M	operations and maintenance
OH	overhead (i.e. utilities or tree branches)
OPCC	Opinion of Probable Construction Cost
OPCD	Seattle Office of Planning and Community Development
PACT	planning analysis coordination tool
PC/PT	point of curvature / point of tangency (on a horizontal curve)
PDB	Project Delivery Branch (SPU)
PE	Professional Engineer
PEG	Public Engagement Guidelines
PEP	Public Engagement Plan
PIT	pilot infiltration test
PLA	Professional Landscape Architect
PMP	Project Management Plan
PROWAG	Proposed Guidelines for Pedestrian Facilities in the Public Right-of-Way
PS	piped sewer
PSD	piped storm drain
PSS	piped sanitary sewer
PSE	Puget Sound Energy
PS&E	plans, specifications, and estimates
QA/QC	quality assurance/quality control

Term	Abbreviation Definition (Continued)
ROW	rights-of-way (or also referred to as "right-of-way")
ROWIM	Streets Illustrated, Seattle's Right-of-Way Improvements Manual (also referred to in the text as "Streets Illustrated ROWIM")
RPM	reflective pavement marker
SCL	Seattle City Light
SDCI	Seattle Department of Construction and Inspections
SDOT	Seattle Department of Transportation
SEPA	State Environmental Policy Act
SERP	State Environmental Review Process
SFD	Seattle Fire Department
SG	Stage Gate
SI	Streets Illustrated, Seattle's Right-of-Way Improvements Manual
SIP	Street Improvement Permitting (SDOT)
SMC	Seattle Municipal Code
SME	subject matter experts
SOP	standard operating procedures
SPD	Seattle Police Department
SPS	Seattle Public Schools
SPU	Seattle Public Utilities
SSD	sub surface drain pipe (underdrain pipe)
STD	standard
SWM	Stormwater Manual for City of Seattle
SWMMWW	Washington State Department of Ecology's Stormwater Management Manual of Western Washington
SWPPP	Stormwater Pollution Prevention Plan
TESC	temporary erosion and sediment control
TM	technical memorandum
TVSPP	Tree, Vegetation and Soil Protection Plan
UIC	Underground Injection Control (Ecology)
UMH	underdrain maintenance hole
USM	Utilities System Management (SPU)
VE	value engineering
WM	water meter
WQ	water quality
WTD	King County, Department of Natural Resources, Wastewater Treatment Division

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Definitions

These definitions are focused on implementing green stormwater infrastructure in the City's right-of-way (ROW) as part of capital improvement projects (as opposed to implementation on parcels).

Bioretention:

Bioretention refers to an engineered shallow earthen depression facility with engineered soil and plants to provide water quality treatment and either retain or detain the treated stormwater for flow attenuation. The facility is designed to mimic natural processes by filtering stormwater through the vegetation and into the imported bioretention soil mix (BSM). When designed with required BSM depth (at least 18 inches), bioretention facilities provide "enhanced" water quality treatment in accordance with COS Stormwater Manual, Volume 3, Section 5.4.4 (infiltrating bioretention) and Section 5.8.2 (non-infiltrating bioretention).

In the ROW, stormwater enters the bioretention facility through sheet flow across landscape/pavement; through breaks in the curb along the roadway or sidewalk; and/or through a piped/culvert system daylighting into the facility. Individual depressions within a bioretention facility are called "**cells**". For ROW applications usually, there are multiple bioretention cells in a series within a block. Because each cell is a depression, water ponds in the cell and infiltrates downward into the underlying soil as opposed to continuing to flow horizontally along the longitudinal profile like a conveyance swale. However, if the cell receives more water than it was designed for, the water ponds up and overflows out of the cell either through a drain curb cut or overflow pipe in the cell.

Depending upon the rainfall event and intensity, stormwater may:

- filter through the vegetation and BSM and infiltrate into the underlying soils;
- filter through the vegetation and BSM and collect in an underdrain pipe that connects to the drainage/sewer system or is conveyed and infiltrates into the underlying soils via a deeper infiltration facility such as a screen well; or
- overflow out of the cell via a drain curb cut or overflow pipe and continue to flow down the road to the next bioretention cell or into the drainage sewer system.

The lay term "rain garden" may be used to describe the system to the public; however, rain gardens are defined as different type of facility from bioretention in the City's code and have different design criteria as noted in the City of Seattle Stormwater Manual and Washington State Department of Ecology's Stormwater Management Manual for Western Washington. See "rain garden" in this section for definition. The lay term "Natural Drainage System" or "NDS" may also be used to describe bioretention in public outreach materials for CIPs led by SPU.

Definitions (Continued)

Biofiltration Swale:

An open, gently sloped, vegetated earthen channel designed to treat stormwater by evenly distributing stormwater flows across the entire width of a densely vegetated channel that has a minimum length of 100 feet (or greater depending upon project design). Stormwater runoff flows into the facility at the head of the swale. The bottom width (2 ft to 10 ft) of the channel is to be constant along the entire length. Longitudinal slope ranges from 1.5% to 2.5%. Basic biofiltration swales provide “basic” water quality treatment in accordance with COS Stormwater Manual Volume 3, Section 5.8.3.

Block:

Refers to a street length from intersection to intersection. A block includes the street and adjacent private/public parcels (residential, commercial, parks etc.). A City block can range from 300-feet to 800-feet long, varying widths, surrounded on four corners by public street right-of-way and may/may not include a public alley through the block.

Cells:

See “bioretention” in this section.

Conveyance Swale:

Conveyance swale refers to shallow vegetated earthen channel to convey stormwater runoff (as opposed to a piped system). See COS Standard Plan 294 for cross section of a vegetated conveyance swale that is not for water quality treatment.

Natural Drainage System:

A term used by SPU for a bioretention facility. See definition for “bioretention” in this section.

Permeable Pavement Facilities:

Permeable pavement is a paving system that allows rainfall to infiltrate into an underlying aggregate storage reservoir, where stormwater is stored and infiltrated to the underlying subgrade or (for larger storms where it cannot infiltrate) removed by an overflow drainage system (such a perforated pipe) that discharges into the drainage system. Permeable pavement consists of a wearing course (e.g. porous asphalt, pervious concrete) and an underlying aggregate storage reservoir/subbase, which is designed to both temporarily store water and provide structural support for intended loads. Facilities that are pollution generating (road or alley) or receive runoff from pollution generating surfaces also can provide “basic” water quality if the underlying subgrade soils meet the water quality treatment requirements. Otherwise a treatment layer within the pavement section is required. See City of Seattle Stormwater Manual Volume 3, Section 5.4.6.

Definitions (Continued)

Permeable Pavement Surfaces:

See COS Stormwater Manual, Volume 3, Section 5.6.2.

Rain Garden:

Rain gardens are non-engineered shallow landscape depressions with compost-amended native soils and adapted plants that ponds and temporarily stores stormwater runoff from adjacent areas. Rain gardens are not defined as a water quality treatment or flow control facility as described in the COS Stormwater Manual, Volume 3, Section 5.4.5, and Washington State Department of Ecology's Stormwater Management Manual for Western Washington. Rain gardens are typically small scale or a singular facility. Rain gardens may be used to manage runoff from new sidewalks to meet "On-Site Stormwater Management" requirements described in COS Stormwater Manual and SPU's Client Assistance Memo (CAM) 1190.

Road:

The road or also referred to as roadway is the portion of a street improved, designed, or ordinarily used for vehicular travel and parking, exclusive of the sidewalk or shoulder. Where there are curbs, the roadway is the curb to curb width of the street. *Definition from Glossary in Streets Illustrated, Seattle's Right-of-Way Improvements Manual. In this document the general rule is to use "street" when referring to the full right of way or elements within the right of way and "road" when being specific regarding the vehicular surface area. The roadway may or may not have a curb along the road edge.*

Street:

A public right-of-way that includes a roadway, shoulder, planting strips and/or sidewalk(s) along other public infrastructure and utilities. *For full definition, see Glossary in Streets Illustrated ROWIM. See also above definition for "road". "Travelled way" refers to just the portion of the street that receives vehicular traffic.*

Street Typology:

See Streets Illustrated, Seattle's Right of Way Improvements Manual.

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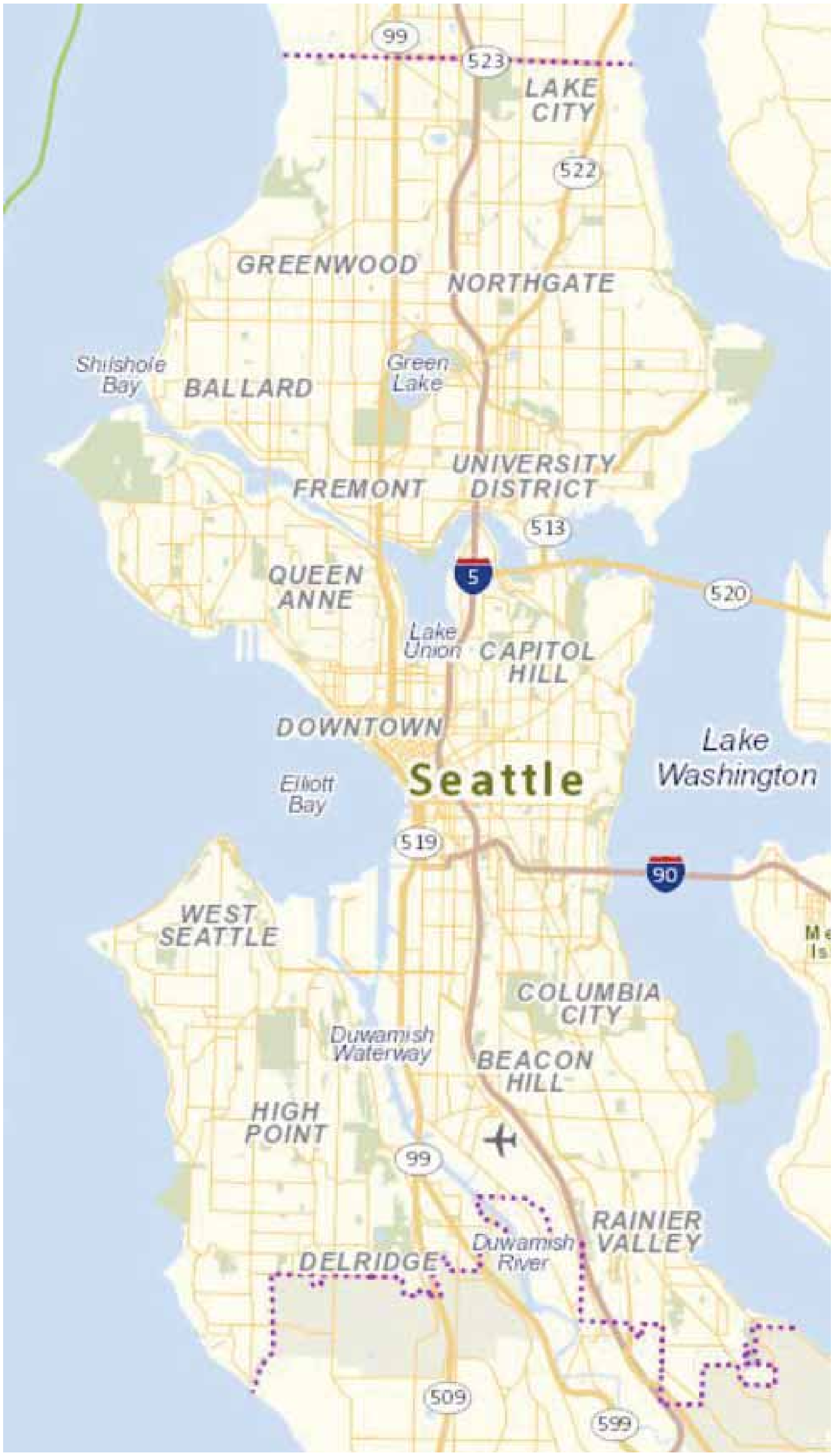

Image: Map of Seattle from SPU's DSO maps.

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Section 1
Introduction

1.1 Overview

Seattle Public Utilities (SPU) has been in the forefront of Green Stormwater Infrastructure (GSI) with public installations as early as 1999. GSI helps our city manage rain naturally. Like a forest, GSI solutions such as roadside bioretention facilities filter out pollution and help rain soak into the ground rather than rush over yards, parking lots, and streets, washing pollutants into the regions living waterways (e.g. rivers, lakes, creeks, streams, ponds, bays). The early projects established the basis for the interdisciplinary and interdepartmental teamwork necessary for success in the urban context. Over the years Seattle has actively participated in the national forum where ideas and practices are shared to encourage broader applications for GSI.

GSI facilities have been installed within the public right-of-way (ROW) for stormwater code compliance, creek basin projects, combined sewer overflow control projects, and/or capital retrofit projects. As its multi-functional value became apparent, using GSI techniques has become a baseline code requirement under the City's National Pollution Discharge Elimination System Permit (NPDES) with Washington State Department of Ecology (Ecology) as described in Ecology's Stormwater Management Manual for Western Washington (December 2014) for "on-site stormwater management". GSI bioretention facilities are now a key component of Seattle's formal utility infrastructure like watermains, stormwater pipes and structures. In addition to meeting Ecology permit(s) and other regulatory requirements, GSI supports SPU's and King County Wastewater Treatment Division's (WTD) strategy of solving problems at the source. Seattle has prioritized the use of GSI where feasible because it is effective, cost-comparable with conventional approaches, and high value. GSI through plantings and providing healthy conditions for urban trees, greens neighborhoods, provides immediate access to nature, calms traffic, improves pedestrian safety, and as needed captures rain for reuse.

> GSI is a community centered utility solution that helps make Seattle a sustainable and resilient city.

This manual is a compilation of protocols and practices based on shared ideas and lessons learned that were developed following observation of various GSI installations over time. The guidance included in this document was developed and reviewed through interdepartmental and interagency collaboration between SPU, Seattle Department of Transportation (SDOT), Seattle Department of Construction and Inspection (SDCI), WTD, Urban Forestry, Field Operations and Maintenance and others. The purpose and intent of this document is to provide design guidance and lessons learned to shift GSI from a prototype to a commonly used infrastructure.

> The primary audience for this manual is City of Seattle and King County WTD staff.

1.2 Purpose

The purpose of the Green Stormwater Infrastructure Manual for Capital Improvement Projects (GSI Manual) is to provide technical design guidance and standard procedures from a project's Initiation through Operations and Maintenance. This manual is structured for staff use on Seattle Public Utilities (SPU) or King County Wastewater Treatment Division (WTD) led capital improvement projects (CIP) that implement GSI technologies along streets in the City of Seattle (City) right-of-way (ROW). The end users of this manual may include SPU, WTD and/or their design consultants.

The GSI technologies described in **Volume III: Design Phase** of the GSI manual focus on the more commonly used bioretention facilities retrofitted into the public ROW along Neighborhood Yield and Neighborhood Curbless streets (see Streets Illustrated, Seattle's Right-of-Way Improvements Manual (ROWIM) for street typology descriptions). As bioretention facilities provide the most effective performance of the GSI technologies, this volume is focused on bioretention facilities that manages road runoff, provides flow attenuation, and provide water quality treatment. Volume III also includes general design guidance for permeable pavement in the public street/alley. Based on joint discussions with SPU, WTD and the Seattle Department of Transportation (SDOT), permeable pavements remain an infrequently used drainage management tool for City led CIPs. Permeable pavements are often used for sidewalks and private installations as a tool for mitigating small areas of hardscape or areas with low traffic volume (see Section 9).

The intent of this manual is to provide consistent designs that meet performance requirement using bioretention. There are other GSI tools that may be used with specific agency approval.

For **WTD-led projects**, the project goal is to use GSI technologies (such as roadside bioretention cells and/or permeable pavements) to reduce combined sewer overflow (CSO) events in combined sewer basins where the overflow is managed by WTD.

Design guidance for non-bioretention GSI facilities in ROW

For the design of other GSI technologies, see COS Stormwater Manual (COS SWM), Streets Illustrated, Seattle's Right-of-Way Improvements Manual (ROWIM), COS Standard Plans and Specifications. Design guidance for rain gardens for sidewalk mitigation is described in SPU Client Assistance Memo 1190.

For **SPU-led projects**, the target will vary depending upon the basin. Bioretention facilities may be used for providing creek protection, water quality treatment, flow mitigation, CSO control and/or other citywide stormwater performance targets along with community streetscape and habitat enhancements.

This volume is the third of 5 volumes of the GSI Manual. Consult with other volumes for additional information:

Volume I:	Project Initiation / Partnering Framework
Volume II:	Options Analysis
Volume III:	**Design Phase**
Volume IV:	Construction, On-Boarding & Commissioning
Volume V:	Operations & Maintenance

1.3 How to Use this Volume of the GSI Manual

The GSI Manual and information in this design volume supplements but does not replace City and County standard design guidelines and manuals for capital improvement projects.

It is intended that, at a minimum, the Design Phase Project Team's Project Manager, Agency's Project Engineer, Landscape Architect of Record, and Engineer of Record read the entirety of this Design Volume and conduct a meeting with the SPU/WTD Project Manager to go over the multidisciplinary integrated approach and establish expectations for outcomes. It is also required that this volume be available to the designers and other agency staff on the Project Team for designing city/county assets.

The design of roadside bioretention in the public ROW requires an integrated multidisciplinary team of outreach professionals, modelers, maintenance staff, landscape architects, civil engineers, geotechnical engineers, and hydrogeologists. The team carefully locates and designs facilities that consider project-specific conditions, site and community context, mobility and access, along with technical function and long-term operations and maintenance.

This design volume incorporates lessons learned and input from the City's Interdepartmental Team (IDT), SPU, SDOT and WTD staff and their consultants, suppliers, contractors, installers, and contract O&M staff. Along with this volume, standards and requirements for designing bioretention facilities and/or associated infrastructure in the City's right-of-way are found in published City documents (see "Resources" in this Section). Note the following:

- Where the guidance in this volume differs from other

Definitions & Abbreviations

Definitions and descriptions for GSI technologies are described in the COS Stormwater Manual.

Definitions and descriptions for street typologies and other ROW elements are described in Streets Illustrated ROWIM.

A list of abbreviations used in this volume is included after this volume's Table of Contents.

City resources and documents and/or is not provided in those documents, the information provided herein was developed and reviewed through the IDT (interdepartmental) coordination with SPU, SDOT, SDCI and WTD staff, and is an "approved deviation" for consideration for use in the right-of-way for SPU/WTD CIPs.

- Where the guidance in this volume is more restrictive than requirements noted in other City documents, the guidance in this volume takes precedence for SPU/WTD CIP retrofits in the ROW.

As project teams review and apply the guidance and information in this Volume, be aware that there are always lessons to learn. As we move toward using natural elements and natural designs to clean our waters, it is important to observe the function and condition of installed facilities through all seasons and weather events. It is also important to observe how facilities are understood by the public and the people that live and walk along them.

City Standards

Where this manual does not indicate a deviation to the City's design standard, users are to use the other City published documents for referencing the requirements. This is intentional to minimize duplicate (and possibly conflicting) information in multiple City documents.

1.4 Design Phase Flow Chart

A flow chart of the Design Phase has been developed to provide an overview of the sequence of tasks (see Figure 1-1 at the end of this section). The chart highlights tasks specific to internal processes of SPU and WTD GSI design projects.

For flow charts for other phases, see Volumes I, II, IV and V of the GSI Manual.

1.5 Resources

The following are documents and resources to use for the Design Phase:

General Primary Resources

<u>SPU- or WTD-led CIP:</u>

- City of Seattle
    - o Right-of-Way Improvement Manual - Seattle Streets Illustrated (current edition)
    - o SDOT's Right-of-Way Opening and Restoration Rules (current edition)
    - o City of Seattle Standard Plans (current edition)
    - o City of Seattle Standard Specifications (current edition)
    - o City of Seattle Stormwater Manual (current edition)
    - o SDOT Street Tree Manual
    - o SPU & SDOT CAD Resources for Plan Preparation
    - o SPU Survey Requirements, CAM 1401, for Plan Review

  - Traffic Control Manual for In-Street Work (City of Seattle, current edition)
  - SPU Communications and Public Engagement Guidelines, Sewer and Stormwater Pollution Prevention (See Appendix B)

- GSI Program
  - GSI Manual, Volume I: Project Initiation / Partnering Framework
  - GSI Manual, Volume II: Options Analysis
  - GSI Manual, Volume IV: Construction & Commissioning
  - GSI Manual, Volume V: Operations & Maintenance
  - Green Stormwater Infrastructure Modeling Methods (see Appendix H)

<u>SPU-led CIP:</u>

- SPU Design Standard & Guidelines (DSG) (current edition)
- SPU Project Management Manual

<u>WTD-led CIP:</u>

- WTD Design Standards
- WTD Sustainability Score Card Process
- WTD Guide Specifications
- WTD Community Engagement Guide

Secondary Resources (project-specific)

<u>SPU- or WTD-led CIP:</u>

- Guidance on when to repair side sewers as part of GSI CIPs (Appendix L)
- Ecology Guidance for UIC Well Registration
- Ecology Guidance for UIC Wells that Manage Stormwater (current publication)
- Other regulatory compliance or legal documents, such as a copy of the agency's Consent Decree
- Funding/Grant requirements (such as WAC for State Revolving Funds, grants, or loans)

<u>SPU-led CIP:</u>

- Seattle’s Cost Estimating Guide
- SPU/SDOT Interdepartmental CAD Standard (updated 4/29/2015)

<u>WTD-led CIP:</u>

- WTD CAD Standards
- WTD Project Management Manual

1.6 Work Completed Prior to Start of Design Phase

At the completion of Options Analysis (as described in GSI Manual, Volume II), it is assumed that the following work described will have been performed for the GSI CIP.

Initial Site Reconnaissance and Assessment:

- Site reconnaissance completed
- Geologic exploration, study and testing conducted to provide information on where GSI is most feasible and provide recommendations for siting and design. Draft Geotechnical Design Report (including final Hydrogeologic Report) completed. (see Figure 5-2)
- Streets reviewed and selected for implementation of GSI (see "Selection of Streets and GSI technology(s) for Design Phase Scope")
- Environmental site assessment (ESA) completed (if applicable)
- Risk assessment/Risk Register completed
- Partnerships with other departments or agencies identified
- Community outreach (initial for public notification of field assessment activities)

Preliminary Design:

- Initial Design Reports completed
  - SPU Basis of Design or
  - WTD Design Parameters & Criteria Report
- Alternate GSI strategies and methods of discharge (pit drains, UICs, pervious pavement, constructed soil cells, or other) identified and evaluated
- The preliminary bioretention cell cross-sections, including dimensions, selected and the design checked in the field to confirm feasibility of retrofitting within the project ROW context
- Modeling conducted to evaluate the performance of the GSI and confirm that project targets will be met. The modeling analysis will have been summarized in a report and quality control reviewed by an independent modeler
- Community outreach and public engagement activities initiated in the project area

Budget/Funding:

- Potential partners identified.
- Funding for project secured

Administrative and Regulatory:

- Preliminary Project Charter (for WTD-led projects) completed
- Memoranda of Agreements / Memoranda of Understanding required with City or County or other departments, agencies and/or utility purveyors identified
- SEPA completed with a determination
  - for SPU-led projects this is at 30 percent design

- Completion tasks required for SPU / WTD's respective Stage Gates prior to start of design
- Other elements described in Volume II of the GSI Manual

Selection of Streets and GSI technology(s) for Design Phase Scope

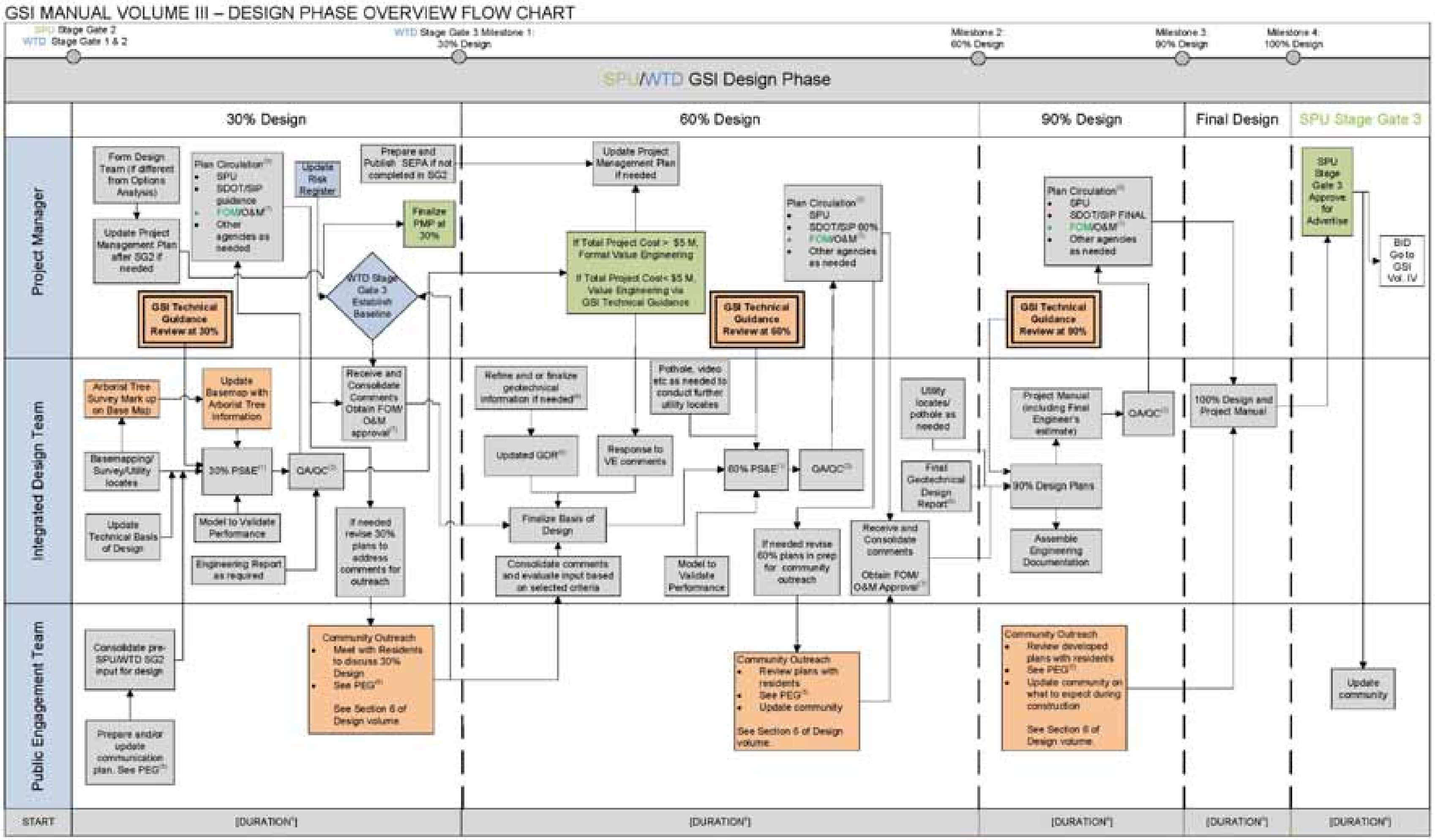
Upon completion of Options Analysis (i.e. approval of the Business Case for SPU and approval of the Recommended Alternative for WTD), it is assumed that the agency has selected the specific streets to move to Design for the CIP.

Sufficient analysis (as noted in this Section) will have been completed to provide a small "buffer" in the number of streets that are (~110 percent of streets selected) needed to meet design targets (performance) for the final design. The type of GSI technology for retrofit on each street (bioretention with shallow infiltration vs bioretention with deep infiltration) will also have been selected. As the project goes through the Design Phase, this "buffer" allows for implementing GSI to be adaptable so that the affected communities (new streets) will not increase during the Design Phase and, if anything, would decrease within the "buffer" of the street selection for the preferred alternative from Options Analysis.

TIP

if a project is to reassess new streets for GSI during the Design Phase (i.e. add new streets to the Design Phase scope) and/or if portions of the work noted in this Section was not completed for Options Analysis (approval of SPU's Business Case/WTD's Recommended Alternative), then see GSI Manual, Volume II for guidance.

Image: Bioretention cell with curb bulb constructed for WTD's Barton CSO Control with GSI project in West Seattle.



Notes:
1) See SPU's Design Standard and Guidelines (DSG) for more details and level of effort.
2) See DSG for QA/QC checklists.
3) Circulation includes outside agencies if needed. See Design Volume-Appendix I for GSI Plan Circulation Checklist.
4) Projects should scale the duration and process based on its scope, scale of project, permit/grant requirements and other project specific timelines/milestones.
5) PEG = Public Engagement Guidelines.
6) If the "Hydrogeologic Assessment, Analysis and Basis of Design" within Geotechnical Design Report was not completed during Options Analysis/Alternative Analysis phase, then the document shall be completed and finalized at 30% Design. Updates may occur to document final design recommendations through 90%. See Section 5 in Design volume.

Text WTD term
Text SPU term
GSI Technical Guidance Milestone Review
Dashed line indicates that task is "As Needed"
WTD only step
SPU only step
GSI Capital Project Step Only

Figure 1-1: Design Phase overview flow chart

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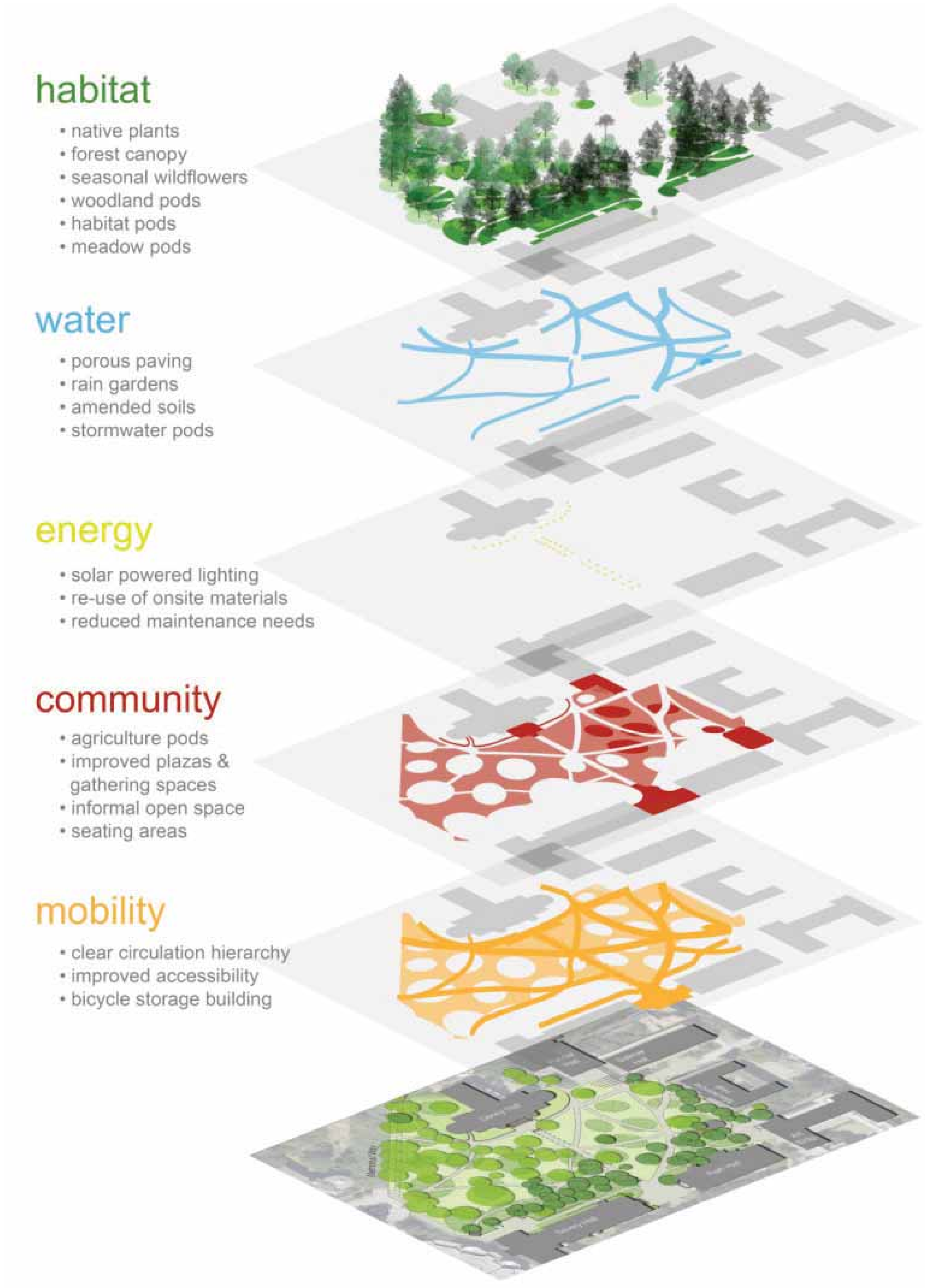

Image: Graphic showing how a Project Team integrates disciplines and considers the different users, infrastructure needs and functions.

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Section 2
Project Team Start-up, Management and Coordination

2.1 The Project Team

A multidisciplinary analysis and integrated design are required for GSI implementation to be successful because GSI is a surface infrastructure that should engage people while performing a stormwater function. It is critical that GSI projects implement this integrated discipline approach throughout each phase of the project, even as modeling parameters are discussed. Input from different perspectives will strengthen feasibility and reduce iterative work. Thinking always of the broad community use, design team members must openly communicate with one another, and must be aware of the project-objectives and how their respective specialties contribute.

The agency's Project Team for the Design Phase is to include the following at a minimum:

- SPU's Line of Business Representative (for SPU projects only)
- Project Manager:
  - o SPU's Project Delivery Branch
  - o WTD's Capital Projects Planning and Delivery Unit
- WTD/SPU Lead Landscape Architect
- WTD's Lead Project Engineer / SPU's Project Engineer[1]
- WTD's O&M or SPU's Facility O&M Representative (FOM)
- Community Relations Lead/Public Engagement Specialist
- Designers/Subject Matter Experts (SME) (see below)

[1]For SPU-led projects: One internal SPU employee is to be assigned as the Project Engineer for each project. They handle cross-discipline coordination and decisions. The Project Engineer oversees, advises, and serves as the primary design contact for the consultant design team. A PE license may be required for SPU's Project Engineer, depending on the complexity of the project. They must have sufficient engineering education and experience to provide guidance for the project. They are also responsible for the QC process. If the Project Engineer has no license, then their work shall be overseen under the direction by a SPU staff person with a PE license.

The designers/SME on the Project Team will vary depending upon project scope, scale and whether the

Design Phase Scope of Work Template

A template for developing consultant scope of work for the Design Phase is available from SPU's GSI Projects Manager. The agency's Project Manager can adapt it for either WTD-led or SPU-led CIPs with GSI.

project is done in-house or through a consultant. The following are potential SME for the Project Team:

Design Experts:

- Project Manager (Design Team's Lead) could be a professional landscape architect, civil engineer, or urban designer that has managed a public implementation project of similar complexity.
- Civil Engineer(s)[2] (for GSI and street improvements design and analysis)
- Landscape Architect[2] (for GSI and street improvements design and analysis)
- Community Relations Lead/Public Engagement Specialist
- Certified Arborist, Landscape Architect or SDOT / WTD staff to review and assess existing trees depending on project scale
- Geologist
- Hydrogeologist
- Geotechnical Engineer
- Structural Engineer (e.g. vertical wall designs)
- GIS Specialist
- Public Artist
- Surveyor (in-house or outside consultant)
- Modeler for both basin analysis and GSI performance evaluation
- Interpretive or cultural consultant
- Archeologist

Technical Experts:

- Permit Specialist
- Drafters/CAD Technicians
- QA/QC Lead (for SPU Projects) / WTD's Technical Manager of Capital Projects
- SPU's Specifications Writer / WTD's Project Engineer
- Cost Estimator

Construction Experts:

- Resident Engineer for Construction
- SPU's Supervising Construction Engineers
- Field Inspector for Construction
- Urban Forester/Arborist
- Field landscape architect
- Outreach
- Procurement Specialist
- Post Construction Monitoring - Instrumentation and Control staff

[2]The Project Team shall also identify the "Engineer of Record" and "Landscape Architect of

Record" for the project's Design Phase and plans. These individuals shall be licensed in their respective disciplines and complete the inspection checklist referenced in Section 12.

2.2 Kick-Off and Design Charrettes

At the start of the Design Phase, the Project Team should conduct a kick-off meeting with the full team to go over project goals and performance target, objectives, scope, project management, communication protocols, stakeholders, project partners, review of past work, concept plans, risk register and other aspects of the work. While the agenda can be broad the focus of the meeting should be to hear from each team member on their understanding of the goals and objectives and their key thoughts as the team starts design.

It is also recommended for the Project Team to conduct a design charrette in the early stages of the Design Phase as project extents and goals are confirmed (between 10 percent and 30 percent design). The design charrette should include the project manager/representative, lead designers (landscape architect and civil engineer) along with community relations lead, O&M staff, geotechnical engineer /hydrogeologist, and other technical experts, to explore opportunities and design approaches and alternatives.

Both the kick-off and design charrette(s) can provide opportunities for multidisciplinary coordination, team building, and flushing out ideas/alternatives for a successful project.

The intent of the design charrette is to openly brainstorm ideas, challenge assumptions and discuss constraints.

2.3 Update SPU/WTD's Project Management Plan (PMP)

The SPU/WTD project management plan is updated by the Project Manager at the start of the Design Phase (see Figure 1-1) and rechecked as the project proceeds through design. The project management plan is to include scope, budget, schedule, a risk assessment/risk register, and a quality assurance/quality control plan. See SPU/WTD's PMP guidelines for more information.

Milestones that may apply to a project's schedule

- Consent Decree milestones
- Grant or funding deadlines
- Value Engineering preparation and review
- MOUs/MOAs with other agencies and entities
- Permit review with other entities (e.g. Ecology).
- Community events such as school, festivals, etc.

2.3.1 Design Phase Schedule

A sample Design Phase schedule template is provided in Appendix A. The Project Team shall tailor the schedule per project-specific requirements (permit, regulatory, funding, etc.) and respective agency standards (SPU/WTD). See side bar for examples of different factors that should be included in the schedule.

The Design Phase schedule shall also consider time for procurement and start of construction to avoid earthwork activities associated with installing bioretention facilities to occur outside of the wet season and/or planting occurring in late fall (not recommended since it would require longer period for establishment). If some work is to occur during the wet season and/or if the project accelerates certain phases of the work, consider what impacts it might have to the design process, bid document preparation or other aspects of the project.

2.4 Update Public Engagement Plan (PEP)

A public engagement plan, typically initiated prior to start of the Design phase, is to be updated by the Design Phase's public engagement team in coordination with the Project Manager and Project Team. See *Seattle Public Utilities' Communications and Public Engagement Guidelines, Sewer and Stormwater Pollution Prevention* in Appendix B for reference and Section 6 in this volume for more information.

2.5 Review of Existing Available Data

The project design team members will need to review and confirm that there have not been updates to existing available technical and social information that was compiled previously for the project, including but not limited to:

- Final reports/basis of design/drawings/memoranda from Options Analysis
- WTD's Preliminary Project Charter
- Social data and community input from earlier phases
- Draft Geotechnical Design Report, which includes final hydrogeologic and draft geologic analyses and recommendations (see Section 5 of this volume)
- Compiled City GIS files and electronic mapping
- Utility coordination – SDOT PACT (Planning Analysis Coordination Tool) database
- Archaeological and historical review
- Street type/typology and minimum widths for different areas/zones within the ROW when doing full or partial ROW improvements (see Streets Illustrated ROWIM) or improving unimproved ROWs.
- Regulatory requirements (such as changes to code, Streets Illustrated ROWIM and other regulatory documents etc.).
- Neighborhood's tree canopy in relation to Seattle's Urban Forest Stewardship Plan.

In addition, to ensure coordination of the design with other infrastructure elements and users of the ROW, review mapping of all the City's plans/goals for the project area and confirm that there have been no updates to the following:

<u>Plans:</u>

- Bicycle Master Plan
- Pedestrian Master Plan
- Transit Master Plan

- Freight Master Plan
- Urban Forest Stewardship Plan
- Other City/neighborhood plans

Maps & Routes:

- Neighborhood Greenways map
- School bus routes
- Safe Routes to School
- King County Metro transit routes
- Fire/emergency vehicle routes through neighborhoods (See Streets Illustrated ROWIM maps and review routes with local fire station)
- SPU recycling/garbage/yard waste management route maps

Programs:

- RainWise Program
- reLeaf Program

Projects:

- Parks, schools, community centers, churches and other community gathering spaces in the project area
- Utility infrastructure improvements (franchise, gas, Seattle City Light, water, sewer, etc.)
- Other capital improvement projects planned for the project area
- Private parcel MUP applications or application for new utility service.

2.6 Review and Update Project Report and Basis of Design

An example template/outline of the Project Report, which includes the Basis of Design, is included in Appendix C. Some sections of the Project Report will have been completed and/or drafted prior to the start of the Design Phase during Options Analysis (i.e. development and evaluation of alternatives to address the problem and approve the Business Case for the CIP). During the Design Phase, the Project Report is to be reviewed and updated for the final design. While content for SPU-led and WTD-led Project Reports are similar, the terminology for the documentation completed prior to the start of the Design Phase differs:

SPU-led projects

For SPU-led projects, an initial Project Report (including draft project management plan, basis of design, geotechnical analysis, public engagement plan, etc.) will have been initiated during SPU’s Options Analysis phase. The purpose of the project and three key performance indicators are to be included in the Basis of Design of the Project Report. Confirmation of the purpose and key performance indicators shall occur during the 30 percent design stage submittal. These key performance indicators will be used during the maintenance of the facility to determine whether the system is performing as designed and the timing of rehabilitation or replacement. During the Design Phase, the Project Report (see Section 12 and Appendix C) must be reviewed and updated accordingly by the SPU Project Team to document any revisions as the project progresses.

WTD-led projects

For WTD-led projects, a technical memorandum will have been completed during the Problem Definition phase. The project will have been approved for funding and transferred to the Capital Project Management Unit and a “Preliminary Project Charter” will be developed. During 0 to 30 percent design, a basis of design will be written. If the project has a Facility Plan, it is to be approved by Ecology for state revolving loan funding.

King County’s Consent Decree with Ecology, United States Environmental Protection Agency (EPA) and United States Department of Justice (DOJ) for addressing CSOs requires a Green for Grey Substitution report which will need to be approved by Ecology and EPA. The Green for Grey Substitution report has a specific deadline as outlined in Appendix E of the County’s Consent Decree. All agency staff and consultants should be familiar and have read the County’s Consent Decree.

The Project Team for the Design Phase of the WTD-led CIP will then need to review and develop a project-specific Basis of Design. The Basis of Design is updated at 30, 60 and 90 percent design. The Project Report outline in Appendix C is to be tailored to meet all reporting requirements for WTD’s Facility Plan, Consent Decree report and Basis of Design.

2.7 Review and Update Risk Register/Management Plan

As the project progresses into the Design Phase, update the Risk Register/Management plan in accordance with SPU/WTD capital projects requirements through the design phase (such as at 30, 60, and 90 percent design). Team disciplines leads shall review the risk register and provide input to the update. The use of new tools or modified design does have a risk to O&M staffing and methodology and should be addressed in the risk register.

2.8 30/60/90 Design for GSI Program Review

During the Design Phase, as referenced in Figure 1-1 and in the template schedule in Appendix A, GSI program design reviews shall be conducted at 30-percent, 60-percent and 90-percent for projects that have one or more of the following conditions:

- Project Area: GSI implemented on two or more City blocks
- Project Construction Estimate: $200,000 or greater

- Project is using deep infiltration
- Project is proposing new design details that are currently not within the GSI Manual

The purpose of the "GSI Program Design Review" is to ensure that project teams are following the GSI program procedures, to review design details that differ from details in the GSI Manual, to review project site context and edge conditions and to provide general design guidance as needed. The review is to be completed prior to submitting for the deliverable for agency Plan Circulation /SDOT's SIP submittal (30/60/90). Scheduling of the GSI program design review is to be through the SPU GSI Projects Program Manager and the Project's SPU / WTD Project Manager. The Project Manager shall send a request a minimum of two weeks in advance of schedule need.

Upon completion of GSI program design review meeting, the Project Team shall submit meeting notes documenting concurrence of next steps for elements discussed. Prior to delivering plans for agency Plan Circulation / SDOT's SIP submittal at 30/60/90, comments from GSI program design review shall be incorporated into the plans.

<u>30-percent GSI Program Design Review:</u>

At 30-percent, a GSI Program Design Review is essentially a simplified version of Value Engineering (VE). It is anticipated to be a one- to three-day meeting (depending upon complexity of project and scale) with the Project Team's design and technical leads with SPU GSI program staff. The meeting(s) will be an intensive review of the project, with a structure to focus on major budget and primary performance items including:

- Optimization of work that has occurred, and suggestions for further focus
- Discussion of and collaboration on ideas and alternatives
- Documentation of options and costs, and which options are recommended for inclusion
- Questions that the Project Team members have for the GSI program staff.

In preparation for the meeting with GSI program, the Project Team shall submit draft 30-percent drawings, a construction cost estimate*, an outline of potential special provisions specifications*, a draft Project Report, a summary of outreach to date, and a meeting agenda with list of topics, questions, design concerns and issues to discuss. (Items with * may or may not be needed depending upon complexity of project).

The drawings for 30% review should include changes to street elements, road alignment layout, cell siting, preliminary bottom width, underdrains, approach to discharge, use of permeable pavements, tree preservation and preliminary plant lists. If new technologies or deviations are being proposed, provide 60% level details. (See Appendix I)

60-percent GSI Program Design Review:

At 60-percent, project teams shall submit draft 60-percent design drawings (including GSI sections and details), updated construction cost estimate, outline of draft special provision specifications, draft 60 percent Project Report, and a list of agenda questions/issues to discuss with GSI program staff. After GSI program staff has reviewed 60-percent documents, a two- to three-hour meeting will be held with Project Team's design and technical leads and GSI program staff to go over agenda items and comments.

The drawings for 60% review should include street elements, road alignment layout, cell siting, cell profiles, cell cross sections, underdrains, approach to discharge, location and sections for permeable pavement treatments, tree preservation, tree replacements and new tree plan and bottom width adjustments, plant palettes, planting cell type layout, watering approach, preliminary determination of restoration extents, and other items identified in Appendix I.

90-percent GSI Program Design Review:

At 90-percent, project teams shall submit draft 90-percent design drawings (including GSI sections and details), draft construction cost estimate, draft special provision specifications, draft 90 percent Project Report and a list of agenda questions/issues to discuss with GSI program staff. After GSI program staff has reviewed 90-percent documents, a two to three-hour meeting will be held between Project Team leads and GSI Program staff to go over agenda items and comments. (See Appendix I)

2.9 Memoranda of Understanding/Agreement

Memorandums of Understanding and/or Memorandums of Agreements can be used to strengthen cooperation, define maintenance responsibilities, and/or define terms of agreement between agencies, departments and/or with franchise utility purveyors. During Options Analysis, a list of potential MOUs/MOAs may have been developed and during 30 percent design stage, Project Teams shall review and update this list. To inform the design and avoid impacts to a project's schedule, during 30 percent design stage, it is recommended the projects obtain (or at a minimum begin to draft) MOUs/MOAs for coordination, design, and installation and/or for activities that will be designed and/or constructed by others.

Examples of MOUs & MOAs

- Franchise Utilities: Puget Sound Energy (PSE) for design and relocation of gas services and mains.
- O&M of Permeable Pavements in roadway or alley (see Section 9).

2.10 Preparation and Coordination for O&M

During the Design Phase, the Project Team will be reviewing and selecting the GSI tools and elements applicable to the project goals and location or context. These GSI tools have generally been reviewed and approved for citywide use in the ROW. Modifications or new approaches may be recommended for conditions or concerns unique to the project.

To ensure that the design incorporates the O&M requirements for equipment/tools, and the project is budgeted for the respective O&M, the Project Team shall submit the materials and documentation noted in Appendix E for O&M concurrence and approval. The O&M representative should participate in periodic project design team meetings. Project Teams shall also develop a Supplemental O&M plan, including guidance for new standard operating procedures (SOP). This should include the new technologies or modifications to standards that affect O&M, life cycle costs for O&M and other elements as requested by O&M to assess. See Appendix E in this volume and GSI Manual Volume V for more information on the checklist and template for preparing the supplemental O&M plan, respectively.

New technology/ design elements

If a new technology/design element/component is being proposed that is not standard (i.e. not in COS Standard Plans or in this volume), then allow for adequate planning starting at 30 percent design stage to meet with asset managers to determine how the agency will maintain and track the asset.

Adequate planning is ensured by inclusion of and coordination between the Project Team and each agency's O&M representatives at 30, 60, and 90 percent and during final design. O&M staff need this early input to budget, establish GIS tracking, perform asset entry into each agency's computerized tracking programs (currently Maximo for SPU and Computerized Maintenance Manual System (CMMS) for WTD), and prepare for the establishment and long-term needs of adding new facilities to O&M. (Note: SDOT uses "Hansen" and Parks Department uses "Plant" for their computerized maintenance tracking programs.)

2.11 Preparation and Coordination for Asset Management

Project Teams, including WTD's O&M Manager(s)/SPU's Facilities Operations Manager (FOM), must coordinate with each agency's asset management and O&M staff in preparation for the on-boarding of new assets. For SPU-led CIP, see SPU's Asset Management Plan for GSI ROW facilities. Project Teams shall also meet with each agency's O&M and asset management staff (recommended at least twice) during the Design Phase to coordinate and prepare for the tracking of new GSI assets in each agency's software tracking system and for mapping in GIS. For some elements of the GSI design, the asset tracking/identification numbers will need to be included on the plans. Review requirements with WTD O&M/SPU's FOM in preparation project plans.

See each agency's Asset Management plan and Appendix E for more information.

2.12 Deviations

Where COS Standard Plans, Streets Illustrated ROWIM, and/or GSI Manual concepts and/or details do not address specific project conditions or meet project-specific performance goals, the Project Team may propose to develop a new detail or request a deviation/modification of an existing detail. Deviations must be reviewed and approved by O&M. This may require developing a detail to 60/90 percent at 30 percent design for O&M to be given adequate information to review the proposal. See Section 7.10 and 12.2 for more information.

Image: Basic retrofit of planting strip with bioretention cell for WTD's Barton CSS basin for CSO control in West Seattle.

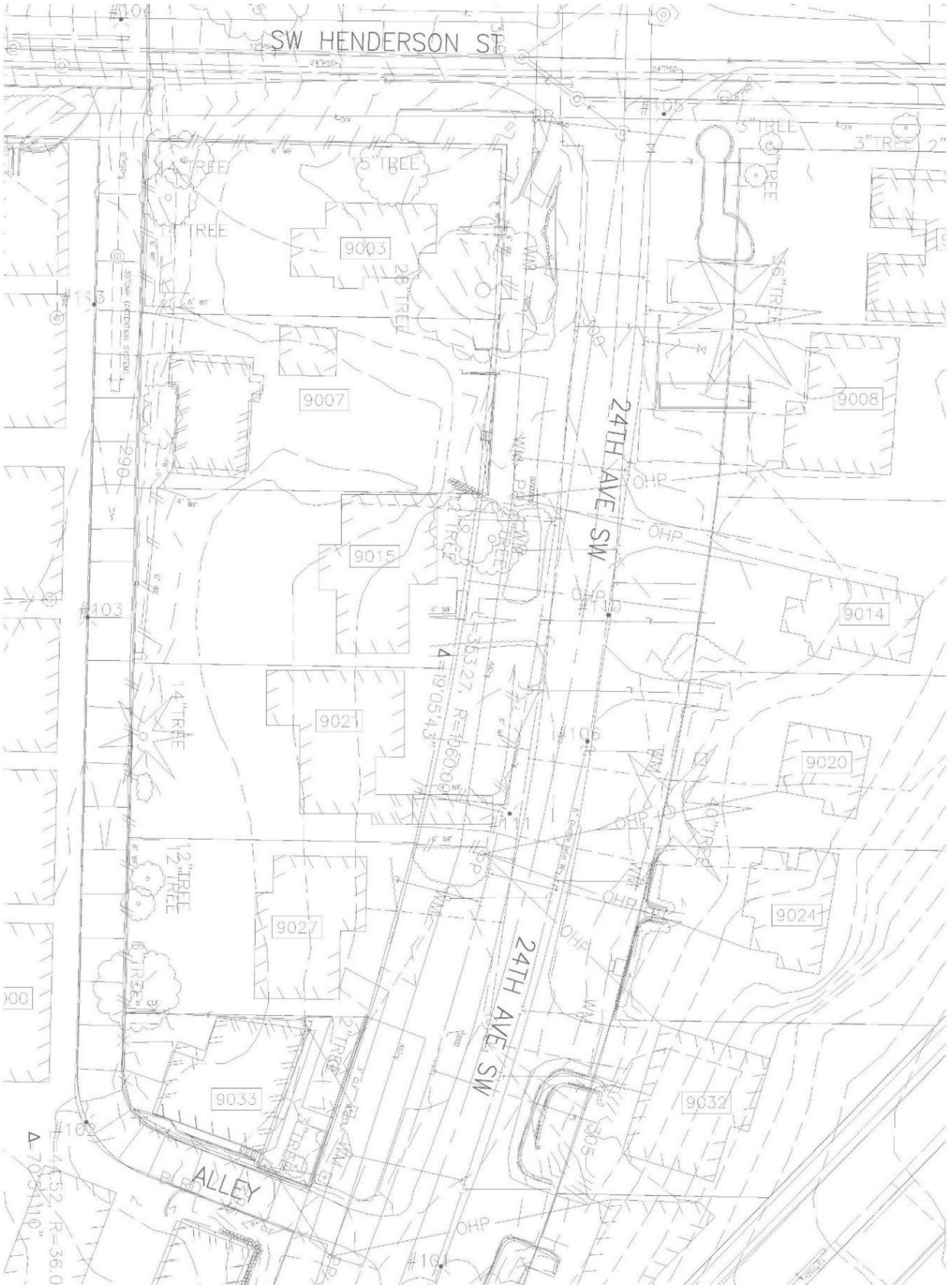

Image: Sample base map of existing conditions.

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Section 3
Base Map/Topographic Survey

After the Project Team for the Design Phase is formed, one of the first tasks is to finalize the scope required to develop a project base map and prepare a base map/topographic survey of the streets selected for implementing GSI.

3.1 General

When developing options and selecting a preferred alternative (~10 percent design), the teams utilized available GIS maps for analysis. For the Design Phase, a topographic survey is required for more detail. The base map preparation should be concurrent with Site Reconnaissance discussed in Section 4, as the field observation may highlight areas needing more survey, such as adjacent conditions, or atypical utility placement. Because this work is in the ROW, SDOT establishes the mapping requirements.

3.2 SDOT Base Map and Survey Checklists

The base map and survey are to be prepared in accordance with SDOT's requirements. SDOT's Base Map and Survey checklists are to be completed by the surveyor preparing the documents. See SDOT's webpage for the checklists: http://www.seattle.gov/transportation/stuse_sip.htm#check

TIP
GIS data is frequently updated and should be reviewed at each phase.

3.2.1 Extents, Format, and Setup

Extents of the base map/topographic survey are to be in accordance with SDOT standards.

The Project Team is to review areas proposed for improvements and expand the survey an additional 50-100 feet beyond the boundary of anticipated improvements. Intersections and monumentation shall be obtained for project controls for each street.

For GSI projects, the base map shall be set up such that it can be used for both 1 inch=10 feet and 1 inch=20 feet scale drawings during design.

3.3 Additional Information to include on Base Map

The following is additional information that the surveyor is to include in the base map for SPU/WTD-led capital projects in coordination with the designers on the Project Team:

- Vertical datum conversion factor to address differences between vertical datums used by WTD and the City of Seattle. Plans (base map and design) shall be in accordance with datum required by SDOT for plan preparation but provide conversion to datum used by WTD

- Geotechnical test locations (pits, monitoring wells, etc.) that were completed in early phases of the project and during Design Phase
- Utility locate information beyond general locates from mapping (see Section 3.4)
- Arborist's tracking information (reference #'s assigned to existing trees, see Section 4)
- Concrete joint panel locations in the roadway
- Franchise utility information (incorporate from utility purveyor)
- Curb discharge (from pipes that daylight at the face of curb)

3.4 Utility Locates

Gather utility locate information from the City's document archive (vault) and from franchise utility purveyors for the initial base map preparation. Utility locates (call 811) should be ordered no later than a week before survey fieldwork begins. Understanding potential utility conflicts may drive decisions for bioretention placement or design detailing.

3.4.1 Utility Investigation

Potholing, probing, radar and/or videotaping are methods that can provide precise location and depth data for existing utilities. Such methods may be needed when a utility cannot be located using standard surface locate techniques or when a project's design requires a more precise understanding of the existing utility condition. Additional utility investigation measures are to be taken between 30 percent and 60 percent to inform the design and provide an updated base map of the project area. If additional investigations are not conducted, the Project Team shall review for risk management of unforeseen conditions occurring during construction.

Field Notifications
Coordinate with Community Relations Lead for public notifications of fieldwork for survey and utility locates. See Section 6.

3.4.2 Water

Pipe Age: Contact SPU Water division for information on a pipe's age and condition and protection requirements given the pipe's condition.

Type of Material: Review type of material of public water main and water services with SPU Water and requirements for protection given material type. For example, if material is cast iron, special measures for protection of pipe (increased setbacks and vibration and settlement monitoring during construction) may be required. See SPU DSG.

Monitoring and Settlement of Water Mains: Obtain monitoring and settlement requirements from SPU Water for the water mains in the project area. It is recommended that Project Teams coordinate and contact SPU Water

TIP: Opportunity for Partnering
If the GSI is proposed in an area with aging infrastructure, there may be opportunities to partner with other departments/utility purveyors on replacing such utilities and sharing in costs. At a minimum, Project Teams must coordinate with other entities (such as SPU Water, Franchise, SDOT) to identify if other work is planned for the area.

Operations during 30-percent design for these requirements (e.g., when working within five feet of CIP or DIP water main; when working within the 1:1 zone of influence of a water main's bedding and backfill; and other SPU water main protection requirements).

<u>Water Services:</u> Water services (piping and meter box) are to be identified on the base map. In general, it is assumed the service pipes are within 2 to 3 feet of existing grade. If there is uncertainty about the location, then it is recommended that the Project Team review whether further inquiry (such as potholing) should be conducted.

Coordinate with SPU Water on the extents of replacement for services. For example, old water services or galvanized iron or plastic water service pipe will require full replacement of the water service from the water main to the meter. During the initial preparation of the base map, coordinate with SPU Water to identify which services would require full or partial replacement if improvements were to impact service.

<u>Public Main Conflicts:</u> Pothole to determine the general depth of the public mains along each street if a potential conflict with proposed work elements (such as utility crossing for new shallow Inlet/CB connection pipe) is anticipated.

3.4.3 Side Sewer and/or Service Drains Location

The actual location of side sewers can vary from available City information. To minimize unforeseen conditions, it is recommended that the Project Team confirm if additional locate measures are needed. Because older service drain installations often do not include the metal detection tape required for surface locate, it may be necessary to employ other utility locate methods (see Section 3.4.1). Locate the service pipe (both horizontal location and approximate depth) where it crosses the middle of the planter on the side of the street where GSI improvements will be implemented. See Section 4 for additional information regarding assessing condition of existing side sewers.

3.4.4 Overhead & Underground Duct Bank (Electrical, Communication & Franchise)

Records of underground duct banks and overhead infrastructure for dry utilities often do not show the extents and/or depth of the dry utility corridor. For example, an underground duct bank may be depicted as a single line, when it is two to five feet wide and two to four feet deep, or has multiple conduits, and/or is encased in specialty concrete backfill. Overhead infrastructure data may not indicate the width and extent of multiple wires, or guy wire bracing may not be fully depicted on the base map.

To assess and map extents, further coordination with representatives of departments/agencies and investigation into franchises' (e.g., communication, cable, and gas) and SCL's records are required, along with field locates and reconnaissance.

Relocation of franchise/power utilities may be necessary for the installation of proposed GSI infrastructure. See Section 2.9 for information relating to the development of Memoranda of Understanding between departments or franchise purveyors.

If bioretention cells are to cross or run parallel to underground duct bank(s), the Project Team is to review whether potholing should be conducted to determine the duct bank's approximate depth of cover and dimensions.

TIP: Design coordination with existing dry utilities

If overhead or underground dry utilities are to be relocated, during 30 percent design meet with SCL and franchises to review setback and relocation requirements. See SCL/Franchises' websites for standards.

See Section 7 for general guidance on setback and clearance requirements.

3.4.5 Gas

The horizontal location of gas mains, valves and services should be included in the base map. The depth of gas infrastructure can vary. For design, generally, it is assumed the existing gas service and main are between 18 inches and 3 feet from the existing surface grade. However, the Project Team shall consider additional utility locate activities (e.g., potholing) in areas where there is uncertainty as to the depth and/or the horizontal location of the gas main or service and/or where, due to age, recent construction or questionable records, there may be conflicts between proposed and existing utilities (e.g., a shallow storm drain crossing over a gas main).

The COS Standard Plan 040 denotes depth of cover for new gas mains in the ROW. For depth of cover for gas services, contact Puget Sound Energy (PSE) for standards. Coordinate with PSE to determine the extents of replacement for services. If a service is to be relocated due to the improvements, the extents of replacement will depend upon the age of the service and the existing pipe material. Older services may require full replacement from the main to the meter (which is typically near the residence on the private parcel), whereas newer services require only partial replacement in the ROW. During the initial preparation of the base map, coordinate with PSE to identify which services will require full or partial replacement if the improvements impact the service.

TIP: Franchise MOU/MOA

Relocation of gas services may be necessary for the installation of proposed GSI infrastructure. See Section 2.9 for information relating to the development of Memoranda of Understanding/Agreement for both design and construction.

3.5 Recheck Conditions Prior to Final Design and Bid

Between 90 percent and Final design, the Project Team shall conduct a field visit/overview of the area of proposed improvements to verify that there have been no significant changes (such as from new construction, redevelopment, addition of new power poles, damage to existing trees from weather events, changes to edge conditions and use, and/or other). The Project Team will need to assess whether the survey/base map is to be updated for any new conditions observed, or if it can be flagged otherwise in preparation for the bid documents. The Project Team should review the design with respect to transitioning to and blending with adjacent conditions. The design team will need to revisit the project site to review conditions as part of each progress submittal. The designer will need to revise plans in accordance with new or newly observed conditions. Formal project photos/video should be retaken at this time. The period between final design and bid/procurement is typically 3-4 months. Prior to bid and if there is a longer delay, the Project Team should re-check existing conditions and formally confirm the plans are valid or prepare an addendum.

Image: Recheck conditions prior to final design and/or bid. Here is a For Sale sign of a residential lot that was subdivided and developed after the survey/base map was completed and design finalized.

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Image: Repeated in-field site reconnaissance of existing conditions is critical for design development.

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Section 4
Site Reconnaissance for Design Integration

4.1 Introduction

Site reconnaissance will have been conducted during Options Analysis phase to assess feasibility. The viable streets will be identified (see Section 1.6). For the Design Phase, the Project Team will need to confirm the information, including social and technical data, and conduct additional analysis and site reconnaissance of other elements described in this section.

4.2 Review Existing Data

At start of Design Phase, teams shall review existing data compiled previously (see GSI Manual, Volume II) for the project:

- Subbasin delineation for siting bioretention
- Overview of trees and vegetation assessment report
- Photos/video of existing conditions especially edge conditions (see Figure 4-1)
- On-street parking patterns along the streets selected and whether there is off-street parking from the street/alley
- GIS mapping (see Sections 2 and 3) of project area information, including utilities, trees, land use, parks, schools, community centers, etc.
- SDCI permits in the project area that may be in process and could affect the design

TIPs

GIS data is often updated and should be reviewed as design develops.

Review community outreach summary from Options Analysis.

Conduct public notifications for field work. See Section 6.

4.3 Confirm Flow Patterns and Point Discharges

The team should visit the site during rain event(s) that generate gutter/sheet flow some time before the 30 percent submittal. This site visit will assist in confirming the subbasin delineation and identify point discharges/concentrated flows. Filming/ videoing the flow patterns from the upstream to downstream end of a block can help identify where flow concentrates, ponds and/or switches direction from one side of the road to the other (due to change in grade, uneven pavement joints, or other). (See Figure 4-2 for examples). This information is used to:

- Design location of flow inlet points.
- Identify point discharges requiring flow dispersion.
- Inform the placement of the bioretention cells (at locations where flow is concentrated)
- Check assumptions for parcel run-on to ROW to inform modeling/sizing (see Section 11).

Examples of flow patterns to check

- Change in direction of sheet flow across road
- Is there flow in the gutter on both sides of the road?
- Piped curb discharges?
- Runoff from alleys or driveways?
- Concentrated/dispersed sidewalk sheet flows
- Sheet flow changes due to uneven grades, joints, pavement, etc.

Street gutter flow with tree debris and mature street trees

Street gutter flows, recently planted street trees, fences, and hedge

Private large cedar tree with large branches over sidewalk and root zone in planting strip

Waste bin pick-up located at street frontage, oversized driveway, hedge, and fence

Review location of water meters and power poles.

Street tree assessment and power pole location review

Recently planted street trees, private hedge, and trees

Recently planted street trees, fence, and mature private trees with canopy over planting strip

Figure 4-1: Site reconnaissance of existing conditions


Gutter flow review - gutter flow side of thrown street


Gutter flow review - no gutter flow side of thrown street


Gutter flow review


Sheet flow transition along curbless street length


Gutter flow testing during construction


Gutter flow testing during construction


Street gutter flow into drain curb cut


Street gutter flow into curb bulb drain curb cut

Figure 4-2: ROW runoff flow patterns and gutter flow review and testing

4.4 Identify Parcel Use and Primary Pedestrian Access to Parcels

Once the base map is prepared, confirm the location of the existing primary pedestrian access to each parcel and where entrances are located on private property. Also note whether the parcel is a single-family lot or a multi-family lot with more than one home (triplex, fourplex), since this will factor in the design and siting of the cells. This information will be used to coordinate crossing locations between the bioretention cells (described in Section 7).

TIP
If disabled parking decal(s) are observed on vehicles parked on the street and/or there are accessibility paths/ramps to a parcel, coordinate with community outreach to inform the resident they can request a disabled parking space permit from SDOT.

4.5 Existing Tree and Vegetation Assessment

During development of 30 percent design, an arborist or representative from SDOT Urban Forestry shall complete an assessment of the existing trees and vegetation in the public ROW within and adjacent to the proposed improvements and a minimum of 50 feet beyond the project limits within the ROW (see SDOT Base Map requirements). The assessment should also include evaluating private trees with canopies or root zones that extend into the ROW and into areas of improvements. If the study area is large and includes many trees, a simplified, preliminary assessment may be appropriate at start-up, with a full assessment performed once the project area has been refined following 30 percent design.

As part of the assessment, Project Teams shall collaborate with the arborist and landscape architect to review access and clearance requirements that may be needed for construction and maintenance of different GSI elements proposed for the project (such as clearance for construction and maintenance equipment near existing tree canopies for UIC wells, construction of underdrains and deep maintenance holes, etc.). Assess also if trees and vegetation (within ROW and adjacent) will need to have maintenance pruning to adhere to required sidewalk clear zone width. (See COS Urban Forestry manual for pruning requirements). While routine maintenance of vegetation is a property owner responsibility it is advisable to review and discuss a clearing specification as part of the project site preparation to ensure the walkable width adjacent to the facility.

Data collection and assessment for existing trees shall include information relating to tree identification and tracking, characteristics of the tree roots and canopy, and tree health. Tree assessment should be conducted again at 90 percent design in case there have been any changes to the trees' condition. Further

Tree assessment includes:

- Location (ROW or private property)
- Genus, species, cultivar
- Diameter at standard height
- Adjacent house number and street (address)
- Reference SDOT tree #
- Assigned individual tracking number
- Critical root zone (CRZ)
- Dripline
- Location of root crown
- Soil quality in root zone
- Locations of species that produce excessive debris
- Condition rating
- Feasibility to transplant

assessment (including arborist recommendations on construction clearance (height to lowest branch), ease of transplanting, places to relocate trees, and/or how close to a tree open trenching can be done) may also be conducted by the arborist to inform the design.

In addition to tree assessment, the Project Team shall review the adjacent landowner's use of and investment in the planting strip, noting extensive, maintained landscaping, vegetable beds, paving, basketball hoops, etc., that may indicate attachment and require outreach. There may be opportunities for aesthetic improvement to paved planting strips or unmaintained vegetation.

4.6 Review Conditions of Existing Sidewalks and Pavement

During 30 percent design development, the Project Team shall review the condition of the existing sidewalks and pavement within and adjacent to the proposed improvements and construction zones. Identify areas where pavement is sunken, uplifted, cracked, and/or raveling and where there are vegetation encroachments into the sidewalk clear zone. Identify locations where existing pavement should be replaced to improve sheet flow to the proposed bioretention facilities. Provide a memo documenting the assessment including formal photo documentation of conditions according to Sections 4.13 and 7.12. See Section 7 for requirements for replacement and restoration of existing sidewalks and pavement.

4.7 Review Maps of Recycle/Waste/Yard Waste Pick-up Routes

If not provided from the previous phases (see GSI Manual, Volume II) of work, in coordination with SPU Solid Waste Management, obtain maps from the service provider for residential collection of recycling, garbage and yard waste in the project area. Use this information to determine the alleys that are used by Solid Waste Management for pick-up and which residents have pick-up along their street frontage (also used for construction coordination). The information will also be used to coordinate bioretention cell locations with pick-up locations.

4.8 Archaeological and Cultural Resources Site Review

A summary of the review and report of the archaeology and cultural resources should have been completed as part of options analysis and selecting the preferred alternative (prior to start of the Design Phase). Once the typical design excavation depth is determined, review the report and assess whether further test sites are required. If the exploration depth was not done to the design depth and further testing not performed, then there is a risk that during construction an on-site archaeologist may be required to observe excavations at the greater depth. If there is potholing or soils testing, consult with an environmental subject matter expert to determine whether an archaeologist needs to be on site during these explorations.

TIP

If the exploration depth was not done to the design depth and further testing was not performed, then there is a risk that during construction an on-site archaeologist may be required to observe excavations at the greater depths.

4.9 Assess Condition of Existing Side Sewers/Service Drains

For SPU-led projects, in coordination with the videotaping pipes (see Section 3), the side sewers and service drains within the overall footprint of the improvements should be inspected and their condition assessed by SPU. The maintenance of side sewers is the responsibility of the property owner. If the location of repair for the side sewer/service drain is within the ROW, it may be determined by the Project Team that the repair should be included as part of the project and occur prior to the placement of the bioretention cells to avoid having to restore the GSI facility after construction. SPU may also work with the property owner to have the repairs completed prior to construction of the improvements. See SPU's "Guidance on when to repair side sewers as part of GSI CIPs" in Appendix L.

For WTD-led projects, see SPU's "Guidance on when to repair side sewers as part of GSI CIPS" (Appendix L) and conduct utility locates and video of the side sewers in the areas of the improvement/construction disturbance. Teams can contact WTD GSI Program Manager for WTD's guidelines on how private side sewers are to be reviewed and assessed.

4.10 Overhead Conditions

Trees, overhead utilities, and other physical objects should be reviewed with the requirements for equipment required to install the facilities, such as the access clearances necessary for drill equipment and for conducting operation and maintenance activities.

4.11 Encroachments

Project Team shall check for private encroachments (such as fences, gates, rockeries, walls, structures, or buildings, etc.) into the public ROW that may need to be relocated to install improvements. Review also vegetation encroachments that require maintenance to provide the City standard clear zone for public sidewalks. See Appendix M for SPU's guidance on addressing encroachments when siting bioretention facilities.

4.12 Future Land Use and Services

When reviewing existing services, also consider future services and review adjacent land use and zoning. If there is a potential for future development, consider if new services may be installed in the ROW (such as side sewers, water services, service drains, gas, underground power, driveways) and where they might be located.

Project Teams may want to consider installing sleeves for future services or new side sewers (capped at ROW) to avoid having the newly installed public GSI (permeable pavement and/or bioretention facility) be disrupted soon after construction.

4.13 Site Photos and Videos

The Project Team shall compile site photos and videos, and additional documentation as needed, from site reconnaissance for each street, intersection, and adjacent property access, and for edge conditions and transition zones. Include photos of existing curb ramps (including companion ramps) at intersections. Photos and videos shall be formally documented, and key photos included in the 30 percent submittal (see SDOT's SIP Material Transmittal for Design Guidance submittals checklist). Photos obtained from the web (such as from Google or Bing street view) are not considered a formal document and are not a substitute for doing field reconnaissance.

The following is guidance for formal site photos and video of existing conditions:

- Photograph every 25 LF or as needed to document full sidewalk condition
- Photograph every 25 LF or as needed to document full road pavement and features condition
- Photograph every structure
- Label by location, date, and direction
- Video/film continuously along street including view of sidewalk
- Save photos as both individual files and as part of AutoCAD file (from GIS camera).

4.14 Full ROW Improvements and Street Type/Typology

If project is to include full ROW improvements, review Streets Illustrated ROWIM's street types/typologies with the desired widths for the various zones within the ROW (frontage zone, pedestrian zone, landscape/furnishing zone/GSI facility, parking, bike facility, travel lane, etc.) along with what width can be accommodated within the existing ROW width. The Project Team should recommend an approach to the surface facilities and coordinate with SDOT.

4.15 Recheck Conditions at 90 Percent Design

During 90 percent design, the Project Team (at least one civil engineer and one landscape architect) must conduct a final field check of the proposed design with site conditions and determine if adjustments to the design are needed. Examples of elements to consider include:

- Transition zones at the end of cells/walls in relation to the parcel pedestrian access/driveways/intersections
- Changes to the adjacent land use and the planting strip (such as parcel access points, ADA-designated parking zones, new utilities, subdivided or redeveloped lot, fencing, driveways etc.)
- Changes in sidewalk condition requiring replacement
- Changes in road pavement condition affecting sheet flow patterns, restoration extents and/or replacement
- Tree conditions

- Reconfirm assumptions for sheet flow to ensure sufficient collection of water will flow to the location of the cells
- Check proposed pavement (sidewalk and road) restoration limits in the context of existing pavement joints/panel locations and pavement conditions (e.g. cracks, sunken/uplifted pavement)
- Location of proposed utility access lid infrastructure in relation to existing site conditions for O&M and pedestrian mobility

Adjustments to the design may be minor and considered incidental but if there are significant changes to field conditions (e.g. requiring more survey to locate new improvements or new driveways and utilities) then it may require a redesign and modifications to the scope and schedule.

Image: Recheck conditions prior to final design and/or bid. For example, this image shows a For Sale sign at a lot that was subdivided and developed after the survey/base map was completed and design finalized.

Image: Field testing for shallow subsurface soil conditions.

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Section 5

Geotechnical / Hydrogeologic Analysis and Reports

5.1 Hydrogeologic/Geotechnical Analysis Flow Chart

The analysis for hydrogeologic and geotechnical review for CIPs will have begun in the project's Initiation phase with majority of work occurring during Options Analysis for selection of the preferred alternative resulting in the final Hydrogeologic report and draft Geotechnical Design Report being available at the start of the Design Phase (see Section 5.2). Unlike other stormwater infrastructure projects, for GSI CIP projects more analyses and subsurface soil tests are done prior to the start of the Design Phase to inform the design direction (e.g. shallow versus deep infiltration or use of underdrain and liner etc.) and select the specific streets for the Design Phase scope. Project Teams shall review past work completed at the start of the Design Phase to assess what supplemental testing and analyses may be needed to complete the Geotechnical Design Report and inform the design of the project's GSI facilities and associated infrastructure.

Hydrogeologic and geotechnical evaluation is a phased approach and is project specific. The number and types of tests (examples in Figure 5-1) and analysis will vary. Project Teams shall check-in after each stage of analysis and testing to determine if it makes sense to go to the next phase of analysis based on what was learned from the previous testing and review. The flowchart outlined in Figure 5-2, describes a phased approach but is to be adapted and tailored by the Project Team. See GSI Manual, Volume II: Options Analysis for more details about using the flow chart in Figure 5-2. Some factors that can affect the project's approach and geotechnical analysis include:

- design phase schedule
- level of risk
- project's scale and size (few blocks versus hundreds of blocks)
- project's performance standard
- volume of water to be managed (typical city block versus flow from multiple blocks)
- cost and budget for testing and analysis
- available known information about the project area
- data gaps to fill
- project's method of discharge (full infiltrate? partial infiltration but with an underdrain?)
- location of project
- size and type of equipment needed for conducting tests within the developed streets
- conditions of project area and where to test given the street types, available space for access in ROW and adjacent conditions (traffic, overhead wires, existing mature trees)
- past testing and results

along with professional judgement will affect the type of analysis that is to be/has been conducted prior to start of the Design Phase. In addition, the preparation time for the field work and time of year to conduct the tests must be factored into the project's overall design schedule. For example, the time to obtain City permits to conduct testing in the ROW can vary from a few days to several weeks. Some tests and monitoring (e.g. measuring the seasonal high groundwater levels) may need to occur through the wet season but planned for (and permitted) well in advance during the dry season.

5.2 Geotechnical Design and Hydrogeologic Reports

A draft Geotechnical Design Report will typically be complete by the end of Options Analysis phase and will become part of the design documentation of the Project Team. The draft Geotechnical Design Report will comprise:

- a **final** "hydrogeologic assessment, analysis, and basis of design" report
- a draft geotechnical assessment with design recommendations

The draft report will include field assessment (see examples of tests in Figure 5-1 and approach to analysis in Figure 5-2) to inform the design such as groundwater conditions and design soil infiltration rates. It will also identify the feasibility of design elements such as deep or shallow infiltration, liners, walls, and underdrains. These elements have major impacts on the design, and it is vital that the Project Team designers review the report throughout the Design Phase.

If any portion of the Geotechnical Design Report is not complete or has not been finalized, the Project Team must finalize the document during the Design Phase. If the hydrogeologic portion of the report is not complete, the Project Team must complete the documentation of field investigation and analysis and finalize the documentation prior to commencing design.

The geotechnical assessment with design recommendations will likely require additional field study and input by the Project Team's geotechnical engineers. Because the feasibility of elements impacts design, it is strongly recommended that the Geotechnical Design Report be finalized by 30 percent design to avoid major design changes.

The following tasks to finalize the Geotechnical Design Report must be complete prior to completion of the 60 percent design:

- Review previous reports and data
- Finalize geotechnical design recommendations
- Review any updated RainWise program installations or proposals
- Continue data gathering from monitoring wells. This may include installing new monitoring wells during 30 percent design development

Method of discharge affects team's approach to design

- Shallow infiltration below bioretention cell
- Deep infiltration
  - o Pit drain
  - o Drilled drain
  - o Screen well
- Conveyance to PSD or other drainage system

- Conduct groundwater mounding, slope stability, modeling and other geotechnical and hydrogeologic analysis depending upon the scope and scale of the project or if required by the COS SWM.
- Other tasks/analyses identified during Options Analysis

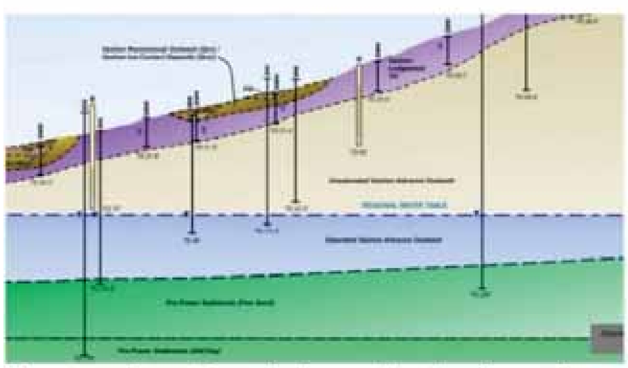
Prior to each 30, 60 and 90 percent submittals, the geotechnical engineers and hydrogeologists responsible for the Geotechnical Design Report shall review the design drawings and specifications to confirm that they are in conformance with the report's recommendations.

Pilot infiltration test (PIT)

PIT

Smaller rig used to drill monitoring wells

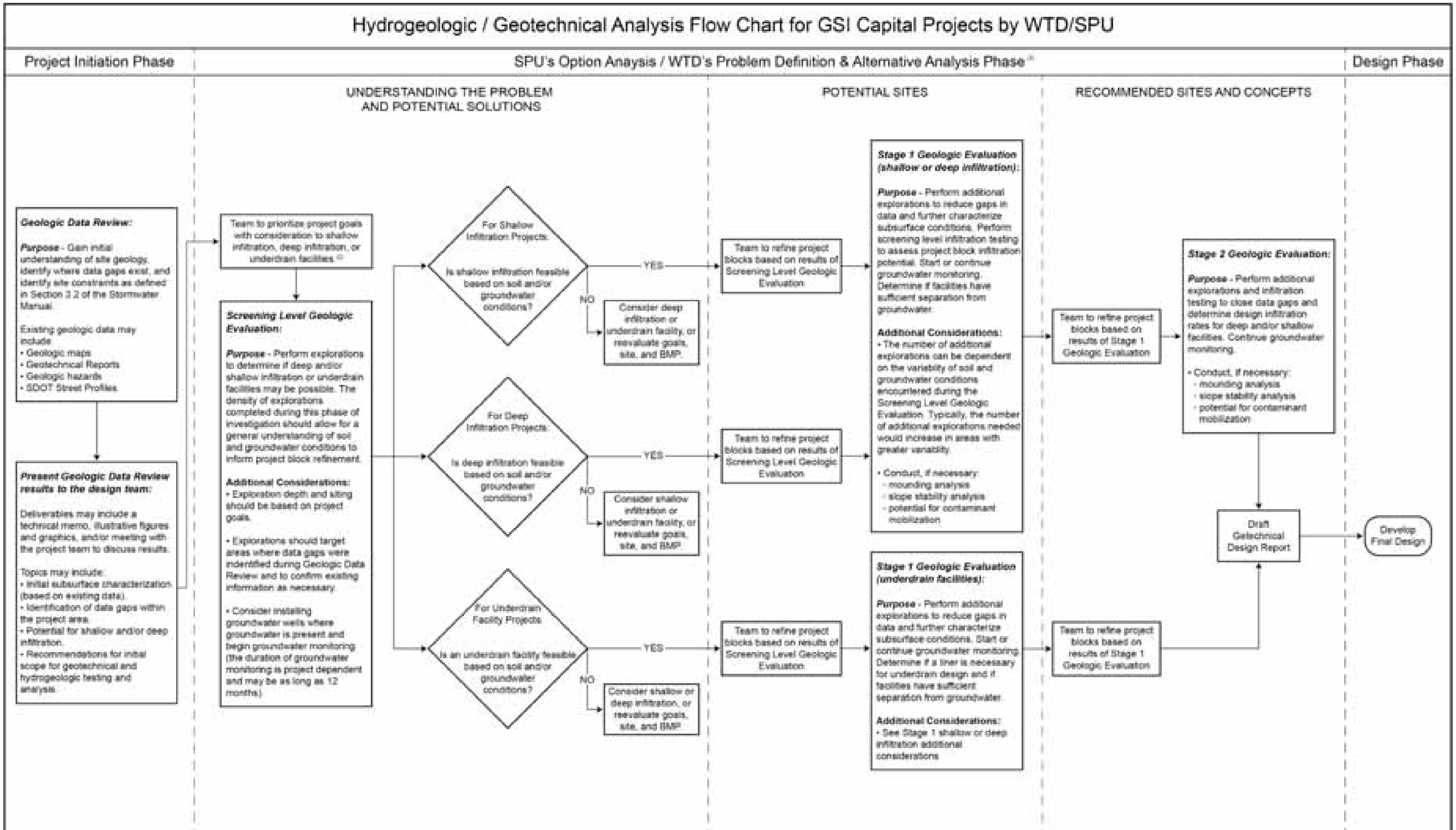
Larger rig used to drill UIC wells



Cross section of monitoring wells showing soil layer and groundwater depths

Larger rig used to drill UIC wells

Figure 5-1: Geotechnical and hydrogeologic testing examples



Notes:

1. Please see GSI Manual, Volume II: Options Analysis for details related to the intended use of this flow chart.
2. Typically, shallow bioretention is the preferred BMP, provided that project goals can be met and that BMPs are not limited by site or subsurface conditions.

This chart was developed by SPU Geotechnical Engineers. See GSI Manual Volume II: Options Analysis for more information.

DRAFT (revised 12/27/19)

Figure 5-2: Hydrogeologic/geologic/geotechnical analysis flow chart for SPU/WTD GSI capital improvement projects

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Image: Photos depicting examples of public engagement and outreach events.

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Section 6
Public Engagement

6.1 Purpose and Objective

Public engagement initiated in previous project phase, Options Analysis, helped build relationships with key stakeholders and inform them about the decision-making process. During the Design Phase, public engagement will serve to reinforce the need for the solution, allow community members the chance to share design preferences, and educate the community about what to expect during construction. It is important for the Project Team to collaborate across disciplines in developing the appropriate level of information to share at each stage in the design process for informing and managing the public's expectations of what will be built.

The objectives of the public engagement effort during the Design Phase are to:

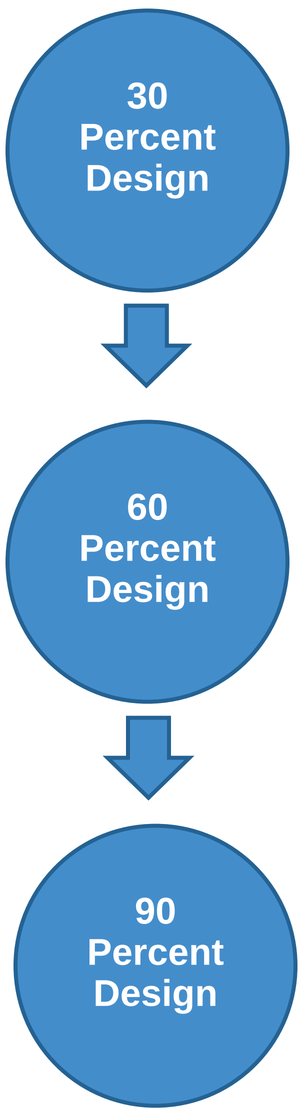
- Update the public engagement plan
- Share easy-to-understand information about the design and plans
- Identify which aspects of design the public can influence
- Respond to public comments in a timely manner with accurate information
- Encourage public comments on the design plans at key milestones
- Ensure historically underserved populations are engaged in the design process
- Report back to the community about how their comments were considered
- Inform the community that facilities may not be installed due to the performance goals of the project
- Present the final design plans and next steps related to construction
- Communicate what to expect during the different phases of construction, and how facilities will look immediately after installation and how they will look once they're established and during different seasons in the year.
- Inform the community on SPU/WTD's O&M for the GSI.
- What to expect as the GSI becomes established over several years

6.2 Approach

Community input received during Options Analysis, along with new project information, will inform the Public Engagement Plan (PEP) update. The update should outline goals and objectives, key messages, audiences, strategies and tactics to inform and engage the public during the design phase. See chart on next page and flow chart in Section 1, Figure 1-1, for general overview of public engagement in coordination with other tasks during the Design Phase.

TIP
Contact the Department of Neighborhoods for coordination of other outreach that might be occurring in an area. See Public Engagement Guidelines in Appendix B.

The SPU/WTD community relations lead on the Project Team will plan and implement all outreach tools in collaboration with the designers on the Project Team. Recommend that the project coordinate its outreach with other City outreach activities in the neighborhood. Outreach tools shall be aligned to share information and/or gather comments about project activities or milestones. While the outreach approach is typically adapted to the project issues and neighborhood, it is suggested that a stepped outreach process be developed to inform and engage the community on the design.



- Update PEP
- Review past outreach summaries
- Publicize event
- <u>Outreach event #1</u> to confirm areas for public influence. Share draft design plans and gather input. Explain how field work has influence design.

- Publicize event
- <u>Outreach event #2</u> to share updated design plans and gather input. Explain how community input informed the updated design.
- Begin to inform what to expect during construction and beyond (such as

- Publicize event
- <u>Outreach event #3</u> to share final design plans and explain how community input informed the design.
- Tell what to expect during construction and beyond (such as adjustment of utilities, encroachments, etc.)
- Prepare public engagement summary

Image: Flow chart general overview of public engagement

6.2.1 Equity and Social Justice

The PEP will outline the project's approach during design for engaging people who have been historically marginalized and underserved. This strategy will follow SPU's Equity Planning Guide for Early Design and consider the results of the demographic analysis for the project area. Potential tools and strategies to equitably engage people in the design process include:

- Hosting briefings, tabling, and attending planned events at community-based organizations.
- Hiring neighborhood leaders to work on the project outreach team.
- Transcreating materials in multiple languages.
- Providing multiple opportunities and ways for people to learn and engage.
- Ensuring all events are held at accessible locations during times that are accessible for people who work a variety of schedules.
- Providing childcare at project events.

The PEP will include a comprehensive approach and list of strategies and tactics tailored to the specific characteristics and needs of the community.

6.2.2 Outreach tools

Specific outreach tools may include, but are not limited to, items identified in Tables 6-1 through 6-4.

Table 6-1: Design Phase Outreach Tools at 30 Percent Design

Potential Outreach Tools	Purpose of Outreach
Outreach Activities: • Community briefings • Open house or workshop • Site tours • Information booth • Stakeholder advisory group • Website update • On-line open houses **Communication Tools:** • Advertising (e.g., postcard, online ads) • Project update mailing/flyers • Updated project materials • Display boards showing GSI images and in different seasons. • Plant image boards • Folio: Community Guide to the stages of the Design Phase (30/60/90) • Media relations • Tailor GSI Program FAQs to specific project • Neighborhood flyer for field work notice • Community survey (See Appendix B) • Email updates • Project communication log	• Build community relationships • Continue to inform the community about the nature of the problem and the GSI benefits • Show how public input influenced the project's development from previous outreach events • Inform immediate residents along block with proposed improvements. • Provide opportunity to comment on the design using both public meetings and online format. • Answer questions in a timely manner • Share information about the design process and future opportunities for public involvement • Show perspectives from sidewalk side and roadway side • Seek information from residents to inform design, such as plans to obtain disabled parking space or driveway curb cut permit(s), or to replace or add utilities, or to redevelop the parcel. • Inform residents of encroachments in the ROW such as fences, overgrown vegetation, planter boxes that would need to be relocated (or owner obtain permit). See Appendix M for SPU's guidance on managing encroachments. • Inform residents of field testing and what type of work they may see (e.g. large drill rigs for deep soil explorations? Excavation pit? Potholing?)

Table 6-2: Design Phase Outreach Tools at 60 Percent Design

Potential Outreach Tools	Purpose of Outreach
Outreach Activities: • Community briefings • Open house or workshop • Site tours • Information booth • Stakeholder advisory group • On-line open houses **Communication Tools:** • Advertising (e.g., postcard, online ads) / flyers • Updated project materials • GSI image boards through the seasons • Plant image boards • Plant palette boards • Media outreach/ blogs • Updated project FAQs • Neighborhood flyer for field work notication • Website update • Project communication log • Email updates	• Continue to inform the community and residents about the nature of the problem and GSI benefits • Update community on project schedule since the last community meeting • Show how public input influenced the draft design • Provide opportunity to comment on aspects of design • Answer questions in a timely manner with accurate information • Inform public of SPU/WTD maintenance responsibility for the GSI facilities through use of similar project images and O&M schedules • For residents fronting the roadside bioretention systems and associated infrastructure share information on the planting design via block level meetings and online. • Discuss plant selection for large level areas to be planted or restored that will be maintained by adjacent property owner • Discuss potential tree or landscaping removal and restoration plans and new plantings • If the project includes depaving roadway areas that are converted to landscape adjacent to the bioretention, then review O&M change with property owner. • Share information about next steps • Inform residents if there have been modifications/changes from previous outreach materials at 30 percent design • Notify owners of encroachments in public ROW. See Appendix M for guidance on encroachments. • If applicable, discuss homeowner’s responsibility for existing non-gsi elements within or encroaching in ROW such as public sidewalks or pruning trees/shrubs on private property that block the public sidewalk.

Table 6-3: Design Phase Outreach Tools at 90 Percent Design

Potential Outreach Tools	Purpose of Outreach
Outreach Activities: • Community briefings • Open house or workshop • Information booth • Stakeholder advisory group **Communication Tools:** • Advertising (e.g., postcard, online ads, flyers) • Updated project materials • Display boards showing plant visuals (palettes, photos, images) • Display boards showing GSI through the seasons • Media outreach / blogs • Updated project FAQs • Website update • Project communication log • Pre-construction survey • Hotline, email, flyers	• Continue to inform the community about the nature of the problem and the solution • Update community on project schedule • Show how public input influenced the design • Communicate how the design has developed and been updated • Share draft construction bid documents • Update residents fronting the proposed bioretention systems and associated infrastructure of modifications to the design (such as changes to driveway width, new street trees locations, pedestrian access, location of cells, type of cell cross section, and/or if their service utility will be relocated/adjusted etc.) • Inform public of SPU/WTD maintenance responsibility for the GSI facilities • If applicable, discuss homeowner's responsibility for maintenance of existing non-gsi elements within or encroaching in ROW such as public sidewalks or pruning trees or shrubs on private property that block the public sidewalk. • Share information about next steps and what to expect during construction • Review potential issues that could impact the public during construction (e.g. noise and work hours variances; requirements for site safety, cleanliness, dust mitigation etc.; time between completion of major construction activities and final punch list; road closures and traffic management.) • Fill gaps in understanding about community needs during construction, such as delivery requirements, access to homes, etc. • Demonstrate that the team has a plan for responding to community needs during construction.

Table 6-4: Design Phase Outreach Tools at 100 Percent/Pre-Construction

Potential Outreach Tools	Purpose of Outreach
Outreach Activities: • Community briefings • One-on-one or small group outreach • Open house • Information booth • Stakeholder advisory group **Communication Tools:** • Advertising (e.g., postcard, online ads) • Project update mailing • Updated project materials • Informational materials (e.g., display boards, fact sheets) • Media outreach /blogs • E-newsletter • Project FAQs • Website update • Project communication log • Hotline, email, flyers	• Present the Final design • Demonstrate how community input influenced the final design • Inform residents of significant design changes, if applicable, that were presented at previous meetings. • Gather input about key community considerations to address during construction • Continue to raise awareness and educate the community about the project and upcoming construction activities • Review bid documents as described at 90 percent design • Fill gaps in the project team's understanding of site-specific issues that should be addressed during construction (e.g., maintaining access to buildings for deliveries, avoiding interruption of utility service for a medical facility, etc.) • Introduce the agency's construction manager and on-site inspector • Help the construction project team get off on the right path by demonstrating that they have a plan to respond to community needs during construction • Inform residents of encroachments that will need to be relocated or removed from ROW. Coordinate notification with SDOT Street Use Inspector (for SPU-led projects).

6.2.3 Documentation

SPU's or WTD's community relations lead will document outreach activities and public comments. The lead shall summarize the results of the outreach process at the completion of the Design Phase. For any communication materials, graphics or renderings developed for the project, document when they were used (30/60/90) and their purpose. This will help inform future GSI project teams if they are adapted for similar projects.

6.2.4 Approach for Coordination with SDOT on Encroachments/Public Space

Teams shall consult and coordinate with SDOT project representative on outreach messaging for encroachments and use of the public space of the right-of-way for consistency in City messaging. For example, for curbless streets there may be a perception that on-street parking will be lost because of the siting of bioretention cells. Locating bioretention along a curbless street with inconsistent parking patterns provides an opportunity to formalize the on-street parking to City standards. See Appendix M for SPU's guidance on encroachments.

The SPU GSI program holds periodic interdepartmental team meetings between SPU and SDOT designers and project managers, which can also be an opportunity to share information and strategies related to encroachments, use of public space and on-street parking.

Images: Examples of encroachments (e.g. fences, shed) and inconsistent parking patterns on Neighborhood Yield Streets prior to retrofit with new sidewalk, curb and roadside bioretention.

6.3 Resources for GSI Outreach

Aside from agency standards for public engagement, samples of past outreach materials, tools and templates are available through the SPU/WTD GSI program (see also Appendix B).

It is important that team members collaborate (technical leads with public engagement and graphic designers) to tailor outreach materials (e.g. FAQs, image boards, graphics) to a project's specific design and to establish consistent terminology to use throughout the materials from start to finish of the Design Phase outreach.

Style Guides for Communication Materials See each agency's style guides for communication materials with the public. For SPU-led CIP, contact SPU's Communications Strategic Advisor for a copy of the current style guide.

Frequently Asked Questions (FAQs) Template The GSI program has developed a template for Frequently Asked Questions that can be tailored by project teams for their specific project during Options Analysis and Design phases. Contact SPU's GSI Projects Program Manager for a copy of the latest template.

Renderings/Graphics for GSI Design Renderings and graphics for community outreach are to follow agency standards. Contact SPU/WTD for standards. The following are additional tips when developing graphics/renderings for outreach/community engagement:

- Tailor the level of detail to the design developed at 30/60/90 percent design. For example, materials at 30 percent design will not have detailed plant types depicted whereas at 90 percent once plantings are determined the renderings can become more specific on materials. Avoid showing detailed materials that are subject to change at 90 percent.
- Demonstrate and depict what the system will feel like for all users of the right-of-way from different vantages (e.g. for a pedestrian moving along the sidewalk next to a bioretention facility to drivers parking along the street).
- Develop renderings for changes with the seasons. Since the look and feel of a bioretention facility will vary with the seasons, it is recommended to include images and/or renderings that depict the varying conditions from winter to summer, or clearly communicate what season is being represented in the materials.
- Develop renderings/images that show the various stages of GSI establishment from construction to initial plantings and then maturity.
- Demonstrate how the ROW use will change for on-street parking/lane widths in simple graphic styles similarly used in other City transportation related projects. Consult with SDOT representative.

Examples from past GSI projects Figures 6-1 through 6-7 provide examples of past outreach renderings and images. Figure 6-1 shows renderings of what the bioretention cell would look like in summer and winter; Figures 6-2 to 6-4 are of three separate projects showing existing condition, rendered image of proposed design, and photo after construction; Figure 6-5 shows image of cell construction phasing; Figure 6-6 shows photos of changes in cell establishment over time; and Figure 6-7 shows example photos of cells through the seasons. Figure 6-8 shows cartoon like graphic that follows a similar style used by the City when there are changes to right-of-way use.

Resource Library
SPU and WTD are reviewing options for potentially developing a library to catalog past outreach materials, images, photos and other resources used on previous projects. Contact SPU GSI Projects Manager for status.

Images from WTD's Barton CSO Control retrofit project in West Seattle.

Figure 6-1: Graphic showing existing condition and renderings of proposed summer and winter bioretention facility

Before: Existing conditions in fall

Design: Conceptual perspective in summer

After: Spring photo taken within the 1st year of planting

Images from WTD's Barton CSO Control project in West Seattle (retrofit of planting strip with roadside bioretention).

Figure 6-2: Example comparison of existing condition, rendered graphic of proposed bioretention, and actual constructed bioretention in spring

Before: Existing conditions in summer

Design: Conceptual pespective and cross-section in summer

After: Summer photo taken within the 1st year of planting

Images from SPU's Ballard Phase 2 NDS project (retrofit of planting strip with roadside bioretention).

Figure 6-3: Example comparison of existing condition, rendered graphic of proposed bioretention, and actual constructed bioretention in summer

Before: Existing conditions in summer

Design: Conceptual perspective in summer

After: Summer photo taken within 1st year planting

Images from SPU's Venema project (full ROW reconstruction).

Figure 6-4: Example comparison of existing condition, rendered graphic of proposed bioretention, and actual constructed bioretention in summer

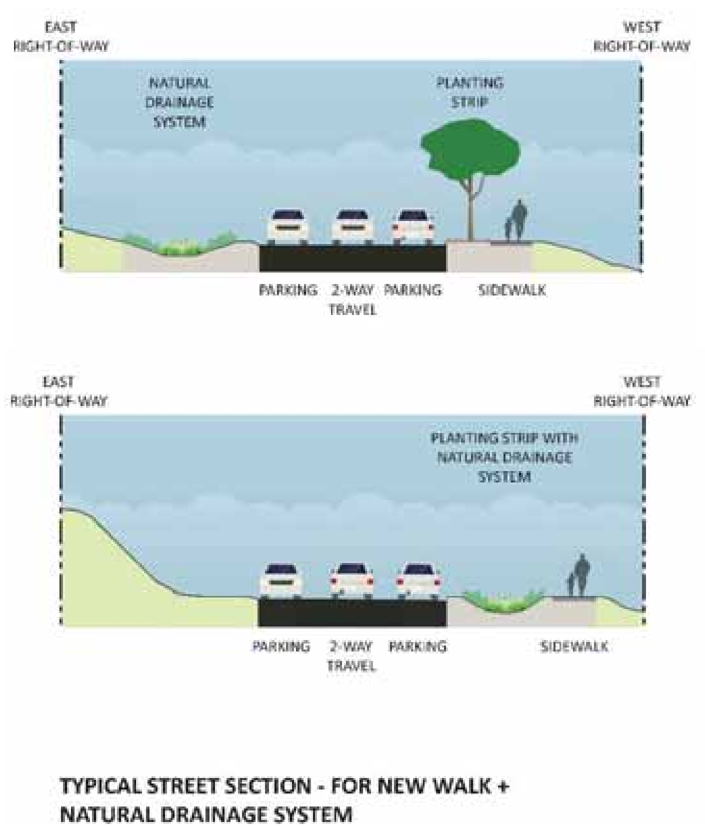
Images from High Point Redevelopment (full ROW reconstruction with roadside bioretention).

Figure 6-5: Bioretention cell plants at installation and 1+ years after installation

Images from SPU's Ballard Phase I project (retrofit of planting strip with roadside bioretention.

Figure 6-6: Establishment of bioretention facility over time

Figure 6-7: Bioretention cells through the seasons



The above images are from a SPU SDOT NDS partnership project that is retrofitting a curbless street with roadside bioretention and new curb, planting strip and sidewalk. The style of graphic was chosen for consistency with outreach materials from a nearby SDOT-led transportation project. The images were used in conjunction with other outreach materials for the proposed design at 30 percent.

Figure 6-8: Sample graphics for changes to ROW use and public space.

6.4 Work Plan

Table 6-5 outlines a draft work plan for the Design Phase.

Table 6-5: Design Phase Work Plan

Task	Participants	Approximate Duration
Update PEP	• SPU/ WTD community relations lead • Project manager	3 weeks
Identify material needs and update materials	• SPU/ WTD community relations lead • Project manager	1-3 months
Plan and implement outreach activities	• SPU/ WTD community relations lead • Project manager	Ongoing
Draft public engagement report	• SPU/ WTD community relations lead	1 month

Image: Example of a community meeting at a local school auditorium.

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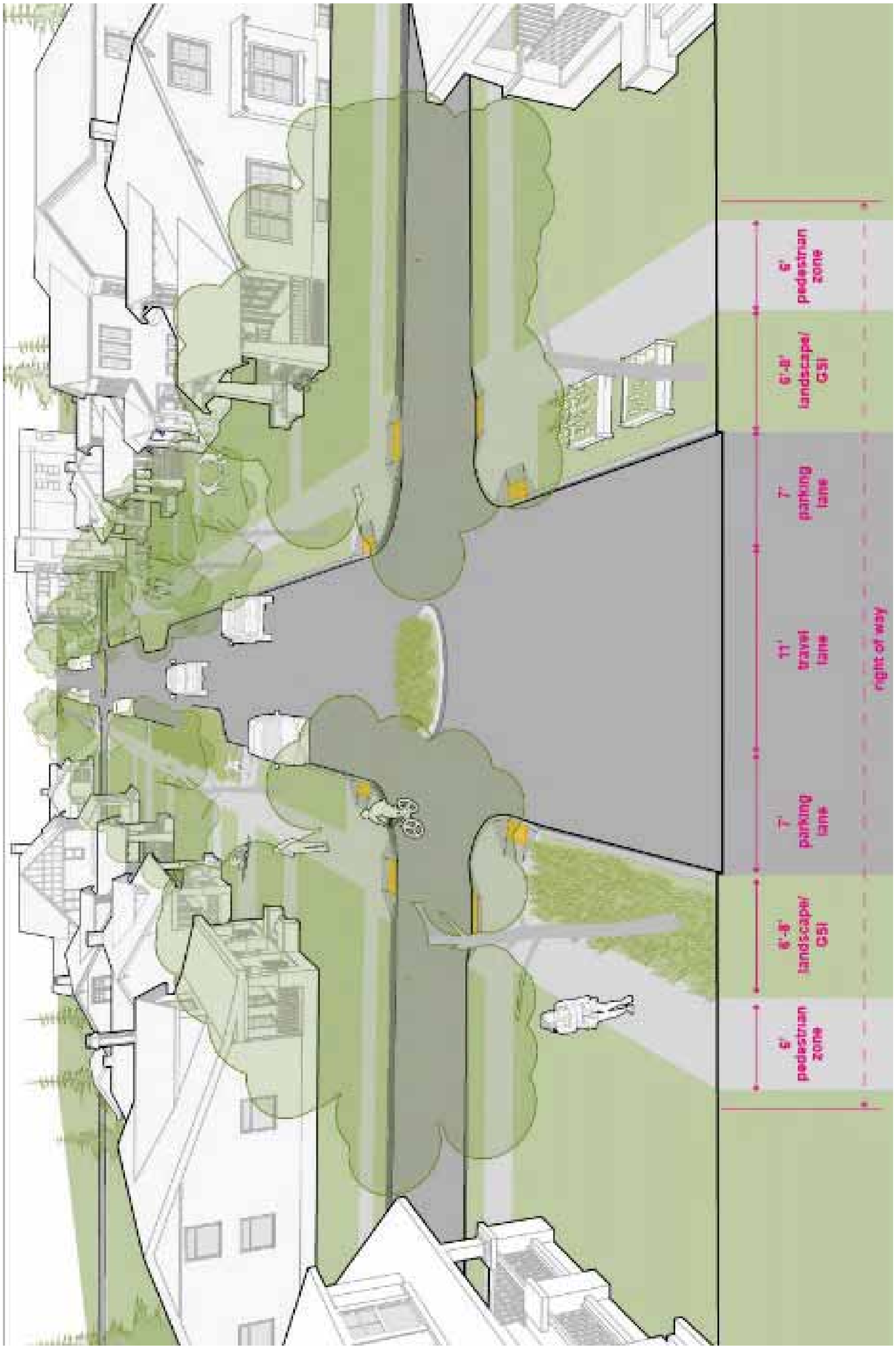

Image: Excerpt from Streets Illustrated ROWIM for a Neighborhood Yield Street (with curb).

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Section 7
Bioretention Design for Neighborhood Yield & Neighborhood Curbless Streets

7.1 Introduction: Designing in the Public Right-of-Way

Seattle's rights-of-way make up approximately 27 percent of all land in the city (Streets Illustrated ROWIM). As such, they are valuable community resources that support diverse mobility needs, green space, community identity and civic activities, vital infrastructure, and critical environmental services. Bioretention facilities and associated elements should be designed to align with and complement these functions.

Implementing bioretention facilities into the streetscape of the public ROW requires multidisciplinary collaboration and analysis (see Section 1). It is critical that projects continue this integrated approach through the design phase. Cross disciplinary input and perspective strengthens feasibility and reduces iterative work. For example, involve the landscape architect when the cell footprint and locations are discussed and involve the civil engineer and O&M lead in the selection and placement of plant material. If the team changes an alignment or even a detail let the entire team know as what may seem minor to one discipline can have a big impact on the performance expected by another.

While the guidance in this section is focused on designing bioretention retrofits in the City of Seattle ROW for Neighborhood Yield and Neighborhood Curbless street types, as identified in Streets Illustrated ROWIM, there is still quite a bit of information to process. A general description for each street typology is as follows:

Neighborhood Yield Streets

Neighborhood Yield streets are typically in areas zoned single-family, with 25-foot-wide roads, on-street parking on both sides, curb and gutter, planting strip/landscape and sidewalks.

Neighborhood Curbless Streets

Neighborhood Curbless streets are also located in areas zoned single-family. The paved roadway edge is typically a gravel shoulder (no curb along road edge). Many of these streets were incorporated into the city limits in the 1970s and do not have some of the infrastructure typical of Neighborhood Yield streets (e.g., sidewalks, formal drainage collection,

Curbless Deviation

In Streets Illustrated ROWIM, Neighborhood Curbless streets are defined as a deviation from Neighborhood Yield streets. Improvements proposed for Neighborhood Curbless require going through SDOT's deviation process. See Streets Illustrated ROWIM for more information.

and piped systems).

For other street types (such as Urban Village Neighborhood Access, Neighborhood Corridor, and Industrial Access) and street classifications (such as principal arterial, collector), see Streets Illustrated ROWIM and Section 8.

7.2 General Design Requirements, Standards and Concepts

Requirements for the design and construction of bioretention systems in the public ROW for SPU/WTD led capital improvement projects include:

- *City of Seattle Standard Plans and Specifications for Municipal Construction*, current edition http://www.seattle.gov/util/Engineering/Standard_Plans_%26_Specs/index.htm
- *Streets Illustrated, Seattle's Right-of-Way Improvement Manual (ROWIM)* **http://www.seattle.gov/transportation/rowmanual/** **http://streetsillustrated.seattle.gov/**
- City of Seattle Stormwater Code and Manual (COS SWM), issued August 2017 (or current edition).
- This volume of the GSI Manual

The *City of Seattle Standard Plans* and *City of Seattle Standard Specifications for Municipal Construction* apply whenever any public or private construction is performed within the ROW of the City of Seattle and includes design and installation of bioretention cells, pervious concrete, and other components of GSI and supporting infrastructure.

The concepts included in *Streets Illustrated ROWIM* provide guidance for selecting appropriate configurations and materials to address site context and social function given a street's typology and classification.

The *City of Seattle Stormwater Code* and *City of Seattle Stormwater Manual (COS SWM)* provide requirements for stormwater management associated with new development, redevelopment, and construction for different project types. CIPs installing bioretention in the City's right-of-way, in general, may be defined as a "roadway," "sidewalk" or "utility" project as defined in the code and manual depending upon the amount of new and replaced hard surfaces and project scope. Design of bioretention facilities to meet code is described in Volume 3 (Project Stormwater Control) of COS SWM.

This section incorporates lessons learned, input and review from the City's Interdepartmental Team (IDT), SPU, SDOT and WTD staff and their consultants, suppliers, contractors, installers, and O&M staff for designing bioretention in the City's ROW. If design criteria are already provided in the other City documents noted, they are typically not repeated in this volume to minimize having duplicate (and possibly conflicting) information. Where requirements in this Section differ from the documents noted herein, they are identified within the text. The requirements and guidance provide in this Section were developed and agreed upon through IDT for bioretention facilities that would be maintained by SPU/WTD. For proposing deviations and alternatives from this Section, see Section 7.10.

The following subsections provide guidance for siting bioretention along a city street and identify common design considerations for the retrofit of bioretention systems in Neighborhood Yield and Neighborhood Curbless streets where not otherwise described in Streets Illustrated ROWIM or COS SWM.

Above Image: Example of a typical Neighborhood Yield Street.

Above Image: Example of a typical Neighborhood Curbless street.

7.2.1 Block Concepts for Neighborhood Yield and Neighborhood Curbless

The layout of bioretention along a neighborhood street described in this section applies to projects sited along Neighborhood Yield and Neighborhood Curbless street types.

Given the range of characteristics and land uses that exist along Seattle's Neighborhood Yield and Neighborhood Curbless streets, designers can anticipate a variety of different roadway conditions. A series of concepts and design scenarios are provided in the figures of this section to address some common variations in the roadway and to demonstrate how cells can be laid out as a response to these variations. The figures also provide examples of laying out cells in response to other elements such as existing soils, available space, stormwater discharge method, treatment function (conveyance, flow control and/or water quality) and O&M considerations.

The concepts are not intended to limit how a design is developed and are not intended to be used as templates that can be applied to all streets. Rather, the concepts provide ideas for siting bioretention and retrofitting existing streets to manage stormwater runoff while considering impacts to the context, character, and social functions of streets. Project teams will need to collaborate and evaluate individual streets' context, project-specific conditions, and performance goals to develop project-specific street concepts.

The concepts shown in Figures 7-1 through 7-3 generally provide two approaches for siting bioretention cells:

- Distributed: spreading bioretention cells along the length of the block when shallow infiltration is feasible
- Consolidated: consolidating bioretention cells at the downstream end of the block due to a variety of factors and can also be used when shallow infiltration is feasible.

Site-specific design

The number of bioretention cells sited on a block is project site-specific. Some factors that can affect the number/size of cells include

- available space
- fixed conditions such as trees and driveways
- method of discharge
- performance target
- type of bioretention cell cross section
- assumptions for effective impervious area
- using pre-sizing factors versus specific modeling
- other assumptions used in the sizing and/or modeling (e.g. infiltration rate).

TIP

If siting only one or two cells along a block length additional care needs to be taken by the design team to address context so walkers and visitors are not suddenly surprised by the change in the edge conditions.

Included with these two basic approaches for siting bioretention (distributed versus consolidated) are considerations to optimize project-specific needs related to:

- Technical function
- Social function
- Site context

As an example of an approach, if an underdrain pipe is required, then the cells are typically consolidated at the end of the block to minimize construction and O&M costs and to maximize the efficiency of capturing stormwater. Consolidating bioretention cells at the downstream end of the block also allows for easier maintenance (cells are all located in one area for crews to work in) and watering.

Another example, if a facility is to receive flow from large upstream area and is to provide conveyance where there is no piped system then the facilities will be installed along the upstream end of the block and may extend the full block for conveyance.

The method of discharge (a “technical function”) after stormwater has passed through the bioretention will also factor into the design of bioretention cells on the block as shown in Figures 7-1 to 7-3.

Examples of technical functions

- Tributary runoff catchment area
- Performance design criteria
- Maintenance efficiency
- Infiltration or discharge method

Examples of social functions

- Access along and across ROW
- Parking
- Neighborhood greenway
- School route
- Cost

Examples of site context

- Tree impacts
- Extent of retrofit
- Fencing
- Rockeries
- Trees and shrubs extent

Figure 7-1 provides some examples of design approaches for siting bioretention cells. Starting on the left side of Figure 7-1, the examples include:

- If shallow infiltration is feasible, the bioretention cells can be distributed on both sides of the street, consolidated on both sides of the street, or consolidated on one side of the street. (Example A-C, respectively, in Figure 7-1)
- If bioretention cells have an underdrain connecting to a single discharge (such as a public storm drain or Underground Injection Control screen well), it is preferred that cells be located at the downstream end of the block near the point of discharge. The cells can be located on one side of the street as shown as Example D in Figure 7-1 or both sides of the street. Consolidating cells near the point of discharge can minimize costs and reduce the area, or length of street, impacted by trenching for the underdrain.
- If bioretention cells have an underdrain (pipe or filter material) that has multiple discharge facilities for deep infiltration (such as a drill drain/pit drain midblock and one further down the block), cells may be congregated midblock and downstream of the block with each of their respective discharge facility. This approach may be more cost effective than consolidating the cells at the end of the block and designing a larger single discharge facility (such as a larger and/or deeper drilled drain with higher flow capacity). (Example E in Figure 7-1)
- For long blocks (~600lf plus), if bioretention cells with an underdrain are to be installed upstream of existing midblock catch basins that are to remain on-line, then bioretention cells can be congregated midblock and downstream of the block. (Example E)

The concepts shown in Figure 7-2 represent conditions that may be encountered on Neighborhood Curbless streets and demonstrate how bioretention cells may be sited.

In Figure 7-3, the design scenario is for concepts managing flow from upstream block(s) onto a Neighborhood Curbless street, and it could also be tailored for a Neighborhood Yield street.

Figures 7-4 and 7-5 are photos with examples of constructed roadside bioretention cells on Neighborhood Yield and Neighborhood Curbless streets.

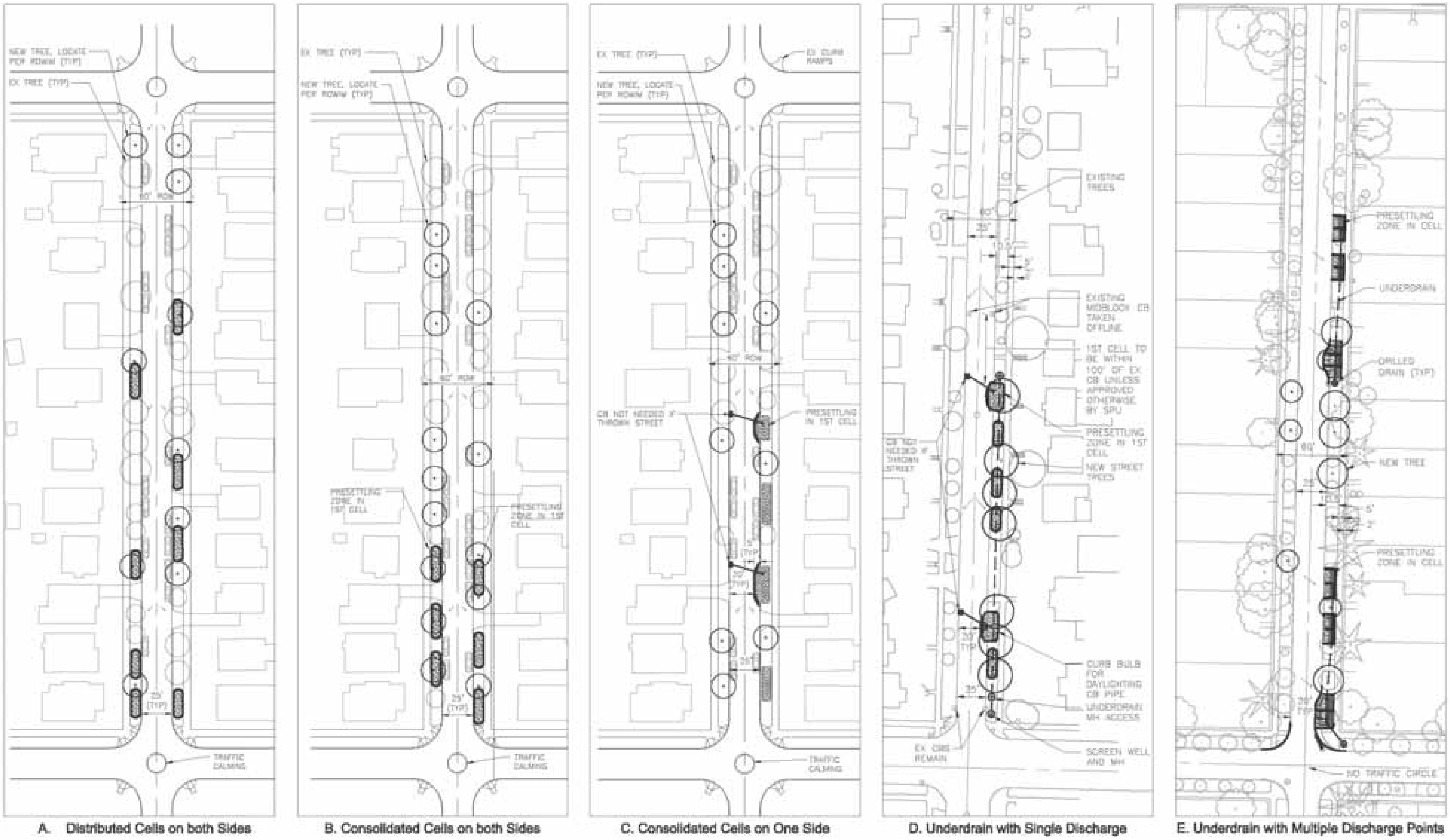

Figure 7-1: Block concepts for managing flow from a single Neighborhood Yield Street for varying site conditions and design approaches

Figure 7-2

These examples depict concepts for Neighborhood Curbless streets with graded side slopes bioretention cells. The design scenarios show how cells might be laid out if flow entering the cells is from the block (as opposed to upstream blocks – see figure 7-3).

- **Distributed Block Concept:** Retrofit bioretention cells with shallow infiltration to manage a single long block of right-of-way runoff and adjacent parcels' run-on.

- **Consolidated Block Concept:** This concept considers locations where shallow infiltration is not feasible. Retrofit bioretention cells with an underdrain to manage a single block of right-of-way runoff and adjacent parcels' run-on. The bioretention cells are sited across the street from a future sidewalk, assuming there is more room for bioretention.

- **Midblock Low Point Block Concept:** This concept depicts a scenario of a block with a closed depression, shallow infiltration, and distributed cells along both sides of the crowned street. Retrofit bioretention cells with shallow infiltration and midblock low point to manage a single long block of right-of-way runoff and adjacent parcels' run-on.

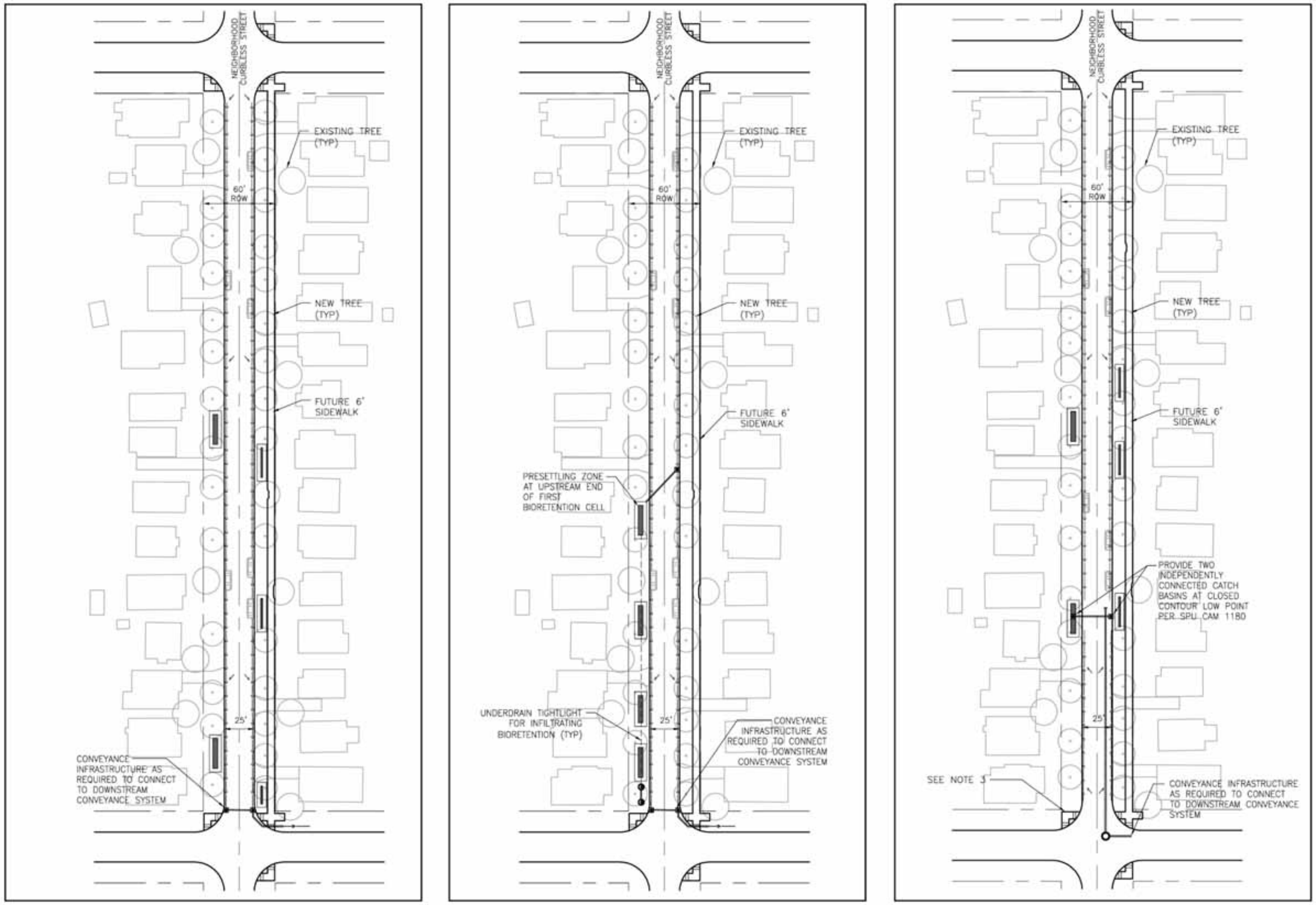

Figure 7-2: Block concepts for managing flow from a Neighborhood Curbless street

Figure 7-3

These examples depict concepts for Neighborhood Curbless streets retrofitted with bioretention cells with graded side slopes. The design scenarios show how cells might be laid out if flow entering the cells is coming from multiple upstream blocks (large tributary area).

- **Full Street Reconstruction Concept:**
  To manage large contributing upstream areas, this concept shows the road centerline shifted and the full ROW regraded to create large areas for bioretention along one side of the street. Storm drain culverts connect bioretention cells at pedestrian access and driveway locations.

- **Reroute Runoff Concept:**
  This concept represents an opportunity to manage runoff from an arterial street, which has higher traffic volumes and assumed higher water quality needs and direct it to a side street that has room to manage flow. This concept requires a grade change between the arterial street and the curbless street to allow discharge pipe of the catch basin to daylight at the outflow. The bioretention cells are sited across the street from a future sidewalk.

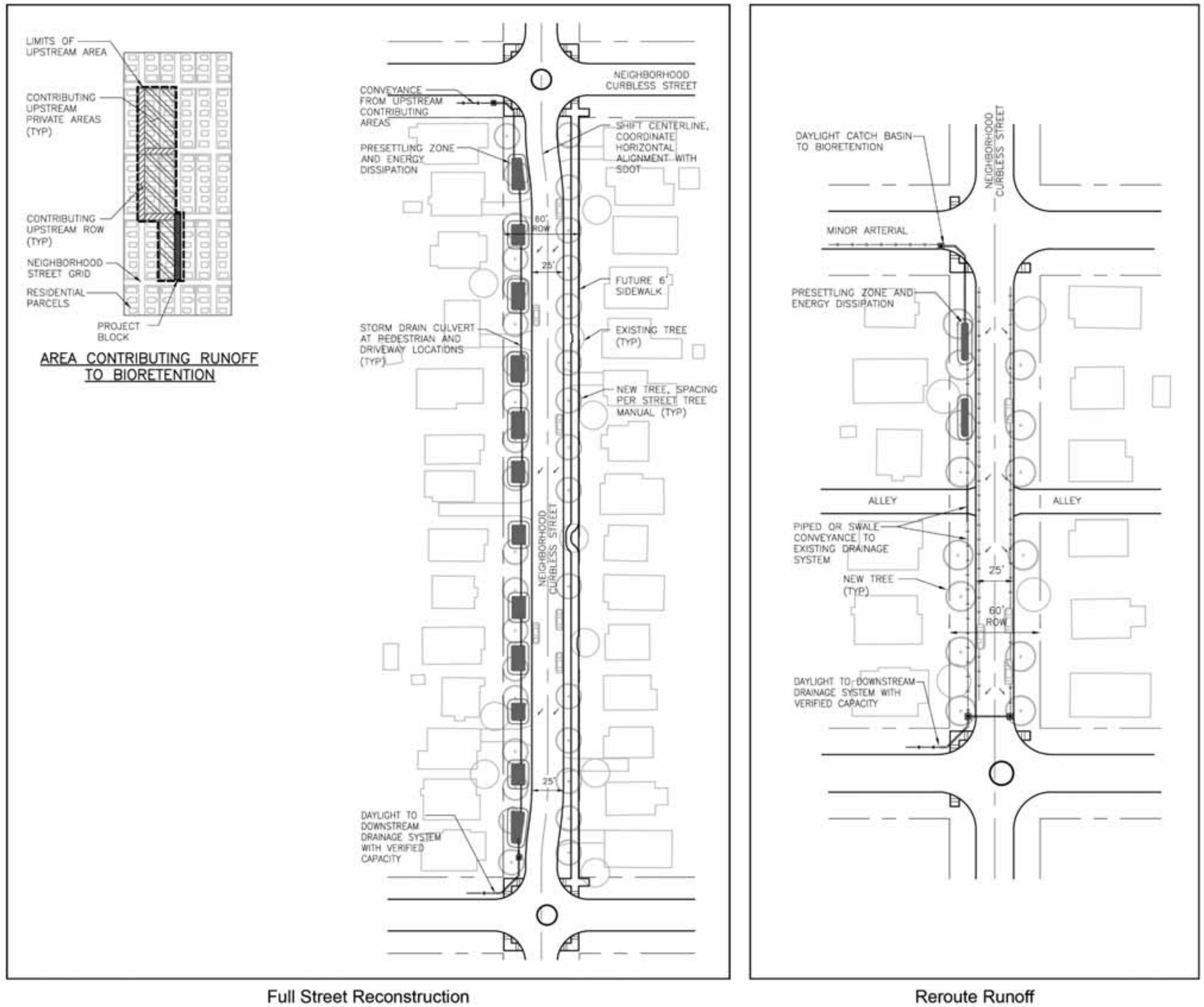

Figure 7-3: Distributed cells block concepts, retrofit to manage flow from upstream blocks onto a Neighborhood Curbless street

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Bioretention with graded side slopes in new curb bulb during rain event, notice retrofit curb

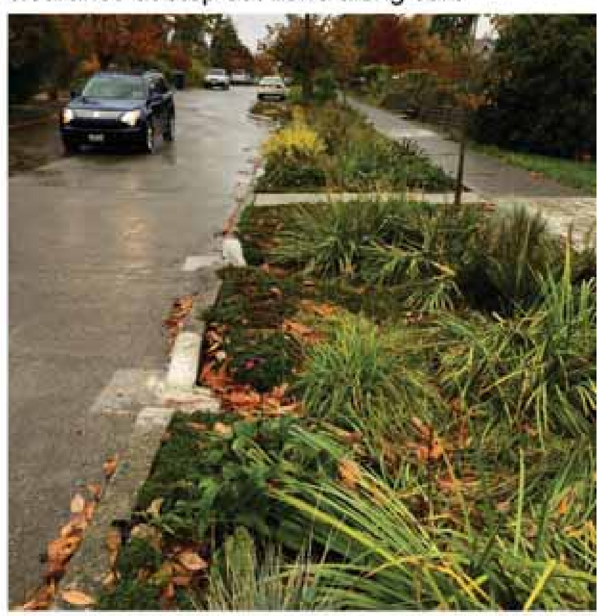
Facility with graded side slopes during storm event. Notice winter conditions may compromise the space in the step out zone

Facility with graded side slopes

Bioretention facility with one vertical wall. Notice abrupt change of condition along the block

Wide biotetention facility with weirs. Full ROW retrofit managing flow from multiple blocks. Recommend allowing more space along sidewalk so as to not constrain pedestrians with steep slope of cell and fence at walk.

Curb bulb with bioretention with graded side slopes, concrete weir and presettling concrete pad. Notice plants held back to allow for clearance at step out zone along curb



Facility with graded side slopes during storm event. Notice winter conditions may compromise the space in the step out zone

Figure 7-4: Examples of Neighborhood Yield streets retrofitted with roadside bioretention

Curbless facility with parking and sidewalk on the opposite side of the street, North Seattle

Curbless facility with parking on both sides, 32nd Ave SW, Seattle

Curbless facility with parking on both sides, notice plants up to road edge and no step out zone, 8th Ave, Puyallup

Curbless facility with narrow road, perpendicular parking bays, sidewalk on one side, notice rock pockets to protect edge at driveways, 2nd Ave NW

Gap curb rain garden facility, 16th Ave S, Seattle

Curbless facility with curb bulbs, 17th Ave NE, Shoreline

Gap curb rain garden facility, notice leaf accumulation is addressed by inlet, 32nd Ave NE, Shoreline

Curbless facility, avoid steep side slope, Broadview Green Grid, Seattle

Figure 7-5: Examples of Neighborhood Curbless streets retrofitted with roadside bioretention

7.3 Retrofitting Streets for Bioretention Systems

The design of bioretention systems requires collaboration and coordination among the representatives of various disciplines on the Project Team, i.e., landscape architect, civil engineer, tree assessor, community outreach, hydrogeologist, O&M lead etc. (see Section 2). The edge conditions of a bioretention cell and the relationship between the cell and adjacent sidewalk, road, and adjacent property, are critical elements.

This section provides guidance for designing and siting bioretention cells in the ROW for retrofit ranging from basic design elements and standard dimensions for the bioretention cell; types of bioretention cell cross sections and how to design for site context and social function in the ROW; design a cell's length and slope; utility and setback requirements for cells; designing and fitting cells in ROW given various conditions from flow patterns, existing mature trees, plant selection and layout, method of watering, designated parking spaces, driveways, etc.; designing and siting cells depending upon method of discharge and road edge condition (curb vs curbless); designing for operations and maintenance; and other considerations.

7.3.1 Design Elements and Dimensions

Table 7-1 identifies typical elements of a bioretention cell in the ROW and introduces dimensional design criteria documented in the GSI details, COS Standard (Std) Plans and Streets Illustrated ROWIM. (Note: actual sections will vary depending on the bioretention cell detail selected).

Criteria noted as "maximum" in Table 7-1 are not the typical or average dimension that should be used for designing a cell. Cells should be designed to **less than maximum criteria** as feasible to provide the right fit and feel for adjacent neighbors (e.g., the average grading depth of a cell should be less than the maximum criteria).

For general description on bioretention design elements, including other setbacks and site restrictions (e.g. such as infiltration feasibility) see the City of Seattle Stormwater Manual, Volume 3.

TIP

Facilities that are designed to less than the "maximum" criteria (e.g. grading depth of cell or height of wall) will have greater public acceptance, less complexity (and possibly cost) for construction and O&M.

Table 7-1: Typical Elements and Guidance for Bioretention Cells in ROW

Bioretention Cross Section Element	Construction Standard/Requirements	Guidance
Cross Section Type	Cells with graded side slopes are preferred. In constrained space, if room allows, cell with one vertical wall on the sidewalk side may be feasible. See Section 7.3.2.	Site context and street typology is more conducive to cells with graded side slopes. See Section 7.3.2.
Cells with graded side slopes, **Grading depth of cell**	See COS Std Plans 292, 293a and 293b.	Depth noted on standard plans is a maximum. Design depth shall be less for majority of cells. Shallower depths (12-18 inches) provide comfort for people walking.
Cells with graded side slopes, **maximum side slope**	See COS Std Plans 292, 293a and 293b.	Varies depending on street type (arterial vs. neighborhood).
Cells with one vertical wall side, **Maximum Wall Height**	See B-7 in Appendix D.	See B-7 in Appendix D.
***Average* bottom width** of cell	Cells with graded side slopes: 1 ft minimum per COS Std Plans Cell with 1 vertical wall: See B-7 in Appendix D.	The bottom width can vary to maintain a consistent edge along sidewalk side. Avoid varying the placement of the wall along the sidewalk side to maintain consistent sidewalk edge.
Maximum temporary ponding depth for cells with graded side slopes	Preferred: 10-inch max. Allowable: 12-inch max. Surface pool drawdown per COS SWM, Vol. 3, 5.4.4.	Prefer 10-inch maximum depth but may use 12 inches for efficiency when needed. For minimum average ponding depth, see COS SWM.
Maximum temporary ponding depth for cells with one vertical side	See B-7 in Appendix D. Surface pool drawdown per COS SWM, Vol. 3, 5.4.4.	See B-7 in Appendix D.
Length of a cell	See Section 7.3.4.	Varies depending upon site context and technical factors.

(table continued next page)

Table 7-1: Typical Elements and Guidance for Bioretention Cells in ROW (continued)

Bioretention Cross Section Element	Construction Standard/Requirements	Guidance
Minimum Freeboard depth	Cells managing flows from adjacent block: • 2-inch on a street with curb • 6-inch on curbless street* Cells receiving flow from larger upstream areas (multiple blocks): • 6- to 12-inch depending upon project-specific conditions. See COS SWM. * **This is an approved deviation from COS 2017 SWM, Vol. 3, Section 5.4.4 for CIPs.*	Measured from maximum temporary water surface elevation to adjacent sidewalk/street gutter elevation at overflow. Overflow from cell shall flow into the road's gutter or along the roadway edge, not onto private property or across public sidewalk or driveway.
Width and grading of step out/access zone *from curb/road edge to top of slope of cell*	Minimum width per COS Std Plans 292 thru 293b and Streets Illustrated ROWIM except some materials used in this zone require wider width than noted in standards. See Section 7.3.8 and details in Appendix D. Grading at curb/road edge per details in Appendix D*. **This is an approved deviation from COS 2020 Standard Plans that show a 1" min. gap off edge of pavement/curb to top of mulch.*	Minimum required width* is greater than specified in standard plans and Streets Illustrated ROWIM for some material types due to constructability and O&M. **To use less width than noted herein submit deviation request (see Section 7.10).*
Bioretention Soil Media (BSM) extents and depth within and adjacent to a cell	Horizontal extents footprint (top of slope of cell) as depicted in COS SWM and in COS Std Plans 292, 293a and 293b. Depth BSM per COS SWM. For lined cells, depth of BSM and amended soils may need to be greater than COS Std Plan 293b and COS SWM to support plant growth.	Avoid using excess BSM outside the required treatment area when feasible. BSM soils drain faster than typical planting soil, which affects the planting design and plant selection. Use amended native soils to allow typical planting soil for upland planting.

(table continued next page)

Table 7-1: Typical Elements and Guidance for Bioretention Cells in ROW (continued)

Bioretention Cross Section Element	Construction Standard/Requirements	Guidance
Bioretention Soil Media type	Type to be in accordance with COS SWM and COS Standard Plans and Specifications.	
Plants	Plants must be on the Bioretention Plant List or they will require deviation approval and O&M sign off (see Appendix G). See Section 7.7.	Plants are to be selected from the list for their water quality treatment and aesthetic qualities and maintenance considerations. Selected plants must meet sight clearance requirements.
Street trees	Trees must be on the Bioretention Tree List (see Appendix G). See Section 7.7, SDOT Street Tree Manual and Streets Illustrated ROWIM.	Trees are an integral element of the bioretention facility and required for the streetscape. GSI Street Tree List was reviewed by SDOT.
Drain curb cuts at graded side slopes	See COS Std Plan 295a-295d.	See Section 7.5.3 for design guidance.
Drain curb cuts for cells with vertical wall.	See Section 7.5.3. There is no standard plan at this time and will require teams to go through a deviation request. See Section 7.10.	Drain curb cuts shall be self-cleaning, have adequate slope and dip at gutter to allow water to flow through and into facility and lids shall be easily removable for O&M access.

TIP - Additional notes about cells with walls

On construction documents, provide design elevations along wall for each cell rather than stating wall height can be “up to xx depth” (based on “maximum” defined in Table 7-1). If the installer is to determine wall height based on an “up to maximum” dimension and/or if the construction survey staking is too complex, the facility’s “average depth” could be installed at the “maximum” throughout. This will require redesign, adjustments to other infrastructure, negatively impact O&M and negatively impact the comfort, fit and feel for the ROW.

7.3.2 Bioretention Cross Section Type for Site Context and Social Function

The two basic types of bioretention cross-sections typically used for Neighborhood Yield and Neighborhood Curbless streets are:

- Bioretention with graded side slopes (preferred)
- Bioretention with 1-sided wall and remaining sides sloped (when space is constrained)

If the planter width (landscape/GSI zones designated in Streets Illustrated ROWIM) allows for space for bioretention with sloped sides (see Table 7-3), then that is the preferred bioretention cell cross section type for meeting site context goals and for comfort and fit for Neighborhood Yield and Neighborhood Curbless streets. Cells with graded side slopes also provide other benefits such as greater flexibility for maintenance of cell and supporting infrastructure, easier to restore if there are future service utility cuts or other repairs in ROW compared to a fixed wall, allow for a greater variety of plants that can tolerate drier conditions and other benefits.

Following Figure 7-6, which show examples of the two cross section types retrofitted into Neighborhood Yield streets, this section provides guidance on how to design for site context and social function.

Bioretention with sloped sides on Neighborhood Yield, COS Std. Plan 293a. First winter season.

Bioretention with 1-sided wall and remaining sides sloped. Requires special review for wall design. Wall shall extend 18" beyond top of slope.

Bioretention with 3-sided wall and remaining side sloped. End walls not recommended.

Bioretention with sloped sides on Neighborhood Yield, COS Std. Plan 293a. Fourth winter season.

Bioretention with sloped sides on Neighborhood Curbless, COS Std Plan 292.

Figure 7-6: Examples of bioretention cell cross section types

Bioretention Type - Site Context and Social Function: Site context and social function relate to how the bioretention cell impacts (favorably or adversely) non-stormwater functions of the ROW and its users. Designers should try to envision how neighbors will perceive the bioretention cells impact to the street frontage – as a positive enhancement, or as shifting the street's character. While every effort should be made to locate bioretention cells to maximize the bioretention infiltration area and stormwater function, the stormwater function must be balanced with the site context, O&M, new and existing infrastructure (including new and existing street trees), and social function variables. Site context and social function considerations are outlined in Table 7-2.

Table 7-2: Site Context and Social Function Considerations

Site Context Element	Considerations
Neighborhood character and aesthetics	• Who are the typical users along the street (i.e., age and ability of residents)? Where are users going (school, park, or stores)? How might the proposed cross-section impact users? • Who are the residents directly adjacent to the cells (i.e. age, ability, children, seniors)? Do they work out of their home and have deliveries daily or multiple cars? How might the proposed cross-section impact adjacent residents? • What is the look and feel of the neighborhood? Are there rockeries, retaining walls, fences or hedges that edge the ROW? How might the new cells affect the residents/users? Are there encroachments (e.g. fences, sheds etc.)? • How might design details like vertical walls, pedestrian crossings, auto-egress and sidewalk edge treatments, and plant selection fit in with and/or enhance this environment? • If the street is in a low activity area, such as at the backside of businesses, additional O&M budget may be required for outreach and closer monitoring of the facility to prevent debris/waste from being deposited into the cells.
Existing trees	• What is the character of the existing street tree canopy for the block (common species and consistent spacing or random mix of type, size and spacing)? • How will the proposed cross-section affect the mature tree retention goals of the City's Urban Forest Stewardship Plan? • How can impacts to existing trees be mitigated (within and adjacent to ROW)?
New street trees	• How will the proposed cross-section (wall, side slopes, liner, underdrain, etc.) affect the new street tree plantings and the ability to plant large canopy or conifers?

(table continued next page)

Table 7-2: Site Context and Social Function Considerations (continued)

Site Context Element	Considerations
Access	• How will the placement of the bioretention cell section impact access **across** the planting strip (from on-street parking to the parcels with housing, businesses, community centers, schools)? • How will the placement of the bioretention cell section impact access **along** the planting strip (adjacent to on-street parking and/or sidewalk)? • If there is no public sidewalk, how will placement of the bioretention cell impact **access from** the property line to the road edge and/or along the row line for the adjacent property owner? • How would/could the bioretention cell be **retrofitted** later for crossing access if conditions or use changed, e.g., if a parcel were subdivided or if a resident were to require ADA access from on-street parking? How difficult or costly would this be?
Sidewalks and adjacent parcel conditions	• Does the width of the existing sidewalks meet City minimum standards for street type? What is the condition of the existing sidewalk? Does the existing sidewalk need to be replaced or widened (see Section 7.12)? • If the street has no sidewalk what is the zone for the new sidewalk (see Section 7.12)? • How much room is there from the sidewalk to the edge of the cell, and what is the condition of the adjacent parcel? If the edge condition of the adjacent parcel is a vertical wall, a fence, a gate, or overgrown vegetation, more room may be required between the sidewalk and the bioretention cell.
Existing slopes	• How do steeper longitudinal streets, which may require the use of weirs, work with neighborhood character and access?
Pick-up locations for waste bins	• How will the proposed locations affect pick-up and placement of multiple waste containers (e.g. yard waste, recycling, garbage) if collection is along the street and not the alley?
Mailboxes	• How will the proposed locations affect single or grouped mailboxes?
Traffic calming and Pedestrian Facilities	• Are traffic calming measures, shortened pedestrian crossing distances, and/or improved pedestrian and vehicular sight lines needed or desired by residents? If so, how can proposed cross-section selection support these needs (e.g., use of curb bulbs)?

(table continued next page)

Table 7-2: Site Context and Social Function Considerations (continued)

Site Context Element	Considerations
On-street parking and traffic calming	• How does placement of bioretention cells work with adjacent on-street parking needs and patterns? Is there frequent parking turnover? Is parking generally congested? Does this area have special events (e.g., is it within 1/4 mile of a school, church, or community center)? • For Neighborhood Curbless streets, see Road Edge Treatment Guidance in Section 7.3. • If a mid-block curb bulb is retrofitted into the ROW, what are the impacts to on-street parking supply and availability? • Do people drive over the curb and park in the planting strip? If so, discuss with SDOT and project team if curb height and/or signage should be added.
Existing utilities	• How do selected concepts and details work with existing utility mains, structures, and services? • Given its type, age, and location, how much of the service utility and/or utility main adjacent to or within the proposed cell footprint would need to be replaced? While residential services are generally easy to relocate and adjust compared to a main distribution, if the service is to a commercial or public facility (school) it could have greater impact. • Will the main need to have settlement monitoring during construction? • Will services need to be relocated or have sleeving for construction of a wall, MH, or other structure?
Existing overhead features	• How does location of overhead wires (power and franchise) affect constructability and placement of the bioretention elements and/or maintenance?
Maintenance	• How will the location of different elements affect maintenance access without using specialized equipment? • Is the bioretention cell and supporting infrastructure easily accessible for maintenance crews from the sidewalk? • Can maintenance crews work without having to close the road or move utilities (overhead wires)?

Figure 7-7 provides examples of existing conditions for the considerations of site context, social function, and constraints. Figure 7-8 and 7-9 introduce guidance for designing supporting utility infrastructure, access, and other elements in consideration of the site context and social function (See later subsections of Section 7 for further information on designing these elements).


Private fence, overhanging hedge and trees, sidewalk condition


Utility pole, established street trees, large private wall and fence on property line


Waste bin pick up at street frontage, established street trees, large private tree, fence/wall


Paved planting strip access, small and established street trees, planting strip garden, private fences


Private planting in row, utility pole, variety of street trees, significant on-street parking, private rockery


Utility pole and overhead wires, street trees, alley, driveway, private fence and trees

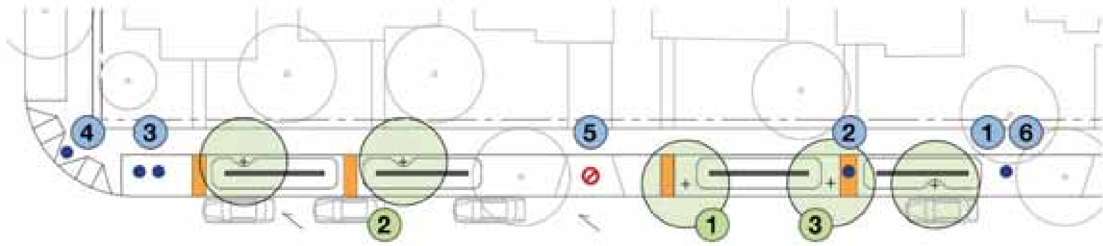

Utility poles and overhead wires, street trees, multiple wide driveways, private fences and trees


Utility poles and overhead wires, street trees, paved planting strips, significant on-street parking, sloped up to private property

Figure 7-7: Examples of considerations for site context, social function and constraints

Designing for Street Character and Context

Each street has it's own character and taking time to observe the way residents use the street ROW will assist the siting of cells. See detailed disussion in this Section. See ROWIM Street Illustrated and SPU's Design Standards and Guidelines for various structure and street tree clearance requirements.



Supporting Utility Infrastructure

1. **Upstream of Bioretention Cells**: Consider impacts to vegetation and trees from locating utilities.
2. **Between Bioretention Cells**: See section on Pedestrian Access between Cells for requirements.
3. **Downstream of Bioretention Cells (in planting strip)**: Allow space downstream of bioretention to locate various utility structures for underdrain.
4. **Sidewalk at Downstream Intersection**: **Do not locate structures in curb ramps or landings.**
5. **Driveways**: To ensure O&M access do not locate structures in driveways.
6. **Avoid Concrete Collar in Landscape Areas, When Possible**

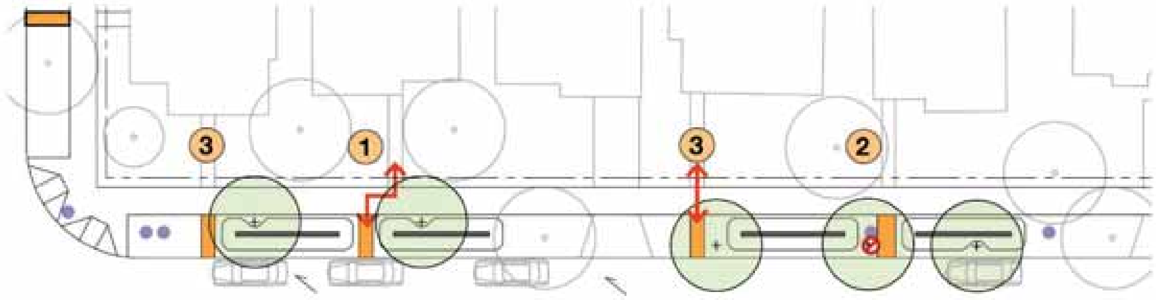
Street Tree Placement

Street Side **Sidewalk Side** **Between Cells**

When trees are located within cells, coordinate tree placement away from drain curb cuts, inlets, and outlets so flows can freely enter and exit the cells as trees mature. See tree placement figures in this section and tree planting details in Appendix D for more information on tree placement and planting.

Note: See Section 7.5 for designing and locating supporting infrastructure, Section 7.3.8 for designing access around the cells and Section 7.7.5 for designing required street trees with bioretention cells.

Figure 7-8: Designing for street character and context (1 of 2)



Pedestrian Access between Cells

Diagrams above show the width between cells, to provide access from street to public sidewalk. The diagrams below show how width should be increased when additional design elements are located between cells.

(1) **Width for access only**

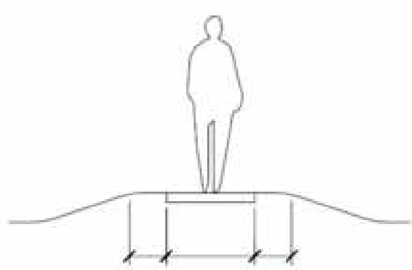
- Provide setback between path and top of swale to allow for pedestrian comfort and grading of side slope.

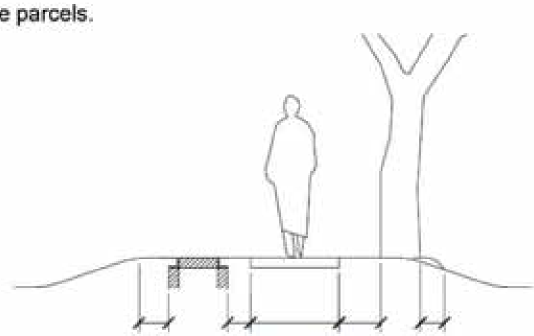
(2) **Increased width for additional design elements**

1. **Utilities:** Do existing/proposed surface castings require concrete encasement?
   - If no, consider locating utility outside of path and provide 6 to 18-inch setbacks between utility and path and top of swale to provide level area for maintenance, pedestrian comfort and aesthetics.
   - If no, but width between cells limits design, then locate in access path.
   - If yes, locate in access path.
   - If utility lid is located within paved path, consider widening the path to avoid uncontrolled cracking of the pavement, reduce potential tripping hazard, and for aesthetics.
2. **Street trees:** locate tree to allow setback from path and/or utilities considering future mature tree and root flare size and maintenance considerations

(3) **Locating access paths**

1. **Required:**
   - Graded Cells: shared paved access within 15 feet of existing paths for private parcel access.
   - Walled cells: access must align with existing path/gate on private parcel (walls only)
2. **Recommended:**
   - Align access with existing paths on private parcels.





Note: See Section 7.5 for designing and locating supporting infrastructure for bioretention cells, Section 7.3.8 and Figures 7-33 to 7-35 for designing access path and determining width of area between bioretention cells given street trees, path, and utilities. Width between cells varies on a block (as shown above) to accommodate other ROW infrastructure elements.

Figure 7-9: Designing for street character and context (2 of 2)

Bioretention Type - Space Available for Retrofit:

The space available for the retrofit of a bioretention facility in the ROW will determine the type of bioretention cross section that is most suitable. Table 7-3 provides guidance for selection of the bioretention cross section type based on the existing width of the planting strip (for streets with a curb). Figure 7-10 shows three cells with graded side slopes (commonly used on Neighborhood Yield streets) and one cell with 1-sided vertical wall at sidewalk (due to a narrower planting strip).

Table 7-3 is based on a clear zone of the planting strip; however, other factors such as the condition of the existing sidewalk or clear walking zone may limit the available planting strip width. If there is no sidewalk or the existing sidewalk width is less than the standard described in Streets Illustrated ROWIM for street typology, then the available width for the bioretention cell may be less than the existing planter width. This is to allow for the future sidewalk and/or level area for maintenance along the property line before transitioning to existing grades. See Section 7.12 for sidewalk assessment.

Cell with graded side slopes, Ballard Phase 1

Cell with graded side slopes and underdrain, plants set back from edge of walk, Barton

Cell with graded side slopes and a vertical wall with soil cells under walk (non-standard), suggest a stronger transition at facility ends, Ballard Phase 2

Cell with graded side slopes, grass is not approved due to subjective O&M, High Point

Figure 7-10: Example of bioretention cross section types

Table 7-3: Guidance for Selection of Bioretention Cross-Section Type for Retrofit into a Neighborhood Yield Street ROW given the Planting Strip's Width

Planting Strip Width[1,6]	Bioretention Cross Section Type[2]	Potential for locating in ROW?	Assumption for Average Bottom Width[6]
12-inch Maximum Ponding Depth[3]			
≥ 10 ft[3]	Graded side slopes	Yes	1 ft
8 ft[3,7] ≤ Width < 10 ft	Wall on one side	No[7]	3 ft
10-inch Maximum Ponding Depth[4]			
≥ 9 ft[4]	Graded side slopes	Yes	1 ft
7.5 ft[4,7] ≤ Width < 9 ft	Wall on one side	No[7]	3 ft
6-inch Maximum Ponding Depth[5]			
≥ 8 ft[5]	Graded side slopes	Yes	1 ft
7 ft[5] ≤ Width <8 ft	Wall on one side	Maybe	3 ft

[1] As measured from the back of curb to the face of sidewalk. Width does not include curb.

[2] Based on COS Std Plans 292 and 293a for bioretention cells with graded side slopes and GSI detail B-7 (Appendix D) for cells with wall on one side. If other materials are used for step out zone adjacent to the curb (see details in Appendix D and Section 7.3.8), then wider width of planting strip may be needed for the bioretention cells regardless of cross section type.

[3] These calculations assume the average ponding depth for the cell with graded side slopes is between 6 inches and 10 inches for 12-inch maximum ponding depth. This assumes the "graded depth" of cell is 1.2 feet measured from top of slope (road side) to bottom of cell plus assumptions in note 6.

[4] These calculations assume the average ponding depth for the cell with graded side slopes is between 5 inches to 10 inches for 10-inch maximum ponding depth. This assumes the "graded depth" of cell is 1 foot measured from top of slope (road side) to bottom of cell plus assumptions in note 6.

[5] These calculations assume the average ponding depth of the cell (regardless of type) will range from 3 inches to 6 inches depending upon bottom slope of cell, longitudinal slope of the road and location of drain curb cut(s). This assumes the "graded depth" of cell is 0.8 feet from top of slope (road side) to bottom of cell plus assumptions in note 6.

[6] The planting strip widths listed in this table were based on the following assumptions: the cross slope of the existing planter is 2%; the street has on-street parking; 6-inch curb; 2-inch freeboard; and the existing sidewalk width is maintained. If design parameters/assumptions are modified, then bioretention sections may be feasible in planting strip widths that are narrower or wider. For example, if the existing planting strip's cross slope is greater than 2% or the freeboard is 6 inches (e.g. curbless street or flow from large tributary area), then a wider planting strip would be needed to locate facility. OR If maximum ponding depth is set at 2 inches then a narrower planting strip would be needed to locate facility.

[7] Cells with vertical wall(s) for sides exceed the maximum ponding depth noted in Table 7-1.

7.3.3 Location

The placement and location of bioretention cells along a street will vary due to site, access, adjacent land use, existing conditions (within and adjacent to ROW), project performance target, features, and community input. Several site features are considered fixed (e.g., driveways, utility poles and guy wires, fire hydrants, significant trees, and utility mains) and bioretention cells should be located to avoid impact to these features. Table 7-4 provides general guidance for siting bioretention cells (with and without underdrains) along a street.

Table 7-4: General Guidance for Locating a Bioretention Cell along a Street

Cell Location – Siting Guidance	Rationale
DO:	
Locate immediately upstream of existing catch basins	To intercept as much stormwater runoff as possible before stormwater flows into the catch basin and discharges to the storm drain or combined sewer.
Site where cell will **receive concentrated gutter/sheet flow**	To intercept stormwater efficiently. Avoid locating at the upstream end of a block unless it receives flow from adjacent blocks.
Center cell longitudinally on the property lines between parcels	To limit impacts to individual property owners and to allow access between cells to be more closely aligned with residence's private pathways.
Locate per public comments to the maximum extent feasible	To reflect input from the public engagement process really think how the location might affect users (e.g., drainage issues, access, social acceptance, etc.).
Locate cells outside of trees' critical root zone unless certified arborist has reviewed proposed impacts.	To protect mature trees and maintain the stormwater and environmental benefits that mature trees provide.
Coordinate location of bioretention cell **with adjacent features and structures**	To review whether features and structures, such as fencing, rockeries, retaining walls, steps, gates, etc., will be affected including during construction.

(table continued next page)

Table 7-4: General Guidance for Locating a Bioretention Cell along a Street (continued)

Cell Location – Siting Guidance	Rationale
DO:	
Accommodate required new street **trees** between cells or if unlined and wide then within cell.	New street trees are required by municipal code and standards set by SDOT for ROW Improvements. (See *Seattle Municipal Code Chapter 15.43, the Tree and Vegetation Management in Public Places Ordinance* and *SDOT Street Tree Manual*) If existing trees are removed, Mayor Executive Order 03-05 requires that for every tree removed from City-owned land, two new trees are to be planted.
Consolidate cells at downstream end of block / upstream of existing CBs to remain **when using underdrain and deep infiltration.**	To minimize construction costs and maintenance area.
Coordinate location of bioretention cell with pick-up locations for waste containers**. Review pick-up locations with SPU Waste Management.**	If containers (3 types) are picked up along the street (not alley), then cells shall be sited to provide space for containers along each parcel frontage. Location can be at driveway, access paths, lawn/planter area (outside of the bioretention cell/planter), and/or at level areas between cells. See Figure 7-11.
DO NOT:	
Do not locate cells adjacent to City-permitted disabled on-street parking spaces for the adjacent residence.	To maintain access for the resident. If through outreach and site reconnaissance it is determined that a resident has a disabled parking placard for their vehicle and/or has ramp access to their parcel for accessibility, then avoid locating cells along the frontage of the parcel unless access from on-street parking to parcel access point is provided.
Do not locate cells in designated loading/unloading zones.	These are intended for hard surface or targeted loading.
Do not locate cells in the critical root zone of mature trees **(both within and adjacent to ROW).**	To protect existing healthy mature trees. Coordinate design near trees with Project Team's arborist. This includes trees adjacent to the ROW.
Do not locate cells in planting strips with extreme cross slopes **(over 5%+/-).**	Extreme cross slopes and grade change between the back of curb and sidewalk present grading challenges that may limit the efficacy of the bioretention cell.

Zone 5 are areas that are appropriate for locating waste bins between cells.

Figure 7-11: Examples of appropriate curb space for accomodating waste bins

7.3.4 Length and Longitudinal Slope

This section describes the length and longitudinal slope when designing bioretention cells along a street.

Longitudinal Slope of Roadway: In general, bioretention cells should be located along streets with longitudinal slopes of 5 percent or less to allow for design flexibility and to maximize the cost-benefit of constructing bioretention. For SPU-led CIP projects, maximum longitudinal slope of the roadway for siting bioretention on that street is 7 percent.

Bioretention cells may be designed for streets with roadway longitudinal slopes over 5 percent (note COS SWM list slopes over 8 percent as meeting On-site List Infeasibility Criteria and 7 percent maximum is allowed for SPU-led CIP projects); however, streets with roadway longitudinal slopes over 5 percent will require wider planting strips (typically not available within 60-foot ROW for Neighborhood Yield streets) and/or result in use of vertical walls (which is noted as one of COS SWM On-Site List Infeasibility Criteria).

Longitudinal slope isn't always uniform

The longitudinal slope of a roadway in a street (intersection to intersection) can change one or more times over the length of a block, so it's important assess individual segments to determine the placement and length of bioretention cells.

Longitudinal Slope and Length of a Cell: The longitudinal slope of the roadway within the street affects the design length of a bioretention cell. To maximize storage volume and filtration capacity through the cell's wetted perimeter footprint, bioretention cells be designed with a flat bottom (~0% longitudinal slope). Bioretention cells designed with a flat bottom often are constrained in length by the longitudinal slope of the roadway and/or may require a weir to maintain desired cell depths. (See Table 7-1).

Bioretention cells with sloped bottoms (which align with the road's longitudinal slope and provide a uniform cross-section throughout the cell's length) may be desired in areas with well-draining subsurface soils or in non-infiltrating bioretention cells with an underdrain. This approach allows some flexibility especially if there is a desire to balance capacity with cell depth to fit context and constructability.

Weirs & Steeper Streets

When bioretention cells are designed on Neighborhood Yield streets with steeper longitudinal slopes for the road (typically over 5%) then weirs or check dams are most often needed for creating ponding area.

See Section 7.5.2 for design guidance on using weirs in ROW.

The maximum cell bottom's longitudinal slope is 3 percent as defined in COS SWM, Volume 3, Section 5.4.4. As a result, for cells along streets with longitudinal slope less than 3 percent then the cell bottom slope can follow the road's longitudinal slope, which may be easier for construction layout. However, if the road's slope is over 3 percent then the cells cross section will not necessarily be uniform from road edge to sidewalk (such as varying bottom widths or side slopes). If the designer elects to design bioretention cells with a sloped bottom greater than 3 percent, then a Non-Standard Detail/Deviation Request shall be submitted as described in Section 7.10.

See details B-3A and B-3B in Appendix D for examples of grading and footprint of bioretention cell with constant bottom width and varying bottom width to reflect whether the cell's longitudinal bottom slope matches or differs from the road's longitudinal slope.

Existing Conditions: Existing conditions and utilities/structures/trees in the ROW will also have an impact on the length of a bioretention cell. The length of an individual bioretention cell in a series should consider impacts to pedestrian access, mobility, and neighborhood context. Table 7-5 provides guidance on lengths for bioretention cells.

Table 7-5: Guidance on Siting and Determining a Cell's Length on a Street

Bioretention Cell Length – Siting Guidance	Rationale
Minimum cell bottom length: 16 feet	To maximize the cost-benefit ratio of bioretention installation and avoid unexpected short grade drops along the sidewalk.
On-street parking, maximum cell top length: 40 feet	To maintain access from on-street parking to the public sidewalk and adjacent private parcels and to support other existing community and civic uses.
No on-street parking, maximum cell top length: 60 feet.	To acknowledge that pedestrians will want to cross the road to the public sidewalk and adjacent private parcels.
Longer bioretention cells (bottom length >30 feet)**: may require weirs.**	Locate weirs to control the maximum depth of bioretention cells. See Section 7.5.2.
Optimize cell bottom length with the infiltration area.	To avoid excess/unused space where water will not pond within the cell. The cell bottom length should be designed to the site grades at the specific cell location.

7.3.5 Quantity and Size of Cells

Building from the analysis completed in Options Analysis, Project Teams shall refine the sizing and number of cells in coordination with the project's performance target and modeling analysis (See Section 11 and Appendix H for modeling GSI) while also balancing other factors such as site-specific context, impacts, and cost. For refining the quantity and size of individual cells on a block and project, team members (modelers and designers) shall also obtain input from O&M staff and SPU/WTD design staff on field observations and performance monitoring of built projects. Through interdisciplinary team collaboration, the most effective/optimal size and quantity of cells can be determined.

7.3.6 Utility Setback and Clearances

An important service of the public right-of-way is to provide space for utilities (water, sewer, gas, electric and lighting, etc.) above and below the street. While the COS Standard Plans identify typical locations for installing utilities and requirements for utility clearances, actual locations can vary significantly. When integrating bioretention cells along an existing street, a similar set of clearances and setbacks is required. These clearances and setbacks facilitate the construction of bioretention and the ability to easily maintain and repair these facilities. Tables 7-6 and 7-7 identify clearances and setbacks for siting bioretention cells. When a design requires a variance from the setbacks and clearances identified or an existing utility needs to be relocated, the designer shall coordinate with the utility provider, SDOT, and other agencies that may be affected (e.g., Fire/Police Department). See Streets Illustrated ROWIM and SPU's DSG for additional utility setback requirements.

Image: Example of existing overhead utility and underground duct bank corridor on right side of street for consideration of setbacks and constraints for siting bioretention. Photo also shows concentrated sheet flow from driveway flowing across thrown road for siting bioretention on left side of street if there was available space.

Table 7-6: Setbacks and Clearances from Power and Franchise Utilities

Category/ Utility	Setback and Clearance Requirement for Bioretention Cells
Overhead and Underground	
Clearance between Overhead /power distribution lines (electrical and/or franchise) and **screen wells/drilled drains**	Screen wells/drilled drains shall be drilled with a minimum 10-ft horizontal clearance between equipment and overhead power lines and distribution wires (electrical and/or franchise) for installation and long-term maintenance clearance. Preferably maintain 10-ft horizontal clearance for individual residence service wires/lighting to avoid disruption for service to adjacent residences and businesses during installation and O&M. If other elements are proposed requiring large equipment to install and/or are needed for maintenance activities, provide similar clearance from overhead distribution.
Power poles, guy poles and wires	See Streets Illustrated ROWIM.
Clearance between primary/ transmission overhead wires and **new street trees**	Small category trees are to be planted under primary and transmission overhead.
Street light overhead wires and **new street trees**	No restrictions on tree size.
Franchise overhead distribution and **new street trees**	No restrictions on tree size.
Franchise and electrical vaults, duct banks, conduits, and services	See Streets Illustrated ROWIM.
Gas mains	To be located outside of the bioretention cell footprint (top of slope) for ease of maintenance access, unless noted otherwise by utility purveyor (PSE). Maintain standard cover and clearance from other utilities. See Streets Illustrated ROWIM.

Table 7-7: Setbacks and Clearances from Public Utilities, Utility Services and Trees

Category/Utility	Setback and Clearance Requirement for Bioretention Cells
Underdrains	
Underdrain pipe for bioretention cells and new street trees	See COS Std Plan 030 and Streets Illustrated ROWIM. Lesser setback is allowed from COS Std Plan 030 as shown in Figure 7-34 and listed in Streets Illustrated ROWIM Section 3.3 between new street trees and solid wall underdrain pipe. See Section 7.5.8 for design of underdrain pipe.
Underdrain pipe cleanout (CO) and bends	See Streets Illustrated ROWIM and Table 7-13 for more information.
Water Service & Meters	
Water service and meter	See Streets Illustrated ROWIM. Special approval required if relocating onto private property.
Water service and meter crossing through bioretention section	See Streets Illustrated ROWIM. Water service shall be sleeved when crossing through bioretention cell with vertical wall(s) and concrete weirs. Consider rerouting water service around wall if approved by SPU Water.
Water Mains	
Water mains	See Streets Illustrated ROWIM, and SPU's DSG. Provide cover over pipe per COS Std Plan 030. Shall not be located within bioretention cell section. Minimize locating improvements such that settlement and monitoring would be required for water mains during construction. See Section 3.4 for reviewing requirements with SPU Water.
Water main/services and wall of bioretention cells	See Streets Illustrated ROWIM.
Water main cast iron with lead joints	See SPU's DSG. Review horizontal clearance requirements with SPU Water. Further clearance (x>5-foot) may be required for construction of vertical wall and protection of main.
Signage	
Signage	See Streets Illustrated ROWIM.

(table continued next page)

Table 7-7: Setbacks and Clearances from Public Utilities, Utility Services and Trees (continued)

Category/ Utility	Description of Setback/Clearance Requirement from Bioretention Cell
Hydrants	
Fire Hydrants (FH)	See Streets Illustrated ROWIM. Provide 4-ft wide clear zone around FH and between FH and street edge.
Storm Drains, Combined Sewer, Sanitary Sewer Mains	
Piped storm drain mains (PSD), combined sewer mains (PS), sanitary sewer mains (PSS), King County Metro lines	Pipe mainlines shall not be located within bioretention cell section, unless approved by SPU/utility purveyor. Maintain City standard pipe cover and clearances.
Side Sewers/Service Drains	
Side sewers/service drains	See Streets Illustrated ROWIM. See Appendix L for guidance on side sewer repairs. See Section 4.9 for assessing side sewer condition. Bioretention cells with pit drains shall not be located within the footprint of a side sewer/service drain. See Section 10 for additional requirements.
Trees	
Existing street trees	Site-specific for each tree. To be reviewed with SDOT’s Urban Forestry staff and project’s arborist.
Existing private trees	Site-specific for each tree. To be reviewed with SDOT’s Urban Forestry staff and project’s arborist.
New street tree	New street trees shall not be located within a lined bioretention cell. If the bioretention cell is lined, horizontal clearances between the root ball of the new tree and the outside of the liner shall be: • Small trees: 3-foot horizontal clearance • All other trees: 5-foot horizontal clearance unless otherwise approved See Section 7.7 for designing and siting new street trees.

7.3.7 Existing Tree Retention, Replacement, Removal and Transplanting

Evaluation of existing trees (within and adjacent to ROW) is a critical step in bioretention cell siting. Tree evaluation determines the health, feasibility of transplanting, and extents of impact that the tree can tolerate. It is important to make the effort to retain existing trees in the ROW, as they provide a stormwater benefit in addition to many other functions. Retaining small-canopy trees where a large-canopy tree could be located will have little value to stormwater interception but may have a public relations value.

> **TIP**
>
> It is important to communicate to the adjacent resident the addition or removal of street trees from the ROW.

Retention and Replacement: Once tree retention decisions are made, the focus should be on techniques to protect existing trees that meet or exceed the City's requirements. Trees adjacent to ROW on private property shall be protected unless circumstances are discussed with the homeowner. Every tree removed from the ROW shall be replaced with a minimum of two trees within the project area. (Review current SDOT Tree Ordinance and Tree and Sidewalks Operations Plan.) Trees may be placed within the specific cell footprint if unlined. Locate as many replacement trees along the same block as the GSI facility. If it is necessary to locate replacement trees outside the immediate block, choose sites with an eye to ease of establishment and long-term maintenance, e.g., across the street or around the corner from a facility. See Section 7.7 for more information on tree selection and siting.

Underdrains add a complexity to tree retention. Though potentially challenging, retaining trees through trenchless technology is an option to be investigated for healthy mature trees that are between cells with an underdrain.

Removal: In general, it is not practical to design around trees that are in decline, are unhealthy, or have been pruned improperly and severely (e.g., topped, lots of suckers).

Transplanting: Trees that are possible for transplant must be in good to excellent condition with a high potential for success. Transplanting shall occur in the fall, after leaf drop.

Trees smaller than ~ 3 inches in caliper: These trees may be suitable to offer for transplant to the community. The following is suggested guidance:

- Notify community of trees that will be offered by posting notices on each tree 2 weeks before transplant operation
- Tree should be in good to excellent condition and not fully established
- Offer tree first to adjacent property owner
- Dig, label with species and care instructions, ball and burlap the tree and set at the edge of the homeowner's property. Tree is to be picked up by homeowner within 24 hours.

- Find a central protected location within the community for unclaimed trees and offer to all residents within the project area. Allow 72 hours. Keep root balls moist.
- Recycle or chip all unclaimed trees.

Trees ~3 inches in caliper or larger: Trees of this size require review by SDOT Urban Forester for CIP or Private Frontage project options for transplanting. Generally, this is not practical however if desired, transplanting of trees 3 inches or larger will require:

- Automatic irrigation (not practical for hand watering with tree bags)
- Appropriate species for the proposed location
- An 8-foot surface clearance zone to provide adequate room to dig up root ball
- A minimum 14-foot vertical clearance zone for equipment to dig up root ball
- Willing partners to accept and maintain tree for 3 years
- Project advocate to coordinate transplant (agency staff or consultant such as arborist or landscape architect)

See Figure 7-12 for example of work associated with preserving, replacing, and transplanting trees.

Existing street tree preserved through trenchless installation of the underdrain pipe

Existing street tree preserved at end of block

Public notice indicating tree to be removed and replaced with two trees

Transplanted existing street tree

Existing street tree protection

Replacement tree located outside bioretention facility area

Figure 7-12: Examples of work for preserving, replacing, or transplanting trees

7.3.8 Pedestrian Mobility with Roadside Bioretention

Along with described conditions for siting cells, bioretention cells should be located to maintain ease of pedestrian access between the road and public sidewalk and adjacent properties.

Pedestrian Access between Cells: Pathways between bioretention cells shall be aligned with existing paths on private parcels whenever feasible. In some circumstances, however, the goal of retaining the existing utility services, such as a water meter or gas connection, or the goal of retaining mature trees, or to avoid having tiny cells, may take precedence over aligning pedestrian access with private walks. The spacing and location of pedestrian access paths should be based on site-specific context. Typically, the term and dimension for access path used here means a hardscape path. In some locations if a secondary access exists between cells this area might be grass or wood chips depending on width and responsibility for maintenance. The actual spacing between top of cells will be wider.

See Figure 7-9 for further guidance for siting pedestrian access between cells to design for site context and social function and Figure 7-13 for examples of constructed pedestrian access between cells.

Pedestrian access for single-family lots (i.e., up to 4 housing units on the lot through duplex/triplexes):

Provide a minimum of one access path between the road and public sidewalk per single-family lot. Depending on location of private parcel walkways a shared access path between lots is preferred to reduce the amount of paving. However, it is recommended that

1) paths align with private access OR
2) be no more than 15 feet offset from the access.

For parcels on corner lots with bioretention on both streets, provide one access path to the parcel from each road (2 paths total).

For cells with graded side slopes provide minimum 4-foot wide path (See Figures 7-33 and 7-34).

For cells with one vertical wall side, provide minimum 4-foot wide path in-line with the lot's private access unless approved by SPU GSI Project lead and O&M lead. (See Figure 7-35).

Approved Deviation from COS SWM

The requirements described in this section is an approved deviation from COS 2017 SWM, Volume 3, Section 5.4.4, which states a minimum of one access path across planting strip be provided between the roadway and public sidewalk for each parcel and that the access path be a minimum 5 feet wide.

***Pedestrian access for multi-family lots (over 4 housing units) and commercial lots**:*

For cells adjacent to parcels with higher number of residential units and/or commercial properties, the access path between cells shall align within the zone of the lot's main access point(s). Provide a minimum of one 5-foot-wide access path per lot and not less than one access path for every 50 feet of frontage.

Pedestrian access between cells with vertical wall/sides:

For cells with vertical wall/sides, pedestrian access between cells shall be aligned with the primary access path for the adjacent parcel. Siting of the vertical walls shall maintain a minimum of 4 feet from each edge of the private access path. (i.e. 4 feet from a line extended out from the edge of path).

Width between Cells to Accommodate Access Path & Other Elements: The following are other elements that factor into determining the minimum width between cells in a series (See also Figures 7-9, 7-33 to 7-35):

- Existing street trees
- Other elements that may in this zone (e.g., meters, maintenance holes, light and utility poles, franchise vaults and hydrants)
- High pedestrian traffic to commercial properties, parcels with multi-family units, community centers, schools, parks, etc., which may require wider path.
- Recycling, garbage, and yard waste containers if pick-up is along the street and not the alley.
- Permitted ADA signed parking zone.
- Other site-specific concerns.

When pedestrian access paths are relocated or created, the surface should provide a relatively level path between the road and public sidewalk. Pedestrian access paths that are currently grass can be maintained by a homeowner as part of a larger area of lawn, but grass is not recommended in small or isolated areas due to the difficulty of property owners maintaining small grass zones. See "Materials" in this section for further guidance pedestrian access path materials.

Curb/Road Edge Pedestrian Access: Curb/road edge pedestrian access (also called "step-out zone" when there is on-street parking) is required in the design of bioretention cells. The dimensions for the curb edge access area, measured from the face of curb/road pavement edge, shall be in accordance with the COS Std Plans 292 to 293b and GSI Manual concepts in Appendix D. The curb edge access area is to be level to its full dimension but not necessarily paved, depending upon

The design team needs to carefully review the context of each block in developing an approach to step out zone treatments and access across the planting strip with bioretention cells.

frequency of foot traffic (e.g., commercial, schools) and length of adjacent cell (designer contextual judgement). Even if there is no on-street parking, the minimum width noted in the COS Standard Plans shall be provided unless approved otherwise by O&M. See “Materials” in this section for further guidance.

Level Area at Back of Cells with Public Sidewalk: See COS Std Plans 292 to 293b for width and materials for landscape area from face of sidewalk to top of slope of the bioretention cell.

Pedestrian Access at Back of Cells without Public Sidewalk: Pedestrian access zone along the ROW/property line when there is not a sidewalk at the back of the cells is required. The width will need careful review especially when vertical walls, rockeries, or slopes over 3.5:1 are used. This access serves multiple purposes including allowing for space for transitioning to existing conditions and access for City maintenance and/or resident doing work along the property line. (See Figure 7-14 for design considerations). For cells that have a vertical wall or rockery and/or are designed to manage flow from large upstream areas, evaluate need for a fence or guardrail. Finally, it is recommended if a facility is adjacent to a parcel with no “line of ownership” such as a fence or rockery then a steel edge be installed at the top of the bioretention facility to delineate the limits of O&M responsibility.

Access and transition along ROW/property line

If the bioretention facility is near a fenced property line, provide a level, mulched area at the front of the fence for both SPU/WTD O&M access and homeowner maintenance access. Similarly, if the facility is near a building or home, provide clear, durable access to and around the homes and buildings. Maintenance in this situation could be achieved with a paved path.


Access path is aligned with parcel path. Preferred.


Length of facility too long without a crossing path. Not recommended. Requires special review.


Access path is within 15' of parcel path at graded facility. Acceptable.


Walled cell placed in front of parcel access. Not recommended. Requires special review.


Paver access path. Not recommended. Requires special review.


Driveway and path between cells on Neighborhood Curbless street. Access path is within 15 feet of parcel path.


Pervious concrete access path marks end of maintained facility zone for O&M ease.


Driveway marks end of maintained facility zone for O&M ease.

Figure 7-13: Pedestrian access between cells

Constrained. Small lawn strip left for parcel owner to maintain. No level access along property line. Fence rail for vertical drop at parcel access with steps.

Constrained. Access zone not provided for fence maintenance.

No fence but a level mulched area is not provided along property line. No clear point of maintenance.

Constrained. Access zone not provided for fence maintenance and vertical drop at property line.

Constrained. Access zone provided for fence maintenance. Acceptable.

Figure 7-14: Constrained conditions at back of cells without public sidewalk along ROW/Property line

Materials for Curb/Road Edge and Pedestrian Access:

Materials for pedestrian access and curb/roadway edge access adjacent to bioretention cells maintained by SPU/WTD are intended to be standardized across the city for social equity and to provide consistency for maintenance crews. Table 7-8 and Figures 7-15 and 7-31, provide guidance on material selection for the area at the back of curb/roadway edge conditions and the access area between cells.

While Table 7-8 indicates a general order of SPU/WTD maintenance material preference, neighborhood conditions and project extents will factor in the approach used. Selection of material for surfacing varies based on the review of the adjacent land use and space available. It may be appropriate to use one approved material for curb edge treatment and a different approved approach for the pedestrian access (such as pervious concrete for the access path and arborist woodchips for the curb edge).

> In high pedestrian activity situations (e.g., a commercial/school/community center area with high parking turnover, Urban Villages, etc.), paving is more suitable for the primary access path.
>
> In Neighborhood Curbless and Neighborhood Yield streets, which have less pedestrian activity compared to some other street types, except for the primary access path between cells, paving other areas (e.g. along road edge, outside primary access path) is not required and in fact is discouraged due to the goal of minimizing impervious/hard surface areas. The SPU/WTD project team should use their own discretion as to when a hard surface is appropriate, e.g., in deference to the need to roll out trash cans/yard waste/recycling containers (when applicable) or other mobility considerations. Use of pavers along the curb edge requires a review and agreement with the agency's O&M lead. Pavers can be hard to weed around and may become unstable, thereby increasing maintenance frequency.
>
> Along curbless streets or streets with low height curb (under ~4 inches), if there is on-street parking, provide measures to reduce potential for people to park vehicles off the roadway pavement, such as providing a curb or low shrubs or other SDOT approved measures. See Section 7.3.17 for further design guidance for road edge treatment along Neighborhood Curbless streets.

ADA accommodations across the planting strip

The planting strip and pedestrian access from curb/edge of road to sidewalk are not considered ADA-accessible routes unless accommodations are requested and approved through City process.

Minimize new hard surfaces

Project Teams shall consider the stormwater impacts of using hard surface materials. If thresholds for new/replaced hard surfaces are met, then mitigation for it will be required per Code. See COS SWM.

Note that more space/width is required for the step out zone (next to curb/road edge) when it is a hard surface. See details in Appendix D.

Table 7-8: Pedestrian Access/Curb Edge Materials in Order of Preference

Material	Considerations (See also Appendix D)
Pervious cement concrete **OR** **Conventional cement concrete**	• Use for primary pedestrian access paths. • Use for high pedestrian traffic volumes expected at commercial or industrial areas, schools, community centers, and parks. • Use for ADA-accessible paths. See Streets Illustrated ROWIM. Coordinate materials for ADA-accessible paths with SDOT (such as through SIP design guidance). • Option if designed for fixed trash/recycling pick-up areas. • Pedestrian access at curb edge (step out zone for when there is on street parking) can be conventional cement concrete if it is continuous and there are multiple cells in a series (cells consolidated on a block portion not distributed). • Note: Increase in hard surface with concrete may require further mitigation to meet Code and COS SWM requirements.
Arborist wood chip (*preferred option*) or Cedar play chip material over reinforced grid	• Along curb edge (Step out zones) Initial installation – 3-inch minimum depth over reinforced grid system such as used in Gravelpave2, GEOPAVE® or other similar product. • Not recommended for primary access path. • Top dress with 2- to 4-inch of chips at least once per year.
Concrete pavers spaced with gravel **or** **Gravel with open-celled grid**	• Can be used when there is a request from homeowner for a firmer surface and use of the material is approved by SPU/WTD O&M. • Option for fixed trash/recycling/yard waste pick-up areas. • Use depends on context. Not recommended for primary access path. • Reinforced grid system required under gravel only surface. • Gravel requires topdressing at least once per year
Steppable plants	• Requires additional construction and maintenance costs but provides a continuous green pervious area for secondary access path. • Requires SPU/WTD O&M approval. • Do not use for primary access path. • Do not use for curb edge
Lawn / Grass	• Access path: Recommended width of 6 feet but requires a minimum width of 4 feet. • Requires SPU/WTD O&M approval • Curb edge: Not recommended for curb edge (step out zone) but if property owner requests and agrees to maintain in writing, then it can be used if there is a minimum of 30 inches along the curb edge and the limits have defines steel edging.

Wood chip mulch step out zone

Concrete step out zone and access path

Paver & gravel step out zone

Tight pavers step out zone after installation

Tight pavers step out zone - difficult to weed

Paver step out zone - difficult to weed

Paver step out zone - difficult to weed

Grass in step out zone too narrow for practical maintenance. Only use if adequate room and property owner agrees to maintain.

Figure 7-15: Curb/Road edge treatment comments

7.3.9 Areas with Designated Parking

Bioretention cells shall not be sited in planting strips where adjacent on-street parking is designated with signage for special parking conditions such as a load/unload zone or immediately adjacent to a City-permitted accessible parking space. Observe the neighborhood use of parking and discuss at outreach events and in flyers. Coordinate with outreach staff on Project Team to determine if there are potential changes to designated parking.

7.3.10 Driveway/Alley Access

Bioretention cells shall not impact driveway/alley access. A recommended 3 feet but a minimum 2-foot setback shall be provided from the pavement edge of the residential driveway curb cut wing to the top (top of slope) of bioretention cell. Where existing residential/alley driveway widths are substandard from Seattle Municipal Code (SMC), additional setbacks should be provided to allow future modification. Occasionally, existing residential driveways to single-family lots are wider than the width noted in SMC and Streets Illustrated ROWIM. If the improvements require driveway restoration and the existing width limits the placement of the bioretention cell, then it is preferred that these driveways are re-installed to a width not greater than the driveway width per SMC and Streets Illustrated ROWIM. It is recommended that the Project Team review revised driveway widths with SDOT, SDCI and the property owner.

In some cases, the property owner may use an “unimproved” driveway, e.g., no driveway curb cut but the property owner crosses the planting strip for vehicle access. While more common on Neighborhood Curbless streets, it can also occur on streets with curbs. Under these conditions, while there is no constructed driveway, the existing condition is a social function that will take effort to resolve. The Project Team should attempt to locate bioretention cells to avoid impacting this use. If the location is needed for stormwater management capacity then discuss prior to 30 percent design submittal with the agency project manager, SDOT and SDCI. It will be important to review if the property has alley access with a garage or viable at grade space and if the non-conforming driveway assists with the use of a mobility device (i.e. back door has stairs and front is at grade). If the decision is to formalize the driveway coordinate with the Outreach team and the agency project manager on whether this is a private SDCI permit by the property owner or part of the project (currently there is no formal policy). When designing the retrofit of a new a curb bulb with bioretention near a driveway, see Section 7.4 for information.

Removal of driveway curb cuts

If the driveway is no longer used by the property owner and there is not a designated parking space on private property as required in SMC, then the driveway curb cut may be removed if approved by SDOT and SDCI. Prior to removal or adjustment of the driveway curb cut, confirm removal with SDCI/SDOT and the property owner.

7.3.11 Converting Existing Paved Planting Strips for Bioretention

If the existing planting strip is paved (from sidewalk to curb) and it is not adjacent to a designated parking space (permitted disabled parking space) and/or driveway or required for an infrastructure utility (such as concrete pad for utility cabinet), then this area may be considered for retrofit for bioretention cells and other drainage/street tree use. If the resident uses the paved planting strip for parking, then the Project Team should consider the social function and review how to formalize the parking to avoid parking in the planting strip and allow its use for bioretention cells, new street trees and/or reduced impervious surfacing.

7.3.12 Depaving Wide Streets for Bioretention

If the existing road is wider than Streets Illustrated ROWIM's standard for Neighborhood Yield and Neighborhood Curbless streets and traffic calming is desired, through design guidance with SDOT, review option of narrowing the roadway to City standard for a Neighborhood Yield street. In some cases, if the existing planting strip is narrow, depaving a portion of the road may provide a wider planting strip with adequate width for bioretention cells, while not decreasing on-street parking.

Coordinate revisions of road layout, road's centerline alignment and depaving with SDOT during 0-30 percent design if it was not approved prior to the start of the Design Phase.

Depaving existing road area for bioretention

A wide road may have an adjacent narrow planting strip, but by installing a curb bulb/ curb extension or narrowing the road width to City standard, a preferred cell cross section type with graded side slopes may be utilized.

7.3.13 Design at Intersections & Curb Ramps

Requirements for restoration at intersections are to be in accordance with SDOT's Right of-Way Opening and Restoration Rules, Streets Illustrated ROWIM, and United States Access Board's Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-Way (PROWAG).

Curb ramp improvements are required whenever the construction of bioretention cells and associated street improvements remove pavement within the crosswalk area of the road or sidewalk, impact curbs, sidewalks, curb ramps, curb returns or landings within the intersection area, or affect access to or use of a public facility. Review project specifics with SDOT (such as through SIP design guidance or through designated SDOT representative assigned to partnering projects).

Curb ramps and companion ramps have very specific criteria and shall be designed and constructed to meet SDOT and PROWAG requirements. If space allows and SDOT and

PROWAG requirements are met, utilize side curbs instead of side wings for curb ramps on the side adjacent to the planter strip and/or provide space between curb ramps for planted areas to minimize impervious footprint.

Three feet is recommended but a 2-foot minimum setback shall be provided from the edge of paving for the public sidewalk/curb ramp at the intersection to the top of slope of the bioretention cell.

Image: Bioretention with vertical wall at sidewalk in new curb bulb just after construction. Less than 2-foot setback provided from edge of ramp to top slope of bioretention cell.

7.3.14 Siting and Designing Cells for Maintenance

In locating bioretention cells, designers need to review the siting approach from the perspective of long-term maintenance.

Key cell siting issues from a maintenance perspective include cell grouping, cell spacing for access and unloading of materials, structure placement, and appropriate drain curb cut placement.

Key cell design issues affecting maintenance include: edging to define limits of facility maintenance, grade transition at edges to ease use of trimmers, drain curb cut type selection, access lids placement and cobble placement for presettling zones and inflow/outflow paths. For defining limits, improvements should extend to, and end at, pavement edges and/or intersections, alleys or midblock, when feasible (see Section 7.7 and Figure 7-36 for examples.).

For SPU-led CIP retrofit projects, a minimum 500 sf of top area of bioretention cell(s) is required on a block or within two blocks of another SPU maintained bioretention facility if it is to be maintained by SPU.

7.3.15 Siting Cells Based on Method of Discharging the Stormwater

The method of discharging the stormwater once it has filtered downward through the bioretention cell is also a factor in the design and siting of the cells along a street. When shallow infiltration is determined to be infeasible, there are three primary options:

- Underdrain conveying filtered stormwater to downstream public storm drain conveyance system
- Underdrain conveying filtered stormwater to a downstream deep infiltration facility (see Section 10)
- A pit drain below the bioretention cell (see Section 10)

The following subsections provide design guidance for varying configurations of bioretention cells along a street depending on the type of infiltration/method of discharge of the treated stormwater.

7.3.15.1 Bioretention Cells without an Underdrain (Shallow Infiltration)

When geotechnical analysis indicates shallow infiltration is feasible, bioretention cells may be distributed along the length of the street, consolidated midblock and/or consolidated at the end of a block. Table 7-9 provides design guidance for siting bioretention cells with no underdrain within the public ROW.

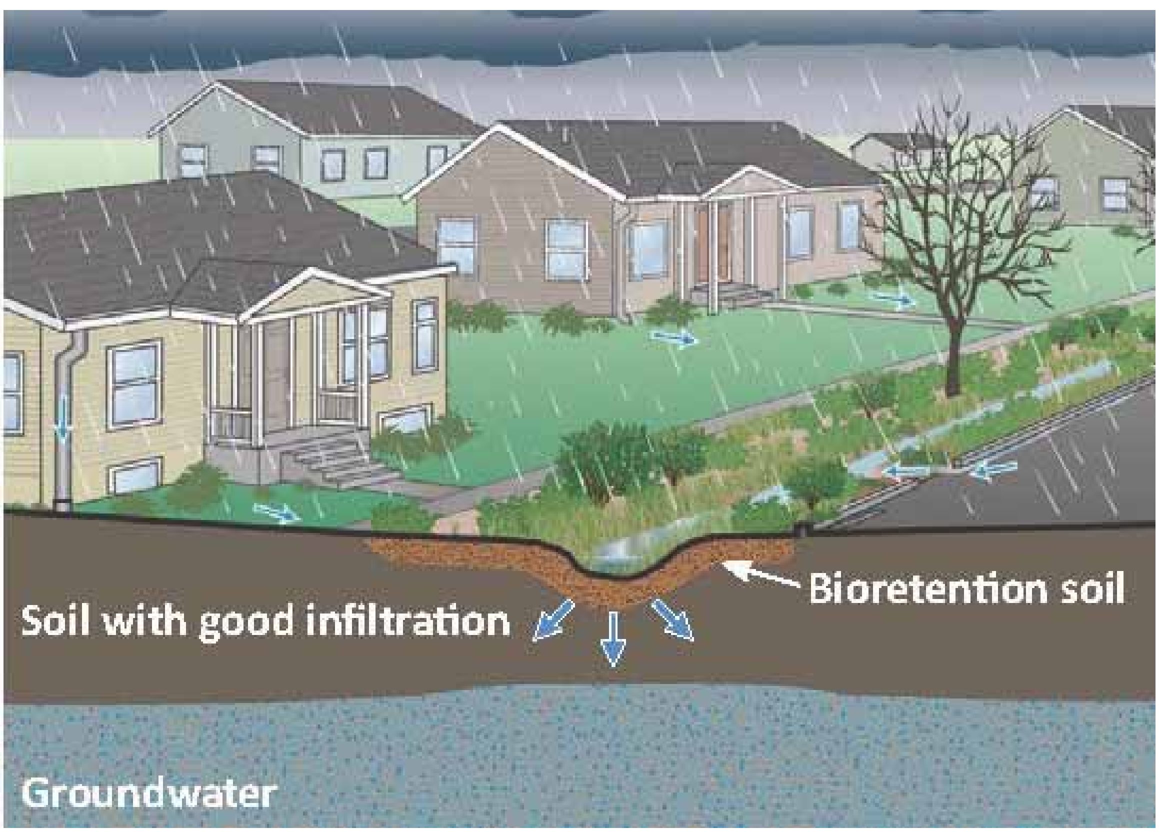
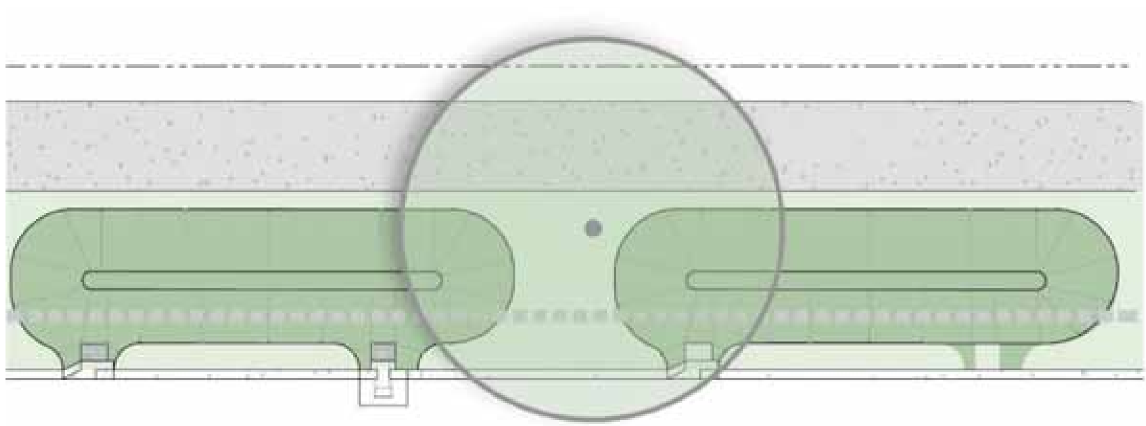


Image Bioretention with shallow infiltration (no underdrain) in planting strip. Graphic from WTD Barton project outreach materials.

Table 7-9: Design Guidance for Siting Bioretention Cells with No Underdrain

No Underdrain – Siting Guidance	Rationale
Single Block Runoff: If cells are distributed and receiving runoff from just the block, then the first bioretention cell at upstream end of street shall be at least 70 ft or more from the point of curvature/point of tangency (PC/PT) of the curb return. Review conditions in the rain to confirm the location of the cell would receive significant gutter flow.	To ensure the upstream impervious area draining in the gutter to the first bioretention cell is large enough to justify the location (Note: 70 lf of 12.5-ft road & 5-6ft +/- sidewalk is about a 5% sizing factor for a cell – see modeling guidance document, Appendix H). If the cells are consolidated at the downstream end of the block, then review if a presettling zone is required within the first cell. See Section 7.5.4 and COS Stormwater Manual for sizing presettling zone.
Larger Area Runoff: If cells are receiving runoff from a larger area upstream of the block, then locate first cell just after the intersection after factoring in space for sidewalk and curb ramps and other ROW elements (e.g. fire hydrants, power poles etc.).	To minimize conveyance infrastructure to the first cell on a block. See COS Stormwater Manual for sizing presettling zone for point discharges from large upstream areas (multiple blocks).
Distributed Cells: If cells are distributed along the full length of the street, then provide overflow (via drain curb cuts or other means such as breaks in the thickened edge on curbless streets).	To achieve a balance between the upstream contributing impervious area and the receiving bioretention cell area. This approach also provides a consistent pedestrian environment and distributes the impact to properties along the street.
Upstream of Catch Basins (CB): If a CB is located at midblock or downstream end, then locate cells just upstream of CBs. Cells may either be consolidated or distributed along the block.	To intercept road runoff before it discharges into the storm drain/combined sewer. This would also allow for the existing CB to be the overflow during larger than design events.
End of Block Cell: Locate last cell (at downstream end) on each block as close as practical to the intersection after factoring in space for sidewalk and curb ramps.	To maximize interception of runoff from upstream impervious areas. This also discourages parking near intersection.



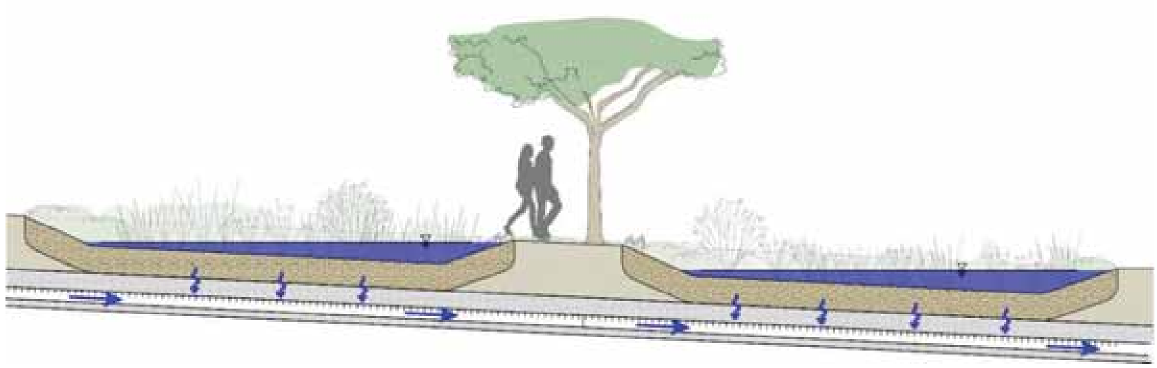


Image Bioretention with an Underdrain. From top to bottom: cross section through planting strip, plan view of bioretention cells, profile section through middle of planting strip) of partially lined bioretention cell in a series with an underdrain. Graphics from WTD Barton CIP.

7.3.15.2 Bioretention Cells with an Underdrain

When an underdrain pipe is used below bioretention cells for conveying flows from multiple cells to a discharge facility, bioretention cells are best consolidated near the discharge facility (e.g. PSD or UIC screen well at end of block etc.). This minimizes construction costs for installing the underdrain network. The discharge facility can vary from discharge into a screen well, media filled hole/drilled drain, pit drain; or discharge into the storm drain conveyance system; or discharge into a detention system with orifice control prior to discharge back into the storm drain system or other.

In addition to designing the underdrain system to collect filtered water, determining the location of the underdrain pipe requires collaboration between the civil engineer, landscape architect, and hydrogeologist/geotechnical engineer. Issues such as clearance between other utilities/services, alignment and/or type of trenching around existing trees to protect, and/or placement of new street trees adjacent to underdrain pipe shall be reviewed by the project team members. See figures in Section 7.7 for options for placement of underdrain system in relation to new street trees.

Table 7-10 provides design guidance for siting bioretention cells with an underdrain and associated discharge facility within the public ROW. See Section 7.5.8 for guidance on designing underdrain systems.

Table 7-10: Guidance for Siting and Designing Bioretention System with an Underdrain

With Underdrain – Siting Guidance	Rationale
Consolidate Cells: Consolidate required bioretention cells in the downstream portion of the street near the infiltration facility/discharge point.	To maximize capture of stormwater runoff from upstream contributing impervious areas; reduce construction costs associated with longer lengths of conveyance pipe between bioretention cells; and reduce potential for existing tree impacts and driveway reconstruction. See also Section 4.5 and Appendix G for preserving and siting trees, respectively.
Underdrain Conveyance: Where an underdrain is used to convey flows to discharge facility, locate discharge facility (screen well, drilled drain, pit drain, flow control structure, etc.) on each block as close as practical to the downstream end of the street.	To maximize interception of runoff from impervious areas; may also provide opportunity to install a shared discharge facility if an adjacent cross street is to have bioretention cells

(table continued next page)

Table 7-10: Guidance for Siting and Designing Bioretention System with an Underdrain (continued)

With Underdrain – Siting Guidance	Rationale
Crowned Roads: On crowned roads, cells with an underdrain shall be located on one side of the street and a CB/Inlet installed on the opposite side of street to collect gutter flow and convey the flow to cells on opposite side.	To minimize construction and O&M costs. A curb bulb may be required to achieve necessary depth to daylight the CB/Inlet connection pipe into the cell.
Long Blocks: For long blocks (~660'+/-) where existing midblock catch basins are not to be abandoned, consolidate and locate bioretention cells just upstream of CB.	To maximize capture of stormwater runoff from upstream contributing impervious areas and re-divert it from entering the CB
Long Blocks – Abandon CB: For long blocks (~660'+/-) where existing mid-block catch basins can be abandoned, consolidate bioretention cells at end of block.	To maximize capture of stormwater runoff from upstream contributing impervious areas when cells are consolidated at the end of the block. The midblock CB may be abandoned if requirements and improvements are met as described in Section 7.6. Project Teams shall review capacity of downstream CB at end of block and upgrade structure if needed.
Street Trees: Accommodate new street trees and protect existing trees (within and adjacent to ROW) identified as to remain and protect.	See bioretention street tree planting details (# BTP-6 & BTP-7) in Appendix D, tree placement figures and concepts in this section, and information in Appendix G. For existing trees, consult with arborist and review excavation extents for wall/liner/underdrain/cell with arborist. Consider using trenchless construction for installation of the underdrain if needed. See Section 4.5.

7.3.16 Siting and Designing Cells that have Liners

Cells with liners are required when concerns regarding infiltration may have negative impacts on the surrounding area as defined in COS SWM and through the geotechnical engineer's and hydrogeologist's evaluations of the subsurface conditions. Designing cells with a liner and underdrain pipe is project-specific given soil and site conditions. Cells may either be fully lined or partially lined depending upon the project subsurface conditions and recommendations from the geotechnical engineer/hydrogeologist.

> **Liner versus No Liner**
>
> The approach to siting and designing cells with a liner and underdrain differs from cells that are unlined.

The extent of liners (depth, length, and placement) in a bioretention cell can have a major impact on the design of other infrastructure elements and space considerations including street trees, plantings, access between cells, O&M etc. As a result, it is recommended that Project Teams determine the design specifications for the liner (and which cells/zones require liners) at 30 percent design in coordination with SPU FOM/WTD O&M, landscape architect, civil engineer, and geotechnical engineer. The liner material can vary depending upon the intended purpose of the liner (e.g. Is it to be watertight vs soil tight?) and how it is to be repaired/maintained as approved by O&M.

Fully Lined Cells: For cells that are to be fully lined see COS Std Plan 293b. Liners that extend up the sides of cells eliminate the opportunity for street tree planting within the cell zone because the root system doesn't have sufficient depth to anchor the tree or allow it to thrive in such a restricted condition. As a result, wider space between cells to accommodate street trees and the required soil volume for street trees (see Streets Illustrated ROWIM), pedestrian access, utility services and other elements outside the line cells is required in siting and designing cells with liners.

Partially Lined Cells (not water tight): When it is determined that subsurface conditions allow for partial liners, where the liner is not along the full cross section of the bioretention cell (such as modification of COS Std Plan 293b where the liner terminates at the interface between the underdrain trench aggregate and the BSM), then there is more flexibility in the siting and designing of cells (as compared to fully lined cells). Partially lined cells, depending on the width and extents of the liner, may allow for opportunity to locate street trees within the cell zone without restricting the root system.

7.3.17 Special Considerations for Retrofitting Curbless Streets

While previous sections provide guidance for bioretention design for both Neighborhood Yield and Neighborhood Curbless streets, curbless streets have some additional design considerations and requirements. The following discussion and figures reflect the types of existing street and drainage conditions that may occur along Neighborhood Curbless streets.

The characteristics of Neighborhood Curbless streets result in a varying context and a wider range of existing conditions when compared to Neighborhood Yield streets. Critical elements that must be considered, particularly for retrofit projects (more so than full street reconstructions) are the width and condition of the existing road pavement, the existing conveyance system, the flow path of surface runoff, existing parking patterns, and access to adjacent properties. See examples of existing curbless street conditions in Figure 7-16.

Neighborhood Curbless Streets typically include:

- Informal or lack of drainage conveyance systems and irregular drainage patterns
- No sidewalks
- Fence and structure encroachments into the right-of-way
- A variation on the standard 25-ft-wide pavement section typical of Neighborhood Streets (i.e. narrower or wider)
- Gravel roadway shoulders
- A variety of on-street parking patterns within a block including perpendicular and parallel parking
- Mailboxes within the street

Space Considerations for Cells and Sidewalk: Along streets that do not have sidewalks, evaluate efficiency in capturing drainage areas for siting bioretention in coordination with providing space for future 6-foot-wide standard sidewalk (required on one side of a Neighborhood Curbless street in accordance with Streets Illustrated ROWIM). Include the required level area adjacent to the walk plus the future sidewalk width when reviewing space.

The location of the space for the future sidewalk (side of the street) depends upon site specific conditions, adjacent land use and City's pedestrian and mobility goals/plans (e.g., Pedestrian Plan, Neighborhood Greenway, Safe Routes to Schools, etc.) for the ROW corridor and movement through the neighborhood.

To maximize the space for bioretention, it may be feasible to plan the future sidewalk on the opposite side of the street from the bioretention. However, it may be more suitable to have the bioretention and (space for future) sidewalk on same side of street, if a larger capture of stormwater (from adjacent parcels and/or the street) can be achieved.

TIP

If during review with SDOT it is determined that on-street parking will be allowed on only one side of the road, then general guidance is to locate the sidewalk on the same side of the street as the on-street parking.

Review the space (e.g. width, side of the street, continuity with other walks on other streets, adjacent land use) set aside for the future sidewalk with SDOT to confirm it aligns with the City's Pedestrian Master Plan for the neighborhood during the 30 percent design stage.

Varying gravel shoulder

Irregular parking patterns

Narrow existing pavement width and localized flooding

Fence encroachments

Existing ditch conveyance

Roadside topography and parcel access

Figure 7-16: Examples of Neighborhood Curbless Street conditions

Retrofit Road Edge Treatment: Project Teams should develop an edge of road treatment based on site context, O&M, and project-specific needs to:

- Define the retrofitted road edge
- Reinforce appropriate parking patterns
- Convey stormwater runoff to and from bioretention cells
- Ensure sufficient conveyance capacity downstream

Table 7-11, developed by an interdepartmental breakout group (SPU and SDOT Traffic Engineers in 2015 and 2016) reflects the preferred approach for developing an edge-of-road treatment for Neighborhood Curbless streets (with asphalt pavement roadway) and lists the recommended minimum requirements and additional traffic and landscape issues to consider on a project-by-project basis.

Table 7-11: Neighborhood Curbless Road Edge Treatments

Edge Treatment	Rationale/Description
Minimum Requirements	
Asphalt Thickened Edge:	When project budget does not allow for the City standard concrete curb, at a minimum an asphalt thickened edge is to be used. Elevated edge helps to define road edge for vehicular use and conveys stormwater runoff along street and to bioretention cells. Provide breaks in the thickened edge to allow runoff to drain into and out of bioretention cells.
Street Trees:	Trees help to define corridor and road edge, reinforcing parking patterns (e.g., parking on pavement rather than planting strip). Trees may need additional protection such as localized curbs or bollards depending on SDOT review.
Additional Landscape Considerations	
Vegetation Along Top of Bioretention Cell:	Plant high contrast low shrubs and other prominent vegetation along the top edge of bioretention cells. This vegetative edge will help define bioretention locations, buffer cells from vehicles, and reinforce desired parking patterns.
Additional Traffic Considerations	
Pavement Markings:	Install paint (fog) lines along the edge of the travel lane/parking lanes to guide drivers as to where to park. This may be a short term-installation (i.e., not continually restriped) to help inform residents while they adjust to the new street layout and while vegetation establishes/becomes more prominent.
Reflective Pavement Markers (RPMs):	An alternate and/or addition to pavement markings, which also provides a tactile element for drivers.
Signage:	Provide parking signs at select locations to inform residents of appropriate parking locations along retrofitted streets. Signs can be temporary or permanent depending on needs (similar approach in how SDOT designs signage for protected bike lanes).

Defining Retrofitted Road Width and Alignment: If the road pavement width is less than or greater than the City standard for Neighborhood Curbless streets and/or if the road centerline is offset from the ROW centerline, review proposed revisions to road width and road centerline alignment with SDOT between 0-30 percent design to determine where to site the cells and locate the road edge treatment.

For retrofits, the new asphalt road edge location will vary depending upon if the road is widened or narrowed and if there is on-street parking.

The width of the new pavement (including the asphalt thickened edge plus roadway pavement restoration) will be project specific. Factors that affect how much new pavement is to be installed include such things as the existing road width and if it is to be widened to meet City standard, the existing surface condition (e.g. road grades and pavement condition), and how siting of the asphalt thickened edge impacts sheet flow for conveying to the proposed cells.

Where the existing road is narrower than City standard, bioretention cells shall be sited based on the future City standard road alignment and road width (factoring in differing road and ROW centerlines if applicable) as if it was a Neighborhood Yield street even if the road is not widened as part of the retrofit project. This is to minimize impacts to the installed and established bioretention facility asset if the road is built to City standards in the future by other development(s).

TIP

For SPU-SDOT partnering projects with cost sharing along Neighborhood Curbless streets where a new sidewalk is to be designed for the full block length, there may be areas where the landscape zone is narrowed to avoid impacting mature trees with the new sidewalk. When the sidewalk is adjacent to the road edge, City standard concrete curb shall be installed. This is to provide an edge and to deter residents from parking on the sidewalk.

Conveyance Preferred Approach: Often curbless streets have informal (or lack of) drainage systems to provide conveyance of runoff collected in the right-of-way. To convey and direct flow to the bioretention and to provide conveyance along the edge of the asphalt road, the preferred road edge treatment approach is to install an asphalt thickened edge, which is less expensive than installing concrete curb and gutter. This also provides adequate conveyance for the block if there are no flows from other blocks upstream. Figures 7-17 shows this concept for a street retrofit with an asphalt thickened edge. If there is no existing conveyance along the street length, it may be necessary to install the road edge treatment (asphalt thickened edge or curb and gutter) along the full street length. The edge treatment can also help guide new parking protocols (e.g. City standard for parallel parking) for the curbless street.

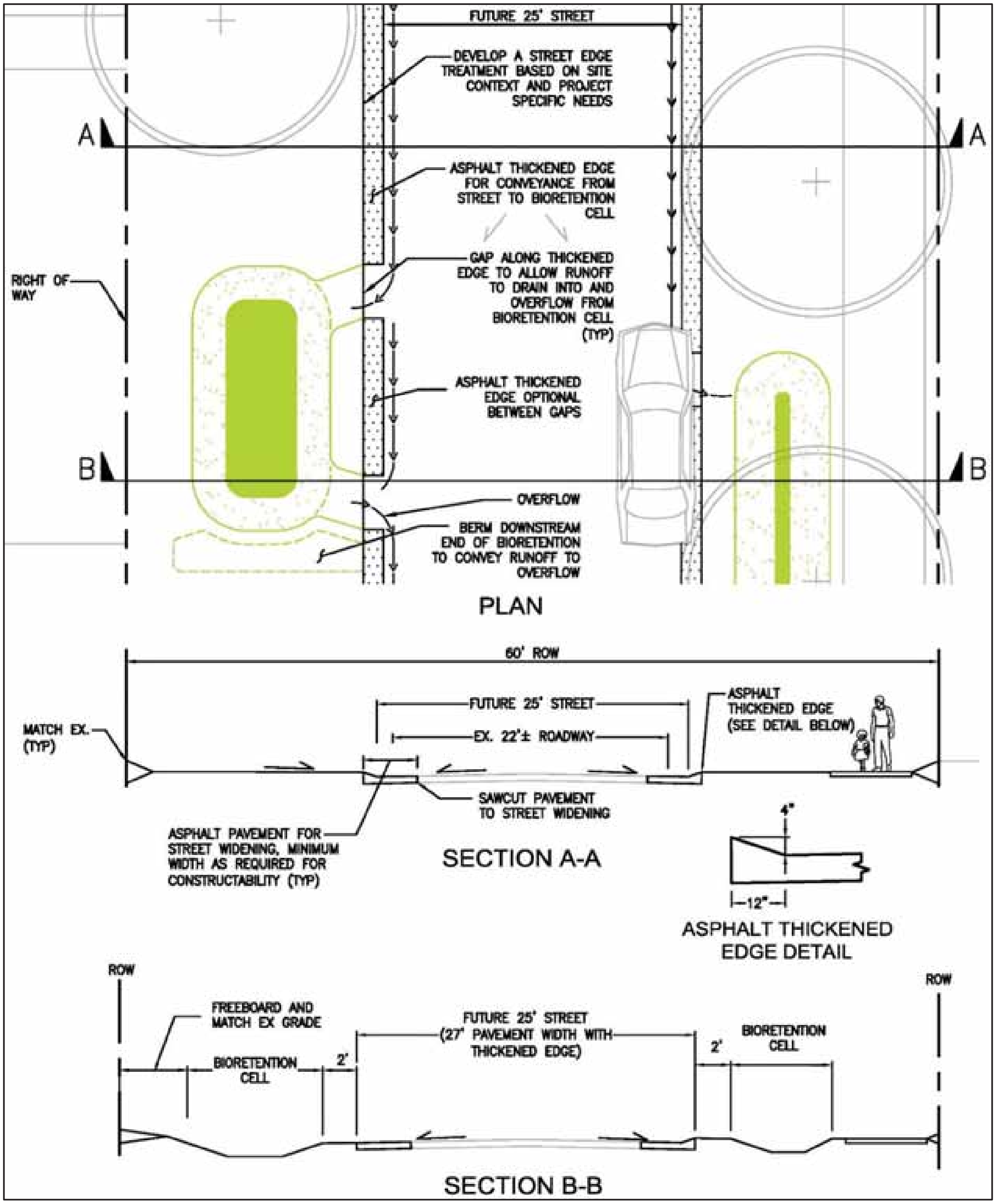


Figure 7-17: Neighborhood Curbless conveyance, asphalt thickened edge

Alternative Approach to Conveyance: Depending on site concept and project-specific needs and/or if the road is conveying flows from a larger upstream area than just the adjacent block, an alternative conveyance approach from the asphalt thickened edge is to retrofit the street with vegetated conveyance swales in accordance with COS Std Plan 294. This concept is shown in Figure 7-18. Review existing grades at the edge of the ROW for feasibility and impacts to desired edge of roadway treatment. Culverts shall be at driveways to convey flow and sized to ensure sufficient conveyance capacity. Provide minimum 6-foot clear zone around culvert ends for SPU maintenance access.

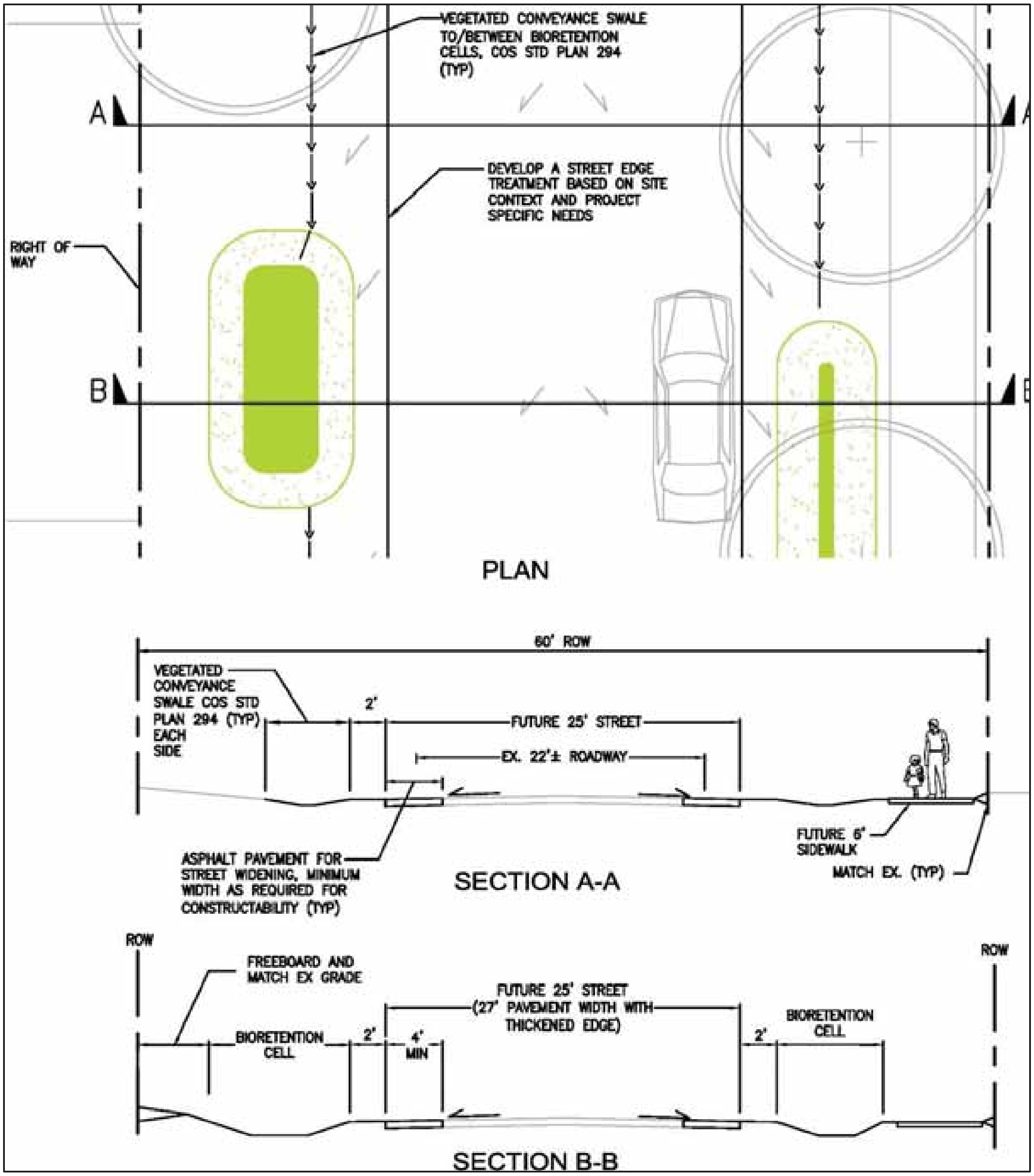


Figure 7-18: Neighborhood Curbless conveyance alternative, vegetated swale

7.4 Retrofitting Roads with Curb Bulbs for Bioretention

Curb bulbs (also referred to as “curb extensions”) may be used to increase the amount of space/volume available for storage of stormwater in the bioretention cell while at the same time providing traffic calming benefits. Retrofitting roads with curb bulbs also allows the opportunity to daylight CB connection pipes (such as from CBs/Inlets on the opposite side of the street) by widening the planting strip and providing more space to increased cell depth in the planting strip (See Figure 7-19 for retrofit examples of constructed curb bulbs). Curb bulbs affect multiple functions of the street and require careful coordination with SDOT and the neighborhood.

See Streets Illustrated ROWIM for design standards (including curb radii requirements) and minimum curb-to-curb width requirements. Review requirements and parameters for analysis with SDOT prior to locating curb bulbs.

Curb bulbs placed at intersections should be reserved for Neighborhood Yield streets unless reviewed and approved by SDOT. Review neighboring land uses and users (e.g., bus/truck routes) of intersecting streets when considering curb bulbs at intersections. When designing curb bulbs at intersections for Neighborhood Yield streets that have atypical conditions (such as intersections not at 90 degrees, narrower road widths, bulbs adjacent to an alley driveway, or other site-specific conditions), SDOT will require a vehicular turning analysis (using AutoTURN® or other similar tool) to assess turning movements around the corner and/or from an alley to the street. Review with SDOT what type of vehicles (truck, school bus, articulated bus, passenger car) to use for the analysis.

Curb bulbs designed at an intersection will require curb ramp and intersection improvements in accordance with SDOT’s Right-of-Way Opening and Restoration Rules. This may also provide opportunities to partner with SDOT in cost sharing for providing traffic calming, improving pedestrian safety through decreasing crossing width, and/or curb ramp improvements.

Table 7-12 provides design guidance for siting bioretention curb bulbs along Neighborhood Yield streets with bioretention cells. See also Figures 7-20 to 7-23 for example concepts.

Bioretention curb bulbs at intersections with arterials

Further analysis by Project Team and review by SDOT are required for designing curb bulbs on Neighborhood Yield streets intersecting with other street types (such as Urban Village Neighborhood Access or Minor Industrial).

Depending upon angles of the intersecting roads and curb bulb width, SDOT may require an AutoTURN® analysis or another method for analyzing turning movements of various vehicle size(s) to determine the offset and alignment of the curb bulb and minimum road width.

Curb bulbs with bioretention retrofitted along Neighborhood Yield streets. Curb bulb allowed for wider planting strip to design cell to receive flow from CB connection pipe daylighting into cell. Retrofitted curb follows curb radii standards per Streets Illustrated ROWIM. 34th Avenue SW, WTD Barton project.

Dual purpose retrofitted curb bulb for bioretention and shortened pedestrian crossing along Neighborhood Corridor street at intersection with Neighborhood Yield street. Note: Straight section of curb along curb bulb does not meet Streets Illustrated ROWIM for compound curve radii. 80th Avenue, NW, SPU Ballard Phase 2 project.

Dual purpose curb bulb for bioretention and pedestrian crossing along Neighborhood Yield street (also a Neighborhood Greenway). 17th Avenue SW, SPU Delridge project.

Figure 7-19: Examples of curb bulb retrofits on Neighborhood Yield streets

Table 7-12: Design Guidance for Siting Curb Bulbs on Neighborhood Yield Streets

Curb Bulbs – Siting Guidance	Rationale
Appropriate Road Width	
Width of Curb bulbs: Shall meet SDOT requirements and maintain minimum road width (curb to curb) as follows: • Neighborhood Yield streets 25 ft wide road: 5-ft curb bulb and minimum 20-ft road width at curb bulb. • Neighborhood Yield streets 26 ft road or wider: 6-ft curb bulb and minimum 20-ft road width at curb bulb. • Other street types: In accordance with the Streets Illustrated ROWIM.	Seattle Fire Department requires a 20-ft minimum road width for emergency vehicle access on neighborhood streets.
Number of Curb Bulbs: Along Neighborhood Yield streets (25 ft curb to curb), one 5-ft curb bulb on one side of the road is preferred. Along long blocks (over ~500 LF), up to two bulbs may be feasible if there is enough space in between bulbs and on-street parking is not too constrained.	When curb bulbs are retrofitted across from each other on Neighborhood Yield streets, the result is 2.5-ft curb bulbs on each side. This layout may be less cost effective and take more on-street parking (if bulbs extend beyond existing restricted parking areas) when compared to a single 5-ft curb bulb on one side of the road.
Spacing Along Street	
Minimum spacing between curb bulbs on the same side of the street shall accommodate at least one parked car between the curb bulbs.	To limit impacts to existing on-street parking and traffic movement through the corridor. Typically, on-street parking is not allowed on the side of the road with the curb bulb.
Minimum spacing between curb bulbs on opposite sides of a street shall be 20 feet between the PC of one curb bulb to the PC of the opposite curb bulb.	For vehicle movement. Wider spacing may be needed depending upon location of driveways.

(table continued next page)

Table 7-12: Design Guidance for Siting Curb Bulbs on Neighborhood Yield Streets (continued)

Curb Bulbs – Siting Guidance	Rationale
At or Near Intersections	
Preferred Location on a Block: locate curb bulbs at the intersection (where no parking is allowed).	To provide traffic and pedestrian benefits (reduced crossing distance). To reduce amount of on-street parking loss.
Neighborhood Greenways (NGW): locate curb bulbs at intersections with arterials.	To provide traffic and mobility benefits (reduced crossing distance) and support NGW goals. NGW focuses siting curb bulbs at arterials but not at all street types.
Intersections <ins>without traffic circles:</ins> curb bulbs shall maintain a 20-ft curb-to-curb dimension. If curb bulb is located at intersection, then full curb return improvements will be required.	To maintain traffic and turning movements per SDOT.
Intersections <ins>with traffic circles</ins>: a curb bulb may extend into the curb return if an 18-ft curb-to-curb dimension is maintained and the traffic circle has a 2-ft-wide mountable curb. If both requirements are met and a curb bulb is located at the intersection, then full curb return improvements will be required.	To maintain traffic and turning movements per SDOT.
For start of curb bulb near an intersection locate the PC for the start of the curb bulb a minimum: • 20 ft from a crossing/crosswalk • 30 ft from a stop sign for consistency with no parking restrictions at intersections and stop signs (SMC Chapter 11.72).	To maintain traffic and turning movements at the intersection. This assumes the curb return at the intersection remains and that the curb bulb is along the Neighborhood Yield street. For design of new curb returns through an intersection, see Streets Illustrated ROWIM. Vehicle turning analysis may be required by SDOT during SIP review depending upon the existing/proposed layout of the curb bulbs.

(table continued next page)

Table 7-12: Design Guidance for Siting Curb Bulbs on Neighborhood Yield Streets (continued)

Curb Bulbs – Siting Guidance	Rationale
Driveways	
To the extent possible, **curb bulbs should be located downstream of existing driveways**.	To maximize interception of upstream flows, simplify conveyance of stormwater across driveway and to limit impacts and access to adjacent private parcels.
If a driveway/alley is located within a curb bulb, then review the driveway/alley width and wing location to determine if more width is needed to accommodate vehicular turning movements.	For vehicle turning movements.
Parking and No Parking Zones	
To the extent possible, **locate curb bulbs centered on property lines** to maintain one on-street parking space along each parcel's street frontage (unless parcel has a driveway for off-street parking).	To limit impacts to individual property owners. However, if parcel has large frontage and/or driveway cuts, then curb bulb may extend further along a frontage if necessary, for technical reasons.
Locate curb bulbs where existing on-street parking is restricted (such as at designated/signed no parking zones, near fire hydrants, driveways, and/or stop signs at intersections). See Figures 7-20 to 7-23 in this section for further guidance.	To minimize negative impacts to existing on-street parking. At fire hydrants and other restricted areas, review on-street parking with curb bulb placement and parking restrictions so that on-street parking is provided for the adjacent parcel.
Do not locate curb bulbs at designated parking spaces or load/unload zones.	Maintain permitted disabled parking space for the residence. See Section 7.3.9.
Locate curb bulbs where on-street **parking congestion is not an issue** of concern to residents.	The loss of on-street parking will not impact the demand.

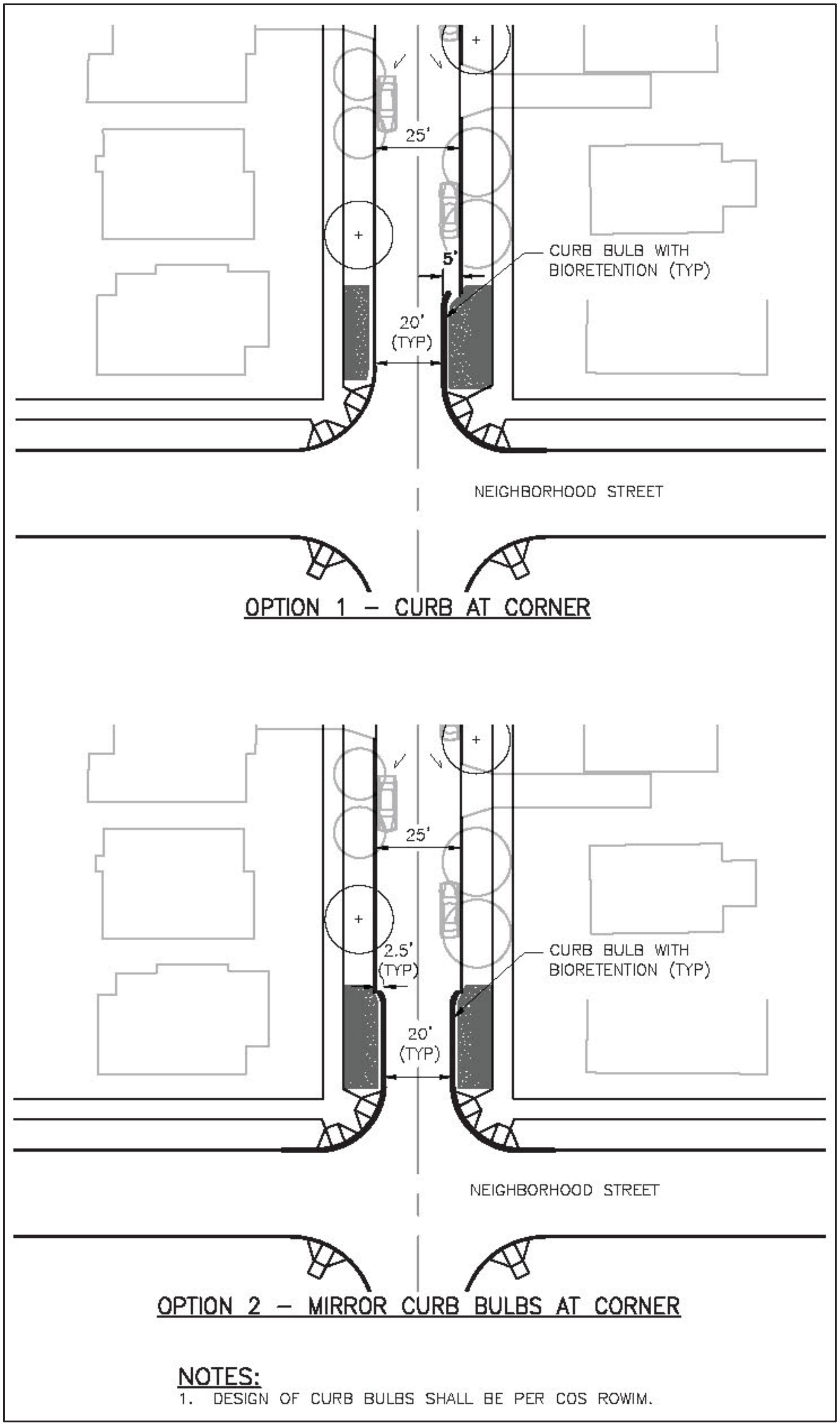


Figure 7-20: Examples of Neighborhood Yield Street curb bulbs options 1 & 2

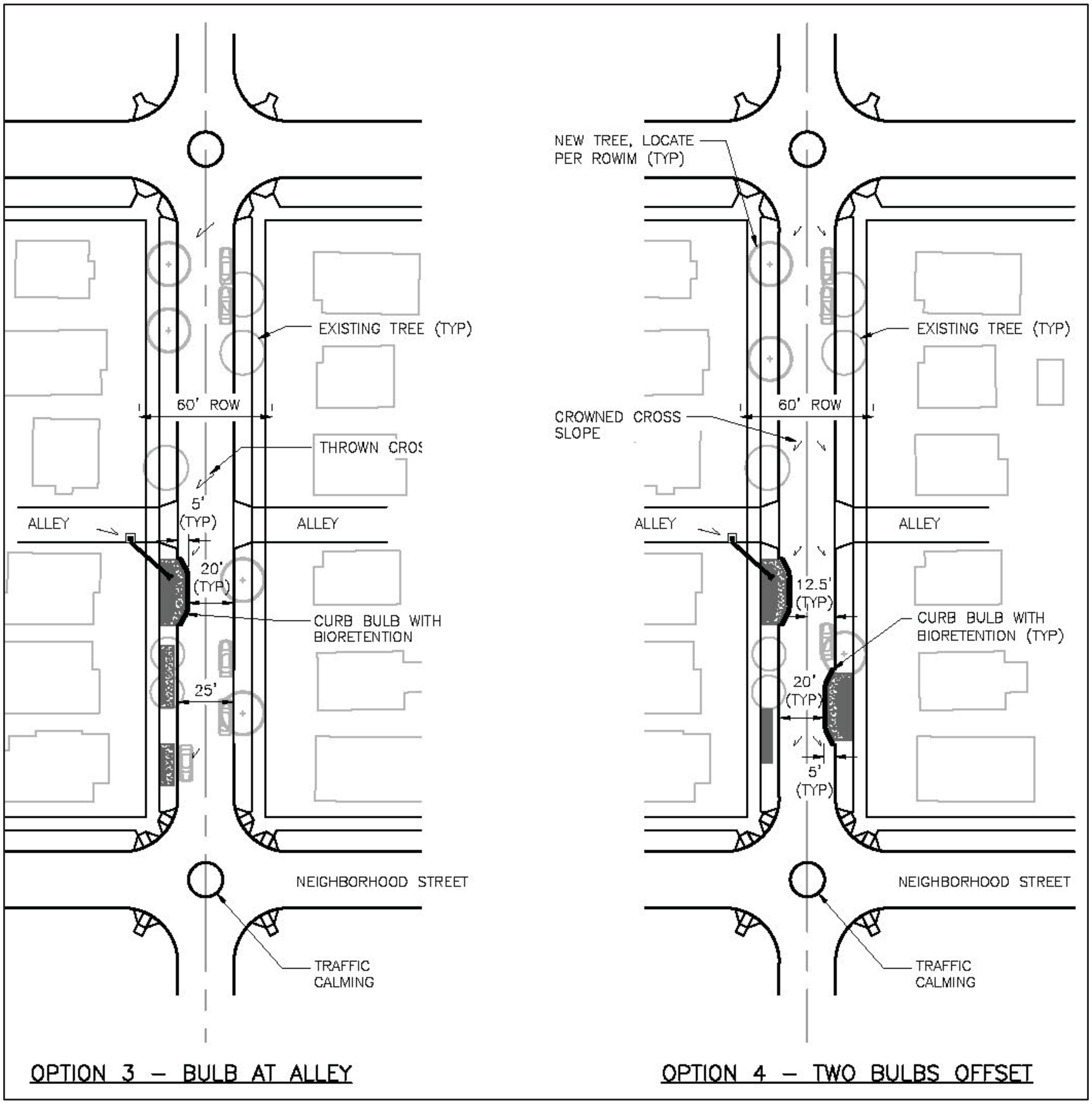
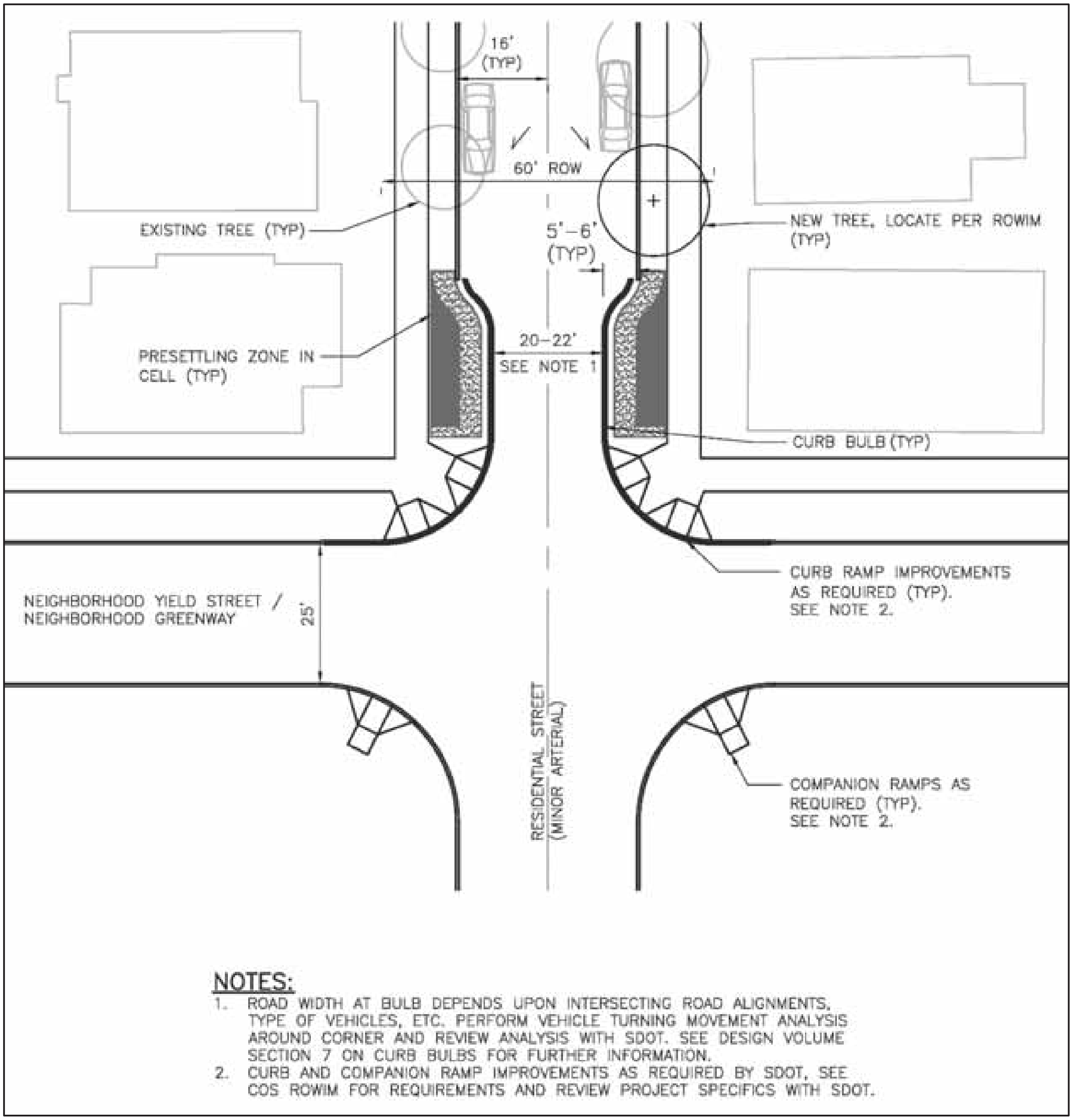


Figure 7-21: Examples of Neighborhood Yield Street Curb bulb options 3 & 4

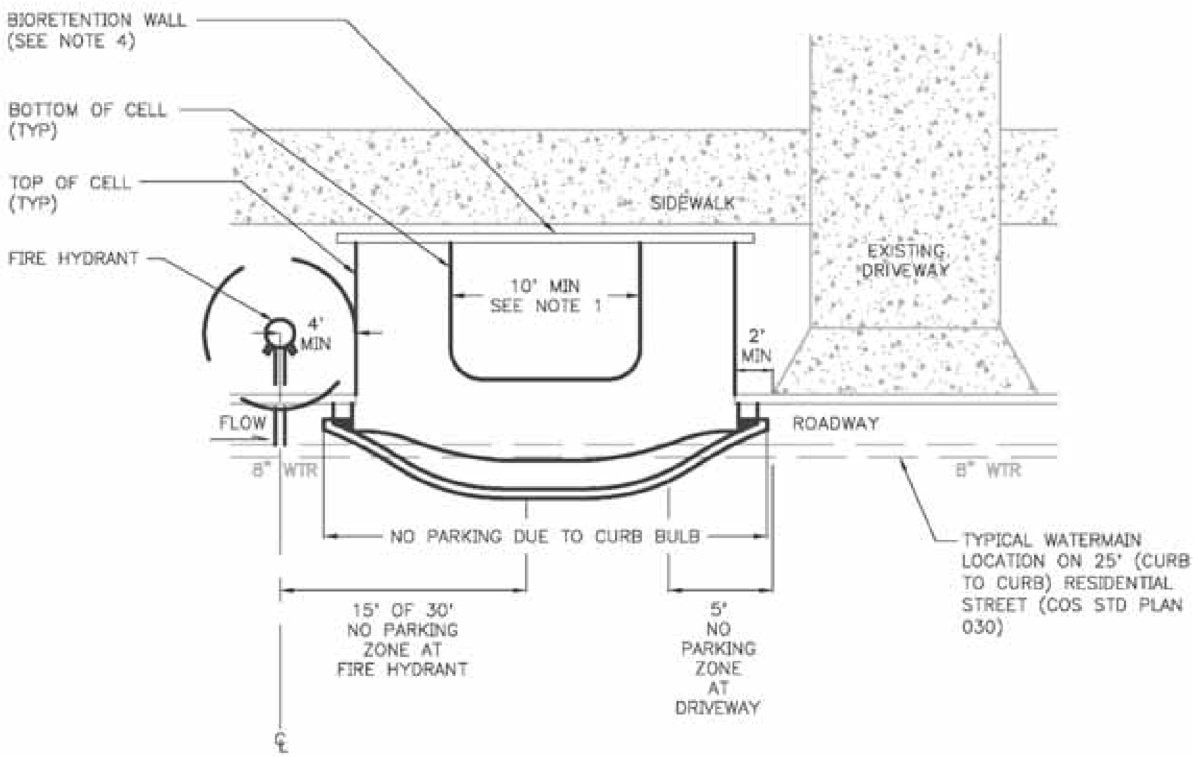


Note: Minor arterial street classification in a residential neighborhood referenced above could include Seattle's street type for Urban Village Neighborhood.

Figure 7-22: Example of curb bulb on Minor Arterial at intersection with Neighborhood Yield

OBJECTIVE:

1. LOCATING CURB BULBS WITHIN NO PARKING ZONES AT FIRE HYDRANTS TO REDUCE ON-STREET PARKING LOSS.



NOTES:

1. TO INSTALL ONE, 10' MINIMUM BOTTOM LENGTH CELL A CURB BULB STARTING AT A FIRE HYDRANT REQUIRES A 25–28' CLEAR AREA FROM THE FIRE HYDRANT TO A DOWNSTREAM OBJECT (TREE/UTILITY POLE/DRIVEWAY) . CLEAR AREA DEPENDS ON CLEARANCE REQUIRED FOR DOWNSTREAM OBJECT (E.G. 2' FROM DRIVEWAY CURB CUT).
2. START OF CURB BULB IS LOCATED TO MAINTAIN 4' LEVEL AREA AT FIRE HYDRANT AND 3' COVER FOR UNDERGROUND FIRE HYDRANT SERVICE PIPE.
3. CURB BULB STARTING AT FIRE HYDRANT TAKES LESS PARKING WHEN COMPARED TO A CURB BULB LOCATED AWAY FROM A FIRE HYDRANT WHEN EQUAL BOTTOM AREAS ARE PROVIDED.
4. CELL TYPE CAN VARY (SLOPED SIDES OR VERTICAL WALL)

Figure 7-23: Example of siting curb bulb at fire hydrant and driveway

7.5 Infrastructure Supporting Bioretention Cells

This section provides design guidance for the other elements that support the bioretention cells. See Section 7.7 for design guidance on plantings that are part of the bioretention cells' infrastructure.

7.5.1 General Design Guidance for Supporting Infrastructure

Consider maintenance activities and access when designing, locating, and selecting structures and the supporting infrastructure. See Figures 7-24 and 7-25 for examples.

Design considerations:

- Structures that require routine maintenance access should be located outside of cells whenever possible to minimize disruption of cell and facilitate work
- Maintenance access openings should be visible, but consideration should be given to location and material type that promote integration with the surrounding landscape
- Lids of maintenance holes, cleanouts, and valve and curb cut inlet covers should be sized and designed to be lifted by one person for ease of inspection and O&M access (see SPU's DSG).
- Lids shall have lift holes or other measures as approved by O&M for opening lid.
- The equipment to open lids and turn valves should be commonly available and easy to turn or lift from the surface.
- If structures will house monitoring equipment, review space, access, and operations for locating equipment with monitoring and O&M staff. Structures may need to be upsized to allow for ease of routine maintenance and monitoring activities.

O&M access
Review space and access requirements with operations and maintenance staff and monitoring staff if personnel will need access to the structure (both within and around structure).

Image: Presettling MH with dual opening sizes and located in level area for MH access. Structures located outside ADA ramp and landings. Photo from SPU's Venema project.

UMH easily accessed away from bioretention. Preferred.

MH and irrigation boxes located outside of bioretention cells in lawn area for easy access.

Maintenance hatch not easily accessed due to weight of lid and location within a walled area. Placement in cell reduces infiltration area. Not recommended.

Cleaning of maintenance structures at access path. Acceptable.

Valves that require concrete collars should be placed in sidewalk or review location to minimize impact.

Figure 7-24: Designing supporting infrastructure for O&M

UICMH is labeled "Property of King County" and "UIC Drain" to differentiate it from typical MH

UMH is labeled "GSI Drain" to differentiate it from typical MH

UMH has dual access opening (3' and 2' dia.) for meeting routine maintenance requirements and opening with MH lift rod. Level area around MH allows space for crews to remove lid.

UIC maintenance hole with UIC assembly and observation port accessible at MH openings.

Figure 7-25: Designing and siting underdrain MHs and UIC MHs for O&M

7.5.2 Walls, Rockeries, and Weirs

The use of walls, rockeries, and weirs should be minimized especially along the sidewalk. A graded edge approach improves users' interaction with the facility in the ROW. If walls, rockeries, or weirs are used, consider height, color, and texture to alert pedestrians of the changed condition. The following are additional considerations for these elements.

Walls and Rockeries for Sides of Cell

- Provide a level, unplanted area at the top of bioretention facility (beyond the back of wall/rockery) when the cell is adjacent to the ROW line for maintenance and private property access to elements such as fences (See Section 7.3.8).
- Bioretention cells with a wall shall only be placed on one side of a bioretention cell typically at the sidewalk side as described in Section 7.3.2. Extend wall along sidewalk beyond the sloped area (at each end of cell) into the level area of the planting strip to create a predictable edge to the facility. See Figure 7-35.
- Low railings may be desired when dispersed cells with vertical walls have a vertical drop over 18 inches from the top of the curb or in areas with heavy pedestrian traffic. If low railings are proposed, this would require review for new materials as described in Section 7.10.
- Designs with rockeries for the sides of a cell will be required to go through GSI Program Review of the design and deviation request for alternative materials (see Sections 2 and 7.10).

Weirs

- When managing flow within a block (not receiving flow from upstream blocks), a weir is typically not necessary for separation of the presettling zone (see COS Standard Plans for presettling zone details).
- Weirs shall be adequately keyed in on the sides (such as with impermeable material with low erosions potential) up to freeboard elevation or up to minimum 3-inches above the maximum ponding depth, whichever is greater. The ponding area shall be properly sized, and weirs properly designed so that the stormwater goes over the top of the weir and not around at the ends of the weir and erode the sides of the cell.
- Place weirs away from drain curb cuts and inlet/outlet points (at least 3 feet) to allow stormwater to enter the cells without obstruction.
- Avoid using weirs less than 16 feet apart both to reduce visual impact, to be cost

Community design supporting elements: Aside from meeting stormwater goals, the project may also have community design goals such as interpretative signage, site furnishings, art, etc. Locate signage, street furnishings, and art to complement proposed bioretention facilities, meet community design goals, and in accordance with City requirements.

effective in design and to ease maintenance.

- Provide rounded, chamfered, or buffered edges across the top of weir. Weirs can be made from cast in place concrete, boulders with grout between or corten steel with rounded molding across the top (to avoid sharp edges). See Figure 7-26 for examples.
- If a slot is set in the weir, it shall be wide enough to not be easily blocked by small debris such as leaves.

Weir location too close and block flows from curb cut. Not recommended.

Facility length and access crossings. Requires special review.

Weir aperture blocked by debris. Requires special review. Weir slot too small for practical ability to keep open

Boulder weir example

Corten steel weirs example. Recommended top edge, especially sidewalk edge, be treated (such as round molding) to avoid sharp edges

Review need for weirs and total number and provide wider intervals

Review need for weirs and provide wider intervals

Figure 7-26: Examples of constructed weirs and material types

7.5.3 Drain Curb Cuts for Bioretention Cells

For streets with curb and gutter road edge and where inflow comes from the adjacent pavement, drain curb cuts are used as the inlet to direct gutter flow into the bioretention cell and as an overflow to direct flow out of the bioretention cell when the maximum temporary ponding depth is reached. A bioretention cell may have one or two drain curb cuts (depending on the length of the cell) to maximize the amount of flow entering the cells and to fully utilize the design ponding depth. For details of drain curb cuts for curb bulbs and cells with graded side slopes, see COS Standard Plans.

All bioretention cells shall have one drain curb cut that functions as "primary" inflow/inlet and, on a shorter cell, can also be the "overflow" drain curb cut. The "primary" drain curb cut shall be located at the upstream end of the bioretention cell. However, if only one drain curb cut is installed for a cell, the "primary" drain curb cut shall be located to meet the requirements for the "overflow" drain curb cut. See Figures 7-27 and 7-28 for photos of constructed drain curb cuts.

TIP

The width of the drain curb cut opening is intended to allow maintenance personnel to use a standard flat, square shovel if removing debris by hand during routine maintenance.

"Overflow" drain curb cuts shall be located such that the gutter elevation at the drain curb cut coincides with the desired maximum temporary ponding elevation and is a minimum of 2 inches below the top slope of the bioretention cell at the downstream end of the cell. Existing grades shall be reviewed to confirm that stormwater overflowing the cell will discharge through the drain curb cut into the road's gutter and not onto adjacent public sidewalk or parcels.

When two drain curb cuts are used for a bioretention cell, they should be a minimum of 7 feet apart (measured from edge of opening to edge of opening); otherwise the transition grading between curb cuts starts to impact the social function/access along the curb edge.

To avoid roadway pavement panel joints from impacting flow into the drain curb cut:

- Review gutter condition for smooth flow
- Review pavement condition for smooth flow
- Consider whether full panel should be replaced
- Shift drain curb cut away from the panel joint
- Locate drain curb cut a minimum ~3 feet upstream or downstream of a joint

The Final design of drain curb cuts should be reviewed to maximize inflow and temporary ponding (Figures 7-27 and 7-29) while maintaining the required freeboard based on field conditions.

Flow test of drain curb cuts during construction for quality assurance

In the bid documents, if the project involves installing multiple drain curb cuts, it is recommended that a gutter flow test of the initial drain curb cut (like a “mock-up” submittal) be conducted so adjustments, if needed, can be addressed by the contractor and to establish what is acceptable by the Inspector.

As part of commissioning and/or quality assurance testing during construction, it is also recommended that gutter flow tests be conducted by the contractor for all drain curb cuts/inlets installed to ensure flow from the road drains into facility.

Contact SPU/WTD GSI Program Manager for sample special provisions/ specifications for specifying drain curb cut mock-ups and gutter flow testing.

Images: Examples of gutter flow test for COS Std Plan 295b Drain Curb Cut Type 1.

Non-standard drain curb cuts

Drain curb cuts not in COS standard plans (see examples in Figure 7-27 and 7-28) require going through deviation request and approval by SPU/WTD O&M. In designing non-standard drain curb cuts, consider the following:

- use lids and frames that are off the shelf and have consistent dimensions and sizes for ease of replacement;
- lids shall have MH lift holes on all four sides of lid and lid weight shall be moderate so that it can be easily lifted off and set back using MH lift rod;
- lids shall have a locking mechanism to reduce potential for vandalism;
- a depression in the roadway’s gutter shall be provided similar to COS standard plans and the concrete channel for the drain curb cut shall be smooth.

Primary drain curb cut meets COS Std. Plan 295b.

Secondary drain curb cut meets COS Std. Plan 295c.

Drain curb cut meets COS Std. Plan 295d.

Drain curb cut does not meet COS Std. Plan 295d. Missing vertical drop from gutter to top of bay. Curb alignment and design not per standard.

Drain curb cut does not meet COS Std. Plan 295b. Cobbles extend across bottom of cell and curb transition not per standard.

Drain curb cuts meets COS Std. Plans 295b and 295c.

Oversized curb cut is not appropriate for urban streets. Does not meet standard plans and excess hardscape impacts access.

Drain curb cut does not meet COS Std. Plan 295d. Missing vertical drop from gutter to top of bay.

Figure 7-27: Standard and non-standard drain curb cut installations

Enclosed drain curb cut. Lid too heavy for removing and resetting. Provide holes on all four sides for lifting lid.

Partially enclosed drain curb cut is difficult to clean. Holes not sized for removing lid to clean out debris.

Continuous curb top. Narrow width allows for rake to clean out curb cut from sidewalk.

Drain curb cut is too wide for urban condition and cars may park partway in cell.

Enclosed drain curb cut with planter. Holes not sized for lifting lid for cleaning.

Drain curb cut at curb bulb. Curb alignment does not meet Std. Plan 295d.

Non-standard drain curb cut. Excess hardscape, uneven, and impacts infiltration area.

Figure 7-28: Non-standard drain curb cuts

Figure 7-29: Examples of various cell cross sections types with temporary ponding water

7.5.4 Presettling Zone for Bioretention Cells

By having a designated "presettling zone," maintenance can be targeted to this area to remove sediment build-up.

Presettling may be required at the flow entrance of a bioretention facility to adequately capture debris and sediment load from contributing areas. The area designated as the "presettling zone" is not to be included in the footprint sizing for required water quality treatment area or flow control. See COS SWM for conditions requiring a presettling zone on Neighborhood Yield (COS SWM uses "residential" for Neighborhood Yield). See COS Std Plan 299 and detail B-5A in Appendix D for presettling zone details. See Figure 7-30 for examples of constructed presettling zones. When a concrete pad is required, the width shown shall not be less than 10 inches to accommodate a standard flat, square shovel when maintenance will be done by hand.

TIP
For bid documents, if the scope includes multiple presettling zones and/or storm drain point discharges, it is recommended that the specifications include a mock-up submittal review of these installations to review whether adjustments may be needed for elements (e.g. placement of plants, cobbless, boulders, grinding of depression).

7.5.5 Storm Drain Point Discharges into Bioretention Cells

Provide energy dissipation where pipes (or other conveyance system) discharge concentrated flows into bioretention cells. The sizing of the energy dissipation will vary depending upon the amount of flow entering the bioretention cell, ranging from curb discharge pipes (2 to 3 inches in size) from a single-family home's downspouts (see detail GC-3 in Appendix D) to pipes (8-inch plus) conveying flows from an alley or upstream block(s). The energy dissipation shall be sized for the flow entering the bioretention cell.

7.5.6 Drainage Structure with Outlet Pipe Discharging into Bioretention Cells

When flow collected in a drainage structure (such as inlet or catch basin) has an outlet pipe that daylights into a bioretention cell via a culvert/pipe across the road/alley, the receiving bioretention cell may need to be located in a curb bulb to allow the cell to achieve the required depth to daylight the pipe and provide minimum cover of the pipe in the road. To assist with daylighting the shallow cover pipe, new drainage structures may be required such as modified COS Type 241 (or other as approved by SPU/WTD O&M) with minimal to no leveling bricks. Roads with minimal longitudinal and cross slopes make it more challenging to daylight the pipe into a cell in a planting strip/curb bulb if there is not enough space to deepen the cell and provide adequate cover over the pipe.

Provide dispersion and energy dissipation where the pipe daylights into the bioretention cell. See COS Standard Plans and detail B-5A in Appendix D for a detail of a pipe from a catch basin discharging into a cell. If the structure is to be maintained by WTD, then the grate of the catch basin/inlet shall be engraved with "Property of King County" to inform maintenance crews.

Concrete and cobble splash pad meets COS Std. Plan 295b

Cobble splash pad meets COS Std. Plan 295b

Presettling cell during rain event, meets COS Std. Plan 295d

Cobbles at pipe discharge point. Presettling pad per modified COS Std. Plan 299

Concrete splash pad at pipe discharge point meets GSI detail B-5A in Appendix D. First winter season.

Concrete splash pad at pipe discharge point meets GSI detail B-5A in Appendix D. Third winter season.

Pipe discharge with energy dissipation downstream of presettling vault (not shown). Custom design for managing flows from multiple blocks. Too much exposed pipe.

Concrete splash pad at pipe discharge point meets GSI detail B-5A in Appendix D. Drain curb cut meets COS Std. Plan 295d.

Figure 7-30: Presettling zones and pipe discharge points

7.5.7 Storm Drain Culverts

If culverts are used to convey flow between bioretention cells or to provide conveyance along a street without curb and gutter road edge, the culvert shall be sized to convey runoff for contributing areas and designed in accordance with SPU’s DSG but with the following modification:

> When bioretention cells are managing flow from a single Neighborhood Curbless street (~600’ long block) and culverts are used to convey runoff to/from bioretention cells in a series instead of drain curb cuts, then the minimum culvert size is 10-inch ductile iron pipe per SPU and SDOT O&M negotiations for the GSI Program (per SPU GSI Program meeting notes 3/16/2017). For culverts at driveways and alleys, to provide minimum pipe cover, the crown of the pipe can be set at the base of the concrete driveway pavement.

7.5.8 Underdrain System Infrastructure

The location of an underdrain system below a bioretention cell needs to be coordinated among the various disciplines, i.e., the hydrogeologist/geotechnical engineer, landscape architect, operations & maintenance lead, and civil engineer. The design of the cross-section and placement of the underdrain piped system should be located to collect filtered water but also allow the siting of new street trees within and between bioretention cells and protect infrastructure to remain.

In between cells where the underdrain may need to pass below an existing tree (within and adjacent to the ROW), review with the arborist the excavation extents (see Section 4.5) and consider using trenchless construction or modifying the layout to avoid going through the tree's protection zone. Trenchless construction is most suitable in areas where there is adequate length for launch pit and exit and there are no service utilities.

Figures 7-33 to 7-35 in this section provide concepts for laying out underdrain system in coordination with new street tree design. Table 7-13 provides design guidance for the components of the underdrain system below the bioretention cells.

See also Appendix F for supplemental plan notes for underdrain system to include on the plans and in the specifications.

Table 7-13: Design Guidance for Underdrain System Infrastructure

Supporting Infrastructure	Guidance
Access structure: Cleanout (CO) *or* Underdrain Maintenance Hole (UMH)	A CO or UMH is required at upstream end of underdrain pipe run to provide maintenance access to underdrain pipe. See “Underdrain MHs” in this table and Section 10 for guidance on underdrains with deep infiltration, including use of gate valves. If underdrain is shallow, CBs or junction boxes may be used in lieu of UMHs. UMH not required for short runs if exceptions defined in Section 7 of SPU CAM 1180 are met.
Underdrain pipe / Subsurface Drain Pipe (SSD)	Underdrain pipe shall be SSD per COS Std Plan 291. Pipe and slot perforations on SSD shall be sized for design conveyance capacity. Note the following: • Pipe diameter shall be 6-inch minimum. • Number of rows of slots may be less than four shown in COS Std. Plan 291 if required for design (such as no slot rows on bottom half of pipe). Where SSD pipe becomes solid wall, use same pipe material as SSD pipe, if pipe is installed trenchless (directional drilling or pipe jacking), the solid wall pipe material can differ. For SPU maintained underdrains within 5-feet of new street tree, see below.
Underdrain pipe material and setbacks at trees and utilities	See Section 7.3.6 for clearance and setback requirements between underdrain pipe and trees and utilities. Underdrain pipe closer than 5-feet to new street tree shall be solid wall (not slotted). Provide full pipe length (no joints) (~16’+) centered on tree as shown in Figure 7-34. For SPU maintained underdrains, the solid wall pipe shall either be ductile iron pipe or solid wall pipe (same pipe material as COS Std Plan 291) in a ductile iron pipe sleeve, unless approved otherwise by FOM. Provide full pipe length (no joints) for ductile iron pipe/sleeve centered on tree.
Maximum SSD pipe bend	22.5º
Partial/full liner for underdrain pipe trench	Using a liner with an underdrain pipe is project-specific given soil and site conditions. If a liner is being considered, the Project Team is to review and develop design in coordination with FOM, landscape architect, civil engineer, and geotechnical engineer in the early stages of the Design Phase (at 30 percent design). See also Sections 7.3.15 and 7.3.16.

(table continued next page)

Table 7-13: Design Guidance for Underdrain System Infrastructure (continued)

Supporting Infrastructure	Guidance
Utility trench dams for underdrain pipe	Provide a utility trench dam at the downstream end of the underdrain pipe run before the last UMH/CO and after the underdrain transitions from slotted to solid wall pipe. The SSD pipe through the trench dam shall be solid wall. See detail GC-1 in Appendix D. For cells in a series along a long block and/or cells receiving large volume of upstream flows (i.e. from multiple blocks), include additional utility trench dams mid-run and/or at other locations along the run. Utility trench dam shall be located outside of the footprint of the bioretention cell.
Cleanouts (CO) & Observation Ports	
Cleanout spacing and location	Provide cleanouts at upstream and downstream end of underdrain system and every 100 feet (maximum spacing) within a pipe run. However, no cleanouts are required within a run from UMH to UMH, except at bends (see Cleanouts at bends below). If installed within bioretention facility, it can also be used as an observation port. SPU cleanouts along an underdrain pipe run shall be constructed per COS Std Plan 281.
Cleanouts at bends	Provide a cleanout where horizontal bends are used to adjust the underdrain alignment at existing power poles and fire hydrants. Cleanout shall be at upstream end prior to first bend.
Cleanout lids	Cleanouts in paved areas shall be per COS Standard Plans except cleanout lid shall be engraved with “KC CO” for WTD facilities.
Cleanout located outside of bioretention cells (preferred)	Locate cleanout in a level area outside the footprint of bioretention cells and roadway pavement where feasible. This will allow for easier maintenance access to structure, maximize the use for plantings and filtration area within the cell footprint.
Cleanout located in bioretention cells	If cleanout is located within bioretention cell, then it shall be an observation port per COS Std Plan 281.
Cleanout located between cells	Coordinate location of cleanout (including concrete collar) with other infrastructure, structures, trees, access path, and features in the area. Locate cleanout in planned paved area to avoid placing additional concrete (collar) in landscape area. If it is placed in landscape area, review with O&M if concrete collar is required given site context.

(table continued next page)

Table 7-13: Design Guidance for Underdrain System Infrastructure (continued)

Supporting Infrastructure	Guidance
Underdrain Maintenance Holes (UMH)	
Provide UMH structure upstream of UIC screen well/drilled drain (deep infiltration facilities) for access to underdrain pipe	UMH to be located upstream of UIC screen well/drilled drain so that underdrain pipe may be plugged (for maintenance) without accessing structure containing UIC. Consider using threaded end for underdrain pipe cap so that it may be plugged for maintenance. Attach cap to UMH ladder run for maintenance access.
UMH Type and Lid	UMH shall be per COS Std Plan 204a or 204b with locking lid per COS Std Plan 230, except UMH lid shall be engraved and labeled “Underdrain” along with name of agency that is responsible for maintenance (i.e. City of Seattle/King County).
Upstream UMH	No sump required for UMH at start of underdrain pipe run.
Downstream and intermediary UMH	Provide 2-ft sump with UMH. This is a modification to COS Standard Plans for MHs.
Maximum horizontal distance between UMHs	300 feet
Short underdrain runs upstream of UMH	Where the underdrain pipe’s horizontal length is 100 ft or less, no UMH is required at the upstream end. Maintenance access to be at downstream UMH. Provide pipe end cap at start of underdrain pipe run.
Location of UMH	Locate UMHs in a level area outside the footprint of bioretention cells and roadway pavement. This will allow for easier maintenance access to structure and maximize space for plantings and filtration area within the cell footprint. If UMH is located within a paved access between sidewalk and curb, align access lid in center of paved path and review joint layout to reduce potential for pavement to crack. This may require widening the access pavement. (See Figure 7-8).
UMH location when between bioretention cells	UMH may be centered or offset from the center of the access path in coordination with other infrastructure and features at the level crossing between cells. Provide a minimum of 8 ft between top of graded bioretention cells to provide 18 inches to 2 ft of clearance between the UMH and top of bioretention cell.

7.5.9 Observation Ports

Locate an observation port for each block in accordance with COS SWM. Observation port shall be per COS Std Plan 281 (except lid shall be engraved with "KC CO" if WTD is maintaining it). The observation port can also serve as a cleanout for the bioretention underdrain as shown in the COS Standards Plans. See Table 7-13 for guidance on siting access lid of cleanout when located outside the footprint of the bioretention cell.

7.5.10 Flow Control Weir and Orifice Control on Underdrain

If flow control weirs or orifice controls are proposed for the underdrain, the design will be project-specific, and Project Teams will need to go through proposing the alternatives through the GSI Program (See Section 7.10).

7.5.11 Structural Soil Cell Systems

If structural soil cell systems are proposed to provide additional flow control storage for bioretention cells (either under the sidewalk, roadway or planting strip), the design will be project-specific, and Project Teams will need to go through proposing the alternative through the GSI Program (See Section 7.10) and review if a MOU/MOA will be needed between departments/agencies regarding responsibility for maintenance (such as if the soil cell is below a sidewalk).

7.5.12 Trench Drains

While trench drains have been installed in the past on some projects, they are not a City standard. The design will be project-specific, and Project Teams will need to go through the process of proposing the alternative through the GSI Program (see Section 7.10). When designing a trench drain to intercept gutter flow from one block and daylighting it into a bioretention cell, consider not only the design of the conveyance channel to provide self-cleaning but also the design at inlet and outlet for preventing debris from clogging the openings, as well as maintenance access and frequency of debris removal.

7.5.13 Infiltration Chambers for Additional Storage

If underground infiltration chambers (slotted/perforated infiltration pipes/structures) are proposed to provide additional flow control storage for water discharging through the underdrain of the bioretention cell, the design will be project-specific, and Project Teams will need to go through proposing the alternative through the GSI Program (See Section 7.10).

In 2017, SPU conducted a review of using infiltration chambers in the ROW and it was determined that depending on the length of chamber required to manage upstream areas, the concept analysis concluded that configuring a layout along a typical Neighborhood Yield

ROWs suitable for infiltration chambers

Sites that may be better suited for retrofit could include rights-of-way adjacent to parks or open spaces, which may not be as limited by utility mains and services in the right-of-way.

or Neighborhood Curbless street(s) would be challenging given the numerous utilities and constraints along a typical City block. At a minimum, feasible locations for retrofit would be in areas with no existing mature trees, no structures (e.g. power poles, cabinets, vaults), no utilities (services and mains) and few driveways. Infiltration chambers also have horizontal setbacks and clearances from water mains, gas mains, duct banks, sanitary sewer mains and other infrastructure, which further limits the siting within typical ROW widths. (For further information on the analysis done in 2017 and follow-up in 2019, contact SPU GSI Projects manager for technical memorandum).

If chambers are to be installed in the ROW, it is recommended that chambers be located along streets/alleys with longitudinal slopes less than 1% to minimize the depth of excavation for the chamber and create a flat subgrade for the chamber for infiltration.

7.6 Modifications to Existing Drainage/Sewer Infrastructure

7.6.1 Assessment of Existing Side Sewers/Service Drains

See Section 4.9 and Appendix L on assessment of existing side sewers/service drains within the footprint of the proposed improvements.

7.6.2 Abandonment of Mid-Block Catch Basins for Conveying Flow to Cells

Catch basins at the ends of blocks are to remain in service (or be relocated) to provide an overflow for the bioretention system. For long blocks (~660’ intersection to intersection) with existing mid-block CBs, it is preferred that the mid-block CBs remain in service after retrofit of the planting strip with bioretention cells. However, if a Project Team is considering abandoning mid-block CBs to maximize the tributary area reaching the cells, then the Project Team shall meet with SPU staff as part of GSI Program Review of the design (see Section 2.8) during 0-30 percent design and document the outcome in the project’s BOD. The following is guidance for abandonment of mid-block CBs.

1. Project drawings shall include “SPU Abandonment of Existing Catch Basin Notes” (see Appendix F).

2. If the midblock CB is to be filled in place (per notes in #1 above), review if CB grate or grades around CB should be adjusted to improve gutter flow over abandoned CB to downstream bioretention cells. Review requirements for abandonment with SPU structures.

3. Confirm that downstream structures have capacity for the flows that bypass the bioretention cells. The following steps outline an approach that might be used to evaluate the capacity of the existing downstream collection system:

    a. Identify the type and inflow capacity of each mid-block and end-of-block drainage structure to document existing conditions. Contact SPU for inflow capacity (if it is available) of COS standard drainage structures and grate types. See also SPU CAM 1180 and DSG.

b. Approximate the ROW catchment area draining to each drainage structure (post construction of GSI).
c. Calculate the peak gutter flow rate for the design storm to the mid-block and end-of-block drainage structures (post construction of GSI).
d. Calculate the flow that will bypass bioretention cells when the bioretention is fully ponded.
e. Determine whether additional improvements (adding or upsizing existing storm drainage collection structures) would be required at the downstream end of each street to collect and convey the design storm's peak flows that bypass bioretention cells.

Image: Full ROW retrofit for SPU's Venema project along a Neighborhood Curbless street. Photo shows the various planting zones starting from existing sidewalk to side slopes of bioretention cell to bottom of facility. This facility manages flow from multiple blocks.

7.7 Bioretention Planting Design for ROW

This section provides guidance for planting design, requirements and criteria that are specific to bioretention facilities located in the public ROW and maintained as a public infrastructure element. Bioretention planting approach draws from both wetland and dry habitat conditions as these facilities must adapt to seasonal changes. Selected plants and trees for bioretention are listed in Appendix G. The intent of the lists is to facilitate selection of plants that have been vetted with SPU, SDOT, KCWTD and others for placement and long-term O&M planning. The lists provide options to allow customization of a palette for a particular project, location or use. A standardized list allows the nursery industry to grow appropriate materials for these public works applications. Plants specifically listed in Zones 1 and 2 are chosen to survive in a range of soil moisture conditions (See Figure 7-31). Below, are the ROW-specific topics that are discussed in this section.

- Planting Design Phase Guidance
- Support for Outreach of the Planting Design (see also Section 6 for Community Outreach)
- Existing Tree Retention, Removal and Transplanting is discussed in Section 7.3.7
- Planting Zones and Clearances in the ROW
- Plant Selection and Grouping Using the Bioretention Plant Lists
- New Street Tree Selection and Siting
- Plant Availability
- Planting Design for Maintenance
- Watering and Irrigation

7.7.1 Planting Design Phase Guidance

The following is an overview of project design decisions in preparation of the plans as described in Section 2.

30 Percent Design Stage

At 30 percent design, the landscape architect is directly involved in the cell siting, layout, and grading. Concurrent with that design effort, the landscape architect begins draft plant selection and layout. The bioretention cell siting should be refined to the point that more specific design decisions can be made regarding existing trees and new street tree layout in concert with adjacent uses. During this period, the landscape architect should work with the arborist and engineer to evaluate the existing trees for their condition, their relationship to the bioretention zone, and their suitability for retention. The landscape

Alternative Plantings at 30 Percent Design

If teams propose to use plants that are not on the GSI Bioretention Plant List, they shall submit deviation request to GSI Program and O&M at 30 percent design. See Section 7.10. Project Teams shall review how their proposed plantings may affect the cell cross section, staffing for O&M, life cycle costs, watering approach, availability of plant material and other impacts to the design.

architect also begins plant selection by reviewing the Bioretention Plant list and Bioretention Street tree lists. (See Appendix G) Listening for ideas from the community at this early stage is helpful as there may not be opportunities for neighbors to request plantings. For example, providing a materials board at early meetings indicates to people what plants you are considering and why. Finally, a discussion of the approach to watering should begin at this time and included in the Project Basis of Design.

60 Percent Design Stage

During the 60 percent design stage, tree retention, selection and location become specific, since by this time the technical issues of cell location, length and grades should be decided. The landscape architect, in collaboration with the civil engineer and others on the Project Team, fine tunes the cell layout to refine the tree preservation approach, determine the placement and spacing of the proposed street trees, and select tree species. The landscape architect also works with the arborist to document the status of each existing tree and coordinate the tree canopy coverage and number of proposed trees for the permitting submittal with SDOT.

Maximize Street Trees

The Project Team is to maximize new street tree plantings in the areas of improvements in accordance with City policies while balancing placement of associated civil infrastructure for the bioretention cells.

The landscape architect should discuss issues with the Project Team and O&M lead relating to existing conditions or comments from residents along the block that may impact the technical elements of cell design and siting. The landscape architect updates the project specific plant palettes (i.e., group of plants) that will be used and develops the plant layout for differing cell types incorporating the community input from the 30 percent design and frames the watering approach by zone with input from agency O&M staff. Finally, a preliminary determination of restoration/planting extents is identified.

90 Percent Design Stage

Between 60 percent design and 90 percent design there should be extensive communication between team members on the detailing of the plans. Small changes from one discipline can have major implications for another part of the design parameters. For example, shifting an inlet may change the type of material immediately adjacent. This design period is also a time where discussion with the O&M staff is important to get feedback on placement around structures, groupings, and edge setbacks.

At the 90 percent design stage, the landscape architect should incorporate technical, SPU and SDOT Urban Forestry design guidance and confirm how public comments have been addressed. Some modifications to the design may happen at this point as other issues are addressed. The landscape architect should adjust the planting design accordingly and notify the project manager if any of the adjustments affect comments raised by the community. At the 90 percent submittal, the tree and accent shrub locations, plant palettes, and plant layout templates should be final. The watering plan and schedule through the establishment period is prepared. This plan may include a full irrigation system, a quick coupler system, or a manual watering approach. This is also the time to finalize decisions on tree retention and transplants discussed in Section 7.3.7 so that specifications can be detailed.

Bid Document/Final design

During the Bid document phase (Final design), address the 90% review and permit comments, review plant layout plan readability at full and reduced size, verify availability of materials, and review how the plantings affect the approach and funding for both establishment and long-term O&M. Review the specified construction schedule and coordinate milestones. Review the plans with the Public Engagement Team to coordinate potential updates to the community on the planting plans.

Image: Planted bioretention cells in the High Point neighborhood (1-2 years after construction).

7.7.2 Support for Outreach of the Planting Design

During the 30 percent and through the 60 percent design, the Project Team's landscape architect shall coordinate with the Public Engagement Team to share the proposed plant palettes with the community (see Section 6). The team will develop plant image boards of trees, accent shrubs, shrubs, perennials, groundcover plants, and emergents. Depending on the project, it may be necessary to develop an image board reflecting seasonal conditions.

The following is phase-specific guidance for public involvement in the planting design (See also Section 6).

30 Percent Design - Public Involvement in Planting Design

The project plant list and sample layouts developed from the planting zone diagram are presented to inform public on general landscape style, such as a focus on grasses and perennials, more evergreens, more flowering, color selection, seasonal interest, or increase in native plants. These ideas can be presented with image boards from the GSI image resource library. The public should be informed that they will see more detailed plans at the 60 percent design submittal.

The design team often receives questions as to whether a resident will be able to add perennials, annuals, or bulbs in cells fronting their property in the ROW. During 30 percent design, it is suggested the team respond by letting residents know that these plantings are maintained by the agency so generally other planting is discouraged. It would be good to clarify that residents will not be allowed to plant in the bottom zone and side slopes of the facility since as a stormwater management facility it is designed and maintained for specific performance and is a stormwater facility asset of the agency. Residents may also ask if vegetable gardening is allowed and it should be clearly noted that it is not allowed because the bioretention facility (also referred to as “roadside rain garden for the public) is for managing and treating stormwater runoff from their City’s roadways.

Public involvement

30 Percent Phase
- Sample layouts
- Image board
- Public input
- Tree framework

60 Percent Phase
- Plant list
- Cell planting palette
- Layout plan
- Tree list

90 Percent Phase
- Refinement
- Feedback

Final
- Inform about final design
- Inform about construction

60 Percent Design - Public Involvement in Planting Design

The level of information provided to the public on the planting design at 60 percent may vary by project, however there are some general approaches that the design team shall consider. Leading up to 60 percent design, the public would typically be informed of the project plant palette and provided plant image boards. It is expected that some residents may have specific comments on how the plants were selected, while others may just want to be informed about the overall design. Planting layout plans for each cell palette should be prepared to inform residents along with the new street trees and accent plants. The landscape architect may track requests for alternative street trees and accent shrubs and discuss with agency staff. During public meetings, it will be important to remind the attendees about the performance and planting criteria for GSI in the ROW, explaining selection, height, and spacing constraints. If there are specific concerns such as special trees or plant species that are not on the approved list, the team should consult with SDOT Urban Forestry staff and SPU/WTD O&M, who may have input on choices based on their experience with ROW plantings and bioretention. While the GSI Program provides design guidance, each project requires some flexibility in the approach to addressing comments on planting design.

It is recommended that the process be stepped through and presentation materials adjusted based on the type of comments received during 30 percent and the evolution of 60 percent design. Graphics such as project-specific perspective sketches may be desired, or the design team may choose to use precedent images from previous projects and note the similarities to and/or differences from the current design. Include images and graphics that show how the facility will look during the seasons, including winter.

When large areas that aren't part of the formal bioretention facility will be planted or restored as part of the project, the project team should coordinate the design with adjacent property owners (see Section 7.7.7). In addition, if the project involves depaving and conversion to a landscape planting strip that will become responsibility of the adjacent property owner to maintain, then review the design with property owner (see Section 6).

90 Percent Design - Public Involvement in Planting Design

Public outreach (meetings, fliers, website, etc.) will inform the public of the final plant design and how their comments were considered and incorporated.

Bid Document/Final design - Public Involvement in Planting Design

Coordinate with the Public Engagement Team (see Section 6) to update the community on the final planting plans. Inform community about how the bioretention facilities will look at installation, when there are more bare areas and varies with time of year when cells are planted, and once the bioretention plantings are established in two to three years.

7.7.3 Planting Zones and Clearances in the ROW

The planting design of the bioretention cell is dependent upon the type of cell cross-section and other supporting infrastructure of the cell. Aside from typical planting design, factors such as size of cells, site context, cells with liners, underdrains, walls, weirs etc., affect the plant selection and options.

The plants on the Bioretention Plant List (see Appendix G) were selected for their suitability to the various conditions in the bioretention cells along with careful consideration to their mature height and maintenance requirements and input from SPU/WTD O&M staff. Groundcovers, emergents, perennials, grasses, low shrubs, accent shrubs, and trees are located within different zones within the cell per the planting zone diagrams.

Plant's "mature height"

Plants often grow taller than the "mature height" because of the bioretention soil media (BSM). As a result, more frequent maintenance may be required to maintain visibility and clearances as compared to plants not in BSM.

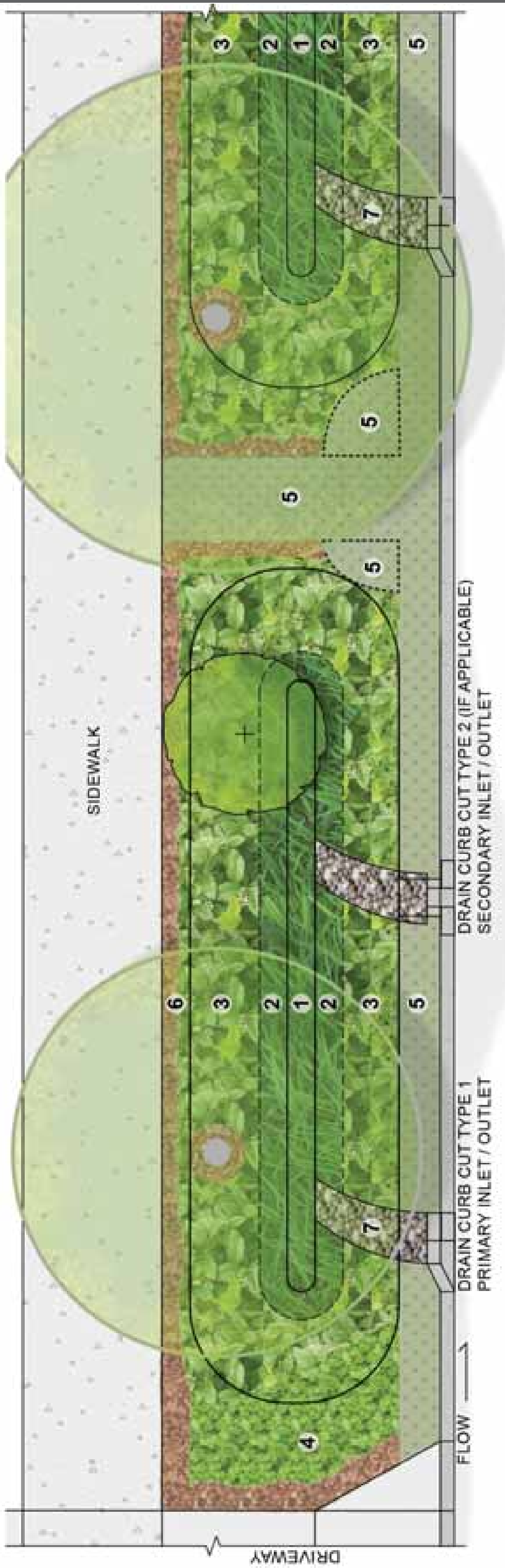
Maximum mature plant height is 24 inches within 30 feet of an intersection (as measured from the edge of the intersecting road). The vegetation at driveways and mid-block crossings shall remain at or below 24 inches for visibility. Review if blooms shoot up above the 24-inch height. Horizontal and vertical clearances are documented in the Seattle Streets Illustrated ROWIM and Green Factor.

Maintenance is a significant cost factor as bioretention facilities expand citywide – proposed plants outside of clear zones shall be between 24 and 30 inches in height (without pruning) depending on the zone location. The exceptions are the accent shrubs, which serve to provide vertical elements and seasonal interest and break up wider facilities. Generally, these accent shrubs should be used singularly in open areas away from driveways, paths, and sidewalks. Limiting the extent of taller shrubs and grasses is to prevent visual barriers so pedestrians can observe and be observed.

Plantings for walled cells

When selecting plants for walled facilities especially those with deeper bottom areas, use evergreen, taller rushes, and sedges as well as wet tolerant shrubs so the vegetation has a year-round presence of 12- 30 inches above the walls marking the extents of the facility.

Each planting zone is delineated based on the zone function, including water quality treatment, conveyance, sight clearance, steppability, etc. The height of vegetation outside these bioretention zones (i.e., in between cells or in project-related restoration areas) is also limited to 36 inches. Refer to planting zone diagram in Figure 7-31.



SYMBOL	ZONE	PLANT TYPE / TREATMENT	LOCATION	FUNCTION	PLANT NOTES
	1,2	Emergents, Perennials & Low Shrubs	Cell Bottom / Lower Slope	Water Quality Treatment	30" max. height above sidewalk
	3	Groundcovers & Shrubs	Sidewalk / Upper Slope	Accent / Border	6"-30" height
	4	Grass / Low Plantings	Driveway / Intersection	Sight Clearance / Durable	24" max. height
	5	Access Surfacing	Crossings / Road Edge / Step-Out Zones / Upper Slope	Access	None
	5	Access Surfacing	Site for Each Parcel per Waste Pick-up Route	Solid Waste Pick-Up Space	None
	6	Sidewalk Setback / Arborist Wood Chip Mulch	Along Sidewalk Edge	Maintain Edge	None
	7	Inlet Cobbles	Inlet to Cell Bottom	Sediment Capture	None
	1,2,3	Tall Accent Shrub	Sidewalk Side of Cell	Accent	4'-8' +/- height range
		Tree (trunk)	Crossing / Sidewalk / Upper Slope (sited for clearances and out of liner zone)	Shade / Water Retention / Urban Forestry	20'-50' - varies based on power line location

Note: For more information, see GSI Manual Vol. III - Design, Chapter 7

Figure 7-31: ROW bioretention cell planting zone diagram

Trees are an important element of the bioretention facility. The placement of trees within bioretention cells may require narrowing the bottom width of the cell as depicted in the GSI details BTP-6 and BTP-7 in Appendix D; however, the reduction in bottom area is incidental in reducing the infiltration area footprint assumed for modeling. This should be discussed with the project team between 30 percent and 60 percent design.

Distance of proposed trees to existing or proposed utilities is to be in accordance with Streets Illustrated ROWIM and COS Std Plan 030, except separation from underdrain pipe (slotted and solid wall) from new trees is to be as noted in Table 7-7 and Tree Placement figures in this section.

TIP

Existing trees that overhang the ROW (within and adjacent to ROW) shall be pruned to maintain horizontal and vertical clearance and visibility for pedestrians, cyclists, and drivers. See the SDOT Street Tree Manual for requirements on pruning.

7.7.4 Plant Selection and Grouping Using the Bioretention Plant List

The Bioretention Plant List for Development of Palettes (see Appendix G) was developed to address specific design criteria for bioretention planting within the urban ROW and with the intent of improving availability of the specialty bioretention plants by alerting growers to Seattle's preferred list.

The Bioretention Plant List provides a variety of information about the plants – whether they are evergreen or drought tolerant, their mature height, which planting zone they are suited for, recommended container size and spacing at installation, whether they are suited for an Urban Frontage setting, and an O&M code that indicates what maintenance is required for the species.

Ten plant lists were developed as a starting point for creating plant groupings for the bioretention facilities.

The **Part Shade List** and **Sun List** are for sites with those sun exposures.

The **Native List** is made up of solely Northwest native or native cultivar plant species. There is a desire for increased use of native plants. The Bioretention Plant List includes native plants or cultivars of natives that meet the height and maintenance criteria. Hardy, drought-tolerant native plants often have a mature

Plant selection and grouping using the Bioretention Plant List facilitates the design process, improves plant availability, and provides consistency for maintenance staff.

Plant lists

- Part shade*
- Sun*
- Native*
- Intersection and sightline*
- Bioretention with Vertical Wall(s)
- Pollinator*
- Short-term infill*
- Vertical shrub and accent
- Groundcover
- Steppable
- Low Nutrient BSM Plants, Shrubs, Trees

height greater than three feet and can be used selectively as accent plants due to sight clearance requirements along the road ROW. Several of the smaller native plants are best suited to shaded conditions and will not thrive in the exposed ROW.

For locations where maintaining sight clearances are required, the **Intersection & Sightline List** is composed of low plants under 24 inches mature height.

For bioretention cells with vertical wall(s), taller plants in the **Plant List for Bioretention with Vertical Wall(s)** provide foliage above the wall to mark the facility. Note the height of the plants and the distance from the pavement to the top of soil to make sure the height of the plants above the wall will not block sightlines. Some larger container plants are recommended for cells with walls to more quickly fill in the facility. Most of the plants used in bioretention cells with vertical walls should be evergreen or have significant presence in the winter.

To provide habitat and food for birds, butterflies and other fauna, the **Pollinator Plants List** is composed of plants that attracts and supports these animals and insects. Bioretention cells with plants from the pollinator list will have a different appearance from the other bioretention cells and should be signed as such for maintenance staff and the public's information.

The next four plant lists are for plants to be used in specific locations within the six plant lists described above.

The plants in the **Short-Term Infill Plants List** are primarily annuals or short-lived plants to enhance the cells at the time of installation. These plants are used to quickly fill in and cover the bare soil after construction.

The **Vertical Shrubs and Accent Plants List** is composed of larger shrubs that should be limited to groups of 3 maximum to preserve sightlines.

For areas where additional low plants are needed, refer to the **Groundcover Plants List**.

For areas where foot traffic is expected, the **Steppable Plant List** provides plants that can tolerate some foot traffic.

The **Low Nutrient Bioretention Soil Mix Plants, Vertical Accent Shrubs and Trees List** is for bioretention cells with graded side slopes that use a bioretention soil media that does not have compost as one of its main components. This list is in draft form and will be refined based on results from SPU field testing and monitoring for plant growth.

SPU and WTD are working with the plant growers to increase the availability of lower-growing natives, so it is hoped that the appropriate native plant list will expand in the next few years. The landscape architect shall also review maintenance considerations for their specific project, since the current recommendations discourage many of the native ground covers due to their more aggressive growth habit and difficulty of weeding through them. Strategic use of these more aggressive native ground covers, such as a single species in a wider zone, or a single plant, may be considered. Use of plants that are not on the GSI Bioretention Plant List will require approval by SDOT Urban Forestry and O&M and review by the GSI Program through a deviation request (see Section 7.10).

For the selection of bioretention cell plant species, determine whether the plants will be used at an intersection, adjacent to a cell with a wall, or at partially shady or sunny areas, and then review the GSI Bioretention Plant List to select the appropriate palette. As the palettes are developed, designers should select a variety but not more than ten species from the list, of which at least 40 percent should be evergreen. Limit the use of perennials or group them between evergreen plants to minimize maintenance requirements and ensure year-round structure. If the project is located near a greenbelt, the design should consider a primarily native mix and limit seeding and aggressive, spreading non-natives. If plants have floppy foliage, such as some of the sedges and rushes, locate them next to “stiffer” plants that can support them for a neater appearance and to avoid continual pruning. (See Figure 7-32 for bioretention planting design examples.)

Context-sensitive plant layout

The plant layout is context-sensitive, in other words, the landscape architect with the overall design team should use the zone diagram (Figure 7-31) as guidance in developing a plant layout that responds to the adjacent uses and planting styles.

When facilities are in low activity areas or along curbless streets with parking, taller, sturdier plants may be appropriate to prevent people and cars from entering the edge of the facility and trampling plants, but plant setbacks to allow an adequate step-out zone should always be provided.

The following are plant selection considerations based on watering approaches (hand-watering or irrigation):

- Drought tolerance of the species. Plants that will be watered by hand should be drought tolerant. Due to the dry nature of Seattle summers, all plants should be drought tolerant to some degree as the automatic irrigation systems may be turned off once the plants are established.

- Watering. When bioretention cells will be hand-watered, consider using larger plant containers or spacing small container plants closer together as it will take longer for the plants to become established compared to plants receiving automatic irrigation. The planting specification should include guidance on soaking the plants prior to planting so improve initial uptake and root growth. The Vertical Shrubs and Accent Plants list (see Appendix G) can be used to assist with choice of deciduous and evergreen accent plant options.


Winter interest provided by native plants


Trimmed evergreen emergents and dogwoods provide winter interest


Floppy emergents are surrounded by upright plants, and plant species are in large groups


Plants are set back from edge of sidewalk


Plants species are in repeating groups


Bright foliage plants highlight curb bulbs


Plant availability: substitution blocks alley sight lines

Figure 7-32: Bioretention planting design examples

Plant selection, grouping, and layout within the bioretention cell should consider multiple factors:

Selection:

- Seasonal interest (leaves, berries, and blooms)
- Durability (dogs, kids, weather)
- Use evergreen plants and deciduous shrubs with strong winter structure especially in cells with 3 to 4 walls (sides or weirs as walls) so that there is a year-round plant presence throughout the cell
- Adjacent context, solar aspect, and wind
- Plant height
- Plant width and "floppiness" factor.
- Plant zone (saturation tolerance)
- Ability to intercept stormwater and provide filtering for improved water quality
- Ability to uptake stormwater for rains in the summer, spring and early fall
- Ability to provide coverage and reduce soil erosion potential
- Bioretention soil media and extents (soil mix may vary according to performance goals and will affect plant growth)
- Availability (certain plants may have limited quantities or container sizing)
- Current scientific data (e.g., updates on disease resistance, new pathogens, water interception and water quality benefits)
- Watering approach. Plant installation size, spacing, and drought tolerance all should be considered with the understanding of how the plants will be watered.

Grouping:

- Group plant species with similar maintenance needs (for example, grasses that are cut at the same time)
- Cluster plants in groups of at least 5 of same species/variety
- Limit the area of deciduous plant groupings – except for deciduous shrubs with winter interest – to an area smaller than 3 feet by 8 feet
- Limit the size of perennial groupings – to an area smaller than 3 feet by 3 feet

Layout:

- Location of adjacent property points of entry
- Locate low growing ground covers 14 inches minimum back from sidewalk edge
- Locate shrubs a minimum of 18 inches from sidewalk edge (further if shrubs are wider than 3 feet)
- Cell edge design (vertical wall vs. graded side slope). Review need for steel edging to delineate limits.
- Provide open areas at stormwater inflow and overflow points (no blocking with plants)

- Maintain minimum 6-foot clear area around structures (MHs, CBs, UIC MHs, Culverts) that require maintenance access or select plants that can handle the disruption.
- Consider the degree of foot traffic and suitable surfacing at edges
- Location of existing and proposed trees and accent shrubs
- Locate emergents with foliage that flops adjacent to other plants or can keep them propped up and at least 30 inches back from wall or edge.
- Consider spiny plants in zones adjacent to step-out zone along curbless streets, to discourage people from parking on the edge of a cell.

7.7.5 Tree Selection and Siting

Street trees are an important asset to Seattle and a critical component of bioretention facilities. Tree canopies, trunks and roots provide habitat and shade, retain stormwater, reduce air and water pollution, and add character to neighborhoods. Coordinate with Public Engagement Project Team members to inform residents of these benefits and why trees are to bioretention facilities and the streetscape.

The trees on the Bioretention Tree List (see Appendix G) were vetted by SDOT and others for use in or along bioretention cells in the ROW. There are some trees on the Bioretention Tree List that are not typically used as street trees due to unique conditions within the bioretention area. Use of trees that are not on the Bioretention Tree List will require approval by the GSI Project Manager and SDOT Urban Forestry.

Consider selecting trees for a block that drop their leaves at similar times so leaf pick-up is not required over an extended period.

The landscape architect should select tree species (small, medium, and large trees) from the approved Bioretention Tree List based on the following considerations:

TIP

If there are deviations from the guidance in this manual and the GSI Bioretention Plant List, then the lead landscape architect shall submit a memorandum identifying the proposed deviation and reason for the request when submitting plans for review. See Section 7-10.

Tree Selection: Environmental / Habitat Considerations

- Increase canopy cover (preference for trees with large and medium canopies)
- Increase use of native trees
- Provide a mix of species. Increase species diversity (both neighborhood and citywide)
- Increase water interception (evergreen trees are more effective).
- Location within the bioretention cell section (top and sides preferred vs. bottom)

Tree Selection: Built Environment / Guidance

- Provide adequate soil volume per SDOT Street Tree Manual and Streets Illustrated ROWIM.
- Meet horizontal and vertical clearances (consider root ball at time of planting, trunk flare and branching habit)
- Market availability
- Current industry data on disease resistance
- Fruit drop and leaf or branch litter
- ROW context

Value of trees

Trees are living infrastructure, and each project should ensure the optimum outcome for them to benefit the project, neighborhood, and city as a whole.

Street trees are required by municipal code and standards set by SDOT designed to provide maximum public benefit and compatibility with other infrastructure in the ROW.

The street tree design criteria are based on transportation safety requirements and minimum requirements for achievement of maximum mature canopy coverage to reduce both stormwater runoff and reflected heat from paved road and sidewalk surfaces. See guidance and concepts for bioretention-related street tree planting in this section and details in Appendix D. Calculate desired number of trees by testing spacing, and then adjust for bioretention cell design according to the guidance. Trees should be installed per COS Standard Plans and BTP details in Appendix D.

See Seattle City Light standards and Streets Illustrated ROWIM for clearance between new street trees and SCL infrastructure: power (overhead & underground) and streetlights (overhead wires maintained by SCL). Note: Depending upon location, streetlights may be maintained by SDOT or SCL, which then affects street tree selection and maintenance. Project Teams shall check with SCL, SDOT and Urban Forestry given project location and conditions. There are no clearance restrictions between new tree plantings and franchise overhead distribution.

The landscape architect should site tree species (large, medium and small trees) from the approved GSI Bioretention Tree List based on the following considerations:

Tree Siting Design Considerations

- Locate some evergreen trees as suitable on each block to provide a mix
- Plant tree outside of the access path zone to private properties. Assume at least 2 feet off the private access path edge alignment.
- Consider tree placement to maintain pedestrian crossing intervals
- Large and medium trees may be placed within 10'± of existing small canopy tree to improve layer value (understory)
- Small trees are best suited to walled cells or understory conditions and may be placed within 15' of large trees.

Tree Placement Guidance

- Underground utilities and clearances (refer to COS Std Plan 030 and Streets Illustrated ROWIM; however, for underdrain pipes, SPU O&M has approved the lesser setback for new street trees as shown in Figure 7-34)
- Locate outside of fully lined cells and walled planters (If possible)
- Overhead utilities and clearances
- Sight distance clearances for intersections, curb ramps, driveways, etc.
- Intersection clearances
- Average spacing of trees is 30’ OC; however, they may be closer or farther depending on conditions
- Trees do not have to be placed consistently along a centerline; zigzag is ok

Tree Siting with Crossings (level areas)

- Generally, line up pedestrian access with residential access points however at a minimum locate a pedestrian access crossing within 15’ of a residential access point (surface type is project-specific) for cells with graded side slopes.
- Allow for crossing (formal or informal) by locating the tree to the side of the crossing
- Walled cells’ width of crossing needs to allow for both pedestrian access and tree growth. Width varies. See Figure 7-35 for minimum dimensions. Wider width will be required if there are other utilities (such as water meters, hydrants) in this zone.

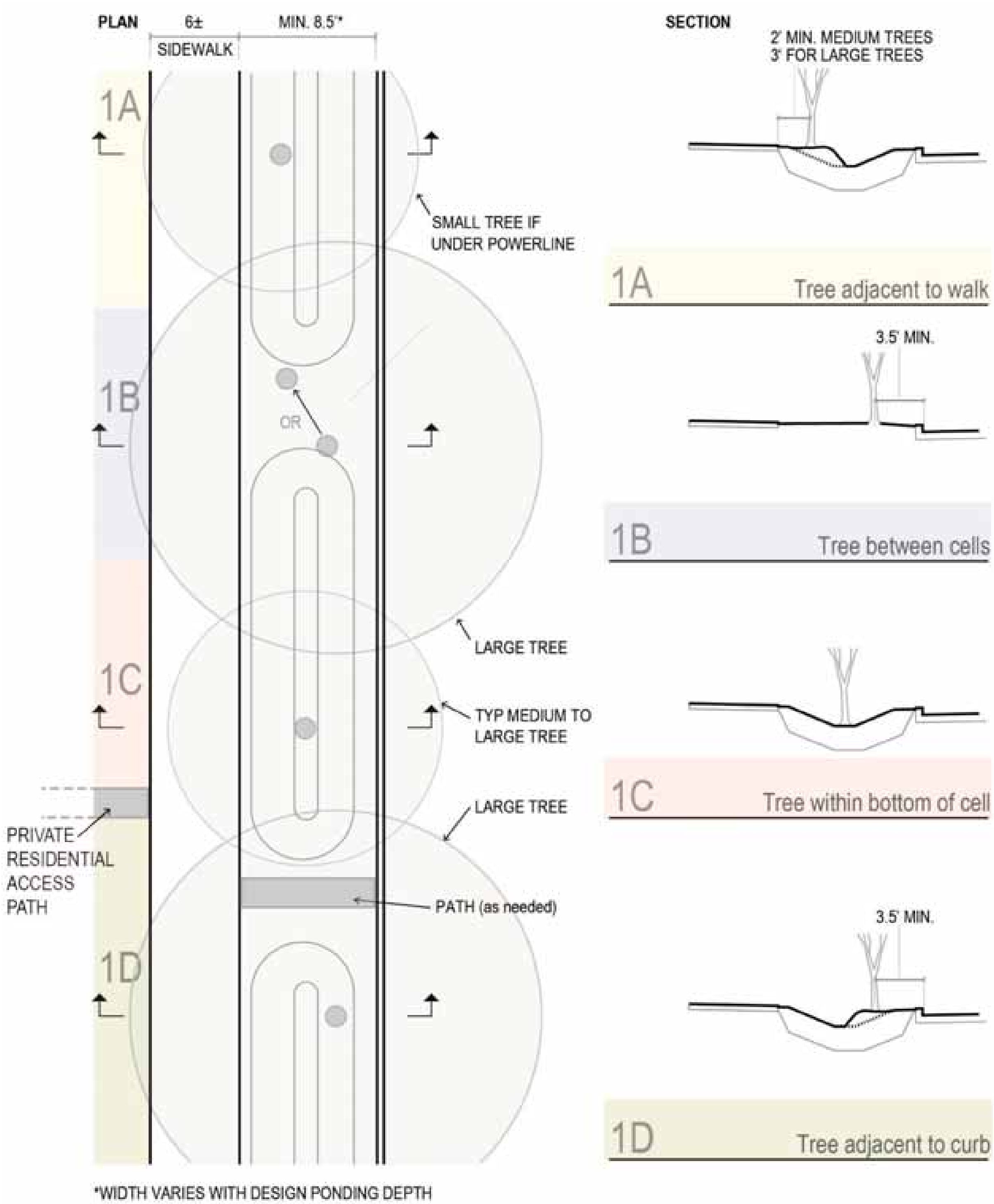
Tree Siting for Informal / Curbless Streets

- Locate 10’ from edge of travel lane
- Consider placement of optional protective elements (e.g., shrubs, curbs, bollards, landscape rocks) in compatibility with SDOT ROW Standards
- Follow strategies within diagrams shown in Figures 7-34 to 7-35 related to underdrains

The design tree placement diagrams in Figures 7-33 to 7-35 (see also earlier Figures 7-8 and 7-9) deconstruct a complex urban environment. The following are additional general tree guidance notes.

- Maximize tree canopy and bioretention cell performance to greatest extent feasible
- Mitigate for trees that are removed per COS; two for one replacement
- Design for a 50-year facility and mature tree lifecycle
- See Table 7-3, Guidance for Selection of Bioretention Cross-Section Type for Retrofit into a Neighborhood Yield street ROW given the Planting Strip’s Width

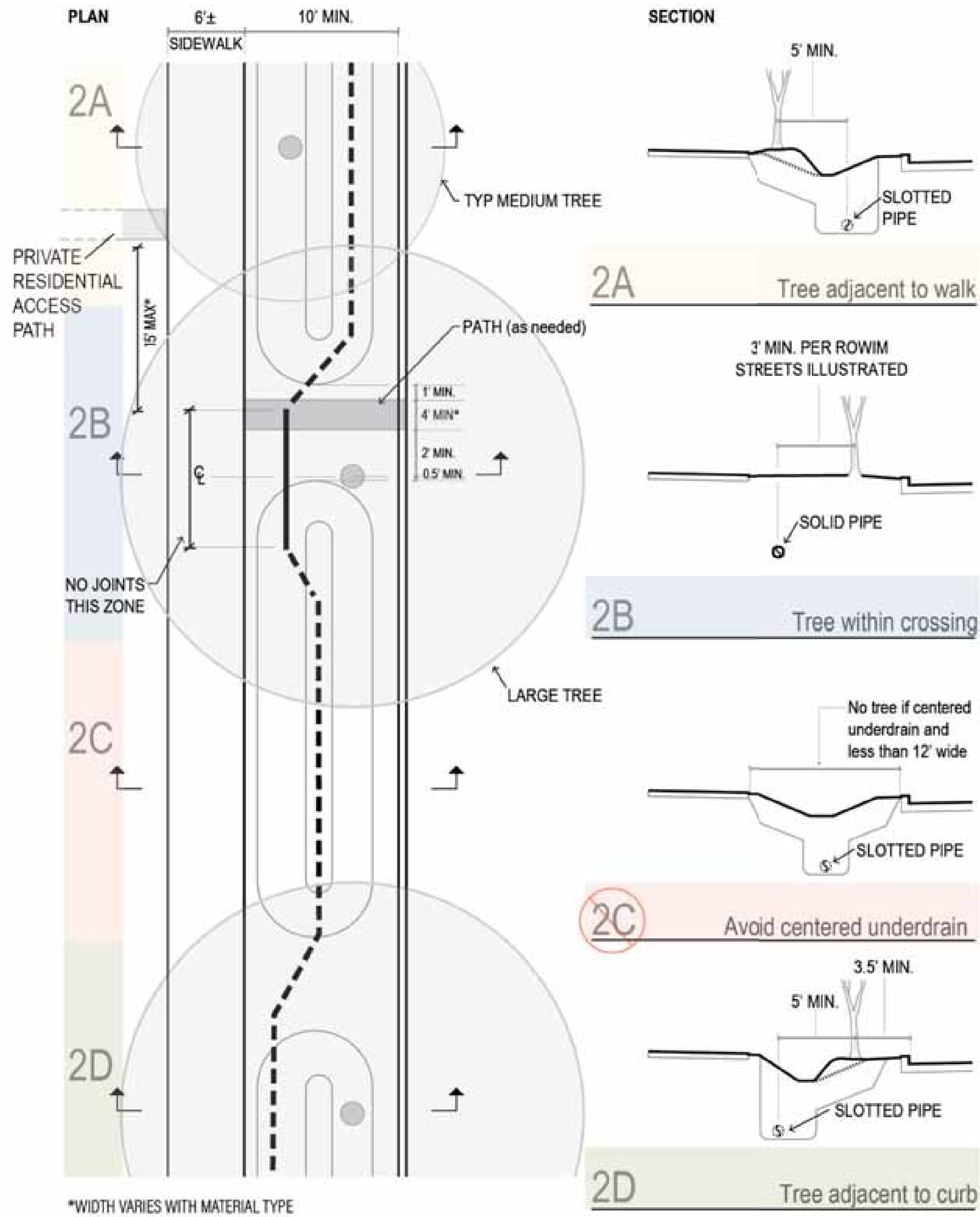
Image: Bioretention cells (grass and vegetated) with elevated underdrain after several years of plant establishment (High Point neighborhood).



Note: See Section 7.3.8 and Figures 7-8 and 7-9 for designing path and access between bioretention cells.

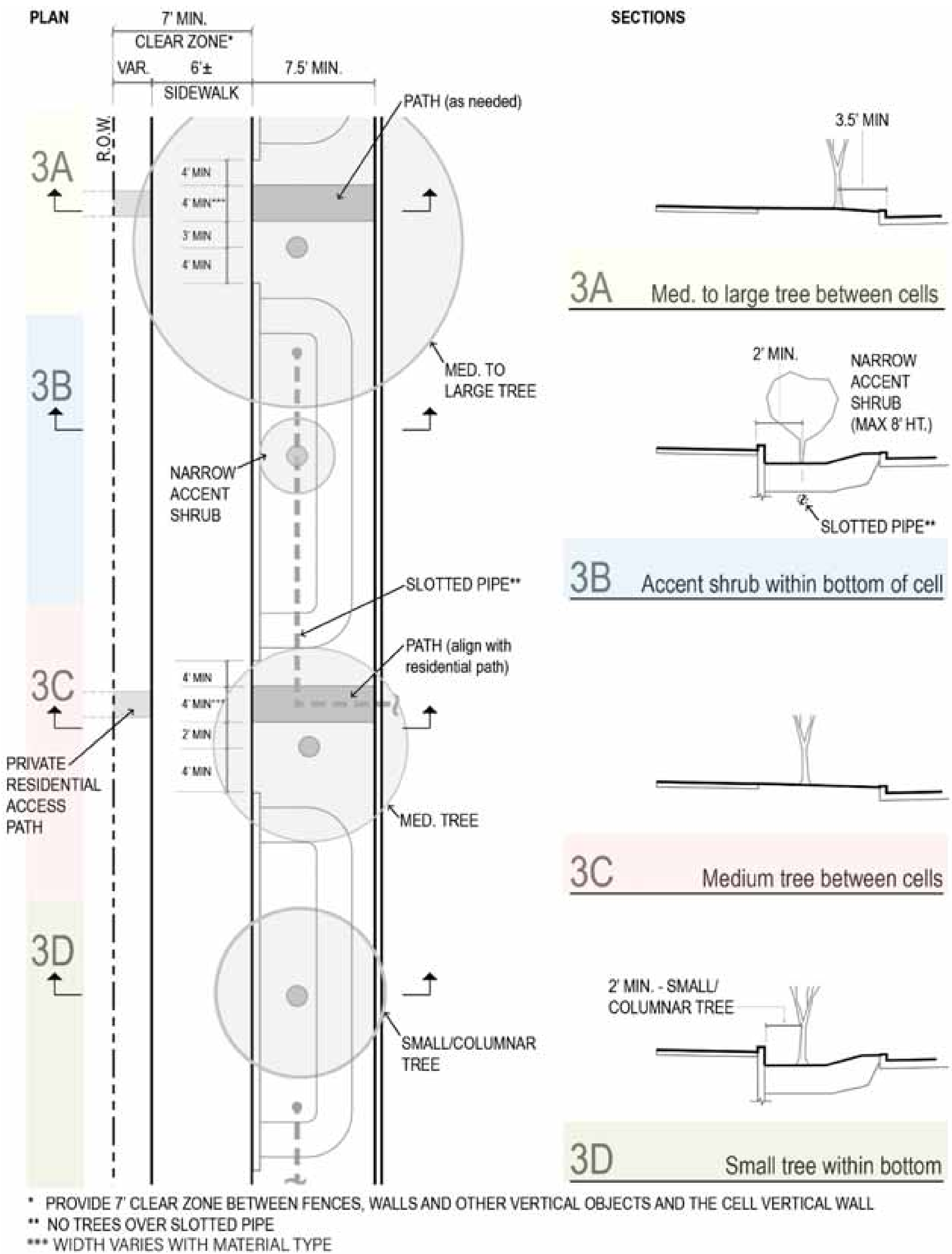
Figure 7-33: Strategies for access path and tree placement for graded cells

Image: Pervious concrete path and new street tree in level area between bioretention cells with graded side slopes on Neighborhood Yield street.



Note: See Section 7.3.8 and Figures 7-8 and 7-9 for designing access path between bioretention cells.

Figure 7-34: Strategies for path and tree placement at graded cells with underdrains



Note: See Section 7.3.8 and Figures 7-8 and 7-9 for designing access path between bioretention cells.

Figure 7-35: Strategies for path and tree placement at cells with a vertical wall

7.7.6 Plant Availability

When selecting plants and trees from the Bioretention Plant and Tree Lists (see Appendix G), the landscape architect should review availability with multiple nurseries and modify plant palettes accordingly. Plant availability (even if using the Bioretention Plant List) should also be rechecked prior finalizing the plans.

During Design, if the lead landscape architect proposes to substitute a different variety or species from the Bioretention Plant List, confirm the height and spread are consistent with the original listed species. Remember height is a constraint for ROW GSI plant selection, and there are height restrictions for sight clearances. Avoid using a plant variety the first year it is introduced. Because plants become a major GSI maintenance item, use only plants that are well tested, tried, and true. Use of varieties and species not shown on the list will require GSI Program Management, O&M, and SDOT review. If there are deviations from the guidance in this manual and the Bioretention Plant and Tree Lists, then the lead landscape architect shall submit a memorandum identifying the proposed deviation and the reason for requesting it when submitting plans for review (see Section 7.10).

Plant substitution

Plant substitution may become an ongoing maintenance issue. For example, Spiraea douglasii, which grows to 6+ feet, was substituted for a much smaller plant, Spiraea betulifolia, which reaches about 3 feet in height. The Spiraea douglasia will require continual maintenance to keep it low at the alley driveway for sightlines.

During the long construction period, a plant species may also become unavailable and require a substitution. When selecting the replacement plant species, start with the Bioretention Plant and Tree Lists and match characteristics.

7.7.7 Planting Design for Establishment & Maintenance

As discussed earlier regarding plant selection and grouping, long-term maintenance must be considered for plant layout and in determining the limits of restoration.

Bioretention cells located adjacent to lawn areas require more maintenance, as lawn areas are maintained by the residents, and the grass may threaten to spread. Provide steel landscape edging to prevent the grass from spreading into the facility. Consider using a concrete mow edge at the outside base of the cell wall so that use of a weed trimmer is not required. Lawn areas are maintained by the residents, and a simple and clear interface between the facility and the lawn area is desired. Do no leave small lawn strips less than 3 feet wide that do not accommodate the width of a standard mower for the residents to maintain. When transitioning grades to existing conditions and the surface is to become lawn, design slopes to accommodate mowing with at least a 5:1 slope.

Bioretention cells next to undeveloped lots or poorly maintained landscape areas will also require more maintenance due to weeds. The designer should review field conditions and determine what edging would best serve the long-term condition.

In some cases where project work disturbs a larger area than the specific cell the project may allow residents the option of enhancement planting outside the bioretention extents/footprint, then the landscape architect will need to work with the SPU/WTD maintenance manager to consider how these special plants are managed during establishment and when the turn over to the property owner for long-term maintenance occurs.

Generally, improvements (including extents of planting maintenance for SPU/WTD) should extend to—and end at—pavement edges and intersections when feasible to provide some visual clues that indicate the beginning and end of a bioretention maintenance zone. Typically, these end points might be elements such as a pedestrian crossing, the intersection, or the end of the tree planting. It is recommended that edging be placed at the end of a GSI maintenance zone to delineate responsibility if a facility is not ended with pavement.

For restoration of existing landscape, see Section 7.11. Projects can consider installing restoration plantings with the option of the adjacent resident maintaining for continuity. When new or revised landscape areas are created that aren't a part of the bioretention facility, work with adjacent property owners on plant selection, etc., so that maintenance can be handed off to them.

Plant layout

Avoid locating plants in the flow paths, e.g., at drain curb cuts or in front of a pipe daylighting into a cell. If street trees are planted on the side slopes of the cell, avoid locating the new street tree directly across from a drain curb cut unless the minimum cell bottom width is maintained.

Tough, spreading plants will renew and fill in bare areas and are easier to maintain and mulch around than delicate plants. Consider initial size of plants (plugs versus gallons) and time of year when it is expected planting would occur during construction (e.g. planting in the fall (as compared to spring/summer) results in a longer establishment period). Plants that are quick to fill in help to prevent weeds that will grow on exposed soils. Large initial plants may be more suitable for cells with vertical wall for getting early coverage (and for aesthetics and public comfort). The landscape architect/designers shall also coordinate the planting locations with other infrastructure elements.

Designers should consider specifying protective measures for the landscape, such as a temporary black or green protective fencing during the establishment period or permanent low rails for high-use areas.

The specifications in the bid documents for plant establishment period varies between SPU and WTD. Note the following:

Typically for **SPU-led CIP projects**, the GSI plant establishment period is three years. The first year of maintenance is by the contractor, and the second and third year are the responsibility of SPU. See GSI Manual Volume V for O&M post construction.

For **WTD-led CIP projects**, review with WTD the length of time the contractor would be responsible for maintenance during the establishment period.

See Figure 7-36 for planting design considerations for maintenance.


Landscape edging defines end of facility


Landscape edging defines end of facility


End of facility not clearly defined


End of facility marked by path


Large planted area at end of facility to be maintained by adjacent homeowner


Plants too close to access path and will need continual pruning


Adjacent vegetation encroaching sidewalk


Green plant protection fence with access to path maintained

Figure 7-36: Plant establishment and maintenance

7.7.8 Watering and Irrigation

The approach to watering is a critical part of the bioretention facility planning. Plants will require consistent water during the full three-year establishment period and subsequently in the dry months from late spring through fall. The frequency of summer watering may increase if drought conditions persist for long periods of time. Tree watering bags will also require filling during the summer months. The designer should discuss watering methods at the start of the 30 percent design so that the method can be considered in both plant selection and layout.

Watering for walled cells

Plants in smaller bioretention cells located in full sun or surrounded by pavement, vertical walls, or gravel will require more frequent watering.

The two most common methods of watering along the ROW for public installations are hand watering or a fully automatic fixed-spray irrigation system. Drip systems, the most water efficient option, have not been used as often in the ROW due to the perceived concerns of vandalism and slightly higher maintenance. Review of drip systems is recommended as the industry expands methods and materials. Considerations in selecting one approach over the other include:

- Upfront costs of separate water meter installation and connection fees, and ongoing charges make fixed-spray and drip irrigation high capital improvement-cost option when irrigation is primarily used for establishment and periods of drought. However, automatic irrigation systems are more reliable and less intrusive to a neighborhood.
- Hand watering and associated labor is required at set intervals during the three-year establishment period. Typically, it is three times per week however this could be daily during hot and dry summers. There is no special maintenance associated with the hand watering method, since typically no equipment is left in the ground. Hand watering does require a source of water, trained staff, and labor hours. It is difficult to water the plants deeply and evenly using this method, so installing soil sensors is recommended. If water trucks are used, then they are another piece of equipment operating in the street ROW, and most generate air and noise pollution.

For **SPU-led GSI projects** and depending upon condition of hydrants in the project area, Project Teams could consider using existing hydrants as a source of water for hand watering with hoses. The Project Team shall coordinate with SPU's FOM, who will review the use of hydrants with SPU Water. A sample analysis comparing different watering methods is provided in Appendix J.

For **WTD-led GSI projects** the method of watering also relates to the contracted maintenance and there may be specific requests based on how those contracts are negotiated.

7.8 Traffic Signage on Streets

Restore existing traffic signage as required per SDOT's Right-of-Way Opening and Restoration Rules. No additional traffic signage is required for bioretention in planter strips.

Where a curb bulb is added, traffic signage (object marker and no parking) is typically not required on Neighborhood Yield streets. SDOT's Traffic Division uses the following escalating approach for signage at curb bulbs:

- Initially, curb bulb shall be painted, and reflectors applied to curb (see Figure 7-19)
- If SDOT determines that more signage is needed post-construction, then flexible object markers will be added by SDOT.
- If users are still not adhering to the flexible object markers, then a fixed object marker will be installed by SDOT.

Images: Examples from WTD's Barton CSO control project of signage adhered to top of curb adjacent to bioretention cells to delineate to residents whom to call for maintenance.

7.9 Process for Preparing GSI Design for Construction and O&M

As noted throughout this volume, siting and design of facilities should factor in constructability and equipment and maintenance access requirements. Review site conditions and specify clearing the sidewalk zone of vegetation for the block length both to ease construction and to prepare the neighborhood for the upcoming change in the planting strip. Overhanging trees branches should be pruned for equipment clearances. Coordinate notifications with the public outreach lead.

See SPU's DSG for general design considerations for O&M. Maintenance staff shall be included in design discussions and review of 30/60/90 plans so that their O&M practices and procedures are accounted for in the design of the facilities. Coordinate design with O&M personnel with regards to what equipment they will use to conduct routine maintenance. Will they need to close a road/lane/alley to safely to conduct routine inspections or maintenance? What space is needed for equipment used in vactoring out MHs, operating valves, and conducting routine cleaning?

Project Teams shall complete the GSI Component Design Checklist for O&M Approval (see Appendix E) at 30 percent design and update and resubmit at 60 and 90 percent if there are changes to the design or design components. The purpose of this checklist is to inform O&M of the components of a project for each agency's asset management and O&M budgeting and to identify elements/components that differ from project GSI details and standards.

If a project is in an undeveloped right-of-way or areas where invasive plantings will affect the maintenance activity frequency and budgeting for the bioretention facility, project teams shall develop a Vegetation Management Plan for work prior, during and after construction. See Appendix G for an example template of a Vegetation Management Plan.

7.10 Proposing New Materials, Elements, Deviations, or Alternatives

Use of materials and details that meet City of Seattle Standard Plans and specifications is preferable whenever possible for cost efficiency, O&M standards, permitting, and ease of installation. The approved standards and the GSI Manual have been vetted by the various City departments and/or through the Interdepartmental Team (IDT) meetings with the GSI program.

Where Standard Plans, Streets Illustrated ROWIM, and/or GSI Manual concepts and details do not address specific project conditions or meet project-specific performance goals, the Project Team may propose to develop a new detail or request a deviation/modification of an existing detail. A new detail or deviation/modification will require more time in design, review, and permitting, so the GSI program manager should be notified prior to proceeding. In the case of a deviation request or to modify an existing GSI detail, the Project Team is to follow the process outlined below. It is recommended that non-standard details requests be submitted at 30 percent design but developed to a 60 percent level design detail to adequately evaluate cost, O&M, and other impacts.

Process for approval of non-standard GSI detail or deviation request:

1. Complete the GSI Component Design Checklist for O&M approval and submit to the project manager for review by the GSI Program (includes O&M).

2. GSI Program with O&M will review and then determine if additional information is needed from the Project Team, which may include:
   a. Description: A description of how proposed work is consistent with the GSI Program and project-specific goals.
   b. Justification: Justification for use of the non-standard GSI detail/deviation. The justification should describe the impacts of meeting the standard and why the non-standard detail/deviation is the preferred alternative. The justification may

be to address a technical (engineering, O&M, etc.), aesthetic, or social function element of the project.

c. Performance Measures: Information on existing and preferred performance measures resulting from use of the non-standard detail/deviation (e.g., stormwater flows and treatment, access and mobility, maintenance, and operations requirements, supporting infrastructure required for alternative design/technology, effects on other elements: street tree spacing, aesthetics/urban design, etc.)
d. Details: The non-standard GSI detail(s) shall be developed to 60 percent at 30 percent design stage. Detail shall be designed to address operation and maintenance access for SPU/WTD O&M staff review.
e. Additional Evaluation Information: Any additional information determined to be necessary to evaluate the need for a non-standard detail/deviation. This may include requirements for O&M and life cycle costs.
f. Signature: Depending on the nature of the improvements, SPU may require the submittal to be signed and sealed by a Professional Engineer.

The agency's Program Manager will review the revision in coordination with the SDOT SIP reviewer, O&M, and other GSI Program staff.

3. Review of non-standard detail/deviation requests:
When a non-standard detail/deviation request is submitted, GSI Program staff will consult with appropriate staff within SPU/WTD and other City/County departments (such as Fire Department, Seattle City Light, Transit) that will be impacted by the requested change. If it is determined that additional information is required to process the request, the agency's Program Manager will notify the Project Team's project manager and set up a design guidance meeting.

7.11 General ROW Restoration for GSI Projects

Restoration of the ROW shall be in accordance with Right-of-Way Opening and Restoration Rules, SDOT Director's Rule 01-2017 (or current edition). (Note: If a project is doing full right-of-way improvements from intersection to intersection, coordinate with SDOT to review minimum dimensions for the various zones (travel lane, flex zone, furniture/landscape/ pedestrian clear zone etc.) of a street's typology as defined in the Streets Illustrated ROWIM.)

Landscape:

Existing landscape areas not receiving improvements are to be restored to preconstruction conditions or better. When restoring existing lawn/grass, prepare the soil and consider using sod to extend the construction window, ensure lawn becomes filled in, and avoid settlement. Finally, the construction specifications should include a final clearing of the sidewalk zone as part of close out to provide a clear walking environment for residents.

Sidewalks:

See Section 7.12.

Curb Ramps:

When restoration requirements include curb ramps, the design of curb ramps (including associated companion ramps) and incoming sidewalks at intersections have very specific criteria. The retrofit of curb ramps is governed under the Americans with Disabilities Act and Title 28 of the Code of Federal Regulations, Section 35.151. If improvement extents include all or a portion of an intersection, SDOT design guidance for curb ramps (including companion ramps) shall begin during 30 percent design. See Streets Illustrated ROWIM and SDOT's Right-of-Way Opening and Restoration Rules for design of curb ramps in coordination with improvements near intersections.

Concrete Pavement in Roadway:

Concrete pavement panels being replaced adjacent to bioretention facilities shall be restored to their original size to avoid creating new joints that will affect sheet flow to the facility. (Note: Over time, debris can sometimes collect in the joints and divert sheet flow from reaching the intended drain curb cut, thus bypassing the flow.)

Utility Main Relocation:

See SPU DSG for SPU utility relocation and design standards. For relocation of other utilities, see respective utility purveyor's standards.

Utility Services:

Utility services that will be impacted by construction are to be replaced in accordance with City code (for water, service drain, side sewer) and agency purveyor's standards (e.g. gas from Puget Sound Energy). For adjusting service drain curb discharges into bioretention cells, see detail GC-3 in Appendix D. For adjusting side sewers, see detail GC-2 in Appendix D.

7.12 Sidewalk Restoration and Replacement when Adjacent to Bioretention

The extent of sidewalk restoration on neighborhood streets depends upon the existing condition of the sidewalk and the amount of sidewalk that will be impacted along a street for construction of the bioretention facilities and associated work (including restoration for utility service adjustments and constructability of vertical walls).

Prior to restoration of existing sidewalk that is disturbed by construction, see Streets Illustrated ROWIM, SDOT's Right-of-Way Opening and Restoration Rules, and SDOT's Trees and sidewalks Operations Plan for guidance on installation, repair, and maintenance of sidewalks and street trees. Examples of sidewalk repair and replacement is shown in Figure 7-37.

Substantial sidewalk repair adjacent to new bioretention facility.

Sidewalk requires replacement and trimming of vegetation overgrowing sidewalk.

Replaced sidewalk adjacent to bioretention cells along with consistent walk edge.

Recommend sidewalk widening be consistent along the walk through the multiple cell zones.

Recommend sidewalk replacement when a section is uplifted next to a new facility. Sidewalks adjacent to cell with vertical wall are to be replaced.

Existing sunken sidewalk was replaced as part of construction of bioretention cell in planting strip.

Figure 7-37: Sidewalk repair and replacement

The following are guidance and requirements for existing sidewalk restoration and replacement adjacent to bioretention facilities:

General:

- Sidewalk restoration and replacement extents for retrofits are to be reviewed and coordinated with SDOT.
- Review City's Pedestrian Master Plan for project area and SDOT's Right-of-Way Opening and Restoration Rules.
- The City's standard width for sidewalks on Neighborhood Yield streets is 6 feet (when the sidewalk is separated from the road by a planting strip). See Streets Illustrated ROWIM.
- When siting and locating bioretention cells along a block that has narrower sidewalks or no sidewalks, Project Teams shall evaluate and provide space for a full 6-foot-wide City standard sidewalk on neighborhood streets in the future. Review the analysis with SDOT for concurrence.
- It is important to maintain a consistent edge so if widening the sidewalk along a bioretention facility the extent of the sidewalk widening should be reviewed with SDOT. For example, if two or more cells are grouped then the edge treatment on the curb side should be consistent and the sidewalk width and alignment should be consistent.
- If cells are distributed, review sidewalk alignment along full length of block.
- Provide technical memorandum on sidewalk replacement approach as described in this section when required by SDOT. Consider using pervious concrete sidewalks if the conditions and amount of area of sidewalk restoration meets the requirements in Streets Illustrated ROWIM.
- When sidewalks are designed and constructed as a part of the bioretention facility project, the sidewalk alignment should be consistent (i.e., no abrupt changes in width) along the length of the block.
- Review opportunities to partner with SDOT to replace sidewalks/curb ramps that are lacking or in poor condition to meet other City goals.

Designing for ease of navigation

To improve navigability for those with visual impairments, consider predictability of the path of travel in the urban environment.

Consistency along a block (e.g., of sidewalk width and of distance between sidewalk and vertical wall/facility side slopes) promotes predictability in both day and during low light conditions and for those with low vision or blindness.

Existing Sidewalk Assessment for Restoration/Replacement:

- Assess condition of existing sidewalks adjacent to improvements and prepare a technical memorandum (see below). Walk the conditions with SDOT pedestrian sidewalk reviewer to determine the direction.
- Sidewalk in good condition: If the sidewalk adjacent to the GSI improvements is in good condition (i.e. no uplifting, sinking, and/or cracking) and is not disturbed by the improvements or used for construction equipment access, then it may remain. This approach might vary if there is other sidewalk restoration along the block that triggers full replacement.
- Sidewalk in poor condition: If the sidewalk (adjacent to the GSI improvements) is in poor condition (i.e., uplifting, sinking, cracking, gaps), it is to be replaced to the nearest joint beyond the facility. Note to avoid abrupt grades, replacement beyond the facility may be required.
- Sidewalk restoration:
  - Sidewalk restoration extents requires designer judgement in concert with SDOT. It is critical to consider the user and provide a consistent path of travel.
  - SDOT recognizes the challenges of retrofits to expand the existing walk width (typically 5 feet) to 6 feet (for Neighborhood Yield streets and when sidewalk is offset from curb by landscape zone) due to space constraints, context, topography/obstructions at back of sidewalk, so existing 5-foot-wide sidewalks may be restored to same width if the amount of sidewalk restoration along the block is minimal (i.e. just adjacent to cell).
  - When the sidewalk replacement is intermittent along the block and/or short sections are replaced for cells dispersed throughout the block, generally the replaced sidewalks will be restored to match existing width.
  - If there is a walled cell edge along the sidewalk then the wall alignment should be consistent for the entire block.to maintain the predictable pedestrian edge. Walled cells constrain the pedestrian environment, so they may trigger the need for retrofitting the sidewalk to the required standard for the street type. (e.g. if the wall is off set 12 inches from the current sidewalk edge then the replacement should be widened for the entire length of the consolidated cell zone.
  - If large sections of sidewalk will be replaced (such as ~half a block), then restore to City's current standard width and location. However, if retrofitting this width has design challenges (e.g., requires using walls in lieu of graded side slopes, impacts mature trees or requires a construction easement on private property, etc.), then review layout and alignment with SDOT.
  - When GSI improvements (such as placement of a cell) trigger sidewalk replacement/restoration next to or close to an intersection that is also being upgraded (curb ramp improvements/upgrades), widen sidewalk to 6 feet. Review width of transition from restored sidewalk to existing sidewalk with SDOT.

On Neighborhood Greenways:

On Neighborhood Greenways, there is a greater likelihood that sidewalks will be upgraded to 6 feet in the future, so Project Teams shall put greater attention to opportunities to upgrade these block lengths to 6-foot width.

Technical Memorandum on Sidewalk Replacement:

The Project Team shall prepare a technical memorandum documenting the sidewalk replacement approach, e.g., if using a vertical wall, note where the vertical wall leaves a 12-inch gap for future sidewalk width; OR review back of walk conditions to determine if the future (wider) sidewalk width can be accommodated there. It is intended that the sidewalk alignment be parallel with curb alignment and not shift from one property frontage to another, but alignment can vary depending upon site context (e.g. working around mature trees). Project Teams shall review analysis with SDOT. Memorandum shall be completed for 60 percent design.

Images: Sections of sidewalk that were either in poor condition and replaced (photo on left) or restored for utility cuts (photo on right) as part of the construction of bioretention cells (on the right in each photo).

7.13 Design for Post-Construction Monitoring

Project Teams should review monitoring requirements with GSI Program during 30 to 60 percent design to determine if monitoring (at the block scale) is to be part of the project. The monitoring program and elements shall be coordinated with O&M representatives. For example, if an observation port is to be installed in the facility for measuring water levels, review number of ports to install with agency Project Engineer and O&M staff. If there is special flow meter equipment that is to be installed in an underdrain MH, review design parameters for installing equipment. Discuss requirements for monitoring early at 60 percent design since the equipment may require design modifications such as a larger MH, modifications to MH access opening (size and orientation on structure's lid), an increase in outlet pipe size, modification to the pipe's length into the MH, and/or change to invert elevation for inlet and outlet pipes, etc.

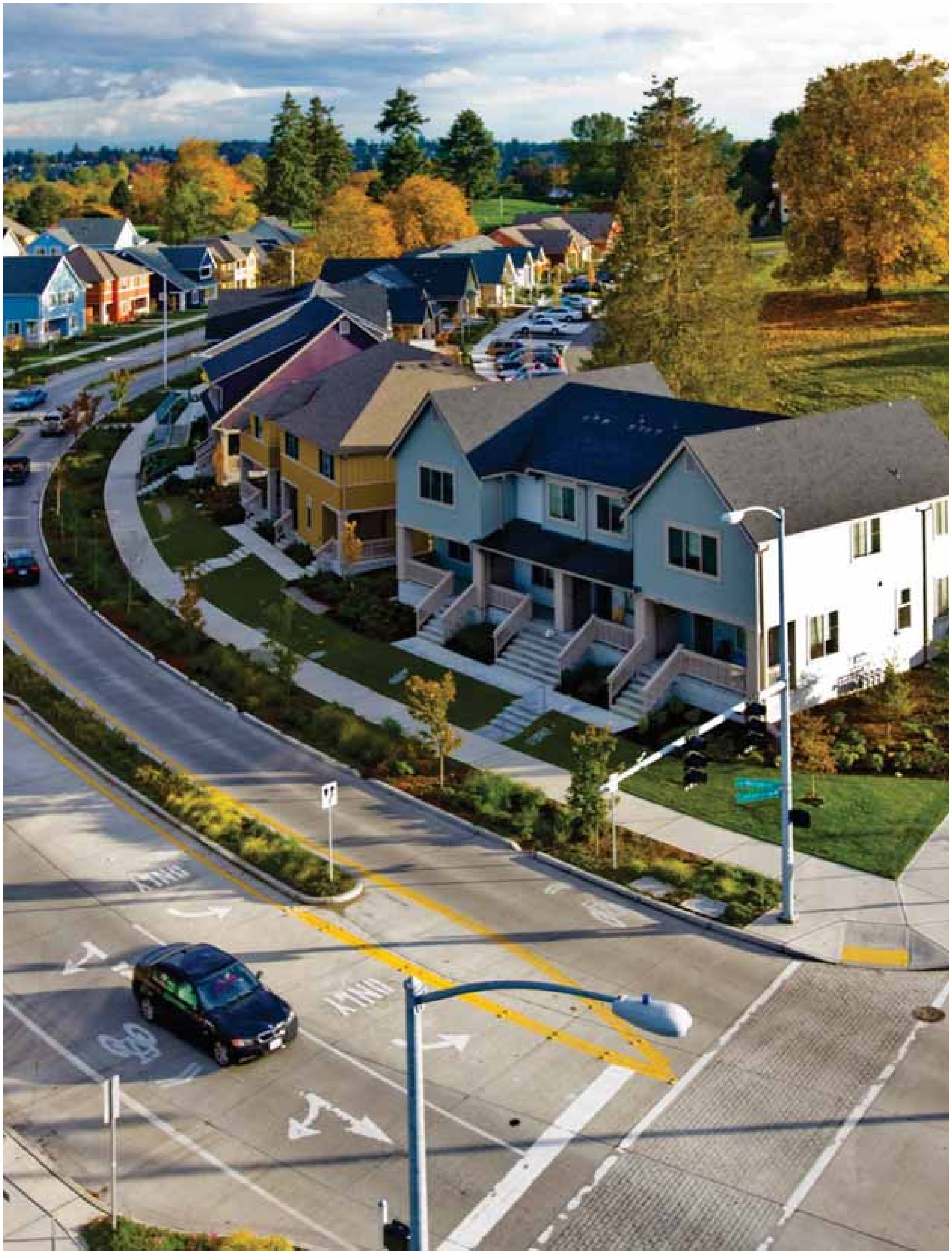


Image: Roadside bioretention cells along Sylvan Way SW (Principal arterial classification, Urban Center Connector street type).

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Section 8

Bioretention Design Considerations for Other Street Typologies

8.1 Introduction

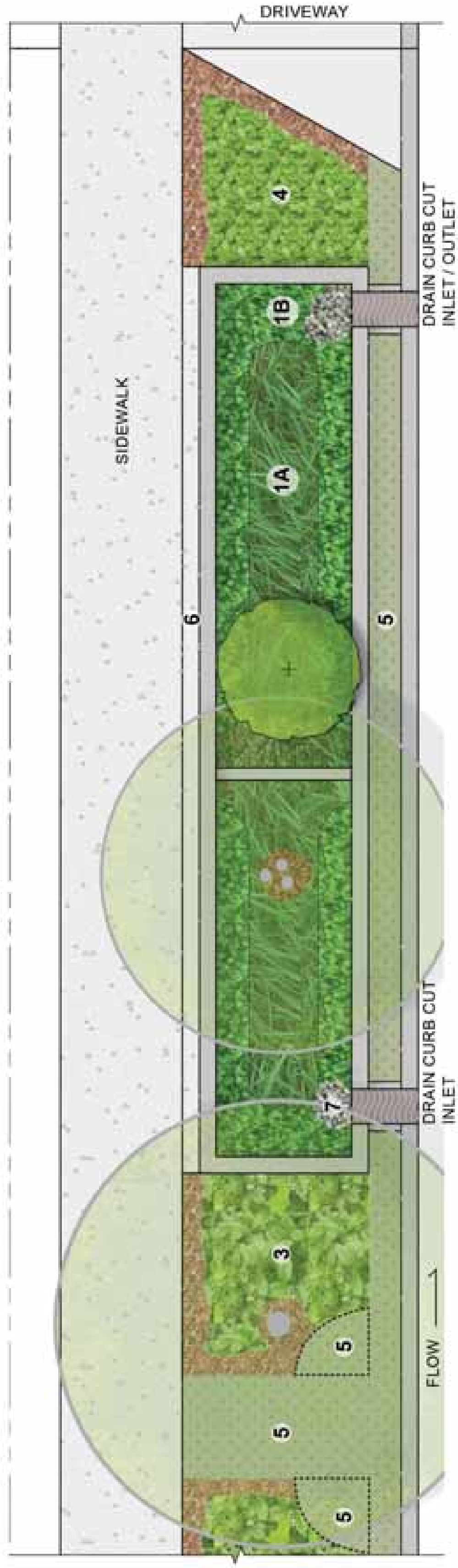
This section (including figures) is a **PLACE HOLDER.**

See Streets Illustrated ROWIM for bioretention design for other street typologies (non-Neighborhood Yield and Neighborhood Curbless streets). Also refer to the National Association of City Transportation Officials' "Urban Street Stormwater Guide" for reference, which included contributors from Seattle Public Utilities and Seattle Department of Transportation (see **https://nacto.org/publication/urban-street-stormwater-guide/**).

Figure 8-1 is a draft sketch developed through IDT depicting ROW bioretention planter planting zones.

Figure 8-2 is a draft sketch that was developed through IDT depicting strategies for tree placement within or adjacent to ROW bioretention cells with vertical walls. The figure also depicts requirements for siting paths between walled ends of cells for pedestrian access to a private residential parcel access.

The concepts provided in the figures are PLACE HOLDERS for teams to consider when developing concepts for other street typologies in residential areas, that may be more conducive for retrofitting in bioretention cells with vertical walls (also referred to as stormwater planters) as opposed to cells with graded side slopes.



SYMBOL	ZONE	PLANT TYPE / TREATMENT	LOCATION	FUNCTION	PLANT NOTES
	1A	Emergents & Perennials	Planter Bottom (Center Areas)	Water Quality Treatment	30" max. height above sidewalk
	1B	Low Shrubs, Emergents & Perennials	Planter Bottom (Edge Areas)	Water Quality Treatment	30" max. height above sidewalk
	3	Groundcovers & Shrubs	Sidewalk Grade	Accent / Border	6"-30" max. height
	4	Grass / Low Plantings	Driveway / Intersection	Sight Clearance/ Durable	24" max. height
	5	Access Surfacing	Curb Edge / Step-Out Zones / Crossings	Steppable	None
	5	Access Surfacing	Site for Each Parcel per Waste Pick-up Route	Solid Waste Pick-Up Space	None
	6	Sidewalk Setback	Along Sidewalk Edge	See notes	None
	7	Inlet Cobbles	At Inlet Drop	Sediment Capture	No plants within 12"
		Arborist Wood Chip Mulch	Along Edge of Cells	Maintain Edge	None
	1A,1B,3	Tall Accent Shrub	Crossing / Planter Bottom	Accent	4'-8' +/- height range
	1A,1B	Small Tree (trunk)	Planter Bottom (Unlined)	Shade / Water Retention / Urban Forestry	Height varies; Consider power line location
	3	Medium / Large Tree (trunk)	Crossings / Sidewalk Grade	Shade / Water Retention / Urban Forestry	Height varies; Consider power line location

Note: For more information, see GSI Manual Vol. III - Design, Chapter 7

Figure 8-1: ROW bioretention planting zone for cells with vertical wall(s) - Placeholder

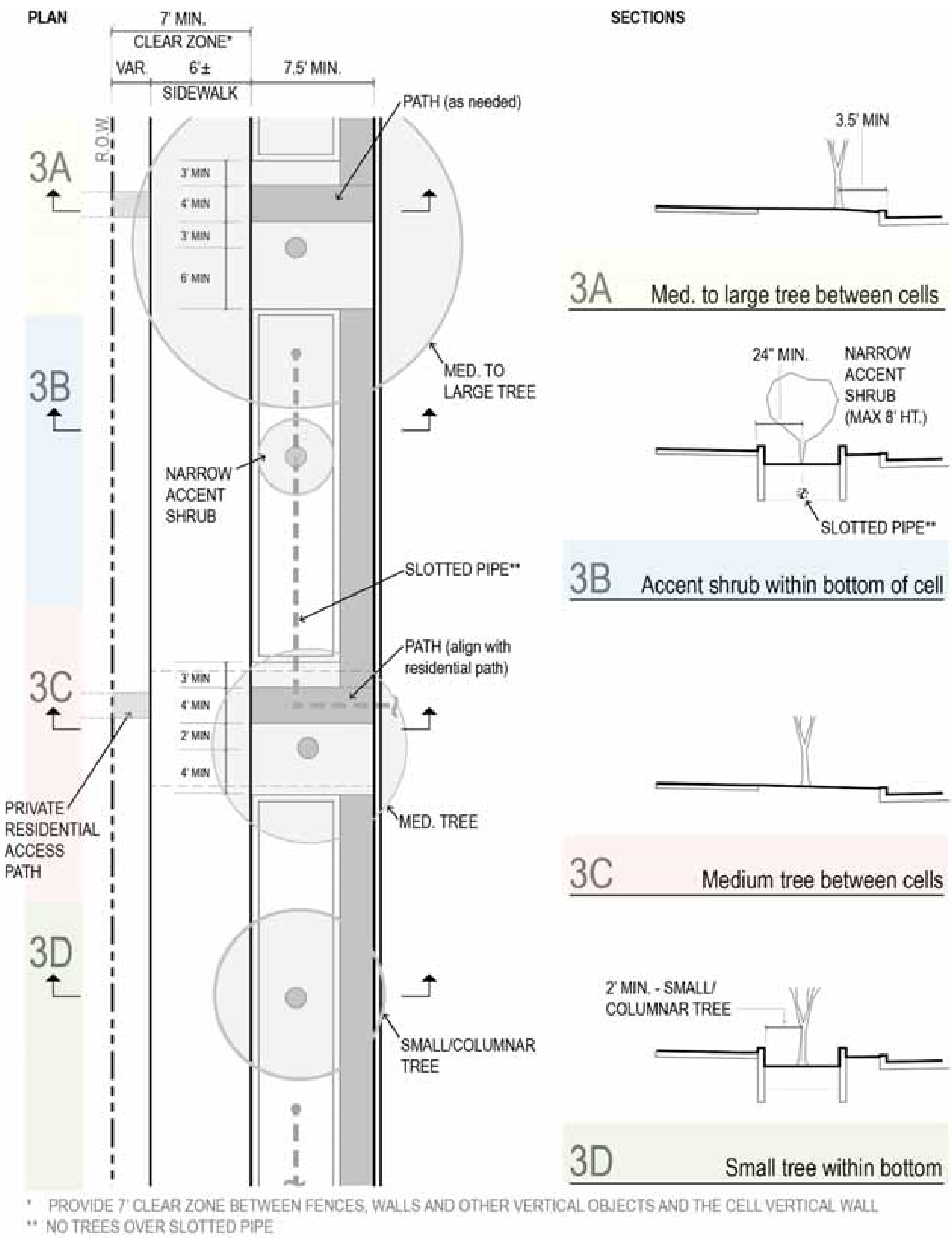


Figure 8-2: Tree placement at bioretention cell with vertical wall(s) -Placeholder

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Image: Pervious concrete sidewalk along a Neighborhood Yield street

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Section 9
Permeable Pavement Design

This section describes the design guidelines for implementing permeable pavements within the public ROW for sidewalks, Neighborhood Yield streets, and residential alleys between Neighborhood Yield streets. The guidance for designing pervious concrete pavement streets and alleys referenced in this section was developed through Interdepartmental Team (IDT) meetings with SDOT, SDCI, and SPU in 2014. See also COS *Stormwater Manual* (COS SWM) and COS *Standard Plans* and *Standard Specifications for Road, Bridge and Municipal Construction*.

9.1 General

The application of permeable pavements (sidewalks, roads, alleys) shall meet the feasibility requirements noted in the COS Stormwater Manual. In addition, Table D-2 in Appendix D provides additional feasibility requirements developed through the IDT meetings for designing permeable pavement for the City's Neighborhood Yield streets and residential alleys.

The installation of pervious concrete pavements in the public ROW has been limited to sidewalks and a pilot residential road constructed in 2005 (see Figure 9-1 for examples). Pervious concrete sidewalks are more common applications of permeable pavements in the City's ROW.

9.2 MOA for Maintenance Responsibility of Alleys and Roadways

Projects proposing to use permeable pavement (pervious concrete or porous asphalt) in the roadway or alley are required to obtain MOA with City for maintenance. Responsibility of maintenance of the roadway/alley is to be by the agency leading the CIP. It is recommended that MOA/ MOU be developed at 0 to 30 percent design, if it had not been developed with City departments during Options Analysis (see GSI Manual Volume II).

For SPU-led CIP projects proposing to install pervious concrete alley to meet Code, project team shall demonstrate that bioretention is not a viable option. See *Memorandum of Agreement #17-058-A between Seattle Public Utilities and Seattle Department of Transportation for Maintenance and Operation of Green Stormwater Infrastructure Assets in the Public Right of Way"* signed by SDOT on August 1, 2017 and SPU on May 27, 2017. Bioretention is the preferred approach for SPU-led CIP for meeting Code requirements in the ROW.

For WTD-led CIP projects proposing to install permeable pavement (pervious concrete or porous asphalt) in the roadway or alley, project teams shall go through SDOT SIP Design Guidance for review of this deviation. A MOA with the City for WTD to be responsible for funding and maintaining the permeable pavement will be required.

Pervious concrete curbless street

Pervious concrete sidewalk

Pervious concrete access path

Figure 9-1: Examples of public pervious concrete installed in City ROW

9.3 Infiltration and Subgrade Soils

The design guidance in this section is based on using permeable pavement for shallow infiltration (either as a surface or facility in the City's stormwater code), where the stormwater infiltrates into the subgrade soils below the pavement subbase. Standards and guidance for using deep infiltration (pit drains, drilled drains, etc.) for discharge of stormwater that has passed through a permeable pavement system would require projects to go through GSI Program Review (see Section 2) and approval process for review of new elements, deviations or alternatives to GSI details (see Section 7.10).

See City's Stormwater Manual for assessing and designing permeable pavement systems for shallow infiltration into the subgrade soils.

9.4 Materials

Pervious pavements in the ROW for residential alleys that are to be maintained by the City of Seattle shall be pervious cement concrete. See Table D-2 in Appendix D for IDT discussion notes on this issue and Streets Illustrated ROWIM. Currently, the City maintains the City's public paved roads/alleys for conventional pavements (non-pervious). While there is a COS standard plan for pervious cement concrete residential alleys, for City of Seattle to maintain it, a MOU/MOA is required with SDOT since it requires a change in operations and maintenance for

SDOT's procedures for residential alleys. If another agency (such as WTD) takes responsibility for road/alley pavement maintenance and funding of long-term maintenance of a road/alley with pervious pavement (see concept scenarios in Figures 9-2 to 9-8 that were developed through discussions with SDOT in 2014) then the City may approve use of alternative permeable pavement materials (such as porous asphalt or permeable interlocking pavers) if an agreement (e.g. MOA) between agencies is obtained.

9.5 Siting and Design

9.5.1 Public Sidewalks

Siting requirements and design for pervious concrete sidewalk are described in Streets Illustrated ROWIM and COS SWM. Specifications for pervious concrete sidewalks shall be in accordance with current COS Standard Specifications and COS Std Plan 425 for pervious concrete sidewalks. Maximum longitudinal slope for pervious concrete sidewalk in the ROW shall be in accordance with COS Std Plan 425 and COS SWM. Pervious concrete sidewalks in the ROW are typically defined as permeable pavement "surfaces" as opposed to "facilities" in the COS SWM, because public sidewalks are not designed to manage stormwater run-on from adjacent areas. For longitudinal slopes of permeable pavement surfaces exceeding 5 percent, subsurface check dams are required per COS SWM.

9.5.2 Public Neighborhood Yield Streets and Residential Alleys

Siting and design considerations for pervious concrete and porous asphalt retrofits for Neighborhood Yield streets and residential (non-commercial) alleys were developed through IDT meetings between SDOT, SPU and WTD in 2014 and are summarized in Table D-2 in Appendix D. The requirements for what are **permissible** and what concepts may be considered in a deviation request for the City's road and alleys depends upon who is responsible for the maintenance and operations of the pavement.

- For ***non-commercial alleys maintained by the City of Seattle***, pervious concrete pavement retrofits shall be applied for the full pavement width (width of alley) and full length of alley (from Neighborhood Yield street to Neighborhood Yield street). See COS Std Plan 403 for pervious concrete pavement section for non-commercial alleys. While it is in the standard plans, projects are to obtain SDOT approval and develop a MOA for the agency constructing the pavement to maintain the alley.
- For ***streets maintained by the City of Seattle***, Streets Illustrated ROWIM notes that "permeable paving as a street surface is not permitted, but is permissible in alleys."
- ***Streets and Alleys to be maintained by Others:*** From the 2014 IDT discussions between SPU, SDOT and WTD, if another agency (such as WTD) is responsible for maintenance and funding of long-term maintenance of the pervious pavement (porous asphalt or pervious concrete) road or alley, then SDOT would consider the concepts

depicted in Figures 9-2 to 9-8. SDOT approval would depend upon in part if an agreement between the City and the non-City agency is obtained and that the non-City agency would maintain the permeable pavement roadway/alley.

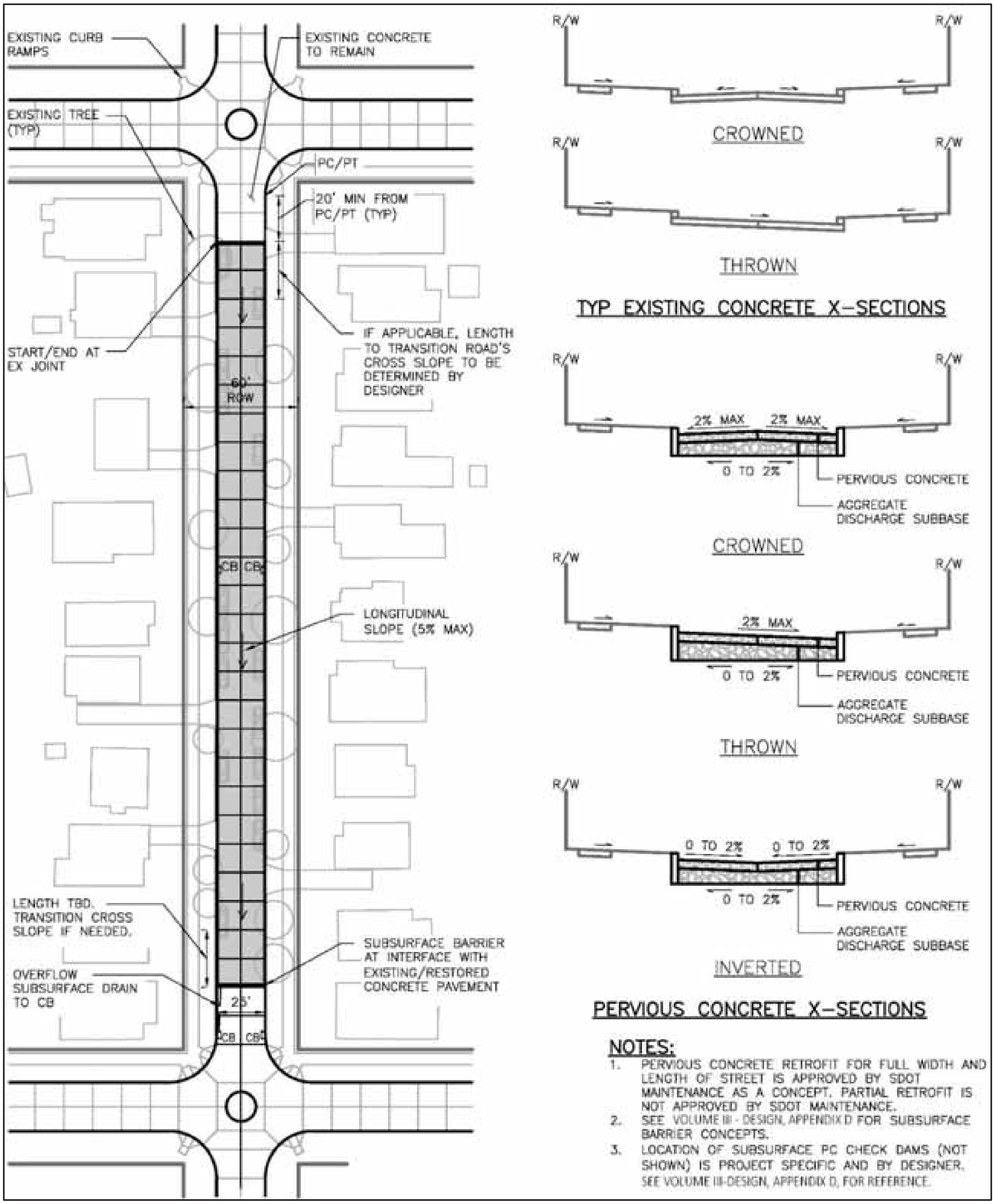
For design of pervious concrete pavement, see Sections 5.4.6 and 5.6.2 of COS SWM Volume 3; COS Std Plan 425 and COS Standard Specification Section 5-06. See Appendix D for background on the 2014 IDT discussions and meeting notes with SDOT.

Design guidance for supporting infrastructure, including but not limited to subsurface check dams, utility trench dams, overflows, and underdrains, is described in COS SWM, Table D-2, along with concepts in Appendix D. Project Teams will be required to develop special provisions and construction details for the design of permeable pavement and supporting infrastructure. Once the project is constructed, then GSI program with SDOT would review what elements might become a standard for future updates to either this manual or in COS Standard Plans.

TIPs

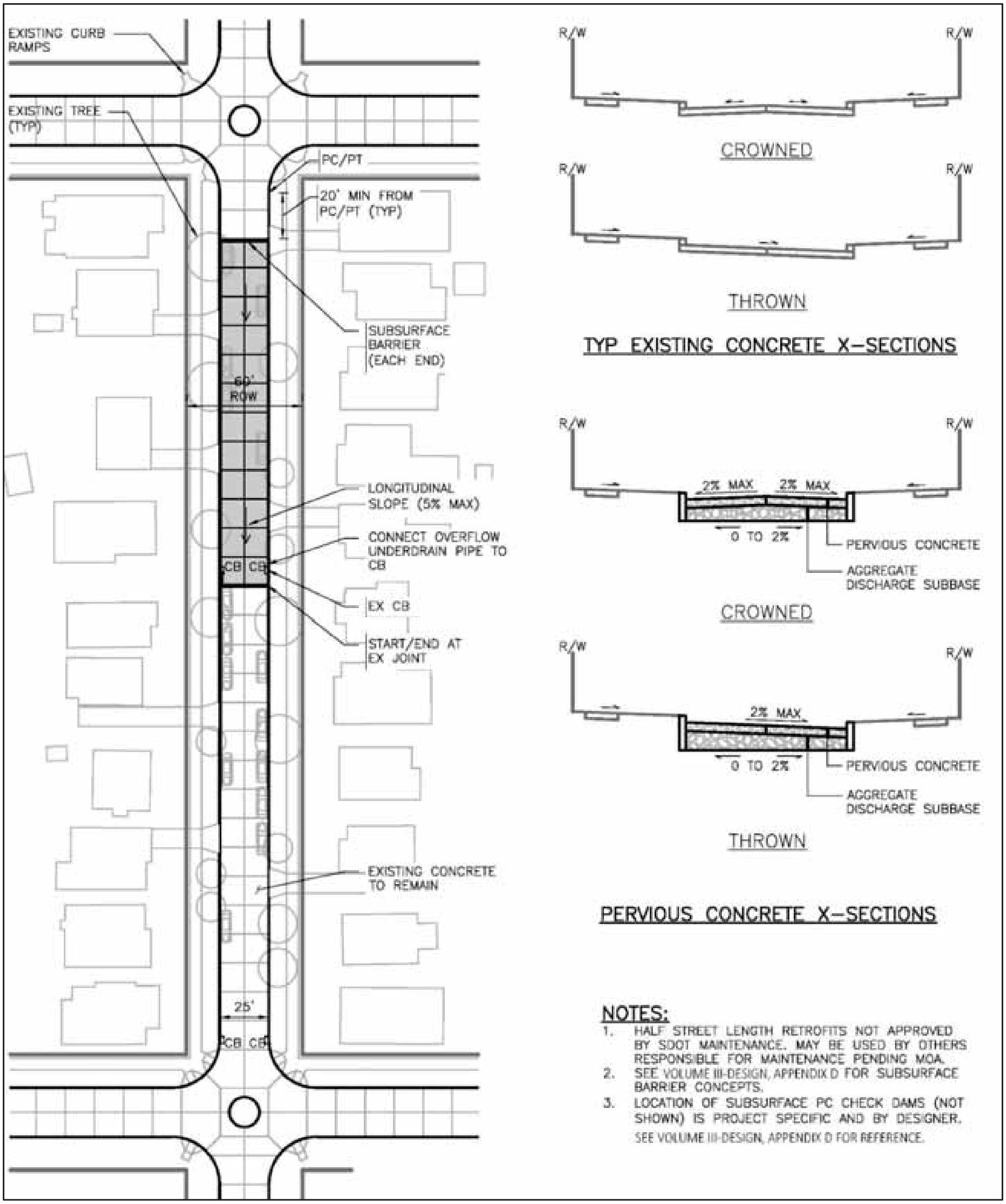
The figures (in this section) and details (in Appendix D) are concept sketches and not construction details.

At this time, aside from the City's 2005 pilot project, there have not been recent public permeable pavement streets/alleys permitted and constructed in the City. It is recommended that Project Team start early with SDOT through SIP Design Guidance to develop design along with discussions for MOU/MOA regarding maintenance of alley/ street.



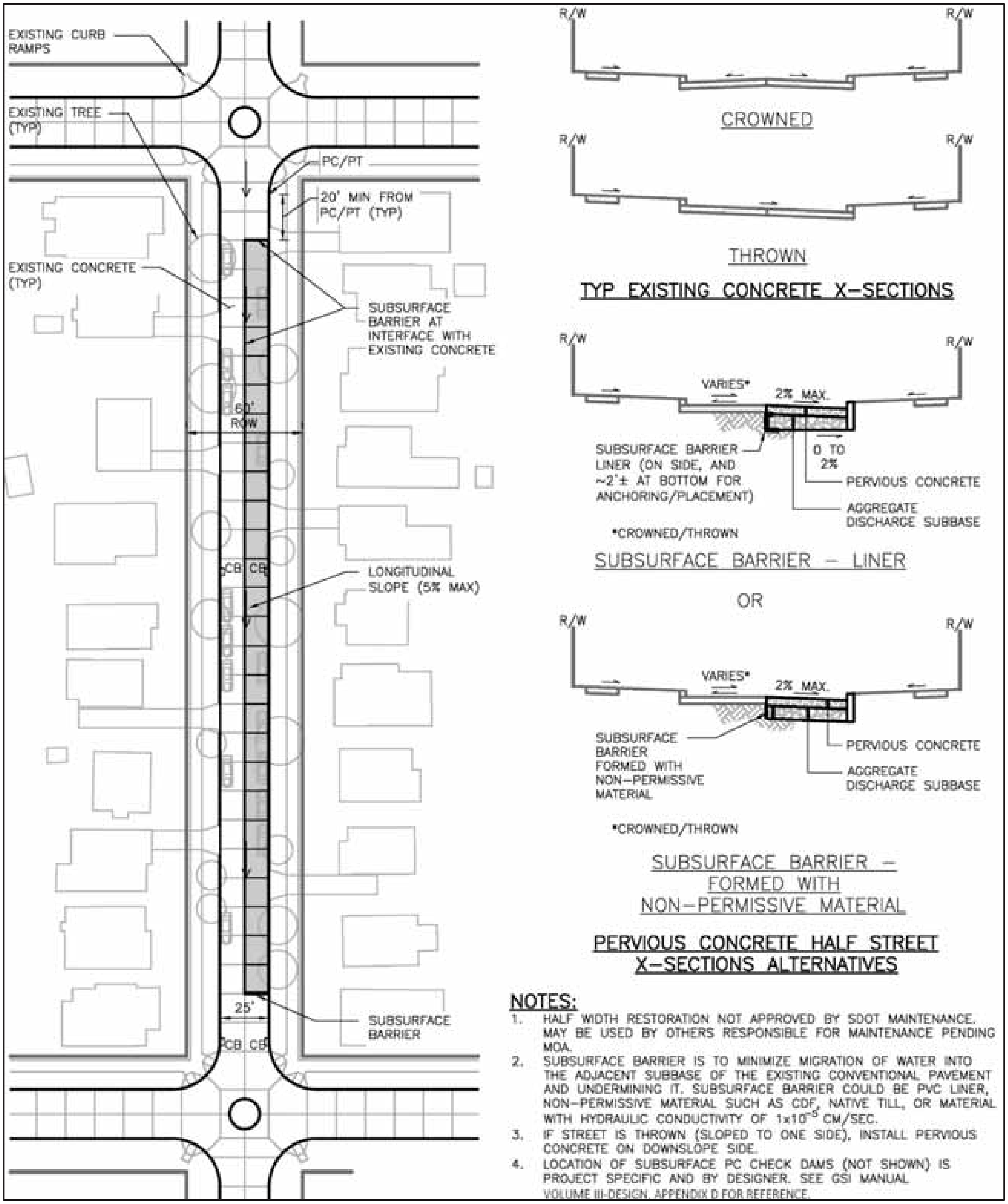
August 2018 Update: Aggregate discharge subbase shown in figure is to be permeable ballast, similar to COS Std Plan 403. Project Team to submit full pervious concrete pavement section design for SDOT review and approval. Water quality treatment to be designed per COS SWM.

Figure 9-2: Neighborhood Yield Street, pervious concrete retrofit, full road width and full street length concept



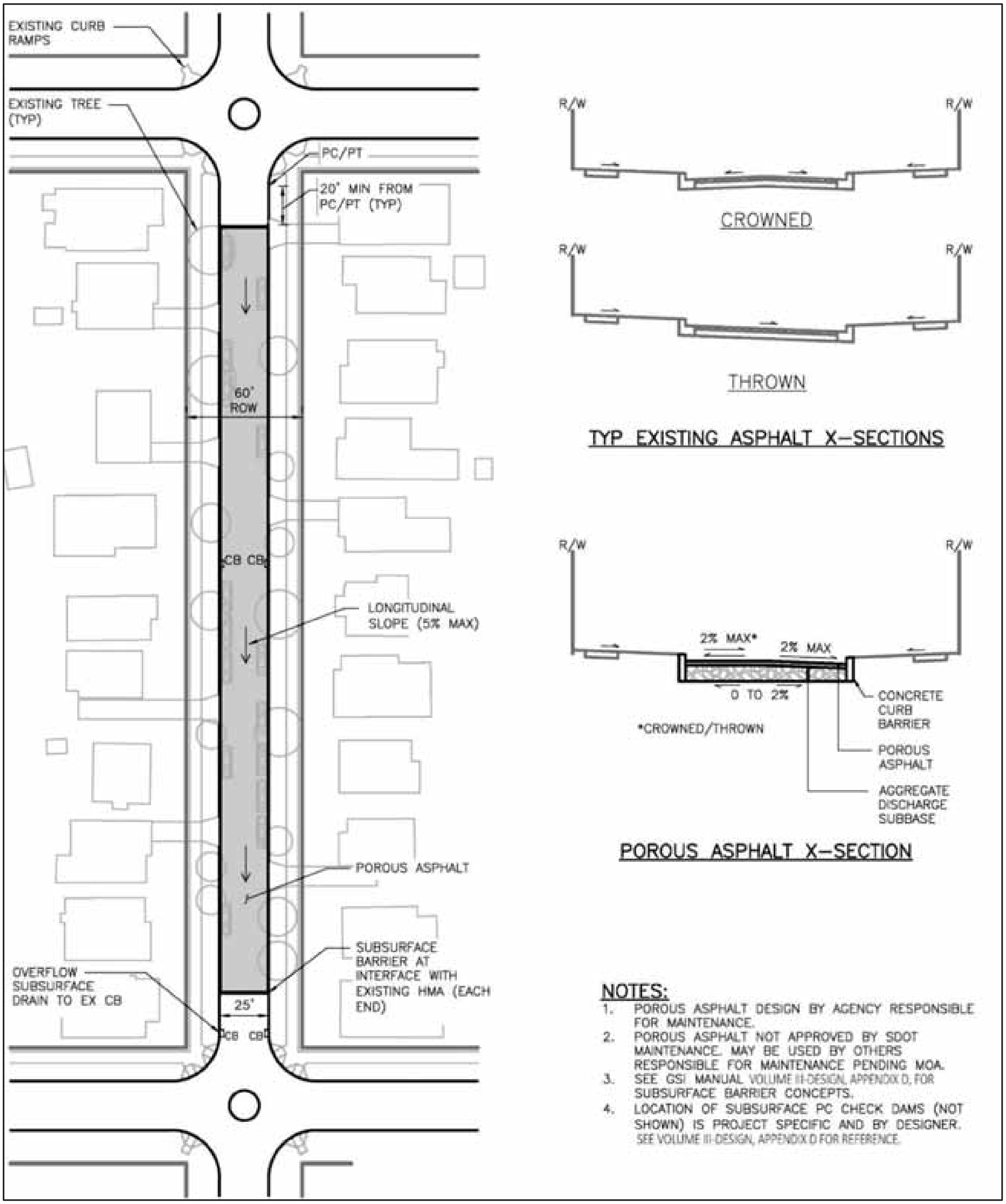
August 2018 Update: Aggregate discharge subbase in figure is to be permeable ballast, similar to COS Std Plan 403. Water quality treatment to be designed per COS SWM.

Figure 9-3: Neighborhood Yield Street, pervious concrete retrofit, full road width and half street length concept



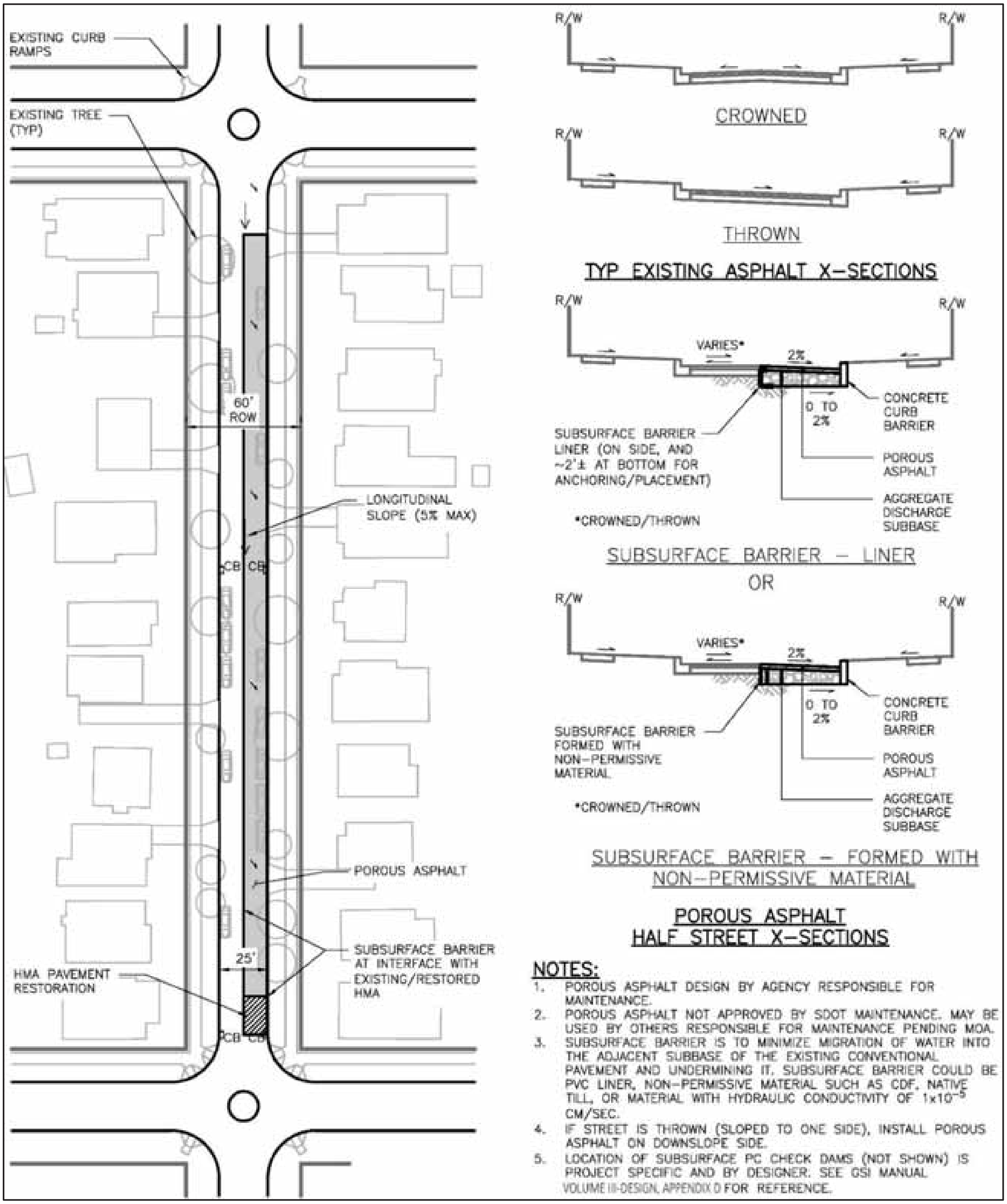
August. 2018 Update: Aggregate discharge subbase shown in figure is to be permeable ballast, similar to COS Std Plan 403. Water quality treatment (not shown) to be per COS SWM.

Figure 9-4: Neighborhood Yield Street, pervious concrete retrofit, half road width and full street length concept



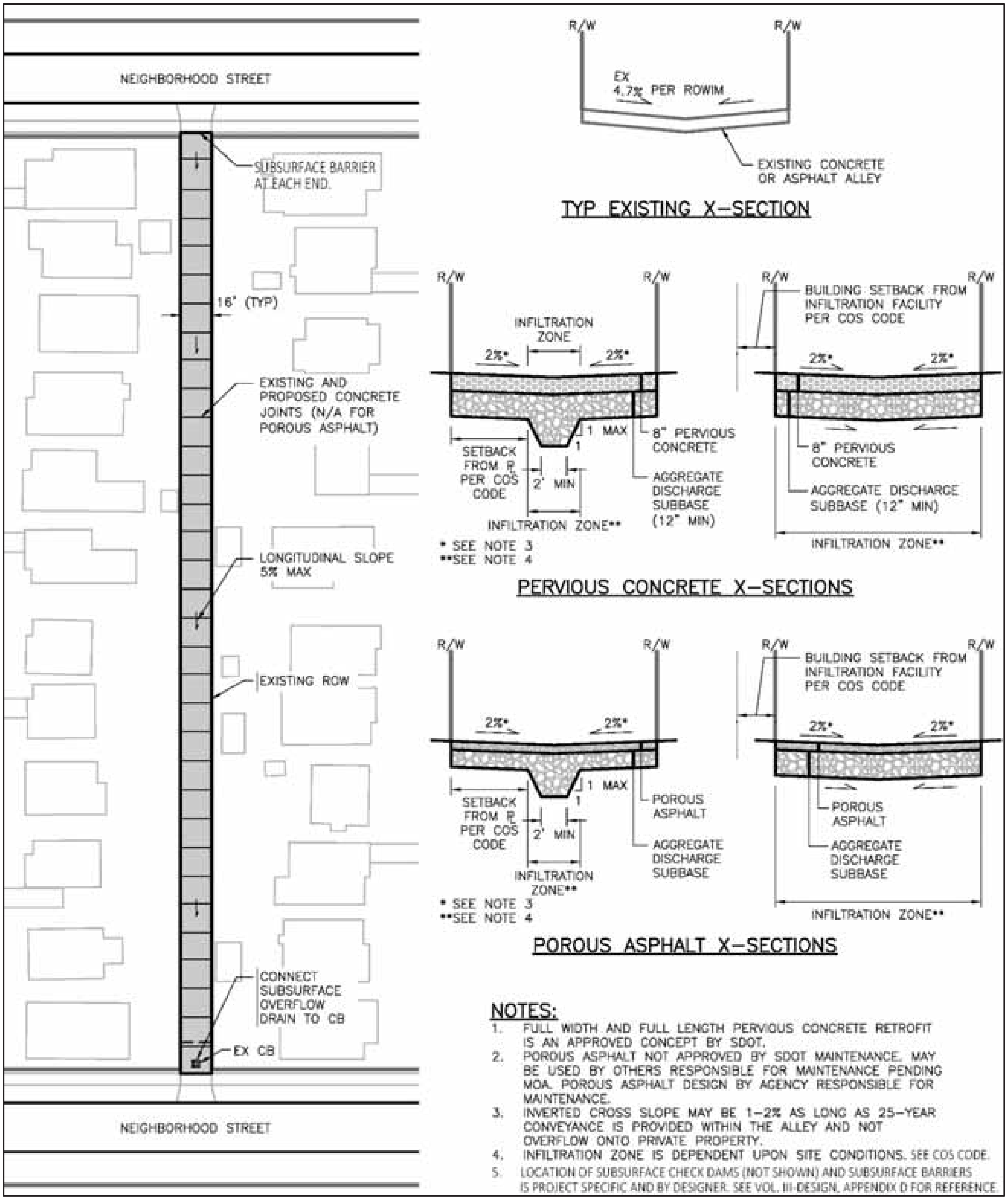
August 2018 Update: Aggregate discharge subbase layer(s) (material type and depth) shown in figure is to be determined by designer. Water quality treatment (not shown) to be per COS SWM.

Figure 9-5: Neighborhood Yield Street, porous asphalt retrofit, full road width and full street length concept



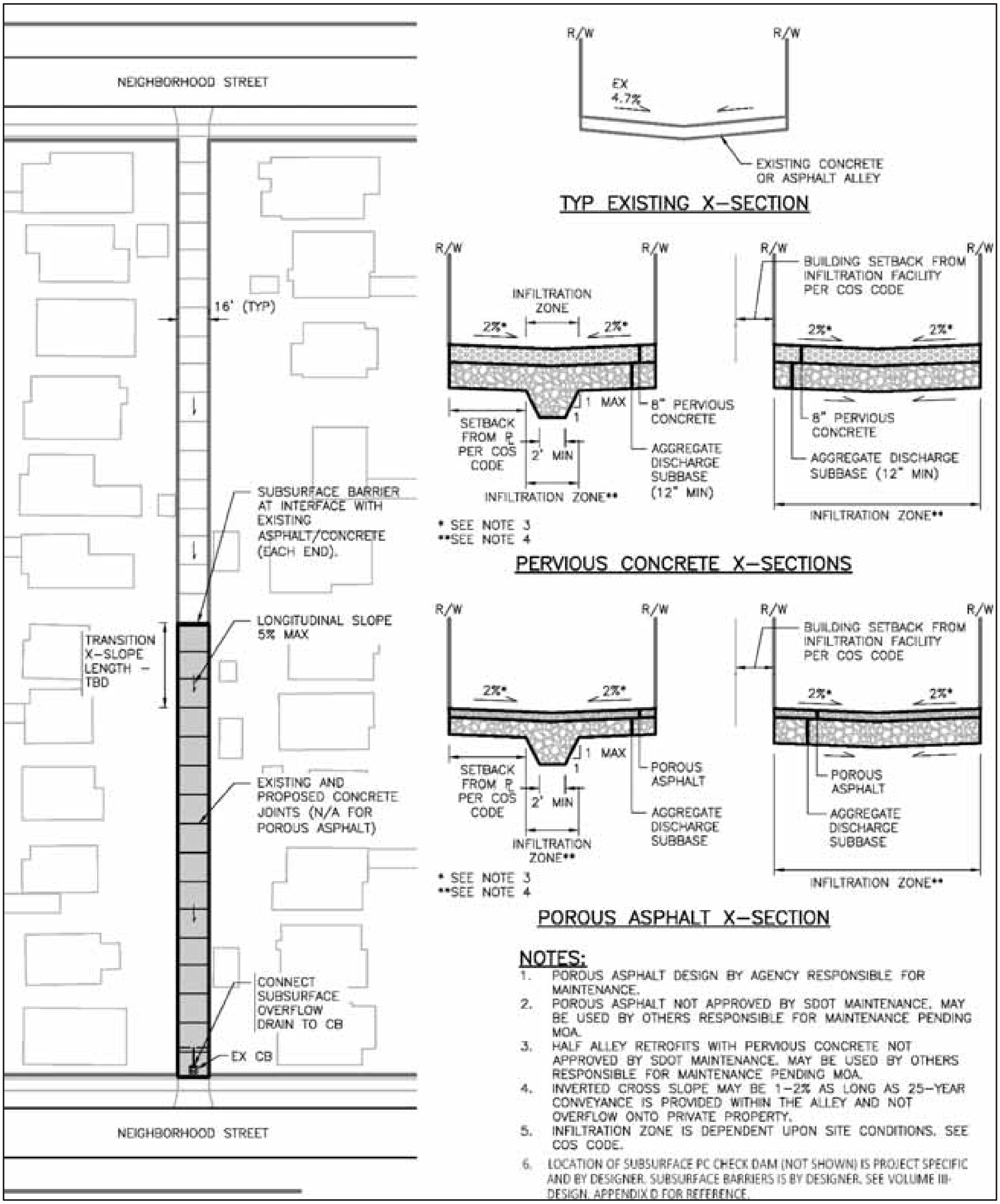
August 2018 Update: Aggregate discharge subbase layer(s) (material type and depth) shown in figure is to be determined by designer. Water quality treatment (not shown) to be per COS SWM.

Figure 9-6: Neighborhood Yield Street, porous asphalt retrofit, half road width and full street length concept



August 2018 Update: Water quality treatment design (not shown) per COS SWM. For pervious concrete pavement section, see COS Std Plan 403. For porous asphalt pavement section, including subbase layer(s) to be determined by designer.

Figure 9-7: Residential Alley, pervious concrete/porous asphalt retrofit, full alley width and full length concept



August 2018 Update: Water quality treatment design (not shown) per COS SWM. For pervious concrete pavement section, see notes in figure and COS Std Plan 403. Porous asphalt pavement section to be determined by designer.

Figure 9-8: Residential Alley, pervious concrete/porous asphalt retrofit, full width and half alley length concept

9.6 Emergency Overflow Assessment

All applications for pervious concrete pavement systems shall assess and design an overflow if the pavement system becomes clogged or receives more infiltration through the pavement system than designed.

9.6.1 Public Sidewalks

For pervious concrete sidewalks, given the longitudinal slope and cross slope of the sidewalk, projects shall be designed so that (overflow) runoff will flow into the road's gutter and/or sheet flow toward the road to a downstream drainage system. Pervious concrete public sidewalks are typically defined as a "surface" in the COS SWM, since their maximum longitudinal slope (profile slope) is limited to 6% (from COS Std Plan 425) and they essentially manage the precipitation that falls on them (i.e., do not receive run-on from other areas greater than 10% of the permeable pavement area).

9.6.2 Public Streets and Alleys

For pervious concrete Neighborhood Yield streets and residential alleys, (overflow) water shall sheet flow within the ROW to a downstream drainage system. Existing conveyance swales and/or catch basins may be retained for the purposes of providing an overflow for surface runoff.

At the downslope end of the pavement system, where the pervious pavement interfaces with conventional pavement a lateral subsurface barrier with slotted drain pipe shall be provided. The subsurface slotted drain pipe (design and size to be determined by civil engineer and confirmed with SPU O&M) shall be located at the upstream side of lateral subsurface barrier and designed to collect excess flow that has filtered downward through the pervious pavement. Subsurface slotted drain pipe shall be connected to the downstream conveyance system (swale or pipe). If the subsurface slotted drain pipe is to discharge into the piped public storm drain (PSD) system, it shall connect to a CB (drainage structure with a sump) prior to connecting to the PSD. The CB can also be used as the "surface overflow" for stormwater that doesn't filter downward through the pervious pavement. See permeable pavement concepts in Appendix D and Table D-2 for additional guidance.

9.7 Alternative: Infiltration below Conventional Pavements

During the City's IDT meetings in 2014, there was discussion of alternative methods to infiltrate stormwater below the pavement surface, including using conventional pavement in the roadway, collecting the stormwater and treating it through a water quality treatment facility (such as bioretention cell or WQ wet vault), and then infiltrating it below the roadway's pavement through a series of infiltration galleries. If this or other non-standard alternatives are being considered for a project, then project teams shall contact SPU's GSI Projects manager during the Options Analysis phase, preferably, or at the start of the Design Phase. New GSI alternatives are to go through a review and approval process (see Section 7.10).

Image: Dual opening UIC screen well lid (foreground) and underdrain MH access lid (background) located downstream of bioretention cells on a Neighborhood Yield street.

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Section 10

Deep Infiltration Infrastructure

Deep infiltration infrastructure is used to direct stormwater past near surface soil layers with low infiltration (such as glacial till) to deeper soil layers with higher infiltration potential (such as glacial outwash sand and gravel). This section provides guidance on using deep infiltration methods when shallow infiltration is not feasible or when augmenting infiltration capacity with deeper infiltration methods. Deep infiltration facility strategies are dependent on the unsaturated thickness between the base of the low-permeability unit at the surface and the depth to groundwater in the infiltration receptor horizon.

2019 UIC Working Group Updates to Section 10 Deep Infiltration Infrastructure were developed from a joint SPU and WTD working group in the fall of 2019 along with testing of SPU's UIC assets funded through a grant with King County Waterworks.

Deep infiltration facilities described in this section include pit drains, drilled drains, and/or screen wells. Figure 10-1 shows an overview of these deep infiltration methods of infiltrating stormwater after it has been pretreated. Terminology for pit drain, drilled drain and screen wells is specific to this manual. Ecology and other designers, agencies, engineers, architects, hydrogeologists and geotechnical engineers may use different terms than herein.

At start of Design Phase, review field testing and geologic analysis conducted during Options Analysis that determined the feasible areas, design approach and GSI technologies (see Figure 5-2 and Section 5).

Design, testing and siting of a deep infiltration facility along with associated components and infrastructure are project-specific in coordination with the owner (SPU/WTD), civil engineer, geotechnical engineer, hydrogeologist, landscape architect, and O&M representative of the Project Team. Project conditions and designs will vary.

10.1 Underground Injection Control Wells for Stormwater

Depending upon the design of the deep infiltration facility, it may or may not be defined by Washington State Department of Ecology (Ecology) as a “Class V Underground Injection Control” well (referred to as UIC in this section) for discharge of stormwater. UICs may be used for discharging treated stormwater when it is designed to meet Ecology's requirements in accordance with Ecology's 2019 Stormwater Management Manual for Western Washington (SWMMWW, 2019), Volume I, I-4 UIC Program. A typical UIC extends through the underlying low permeability soils and discharges treated stormwater runoff into an infiltration receptor horizon. Stormwater is discharged via a slotted well screen pipe or media backfilled trench located in permeable soils that are suitable for infiltration. Ecology defines a “deep UIC well” as an infiltration facility that extends below an upper confining layer and discharges into the underlying vadose zone (SWMMWW, 2019, Volume I-4.15). Permitting and registering of UICs is through Ecology.

In SWMMWW, 2019, Volume I, Section I-2.14, the Ecology UIC program defines a "*UIC well as a well that is used to discharge fluids from the ground surface into the subsurface and is one of the following:*

1. *A bored, drilled or driven shaft, or dug hole whose depth is greater than the largest surface dimension; or*
2. *A dug hole whose depth is greater than the largest surface dimension, or*
3. *An improved sinkhole; which is a natural crevice that has been modified, or*
4. *A subsurface fluid distribution system which includes perforated pipes that distribute fluids below the surface of the ground."*

Examples of UIC wells or subsurface infiltration systems are the following:

1. *Drywells*
2. *Drain Fields*
3. *Infiltration trenches with perforated pipe*
4. *Storm chamber systems with the intent to infiltrate*
5. *French Drains*
6. *Bioretention systems intending to infiltrate water from a perforated pipe below the treatment soil*
7. *Other similar devices that discharge to ground"*

Ecology also notes that "bioretention systems transporting water via a perforated pipe to a drainage system or to a receiving water" are not considered UICs.

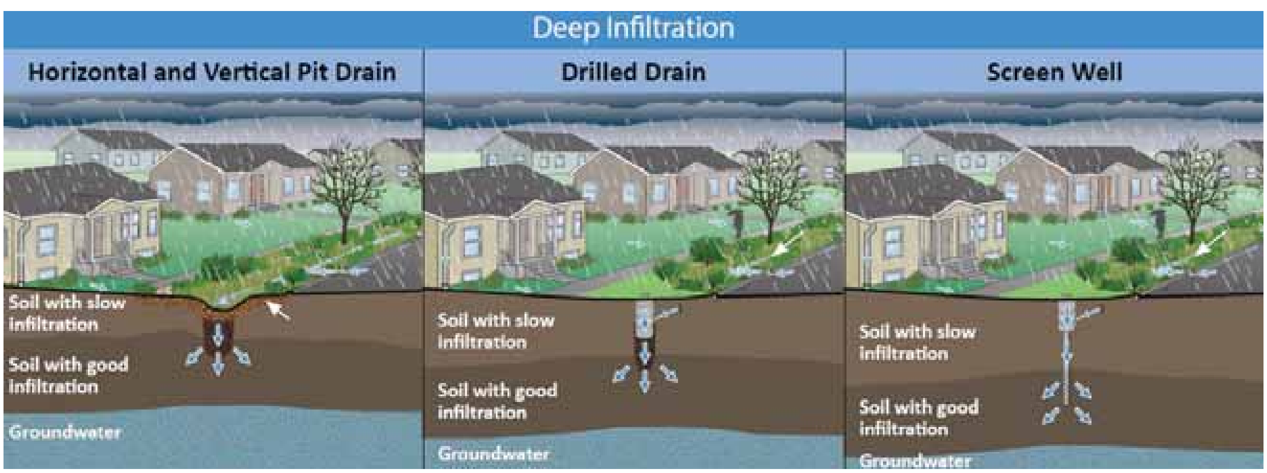


Figure 10-1: Different methods for deep infiltration.

10.2 Horizontal and Vertical Pit Drains

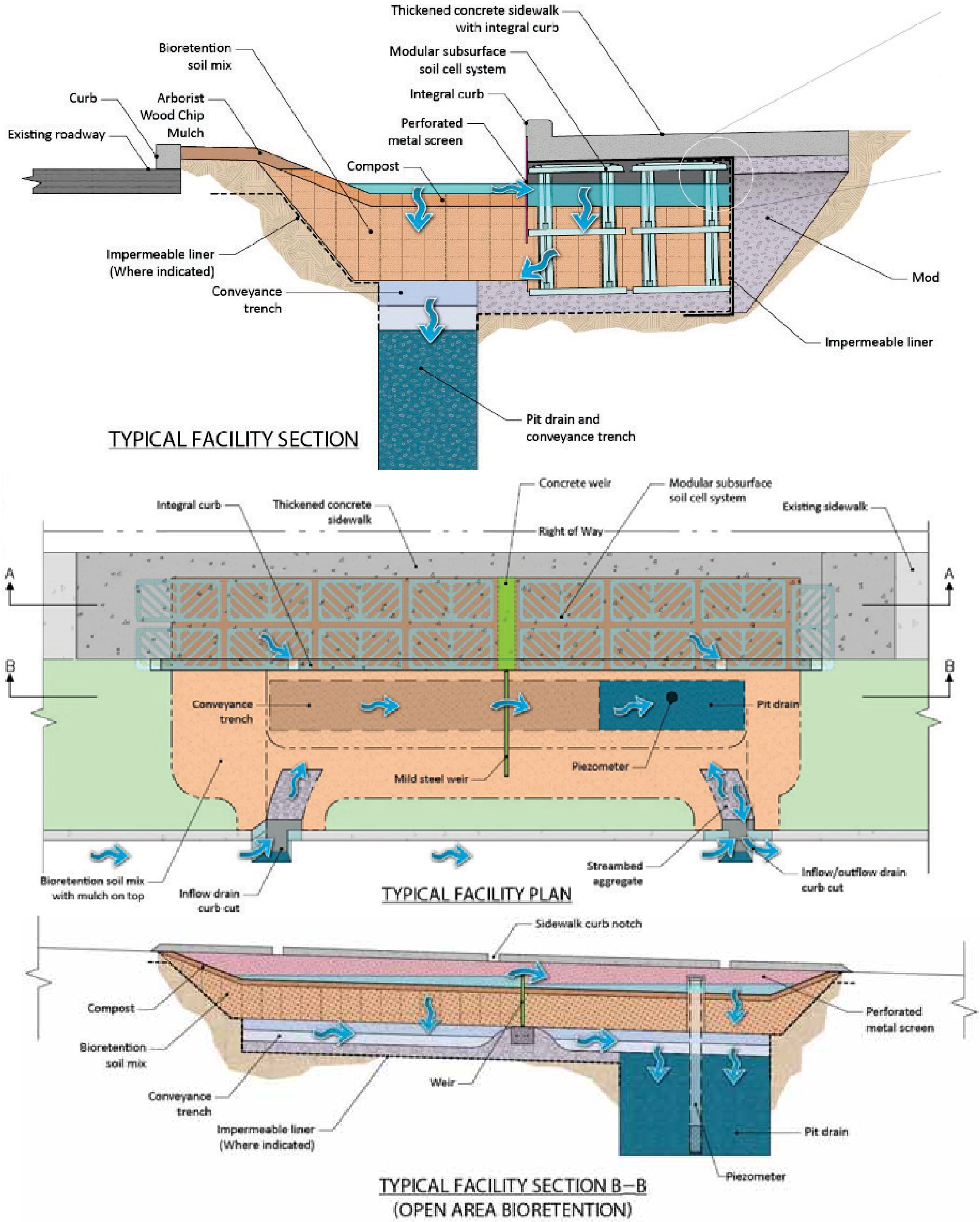
Pit drains are infiltration trenches (horizontal) or augered holes (vertical) where soils are excavated and backfilled with free-draining media backfill.

10.2.1 Horizontal Pit Drains

A horizontal pit drain is a trench that is excavated to a depth of ~10 to 20 feet and backfilled with free-draining media backfill. Horizontal pit drains can be used for discharging treated stormwater when the layer of low permeability sediments such as uncontrolled fill or glacial till near the surface is thin (generally less than about 10 feet) and soils that are more suitable for infiltrating are at a depth that is within reach of an excavator. Horizontal pit drains can also be used when the soils are stratified with varying levels of infiltration capacity. If the horizontal pit drain's depth is greater than its surface dimension (length or width), then it is considered a UIC by Ecology. The media backfill will could consist of COS Type 26 Mineral Aggregate or other free draining material. Pea gravel (e.g. COS Type 22) has also been used but should not be used in City right-of-way where future excavations may occur (e.g. utility trenching) through the pit drain, or adjacent to the facility, resulting in loose pea gravel falling into the excavation.

Horizontal pit drains have typically not been considered UICs because the depth of the facility is usually less than the largest surface dimension. However, the 2019 Stormwater Manual for Western Washington (SWMMWW) UIC Program has changed the UIC definition such that if the infiltration facility extends below an upper confining layer and discharges into the underlying vadose zone, then it may be considered a "deep UIC well" regardless of surface and depth dimensions (SWMMWW, 2019, Volume I-4.15). Project Teams shall review their designs with Ecology to determine whether the pit drain is considered a UIC and requires registration with Ecology.

Figure 10-2 is an example of a horizontal pit drain taken from SPU's Ballard Phase 2 NDS project that also piloted the use of structural soil cells next to the bioretention cells. Structural soil cells are not required when using horizontal pit drains.



Graphics are from SPU's 2017 Blue Book for Ballard Natural Drainage Solutions 2016 Project (December 28, 2017) that piloted the use of horizontal pit drain and structural soil cells with bioretention. See project's blue book for more information on the detail.

Figure 10-2: Example of horizontal pit drain with structural soil cells

10.2.2 Vertical Pit Drains

Vertical pit drains function similarly to horizontal pit drains, but they are used when the more permeable soils targeted for infiltration are deeper than the reach limitations of an excavator or to avoid the need for shoring during excavation. Vertical pit drains are usually 24 to 36 inches in diameter, are installed using a drill rig, and are backfilled with media backfill (COS Type 26 Mineral Aggregate or other free draining material). Pea gravel (e.g. COS Type 22) has also been used but should not be used in City right-of-way where future excavations may occur (e.g. utility trenching) through the pit drain, or adjacent to the facility, resulting in loose pea gravel falling into the excavation.

The depth of a vertical pit drain is ultimately limited by the groundwater table, available construction space and construction access considerations. Installations have varied in depth from about 20 feet to over 100 feet. Projects should consider varying size and capabilities of installation equipment for vertical pit drains depending on site access, staging availability and subsurface conditions. Vertical pit drains, if penetrating a surficial low permeability layer such as glacial till, meet Ecology’s definition for deep UIC and require registration with Ecology.

Pit drains are generally designed as below grade infiltration facilities with landscaping or bioretention facility above the pit drain. An observation vertical pipe/port extending to the bottom of the pit drain should be included during construction of the pit drains so that water levels can be monitored to assess performance. If performance of the system degrades over time, and the monitoring results show it may be due to decreased infiltration capacity, then the media backfill can be removed and replaced. Additional information on UIC rehabilitation is included in Section 10.10.

If bioretention is chosen for the pretreatment system, pit drains may be installed directly below a bioretention cell, thus not requiring an underdrain pipe. Alternatively, the pit drain may receive filtered stormwater from a series of bioretention cells with an underdrain pipe. Table 10-1 provides guidance for siting pit drains within the City’s ROW.

Table 10-1: Guidance for Siting Pit Drains within the City ROW

Pit Drain Siting Description	Rationale
Location: Locate pit drains in landscape areas. Do not locate beneath pavement.	To allow for easier access to pit drain if rehabilitation is required during O&M
Dimensions: Depth and dimensions of pit drains to be determined by geotechnical engineer/ hydrogeologist and civil engineer on Project Team.	Total depth of horizontal pit drain is driven by the reach of an excavator for construction in a developed ROW. Depending upon depth of pit drain and construction methods, roadway pavement and sidewalk may need to be replaced if undermined during construction.
Underground Utilities: Pit drains shall have 10-ft of horizontal clearance from deep underground utilities (including side sewers, storm and sewer mains). Shallower utilities (such as services, water, gas, and public mains with up to 4-ft of depth) may have a min. 5-ft of horizontal clearance from a pit drain.	To allow for ease of construction/maintenance of service utilities/public mains without impacting the aggregate backfill for horizontal pit drains or backfill for the utility trenches. Utility service crossing through a pit drain is not allowed. Except for horizontal pit drains, a shallow service is to be placed in a PVC casing (with no pipe joint in the pit drain) extending a minimum of 2 foot beyond the width of the horizontal pit drain.
Setback from Trees: Pit drains shall not be located within the dripline/canopy and critical root zone of existing mature trees to be protected.	Consult with arborist if pruning is feasible to improve clearance and if there are other construction considerations that might impact the tree species (tree root zone may be larger than tree canopy resulting in wider clear zone).
Setback from Overhead Utilities: Pit drains shall have clearance from overhead wires (Seattle City Light, franchise utilities, etc.). Drill rigs used for vertical pit drains require a 10-foot horizontal clearance from power lines with voltage up to 50kV.	Clearance will depend upon type of overhead distribution and standards per Seattle City Light and franchise utilities. Review clearance required for construction and maintenance equipment when siting both horizontal and vertical pit drains.
Locate cleanouts outside pit drain: Locate underdrain cleanouts in a level area outside the footprint of the bioretention cell and pit drain.	See section 7.5.8 and Table 7-13 for more information on underdrain infrastructure and cleanouts.

10.3 Drilled Drains

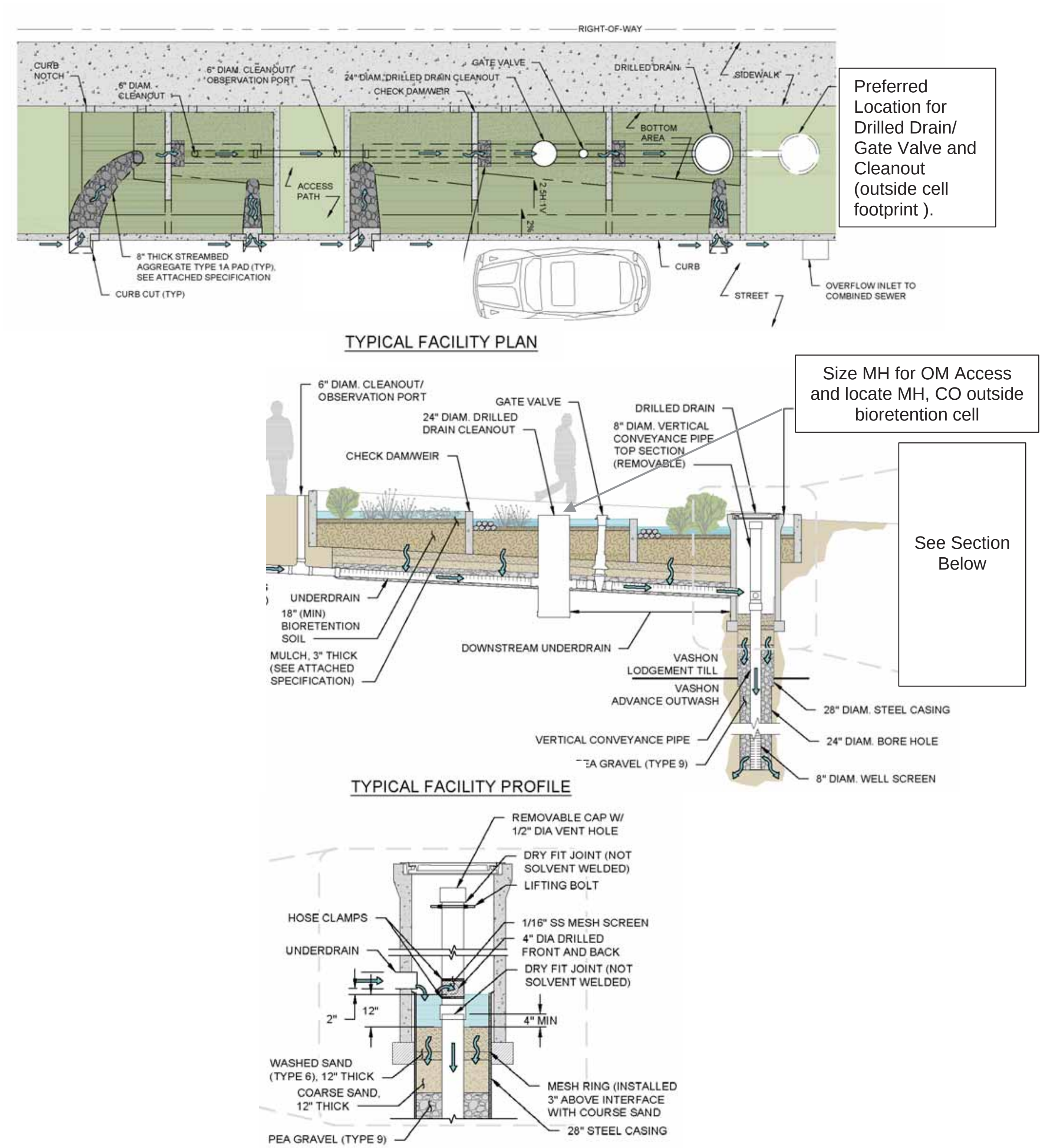
A drilled drain is constructed with a drill rig to reach suitable soil for infiltration at depths of 20 feet to greater than 100 feet below the surface. Drilled drains typically fall within the definition of a deep UIC and require registration with Ecology.

The sizing and design of the surface casing and media backfill are project-specific, factoring in both infiltration rate of the native soils and maintenance access (for observation ports, conveyance pipes, etc.). Other project-specific design elements include but are not limited to well depth, design infiltration rate, method of construction, well development criteria, sand filter pack design, overflow conveyance pipe, observation port, and MH structure.

10.3.1 Bore hole and Casing

A drilled drain usually includes a 24-inch to 36-inch diameter bore hole, filled with media backfill. Treated water is conveyed vertically via gravity flow through the media into suitable soils for infiltration at depth. Maximum depth of a drilled drain depends on the elevation of the groundwater and construction considerations such as the stand-up time of the soils during drilling. Media backfill will typically consist of COS Type 26 Mineral Aggregate, pea gravel, or other free draining material. A surface MH structure is located over the drilled drain for maintenance access. See Figure 10-3 for an example design detail of a drilled drain from SPU’s Delridge NDS project.

The upper section of the boring (characterized by low-permeability soils) will be a minimum 4 inches wider than the outside diameter of the borehole casing to accommodate a surface seal and a casing. The annular space between the casing and borehole wall will be sealed per Chapter 173-160 Washington Administrative Code (WAC), “Minimum Standards for Construction and Maintenance of Wells.” The casing will extend to a depth of about 4 feet below the contact between the low permeability sediments and underlying infiltration receptor horizon. The casing will be seated on the lip between the larger-diameter upper portion and smaller-diameter lower portion of the UIC and driven into place. The casing is intended to limit the potential for shallow groundwater seepages and fines on or within the low permeability soil to pipe into the UIC backfill.



Graphics are from SPU's 2017 Blue Book for Delridge Natural Drainage Solutions 2015 Project (August 31, 2017) that piloted the use of a drilled drain with bioretention. See project's blue book for more information on the detail.

Figure 10-3: Example drilled drain (with sand filter) from SPU's Delridge NDS project

10.3.2 Sand Filter Layer (optional)

Under typical use, the treated stormwater is conveyed to the bottom of the MH structure, infiltrates through the media backfill material to the base of the well, builds up head, and then infiltrates into the surrounding soils. A 24-inch-thick sand filter layer can be included on top of the media backfill to filter particulate matter that may remain in the stormwater after treatment. The sand layer in drilled drains can restrict the maximum flow rate but is advantageous in applications where final sand filtration of the stormwater is desired immediately prior to entry into the UIC. Figure 10-3 shows a section from the SPU's Delridge NDS project that included this sand filter layer. While this provides additional filtering for particulates, the project team should carefully consider maintenance needs of this filter layer and receive approval from O&M regarding procedures for cleaning and replacing this filter layer within the MH. A larger size access maintenance hole that would allow personnel and equipment to enter the structure is more suited for maintenance access (e.g. provide more space between the vertical pipe and MH interior for personnel and equipment to enter the MH than depicted in Figure 10-3).

10.3.3 Vertical Conveyance Pipe

Drilled drain design can include a vertical conveyance pipe so that higher peak flow events can be conveyed to the base of the drain more quickly thereby reducing potential surcharge of upstream infrastructure. A vertical conveyance pipe, typically 6- to 8-inch diameter, can be used as an overflow for the drilled drain. Under heavy storm events or if the sand filter becomes clogged such that the water backs up into the MH, the vertical conveyance pipe directs treated stormwater to the bottom of the media, where it exits the pipe through a well screen and infiltrates into the surrounding media and then into the surrounding soil.

10.3.4 Depth and Design Infiltration Rate

The total depth and assumptions for design infiltration rate for the drilled drain are determined by the geotechnical engineer/hydrogeologist and are site-specific. Section 10.5.3 includes a discussion of infiltration factor of safety related to design methodology.

10.3.5 Setbacks

Setbacks for drilled drains are same as a pit drain and would need to have a minimum of 10 feet drill rig clearance from overhead power lines. See Table 10-2 regarding setbacks for associated infrastructure including the MH.

Locating UICs and Supporting Infrastructure in the ROW

When siting UICs and the associated infrastructure consider the site context, social function, street character and equipment and personnel access (for construction and O&M). For discussion on this, see Sections 7.3 and 7.5 along with examples and considerations noted in Figures 7-8, 10-5 and 10-6.

10.4 Screen Wells

A screen well is a type of deep infiltration UIC that is typically used either for higher performance or for constructability considerations where the infiltration receptor is deep or less suitable for auger-style drilling methods. A large truck-mounted drill rig is used for construction of screen wells. Boring diameter for a screen well can vary (e.g., 10- to 12- inch) with a 6- to 8-inch well casing. Screen wells are located below a UIC MH.

Screen wells are considered to meet Ecology’s definition for “Deep UIC” and require registration with Ecology. Table 10-2 provides guidance for siting within the ROW screen wells that are accompanied by a maintenance hole for access. Sizing and design of the casing and screen are project-specific, factoring in both infiltration rate of the native soils and maintenance access. Other project-specific design elements include but are not limited to well depth, design infiltration rate, method of construction, well development criteria, filter pack specification and thickness, conveyance or drop pipe, observation port and MH structure. Section 10.5.3 includes a discussion of infiltration factor of safety related to design methodology. Figure 10-4 shows a typical design detail for a screen well and UIC MH over the well that was developed by the SPU/WTD UIC working group based on past ROW installations.

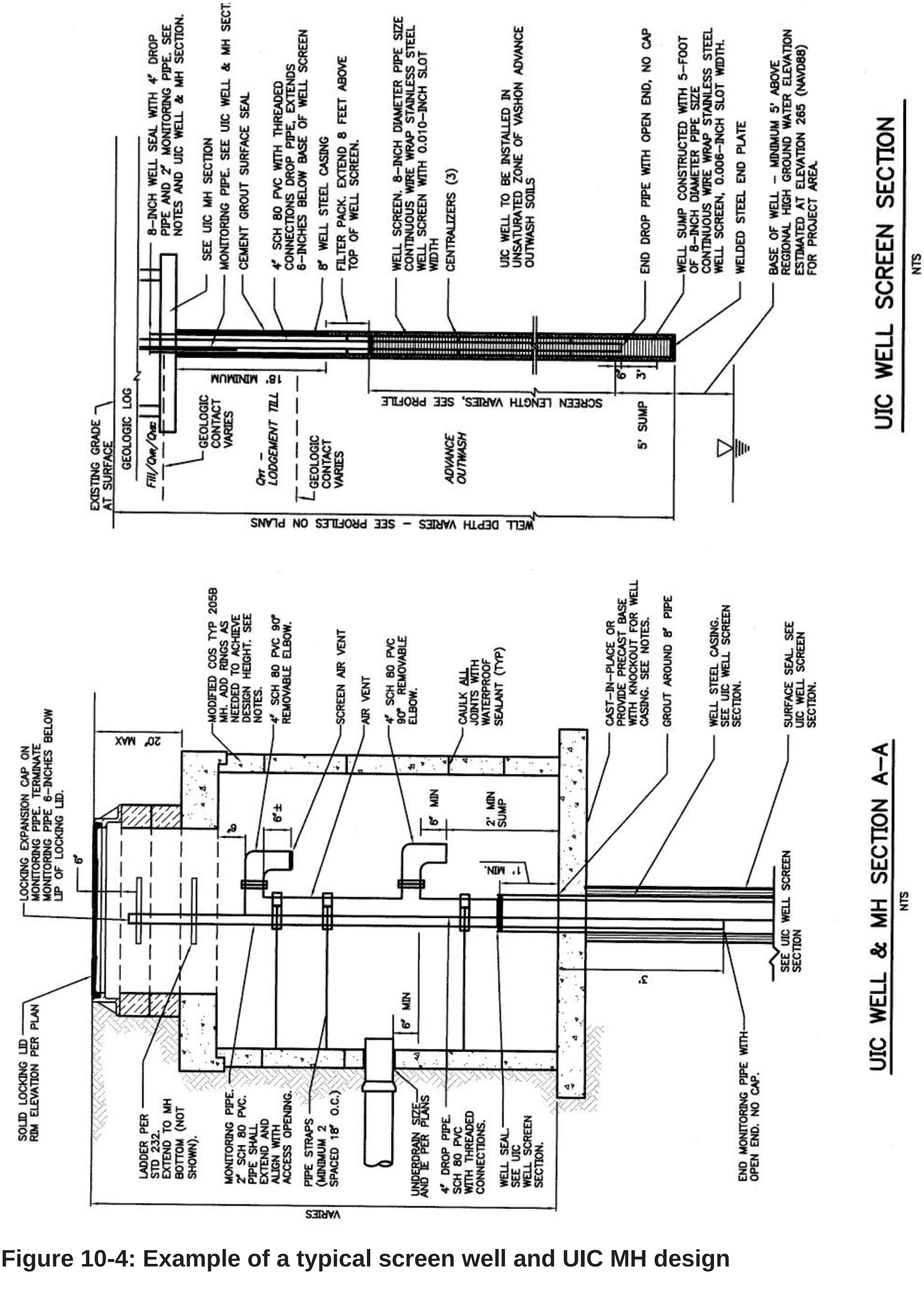


Figure 10-4: Example of a typical screen well and UIC MH design

Table 10-2: Guidance for Siting UIC Screen Wells and Drilled Drains in the ROW

Siting Description	Rationale
General	
Clearance between UICs: Minimum distance between UICs is project-specific and determined by geotechnical engineer/ hydrogeologist in coordination with the others on Project Team (e.g., landscape architect, civil engineer, O&M)	Aside from design parameters also review community considerations (social function and site context – See Section 7.3) and constructability for placement of MH for screen well/drilled drain. For example, consider impacts to residents during construction and access for routine and non-routine OM activities.
UIC MH size and design: MH designed over UIC shall be sized to accommodate clearance requirements for O&M crews and monitoring equipment. MH should be designed such that confined space entry is not required for routine maintenance and monitoring. MHs need to be easily accessible by drill rigs and vactor trucks for maintenance.	To provide access and meet OSHA requirements. See SPU's DSG for design requirements and considerations for O&M access. See examples in Figures 10-5 to 10-6.
UIC MH Access Openings: UIC MHs Access lid (and associated infrastructure access lids) shall have solid locking lids and be easily accessible and operational for routine maintenance and inspection. UIC MH lids shall be engraved with "UIC Drain" and name of agency maintaining facility (SPU/King County). Including a dual access lid is preferable for ease of opening during routine maintenance, testing and monitoring.	Grates shall not be used for the lid to avoid untreated stormwater and debris from entering UIC MH. Access lid shall be like COS Type 230L casting and easily lifted by one person. If larger opening is required, review with O&M staff. See SPU's DSG for design requirements and considerations for O&M access. See Figure 10-6 for example of dual access opening lid. Review options with O&M and geotechnical engineer/ hydrogeologist given O&M activities. Obtain O&M approval.
Underdrain MH upstream of UIC MH: An underdrain MH (UMH) shall be located upstream of the UIC MH for access to the underdrain pipe discharging into the UIC screen well/drilled drain. See Section 7.5 for UMH siting.	To provide access to underdrain pipe without opening the UIC screen well MH. Also, to reduce possibility of debris (e.g. leaves, mulch) falling into the well during maintenance of the underdrain pipe.

(table continued next page)

Table 10-2: Guidance for Siting UIC Screen Wells and Drilled Drains in the ROW (continued)

Siting Description	Rationale
General (continued)	
Gate valve: A gate valve (GV) or removable plug for underdrain pipe may be required upstream of UIC screen wells/drilled drains at the UMH or upstream of UMH. Review with SPU/WTD O&M staff at 30 percent design. GV lids shall have engraving on lid denoting them as GV for UIC Wells, e.g., "UIC GV" or as determined by O&M.	GV allows for O&M to block flow from underdrain to UIC well for operation and maintenance of well during rain events. GV also allows the UIC to be off-line during establishment/flushing of bioretention. GV to be located outside the footprint of the bioretention cell. Preferred location is in a paved area to avoid the need for a concrete collar in a landscaped area.
GV and MH access casting lids general siting: Provide ~4-foot level/flat clear zone around access lid, GV, etc., for O&M. When bioretention pretreatment is used, locate UIC MH access lid, GV, UMH and associated structures for UIC completely outside of the bioretention cell footprint. Avoid siting in roadways and driveways when possible.	To allow for ease of access for O&M crews in removing MH lid and/or operating GV and doing routine activities. To allow maximum usefulness of the bioretention cell. See SPU's DSG for further guidance on MH access casting lids.
GV, MH access casting lids in landscape areas: If in landscape area, if possible, include a concrete collar around the MH or slightly raise relative to surrounding grade to limit potential for organic debris or sediment to collect on the lid.	The concrete collar may help to limit potential for organic debris (leaves, grass clippings or soil) or sediment to collect on the lid, which could fall into the UIC MH when the lid is removed. Consider visual aesthetics when siting concrete collars in landscape.
UIC MH access lids connections: Design bolts or other lid penetrations to be watertight and consider waterproofing outside MHs to keep water from infiltrating where MH rings are grouted.	To limit potential for sediment or unintended water seepage into UIC MH.

(table continued next page)

Table 10-2: Guidance for Siting UIC Screen Wells and Drilled Drains in the ROW (continued)

Siting Description	Rationale
General (continued)	
MH access lids in paved areas: MH access lid and casting must not be placed within a crosswalk, curb ramp, or landing area behind or in front of the ramp. When placed in paved areas, provide adequate width of concrete around the lid to reduce potential for uncontrolled cracking. Use non-skid lid in pedestrian areas.	To minimize pedestrian safety issues and in accordance with SDOT. See SPU's DSG Chapter 4 for additional information. To allow for O&M access (e.g., drill rig) and to avoid MH access lid in main pedestrian route areas of public sidewalk.
Casting lids with concrete collars: If a casting lid is required to have a concrete collar by O&M, locate facility within an area that will already be paved (non-vehicular areas), where feasible.	To minimize impervious footprint and for ease of locating structure during O&M.
Orientation of access openings: UIC well's observation port, well, and MH access must be oriented and sized for the components and to allow for videotaping well screen, retrieving data logger information, performing capacity testing and potential rehabilitation of the UIC without requiring confined space entry.	To allow for monitoring of the screen well and ease of access by O&M personnel without disassembling the components of the screen well system. Design access such that videoing and monitoring equipment do not require personnel to enter MH to conduct routine inspections/monitoring.
Identification: Engrave access lids for UIC MHs to identify type, i.e., if WTD facility, label "UIC Drain" and "Property of King County." If SPU facility, "UIC Drain" and "Property of City of Seattle."	To provide O&M identification. Also consider providing as-built information on a tag in UIC MH, such as well ID #, well depth, screen length, or other for O&M.

(table continued next page)

Table 10-2: Guidance for Siting UIC Screen Wells and Drilled Drains in the ROW (continued)

Siting Description	Rationale
Clearances	
Existing Trees (trees within and adjacent to ROW): MH for UIC screen wells/drilled drains shall not be located within the dripline/canopy and critical root zone of existing mature trees to be protected.	Consult with arborist if pruning is feasible to improve clearance and if there are other construction activities and improvements that might impact the tree species.
New Street Trees: New street trees shall be a minimum 10 ft clear from MH with UIC screen well/drilled drain. More clearance may be required for larger canopy trees. Consult with arborist.	To provide clearance during future UIC O&M.
Underground service utilities: Exterior face of UIC MH shall be minimum 5 feet clear from existing service utilities (e.g. gas, sewer, water, power, communications) unless approved otherwise.	To allow for ease of construction of UIC, MH, and future O&M of the services and UIC.
Overhead Utilities: UICs shall have clearance from overhead wires (SCL and franchise utilities, etc.) Drill rigs used for UICs require a 10-ft horizontal clearance from power lines with voltage up to 50 kV.	Clearance will depend upon type of overhead distribution and standards per SCL and power utility purveyor. Review clearance required for UIC construction equipment and O&M equipment when siting the UIC.
Public ROW and Parcel Access: UICs shall be sited within the public right-of-way with enough available space for maintenance to avoid requiring an easement on private property. Consider the distance of UIC MHs from access points (e.g. paths, gates) to parcels.	Locate UIC MHs away from parcel access points (e.g. driveways, walks, approaches to front doors/main entrance) to minimize impacts to O&M access during maintenance, monitoring, and UIC rehabilitation. Routine maintenance and potential rehabilitation require space for vactor trucks, truck-mounted drill rigs, hoses, and access to fire hydrants (if used as source of water during testing).

UMH easily accessed away from bioretention. Preferred.

MH and irrigation boxes located outside of bioretention cells in lawn area for easy access.

Maintenance hatch not easily accessed due to weight of lid and location within a walled area. Placement in cell reduces infiltration area. Not recommended.

Cleaning of maintenance structures at access path. Acceptable.

Valves that require concrete collars should be placed in sidewalk or review location to minimize impact.

Figure 10-5: Considerations for siting UIC MH, UMH and GV

As depicted in Figure 10-6, the underdrain maintenance hole is labeled “Property of King County” and “GSI Drain” to differentiate it from typical sewer MH lids (COS Std Plan 230). The UIC MH (for screen well) is also located outside of bioretention cells with dual access opening (3’ diameter and 2’ diameter) for ease of O&M access and different O&M activities.

UICMH is labeled “Property of King County” and “UIC Drain” to differentiate it from typical MH

UMH is labeled “GSI Drain” to differentiate it from typical MH

UMH has dual access opening (3' and 2' dia.) for meeting routine maintenance requirements and opening with MH lift rod. Level area around MH allows space for crews to remove lid.

UIC maintenance hole with UIC assembly and observation port accessible at MH openings.

Figure 10-6: Examples of underdrain/UIC MH access openings

10.5 UIC Design

10.5.1 Key Geologic Factors and Siting Considerations

Most of the geologic factors to consider for UIC design are similar to what is evaluated for other infiltration facilities covered in Section 5 of this volume. The primary difference is that shallow infiltration facilities depend on vertical flow from a horizontal system, whereas UICs utilize horizontal flow from a vertical system. Highly layered geologic units will have anisotropic hydraulic conductivity, with horizontal hydraulic conductivity being much greater than vertical hydraulic conductivity. This greater capacity allows a deep infiltration system to generally accept more water than a shallow infiltration system. Understanding the depositional environment and layering/stratification of the geologic unit that will be receiving water from the UIC is important to design. The project team should understand and evaluate proximity of the project to geologic hazard areas that may be affected by the proposed UICs such as steep slopes, historic landslides, and landfills. Teams must also know if the UIC is located within a ground water protection area and if there are areas of known contamination that could be mobilized by the UIC.

UICs shall not be sited where there are soil contaminants that could be transported to ground water unless the site is remediated prior to construction.

10.5.2 Vertical Separation

Elevation of seasonal high groundwater table combined with Ecology requirements for separation from groundwater determines the bottom elevation of the UIC. During design, the geotechnical engineer/hydrogeologist should compare project-specific seasonal high groundwater levels with regional decadal data for the aquifer. Teams should keep in mind that aquifers beneath a low permeability unit can be generally higher in June/July/August versus the standard “wet season” that most project teams are concerned with when measuring shallow groundwater levels.

Ecology requires a minimum 15-foot separation between the base of a “deep UIC” and the surface of the seasonal high ground water table. For a UIC design that is not considered “deep” and meets the presumptive approach, the minimum vertical separation is 5 feet between the base of the UIC and the highest elevation of seasonal high ground water table, bedrock, hardpan, or other low-permeability layer. This can be reduced to 3 feet if a demonstrative approach confirms that this smaller separation will meet the non-endangerment standard (SWMMWW, 2019, Volume I-4.10).

10.5.3 Infiltration Capacity

Field testing for infiltration capacity shall follow methods described in the COS SWM, Appendix D (2017). UIC testing protocol generally consists of stepped-rate and constant-rate flow tests. Like shallow infiltration tests, inflows are monitored with an in-line digital flow meter providing both instantaneous and total flow volumes. A potable water source such as a fire hydrant (with applicable permits) or portable water storage tanks are used to provide a continuous supply of water during the inflow portion of the test. The flow rate, total volume, and stage height/water levels are recorded, and the duration of the test must be sufficient to confirm stabilization of water level in the well at specific flow rates. Testing duration is typically a minimum of 8 hours per UIC location. Generally, all the water should infiltrate into the subsurface so pumping and removal of the water is not required. Testing will require outreach to the nearby residences and businesses. Traffic control and street use permits may be necessary depending on the project location and street configuration.

For infiltration testing, consider water availability and access, street use permits, traffic (all mobility types) control, weather conditions for conducting tests, who will be responsible for overseeing testing, flow bypasses that may be needed etc. to conduct testing.

The UIC infiltration capacity used for design depends on several project variables. Table 10-3 describes how variables may drive the project team to choose a lower or higher factor of safety for UIC design. The whole project team should have input on these variables, since they are dependent not only on geologic factors, but also project performance standards, O&M decisions, and life cycle cost. Factor of safety used for UIC infiltration capacity shall be no less than 2.

Table 10-3: UIC Infiltration Capacity Factor of Safety for Projects

Variable	Higher Factor of Safety	Lower Factor of Safety
Soils Information	Available information is of low quality or frequency. Geologic setting indicates variable depositional environment with depth and/or laterally within the project area.	Available information is specific to UIC locations and depths and is of high quality and frequency. Available information demonstrates consistent subsurface conditions throughout the project area.
Groundwater Data	Groundwater data not sufficient to establish seasonal high groundwater elevation with a high level of certainty.	Groundwater levels have been monitored for enough time to establish seasonal high elevations with a high level of certainty and there is regional decadal data available for comparison.
Type of Infiltration Test	Small-scale testing conducted. Test results are of low quality, or multiple tests demonstrate variable infiltration rates.	Full-scale test of UIC conducted. Test results are specific to UIC locations and depths, are of high quality, and demonstrate consistent infiltration rates.
Runoff Area	A large runoff area will be directed toward the UIC (i.e. centralized point of collection versus block facilities).	The UIC will receive only flow from one "short block", or about 330 feet of street and adjacent property including both sides of the street.
Pretreatment System	Media with compost can introduce nutrients and accelerate accumulation of biofouling on the well screen.	Pretreatment will capture particulate matter and nutrient loads prior to stormwater entering the UIC. Include a polishing layer if using bioretention soil media that has compost as one of its components.
Project Importance and Performance Requirements	The project must meet regulatory requirements, is critical to the utility or agency, is highly visible and important to community.	The project has less importance for the utility or agency, the stormwater volume reduction is desired but not needed for regulatory requirements, project is less visible to the community.

(table continued next page)

Table 10-3: UIC Infiltration Capacity Factor of Safety for Projects (continued)

Variable	Higher Factor of Safety	Lower Factor of Safety
Maintenance and Monitoring Expectations	The owner chooses to not allocate funds or resources for maintenance of the pretreatment system, testing, video inspection, monitoring of the residual water levels in the UIC, and/or for rehabilitation of the UIC.	The owner will allocate appropriate funds and resources for regular maintenance of the pretreatment system, monitoring of residual water levels in the UIC, video survey, capacity testing, and UIC rehabilitation.
Level of Oversight During Construction	The project hydrogeologist/geotechnical engineer will have limited oversight during construction.	The project hydrogeologist/geotechnical engineer will be on-site during construction and will monitor installation, video survey, and multiple rounds of capacity testing during construction of the UIC, and all earthwork related to MH and conveyance installation.
Value Engineering	Test wells used during design will be utilized for production UICs that may not have ideal well diameter or screen length.	Project team will site and design for a new UIC to be installed in the future if the UIC fails or does not meet performance expectations. UICs have been designed such that media backfill can be removed and replaced in the future if performance degrades over time.

10.5.4 Well Screen and Filter Pack

Drilled drains and screen wells will both include a well screen, but their purpose, significance, and materials will be different. In screen wells, treated water can only exit through the well screen. In drilled drains, the primary pathway for treated water is gravity flow through the media backfill. Treated water will flow through a conveyance pipe to the well screen at the bottom of the drilled drain only in an overflow condition.

The appropriate depth, slot sizes, and screen lengths for UICs are dependent on the geologic conditions and elevation of the existing groundwater table elevation. Either stainless steel or PVC well screen can be used with the material selection depending on the UIC type and depths. Stainless steel (SS) screen has higher strength to allow for more open area for the treated stormwater to exit the UIC. The larger open area also allows for greater energy penetration into the formation soils during cleaning of the well screen. SS screen is known to be more durable than PVC to resist damage during cleaning. An advantage of PVC is lower material cost. Screen well UICs should be designed with SS screen due to the typical installation depths and rehabilitation (cleaning) requirements. Drilled drains can use either SS or PVC screen since this screen serves as the secondary pathway into the media backfill.

The annular space between the well screen and boring wall is called the filter pack. The filter pack may be composed of the natural material ("natural filter pack") or by adding properly selected sand and gravel filter material "artificial filter pack." A natural filter pack is produced by removing the fine sand and silt material from the natural formation during well development. An artificial filter pack is installed by drilling the borehole larger than the well screen, centering the well screen in the borehole, and then backfilling around the well screen with properly selected sand and/or gravel filter material. A natural or artificial filter pack can be used with screen well UICs, while drilled drains will utilize an artificial filter pack (the media backfill). For either natural or artificial filter pack, proper well development is very important to the function of the UIC (see Section 10.6).

If the UIC is designed with a natural filter pack, it is preferred to design the well screen based on grain size testing results of soils collected during borehole drilling or to conservatively size the well screen to manage the predicted inflow and limit sanding into the well. Grain size data from the formation can be collected from a small diameter exploration boring completed prior to drilling of the final UIC borehole, performed either during the design phase or under the construction contract. This data allows the well designer to optimize the screen length, placement and the well screen opening depending on grain size and layering of the receptor formation. If the test borehole is performed during construction, the construction contract would need to be structured to require the contractor to have varying sizes of well screens and lengths available for installation during construction. The geotechnical engineer/hydrogeologist shall be present during the test hole effort to observe soils and design the well screen opening and length.

10.6 Well Development

Well development improves the hydraulic connection between the well and the surrounding soils by removing fine sand that would otherwise move through the well screen into the UIC. In the case of natural filter packs, well development creates a graded filter pack around the UIC. Development also helps repair the damage or smear produced along the boring sidewalls during drilling. Always include well development requirements in the project specifications and require the work to be done by an experienced UIC driller who is a licensed water well driller. The geotechnical engineer/hydrogeologist shall be on-site to monitor well development during construction.

Well development requires a large volume of potable water because the driller must create a head of water above the well screen to surge and pump/vactor. The well development process will require the use of fire hydrant (with applicable permits) or other potable water source. Disposal of the pumped water and sediment requires storage tanks, vactor trucks, and/or a waste discharge permit. Well development usually takes 1 to 3 days until wells are thoroughly developed; the process will generally take longer if a natural filter pack is used. See Appendix N for a screen well development specification language that may be modified and tailored to fit a project's specific design and construction contract requirements.

10.7 Managing UIC Fouling or Clogging

10.7.1 Definition

There are three general types of fouling or clogging that result in diminished UIC capacity: 1) biofouling, 2) mechanical (sediment) clogging, and (3) chemical (mineral) precipitation.

Biofouling of UICs is a biological process which occurs when bacteria attach, grow, and block the well screen, filter pack, or soil formation thereby limiting or preventing proper function of the UIC. Bacteria responsible for biofouling are naturally occurring in the formation. The introduction of oxygenated water causes the bacteria to grow. The bacteria growth results in a biofilm that can be viewed as an organic polymer gel with living microorganisms inside. Figure 10-7 shows well screens with and without biofouling.

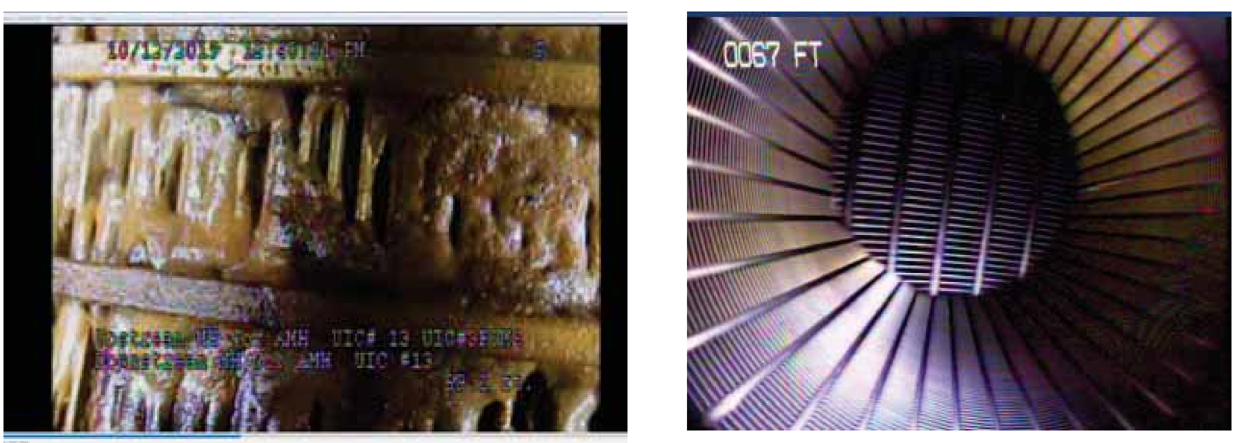


Photo on left is from the side of UIC well with considerable buildup of biofilm. This well receives flow from a large tributary area (multiple blocks). Photo on the right is looking down the well screen to the sump bottom from UIC well with less buildup of biofilm within a year of installation. This well receives flow from drainage area of a single residential City block.

Figure 10-7: Photos of well screens with varying degrees of biofouling.

Biofouling is generally independent of a higher permeable or lower permeable formation. However, wells with slower infiltration rates (due to lower permeable formation) may see reduced performance due to biofouling earlier because the smaller pore spaces will clog more quickly with biofilm.

Clogging is a physical process which occurs when sediment or other material, either from the stormwater introduced to the UIC or from fine sediment in the natural formation, clogs the well screen. Sediment clogging can be a result of insufficient pretreatment, insufficient well development, and/or improper well screen or filter pack design.

Fouling and clogging can occur in any UIC. After testing demonstrates that significant UIC capacity has been lost to fouling and clogging, UIC rehabilitation is necessary. Information on performing and planning for UIC rehabilitation is included in Section 10.10.

10.7.2 Reducing and Planning for Fouling and Clogging During Design

Following are methods to include in the design to reduce and manage the biofouling and clogging that occurs in UICs over time.

Increase Well Screen Length

Increasing the length of the well screen or diameter of the well or designing the well screen to maximize the inflow specific capacity can provide an increased factor of safety towards managing biofouling that will occur over time. For example, if it is expected that 20-feet of well screen is needed then increase the length of the well screen by 10-feet if feasible given the subsurface water table.

Drop Pipe

Drop pipes can be incorporated into the design of screen well UICs to reduce biofouling on the well screen. They are not applicable to drilled drains or pit drains. A drop pipe is a 3- to 4-inch diameter Schedule 80 PVC vertical conveyance pipe that extends from the top of the well to near the base of the well or below the base of the well screen (into the well sump). The diameter of the drop pipe is determined by the hydraulic designer based on anticipated flow volumes and size constraints of the well components. The intent of the drop pipe is to extend the life of the well screen by conveying water to the base of the well, limiting water flowing down the well casing and minimizing the amount of screen that is in the wetted zone. Limiting flow over the well screen is intended to reduce screen plugging potential and bacterial growth leading to biofouling. An air vent riser is recommended on the top of the UIC drop pipe. The air vent releases air from the drop pipe to avoid air lock and secondarily to avoid forcing air into the formation.

Potential reduction in maintenance or effect on long-term well performance from use of a drop pipe compared to a UIC without a drop pipe cannot be quantified with current information. Presence of the drop pipe does make it more difficult to inspect the well screen condition during video inspection as it obscures a portion of the well screen, and more difficult to remove sediment or other material that has collected at the bottom of the well screen. In addition, the drop pipe won't reduce the oxygen content in the water, which is a significant biofouling factor. Additional research and information are needed to quantify the benefits of a drop pipe in screen well UICs.

Pretreatment for managing nutrients from bioretention compost medias

Biofouling can be accelerated by introducing nutrient- and particulate-laden water into the screen well. Increased biofouling can occur if stormwater conveyed to a bioretention facility for pretreatment picks up nutrients from the current, standard bioretention soil media (BSM) formulation that has compost as one of its components. Project teams should carefully consider the pretreatment methods for UIC screen wells. While bioretention facilities are a beneficial GSI pretreatment tool that also provides community and habitat benefits, the project team should also evaluate other pretreatment means that may result in less potential for delivering nutrient load to UICs and the associated increase in biofouling and rehabilitation costs, such as adding a polishing layer below the bioretention soil media to capture the nutrients or "flushing" the bioretention soil media. See Appendix N for discussion on flushing options to consider for UIC Screen Wells.

Sand Filters

For project using bioretention facilities for water quality treatment, a minimum 6-inch Type 6 (or similar) sand filter layer should be incorporated into the design for pit drains, drilled drains and screen wells. This sand filter layer is placed below the bioretention soil media layer and above the COS Type 26 layer. The sand layer can help capture additional particulate load that remains in the treated stormwater. Stormwater should infiltrate through this sand layer after moving through the BSM and before entering the underdrain or media backfill material. For SPU's Delridge NDS project the sand filter was also incorporated in the UIC MH above the drilled drain's media backfill material (See Figure 10-3).

Polishing Layer

An alternative to a sand layer but with higher construction cost is to use a polishing layer that can treat the nutrients contributed by compost in the bioretention soil media.

As of December 2019, SPU has been part of a regional working group conducting research and study into the development of a "polishing layer mix (PLM)" below the City/Ecology's standard BSM (with compost) when the cell has an underdrain. Through the research of different mixes, the working group has recommended a PLM consisting of volcanic sand, fine activated alumina, and iron aggregate. This mixture was recommended based on its ability for chemical capture and physical filtration of contaminants including capture of nitrogen, phosphorous, and copper prior to the treated stormwater entering the underdrain.

SPU recently completed a pilot project that used the study's recommended PLM beneath the COS 2017 standard specification BSM in a biofiltration swale (lateral treatment at the surface of the swale as opposed to bioretention cells with vertical downward treatment) with an underdrain. The PLM was placed between the bottom of the BSM and above the COS Mineral Aggregate Type 26 material around the underdrain pipe. Because this PLM is a pilot mix and not locally sourced, costs to have the components sourced and mixed in small batch volumes are high (SPU unit cost estimates a range of $350 to $450 per cubic yard in 2019) compared to COS Type 6 sand (SPU APWA 2018 unit cost $48 per cubic yard). SPU is monitoring the effectiveness and use of PLM of this pilot biofiltration project that provides water quality treatment for a large drainage basin. SPU is also evaluating the sustainability/life cycle costs of the PLM given the sources of the components. The use of PLM is under review by Ecology and so project teams must consult with SPU GSI Projects Program Manager if considering using it on a project. Furthermore, project teams are encouraged to contact suppliers early to gain accurate cost estimates for the PLM.

As technologies develop, other means and methods to reduce particulate and nutrient loads can be incorporated into the design.

Non-Compost Bioretention Soil Mix

Currently, a regional bioretention work group (including SPU) is finishing a multi-year lab research project to recommend to Ecology a new, non-compost-based bioretention media which may greatly reduce the nutrient and copper export issue. By the end of 2020, it is expected that Ecology will complete its review of the lab study and then the regional working group will conduct field tests. As part of the pilot field test, SPU will also be evaluating how the bioretention cell sizing and design (e.g. watering, suitable plants for the growing, costs, availability) may be modified for use of the mix that is low in nutrients. This new non-compost bioretention soil media may become suitable in lieu of the COS 2020 Standard Specification for BSM with a PLM. Contact SPU GSI Projects Program Manager for more information.

10.8 Design for Regular UIC O&M and Monitoring

General guidelines for UIC O&M are included in the GSI Manual Volume V, but all UIC projects need to consider project-specific requirements for regular maintenance. When designing the MH structures and siting the facilities, the following access requirements for O&M should be followed:

- All routine maintenance and inspection can be done from street grade without having personnel enter the MH.
- Confined space entry is not required to clean the UIC MHs or take measurements through an observation or monitoring port through the UIC head.
- No disassembling of UIC components is required to clean the UIC MH.

- No piping should have to be removed in order to perform video inspection of the well screen.
- Use a dual opening access lid design for UIC MH cover (See Figure 10-6).
- UIC MHs should always be located outside of the footprints of the pretreatment facilities that are landscaped (e.g. bioretention cells).
- UIC MH structures, well screen diameter, and appurtenances must also allow for a video apparatus to fit down the well for video monitoring of the well screen.
- Design UIC MH openings to keep foreign debris out of the MH and screen well head entry points (i.e. downturned elbows).

The project team should assume the capability of WTD/SPU's asset management staff and crews are generally limited to visual observations of the MHs and cleaning the structures of water and debris using a vactor truck. If other regular maintenance is required, the instructions should be simple and understand that the field crews cannot achieve precise levels of measurement. For example, sand filters that are placed above the media backfill of drilled drains is required to be removed when it gets clogged. To simplify this regular maintenance, the project team should put the removal and replacement on a set schedule (not dependent on field observation) and thickness of removal and replacement should be able to accommodate a variation of +/- 1 foot of material.

10.9 UIC Testing, Inspection, and Monitoring

Testing, inspection, and monitoring of UICs are important for quality control during construction, understanding the performance of the UICs, and informing asset managers when well rehabilitation is required. These efforts generally apply to drilled drains and screen well UICs, although water level monitoring and capacity testing in pit drains can also be performed.

Once the infiltration capacity of a UIC degrades more than 20% due to plugging or biofouling, it is very unlikely to re-establish the original infiltration capacity that was achieved immediately following construction. Regular testing, inspection, and monitoring are important to the long-term performance of UICs and should be programmed into the life cycle cost.

10.9.1 Infiltration Testing for UIC Specific Capacity

Infiltration testing to measure UIC specific capacity is performed similarly to the initial testing done to establish the design infiltration capacity of the soils. Infiltration testing should be performed for all UIC types, although methods vary if there is no screen well (i.e. pit drains). Infiltration testing methodology and details are discussed in Section 10.5.3.

Infiltration testing should be performed during construction immediately following well development. Testing should be repeated again after the upstream pretreatment systems are constructed, surfaces draining to the UIC are permanently stabilized (e.g. paving, plants/landscape), and other associated project improvements are constructed to ensure the water quality pretreatment systems and UIC performance have not been impacted by construction stormwater runoff. The inflow specific capacity test should be repeated one year after the UIC has been put in service and be tested every 5 years thereafter. Testing should take place at the same time of year for comparison between testing, ideally towards the end of the dry season (August). If capacity testing shows more than 20% reduction in infiltration capacity after any test, or other degraded threshold as determined by the Project's Hydrogeologist in coordination with the Project Engineer, then the asset owner should assess whether to begin the process perform UIC rehabilitation (see Section 10.10). Other factors to consider could include evaluation from video inspection, review of monitoring water levels, drainage through the pretreatment facilities and overall performance of the system during the wet season.

10.9.2 Video Inspection

Video inspection of the well screen should be done on a yearly basis. The downhole video survey is used to observe the condition of the well screen and to confirm that the well is not biofouled, clogged, or containing other foreign debris. The video will also show other damages such as screen plugging, pipe corrosion, pipe breaks, or other deformities. The cameras should fit through the observation port and be capable of both downhole and side view. Each project should develop a standard operating procedure (SOP) for performing the video inspection that is specific to the UIC design. This consistency in inspection will allow direct comparison of the amount of siltation, degradation, biofouling, or other conditions that is observed in the video surveys over time.

The following is an example of steps for a SOP to conduct UIC screen well video inspection:

- Use a clean down-hole camera that can reach up to the full depth UIC well (~minimum 100 feet from ground surface) and be lowered through a two-inch diameter pipe.
- The camera shall be able to switch from a downhole view to a side scan view.
- Lower the down-hole camera into the well via the two-inch diameter monitoring port.
- The image shall be observed on a video monitor and simultaneously recorded.
- The depth that the camera is currently at is superimposed onto the video image and shall be recorded.
- Note where the depth is measured from (e.g. UIC MH lid, top of well cap, etc.).
- The equipment used to complete the video survey shall produce a DVD/video recording with an automatic depth indication (to the nearest 0.1 feet)

10.9.3 Monitoring Water Levels

Monitoring the UIC includes placing water level dataloggers in the observation port to record residual water levels at set time intervals. Observation ports should be included on all types of UICs. Relative performance of the UIC wells over time can be assessed using the hydrographs from each well. The well response to inflow (water level rise) and the well recovery (water level drawdown) can be reviewed and compared to historic data. Key performance criteria include: 1) the shape of the drawdown curve following storm events, 2) the height of the water remaining in the well between storm events, and 3) the magnitude of head rise. If inflows are also measured then a regression analysis can be performed, and specific capacity can be estimated to determine if water levels suggest diminished UIC capacity. When combined with video inspection and surficial inspection of the pretreatment system, water level data can be useful for evaluating performance in the time spans between infiltration capacity testing.

Water level data collection and download frequency is a project-specific requirement that should be developed by the design team. The project team should focus on specific use of the data to evaluate performance metrics and understand the resource cost needed to collect, store, and evaluate the data. The need for monitoring water levels should be tied to specific project goals and performance expectations. For example, if no standing water in the bioretention pretreatment cells is the primary project goal, then monitoring water levels in the UICs will provide data to show that the project is meeting this performance metric. If a project wants to infiltrate all or a percentage of stormwater flows within a basin, then the input volumes to the UIC system must also be known as water level data alone may not be enough to evaluate this performance metric.

Note that maintaining field instruments, downloading data, managing large amounts of data, and interpreting water levels will require a long-term commitment of in-house resources (employees, equipment, and IT). Before committing the Owner to a monitoring program, the team should consider the cost of these resources versus the need for performance monitoring.

10.10 UIC Rehabilitation

Testing, inspection, and monitoring of UIC performance should inform the WTD/SPU asset management of decreases in UIC infiltration performance such as:

- Higher residual water levels for longer periods of time in UICs after storm events,
- Visual build-up of biofouling on the well screen,
- Sediment or debris build-up within the UIC, and/or
- A decrease in infiltration capacity based on capacity testing.

The regularly scheduled testing, inspection, and monitoring efforts described in Section 10.8 will be the primary driver for deciding to rehabilitate (rehab) a UIC. UIC rehab should always be preceded by an infiltration capacity test to establish how much the infiltration rate has degraded.

Define Allowable Reduction in Capacity

During design, the project team should set an allowable level of infiltration reduction capacity that is documented in the O&M manual. When the allowable reduction is surpassed, the O&M manual should specify that UIC rehab is required.

Capacity test will also serve as a baseline for how much capacity was re-established after rehab (i.e. benefit of rehab). This test may take place during the regular testing schedule (Section 10.9.1) or may be triggered by a yearly visual inspection of the well screen that shows accelerated biofilm growth, sediment in the well, or other defects.

The amount of reduction in specific capacity of a UIC that can be sustained prior to rehab depends on the original design philosophy of the project. For example, if a high factor of safety was utilized in design so that maintenance and rehab efforts are reduced, then permanent losses in infiltration capacity can be sustained and the project will still meet performance criteria. Conversely, if a lower factor of safety was utilized to reduce the number of UICs needed, then the project cannot sustain permanent losses in infiltration capacity. Once the infiltration capacity of a UIC degrades more than 20%, it is not possible to re-establish the original infiltration capacity that was achieved immediately following construction.

10.10.1 Screen Well

Rehab of the UIC Screen Well is performed by brushing and surging the well screen and formation. Rehab usually begins by mechanical brushing to remove material and biofouling on the well screen itself. Loosening the formation pore spaces can be performed using mechanical cleaning such as an impulse generation tool followed by mechanical surging. Biofouling can also be reduced using chemical treatments to penetrate and disperse the biofilm. Chemical treatment should be limited to chemicals applied in accordance with AWWA A100-06 Water Wells, current standard, by American Water Works Association. These chemicals are approved by the water well industry that are considered inert, environmentally friendly chemicals. Application of chemical treatments should be performed by a specialty well driller licensed per RCW 18.104. See Figure 10-8 for equipment that was used for SPU’s UIC screen well rehabilitation at the Venema NDS project.

10.10.2 Drilled Drains and Pit Drains

Impulse Generator Tool

Rehabilitation of drilled drains or pit drains for inflow capacity can consist of flushing the media, partially or fully removing the media backfill material via a vacuum truck, cleaning the conveyance pipe screen if installed, and reconstructing the drain with new media backfill. For pit drains, this will also involve removal and replacement of the bioretention cells that are located above the drains. Removing media backfill with a vacuum truck has been successful for drains up to 100 feet deep. However, this requires specialty equipment and cannot generally be performed by in-house crews. Replacing the media backfill material will remove clogged material in the drain but does not clean pore spaces in the geologic formation that have been clogged by particulates or biofouling.

10.10.3 Budgeting and Planning for UIC Rehab

UIC rehab will require specialty contractors, consultation with a hydrogeologist or geotechnical engineer experienced with UICs, permitting for temporary street use, traffic control, water supply and water disposal, and in-house or agency staff time. Life cycle costs for the project should include estimates for in-house staff, permits, and required contractors and consultants to support the rehab process. The project team should allocate budget based on an estimate of how many UICs will need rehab and how often and factor in all associated work. The estimate will depend on performance standards for the project, the pretreatment system, the factor of safety used in design, consequence of failure, and if the UICs can easily be replaced if they fail during the project life cycle.

The UIC rehab process will require the use of a potable water source, such as a fire hydrant (with applicable permits), possibly street use permits and traffic control, and public relations/outreach to the affected community. Rehab will require disposal of particulate laden water and sand that has been pumped from the UIC. The Owner should assume approximately two days per UIC for the rehab, followed by an additional round of infiltration capacity testing and video inspection to observe the effects of the rehab. Rehab of pit drains where the mature plants, pretreatment cells and media backfill are removed will require additional time working in the right of way depending on the project configuration. See Figure 10-8 for example photos of equipment used in UIC screen well rehab.

UIC Screen Well Rehab at SPU's Venema NDS

Impulse Generator Tool

Support truck, drill rig, vactor truck, and traffic

Sand pumped from UIC during rehab

Figure 10-8: Example of equipment for UIC screen well rehabilitation

10.11 Value Engineering

Value engineering is an important aspect of UIC design to lower project cost and/or increase infiltration capacity of the system. Examples of value engineering that can be done with UIC projects could include the following:

- Selecting horizontal or vertical pit drains versus drilled drains or screen wells can reduce long term maintenance cost since regular monitoring, inspection, and testing efforts are typically not performed for pit drains. If performance of the pit drains is reduced over time, rehab generally consists of removing and replacing media backfill and associated bioretention cells that are located on top of the pit drains. This construction typically does not require specialty contractors. Over the life of the project, this method of rehab may prove less costly than performing monitoring, inspection, testing, and UIC rehabilitation.
- Maximize the UIC diameter and screen length to get the most infiltration capacity per site. The incremental cost to drill larger holes and/or have more screen length is small compared to overall construction cost.
- Where final stormwater facility locations are relatively well-known, convert test wells installed during design into permanent UICs. Initial project planning would need to carefully locate the test wells and construct them in a similar manner as production wells. This may increase upfront planning and materials costs but will reduce construction cost. Test wells converted to permanent UICs will likely need well development to be repeated during construction using more rigorous methods.
- Project teams can plan that rehab will not be performed, and instead a failing UIC will be replaced with a new UIC. During design the project team will identify potential alternative sites for new UICs. This option should be approached with caution because the time of failure, future availability of alternative sites, and future cost to replace will be difficult to accurately estimate and budget for.
- Project teams can plan that rehab will not be performed and install a redundant in-line UIC during the initial construction that can be utilized as the first well fails over time. For UICs with excess design capacity, consider adding pre-treatment facilities on adjacent blocks to capitalize on the investment in the UIC.

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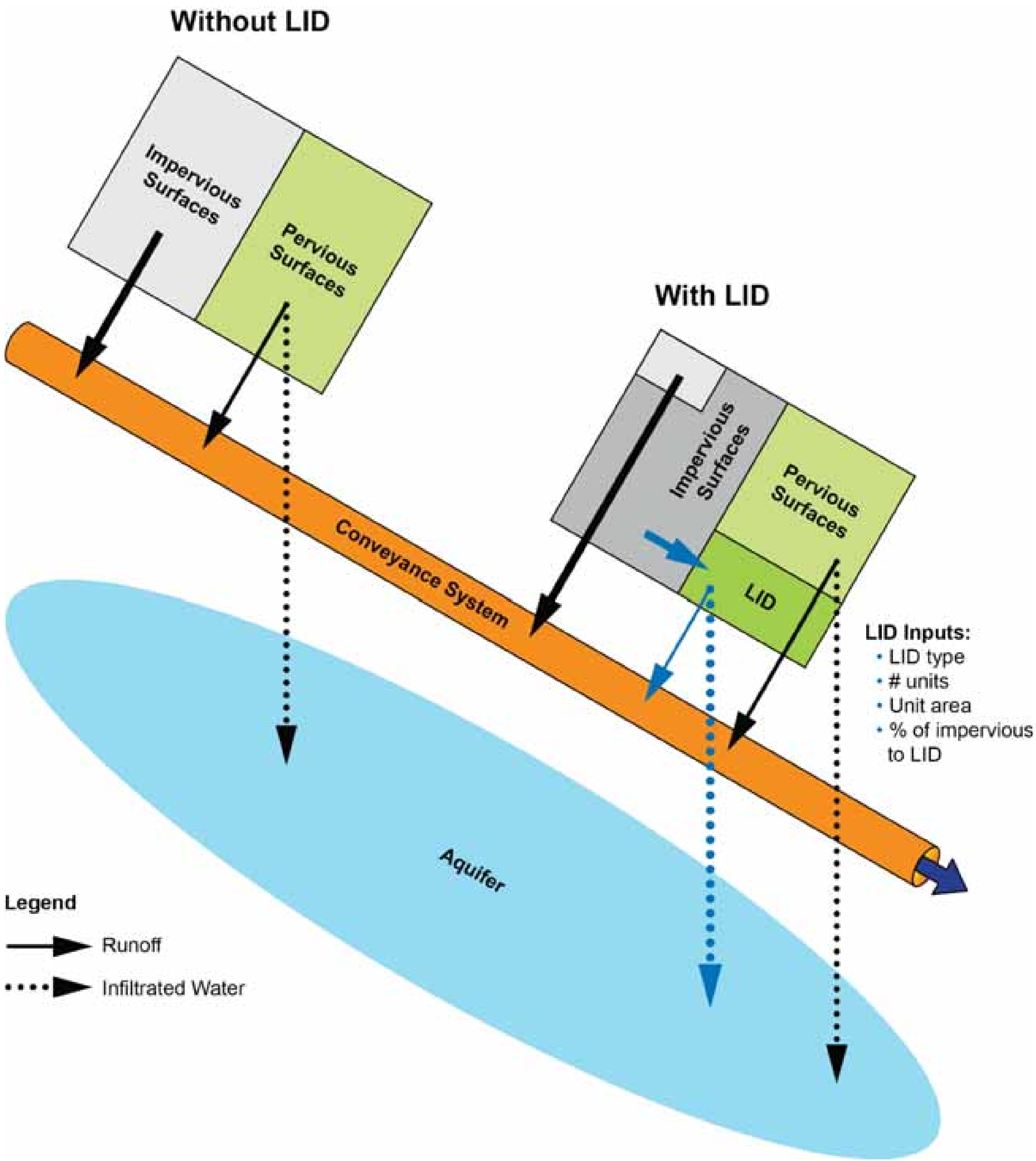

Image: Excerpt from GSI Modeling Methods in Appendix H. A conceptual representation of GSI modeling in EPA's stormwater management model version 5 software.

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Section 11
Hydrologic & Hydraulic Model Development

The Project Team is to develop a plan for modeling the performance and sizing the GSI facilities. Guidance for modeling GSI for SPU/WTD GSI capital projects is provided in “Green Stormwater Infrastructure Modeling Methods” (see Appendix H).

Other modeling analysis, aside from modeling the performance of the GSI bioretention cells, could also include:

- Conveyance for supporting infrastructure. See SPU CAM 1180 and SPU’s DSG.
- Hydrogeologic analyses such as slope stability, groundwater mounding, etc.
- Other as required for designing and permitting the project.

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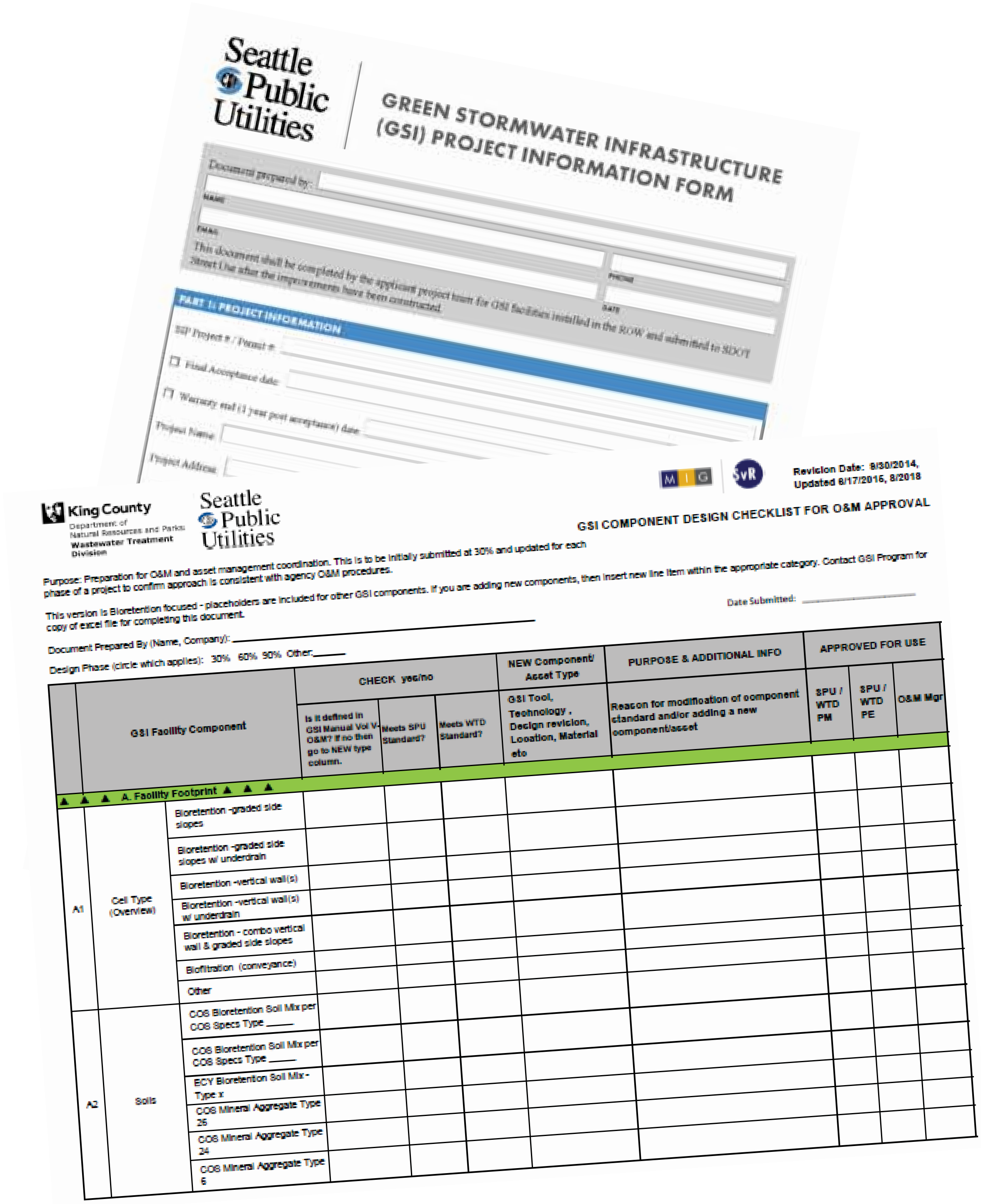

Seattle Public Utilities

GREEN STORMWATER INFRASTRUCTURE (GSI) PROJECT INFORMATION FORM

Document prepared by:
NAME
EMAIL
PHONE
DATE

This document shall be completed by the applicant project team for GSI facilities installed in the ROW and submitted to SDOT Street Use after the improvements have been constructed.

PART 1: PROJECT INFORMATION

SIP Project # / Permit #:
☐ Final Acceptance date:
☐ Warranty end (1 year post acceptance) date:
Project Name:
Project Address:

King County Department of Natural Resources and Parks Wastewater Treatment Division

Seattle Public Utilities

MIG SvR

Revision Date: 8/30/2014, Updated 8/17/2015, 8/2018

GSI COMPONENT DESIGN CHECKLIST FOR O&M APPROVAL

Purpose: Preparation for O&M and asset management coordination. This is to be initially submitted at 30% and updated for each phase of a project to confirm approach is consistent with agency O&M procedures.

This version is Bioretention focused - placeholders are included for other GSI components. If you are adding new components, then insert new line item within the appropriate category. Contact GSI Program for copy of excel file for completing this document.

Date Submitted: ________

Document Prepared By (Name, Company): ________

Design Phase (circle which applies): 30% 60% 90% Other____

	GSI Facility Component		CHECK yes/no			NEW Component/ Asset Type	PURPOSE & ADDITIONAL INFO	APPROVED FOR USE		
			Is it defined in GSI Manual Vol V-O&M? If no then go to NEW type column.	Meets SPU Standard?	Meets WTD Standard?	GSI Tool, Technology, Design revision, Location, Material etc	Reason for modification of component standard and/or adding a new component/asset	SPU / WTD PM	SPU / WTD PE	O&M Mgr
A. Facility Footprint										
A1	Cell Type (Overview)	Bioretention -graded side slopes								
		Bioretention -graded side slopes w/ underdrain								
		Bioretention -vertical wall(s)								
		Bioretention -vertical wall(s) w/ underdrain								
		Bioretention - combo vertical wall & graded side slopes								
		Biofiltration (conveyance)								
		Other								
A2	Soils	COS Bioretention Soil Mix per COS Specs Type ___								
		COS Bioretention Soil Mix per COS Specs Type ___								
		ECY Bioretention Soil Mix - Type x								
		COS Mineral Aggregate Type 26								
		COS Mineral Aggregate Type 24								
		COS Mineral Aggregate Type 6								

Images: Excerpts from various project documentation described herein in preparation for O&M.

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Section 12
Project Documentation

12.1 Project Report

As the project progresses from the phase of Options Analysis through the Design phase, the Project Team is to assemble and compile a Project Report documenting the design and analyses that were conducted. See Appendix C for example of Project Report outline. Certain elements of the document will have been drafted prior to the Design Phase and are to be finalized during the Design Phase. The document is to be updated as the project proceeds through 30, 60, 90 percent and Final design. The Project Report shall be divided into sections (e.g., Executive Summary, Basis of Design, Public Engagement, etc.) which can be extracted for specific submittals to other regulatory agency reviews.

If an Engineering Report is required to be submitted to Ecology, project teams should follow the Project Report's prescribed outline in Appendix C. Typically draft Project Reports are submitted to Ecology after 30 percent PS&E is completed and then followed with final after 90 percent PS&E.

SPU-led CIP Project Report reviews

For SPU-led projects, there will be three sequential reviews of the PE report prior to submitting to Ecology: one by the Project Team, a second by SPU's regulatory lead and GSI Program lead, and a final (short) review by SPU's regulatory lead to confirm that all the changes have been made.

12.2 Supplemental Reports/Memorandums for Project Files

12.2.1 Drainage Report

The Drainage Report is to include an analysis related to COS Stormwater Code requirements. This can be documented as a letter/memorandum to SPU/WTD's Project Files. Once the COS Stormwater Code requirements are analyzed for the project and documented, then Project Team shall submit information to SPU's Design Services Office (DSO) plan reviewers (either via SIP process for WTD-led projects or as part of the CIP in-house review for SPU-led projects). For SPU-led GSI projects, if the project includes special agreements on compliance, first review the approach (during 0-30 percent design) with SPU's Utilities Services Management's Policy Planning & Regulatory group; final code compliance documentation shall go into the Drainage Report.

12.2.2 GSI Project Information Form

Project Teams shall complete the GSI Project Information Form (see Appendix E). This city form is used for entering SPU O&M project data and for tracking metrics (part 4 of the form) in meeting the City's goals for managing 700 million gallons of polluted runoff per year with

GSI by 2025 (see Seattle Council Resolution 31459). It is intended that some of the information documented in the Drainage Report can be used to provide the metrics in the GSI Project Information form.

12.2.3 Design Decisions Logs/Documentation

For SPU led CIP projects, design decision records/tracking are required throughout the project including when a decision is made or overturned. This shall include but not be limited to communication and approvals from the FOM, SDOT, SPU GSI Program, stakeholders, community, etc.

For WTD-led CIP projects, information shall be tracked through the SDOT SIP reviews and WTD's project logs as decision logs or another similar format.

Project meetings, whether within or between departments or agencies, shall document discussions and outcomes through meeting notes. For regular interdepartmental meetings, it may be productive to maintain a log of meeting notes (in sequential order) like SDOT SIP reviewers' tracking of meetings for SIP Design Guidance and permit submittals. This will allow for ease in locating interagency/departmental decisions.

12.2.4 Preparation for O&M and Asset Management

Project Teams shall coordinate with O&M representatives, each agency's asset managers, and GIS personnel in preparing a project for O&M. Preparation and planning for O&M and asset management begins during 30 percent Design and continues through later design and construction phases. See Sections 2.10 and 2.11.

Project Teams shall complete the GSI Component Design Checklist for O&M Approval (see Appendix E) <u>at 30 percent design</u> and update and resubmit <u>at 60 and 90 percent</u> if there are changes to the design or design components. The purpose of this checklist is to inform O&M of the components of a project for each agency's asset management and O&M budgeting and to identify elements/components that differ from project GSI details and standards.

Preparation of O&M cost estimate will be done by each agency's staff for standard items (see Appendix E for excerpts for SPU's cost estimating guide). Project Teams shall assist agencies in developing estimate for non-standard design elements.

If a project is located in an undeveloped right-of-way or area with invasive plants that could affect the maintenance frequency for the new bioretention asset, project teams shall develop a Vegetation Management Plan for work before, during and after construction. A template is provided in Appendix G for Project Teams to use for developing a project specific plan.

12.2.5 Carbon Accounting for GSI CIP

SPU and WTD have policies for carbon accounting on CIPs. Specific to GSI projects, an example of how to conduct carbon accounting for materials on GSI projects (bioretention soil, compost, etc.) is included in Appendix K.

12.2.6 Memorandum on Deviations from GSI Manual

If there are deviations from the guidance in this Manual, then the Project Team shall submit a memorandum identifying the proposed deviation and the reason for requesting it when submitting plans for review by SPU/WTD GSI Projects staff and O&M. See also Section 7.10.

Some example scenarios of deviations include:

- If plantings differ from Bioretention Plant and Tree Lists, then lead landscape architect shall submit a memorandum for the deviation request.
- If cells are located along a street not in accordance with the guidance in the text and tables in Section 7 of this volume, then lead landscape architect/civil engineer shall review and identify reason for deviation request.
- If cells are to install bioretention planters with 4-sided walls on a Neighborhood Yield street, a deviation request is required.
- If permeable pavement is to be installed in a city street', deviation request is required to be submitted to O&M and SDOT.

For some deviations to be approved, they may require development of Memorandums of Agreement between departments and agencies. See Section 2.9.

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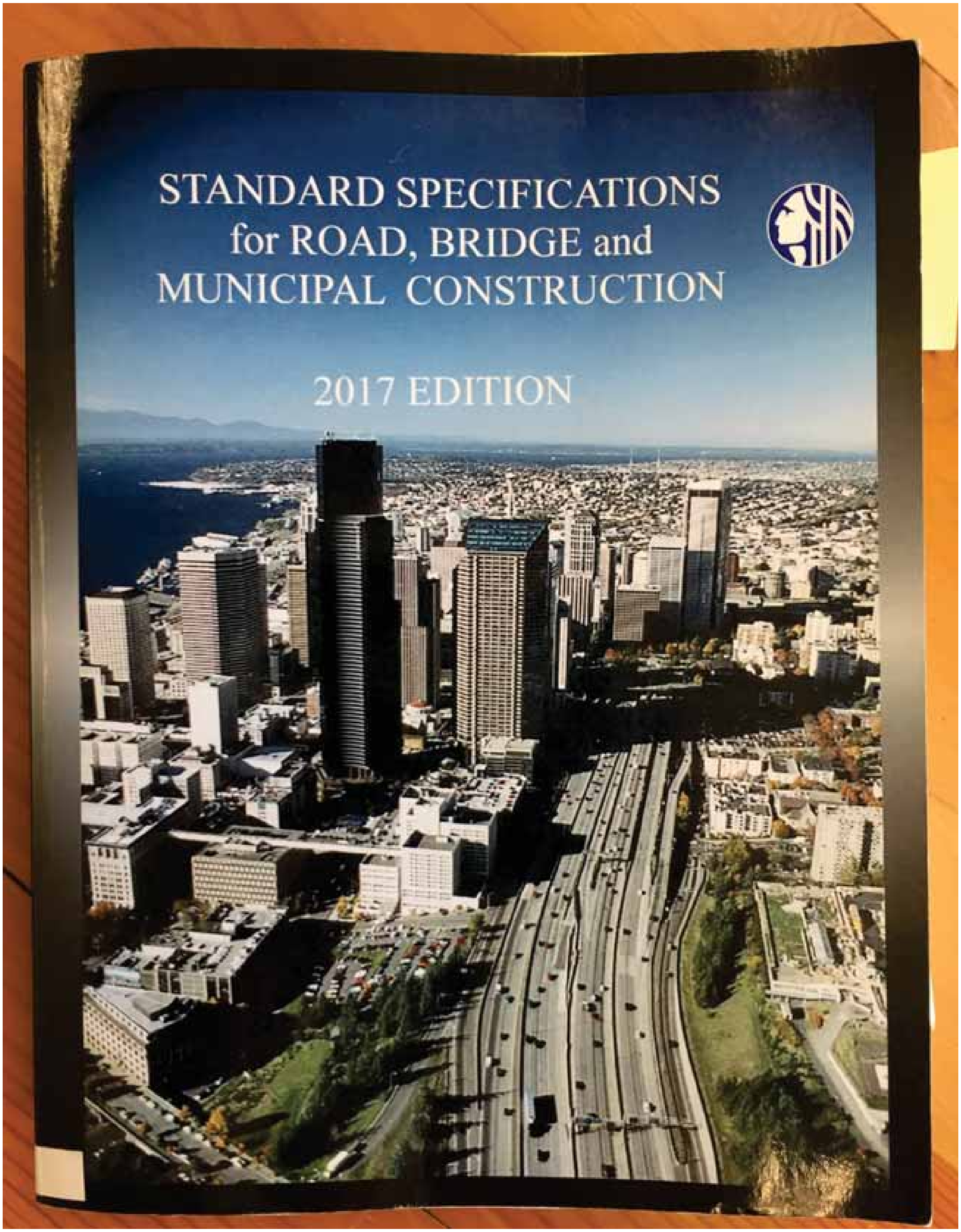

Image: City of Seattle Standard Specifications, 2017 edition, for construction in ROW.
Note: check for current edition and updates.

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Section 13
Plans, Specifications, Estimates & Procurement

In this section, the project's Plans, Specifications and Estimates (PS&E) are outlined along with general guidance specific to SPU-led and WTD-led GSI projects. Submit PS&Es in accordance with each agency's standards for the Design Phase.

13.1 Plan Preparation

Plan preparation, including draft standards, shall be in accordance with SDOT SIP plan production requirements. See SPU's CAD Resources (http://www.seattle.gov/util/Engineering/CAD_Resources/index.htm) and SDOT's Plan Preparation (http://www.seattle.gov/transportation/stuse_sip.htm) websites for title blocks, SIP checklists, and standard notes.

13.1.1 Plan Sheet Set Up

The scale for plan views on the drawings shall be in accordance with SDOT SIP requirements. However, for bioretention retrofit CIPs along Neighborhood Yield and Neighborhood Curbless streets, where a majority of the work is in the planter strip with no major utility main replacements, the drawing scale may be at 1"=20' for the plan sheets (landscape and civil), with more detailed elements such as intersection and curb ramp grading at 1"=10' or 1"=5'.

For projects with bioretention cells with wall(s), rockeries, stepped weirs or other items requiring more detail, it is recommended that civil plan and profile sheets be set at 1'=10' scale in accordance with SDOT SIP requirements for readability and clarity.

For Landscape plans, it is recommended that plans be at the same scale and plan view alignment and layout as the civil plan and profile sheets; however, a 1" =10' scale allows for easier layout of irrigation (if used) and plants. Planting plans created for each bioretention cell are easier for contractors to follow and make it easier to lay out plants. Template planting layout plans may be appropriate for very simple/repetitive planting plans.

It is recommended that the various disciplines of the Project Team coordinate plan sheet set prior to 30 percent design for developing a cohesive construction document set, such as review where plan views are to start and end for a street or review format for sheet set up elements especially if there are multiple subs designing different streets and details but it will be within the same construction package, etc. In addition, teams are to review and confirm drawing scale with SDOT and SPU during 0 to 30-percent design guidance. For all other projects (on non-Neighborhood Yield streets), including those with full ROW improvements and/or located in downtown or along arterial streets, sheet scale shall be in accordance with SDOT SIP requirements.

13.1.2 Plan Sheet List

The drawings, including details and specifications, shall be developed in accordance with SDOT SIP requirements and SPU Design Standards and Guidelines. The order, types and number of sheets will vary depending upon project scope and contract (unit price vs. lump sum bidding). The following is an example drawing list for GSI capital projects.

- Cover with Vicinity Map, Location Map, Detail and Section Referencing, Sheet Index
- Key Map Streets (for sheet #)
- Basis of Design Plan Sheet (for SPU-led projects)
- Street Overview of Project Area and Zones of Improvements
- Notes (See SDOT website for SIP Standard Notes) http://www.seattle.gov/transportation/stuse_sip.htm)
  - SDOT General Notes
  - Survey Control, Datum Notes
  - SPU Bioretention Notes
  - SPU Side Sewer Notes
  - SPU Water Service Notes
  - Erosion and Sediment Control Notes
  - Bioretention and LID Protection Notes (see Appendix F)
  - Underdrain Notes (see Appendix F)
  - SPU General Notes for Abandonment of Existing Catch Basins for GSI (See Appendix F)
  - Other standard notes as applicable (SCL notes, striping and signage notes, etc.)
- Legend, Abbreviations and Notes (if different from COS Std Plan 002a-f and 003a-q
- Construction centerline control/survey control plan
- Existing Survey/Base maps
- Demolition/Site Preparation plan (required for SPU unit pricing but may not be needed for WTD projects (lump sum bid) depending upon complexity of the work)
- Tree, Vegetation and Soil Protection Plan (including protection for adjacent private trees)
- Existing and Replaced ROW Tree Summary Plan
- TESC/CSEC Plan and notes
- Civil Plan and Profile (drainage, grading, utility adjustments, bioretention, pavement restoration, protected trees)
- Landscape Plan
  - Irrigation Plan and Schedule (if applicable) and/or Watering Protocols
  - Landscape Plan and Protected Trees
  - Landscape Tree, Accent shrub and Plant Schedule
- Details (*In COS Standard Plans as of 2020)

- o CSEC details
- o Bioretention cell cross sections* (from road edge to sidewalk)
- o Presettling zone details*
- o Bioretention cell grading key
- o Drain curb cut details*
- o Permeable pavement section details*
- o Intersection details (such as for curb ramp, companion ramp, curb return grading) at 1” =5’ scale, unless approved otherwise by SDOT
- o Miscellaneous civil details (such as screen well detail, drilled drain, pit drain detail, slotted drain pipe, utility trench dam, adjustment to side sewer, weir details, wall details)
- o Cell layout details
- o Planting palette or enlarged cell planting details (if applicable where plant placement is particularly critical such as intersections, mixed plantings, sightlines)
- o Miscellaneous planting details*
- o Irrigation and/or watering details (if applicable)
- o Establishment O&M schedule

See examples from previous SPU and WTD projects for further reference.

13.1.3 Details on Plan Sheets

The plan set list noted above provides guidance for GSI details that would be included in typical GSI CIP. The COS Standard Plans reference the required COS construction specifications and these standard plans do not need to be included as a detail in the plan set (i.e. redrawn or copied as a detail on the drawings) unless there are modifications/deviations to what is shown in the standard plans. For example, if the drain curbs cuts follow the standard plans then the drawings would just reference COS Std Plan 295b for construction of Drain Curb Cut Type 1.

If there are modifications to the COS standard plans, then the Project Team shall include a modified detail of the standard plan on the drawings. The details on the plan set shall follow same style as the COS Standard Plan that is being modified (e.g. same hatch pattern and line weights for materials that are the same as in the standard plan).

For bioretention cross sections (shown from roadway to sidewalk), Project Teams shall include a detail based on the standard plans (e.g. No. 292-293c) but adapted to the project-specific design dimensions and cell edge materials (e.g. along curb/road edge). For example, denote the design’s maximum and minimum grading depths.

TIP
The hatching style used in a detail on the plans shall be consistent with COS standards. The hatch patterns shall also be consistent for the same material type if it is shown in multiple details on the drawings.

See also SPU drafting standards, CAD resources and DSG.

13.1.4 Plan Circulation Checklists

Appendix I includes information on deliverables and submittal checklists for the Project Team at 30/60/90/Final design completion.

- Table I-1 summarizes checklists that are required at different phases of the Design in preparation for circulation of the documents for review.
- Table I-2 is a list of deliverables for SDOT / interdepartmental review of the design.
- Table I-3 is a list of deliverables for lead agency review (SPU/WTD) of the design.

13.2 Project Manual and Specifications

Project manual and contract requirements must be in accordance with SPU and WTD's agency standards, respectively.

- For SPU-led projects, the format shall be in accordance with APWA as referenced in DSG. Special Provisions shall be developed for elements that are not included in the City's Standard Specifications.

  The bid form in the Project Manual is typically unit prices following the measurement and payment described in the COS Standard Specifications. Some components, especially those hard to measure, require a special provision when components are combined into lump sum bid item. The packaged Project Manual must use consistent terminology between the bid tab, specifications, and plans. See SPU's DSG.

- For WTD-led projects, the specifications follow a modified Construction Specification Institute (CSI) format, and the Project Team is to use the WTD template specifications. For WTD GSI capital projects that are in Seattle's public ROW, the WTD template specifications are to be modified to reflect the technical (not contractual) requirements referenced in the City of Seattle Standard Specifications.

  The bid form in the WTD Project Manual is typically lump sum for CIP. However, when elements are subject to change during construction because they are "design-build" Project Teams shall consider including lump sum unit prices for those elements. For example, the length of the screen well or the depth of the pit drain may

Special Provisions

For projects that require an element not covered in the *City of Seattle Standard Specifications*, Project Teams shall contact SPU's GSI Projects Manager for examples of Special Provision from past projects with similar elements that may be used as starting point. If an example does not exist, then the Project Team shall coordinate with SPU's Specification Writer and SPU Construction Supervisor for development of special provisions (for SPU-led projects).

vary from design at bid after the hydrogeologist evaluates the extracted subsurface soils during construction. For past example, using WTD CSI specifications for bioretention and associated infrastructure along with select lump sum bid items, contact the WTD's GSI Program Manager.

Commissioning: Teams shall review in coordination with construction management, commissioning procedures for construction (see GSI Manual, Volume IV – Construction and Commissioning) and ensure the specifications have mock-ups and quality assurance testing for key GSI elements (e.g. drain curb cuts, planting layout and placement for a typical cell, gutter flow tests for drain curb cuts/inlets to bioretention cell, fine grading of cell, presettling zone, etc.) that can affect the performance and long-term maintenance of the facility.

13.3 Construction Cost Estimates

SPU Engineer's Construction Estimate/WTD's Opinion of Probable Construction Cost (OPCC) estimates shall be prepared by the Project Team in accordance with each agency's standards.

- For SPU projects, see SPU's Cost Estimating Guide (CEG).
- For WTD projects, see WTD's Estimating Guidelines.

For SPU-SDOT partnering projects, to determine cost sharing, contact SPU GSI Projects Manager for method of analysis.

TIP:
The construction budget estimating tool developed for Initiation and Options Analysis (see GSI Manual Volume II) is not to be used for the Design Phase. Projects are to prepare construction cost estimates per each agency's standards for construction contracts.

13.4 Procurement

Procurement for GSI capital projects follows the same procedures as required for non-GSI projects. See each agency's respective standard processes for procurement through bid award. Contact the agency's Project Team project manager for standards. The type of contract will vary given size, budget, scope, contract amount and other agency contracting requirements.

<u>SPU-Specific:</u>

Table 13-1 provides examples for different types of contracts for SPU-led projects. Each of these has parameters for minimum/maximum contracts and qualifiers for bidders. Discuss details with the SPU project manager.

Table 13-1: Contract and Project Examples for SPU Led GSI CIPs

Type of Contract	Example of Types of Projects
Small Public Work Rosters	• Up to 2 city blocks* with infiltration bioretention graded side slopes • Up to 4 mid-block bioretention graded side slopes/curb bulbs • Pervious concrete sidewalk for up to 2 city blocks
GC/CM Design Build	• Multiple blocks with bioretention cell retrofit, including deep infiltration
Design Bid Build	• Multiple blocks with deep/shallow infiltration using bioretention/pervious pavement • Pervious concrete roadway/alley city block(s)
Job Order Contracting	• One job order to develop UIC screen well and MH assembly(s) or drilled drains & MH assembly(s) • One job order to install underdrain and bioretention system • Prior to constructing GSI, one job order to adjust utilities (i.e., side sewer, gas, water service)
Vendor Contract	• Bioretention soil mix • Plants for GSI • Growing contract for plantings • Training for maintenance
Task Order Contracting	• Based on 30 percent design • Small projects (review with Procurement) that are simple (i.e. easily replicable). • Unit Price

* Assumption for City block ~ 330 lineal feet (intersection to intersection)

Seattle Dept of Transportation
Street Use Permits, 23rd Floor
700 Fifth Ave, Suite 2300
P O Box 34996
Seattle, WA 98124-4996

STREET IMPROVEMENT PERMIT

Permit No.: 163005

PERMITTEE

Inspector: William Bou
Inspection District: WEST SEATTLE

LOCATION

Address: 7317 34TH AVE SW	**Application Date:** 9/26/11 7:43 am
Details:	**Issue Date:** 6/11/13 10:32 am

PARTIES (* Primary Applicant)

Role	Name	Address	Phone
*24 Hour Contact		1205 2ND AVE STE 200,,SEATTLE,WA,98101	(206)223-0326
Permittee	KING COUNTY WASTEWATER	201 S JACKSON ST,MAILSTOP: KSC-NR-0512,SEATTLE,WA,98104-3855	(206)263-6453
Owner	KING COUNTY WASTEWATER	201 S JACKSON ST,MAILSTOP: KSC-NR-0512,SEATTLE,WA,98104-3855	(206)263-6453

PERMITTED USES

Use Code: 45	**Vault Plan #:** 774-991	**Plan Serial #:** 35952
Right of Way: NON-ARTERIAL	**DPD #:**	**To Be Restored By:**

Space	Start Date	Duration	Sq. Feet	Description	Conditions

CONDITIONS OF USE

E1.15 :
MULCHING AND MATTING - Apply mulch to protect exposed soils and promote plant establishment.

E1.40 :
PERMANENT SEEDING AND PLANTING - Install temporary surface runoff control measures prior to seeding or planting to protect the surface from erosion until the vegetation is established. Establish permanent vegetation (e.g., grasses, legumes, trees, and shrubs) as rapidly as possible to prevent soil erosion by wind or water.

E1.45 :
SODDING - Establish permanent turf for immediate erosion protection or to stabilize drainage pathways where concentrated overland flow will occur.

E1.50 :
TOPSOILING - Preserve and use topsoil to enhance final site stabilization with vegetation and to provide a suitable growth medium for final site stabilization with vegetation.

E3.25 :
STORM DRAIN INLET PROTECTION - Install storm drain covers on stormwater structures less than 12 inches deep during construction. Install catch basin filter socks in stormwater structures greater than 12 inches deep. Place the storm drain or catch basin grate on top of the catch basin filter sock to hold it in place.

C1.20 :
USE OF CHEMICALS DURING CONSTRUCTION - Use only the recommended amounts of chemical materials and apply them in a proper manner. Neutralize the pH of concrete wash water from concrete mixers, if necessary.

C1.35 :
SAWCUTTING AND PAVING POLLUTION PREVENTION - Vacuum slurry and cuttings during the activity to prevent migration offsite and do not leave slurry and cuttings on permanent concrete or asphalt paving overnight. Dispose of collected slurry and cuttings, waste material, and demolition debris in a manner that does not violate groundwater or surface water quality standards. Implement preventative measures such as berms, barriers, secondary containment, and vactor trucks if observations indicate that a violation of water quality standards could occur.

C1.45 :
SOLID WASTE HANDLING AND DISPOSAL - Remove and dispose of accumulated solid waste at authorized disposal areas. Label waste containers and place them in a covered area with closed lids. Salvage and recycle any useful materials.

BMP5 :
SPILL PREVENTION AND CLEANUP-Keep a spill cleanup kit in a nearby vehicle or next to the work site so that it is easily accessible. Make sure the contents of the spill kit are appropriate for the types and quantities of materials used for this work task. Refill spill kit materials before beginning work.

BMP16 :
CONCRETE POURING, CONCRETE/ASPHALT CUTTING, AND ASPHALT APPLICATION - Sweep or shovel loose aggregate chunks and dust for recycling or proper disposal. Place storm drain covers or similarly effective containment devices over all storm drains located downslope or adjacent to the work area. Shovel or vacuum all slurry and remove from the site. Perform cleaning of concrete application and mixing equipment or concrete-delivery vehicles in a designated area where the rinse water is controlled.

BMP20 :

Image: Sample excerpt from a past SDOT SIP permit.

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Section 14
Permitting

Project Team shall prepare and submit documentation as required for various permitting requirements associated with the improvements. Possible permitting depending upon project scope would include:

Seattle-specific:

- Street Improvement Permit with SDOT (SCL, SPU, SFD, etc.)
- SDOT Tree Permit
- SDOT Street Use Permit
- SPU hydrant permit (if water is needed) associated with work for geotechnical testing or irrigation
- SEPA
- Parks Revocable Use Permit (if construction easement on parks property is required)
- SDCI Shoreline Permit
- Side sewer permit with SDCI for adjustment of side sewers
- Utility Relocations Permit (gas, franchise)
- New water service application (for new irrigation meter) Water Availability Certificate
- Relocation of existing water services by SPU

Other permits/review:

- King County Industrial Waste Discharge Permit
- UIC Well Registration with Ecology
- NPDES Construction Stormwater Permit from Ecology
- Hydraulic Project Approval (HPA) with Washington State Department of Fish and Wildlife (WDFW)
- Miscellaneous environmental permits under the Joint Aquatic Resource Permits Application (JARPA)
- Ecology Consent Decree Reporting
- Air Quality permit (for working around existing asbestos pipe)
- Franchise review

The following are additional guidelines for environmental permits for development (including construction of bioretention retrofits) within the City's Shorelines and City's Environmentally Critical Areas (ECA), particularly over and near creeks, wetlands, riparian areas:

General

- Consult with SDCI's Shoreline reviewer and SDCI's ECA reviewer for guidance on what is allowed and not allowed within the Shoreline Management District and

ECA, respectively. They can also be consulted for guidance on outside permit(s) (e.g. HPA, JARPA etc.).

- Avoid locating bioretention and associated work within ECA (e.g. wetland and riparian zone) and Shoreline, if possible.
- When work is done within wetland to creek and creek and other critical areas, environmental permit will require work be limited to certain times of the year for the Fish window.

ECA

- SMC Chapter 25.09 regulates development within City's ECA.
- For ECA provisions (but not Shoreline approvals), SPU-led CIP projects can self-issue ECA approvals (rather than go through SDCI for that approval). SPU to meet the letter and spirit of the provisions of SMC 25.09.
- Ground disturbance and vegetation modification/removal within ECA is highly restricted as described in 25.09. Exemptions to ECA provisions are found in SMC 25.09.045.
- For SPU led CIP projects, SPU to document City's regulation of riparian and wetland under Code 25.09 is met. No vegetation removal, grading and other work in these areas is allowed unless an exemption to ECA provisions is obtained.

Shorelines:

- SMC Chapter 23.60A regulates development within City's Shoreline Management District (which includes Lake Washington, Lake Union, Bitter Lake, Haller Lake, Green Lake; Duwamish Waterway; or Puget Sound).
- For work in the Shoreline Management District, SDCI needs to be engaged to issue either the exemption or the Shoreline Substantial Development Permit, whichever applies.
- As of March 2018, exemptions to the Shoreline provisions are identified at SMC 23.60A.020, but the application of those exemptions (e.g. 23.60A.020. 15) to construction of raingardens/bioretention is less clear than exemptions for ECAs.

Other permits:

- Hydraulic Project Approval (HPA) from Washington State Department of Fish and Wildlife is required for discharges to creeks and wetlands connected to creeks etc. For SPU-led CIP projects, team to work with City's permit specialist for HPA application.
- If fill is placed in a wetland or below a creek's Ordinary High-Water Marks, then an authorization from the Army Corps of Engineers (Corps) would be required in addition to the HPA from WDFW.

Images: Excerpts from Bid Award announcements in newspaper and COS and King County websites. Closeout of Design Phase occurs after procurement and award.

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Section 15
Closeout of Design Phase

The Design Phase for a project ends upon completion of the procurement phase and the awarding of the project. Upon completion of the design of both SPU- and WTD-led projects, the Project Team shall conduct a closeout meeting. Participation in the close out meeting and input on lessons learned from the Design Phase shall be gathered from team members—including the designers/subject matter experts, i.e., the landscape architect(s), civil engineer(s), community relations representative, geologist/hydrogeologists, geotechnical engineer, modeler, project manager, and operations and maintenance representative—and documented in meeting notes.

As the Project Team looks back over the work and scope of the Design Phase, along with each agency's procedures for closeout meetings, suggested discussion topics for reviewing lessons learned include:

- What worked well during the Design Phase?
- What could have been done differently and why?
- How did the interdisciplinary interaction work? How could roles improve?
- What were the lessons learned?
- How did the departments/divisions/agencies work together?
- What would you change in the consultant design scope of work?
- What can be improved on community interaction? What would you change in the consultant outreach scope of work?
- Was there adequate contractor interest to achieve competitive bid?
- Was the bid period adequate? Any suggestions for procurement and award process?
- Did contractor questions or addendums trigger any recommendations for future project PS&E's?
- Recommendations/suggestions for changes to GSI design standards, GSI details/concepts, guidance documents, specifications, GSI Manual, procedures, protocols, general agency/policy procedures, etc.
- If new details or templates or procedures were developed, review whether these should be considered for the GSI program, or for general use (not just GSI projects) or other.
- Recommendations for streamlining the process.

Following the team's closeout meeting, a meeting shall be held with SPU GSI Projects Manager and GSI Program staff to review comment from the closeout meeting discussion, recommend actions and assign responsible party.

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List of Appendices

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Appendix A: Design Phase Schedule Template

- Design Phase Schedule Template for GSI Projects, Draft November 5, 2013

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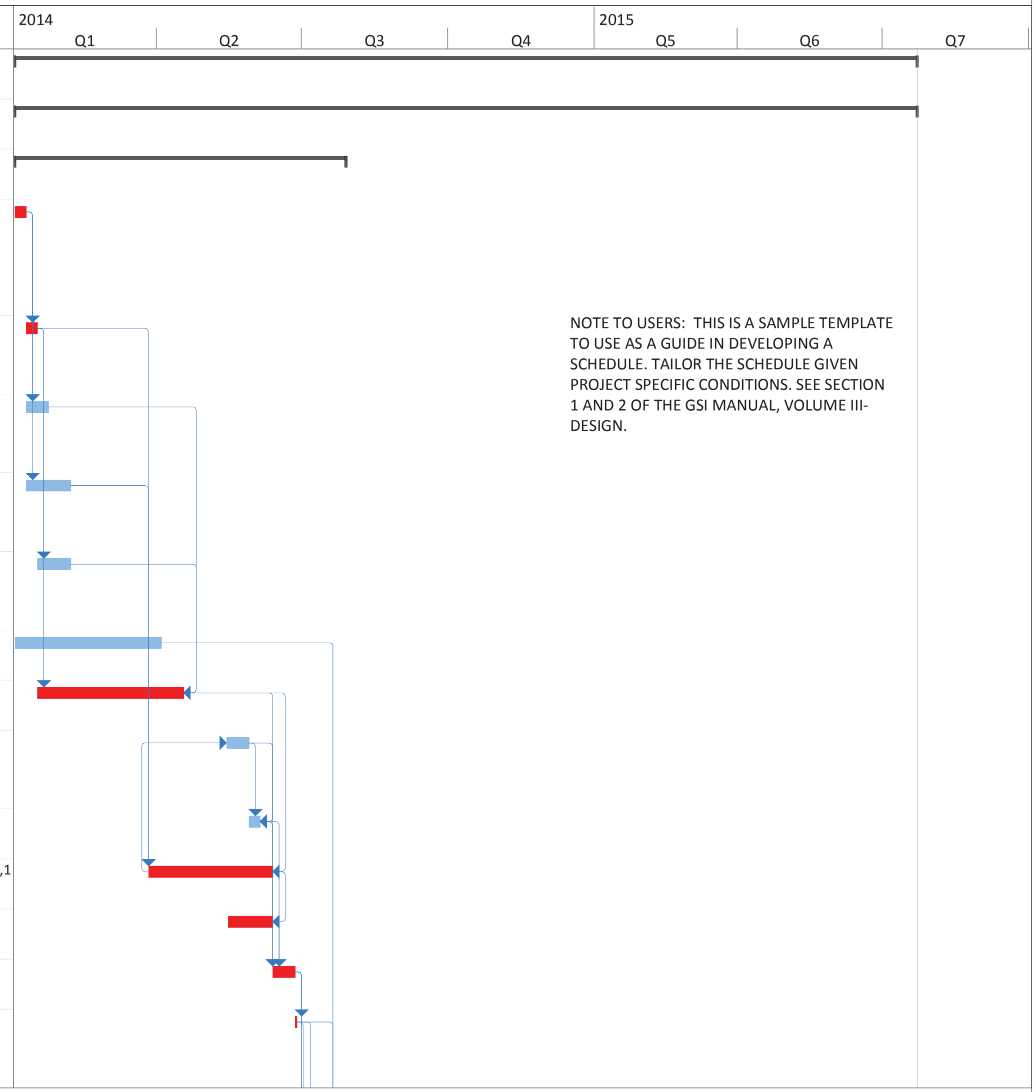
Green Stormwater Infrastructure
Design Schedule Template

ID	Task Name	Duration	Start	Finish	Tot Float	Predecessors	Successors
1	**GSI Design Activities for CSO P**	**405 days**	**Thu 1/2/14**	**Wed 7/22/15**	**0 days**		
2	**Design Phase**	**405 days**	**Thu 1/2/14**	**Wed 7/22/15**	**0 days**		
3	**30% Design**	**148 days**	**Thu 1/2/14**	**Mon 7/28/14**	**0 days**		
4	Update Project Management Plan, Form Design Team, & Issue Design NTP	5 days	Thu 1/2/14	Wed 1/8/14	0 days		7,6,5
5	Review Pre-SG2 Documents for Design	5 days	Thu 1/9/14	Wed 1/15/14	0 days	4	13,10,8
6	Prepare/Update Communication Plan	10 days	Thu 1/9/14	Wed 1/22/14	61 days	4	10FF
7	Update Technical Basis of Design	20 days	Thu 1/9/14	Wed 2/5/14	35 days	4	13
8	Arborist Tree Survey Mark up & Incorporate to Base Map	15 days	Thu 1/16/14	Wed 2/5/14	31 days	5	10FF+20 days
9	Prepare/Publish SEPA	66 days	Thu 1/2/14	Thu 4/3/14	101 days		19
10	Survey & Basemappin	66 days	Thu 1/16/14	Thu 4/17/14	0 days	5,8FF+20 days,6FF	13FF+40 days,12FF
11	Model to Validate Performance	10 days	Thu 5/15/14	Wed 5/28/14	6 days	13SS+35 days	15,12
12	GSI Tech Review @ 3(	5 days	Thu 5/29/14	Wed 6/4/14	6 days	13FF-25 days,10FF,11	15
13	30% PS&E	56 days	Thu 3/27/14	Thu 6/12/14	0 days	5,10FF+40 days,7	15,12FF-25 days,11SS+35 days,1
14	Engineering Report	20 days	Fri 5/16/14	Thu 6/12/14	0 days	13FF	15
15	30% QA/QC and Revis	10 days	Fri 6/13/14	Thu 6/26/14	0 days	13,11,14,12	17,16,18
16	SIP Design Guidance Meeting	1 day	Fri 6/27/14	Fri 6/27/14	0 days	15	19,18,25FS+5 days

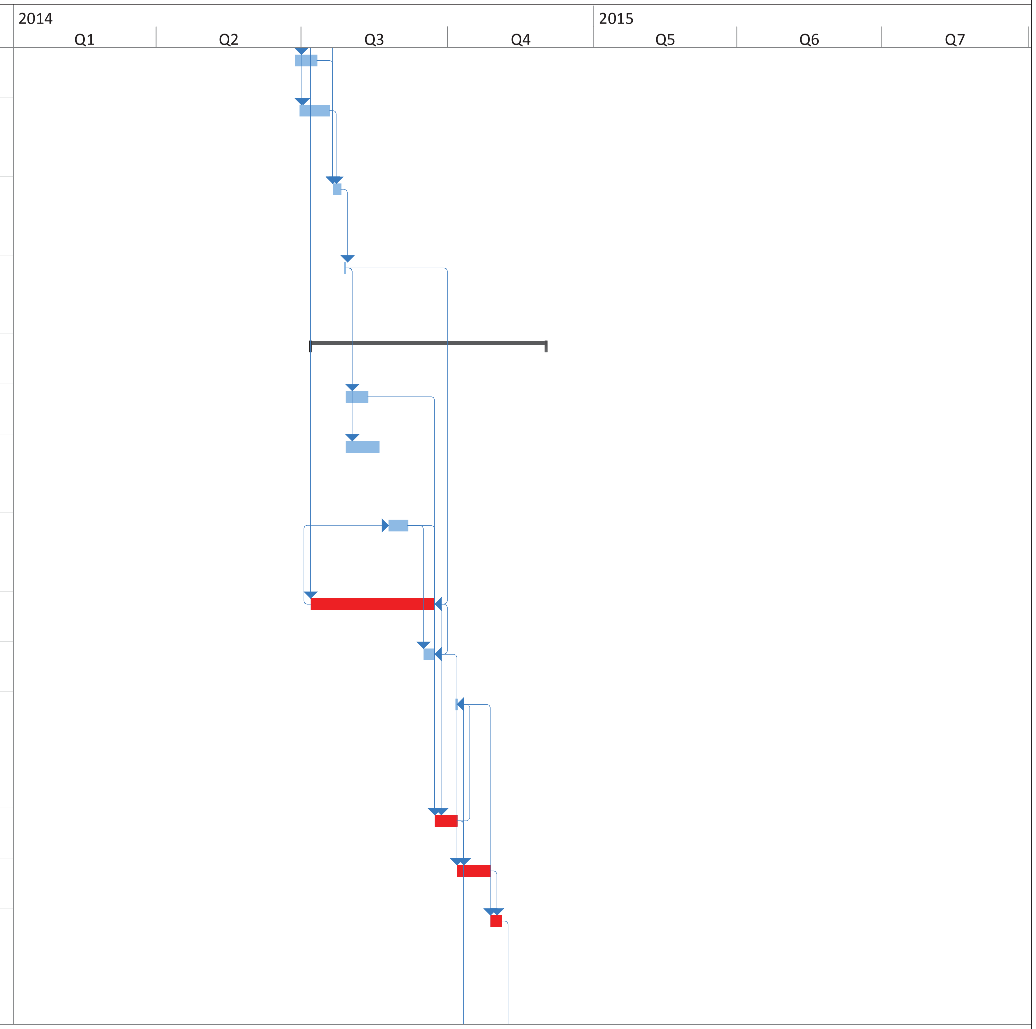


Project: GSI Design Template	Task	Milestone	Summary	Project Summary	Critical

Green Stormwater Infrastructure

Design Schedule Template

ID	Task Name	Duration	Start	Finish	Tot Float	Predecessors	Successors
17	Circulate 30% Plan	10 days	Fri 6/27/14	Thu 7/10/14	31 days	15	19
18	Meet w/residents to discuss 30% design and collect input	15 days	Mon 6/30/14	Fri 7/18/14	25 days	16,15	19
19	Receive and Consolidate SEPA/SIP/Circ Comments	5 days	Mon 7/21/14	Fri 7/25/14	25 days	9,17,16,18	20
20	WTD Stage Gate 3- Project Baseline	1 day	Mon 7/28/14	Mon 7/28/14	25 days	19	23,22,25FF+15 days
21	**60% Design**	**106 days**	**Mon 7/7/14**	**Mon 12/1/14**	**0 days**		
22	Finalize Basis of Desig	10 days	Tue 7/29/14	Mon 8/11/14	30 days	20	28
23	60% Utility Locates/pot hole as needed	15 days	Tue 7/29/14	Mon 8/18/14	242 days	20	
24	Model to Validate Performance	10 days	Mon 8/25/14	Fri 9/5/14	11 days	25SS+35 days	28,26
25	60% PS&E	56 days	Mon 7/7/14	Mon 9/22/14	0 days	16FS+5 days,20FF+15 da	28,24SS+35 days,26FF
26	GSI Tech Review @ 6(	5 days	Tue 9/16/14	Mon 9/22/14	10 days	25FF,24	29
27	SIP Design Guidance Meeting for 1st 60% Submittal	1 day	Mon 10/6/14	Mon 10/6/14	8 days	28FF	30,31
28	60% QA/QC and Revis	10 days	Tue 9/23/14	Mon 10/6/14	0 days	25,24,22	29,27FF
29	Circulate 60% plan	15 days	Tue 10/7/14	Mon 10/27/14	0 days	28,26	30
30	Receive and Consolidate SIP Comments from 1st 60% Submittal	5 days	Tue 10/28/14	Mon 11/3/14	0 days	27,29	32

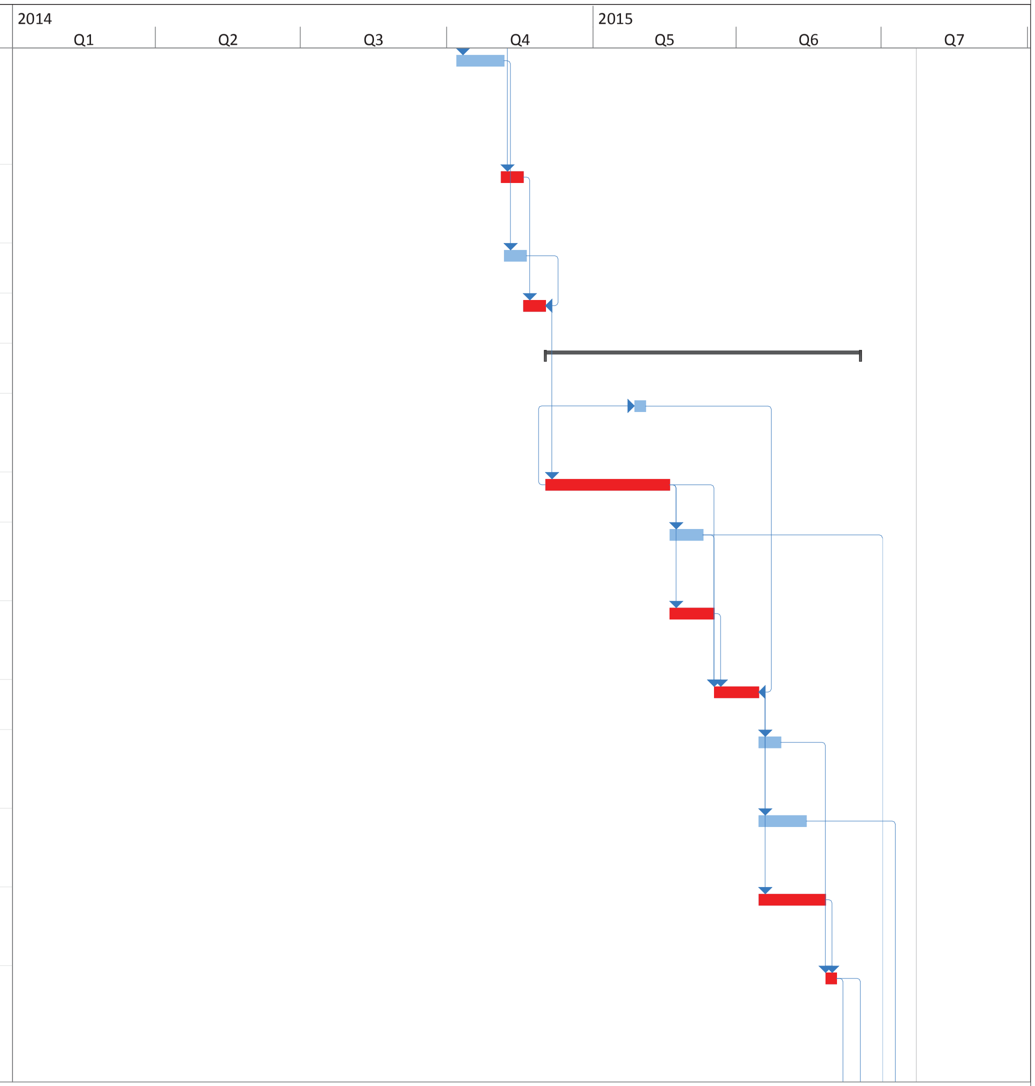


Project: GSI Design Template | Task | Milestone ◆ | Summary | Project Summary | Critical

Green Stormwater Infrastructure

Design Schedule Template

ID	Task Name	Duration	Start	Finish	Tot Float	Predecessors	Successors
31	Prep Materials/Meet with residents to discuss 60% design	22 days	Tue 10/7/14	Wed 11/5/14	8 days	27	33
32	Revise 60% for 2nd SIP Submittal	10 days	Tue 11/4/14	Mon 11/17/14	0 days	30	34
33	Update Community	10 days	Thu 11/6/14	Wed 11/19/14	8 days	31	34FF
34	SDOT 60% SIP Approv	10 days	Tue 11/18/14	Mon 12/1/14	0 days	32,33FF	37
35	**90% Design**	**142 days**	**Tue 12/2/14**	**Wed 6/17/15**	**0 days**		
36	GSI Technical Guidance Review at 90%	5 days	Tue 1/27/15	Mon 2/2/15	51 days	37SS+40 days	40FF
37	90% Design Plans	56 days	Tue 12/2/14	Tue 2/17/15	0 days	34	39,38,36SS+40 days,40
38	Assemble Engineering Documentation	15 days	Wed 2/18/15	Tue 3/10/15	5 days	37	40,49
39	Project Manual (include Final Engineer's estimate)	20 days	Wed 2/18/15	Tue 3/17/15	0 days	37	40
40	90% QA/QC and Revis	20 days	Wed 3/18/15	Tue 4/14/15	0 days	39,38,37,36FF	41,43,42
41	Circulate 90% Design & Project Manual	10 days	Wed 4/15/15	Tue 4/28/15	20 days	40	44
42	Community Engagement at 90%	22 days	Wed 4/15/15	Thu 5/14/15	34 days	40	48FF
43	90% SIP Plan Circulation (SDOT)	30 days	Wed 4/15/15	Tue 5/26/15	0 days	40	44
44	Revise 90% Plans for SDOT circulation comments	5 days	Wed 5/27/15	Tue 6/2/15	0 days	43,41	45,48

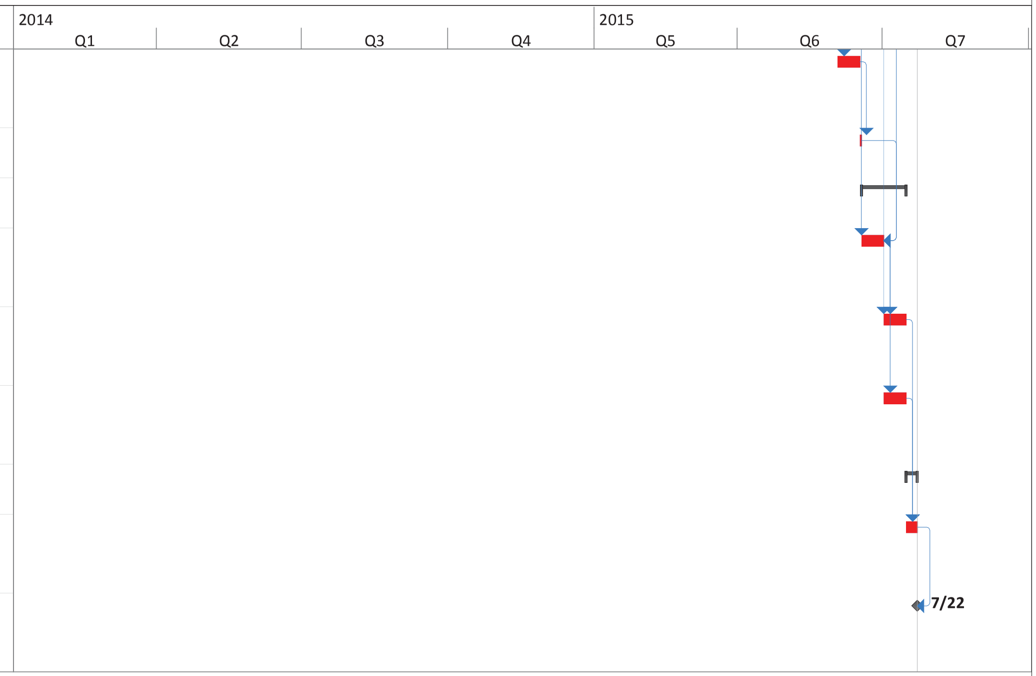


Project: GSI Design Template | Task | Milestone | Summary | Project Summary | Critical

Green Stormwater Infrastructure

Design Schedule Template

ID	Task Name	Duration	Start	Finish	Tot Float	Predecessors	Successors
45	Resubmit 90% SIP Plans to SDOT	10 days	Wed 6/3/15	Tue 6/16/15	0 days	44	46
46	90% SIP Approval	1 day	Wed 6/17/15	Wed 6/17/15	0 days	45	48FF+10 days
47	**Final Design**	**20 days**	**Thu 6/18/15**	**Wed 7/15/15**	**0 days**		
48	100% Design and Project Manual	10 days	Thu 6/18/15	Wed 7/1/15	0 days	46FF+10 days,42FF,44	50,49
49	Assemble Final Engineering Dcoumentation	10 days	Thu 7/2/15	Wed 7/15/15	0 days	48,38	52
50	Submit 100% SIP Plans for SDOT signature	10 days	Thu 7/2/15	Wed 7/15/15	0 days	48	52
51	**SPU Stage Gate 3**	**5 days**	**Thu 7/16/15**	**Wed 7/22/15**	**0 days**		
52	Prep SPU SG3 Materials/Schedule Meeting	5 days	Thu 7/16/15	Wed 7/22/15	0 days	50,49	53FF
53	Stage Gate 3 Approve for Advertize	0 days	Wed 7/22/15	Wed 7/22/15	0 days	52FF	



Appendix B: Public Engagement Guidelines

- SPU Communications and Public Engagement Guidelines: Sewer and Stormwater Pollution Prevention, May 10, 2012.
- Example of preconstruction community survey (from Barton CSO control project with GSI)
- Template for Frequently Asked Questions for GSI CIPs

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Seattle Public Utilities | Protecting Seattle's Waterways

Communications and Public Engagement Guidelines

Sewer and Stormwater Pollution Prevention

Updated 5/10/12

Communications and Public Engagement Guidelines

Protecting Seattle's Waterways

Sewer and Stormwater Pollution Prevention

Updated 5/18/12

Table of Contents

Questions? Suggestions?

Contact:

Christina Faine
Communications
206.615.1098
44th FL, Seattle Municipal Tower
christina.faine@seattle.gov

Acronyms and Abbreviations

ADA	Americans with Disabilities Act
BMP	Best Management Practices
CSO	Combined Sewer Overflow
DNS	Determination of Non-Significance
DOE	Washington State Department of Ecology
DON	Seattle Department of Neighborhoods
DPD	Seattle Department of Planning and Development
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
FAQ	Frequently Asked Questions
GSI	Green Stormwater Infrastructure
IOPE	Inclusive Outreach and Public Engagement Guide
LEP	Limited English proficiency
LTCP	Long-Term Control Plan
NCES	National Center for Education Statistics
NDC	Neighborhood District Council
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
Parks	Seattle Parks and Recreation
PEP	Public Engagement Plan
PEIS	Programmatic Environmental Impact Statement
RSJI	Race and Social Justice Initiative (City of Seattle Initiative)
SEPA	State Environmental Policy Act
SSPP	Sewage and Stormwater Pollution Prevention
SPU	Seattle Public Utilities
WAC	Washington Administrative Code
WTD	King County Wastewater Treatment Division

Glossary

Best management practices (BMP)	The U.S. Environmental Protection Agency defines BMP as a "technique, process, activity or structure used to reduce the pollutant content of a stormwater discharge."
Bioretention	Bioretention is a process by which contaminants and sediment are removed from stormwater runoff. A treatment area that consists of a bed of sand, layer of mulch, planting soil and plants collects stormwater, which slowly infiltrates or evaporates.
Green Alleys	Green alleys are alleys that are paved, at least partially, with permeable pavement and a stone reservoir underneath. The reservoir temporarily stores stormwater runoff before it infiltrates the ground, preventing the stormwater from entering the sewer system.
Natural Drainage Systems	Natural drainage systems enhance previously unimproved public rights of way with features to capture stormwater runoff and prevent it from reaching the sewer system. Natural stormwater management practices include interconnected bioretention cells and permeable pavement. Bioretention cells are wide depressions planted with deep-rooted native plants and grasses along the stormwater flow path to temporarily hold and cleanse stormwater, before infiltrating or slowly releasing it into the sewer system.
RainWise	RainWise is a Seattle Public Utilities program that provides eligible property owners with substantial rebates for installing a rain garden or cistern on private property.
Roadside Rain Gardens	Roadside rain gardens are similar to natural drainage systems but used in places with existing curbs and gutters. They are located in public right of way in the parking strip adjacent to the street or in curb extensions constructed into the street.
SEPA Responsible Officer	The SEPA Responsible Official is the SPU staff person responsible for the documentation and content of the environmental analysis conducted under SEPA.

Executive Summary

By the time it's complete, the effort to protect Seattle's waterways from stormwater pollution and sewage overflows will have lasted more than 15 years and touched more than a dozen neighborhoods.

Protecting Seattle's Waterways will also have made significant progress toward the important environmental goals (and federal regulations) of keeping our waterways clean, protecting people, animals and plants and providing our communities with fresher, healthier beaches, lakes, rivers and Puget Sound.

When it rains, millions of gallons of stormwater runs off our streets, roofs and driveways, bringing with it pollution like motor oil, heavy metals from vehicle brakes, hydrocarbons from vehicle exhaust, and nitrogen and phosphorous from lawn fertilizers.

The stormwater takes up room in the pipes meant for sewage, causing overflows of combined stormwater and sewage into our waterways. Regionally, annual overflows have fallen from 30 billion gallons per year in 1970 to more typically less than 1 billion a year now. While overflow volumes are significantly better, the U.S. Environmental Protection Agency has established even more stringent standards of one overflow per outfall per year.

To meet that standard, Seattle Public Utilities envisions a series of projects that will be highly visible and create impacts: the construction of large underground tanks to store raw sewage and untreated stormwater; the installation of natural drainage systems (also known as green stormwater infrastructure) to keep stormwater out of the sewer system and reduce the amount discharging from the drainage system directly into the waterway.

To get a job this big done right, the first time, will take phenomenal planning both inside Seattle Public Utilities and *out there*, among the residents, ratepayers, park users and others who have a direct stake in the outcome.

For Protecting Seattle's Waterways to be successful, it's imperative that the public understands and accepts the notion of preventing polluted runoff and sewage overflows. That doesn't mean every citizen will love or even support every project. What it does mean is that those affected by the work will be given every opportunity to learn about details, express their opinions, perhaps to influence the work and certainly to believe at the end of the process that their voices were heard.

That's important for the success of the program, the reliability of the budget and, finally, the larger concern of building healthy communities.

These guidelines are a roadmap for securing that kind of public buy-in known as Informed Consent. The guide will give SPU planners, program and project managers and communicators detailed tips for education, outreach, listening and understanding.

We're already taking early feedback seriously, which is why the old CSO program (combined sewer overflows) has become Protecting Seattle's Waterways.

Chapter 1 – Introduction

1.1 Purpose of these Public Engagement Guidelines

These Public Engagement Guidelines are designed to assist public communication and engagement for Protecting Seattle's Waterways, formerly known as the Combined Sewer Overflow (CSO) Reduction Program. Seattle Public Utilities program and project teams should use the guidelines for educating the public about Protecting Seattle's Waterways, engaging stakeholders in the decision-making process and meeting any legal or regulatory requirements for public engagement.

The guidelines describe a general public engagement approach for engaging and informing the public about Protecting Seattle's Waterways projects. It should serve as a roadmap for developing a project-specific public engagement plan, but it is not a substitute for engaging a Seattle Public Utilities Communications Lead. Different public engagement strategies, tools, and tactics may be appropriate at different milestones, and it is up to the project team and SPU Communications Lead to determine which approach best suits an individual project and to adjust the approach when necessary.

The purpose of these guidelines is to:

- Align communications and public engagement across Protecting Seattle's Waterways and all related planning and projects
- Allow for other Seattle Public Utilities staff to adapt the guidelines to their specific project

The guidelines describe Seattle Public Utilities' approach to communications and public engagement for Protecting Seattle's Waterways, including:

- Goals and objectives
- Key messages
- Public engagement milestones
- Stakeholders
- Communications and public engagement tools and tactics, including those specifically required by the State Environmental Policy Act (SEPA)

These guidelines will be updated periodically based on policy changes and lessons learned.

1.2 Protecting Seattle's Waterways

1.2.1 Background

Like many cities across the U.S., Seattle's sewer system was designed to carry both sewage from inside homes and stormwater from rooftops and streets. This system worked well enough when Seattle was a much smaller city, but Seattle has outgrown its sewer system. Today when it rains, the sewer system runs out of capacity and excess raw sewage and stormwater overflows into Puget Sound, Lake Washington, the Ship Canal and the Duwamish Waterway. Even though this problem does not affect our drinking water, we must prevent these overflows to protect people and the environment from raw sewage and polluted stormwater and keep our waterways healthy for future generations. In addition, Seattle Public Utilities is required to reduce sewage overflows to no more than an average of one per outfall per year to comply with the Clean Water Act and state regulations.

Seattle Public Utilities provides essential sewer and drainage services for Seattle residents and, in partnership with King County, is responsible for preventing sewage and stormwater overflows in Seattle.

Early-Action Projects

Seattle Public Utilities is working on several early-action projects – beginning in 2010 and running through 2015 – to address sewage overflows at the most critical sites. Combined, these early-action projects will reduce the volume of sewage overflows in Lake Washington by 45%.

Early-action projects include:

- Improving existing overflow prevention facilities
- Constructing large infrastructure projects to reduce sewage overflows into Lake Washington in the Windermere, Genesee and Henderson basins
- Constructing "green" or natural stormwater management systems citywide

Long-Term Control Plan

The Long-Term Control Plan (LTCP) will define SPU's sewage and stormwater pollution projects from 2016-2025. The goals of the LTCP are to protect and enhance water quality, select cost-effective sewage and stormwater pollution prevention approaches, equitably distribute the impacts of project alternatives throughout neighborhoods, and maximize system efficiencies.

Specifically, the LTCP will:

- Identify areas of the city where projects are required
- Evaluate alternatives for reducing sewage and stormwater pollution in affected areas
- Select a preferred alternative (solution) for each affected area
- Recommend a schedule for designing and constructing projects from 2016-2025
- Estimate program costs and associated rate impacts
- Consider public and stakeholder input

Public involvement for the LTCP began in 2010 when Seattle Public Utilities convened a Sounding Board of residents representing a variety of perspectives. SPU has also conducted public meetings, briefings and presentations to introduce the Long-Term Control Plan and gather public input.

Relationship with King County CSO Control Program

Seattle's sewer system is linked with King County's. Each government's operations, maintenance and capital improvement plans can affect the other. In addition, SPU and King County both manage sewage overflow outfalls in Seattle: SPU manages 90 outfall locations and King County manages 38.

King County and Seattle Public Utilities have identified three program areas for joint collaboration:

1. LTCP – Two of the three LTCP plan alternatives under consideration allow for collaboration between King County and Seattle Public Utilities.

2. Natural Stormwater Management[1] – King County and SPU are collaborating on natural stormwater management projects in Seattle neighborhoods, including county-led projects in the Barton/Fauntleroy, University District and Montlake basins. King County and SPU also collaborate on the RainWise program.

3. Real-time Seattle sewage overflow map – King County and SPU maintain a website, www.seattle.gov/cso, to provide the public with real-time information about when and where sewage overflows are occurring.

1.2.2 Protecting Seattle's Waterways

The goals of Protecting Seattle's Waterways are to:

- Protect people and the environment from raw sewage and stormwater pollution and keep our waterways healthy for future generations

- Comply with U.S. Environmental Protection Agency (EPA) and Washington State Department of Ecology (DOE) regulations and requirements

1.2.3 Regulatory Context for Protecting Seattle's Waterways

Controlling sewage overflows is required by the following state and federal laws and governing agencies, some of which have specific requirements for public involvement (described in 2.6 Regulatory Requirements for Public Involvement):

EPA – The Environmental Protection Agency is a federal regulatory agency whose main purpose is to protect human health and the environment. When Congress writes an environmental law EPA implements it by writing regulations or setting national standards that states and tribes enforce through their own regulations. If states or tribes fail to meet the national standards, EPA provides tools and funding to help them.

Clean Water Act – In 1972, Congress passed the Clean Water Act, the primary federal law governing water pollution, which is administered by EPA. Seattle is on EPA's list of nearly 800 cities that operate a combined sewer system. The Clean Water Act requires that sewage

[1] Based on extensive public opinion research, Green Stormwater Infrastructure will be called Natural Stormwater Management. Please refer to 2.4 Key Messages for more details on key messages and terminology.

overflows happen no more than once per outfall per year. In some cases, the EPA can issue additional requirements through an Administrative Order or Consent Decree.

2009 CSO Compliance Order – In 2009, EPA issued a compliance order directing the City of Seattle and King County to step up efforts to reduce sewage overflows. The compliance order issued to the City of Seattle addresses wastewater discharge permit violations found during a March 2008 EPA investigation. The order requires the City of Seattle to prepare plans for overflow emergency response, clean the collection system in a more systematic way, and create more storage to hold sewage overflows rather than discharging them. The order requires the City of Seattle to prepare plans to reduce the number of basement backups and dry weather overflows. EPA expects the City of Seattle to be in compliance with the order by 2012.

National Pollutant Discharge Elimination System - As authorized by the Clean Water Act, the National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into surface waters. Point sources are individual pipes or man-made ditches to transport wastewater. Individual homes that are connected to a municipal system, use a septic system, or do not have a surface discharge do not need an NPDES permit; however, industrial, municipal and other facilities must obtain permits if they discharge directly to surface waters. In most cases, the NPDES permit program is administered by authorized states.

DOE - EPA has delegated authority to the state Department of Ecology to enforce clean water standards. Seattle's drainage and wastewater system is permitted under NPDES, which allows sewage overflows during rainy weather. In accordance with both state and federal law and its NPDES permit, the City is required to reduce sewage overflows through both shorter-term best management practices, proper operations and maintenance programs, and longer-term capital-intensive projects.

SEPA – The State Environmental Protection Act provides a way to identify possible environmental impacts that may result from governmental decisions. These decisions may be related to issuing permits for private projects, constructing public facilities or adopting regulations, policies or plans. Environmental impacts can be effects to the natural environment, such as air, water or habitat. Environmental impacts can also be effects to the human environment, such as noise, sightlines, public services or transportation. Seattle Public Utilities will meet all requirements for public outreach under SEPA, as outlined in the Chapter 25.05 of the Seattle Municipal Code.

Seattle Public Utilities will usually begin the SEPA process by completing an environmental checklist. The checklist is a standard form to obtain information about a proposed project, including its location and potential environmental impacts.

If there are no likely significant adverse environmental impacts, DOE issues a determination of non-significance (DNS). If the information in the checklist indicates that the proposed project is likely to have a significant adverse environmental impact, DOE will require Seattle Public Utilities to prepare an environmental impact statement (EIS). The EIS will include an evaluation of alternatives to the proposed project and mitigation measures to avoid or minimize the likely environmental impacts of the proposed project.

Chapter 2 –Approach to Communications and Public Engagement

2.1 Communications and Public Engagement Goals

The goals of Protecting Seattle's Waterways communications and public involvement are to:

Goal A: Achieve and sustain Informed Consent for Protecting Seattle's Waterways projects.

Objective 1: Communicate the seriousness, urgency and scope of the sewage overflow problem in Seattle to stakeholders.

Objective 2: Demonstrate that Protecting Seattle's Waterways is an important investment in public health and environmental stewardship in Seattle.

Objective 3: Establish Seattle Public Utilities, in partnership with King County, as the right agency to address this problem.

Objective 4: Provide regular communication and feedback to stakeholders throughout individual projects, and report back to the public and to decision-makers on how public input has been used.

Objective 5: If low-income, underserved, or Limited English Populations (LEP) populations will be affected by a project, engage them early in the public involvement process and provide opportunities designed to meet the unique needs of these groups.

Objective 6: Publicize programs and activities through multiple and diverse communications vehicles and when possible, hold meetings in facilities accessible by transit and in compliance with the Americans with Disabilities Act.

Objective 7: Ensure that clear, honest and thorough information about the program and the decision-making process is available to the public and the media.

Goal B: Help manage risk to ensure smoother, more cost-effective project delivery

Objective 1: Surface community concerns early enough to address them in the final design

Objective 2: Engage all potentially affected stakeholders by identifying them early in the project and notifying them of public engagement opportunities using the appropriate media

Objective 3: Identify and address community concerns in a timely manner.

Objective 4: Respond to public inquiries in a timely and thorough manner.

Objective 5: Meet all legal requirements (i.e. SEPA) and applicable City policies regarding public engagement.

Objective 6: Coordinate Seattle Public Utilities and King County public engagement and communications when there are joint SPU-King County projects or when individual projects affect the same geographic area.

Goal C: Support Seattle Public Utilities, City Council and the Mayor's decision-making processes.

Objective 1: Provide public engagement opportunities as appropriate prior to decision-making.

Objective 2: Provide regular updates to decision-makers about the project, public engagement and how feedback has informed the decision-making process.

2.2 Communications and Public Engagement Strategy

Seattle Public Utilities' strategy for Protecting Seattle's Waterways communications and public engagement is to:

1. Communicate to the public the serious nature of the sewage and stormwater pollution problem
2. Establish SPU's legitimate role as the agency to solve the sewage and stormwater pollution problem, in partnership with King County
3. Ask for the public's feedback on the program early and often
4. Use data and illustrative stories that help people understand the impacts of sewage and stormwater pollution on surface water quality, human health and quality of life

5. Use public input to inform decisions around planning, siting and design of Seattle combined sewer overflow and stormwater facilities
6. Keep decision-makers informed about the project, the public engagement process and how public input was considered and addressed in project decisions
7. Meet all legal or regulatory requirements for public engagement regarding sewage and stormwater pollution prevention

Informed consent does not necessarily mean support or consensus, but that those affected by a project have been given ample opportunities to learn about a proposal, to voice concerns and to understand how the plan fits into SPU's mission.

2.3 Guiding Principles

The following principles guide all Protecting Seattle's Waterways public involvement activities:

- **Tell the story.** Public opinion research suggests that once people know about sewage and stormwater pollution they are likely to support projects to prevent sewage overflows and stormwater runoff. Therefore, SPU should focus on telling the story about sewage and stormwater pollution in neighborhoods that are close to outfalls and likely to be affected by Protecting Seattle's Waterways. The story should include data that help people understand the nature and urgency of the problem. For example, when talking about the serious nature of the sewage and stormwater pollution problem, share data about the number of beach closures due to overflows and show visual depictions of sewage overflows to capitalize on the "ick" factor. Be forthright about the fact that SPU is discharging raw sewage and polluted stormwater into Seattle waterways. Focus groups conducted on behalf of SPU revealed that residents want this information.
- **Early and frequent public engagement**. Early and frequent public engagement will help identify key stakeholders, surface community concerns early, manage risk, and help meet Protecting Seattle's Waterways timelines, budgets and regulatory requirements.
- **No surprises**. Seattle Public Utilities will provide the community with timely, accurate information. Seattle Public Utilities will identify and evaluate potential stakeholders as early as possible, to ensure that people who may be affected by Protecting Seattle's Waterways have a meaningful opportunity to share their concerns and preferences with

us. Most importantly, Seattle Public Utilities will keep decision-makers, such as executive managers, City Council members, and the Mayor informed of public engagement activities, public feedback, and how public input is being considered and addressed in decisions.

- **Public opinion matters**. Seattle Public Utilities will consider public input as part of the decision-making process. Seattle Public Utilities will balance the needs of affected community members with the technical, financial, and regulatory requirements of a project. Where feasible and appropriate, Seattle Public Utilities will identify opportunities to engage stakeholders in developing project architectural and restoration elements that reflect the surrounding communities' values and appearance.
- **Outreach must be equitable and inclusive**. Race, ethnicity, income, language, mobility challenges, or religious observances should never be a barrier to public participation. Seattle Public Utilities will provide interpreters and translation according to the City's Translation and Interpretation Policy to ensure that LEP stakeholders have meaningful opportunities to understand and participate in the process.
- **Enlist the media as partners.** The media are where most people get their information about sewage and stormwater pollution and can help get the word out about Protecting Seattle's Waterways. Seattle Public Utilities will reach out to traditional media (such as *The Seattle Times* and *KUOW*) and local micromedia, such as blogs and neighborhood newsletters.
- **Leverage existing relationships and allies.** Seattle Public Utilities will look for opportunities to coordinate with other City of Seattle departments and King County in communications and outreach. Environmental and advocacy groups may support Protecting Seattle's Waterways and can help tell the story of the nature and urgency of the sewage and stormwater pollution problem.
- **Manage expectations**. We will educate the public about the need for sewage and stormwater pollution prevention and the project without overselling the project benefits or the merits of a single alternative or the extent to which public opinion can dictate project siting decisions.

2.4 Key Messages

According to research conducted on behalf of Seattle Public Utilities, most people do not know about combined sewer overflows and polluted stormwater and why it is so urgent and important to reduce sewage and stormwater pollution. They are not aware of Seattle Public Utilities' many programs to address sewage overflows and water quality. This means that every time Seattle Public Utilities introduces a Protecting Seattle's Waterways project to a neighborhood, staff have to work that much harder to educate the community about the nature and seriousness of the problem we are trying to solve. That is, unless there is an existing community working group, such as those associated with Neighborhood District Councils, already working on drainage and/or wastewater issues.

We will be more efficient and successful in helping people understand why the nature and urgency of the sewage overflow problem if we use consistent, compelling messaging. That means that for every Protecting Seattle's Waterways project, every executive manager, staff member, and consultant should use the same terminology and messages when communicating with the public. Even elected officials and staff from other City of Seattle departments should be familiar with and use our messaging.

Protecting Seattle's Waterways Messaging Platform outlines these key messages. The Messaging Platform is based on sound research, including a random sample telephone survey, focus groups, and media and materials audit.

Seattle Sewage and Stormwater Pollution Prevention	
We are:	Seattle Public Utilities
Our core story:	We must protect people and the environment from raw sewage and stormwater pollution, and keep our waterways healthy for future generations.
Our vision:	Protecting Seattle's waterways
Our initiative:	Seattle Sewage and Stormwater Pollution Prevention
We are:	Technically competent Open Responsive Helpful Collaborative Responsible Caring Sincere Nice

Call to Action

Take actions to protect Seattle's waterways.

TALK TO US	MAKE CHANGES TO YOUR PROPERTY	SUPPORT CHANGES IN YOUR NEIGHBORHOOD	LEARN MORE ABOUT SEATTLE SEWAGE AND STORMWATER POLLUTION PREVENTION
• Public participation is an important part of Seattle Public Utilities' decision-making process. • Seattle's efforts may both benefit and impact your neighborhood. • Seattle Public Utilities commits to carefully considering community impacts whenever we plan, site, design, and construct a project. Seattle Public Utilities will be hosting public meetings and	• You can help reduce the amount of pollution in Seattle's waterways. • You may be able to reduce the amount of stormwater that your household contributes to the problem by disconnecting your downspout from the sewer system and installing a rain garden or cistern on your property to temporarily hold and clean rainwater.	• Seattle Public Utilities will plan and build projects in Seattle neighborhoods to prevent raw sewage and stormwater pollution in our waterways. • Seattle pollution prevention projects will benefit your neighborhood by reducing the amount of raw sewage and polluted runoff entering local waterways. In many cases, projects will also create opportunities to provide other	• Participate in public meetings and other project-related events in your neighborhood. • Visit www.seattle.gov/cso

Call to Action			
Take actions to protect Seattle's waterways.			
TALK TO US	**MAKE CHANGES TO YOUR PROPERTY**	**SUPPORT CHANGES IN YOUR NEIGHBORHOOD**	**LEARN MORE ABOUT SEATTLE SEWAGE AND STORMWATER POLLUTION PREVENTION**
other events in your neighborhood, which will be an important opportunity to learn about protecting Seattle's waterways and to inform us about your preferences. • Your participation is important and makes it easier to achieve our community's vision of cleaner waterways for a healthy Seattle.	• You may be eligible for a rebate that will pay for most or all of the cost of installing a rain garden or cistern. Visit www.seattle.gov/util/rainwise for more information.	benefits. • Projects may affect the look of a neighborhood with new features such as rain gardens in parking strips, signage at the end of some streets or access panels placed in the lawn of a local park. • In some cases, neighborhood streets may lose some street parking. • During construction, projects will have temporary impacts on neighborhoods, including increased traffic congestion, noise, disrupted access or visual effects. • Seattle Public Utilities commits to carefully considering community input when we plan, site, design and construct a project. By talking with us, you can help us maximize the benefits for and minimize the	

Call to Action

Take actions to protect Seattle's waterways.

TALK TO US	MAKE CHANGES TO YOUR PROPERTY	SUPPORT CHANGES IN YOUR NEIGHBORHOOD	LEARN MORE ABOUT SEATTLE SEWAGE AND STORMWATER POLLUTION PREVENTION
		impacts to your neighborhood. • Your support for these projects is important and makes it easier to achieve our community's vision of cleaner waterways for a healthy Seattle.	

Description of stormwater runoff and sewage overflow

Every time it rains, millions of gallons of stormwater threaten the health of Seattle's waterways and our quality of life. Runoff causes sewage overflows into our waterways and sewage backups into streets, homes and businesses. It leads to flooding, erodes creeks, and pollutes waterways with hydrocarbons, heavy metals like copper and zinc, motor oil, pesticides, fertilizers, and pet waste. When it rains, stormwater gets into the sewer system, taking up space meant for raw sewage and causing sewage backups and overflows into Puget Sound, Lake Washington, the Ship Canal, the Duwamish Waterway and Longfellow Creek. Even though this problem does not affect our drinking water, we must take actions to prevent these overflows to protect people and the environment and keep our waterways healthy for future generations.

Seattle Public Utilities protects residents, businesses, and local waterways from the damaging effects of stormwater, and, in partnership with King County, is responsible for reducing sewage overflows.

Tools that Seattle Public Utilities uses to prevent sewage and stormwater overflows

1. **Fix it First**
   Sewer System Improvements
   In some areas, Seattle Public Utilities can reduce CSOs by making minor modifications to the existing sewer system to make it more

efficient. Examples include adjusting the height of gates to provide more capacity for stormwater, or maintenance and operations activities.

2. **Keep Stormwater Out**
   Natural Drainage Solutions
   The term natural drainage solutions describes a variety of measures that use soil to absorb stormwater or slow the rate of stormwater entering the sewer system. Examples include:
   - Rain garden – a garden area on private or public property with deep, compost-amended soils and plants that temporarily hold runoff from roofs, streets and sidewalks.
   - Porous pavement – pavement that allows stormwater to filer through and slowly seep into the native soil rather than enter the sewer system.
   - Cistern – a large barrel that temporarily holds 200-1,000 gallons or more of rainwater during a storm. When the storm passes, and sewer capacity is normal, the water is drained to the sewer system.
3. **Store What’s Left**
   Underground Storage
   Underground storage facilities temporarily hold combined sewage and stormwater during a storm, when there is less capacity in the sewer system. When the storm passes and capacity is available, the facility gradually sends flows to the sewage treatment plant.

   Storage facilities can be in the form of tanks, pipes or tunnels. In general, tanks and tunnels are used to store larger storage volumes while storage pipes are appropriate for smaller storage volumes. Larger storage tanks and tunnels require larger sites, whereas a smaller storage pipe can more easily be built underneath the street.

2.4.1 Joint Seattle Public Utilities–King County Messages

Knowing that the public does not differentiate between Seattle Public Utilities and King County when it comes to stormwater and sewage overflows and sewage and stormwater pollution prevention projects, King County and Seattle Public Utilities have discussed that each agency will use the following coordinated messages as appropriate:

Messages that explain the purpose and need for sewage overflow and stormwater pollution prevention

- Reducing sewage overflows and stormwater pollution improves water quality and addresses a public health risk.
- Reducing sewage overflows is part of a larger regional effort to protect Puget Sound and our waterways.
- Seattle and King County are required by state and federal regulations to reduce sewage overflows.
- Seattle Public Utilities and King County Wastewater Treatment Division are the right agencies to address sewage overflows.

Messages that explain how we solve sewage overflows

- Seattle Public Utilities and King County use a similar toolbox of solutions.
- Seattle Public Utilities and King County address sewage overflows with a combination of green and grey strategies to find the most comprehensive and sustainable solution for preventing sewage overflows. We strive to:
    - Fix it first, by making the best use of existing facilities
    - Lead with green where possible
    - Follow with grey to finish the job
- These are ongoing programs. Seattle Public Utilities and King County have been making steady progress over time to reduce sewage overflows.
- King County and Seattle Public Utilities are looking for opportunities to partner so that combined sewer overflow reduction projects:
    - Are more efficient and less costly for ratepayers
    - Provide better environmental outcomes
    - Result in less disruption to the community, because we may be able to solve the problem with one coordinated project rather than two separate projects.

Note that King County will continue to use “combined sewer overflow” and “CSO”, and that the agency refers to their CSO program as a “control” program, rather than a “protection” program. Therefore, even with coordinated messaging, there may be some slight variation in how Seattle Public Utilities and King County describe their respective programs.

2.5 Public Engagement Risks and Mitigation Strategies

Risk	Mitigation Strategy
Stakeholders who oppose the project demand that decision-makers – such as executive managers, City Council members, or the Mayor – stop or drastically alter the project.	• Clarify the decision-making process at the beginning, including who makes decisions, how and when the public will have an opportunity to provide input, and how their input will be considered and addressed. • Brief decision-makers at each project milestone about the public engagement process, participation levels, what we heard from the public, and how that input was considered and addressed. • Pro-actively identify project opponents and their concerns. Brief decision-makers about these concerns and how they are being addressed. If their concerns cannot be addressed, provide decision-makers with clear, defensible reasons for why their concerns cannot be addressed.
Public may not believe that Seattle has water quality problems.	• Show visual images of sewage and stormwater overflows • Provide materials that describe Seattle’s water quality issues in simple language, using sound data to support • Coordinate with community groups and partners – such as the Puget Sound Partnership, People for Puget Sound, and King County – to ensure that messages about Seattle water quality are consistent and we are leveraging every opportunity to reinforce the message.
Public may not agree that Seattle Sewage and Stormwater Pollution Prevention is the right solution to Seattle’s water quality problems. Some people may feel that other interventions are more effective.	• Key messages and materials must include evidence-based language in plain talk about why sewage and stormwater pollution prevention is an important part of addressing Seattle’s water quality issues. • Develop a graphic that shows how Seattle Sewage and Stormwater Pollution Prevention and other strategies work together to address Seattle’s water quality issues. Use this graphic on program materials and share with other Seattle Public Utilities divisions, community groups, and partners.

Risk	Mitigation Strategy
Stakeholders may be confused about the relationship between King County and Seattle sewage and stormwater pollution prevention programs.	• Develop displays, handouts, and website content to explain the different geographic focus of each agency and how the two agencies are working together. • Invite King County CSO Program representative to attend relevant public meetings to answer questions and share program information. • Coordinate briefing schedules and when possible conduct joint briefings.
People living in neighborhoods that will be affected by a Protecting Seattle's Waterways Project may feel singled out.	• Demonstrate that individual Protecting Seattle's Waterways projects are part of an overall systemwide strategy. Use a graphic to show each individual project, the basin that project will affect, and the Protecting Seattle's Waterways goal associated with that project.
Rumors about Seattle Public Utilities condemning private property or impacting a treasured park may derail a public involvement process.	• Outreach must be early and frequent, to build trust with neighbors, and so they will always know who at Seattle Public Utilities to contact if they have questions or concerns about a project. • Protecting Seattle's Waterways materials should describe the programmatic guiding principles that avoid condemnation and set limits for impacts on parks.
Conflicting interests among stakeholders, including the tribes, environmental groups, parks advocacy groups, business owners, elected officials, and neighbors may prevent consensus around a feasible alternative.	• Outreach must be early and frequent, with the objective of identifying and engaging every potential stakeholder at the beginning of the process. • Identify issues and concerns, as well as outreach strategies and tactics for each stakeholder. • Create public engagement opportunities that allow different stakeholders to interact with each other and better understand the variety of needs that a given project needs to meet. Tools and tactics for this type of engagement include charrettes, interactive community workshops, facilitated decision processes, random sample surveys, and focus groups. See 2.7 Public Involvement Tools and Tactics of these Public Involvement Guidelines for more information. • Facilitate constructive dialogue between stakeholders to encourage mutual understanding of different perspectives, issues, and concerns. • Establish clear guidelines and messaging for how Protecting Seattle's Waterways will work with Seattle Parks Department. Conduct joint briefings with parks advocacy groups before beginning any project siting. • Develop a policy statement describing the conditions under which Seattle Public Utilities would consider a private property solution for siting underground storage facilities.

2.6 Regulatory Requirements for Public Engagement

As described in Chapter 1, Seattle Public Utilities will usually begin the SEPA process by completing an environmental checklist, which is a standard form used by all agencies to obtain information about a proposed project. If Seattle Public Utilities determines there are no likely significant adverse environmental impacts, it issues a determination of non-significance (DNS). If the checklist indicates that the project is likely to have a significant adverse environmental impact, Seattle Public Utilities will begin to prepare an environmental impact statement (EIS).

The following subsections describe the SEPA requirements for public engagement and notification. The timing of outreach for an EIS will vary by project. For example, for some projects it will make sense to develop a Draft EIS simultaneously with the detailed evaluation of alternatives, while for other projects it will make sense to do this after a preferred alternative has been identified. The Community Outreach Lead should plan to meet with the SEPA Responsible Official early in the project to determine when and how SEPA-required public involvement should be addressed.

DNS

Seattle Public Utilities will provide a 14-day period for the public, agencies and tribes to submit comments on the proposed project. Comments will be accepted by mail, email, online and in person if a public meeting is held. A required 21-day appeal period is held concurrent with the comment period.

In order to provide all concerned parties an opportunity to participate in the environmental analysis and review, Seattle Public Utilities will:

- Place notification of the DNS on the property, for site-specific proposals; and
- Publish notice in a newspaper of general circulation in the area where the proposal is located [WAC 197-11-510(2)].

Although not required by SEPA, additional notifications are strongly recommended for important or controversial proposals, regardless of environmental significance. Public hearings, community meetings, briefings, and outreach tabling events can provide additional avenues for public involvement, comment and discussion.

EIS

The EIS process is a tool for identifying and analyzing probable adverse environmental impacts, reasonable alternatives, and possible mitigation. The process provides opportunities for the public, agencies and tribes to participate.

If SPU determines it is necessary to prepare an EIS, we will follow these steps for the public involvement process:

Scoping. The first step in preparing an EIS is to determine the scope of issues to be analyzed. During the scoping phase of the environmental process, we collect, review and consider input from the public, tribes, and agencies. We use this input to identify reasonable concepts for meeting the proposed project purpose and need, and to identify potentially significant issues that the EIS will analyze in detail.

As part of scoping, Seattle Public Utilities holds at least one public scoping meeting to present the project to the public and offer the opportunity to ask questions and submit comments. Seattle Public Utilities must provide a minimum 21-day comment period during scoping. If the project is particularly complex or controversial, SPU may choose to provide an extended 30-day comment period. We will accept comments by mail, email, and in person at a public scoping meeting.

To meet SEPA requirements for notification, SPU must file a notice of scoping with the City of Seattle's SEPA Public Information Center

In addition, it is good practice to take the following steps to inform community members of scoping-related involvement opportunities:

- Place display advertisements in community newspapers and blogs at least 15 days before the first scoping meeting
- Mail postcard notification to residences and businesses in potentially affected neighborhoods
- Do outreach through community organizations
- Place display advertisements in foreign-language publications to reach limited English-proficient populations, if demographic analysis suggests this is necessary.

Following the comment period, SPU will prepare a scoping report to document comments received during the formal scoping period, as well as a summary of briefings held during the scoping process. The report also will be posted on the project website.

Draft Environmental Impact Statement (Draft EIS) – The Draft EIS provides a detailed analysis of project alternatives, potential impacts and mitigation measures. Seattle Public Utilities will host at least one formal public hearing at which the public will have an opportunity to review the findings of the Draft EIS and offer formal comments, recorded by a court reporter. The hearing will be conducted between 21 days and 50 days after the Draft EIS is issued.

Seattle Public Utilities must provide a minimum 21-day comment period upon release of the Draft EIS. If the project is particularly complex or controversial, we may choose to provide an extended comment period of 30 to 45 days.

In addition, SPU will take the following steps to inform community members of Draft EIS-related public involvement opportunities:

- Publish legal notice of the Draft EIS and public hearings in a newspaper with general circulation (e.g.: *The Daily Journal of Commerce*) no later than 10 days before the public hearing.
- Place display ads in at least one relevant community newspaper, no later than 10 days before the public hearing.
- Mail notice of the Draft EIS issuance to the project database.

Upon publication, Seattle Public Utilities will file the Draft EIS with the City's SEPA Public Information Center.

Final Environmental Impact Statement (Final EIS) – The Final EIS responds to all comments submitted by the public, tribes and agencies on the Draft EIS.

To meet SEPA requirements for notification, SPU’s notification of publication of the Final EIS and comment period will include but is not limited to:

- Submitting notice of the Final EIS and procedures for appeal in a newspaper with general circulation (e.g., *The Daily Journal of Commerce*).
- Placing display ads in at least one community newspaper that serves the community affected by the proposed project, no later than 10 days prior to the public hearing.
- Mailing notice of the Final EIS issuance to the project database, including anyone who submitted comments on the Draft EIS or who received the Draft EIS but did not comment.

Upon publication, SPU will file the Final EIS with the City's SEPA Public Information Center, and it will be published in the SEPA Register.

2.7 Public Engagement Tools and Tactics

The following section describes each public engagement tool and tactic available to Seattle Public Utilities. The decision about which tools and tactics to incorporate into a public engagement plan depend upon a few factors:

1. Who the stakeholders are
2. The extent to which the project is expected to affect stakeholders (long-term and short-term)
3. The type of project (long-term control plan, facility siting or natural stormwater management)
4. Whether or not the project is undergoing a SEPA environmental review process, in which case it is subject to specific public engagement requirements as described in the previous section

In subsequent chapters of these public engagement guidelines, we incorporate these tools and tactics into a step-by-step approach for conducting public engagement. Chapter 5 describes the step-by-step public engagement process for siting an underground facility, and Chapter 6 describes the step-by-step public engagement process for siting a natural stormwater management project.

2.7.1 Public information or one-way communications

Seattle Public Utilities will use some or all of the following tools to increase public understanding of the seriousness, urgency and scope of the sewage and stormwater pollution problem and the value and benefits of Protecting Seattle's Waterways. SPU also will use these tools to share information about specific Protecting Seattle's Waterways projects.

Tool	Description	Audience(s)	Type of project	Timing
Media Relations	Media relations includes outreach to print and online newspapers, radio and television stations and micromedia. Examples of micromedia include community newsletters, blogs, Facebook pages and websites for organizations in the project area. According to public opinion research conducted for Protecting Seattle's Waterways, most people get their information about sewage and stormwater pollution and water quality issues from the media. Proactive and creative media relations can help SPU disseminate key messages about Protecting Seattle's Waterways and the purpose and need of a specific project. It can also help prevent misconceptions about Protecting Seattle's Waterways. Media relations is also an effective tool for informing the public about the public involvement process and upcoming public involvement activities.	• All audiences	• LTCP • Rate increases • Projects with high or broadly distributed impacts • Projects that affect LEP populations • Natural stormwater management projects	• Project inception • Scoping • Evaluation of alternatives • Publication of Draft EIS • Selection of preferred alternative • Publication of Final EIS • Pre-construction • During construction

Tool	Description	Audience(s)	Type of project	Timing
Design visualization	Design visualizations are illustrations or animations that help people visualize a project or concept. Design visualizations can be used in multiple ways. They can help illustrate the nature of the sewage and stormwater pollution problem. They can show how different project alternatives may affect a community during construction or look after construction. For complex or controversial projects, design visualizations can be a useful tool to build understanding of the project purpose and need and alternatives. Because they are visual tools for building understanding, design visualizations are also a good tool for sharing information with limited-English proficient populations.	• Affected residents • Affected businesses • Community and neighborhood groups • Parks users and advocates • LEP populations • Internal staff, executive managers and advisory boards • Elected officials • Other project stakeholders	• LTCP • Projects with high impacts or complex projects • Projects that affect LEP populations • Natural stormwater management projects	• Evaluation of alternatives • Design • Pre-construction

Tool	Description	Audience(s)	Type of project	Timing
Information kiosk/Project sign	Information kiosks or project signs are places throughout an affected neighborhood where Seattle Public Utilities posts information about the project purpose and need, decision-making process, upcoming public involvement activities, construction information and project updates. These can be located on existing bulletin boards at parks, libraries and community centers or they can be kiosks set up by Seattle Public Utilities (with the permission of the property owner, Parks, SDOT). Information kiosks/project signs are a good tool for reaching audiences who may not attend public meetings or check the project website. Information kiosks should be updated at each project milestone.	• Affected residents • Affected businesses • Community and neighborhood groups • Parks users and advocates • Other project stakeholders	• Projects with high impacts • Projects in Parks • Projects under construction	• Project inception • Scoping • Evaluation of alternatives • Publication of Draft EIS • Selection of preferred alternative • Publication of Final EIS • Pre-construction • During construction

Tool	Description	Audience(s)	Type of project	Timing
Listserv	A project listserv is a database of project stakeholders. The listserv is a great tool for distributing surveys; meeting invitations, agendas, summaries, and other project-related information. Stakeholders can sign up for the project listserv by emailing the designated Seattle Public Utilities email address.	• Affected residents • Affected businesses • Community and neighborhood groups • Parks users and advocates • SPU staff, executive managers and advisory board members • Elected officials • Other project stakeholders	• All Protecting Seattle's Waterways Projects	• Project inception • Scoping • Evaluation of alternatives • Publication of Draft EIS • Selection of preferred alternative • Publication of Final EIS • Pre-construction • During construction

Tool	Description	Audience(s)	Type of project	Timing
Paid newspaper advertisement	Newspapers, specifically the *Seattle Times* and *Daily Journal of Commerce*, are the primary media for required public notification of environmental process comment periods, hearings and announcements. Other local newspapers, such as the *Seattle Weekly* and *The Stranger,* provide added opportunity for public notification through display ads. The *Seattle P-I* is an option for posting online advertisements. Publications that serve ethnic communities are an important medium for reaching LEP populations. Seattle ethnic publications include: *International Examiner, Phuong Dong Times, Siete Dias, Northwest Asian Weekly, The Facts,* and *The Seattle Medium.* The ad purchase typically includes translation.	• All audiences	• Projects undergoing a SEPA environmental process	• Scoping • Publication of Draft EIS • Publication of Final EIS

Tool	Description	Audience(s)	Type of project	Timing
Website	The project website is a primary means of sharing project information with the public and providing a tool for obtaining feedback about the project. The project website should be updated at each project milestone from project inception through design to ensure timely access to current project information. Once a project has entered construction, we recommend updating it periodically with photos of progress and information about what the community can expect to see, hear and do during construction. The website address should be printed on all communication pieces. Website content typically includes the purpose of the project and project benefits, a description of the project, a schedule and timeline, workshop and open house information and summaries, community briefing presentations, frequently asked questions, and project contact. If translated materials are available on a project website, there should be a message *at the top of the main project webpage* indicating that in the target language(s) that translated information is available.	• All audiences	• All Protecting Seattle's Waterways projects (except short duration/low impact projects such as retrofits)	• Project inception • Scoping • Evaluation of alternatives • Publication of Draft EIS • Selection of preferred alternative • Publication of Final EIS • Pre-construction • Continuous updates during construction

2.7.2 Public engagement or two-way communications

Seattle Public Utilities project staff will use any or all of the following tools to engage the public and stakeholders in the decision-making process.

Tool	Description	Audience(s)	Type of project	Timing
Community/ Neighborhood Briefings	Briefings or presentations to groups of residents and businesses in the affected neighborhood are a good way to build trusting relationships, develop project champions, and to provide accurate, updated project information in a more intimate setting than a larger public meeting. Briefings in advance of a public involvement opportunity – such as a public meeting or interactive workshop – also allow Seattle Public Utilities to surface potential concerns early, so they can be addressed and do not derail the public meeting. Seattle Public Utilities project staff will offer briefings to community residents and businesses early in the project to introduce the project purpose and need and decision-making process. Seattle Public Utilities staff will offer briefings at key project milestones, such as just before public meetings, to keep neighbors informed on the project progress and encourage participation in the workshops and open houses.	• Affected residents • Affected businesses • Community and neighborhood groups • Elected officials	• LTCP • Projects with high or complex impacts • Natural stormwater management projects • Projects entering or under construction	• Project inception • Scoping • Evaluation of alternatives • Selection of preferred alternative • Pre-construction • Construction

Tool	Description	Audience(s)	Type of project	Timing
Brown bag presentations	These are internal gatherings at lunch to present the most current project information and messaging to internal staff and advisory boards.	• Internal staff and advisory boards	• LTCP • Projects with high or complex impacts • Natural stormwater management projects • Projects entering or under construction	• Project inception • Scoping • Evaluation of alternatives • Selection of preferred alternative • Pre-construction • Construction
Door-to-door outreach	This is often a good first step in a potentially controversial project. Door-to-door outreach offers Seattle Public Utilities the opportunity to introduce the project and designated staff as the primary point of contact, should residents or businesses have concerns or questions. Door-to-door outreach should also be conducted before and during construction.	• Affected residents • Affected businesses	• LTCP • Projects with high or complex impacts • Natural stormwater management projects • Projects entering or under construction	• Project inception • Design • Pre-construction • During construction

Tool	Description	Audience(s)	Type of project	Timing
Hearing	A hearing is a formal meeting that is required as part of the public's opportunity to participate and comment on findings during a SEPA environmental process. Seattle Public Utilities will host a hearing during a Draft EIS comment period. The meeting will provide the public with ability to review the findings of the Draft EIS. A court reporter is required to take official public comment. Comments may also be submitted in writing at the meeting. Hearings will be held at ADA- and transit-accessible, publicly-owned facilities in the affected neighborhood.	• Affected residents • Affected businesses • Community and neighborhood groups • Parks users and advocates • Tribes • Internal Seattle Public Utilities staff, Executive Managers, and advisory groups • Elected officials • Seattle Parks Department and Department of Transportation staff • King County Wastewater Treatment Division (WTD) • Other project stakeholders	• Projects undergoing a SEPA environmental process	• Publication of Draft EIS

Tool	Description	Audience(s)	Type of project	Timing
Tabling outreach	Seattle Public Utilities project staff can host outreach tables at parks, in front of grocery stores, at community fairs and festivals, and farmers markets. This is a great way to reach community members who are not yet engaged in the project. Seattle Public Utilities project staff can hold one-on-one outreach at the beginning of a project to inform community members about the project purpose and need, decision-making process, alternatives under consideration, and public involvement opportunities. One-on-one outreach can also take place during the alternatives analysis, to gather feedback on each alternative. One-on-one outreach is also a good tactic in advance of construction, to prepare the community for construction impacts.	• Affected residents • Affected businesses • Community and neighborhood groups • Parks users and advocates • Historically-underserved populations	• Projects with high or complex impacts • Projects that affect historically-underserved populations • Projects entering construction	• Project inception • Scoping • Evaluation of alternatives Selection of preferred alternative • Pre-construction

Tool	Description	Audience(s)	Type of project	Timing
Online open house	Online open houses supplement in-person open houses and provide a convenient, accessible option for people who are unable or unwilling to attend an in-person meeting. An online open house is conducted in real time using webinar software. Participants register for the event by following the link from the listserv e-mail or typing the link into the search bar. After registering, participants receive an e-mail confirmation containing specific participation instructions. Once logged into the online open house, participants have access to a library of information and further instructions on how to participate in the meeting. Similar to an in-person open house, users can log on and participate at any point during the online open house. Meeting materials are similar to those developed for the in-person open houses, re-formatted for online delivery. Periodic presentations will welcome participants and provide a brief overview via webcast. Participants are able to view the webcast on their screen and listen to it using their computer speakers or by dialing into the meeting on their telephone. Using the control panel on their screen, participants are able to type and send questions and receive answers from Seattle Public Utilities staff. Online open houses can be held in conjunction with in-person open houses for scoping and the formal hearing for the draft EIS.	• Affected residents • Affected businesses • Community and neighborhood groups • Parks users and advocates • Tribes • Internal Seattle Public Utilities, staff, Executive Managers, and advisory boards • Elected officials • Seattle Parks Department and Department of Transportation staff • WTD • Other project stakeholders	• LTCP • Projects undergoing a SEPA environmental process • Projects with high or complex impacts	• Scoping • Publication of Draft EIS
Open house	Open houses are an opportunity for the public to speak one-on-one with project staff and provide comments on a project. The purpose of an open house	• Affected residents • Affected	• LTCP • Projects undergoing a	• Scoping • Scoping • Evaluation of

Tool	Description	Audience(s)	Type of project	Timing
	is to share information with and gather feedback from the affected residents and stakeholders. Open houses should be held in conjunction with project milestones, such as scoping, finalizing project alternatives, confirming a preferred alternative, and pre-construction. Seattle Public Utilities can hold open houses early in the project to inform the community of the project purpose and need, explain the decision-making and public involvement process, and gather feedback on the “scope” of alternatives, impacts, and potential mitigation measures. An open house can be held again to present an evaluation of project alternatives to the community, demonstrate the role of community input in the identification alternatives, and present proposed mitigation to the community. Open houses can be held before construction to communicate construction-related information; gather feedback on ways to lessen the impact of construction-related activities to inform development of construction plans; and prepare the community for the start of construction. With open house style meetings, people can show up at any point during the event. Materials, including display boards, fact sheets, and PowerPoint presentations translate complex and detailed information into simple language and graphics. Key project team members are available to answer questions and address individual issues and concerns. Often, a senior member of Seattle Public Utilities staff gives an overview presentation. Public comments are	businesses • Community and neighborhood groups • Parks users and advocates • Internal staff, executive managers, and advisory boards • Other project stakeholders	SEPA environmental process • Projects with high or complex impacts • Natural stormwater management projects • Projects under construction	alternatives • Design • Pre-construction • Construction

Tool	Description	Audience(s)	Type of project	Timing
	collected and included in the project record. Open houses should be held at ADA- and transit-accessible, publicly-owned facilities in the affected neighborhood if possible.			
Site tour or "On-Site Walk and Talks"	Site tours provide an opportunity to build understanding of the project purpose and need, potential impacts, and how it will look and operate when complete. It is also an opportunity for Seattle Public Utilities to gather input from the affected community about the site. Seattle Public Utilities staff can hold site tours of the potential sites under consideration for a project or of existing similar projects, to help community members visualize the potential impacts of construction and what the project might look like when completed.	• Affected residents • Affected businesses • Community and neighborhood groups • Parks users and advocates • Other project stakeholders	• LTCP • Projects with high or complex impacts • Natural stormwater management projects	• Scoping • Evaluation of alternatives Design • Pre-construction

2.7.3 Printed Materials

To ensure that all printed materials for Protecting Seattle's Waterways projects are easily recognizable and consistent in messaging, printed materials will adhere to Protecting Seattle's Waterways key messages described in 2.4 Key Messages. Print materials should always include project contact information including a contact person's name, phone number, email, program website, and a language block for interpretation services. Print materials can be distributed at public meetings, project briefings, and other project-related events. They can also be displayed at information kiosks and on bulletin boards at parks and community gathering places throughout the affected neighborhood.

Tool	Description	Audience(s)	Type of project	Timing
Community Guide to the EIS and Project Alternatives	The community guide, developed during the scoping process and updated prior to the draft EIS, provides an overview of the environmental review process, including the project purpose and need, timeline, alternatives under consideration, and public engagement opportunities. Distribution: project listserv, website, public meetings, information kiosks, one-on-one outreach, briefings.	• Affected residents • Affected businesses • Community and neighborhood groups • Parks users and advocates • Tribes • Internal Seattle Public Utilities staff and advisory boards • Elected officials • Seattle Parks Department and Department of Transportation staff • King County WTD • Other project stakeholders	• Projects undergoing a SEPA environmental process	• Scoping • Publication of the Draft EIS

Tool	Description	Audience(s)	Type of project	Timing
Decision-making process graphic	The decision-making process graphic describes project milestones, when and how decisions will be made, who will be making decisions, and when and how the public will have opportunities to provide input. This graphic should be developed at the beginning of every Protecting Seattle's Waterways project. Distribution: project listserv, website, public meetings, information kiosks, one-on-one outreach, briefings, media relations.	• Affected residents • Affected businesses • Community and neighborhood groups • Parks users and advocates • Tribes • Seattle Public Utilities staff, executive managers, and advisory boards • Elected officials • Seattle Parks Department and Department of Transportation staff • WTD • Other project stakeholders	• All Protecting Seattle's Waterways projects	• Project inception

Tool	Description	Audience(s)	Type of project	Timing
Display boards	Display boards are used at public meetings to describe the project and alternatives under consideration.	• Affected residents • Affected businesses • Community and neighborhood groups • Parks users and advocates • Tribes • Seattle Public Utilities staff, executive managers, and advisory boards • Elected officials • Seattle Parks Department and Department of Transportation staff • WTD • Other project stakeholders	• Projects undergoing a SEPA environmental process	• Scoping • Alternatives analysis • Pre-construction

Tool	Description	Audience(s)	Type of project	Timing
E-newsletter	Protecting Seattle’s Waterways is developing an electronic newsletter. Electronic newsletters provide an opportunity to update project stakeholders about the decision-making process, public input received to date and how that input is being incorporated into decisions, and upcoming public involvement opportunities. Distribution: project listserv. Project managers and communications staff should utilize this resource whenever possible.	• Affected residents • Affected businesses • Community and neighborhood groups • Parks users and advocates • Tribes • Seattle Public Utilities staff, executive managers, and advisory boards • Elected officials • Seattle Parks Department and Department of Transportation staff • WTD • Other project stakeholders	• LTCP • Projects with high or complex impacts • Natural stormwater management projects	• Project inception • Scoping • Alternatives analysis • Publication of the Draft EIS • Selection of the preferred alternative • Publication of the Final EIS • Pre-construction • During construction

Tool	Description	Audience(s)	Type of project	Timing
Fact sheet	A project fact sheet provides the project purpose and need, descriptions of each project alternative, ways to provide comment, and upcoming public engagement opportunities. Distribution: project website, public meetings, information kiosks.	• Affected residents • Affected businesses • Community and neighborhood groups • Parks users and advocates • Tribes • Seattle Public Utilities staff and advisory boards • Elected officials • Seattle Parks Department and Department of Transportation staff • WTD • Other project stakeholders	• All Protecting Seattle's Waterways Projects	• Project inception • Scoping • Alternatives analysis • Publication of the Draft EIS • Selection of the preferred alternative • Publication of the Final EIS • Pre-construction • During construction

Tool	Description	Audience(s)	Type of project	Timing
Frequently Asked Questions (FAQs)	FAQs address common questions or concerns from the public. FAQs should be updated frequently to incorporate any emerging questions or concerns. Distribution: project website, public meetings, information kiosks	• Affected residents • Affected businesses • Community and neighborhood groups • Parks users and advocates • Seattle Public Utilities staff and advisory boards • Elected officials • Seattle Parks Department and Department of Transportation staff • WTD • Other project stakeholders	• All Protecting Seattle's Waterways Projects	• Project inception • Scoping • Alternatives analysis • Publication of the Draft EIS • Selection of the preferred alternative • Publication of the Final EIS • Pre-construction • During construction

Tool	Description	Audience(s)	Type of project	Timing
Introductory letter	According to research, many people prefer to get information about Protecting Seattle's Waterways through the mail. Whenever possible, Seattle Public Utilities should work with a professional bulk mailhouse to get the names and addresses of residents, businesses, and property owners in an affected area and conduct an electronic mail merge to personalize letters. These letters can be used to introduce the project purpose and need, describe the decision-making process and public involvement opportunities, and prepare communities for construction. Although it is more resource intensive than bulk mail, personalized letters may deliver more bang for the buck if they are read rather than discarded. The introductory letter should include the following: • Introduce the project purpose and need • Describe the proposed solution • Introduce a contact person should residents or businesses have questions or concerns • Ask residents to contact Protecting Seattle's Waterways if they have questions or would like a one-on-one briefing • If it is a Roadside Rain Gardens project, the introductory letter should include a brief survey about concerns and issues that should be considered during the siting process, such as basement flooding.	• Affected residents • Affected businesses • Affected property owners	• Projects with high or complex impacts • Natural stormwater management	• Project inception • Scoping • Alternatives analysis • Publication of the Draft EIS • Selection of the preferred alternative • Publication of the Final EIS • Pre-construction • During construction

Tool	Description	Audience(s)	Type of project	Timing
Project timeline	The project timeline provides a graphic overview of key milestones and corresponding public involvement opportunities. Distribution: the timeline should appear on key project materials, including display boards and fact sheets.	• Affected residents • Affected businesses • Community and neighborhood groups • Parks users and advocates • Tribes • Seattle Public Utilities staff, executive managers, and advisory groups • Elected officials • Seattle Parks Department and Department of Transportation staff • WTD • Other project stakeholders	• All Protecting Seattle's Waterways projects	• Project inception

2.7.4 Joint Seattle Public Utilities-King County Materials

Seattle Public Utilities and King County will develop and regularly update a fact sheet to explain the actions both agencies are taking to reduce sewage overflows in Seattle. Seattle Public Utilities and King County will distribute this brochure or fact sheet at public meetings, post it on their respective websites, and share them with stakeholders in common, such as the media. Seattle Public Utilities and King County will also present this information on a display board at joint public meetings.

Topics to cover include:

- What sewage overflows are and why they are a problem
- Map of outfalls managed by both agencies, with first and secondary responsibilities identified
- Brief explanation of why sewage overflows in Seattle are managed by both Seattle Public Utilities and King County
- Explanation of how the two agencies work together
- Description of sewage overflow prevention tools and technologies
- Snapshot of Seattle Public Utilities and King County key statistics, including annual volume of overflow discharged by each system and average number of sewage overflows annually
- Joint timeline showing each agency's schedule for sewage pollution prevention projects
- Information about how to learn more and get involved

Future joint publications may include:

- Map showing each agency's sewage pollution prevention projects
- Consolidated schedule of all projects
- Information on rate increases and combined program rate information, including the regional cost of sewage pollution prevention and the per-homeowner cost of sewage pollution prevention

2.7.5 Construction Communications

- **Construction Contact –** When a project is under construction, the project manager (PM) is the point of contact. The PM's phone number or a construction hotline number (managed by the PM) should be visible on signage placed at the construction site, on all project communications and project website. The phone number should also be distributed to all project stakeholders, especially those living or doing business in close proximity to construction. Calls should be returned within one business day and a log of calls received and responses should be kept.

Chapter 3 – Stakeholder Audiences

This chapter describes the individuals, groups, and organizations that will be affected in some way by Protecting Seattle's Waterways.

3.1 Stakeholder identification

In order to gain Informed Consent and manage risk, it is critical to identify all potential stakeholders in an equitable manner and engage them early in the decision-making process. These stakeholders can be individuals, groups, businesses, organizations, public agencies or public officials. Affected stakeholders include those who may be affected by the project and those who think they may be affected. 4.3 Identify and analyze stakeholders and create a community profile provides step-by-step guidance for identifying potential stakeholders.

3.2 Stakeholder Analysis

Stakeholders for Protecting Seattle's Waterways projects will vary in how much they will participate in the decision-making process. Their level of participation will depend on a number of factors, including:

1. The potential for a Protecting Seattle's Waterways project to benefit or harm them or a resource they care about
2. Their level of responsibility for participating in the decision-making process
3. Their ability to participate

In many cases, people or groups will need to learn more about the Protecting Seattle's Waterway project before determining the level of participation appropriate for them.

In other cases, the Neighborhood District Council or Neighborhood Plan has identified the project or problem, so an interested stakeholder group already exists.

The following table describes each potential stakeholder audience for Protecting Seattle's Waterways, their likely issues and concerns, what a win would look like, and appropriate outreach strategies and tactics. We have organized the table by likely level of involvement in the public participation process, based on the extent to which each stakeholder group is likely to be affected by Protecting Seattle's Waterways projects.

Stakeholder group	Issues and concerns	What a win would look like	Outreach tools and tactics
High level of involvement			
Residents, property owners and neighborhood groups near or adjacent to a Protecting Seattle's Waterways project	• Potential project could permanently affect neighborhood aesthetics or park • Perceived or real operation impacts, including noise, odor, maintenance, loss of street parking, new signage, safety and mosquitoes (Roadside Rain Gardens) • Construction impacts, including noise, traffic, visual impacts, dust, access • Impacts on property value • Property acquisition, including temporary and permanent easements • Confusion or lack of clarity about the decision-making process and how residents, property owners and neighborhood groups can influence decisions	• People in the neighborhood are aware of the project early on and know whom to talk to if they have questions or concerns • Project information is clear, timely and accurate • People feel their concerns have been heard and considered by Seattle Public Utilities • People believe they can live with the selected alternative and proposed mitigation • People trust SPU to construct and maintain a successful project	• Local stakeholder group • Community Guide to EIS and Project Alternatives • Micromedia • Decision-making process graphic • Design visualizations • Door-to-door outreach • E-Newsletter • Fact sheet • FAQs • Google map tool • Hearings • Information kiosk • Project signage • Interactive community workshops • Neighborhood briefings • One-on-one outreach • Open houses • Personalized letters • Project timeline • Site tours • Website

Stakeholder group	Issues and concerns	What a win would look like	Outreach tools and tactics
Parks users and -advocacy groups for parks near or adjacent to a Protecting Seattle's Waterways project	• Potential project could permanently affect park • Operation impacts, including noise and odor • Construction impacts, including noise, traffic, view, dust, access • Questions about the decision-making process and how parks users and advocacy groups can influence decisions	• Parks users and advocacy groups are aware of the project early on and know whom to talk to if they have questions • Parks users and advocacy groups are aware of the decision process and know when and how their input will be considered and addressed • Project information is clear, timely and accurate • Parks users and advocacy groups feel that all reasonable and feasible alternatives have been carefully considered • Parks users and advocacy groups believe they can live with the selected alternative and construction impacts	• Local stakeholder group • Community Guide to EIS and Project Alternatives • Micromedia • Decision-making process graphic • Design visualizations • E-Newsletter • Fact sheet • FAQs • Google map tool • Hearings • Information kiosk • Interactive community workshops • One-on-one outreach • Open houses • Personalized letters • Project timeline • Site tours • Stakeholder briefings • Website

Stakeholder group	Issues and concerns	What a win would look like	Outreach tools and tactics
Businesses near or adjacent to a Protecting Seattle's Waterways project	• Potential impacts on businesses, including parking, access, traffic, noise, visual effects • Questions about the decision-process and how businesses can influence decisions	• Business owners/managers are aware of the project early on and know whom to talk to if they have questions or concerns • Business owners/managers understand the decision process and know when and how their input will be considered • Project information is clear, timely and accurate • Business owners/managers feel their concerns have been heard and considered by Seattle Public Utilities • Business owners/managers believe they can live with the selected alternative and construction impacts	• Local stakeholder group • Community Guide to EIS and Project Alternatives • Micromedia • Decision-making process graphic • Design visualizations • Door-to-door outreach • E-Newsletter • Fact sheet • FAQs • Google map tool • Hearings • Information kiosk • Neighborhood briefings • One-on-one outreach • Open houses • Personalized letters • Project timeline • Site tours • Website

Stakeholder group	Issues and concerns	What a win would look like	Outreach tools and tactics
Historically underserved populations (people living in low-income households, minorities, limited-English proficient residents, people living with disabilities) who will be affected by a Protecting Seattle's Waterways project	• Impact of rate increases • Fear of, discomfort with, or obstacles to participating in decision-making process • Potential construction- and operation-related impacts, including noise, traffic, dust, visual effects, odors, property acquisition, impacts to parks, access to homes	• Historically underserved populations who will be affected by a project are aware of the project or rate increase early on • They understand the decision process and know when and how their input will be addressed • Public involvement opportunities are frequent, accessible, convenient and comfortable for historically underserved populations • Project information is clear, timely, accurate, and accessible for historically underserved populations • Historically underserved populations who will be affected by a project feel their concerns have been heard and addressed by Seattle Public Utilities • Historically underserved populations believe they can live with the selected alternative • Historically underserved populations who will be affected by rate increases understand the options for payment assistance	• Partnerships with community-based organizations that serve historically underserved populations • Media relations to ethnic media • Community Guide to EIS and Project Alternatives (translated) • Decision-making process graphic (translated) • Design visualizations • Fact sheet (translated) • FAQs (translated) • Google map tool • Hearings (with interpreters) • Information kiosk • Interactive community workshops • Interactive workshops that are designed to accommodate language differences, child care needs, disabilities and cultural sensitivity • Transit and ADA-accessible community meetings • Neighborhood briefings • One-on-one outreach • Open houses • Personalized letters • Project timeline • Site tours • Website

Stakeholder group	Issues and concerns	What a win would look like	Outreach tools and tactics
People who will always object to the project (refer to 3.5 Strategies for addressing stakeholders who consistently oppose a project for more information on reaching this group)	• Past negative experiences with Seattle Public Utilities or another public agency • Distrust of SPU or government in general • Perceived or real construction or operation impacts • Concerns about the cost of the project or use of ratepayer dollars • Belief that sewage overflow prevention is not the best way to address water quality issues	• Some members of the group are persuaded • Other groups acknowledge or praise SPU's efforts to reach out to those in opposition	• One-on-one meetings • Alternatives to public meetings, such as door-to-door outreach • Local stakeholder group to counterbalance • Media and micromedia outreach • Listserv • Website

Stakeholder group	Issues and concerns	What a win would look like	Outreach tools and tactics
Neighborhood District Councils (NDC), Community Councils, and Neighborhood District Coordinators including but not limited to: • **Ballard NDC** • **Central Area NDC** • **Delridge NDC** • **East NDC** • **Greater Duwamish NDC** • **Lake Union NDC** • **Madison Park Community Council** • **Magnolia/Queen Anne NDC** • **Northeast NDC** • **Portage Bay/Roanoke Community Council** • **Southeast NDC**	• The decision-making process and how residents and community groups can influence decisions? • Potential impacts on the neighborhoods they serve or represent? • Managing concerns • At what point in the process will public comment be invited? • When will public meetings occur?	• Clear understanding of the decision process and how community input will be gathered and addressed • Information about the project and its effects are clear and timely • Meaningful involvement for people in the neighborhood • Neighborhood District Coordinators and Councils receive ongoing feedback about how stakeholders' viewpoints are being considered and addressed	• One-on-one briefings • Briefings at regular meetings • Listserv • Website

Moderate level of involvement			
Residents, property owners, businesses and community groups in the sewage and stormwater pollution basin	• How the project will benefit the community • Construction impacts that could affect the wider community, such as traffic congestion • Cumulative effects of multiple projects • Understanding of overall area drainage and wastewater status, plans, limitations, etc.	• Basin stakeholders receive information about the project early on, and regular communications as needed • Benefits to the community are communicated clearly and accurately, using supportive data • Stakeholders believe their input is being considered and addressed • Communication efforts are coordinated among multiple projects in the area	• Local stakeholder group • Community Guide to EIS and Project Alternatives • Community-based media • Decision-making process graphic • Design visualizations • E-Newsletter • Fact sheet • FAQs • Google map tool • Hearings • Information kiosk • Interactive community workshops • Neighborhood briefings • One-on-one outreach • Open houses • Personalized letters • Project timeline • Website

Environmental groups including but not limited to: • **Duwamish Alive!** • **Duwamish River Cleanup Coalition** • **Environmental Coalition of South Seattle** • **Groundswell NW** • **People for the Puget Sound** • **Puget Soundkeeper Alliance** • **Sustainable South Seattle**	• Potential benefits and impacts to environment or a specific environmental resource • Given limited resources, some environmental groups may not be persuaded that sewage and stormwater pollution prevention is the most effective way to address water quality • What is the decision process and how can environmental groups influence decisions • Sewage and stormwater pollution reduction levels and water quality benefits from sewage and stormwater pollution reduction • Opportunities to promote natural stormwater management	• Relevant environmental groups are aware of the project early on • Environmental groups are aware of the decision process and know when and how their input will be considered and addressed • Project information is clear, timely, and accurate • Environmental groups have data to demonstrate that the selected alternative provides a reasonable amount of benefits to the environment or a specific environmental resource • Environmental groups understand that sewage and stormwater pollution prevention is part of a system-wide approach to addressing water quality	• Community Guide to the EIS and Project Alternatives • Decision-making process graphic • E-newsletter • Fact sheet • FAQs • Google map tool • Interactive workshops • Listserv • Roundtable discussions • Stakeholder briefings

Tribes • **Muckleshoot Indian Tribe** • **Duwamish Tribe** • **Snoqualmie Tribe** • **Suquamish Tribe** • **Tulalip Tribes** • **Puyallup Tribe**	• Effects of sewage and stormwater pollution on fish and aquatic habitat in usual and accustomed tribal fishing areas • Access to usual and accustomed fishing areas during construction • Benefits to water quality in tribal fishing areas • SPU stewardship responsibilities	• Protecting Seattle's Waterways projects deliver tangible benefits to water quality in tribal fishing areas • Tribes are informed of and engaged in decision-making process	• Personal letters • One-on-one meetings with a Seattle Public Utilities Executive • Community Guide to the EIS and Project Alternatives • Decision-making process graphic • E-newsletter • Fact sheet • FAQs • Google map tool • Interactive workshops • Listserv • Roundtable discussions • Stakeholder briefings

Limited level of involvement			
Seattle Public Utilities Ratepayers	• Rate increases to pay for Protecting Seattle's Waterways • Impacts on low-income households • Some may believe that sewage and stormwater pollution prevention is not be the most effective way to address water quality	• Ratepayers agree that there is a problem and sewage and stormwater pollution prevention is the right solution • Ratepayers agree that Seattle Public Utilities is the appropriate agency to address sewage and stormwater pollution prevention • Ratepayers feel that they are getting something valuable for their rate increase • Ratepayers understand that this is part of a system-wide approach to addressing water quality	• Fact sheet • FAQs • Media relations • Paid advertising • Partnerships with environmental and advocacy organizations • Seattle Public Utilities newsletter • Website

Media	• Tell a compelling story • Provide public with valuable, timely, accurate information	• Positive media coverage or editorial endorsement of Protecting Seattle's Waterways • Seattle Public Utilities provides accurate, timely information to media and responds to questions and concerns quickly and honestly • Seattle Public Utilities provides data and illustrative stories to convey the seriousness, urgency, and scope of the sewage and stormwater pollution problem and benefits of Protecting Seattle's Waterways	• Fact sheet • Media relations • Website
Business organizations, including but not limited to: • **Greater Seattle Chamber of Commerce** • **Downtown Waterfront Businesses** • **Seattle Marine Business Coalition** • **Local Chambers of Commerce** • **Labor**	• Impacts of rate increases on commercial customers • Jobs and economic opportunities associated with infrastructure projects • Potential effects of project construction and operation on access, traffic	• Rate increases and the benefits that they will purchase are clearly and accurately communicated • Jobs and economic benefits associated with projects are quantified • Businesses in affected areas receive timely, accurate information about impacts and mitigation	• Briefings • Listserv • Website

Partners and Collaborators			
Seattle Public Utilities staff and leadership	• Potential benefits and impacts to Seattle Public Utilities customers • Responsibilities as public service organization • Financial and technical feasibility of project • Public perceptions of Seattle Public Utilities • What is the decision process and roles of individual SPU staff and leaders in making decisions	• Seattle Public Utilities staff and leadership are aware of decision process and their role in process • Decision making is transparent • Public is persuaded they can live with selected alternative • Selected alternative is technically feasible and meets triple bottom line	• Decision-making process graphic • Fact sheet • FAQs • Internal briefings and brownbag presentations • Listserv • Website
Seattle Public Utilities Advisory groups • **LTCP Sounding Board** • **Creeks, Drainage, and Wastewater Advisory Committee**	• Potential benefits and impacts to Seattle Public Utilities customers • Financial feasibility of project • What is the decision-process and roles of individual Seattle Public Utilities staff and leaders in making decisions	• Seattle Public Utilities Advisory groups are aware of decision process and their role in process • Decision making is transparent • Public is persuaded they can live with selected alternative • Selected alternative is financially and technically feasible	• Briefings at project inception and key milestones • Decision-making process graphic • Fact sheet • FAQs • Listserv • Website

Seattle Parks Department (Parks), Department of Transportation (SDOT), Department of Neighborhoods (DON), and Department of Planning and Development (DPD)	• Potential impacts to parks, neighborhoods, and transportation resources • Opportunities to realize multiple benefits • Parks, SDOT, DON, and DPD's role in the decision making process and how their role should be messaged to the public	• Parks, SDOT, DON and DPD are aware of the decision-making process and their role in that process • Decision-making is transparent • There are opportunities to leverage Protecting Seattle's Waterways to achieve the goals of other City departments and initiatives • Communications between departments and with the public is coordinated and consistent	• Briefings at project inception and key milestones • Decision-making process graphic • Fact sheet • FAQs • Listserv • Website
King County Wastewater Treatment Division (WTD)	• Public confusion about which agency is responsible for each sewage pollution project • Potential impact of Seattle Public Utilities sewage pollution-related public engagement and communications on King County's efforts	• Public understands that Protecting Seattle's Waterways is part of a *system-wide* approach to addressing water quality • Seattle Public Utilities messaging complements, rather than undermines or confuses King County message • SPU and King County demonstrate that processes are coordinated	• Briefings at project inception and key milestones • Decision-making process graphic • Fact sheet • FAQs • Listserv • Website

Mayor's Office	• Solves a problem • Ability to make informed decisions on projects when the Mayor's vote is required • How constituents will win or lose • Financial feasibility of project • Environmental legacy • Public perceptions of City of Seattle, Mayor • Program costs and impacts on rates • Sewage and stormwater pollution prevention that project will achieve • Opportunities for realizing multiple benefits, such as Mayor's Walk/Bike/Ride initiative or economic development opportunities	• Mayor's office has access to clear, accurate, timely and easy-to-understand information and conveys information about the project purpose and need, alternatives under consideration, and next steps • Mayor's office has documentation to support a full and fair public process that demonstrates that constituent concerns have been identified and their input has been considered and addressed in the decision-making process. • Mayor's office is invited to participate in discussions about achieving multiple benefits • Mayor's office has clear, current, and accurate information and data about program and project costs, expected reductions in sewage overflows and volumes, other potential benefits, and expected impacts on rates.	• Briefings • Decision-making process graphic • Fact sheet • FAQs • Listserv • Website

Council Members	• Solves a problem • Ability to make informed decisions on projects when their vote is required • How constituents will win or lose • Financial feasibility of project • Environmental legacy • Public perceptions of Seattle Public Utilities, City of Seattle, and elected officials	• Council and staff have access to clear, accurate, timely, and easy-to-understand and convey information about the project purpose and need, alternatives under consideration, and next steps • Council has documentation to support a full and fair public process that demonstrates that constituent concerns have been identified and their input has been considered and addressed in the decision-making process. • Chairs of Seattle Public Utilities and Department of Neighborhoods committees have clear, current, and accurate information and data about program and project costs, expected reductions in sewage overflows and volumes, other potential benefits, and expected impacts on rates.	• Briefings • Decision-making process graphic • Fact sheet • FAQs • Listserv • Website • Public involvement activities documentation (see **Chapter 7 – Public Engagement Evaluation and Reporting**)
Regulatory Agencies	• Compliance with federal, state, and local regulations and guidance related to public involvement	• Public involvement complies with federal, state, and local regulations and guidance	• Public involvement activities documentation (see **Chapter 7 – Public Engagement Evaluation** and Reporting

3.3 Outreach to historically underserved populations

Some Protecting Seattle's Waterways projects will affect historically underserved populations, which include low income, minority, and LEP residents of Seattle. Inclusive public outreach is a core guiding principle for SPU and Protecting Seattle's Waterways. Furthermore, the Mayor has directed all City of Seattle departments to apply the tools and principles of the Inclusive Outreach and Public Engagement Guide and the City Council passed a resolution in support of this initiative. Seattle Public Utilities offers multiple resources to help SPU project staff ensure that public engagement for Protecting Seattle's Waterways is inclusive.

The following section describes the historically underserved populations in the Seattle sewage and stormwater pollution basins, goals and objectives of inclusive outreach, key strategies for ensuring inclusive outreach, and resources to support inclusive outreach.

3.3.1 Demographic analysis of CSO basins

According to U.S. Census and National Center for Education Statistics (NCES) data, most of the Seattle CSO basins have minority LEP, and low-income populations. Refer to the City's Language and Interpretation InWeb site for language maps:

http://inweb/language/resources.htm

3.3.2 Goals and objectives of inclusive outreach

Goal A: Provide *all* affected residents with meaningful opportunities to influence decisions that affect their lives, regardless of race, ethnicity, income, or language

- Objective 1: Work with Seattle Public Utilities' Environmental Justice and Social Equity (EJSE) Division to develop a plan for inclusive engagement for projects that will affect low-income, minority or LEP populations
- Objective 2: Build ongoing and trusted partnerships with agencies and organizations that serve or represent low-income, minority and LEP residents
- Objective 3: Provide a range of public involvement opportunities and translation and interpretation services to help people overcome typical barriers to participation, such as work schedules, child care responsibilities, language barriers and mobility barriers
- Objective 4: Create a welcoming and comfortable atmosphere by honoring the affected community and working with community partners to design and facilitate culturally sensitive and inclusive public involvement opportunities.

Goal B: Achieve informed consent from *all* affected residents, including low-income, minority and LEP populations

- Objective 1: Engage historically underserved populations (low-income, minority and LEP) who will be directly affected by the project early in the public involvement process

- Objective 2: Coordinate with other City of Seattle and King County outreach efforts to ensure that neighborhoods and community-based organizations and agencies are not overwhelmed with requests

Goal C: Meet the City of Seattle's public involvement policies and requirements for outreach to historically underserved populations

- Objective 1: Follow or exceed all City policies with respect to translation and interpretation
- Objective 2: Conduct a Racial Equity Analysis prior to initiating any Protecting Seattle's Waterways project

3.3.3 Requirements for inclusive outreach

Equity planning: Seattle Public Utilities' EJSE Division has developed a number of tools to assist project teams with incorporating RSJI principles into their work, including the Stakeholder Analysis worksheet. The project team including representatives from EJSE and Communications Divisions should discuss and complete this worksheet prior to initiating a Protecting Seattle's Waterways project.

Translation and interpretation: It is the City of Seattle's policy that when conducting major projects in a neighborhood where 5 percent of the population consists of a specific language group based on current Census data, departments should translate and distribute documents relevant to the project in that language. Not all materials should be translated; consult with SPU EJSE or Communications Division.

Tailor intensity of outreach based on the likelihood that the project will have substantial and immediate impact on low-income, minority or LEP residents

To develop these guidelines, Seattle Public Utilities conducted a series of executive interviews with leaders and staff of community-based organizations that serve low-income, minority and LEP populations in Seattle. A key outcome from these interviews was that given the multiple issues and concerns that are top of mind for many historically underserved residents and the agencies that serve them, it is unlikely that these groups will turn out for Protecting Seattle's Waterways public meetings or read mailings unless the project is likely to have a *substantial* and *immediate* impact on them. In other words, even if there are low-income, minority or LEP residents in the affected basin, if the project impacts are far from where they live, work, or recreate or if there may be impacts but not for five to 10 years, it is unlikely to be a top-of-mind issue for them.

If, after completing the stakeholder analysis, Seattle Public Utilities determines that the project may have a substantial and immediate impact on low-income, minority or LEP residents, the program or project manager, SPU EJSE Division, and Communications Division, should develop strategies for informing and engaging these groups in a meaningful way. Recognize that it will take extra resources and effort to implement a truly inclusive public engagement process.

Revisit stakeholder analysis at project milestones and update inclusive outreach plan as needed

On the other hand, if the stakeholder analysis indicates that the project is unlikely to substantially and immediately affect these populations, the Community Outreach Lead should plan to carefully monitor the project as it progresses. The Community Outreach Lead should reevaluate the stakeholder analysis at each project milestone (e.g.: preliminary screening of alternatives, 3-5 alternatives, 1-2 alternatives, preferred alternative, construction) to determine whether things have changed and substantial and immediate impacts on low-income, minority or LEP populations are possible.

The Community Outreach Lead should be careful to analyze not just residents in the affected neighborhood, but also business owners, employees and people who use transportation facilities (roads, transit, sidewalks and bike lanes), parks and other recreational facilities, faith-based organizations, schools, libraries, and community-gathering places that may be affected by the project.

Use messages that are relevant to the target audiences

Community leaders whom SPU interviewed to develop these guidelines strongly suggested that messaging to the populations they serve focus on the public health benefits of sewage and stormwater pollution prevention, especially as it relates to fishing and swimming. They discouraged using language about environmental protection, sustainability or "green" messaging, because it does not resonate or translate well.

Create culturally sensitive and welcoming outreach opportunities

Oftentimes, a key barrier to participation in public engagement opportunities is discomfort with engaging in a public meeting setting. This is especially true for many new immigrants and refugees, who may come from a culture where public processes are uncommon or where speaking out loud in public meetings is considered impolite. We recommend working with the EJSE Division to evaluate the audiences you are trying to reach and develop culturally sensitive and welcoming outreach opportunities.

It may also be difficult for low-income parents to participate in public engagement opportunities because of difficulties with child care or transportation, or because of an evening work schedule. An inclusive public engagement approach would include public engagement opportunities scheduled at multiple times during the day. Providing child-friendly activities (such as a table with materials for coloring or toys) is a welcoming way to address some of these barriers.

Holding a public engagement opportunity at a neighborhood setting where people regularly gather and feel comfortable, such as an ethnic community center or church common room, may help put people at ease. It is also a good idea to conduct outreach at existing community events.

It is important to understand the English language proficiency of the community you are trying to reach. It may be necessary to have an interpreter attend these events.

Some community leaders interviewed cautioned against showing up once to share information at an event or community center. One community leader noted, "It can look somewhat suspicious to show up just once to share information." This underscores the importance of building long-term relationships at the agency level and making regular appearances at community events and meetings, even in between project milestones. If you do not have anything significant to report about the project, call in advance and ask if it would be okay to attend a meeting as an observer.

Consider alternatives to translation and interpretation

Some language groups — including Somali and other East African language groups, as well as some segments of the Vietnamese- and Cambodian-speaking communities — have limited literacy in their native language. If Seattle Public Utilities is conducting a project that will affect one of these language populations, it may be valuable to use alternative ways to communicate information. For a fee, Somali TV may be willing to partner with SPU to convey information about a project that will affect Somali-speaking residents by producing and cablecasting a video in Somali.

A recent strategy that many agencies have relied upon is expecting children and young people to interpret for their parents and grandparents. Some community leaders tell us this is not an ideal approach because of potential problems in family dynamics. Also, some subject matter may be difficult for children to understand or may not be appropriate.

It is important to remember that words like "sustainable" and "stormwater" may not translate well. In addition, many newcomers from developing countries may not be familiar with our sewer system. As such, words like "sewer" and "wastewater" may not translate well and require base knowledge that many people may not have.

Do not rely solely on print materials to convey information

3.3.5 Resources

The following resources are available to assist project teams with outreach to historically underserved populations:

Seattle Public Utilities Environmental Justice and Service Equity Division – This division will assist SPU project teams in developing, implementing and tracking inclusive outreach plans. The division also is a clearinghouse of inclusive-outreach resources.
http://spuweb/ejse/default.htm

Seattle Public Utilities Equity Guide – The guide aims to increase equitable access and relevancy in SPU projects, programs, and services. As a result SPU will build a more diverse and larger constituency that will better understand, support, and partner with us in our mission: **To provide reliable, efficient, and environmentally conscious utility services to enhance the quality of life and livability in all communities we serve.**
http://spu-sharepoint/Programs/equityplanning/default.aspx

Solid Ground Community Messaging Service – Solid Ground, a community-based social service agency, sends out a regular text message to 2,000 subscribers. The agency is willing to include messaging about public engagement activities related to Protecting Seattle's Waterways. Contact Solid Ground at (206) 694-6771.

Translation and Interpretation Procedural Manual – The City of Seattle has developed a manual that provides guidance and contact information for translation and interpretation.
http://inweb/language/resources.htm

City of Seattle Population and Demographics website – This website houses demographic data and maps for specific neighborhoods.
http://www.seattle.gov/dpd/Research/Population_Demographics/Census_2000_Data/Data_Maps_for_Locally_Defined_Areas/DPDS_007014.asp

3.4 Shared Seattle Public Utilities-King County Stakeholder Audiences

Seattle Public Utilities and King County have some stakeholders in common. If both agencies are planning sewage pollution prevention projects that will affect any of the following stakeholders, Seattle Public Utilities and King County will coordinate joint briefings:

- Seattle City Council
- Neighborhoods where joint Seattle Public Utilities-King County projects are under consideration:
    - Neighborhoods adjacent to the Ship Canal
    - Montlake-Madison-Leschi
    - Duwamish
- Regional stakeholders
- Stakeholders affected by joint SPU-King County projects or by individual projects in the same geographic location. These include University of Washington and District Councils where joint projects are located.
- Tribes, including those with treaty-protected fishing rights or interest in Puget Sound, Ship Canal, Lake Washington and the Duwamish River:
    - Muckleshoot Indian Tribe
    - Duwamish Tribe
    - Snoqualmie Tribe
    - Suquamish Tribe
    - Tulalip Tribes
    - Puyallup Tribe
- Environmental and advocacy groups
    - Duwamish River Cleanup Coalition
    - Sustainable South Seattle
    - People for Puget Sound
    - Puget Soundkeepers Alliance
- Citywide media
- Agencies

- State Department of Natural Resources
- Port of Seattle
- Seattle Parks Department

3.5 Strategies for addressing stakeholders who consistently oppose a project

Members of this group are unlikely to reach any kind of acceptance regardless of the level of community engagement. Seattle Public Utilities' strategy should focus on providing an opportunity to voice concerns and objections.

It may be possible to build a positive relationship with some of these stakeholders by making an extra effort to reach out to them. However, the amount of resources required to make this extra effort may be prohibitive. At a minimum, the project manager or planner should:

- Identify these stakeholders as early as possible
- Offer one-on-one meetings
- Confirm that stakeholders are included on email listservs and mailing lists and receive invitations to public involvement opportunities.

Chapter 4 – Developing the public engagement plan (PEP)

The following section describes how to develop a PEP.

4.1 Define the project

To identify potential stakeholders and determine the level of public engagement needed, it is important to define the project by answering the following questions:

1. What is the overall DWW plan for this neighborhood?

2. What type of project is this?
    a. Plan
    b. Sewer system improvement project
    c. Natural stormwater management project
    d. Underground storage project
3. What is the purpose of and need for this project?
    a. Where did this plan originate?
4. What is the geographic area that could be adversely affected by this project?
5. What is the geographic area that could benefit from this project?
6. What phase of work is this project in?
    a. Planning
    b. Environmental analysis
    c. Pre-design
    d. Design
    e. Construction
    f. Operation
7. What is the anticipated duration and magnitude of impacts of project construction?
8. What is the anticipated magnitude of impacts of project operation?

4.2 Establish communications roles and responsibilities

Clearly defined roles and responsibilities for communications and public engagement are essential to successful project implementation. Below are guidelines for the different roles. One person may fill more than one role.

4.2.1 SPU Community Outreach Lead

- Provide strategic communications support
- Lead stakeholder identification and analysis
- Develop, update and oversee implementation of PEP
- Execute consultant contracts for communications and public engagement
- Support media relations in partnership with SPU Media Coordinator
- Ensure that team members are using Protecting Seattle's Waterways messaging platform and consistent messaging

4.2.2 Outreach Implementer(s)

- Staff public meetings, community and neighborhood briefings, and local area stakeholder group meetings
- Support outreach to community-based organizations, environmental and advocacy organizations, etc.
- Support site tours and interactive workshops
- Schedule and coordinate events and public meetings
- Staff events and public meetings
- Maintain stakeholder database
- Update website

4.2.3 Project Specifier or Project Manager

- Serve as principal contact with public from project initiation through close-out
- Staff public meetings, community and neighborhood briefings, and local stakeholder group meetings
- Develop project materials
- Brief Seattle Public Utilities Executive Managers, SDOT, DON, DPD and Parks
- Review project materials and PEP

4.2.5 SEPA Responsible Officer

- Advise on when and how SEPA-related public engagement activities and notifications should be implemented
- Review the PEP
- Review SEPA-related project materials, including boards and the community guide for scoping and Draft EIS meetings, notifications and display ads
- Place all SEPA-required public notifications as outlined in **2.6 Regulatory Requirements for Public Involvement**

4.3 Identify and analyze stakeholders and create a community profile

Early in the project, the Community Outreach Lead should cast as wide a net as possible in identifying potentially affected stakeholders.

4.3.1 Steps for identifying stakeholders and profiling the community

The following describes steps to take in identifying stakeholders and profiling the affected community:

1. Consider the following questions:
    a. Who will be affected by this project? Residents? Businesses? Property owners?
    b. How will this project affect residents, businesses and property owners? How will the impacts vary, depending on where people live or own property?
    c. Who will benefit from this project?
    d. Who will be inconvenienced by this project or plan? How?
    e. Who are the likely project supporters?
    f. Who might oppose this project? Why?
    g. Which elected officials will be interested in this project?
    h. Which agencies will be interested in this project?
    i. Who will decide whether this project will happen?
    j. Who needs to give informed consent for this project to move forward?
    k. What is Seattle Public Utilities' history of involvement in the project area and the neighborhood? Has SPU interacted with stakeholders in the area previously? Have other Protecting Seattle's Waterways projects or SPU projects been discussed or constructed in the area? Are other City projects happening in the same area? What are the lessons learned from past projects in the area? What worked and what did not work? Is there an overall plan or strategy for Drainage and Wastewater in this neighborhood?
    l. What is the likely media interest in the project? Have media stories been published about the project? What are the key media outlets in the area?
2. Research the history of the project, if any, and identify who has been involved with it in the past. Also research other projects that have affected the community and identify who has been involved with those projects.
3. Consult with the appropriate Department of Neighborhoods District Coordinator in:
    a) Identifying the individual neighborhoods in the affected community (e.g. Windermere, Viewridge, Wedgewood, etc.)
    b) Identifying potential stakeholders, neighborhood groups, community councils, key community leaders, informal media
    c) Recommending localized communication strategies
    d) Identifying existing DON neighborhood plans, working group or subcommittee directly concerned with sewage overflows and other drainage issues.
    e) Identifying local fairs, festivals and farmers markets.

4. Conduct a demographic analysis of the project area using the most recent census data as well as demographic data from Seattle Public Schools. Refer to the demographic analysis in **3.3.1 Demographic analysis of CSO basins** for an example. A demographic analysis will allow you to determine the number of residents that may be affected by the project and whether there are any historically underserved or LEP populations living in the affected area.

5. Identify localized or special-interest constituencies; e.g., Friends of Meadowbrook Pond, who may not live or work in the project area but have direct interest in it.
6. Conduct a site visit with PM and project team of the affected neighborhood. Drive through the project area and identify any
    a. Community centers
    b. Business districts
    c. Faith-based organizations (including ethnic churches or mosques)
    d. Schools
    e. Hospitals
    f. Parks and recreational facilities
    g. Libraries
    h. Community resources (such as p-patches, neighborhood services, and community gathering places).
7. Parks staff should be contacted early in the project planning phase. Whenever possible, engage them in planning for public engagement and encourage Parks staff to be a visible presence at project public meetings. It may be difficult to determine whether low-income, minority or LEP populations use the park. Check with Parks staff to find out what they know about Parks usage. Another good strategy is to visit the park on a Saturday or Sunday afternoon, when many families are likely to be using the picnic facilities or playground.
8. If the roadway will be considered, you will need to identify potential frequent users of that roadway, such as bicyclists, pedestrians, transit users or freight.
9. If any other community resources will be affected by the project, you will need to evaluate whether their users or stakeholders include low-income, minority or LEP populations. You may need to call or visit the organization and do additional research to make this determination.
10. Identify businesses in the project area. Use Equity Tool Kit to separate out ethnically-owned businesses. Seattle Public Utilities purchased a list of businesses in 2010. Access this list by contacting the staff person in the role of SPU Customer Programs & Contracts Management.
11. Conduct an internet search to identify local blogs, local newspapers and other micromedia.

4.3.2 Accessing demographic analysis
Census research is available from the Department of Neighborhoods, EJSE and Seattle Office of Civil Rights.

4.3.3 Conduct a stakeholder analysis
Once the project team has identified possible stakeholders, the team should work together to complete the Seattle Public Utilities Equity Planning Toolkit Stakeholder Analysis worksheet. Use the information from this worksheet and the outcomes from your research on stakeholders to answer the questions on the worksheet.

4.4 Assess the need for public involvement
The level of public involvement needed for a project will depend on a number of factors, including:

1. Community-identified priorities, via Neighborhood Plan or NDC working group
2. Magnitude and duration of potential construction impacts on the affected community
3. Magnitude of potential operations impacts on the affected community, such as noise, odors, aesthetics and access to community resources
4. Legal requirements for public involvement, such as SEPA
5. Previous interactions with the affected community, or impacts of previous projects on the affected community
6. Opportunity for realizing multiple benefits, such as bicycle and pedestrian improvements or traffic calming
7. Other potential issues, such as political environment or environmental sensitivities

The following table describes the criteria that Seattle Public Utilities uses to determine community outreach levels. Level 1 represents the least challenging project, which means that it will require the minimal public involvement. Level 3 represents a very challenging project that will require intensive and frequent public involvement.

The Project Specifier or Project Manager should review this table and determine which level best characterizes the project, based on the criteria listed below. If a project seems to straddle two levels, we recommend selecting the higher level of challenge.

Criteria	Level 1 (least challenging)	Level 2 (moderately challenging)	Level 3 (very challenging)
Sites available	There are one or more sites that will be acceptable to the community	Even if there are some sites with perceived impacts on the community, there are one or more sites that will be acceptable to the community	All potential sites will have negative impacts on the community
Temporary or construction-related impacts	The project will create minimal temporary or construction-related impacts on the community	The project will create one of the following temporary impacts, or the magnitude and duration of the impacts will be minimal: • Easement on private property • Disrupted access to private property, parking, transit, roadway	The project will create many or all of the following temporary impacts, or the magnitude and duration of the impacts will be high: • Easement on private property • Disrupted access to private property, parking, transit,

Criteria	Level 1 (least challenging)	Level 2 (moderately challenging)	Level 3 (very challenging)
		• Disrupted access to business district, school, community center, park • Construction impacts, such as noise, dust, traffic, night work	roadway • Disrupted access to business district, school, community center, park • Construction impacts, such as noise, dust, traffic, night work
Permanent impacts	The project will not create any permanent impacts on the community	The project will create some of the following permanent impacts on the community, or the project will create several of these impacts but the magnitude of the impacts will be minimal: • Noise • Odors • Change in aesthetics • Loss of parking • Private property acquisition • Effects to public right-of-way, such as park or parking strip • Effects to transportation facility, such as roadway or transit stop	The project will create many or all of the following permanent impacts on the community, and the magnitude of the impacts will be high: • Noise • Odors • Change in aesthetics • Loss of parking • Private property acquisition • Effects to public right-of-way, such as park or parking strip • Effects to transportation facility, such as roadway or transit stop
Affected stakeholders	The project will not affect any of the following stakeholders: • Low-income or minority populations • LEP populations	The project directly or indirectly will affect any of the following stakeholders: • Low-income or minority populations	The project will directly affect any of the following stakeholders: • Low-income or minority populations • LEP populations

Criteria	Level 1 (least challenging)	Level 2 (moderately challenging)	Level 3 (very challenging)
	• Seniors or people with mobility challenges • Tribes or tribal fishers	• LEP populations • Seniors or people with mobility challenges • Tribes or tribal fishers	• Seniors or people with mobility challenges • Tribes or tribal fishers
Magnitude, duration and location of project	Project improves an existing facility or is routine maintenance	• Project is a new site or facility • From planning through construction, project will last less than six months	• Project is a new site or facility • From planning through construction, project will last more than six months
Public engagement requirements	There are no public engagement requirements associated with this project.	• Project is undergoing a SEPA environmental review • There are public engagement requirements associated with permitting processes • There are other local ordinances or policies requiring public engagement activities	• Project is undergoing a SEPA environmental review • There are public engagement requirements associated with permitting processes • There are other local ordinances or policies requiring public engagement activities
Community interest	• There does not appear to be opposition or interest in the project • The project does not have a high profile	• There is some potential for interest and opposition • The project has a high profile • The project is located in a neighborhood with well-connected residents or businesses • There is at least one organized opposition group	• There is active opposition to the project • The project has a high profile • The project is located in a neighborhood with well-connected residents or businesses • There is more than one organized opposition group

Criteria	Level 1 (least challenging)	Level 2 (moderately challenging)	Level 3 (very challenging)
History of the project area and previous community interactions	• SPU has not conducted ongoing work in or near the project area in the past five years • SPU has not conducted public outreach in the project area • There have been no controversial interactions with SPU in the project area in the past 10 years • There have been no other major projects that have impacted residents or businesses in or near the project in the past five years • There are no other major projects (including non-Seattle Public Utilities projects) planned for the area	• There has been SPU work in or near the project area, but perceived or actual impacts were minimal • There have been no controversial interactions with SPU in the project area in the past 10 years • There has been a major project (not necessarily an SPU project) in the past five years • There is a major project (including non-SPU projects) planned for the area	• There have been controversial interactions with SPU in the project area in the past • There have been problems with an existing SPU facility in the project area, such as odors, noise, overflows, etc. • There has been SPU work in or near the project area, and perceived or actual impacts on neighbors was high • There has been a major project (not necessarily an SPU project) that has affected residents or businesses in the past five years • There is a major project (including non-SPU projects) planned for the area
Political interest	• No elected officials have expressed concern about this project • This project will not require inter-agency or inter-jurisdictional coordination • There has been no interest from the news media in this project	• An elected official has a concern about the project • The project will require inter-agency or inter-jurisdictional coordination, such as coordination with SDOT or King County WTD • There has been interest from the news media in this	• An elected official has a concern about the project • The project will require inter-agency or inter-jurisdictional coordination, such as coordination with SDOT or King County WTD • There has been substantial interest from the news

Criteria	Level 1 (least challenging)	Level 2 (moderately challenging)	Level 3 (very challenging)
		or similar projects	media in this or similar projects
Project types	• Sewer system improvements	• RainWise • Green alleys • Underground storage facility	• Roadside rain gardens • Green alleys • Underground storage facility

4.4.1 Level 1–Least Challenging

Based on the outcomes of the needs assessment, the public engagement planning effort may indicate a minimal need for outreach tasks and tactics. This is because this project will have little to no impact on any members of the public or stakeholders. An example of this type of project might be sewer system improvements.

Even if the initial needs assessment indicates that there is no apparent need for public engagement, projects and surrounding conditions can evolve and change. Therefore, we recommend reevaluating the project at each stage gate to ensure that there is no emerging need for public engagement. If conditions have changed enough to warrant considering additional public engagement, it may be necessary to repeat the needs assessment.

4.4.2 Level 2–Moderately Challenging

Projects that may have impacts but are not particularly complex or controversial require a moderate public engagement effort. These could include some natural stormwater management projects, such as green alleys and RainWise.

A moderate public engagement effort would have the same objectives as a very challenging public engagement effort, but the intensity and frequency of engagement and communications would be less. For example, a moderate public engagement effort may include an introductory letter to the affected community, whereas public engagement for a very challenging project might require door-to-door outreach.

Issues or concerns could emerge during any stage of the project that could push it to a high level of public engagement. These could include:

- Additional technical complexities in the project
- A concerned or resistant group of stakeholders or community members
- Unanticipated political sensitivities
- Collateral effects of another Seattle Public Utilities or King County WTD project

If any of these factors emerge, we recommend repeating the needs assessment to determine whether a higher level of public engagement is appropriate.

4.4.3 Level 3–Very Challenging

These projects have a high potential for impacts on the surrounding community, controversy, or a need for substantial involvement by stakeholders. Such projects are more vulnerable to community pressure, so it is important to fully define the public engagement needs of the work and develop a public engagement plan that will address those needs.

As described earlier, public engagement for a very challenging project requires a higher intensity and frequency of outreach. Many of the underground storage facility siting projects will require a high level of public engagement, as will most natural stormwater management projects. See Chapter 5 for step-by-step guides to public engagement for facility siting and natural stormwater management projects, respectively.

4.5 Develop a strategy and public engagement approach

This step should be done in partnership with the Project Specifier or Project Manager. The strategy and approach should be aligned with the decision-making process and project milestones. To develop a strategy and approach, answer these questions:

1. How much influence does the public have on project decisions?
2. Which project decisions should the public have an opportunity to influence, and in what ways?
3. What does the project team need to learn from the public to make good decisions?
4. How and when will project decisions be made?
5. What are the key communications risks and mitigation strategies to address them?

4.6 Develop key messages

Use Protecting Seattle's Waterways Messaging Platform (**2.4 Key Messages**) as a basis for key messages, and add new ones specifically tailored to the project. Key messages should address:

- The project purpose and need
- Public engagement goals and objectives for this project
- The public engagement process
- Potential communications risks

4.7 Draft or update a PEP

The next step is for the SPU Communications Lead to assemble this information into a PEP.

Once the SPU Communications Lead has drafted the PEP, it should be reviewed by Project Specifier and Project Manager. Beyond the project team, the level of review should depend on the extent of the long-term impacts and nature of the project.

The PEP is a living document, which means that the Community Outreach Lead should plan to update it at project milestones to adapt to changes in the project over time. New stakeholders, concerns, technical realities, and impacts may emerge, the Community Outreach Lead needs to reevaluate and adjust the plan.

Chapter 5 – Public Engagement for Underground Storage Facilities

Underground storage facilities include underground storage tanks, new pipes, and tunnels. The public engagement approach for siting, designing, and constructing these facilities is tied to project milestones from initial site selection through design and construction.

5.1 Background

Underground storage facilities temporarily hold combined sewage and stormwater during a storm, when capacity in the combined sewer system is reduced. When the storm passes and capacity is available, the facility gradually sends the stored sewage and stormwater downstream for treatment and discharge.

Storage facilities can be in the form of tanks, pipes or tunnels. They can be built underneath streets, parking lots, parks, waterways or private property, if there is a property owner willing to sell land to SPU.

Larger tanks and tunnels require larger building sites and may have greater impacts on the surrounding community.

5.2 Underground storage facility public engagement strategy

Project impacts depend on many factors, including the size of the proposed underground storage facility and the available construction sites. Potential impacts could include:

- Noise, dust, traffic, and visual effects during construction
- Permanent changes to a neighborhood park or other community resource
- Disruption of access to private property or a park or other community resource
- Acquisition of private property

Public engagement for underground storage facility projects involves the tools and tactics discussed in **2.7 Public Involvement Tools and Tactics**. Underground storage facility projects are likely to be moderately or very challenging and will require frequent and intense public engagement.

5.3 Underground storage facility public engagement goals and objectives

Goals and objectives for underground storage facility projects are similar to those for all Protecting Seattle's Waterways projects.

Goal A: Achieve and sustain ongoing informed consent for the underground storage facility project

- Objective 1: Educate the affected community about the nature, seriousness and scale of the sewage overflow problem
- Objective 2: Establish that SPU is the right entity to be addressing this problem
- Objective 3: Familiarize the affected community with SPU's approach to preventing sewage overflows (fix it first, keep stormwater out, store what's left) and why underground storage is the right solution for controlling the remaining volumes.
- Objective 4: Identify all potential stakeholders and conduct a stakeholder analysis.
- Objective 5: Demonstrate to the public how their input influences project decisions.
- Objective 6: Educate the community on what they should expect to see, hear and do during construction.

Goal B: Help manage risk to achieve smoother, more cost-effective project delivery.

- Objective 1: Ensure that there are no surprises and the public is aware of the project and opportunities for engagement. Communicate with the public early and often.
- Objective 2: Gather public input that will support the decision-making process at each project milestone.
- Objective 3: Surface community concerns early in the project, so they can be addressed during the preliminary and detailed evaluation of alternatives and at the 30 percent stage of design.
- Objective 4: Tailor the intensity of the outreach and communications based on potential impacts on the stakeholder. For example, stakeholders who live near the project or belong to a parks advocacy group that will be affected by a project should receive more frequent and intensive communications and public engagement than a stakeholder who lives in the basin but away from the project.
- Objective 5: Provide ways to give voice to those potentially affected stakeholders who are opposed to the project without allowing a small group to derail the siting, design and construction process.
- Objective 6: Give the affected community enough time and opportunity to provide input, and enough information to get to informed consent.

Goal C: Support Seattle Public Utilities, City Council, and the Mayor's decision-making processes.

- Objective 1: Maintain internal knowledge about and support for the project/program, program goals, program timeline, and strategies by providing regular briefings and updates to internal leadership and staff at key project milestones.
- Objective 2: Ensure consistency of communications and smooth delivery of projects by clarifying roles and responsibilities and holding regular team meetings.
- Objective 3: Clearly show the public engagement process and how public input helped to inform decisions around project siting, design and construction.
- Objective 4: Provide frequent briefings and project information to avoid surprises and provide policy-makers with the information they need to make decisions.

5.4 Underground storage facility stakeholder identification

4.3 Identify and analyze stakeholders and create a community profile describes the process of identifying stakeholders. As with all Protecting Seattle's Waterways projects, it is important to identify stakeholders early.

5.4.1 External stakeholders

Stakeholders of underground storage projects are likely to include:

- Adjacent property owners
- Residents, property owners and businesses in the project community
- Citywide advocacy and environmental organizations
- Parks users and advocacy groups
- Private-property rights advocates
- Stakeholders who will not support the project under any circumstances
- Micromedia: blogs, newsletters and other media based in the target community
- Neighborhood District Councils, business councils and other community groups in the affected community
- Retail and community centers in the affected community
- Citywide and regional media
- Elected officials who represent the affected community

Residents, property owners and businesses in the basin where the underground storage project is being considered will benefit from these projects, even if they are far from where these projects are located. Therefore, it will be important to extend outreach and communications throughout the basin. However, outreach to and communications with stakeholders should vary in intensity, depending on which tier stakeholders fall within:

- Tier 1: residents, property owners, and businesses that will be directly affected by the project
- Tier 2: parks users and people who use transportation facilities that may be affected by the project
- Tier 3: residents, property owners and businesses in the affected basin

5.4.2 Internal stakeholders

Because this approach to sewage and stormwater pollution management is relatively new and there has been some recent public controversy around Seattle Public Utilities natural stormwater management projects, it is essential to maintain good communication within project teams and with key internal stakeholders. These stakeholders include:

- Seattle Public Utilities Executive managers
- City Council and Mayor's Office
- Other City departments (DON, SDOT, DPD)
- Other Seattle Public Utilities branches (PDB, USM, CSB)

- Protecting Seattle's Waterways project team

5.5 Milestone: Preliminary evaluation activities

Public involvement objectives

- Identify all potential stakeholders and conduct a stakeholder analysis.
- Maintain internal knowledge about and support for the program, program goals, program timeline and strategies by providing regular briefings and updates to internal leadership and staff.
- Ensure consistency of communications and smooth delivery of projects by clarifying roles and responsibilities and holding regular team meetings.

Task list

- ☐ If it is known at this point whether the project will receive a DNS or will undergo an EIS, meet with the SEPA Responsible Officer to identify when and how SEPA public involvement requirements will be met
- ☐ Identify stakeholders and analyze all potential stakeholders and create or update a community profile. See **4.3 Identify and analyze stakeholders and** create a community profile.
- ☐ Conduct a Stakeholder Analysis using the SPU Equity Planning Toolkit with project team
- ☐ Determine whether translation or interpretation services will be necessary
- ☐ If the project is likely to have substantial and immediate impacts on low-income, minority or LEP residents, the team should meet with a member of the EJSE team and identify an approach that addresses the unique needs of the affected group
- ☐ Draft or update project-specific PEP
- ☐ Develop and maintain stakeholder database
- ☐ Establish communications log to track contacts with the public
- ☐ Hold internal briefings with Seattle Public Utilities Executive Managers and SDOT, DPD, DON and Parks to introduce the project and PEP. Offer briefings with an Executive Manager to the Mayor's office and City Council. Determine which City departments and staff members should have more intensive participation in siting and design processes
- ☐ Offer briefings with an Executive Manager to individual Tribes to introduce the project and PEP
- ☐ Create or update project collateral: introductory letter, project fact sheet with timeline and decision-making process graphic, FAQs
- ☐ Establish or update project website and project listserv
- ☐ For a Level 3 (very challenging) project, consider establishing a local area stakeholder group composed of 10-15 key stakeholders, including community leaders, adjacent property owners and residents, bicyclists and others who may be affected by the project. See

- **2.7.2 Public engagement or** two-way communications for guidance on how to decide whether a local stakeholder group is appropriate.
- Identify and brief mainstream and micromedia (local newsletters, neighborhood blogs, community council newsletters, and other media focused on the project area) about the project

5.6 Milestone: Preliminary screening of site alternatives

Public involvement objectives

- Educate the affected community about the nature, seriousness and scale of the sewage and stormwater pollution problem
- Familiarize the affected community with SPU's approach to sewage and stormwater pollution prevention (fix it first, keep stormwater out, store what's left) and why underground storage is the right solution for controlling the remaining volumes
- Build and sustain trust with stakeholders by maintaining a consistent communications contact and easy access to SPU staff from project initiation through construction
- Ensure there are no surprises and that the public is aware of the project and opportunities for engagement
- Gather public input that will support the decision-making process at each project milestone
- Surface community concerns early in the project, so they can be addressed during the preliminary stage of design
- Tailor the intensity of the outreach and communications based on potential impacts. For example, stakeholders who live near the project or belong to a parks advocacy group that will be affected by a project should receive more frequent and intensive communications and public engagement than a stakeholder who lives in the basin but away from the project.
- Provide ways to give voice to those potentially affected stakeholders who are opposed to the project without allowing a small group to derail it

Task list

- Hold an introductory meeting with the Neighborhood District Council or its working group concerned with drainage issues
- Conduct introductory briefings with community groups (community councils, stakeholder groups, environmental and advocacy groups) at their regular meetings to introduce the project and project contact and to gather input
- Hold introductory meeting with local area stakeholder group to identify key community concerns and confirm the format and content of the first major public involvement activity
- If this is a Level 3 (very challenging) project, conduct a walk-through in the neighborhood and go door-to-door to Tier 1 stakeholders (residents and businesses who will be directly affected by the project). These visits should tell the story about the project, let them know that SPU is in the early stages of planning and that we will be sending a personalized introductory letter
- Send personalized introductory letter, project fact sheet, and FAQ to Tier 1, 2, and 3 using mail merge

- Develop display boards for public meetings with photographs of existing representative projects and design visualizations
- Update micromedia and mainstream media about the project to announce the public engagement activity
- Hold a public engagement activity to introduce the project purpose and need to the community, describe the public engagement process, review basin map with stakeholders, and capture community input on potential sites. Depending on the needs and interests of the community, this activity could be a public meeting, interactive workshop or door-to-door outreach.
- Post display boards or other print materials from the public engagement activity to the website
- Send email to listserv members, local area stakeholder group, and meeting participants summarizing the outcomes from the first public involvement activity and how the community input will be considered as SPU selects three to five site alternatives
- Hold internal briefings with Seattle Public Utilities Executive Managers and SDOT, DPD, DON, and Parks. If this is a Level 3 (very challenging) project, offer briefings with an Executive Manager to the Mayor's office and City Council. Update on the outcomes of the first public engagement activity and how the input was considered and addressed as SPU narrowed the alternatives.
- Revisit the stakeholder analysis and determine whether the PEP needs to be revised based on the three to five alternatives under consideration. Be sure to consider any new impacts on low-income, minority or LEP residents.
- Update PEP as needed
- Update project collateral to show three to five site alternatives. Visualizations become increasingly important at this stage. Materials should show existing conditions, expected conditions during construction and after construction and a project-area map with the boundaries of each alternative. As it may not be appropriate to use project-specific visualizations at this stage, consider showing photos or renderings of similar completed or in-process projects.
- Produce and mail a construction notice to announce fieldwork that could affect residents and businesses, such as geotechnical investigations and surveying. Clarify what residents can expect during the work (e.g. noise levels, visual effects, parking and access impacts, duration of work, and maintenance after construction is completed).
- Provide field staff with business cards for SPU contact information. Ask project staff to distribute these cards to anyone who has questions about the project.
- For a Level 3 (very challenging) project, hold a second meeting with local area stakeholder group to present the three to five site alternatives, gather feedback on community concerns and confirm format and content of second public meeting.
- For a Level 3 (very challenging) project, hold second public engagement activity (meeting, workshop or door-to-door outreach) to present site alternatives, the selection process and criteria and to get community input on each alternative.

- Send email to listserv members, local area stakeholder group and meeting participants summarizing outcomes from the second public involvement activity and how the community input will be considered as SPU narrows to one or two alternatives
- Hold internal briefings with Seattle Public Utilities Executive Managers and SDOT, DPD, DON and Parks. If this is a Level 3 (very challenging) project, offer briefings with an Executive Manager to the Mayor's office and City Council. Update on the outcomes of the second public involvement activity and how the input was considered and addressed.
- Document all public involvement activities

5.7 Milestone: Detailed Evaluation of Site Alternatives

Public Engagement Objectives

- Demonstrate to the public how their input influenced project decisions
- Give the affected community enough time and opportunity to provide input, and enough information to get to informed consent
- Clearly show the public involvement process and how public input helped to inform decisions on project siting design, and construction
- Provide frequent briefings and project information to avoid surprises and provide policy-makers with the decisions they need to make decisions

Tasks

- If it is known at this point whether the project will receive a DNS or will undergo an EIS, meet with the SEPA Responsible Officer to identify when and how SEPA public involvement requirements will be met
- Revisit the stakeholder analysis and determine whether the PEP needs to be revised based on the one or two alternatives under consideration. Be sure to consider any new impacts on low-income, minority or LEP residents.
- Update PEP as needed
- Develop or update project collateral to show the final two alternatives, including FAQ and website. Include updated visualizations. Whenever possible, visualizations should provide more detail than those used in the previous project phase. Include an updated project map outlining the boundary of the alternatives under consideration.
- For Level 3 (very challenging) projects, hold local area stakeholder group meeting to present remaining alternatives, gather input on potential community concerns, and confirm format and content of next public involvement activity
- Update micromedia and mainstream media about the project
- Send project update mailing to Tiers 1, 2 and 3 stakeholders to invite them to the next public involvement activity
- For Level 3 (very challenging) projects, hold a third public involvement activity (public meeting, interactive workshop or door-to-door outreach) to present final alternatives, report on how past public input was addressed, and gather community input

- For Level 3 projects, hold one-on-one outreach events in the community, such as a table at a neighborhood park or grocery store or small meetings hosted in residents' homes to address potential concerns and answer questions
- For Level 3 projects, send email to listserv members, local area stakeholder group and meeting participants summarizing the outcomes from the third public involvement activity and how the community input will be considered as SPU selects a preferred alternative
- For Level 3 projects, hold internal briefings with SPU Executive Managers and SDOT, DPD, DON and Parks. Offer briefings with an Executive Manager to the Mayor's office and City Council. Update on the outcomes of the third public involvement activity and how the input was considered and addressed as SPU selects a preferred alternative.
- Revisit the stakeholder analysis and determine how the PEP needs to be revised based on the preferred alternative. Be sure to consider any new impacts on low-income, minority or LEP residents.
- Update PEP as needed
- Hold local area stakeholder group meeting to present preferred alternative, gather input on community concerns, and confirm format and content of next public involvement activity
- Hold another public involvement activity (public meeting, interactive workshop or door-to-door outreach) to present preferred alternative, report on how past public input was considered and addressed, and gather community input
- Send email to listserv members, local area stakeholder group and meeting participants summarizing the outcomes from the latest public engagement activity
- Hold internal briefings with Seattle Public Utilities Executive Managers and SDOT, DPD, DON and Parks. Offer briefings with an Executive Manager to the Mayor's office and City Council. Update on the outcomes of the latest public engagement activity.

5.8 Construction

Public involvement objectives

- Build and sustain trust with stakeholders by maintaining a consistent project contact and easy access to SPU staff
- Demonstrate to the public how their input influenced project decisions
- Educate the community on what they should expect to see, hear and do during construction
- Clearly show the public engagement process and how public input helped to inform decisions around project siting, design and construction
- Provide frequent briefings and project information to avoid surprises and provide policy-makers with the information they need to make decisions

Tasks

- Hold internal briefings with Seattle Public Utilities Executive Managers and SDOT, DPD, DON and Parks to update them on the plans for construction
- Develop or update project collateral to show plans for construction, including FAQ and website

- For Level 3 (very challenging) projects, hold local area stakeholder group meeting to present plans for construction, gather input on potential community concerns, and confirm format and content of next public engagement activity
- Send project update mailing to residents, property owners and businesses in the affected basin
- For major construction activities, such as an overnight road closure or during a period of intense construction, consider developing a fact sheet specific to the construction event to share information about traffic, noise and other impacts. It may be appropriate to deliver fliers door to door to the affected area, and post fliers in nearby community gathering places such as coffee shops, grocery stores and community centers. Work with SDOT to issue traffic advisory.
- For Level 3 (very challenging) projects, host small meetings with affected property owners ahead of major construction activities, detours or other invasive work
- Place signage adjacent to construction sites that explain the project purpose and need, timeline, what to expect during construction and contact information if people have questions.
- Document all public engagement activities and log all communications with the public.

Chapter 6 – Natural Stormwater Management Public Engagement

6.1 Background

Polluted stormwater runoff is Puget Sound's largest source of toxic pollutants and a major factor in the decline of waterways statewide. Stormwater is water that originates during precipitation, either rain or snowmelt. Water that is not absorbed into the ground becomes surface runoff that either flows directly into surface waterways or is channeled into storm sewers and eventually discharged to surface waters. Polluted stormwater is of concern for three main reasons: Sudden influxes of polluted stormwater can flood and damage habitats; even small amounts of stormwater can overtax the sewer system and cause sewage overflows into streams, lakes, and Puget Sound; and the contaminants in polluted stormwater damage aquatic life and pose threats to human health.

A variety of natural stormwater management[2] planning and engineering approaches have been implemented regionally and nationally to address goals for minimizing the impacts of stormwater runoff and the resulting pollution. Since 2002, Seattle Public Utilities has designed and installed a variety of natural stormwater management projects to slow the flow of stormwater; improve water quality; and protect Seattle's creeks, lakes and Puget Sound from the damaging effects of stormwater runoff. Natural stormwater management is cost-effective, sustainable and environmentally friendly. And, because natural stormwater management projects are typically constructed in neighborhoods, they may provide additional benefits such as pedestrian and bicycle enhancements; traffic calming measures, and improved neighborhood aesthetics through the addition of plants, trees and a more interesting streetscape.

Seattle's interest in natural stormwater management has increased steadily since 2000. Today, several nonprofit organizations are working to leverage this interest into action. Other cities, including Portland, San Francisco and Philadelphia, have seen the same heightened interest in natural stormwater management and have developed programs to design and install them.

As sewage overflows are composed of 90 percent stormwater and 10 percent sewage, strategies that reduce the stormwater entering the sewer system can be very effective. Recently, Seattle became one of the first cities to use natural stormwater management to help prevent sewage overflows. (The regulatory requirements for Protecting Seattle's Waterways projects are discussed in **1.2.3 Regulatory Context for Protecting Seattle's Waterways**.)

Seattle is using four natural stormwater management solutions for sewage pollution prevention:

[2] Green stormwater infrastructure (GSI), low-impact development (LID), and natural drainage systems are other terms that are frequently used for GSI.

- **Natural Drainage Systems**, which reconstruct unimproved public rights-of-way to provide roadway and sidewalk improvements as well as capture stormwater runoff and prevent it from reaching the sewer system. Natural stormwater management practices include interconnected bioretention cells and permeable pavement. Bioretention cells are wide depressions planted with deep-rooted native plants and grasses placed along the stormwater flow path to temporarily hold and cleanse stormwater, before infiltrating or slowly releasing it into the sewer system.
- **Roadside Bioretention/rain gardens** are similar to natural drainage systems but used in places with existing curbs and gutters. They are located in public right-of-way in the parking strip adjacent to the street or in curb extensions constructed into the street.
- **Green alleys** are alleys paved, at least partially, with a permeable surface and a stone reservoir underneath. The reservoir temporarily stores stormwater runoff before it infiltrates the ground, preventing the stormwater from entering the sewer system.
- **RainWise** is a City of Seattle program that offers incentives to private property owners who disconnect roof drains from the combined sewer system and channel the runoff to a cistern or rain garden on their own property. RainWise has been very popular and successful since its launch in July 2010. Future expansion of the RainWise program may include green roofs on commercial parcels.

6.1.1 How is natural stormwater management different from other Protecting Seattle's Waterways projects?

While there are many supporters of green solutions for sewage pollution prevention, it is essential to engage the community early and often in the life of a project to be successful. Natural stormwater management projects have the potential for negative impacts, including:

- Reduction in available parking
- Temporary or permanent changes in access to private property
- Noise and visual impacts associated with construction
- Change in neighborhood aesthetics, including concerns with signage and depressions
- Ongoing and new maintenance requirements in the public right-of-way for both the City and adjacent residents

In previous natural stormwater management projects installed in the public right-of-way, community members have also raised concerns about safety and public health, including:

- Safety issues associated with standing water, such as mosquitoes and drowning
- Safety issues concerned with significant side slopes
- Groundwater seepage or basement flooding
- Adverse effects to property values
- Toxics or heavy metal build-up in soil

Because SPU designs natural stormwater management projects to minimize these problems, their likelihood is very low. Nonetheless, these concerns represent serious worries for residents, and SPU will continue to address these questions directly and honestly.

Public Engagement for natural stormwater management projects

Public engagement for natural stormwater management projects involves many of the same tactics and tools discussed in **2.7 Public Engagement Tools and Tactics**. SPU staff should continue to demonstrate commitment to engaging residents, business owners, community members and local organizations in the planning and implementation of natural stormwater projects. However, several factors are unique to these projects and require a high level of public engagement:

- Natural stormwater management projects located in the public right-of-way are typically adjacent or very close to residences. Therefore, the design and construction process is more apparent to the public than projects sited on public lands or larger parcels not located in residential neighborhoods.
- Because of the unique character of every neighborhood, each public engagement effort must be tailored to the project area and even the specific streets where a natural stormwater management project is proposed. This means more up-front work to identify stakeholders and their concerns and preferences.
- Adjacent property owners require a high level of one-on-one communications. Over the time that it takes to plan and implement a natural stormwater management project, it is imperative that these property owners develop a close and trusting relationship with Seattle Public Utilities staff and the project team. For this reason, it is critical to have one main contact throughout all phases of the project as well as easy access to the project team. This is the responsibility of the project manager. In addition, it is critical that the project manager be available to the property owners through in-person meetings, phone conversations, email and other inter-personal communication channels.
- This approach to stormwater management is still relatively new and many people do not understand the technology or are unfamiliar with the likely effects – positive and negative – of natural stormwater management projects. Communities may need education before they accept this approach to address sewage overflows. In particular, they may need information about how rain gardens work and the effects of water ponding depths on the functionality of rain gardens.
- Because natural stormwater management projects capture stormwater upstream from CSO outfalls, natural stormwater management sites may not be near the actual outfall. The result is that some members of communities affected by natural stormwater management projects may not see the connection between the proposed solution and the problem, because they cannot see the CSO outfalls and may not even know where they are.
- SPU's approach to controlling sewage overflows is to fix them first with relatively low-cost, low-impact sewer system improvements; slow the flow with natural stormwater management projects; and control the remaining volumes with underground storage. Therefore,

neighborhoods that are affected by natural stormwater management projects may receive mailings or hear about future Protecting Seattle's Waterways projects in their neighborhood.

6.2 Natural stormwater management public engagement strategy

Public engagement for natural stormwater management projects is similar to public engagement for underground facility siting. Seattle Public Utilities will site and construct roadside rain gardens or green alleys where they are technically feasible, giving preference to locations where projects would provide multiple benefits such as traffic calming or new bicycle or pedestrian facilities. Once SPU has determined that it has reduced sewage overflows as much as possible through natural stormwater management, we will plan and construct an appropriately sized underground storage tank or other "gray" solutions to meet our federally mandated goal of no more than one overflow per year per outfall.

To help ensure the success of natural stormwater management solutions, the first step will be to maximize participation in the incentive-based RainWise program. RainWise can help educate and engage the public about sewage overflows and how people can help reduce them. As SPU introduces rain gardens and other natural stormwater management solutions, the agency will work to ensure that residents understand:

- Why sewage overflows are a problem that SPU must address and why it would be financially and environmentally irresponsible not to do so
- How natural stormwater management projects work
- The history of and lessons learned from SPU's natural stormwater management program
- Why we're implementing natural stormwater management projects before siting and designing underground storage
- How projects will change the public right-of-way
- What the community can expect to see during construction
- What the community can expect to see over the first few years as plantings mature, including ponding
- What the community can expect to see from season to season
- What signage and other components will look like and why we need them
- The perceived risks of natural stormwater management (e.g., drowning, safety hazards, mosquitoes, etc.), and SPU's thoughtful approach to mitigating those risks
- What maintenance will be required and what it will look like at different stages of maturity
- Additional benefits of rain gardens, where applicable

6.3 Natural stormwater management public engagement goals and objectives

Natural stormwater management public engagement goals are similar to those for all Protecting Seattle's Waterways projects, with some additional objectives:

Goal A: Achieve and sustain ongoing informed consent from affected community members for Seattle Public Utilities natural stormwater management projects.

- Objective 1: Educate the affected community about the nature, seriousness and scale of the sewage overflow problem
- Objective 2: Familiarize the affected community with natural stormwater management solutions and the business, environmental and economic case for controlling sewage overflows with natural stormwater management
- Objective 3: Establish that SPU is the right agency to address the sewage overflow problem by telling the story of how Seattle Public Utilities began implementing natural stormwater management and project successes to date.
- Objective 4: Identify all potential stakeholders prior to implementing a natural stormwater management project, including residents and property owners in the geographic area where a project is being considered. Broaden outreach to include stakeholders in the basin where natural stormwater management projects are being considered, because they will benefit from the projects even if they are not directly affected. Tailor the intensity and frequency of outreach based on whether stakeholders are in the basin, on a street where projects are located, or adjacent to a project.
- Objective 5: Anticipate and address the affected community's expectations about natural stormwater management by familiarizing them with how natural stormwater management looks and feels during and after construction and at different stages of maturity and seasons, using photographs and design visualizations.
- Objective 6: Ensure that historically underrepresented stakeholders are provided with the information and resources necessary to equitably participate in the public involvement process.
- Objective 7: Build and sustain trust with stakeholders by maintaining a consistent contact and easy access to SPU staff from project initiation through construction and ongoing maintenance.
- Objective 8: Carefully consider community input by providing potentially affected stakeholders with meaningful opportunities to discuss their concerns and preferences about the siting and design of natural stormwater management projects with Seattle Public Utilities before final siting and design decisions have been made.
- Objective 9: Identify the key variables around which the public may have decision-making opportunities, such as choosing between pre-selected plant palates and hardscape options.
- Objective 10: Engage stakeholders in identifying multiple benefits that could be achieved from natural stormwater management implementation, such as Walk/Bike/Ride and Neighborhood Greenways initiatives.
- Objective 11: Demonstrate to the public how their input influenced project decisions.
- Objective 12: Inform the community about construction impacts and what they should expect to see, hear and do during construction.

Goal B: Help manage risk to deliver a smoother, more cost-effective project.

- Objective 1: Ensure there are no surprises and the public is aware of the project and opportunities for engagement by communicating with the public early and often.
- Objective 2: Gather public input that will support the decision-making process at each milestone.
- Objective 3: Surface community concerns early in the project, so they can be addressed during the preliminary and detailed evaluation of alternatives and the 30 percent design phase.
- Objective 4: Align and streamline public engagement and communications with other City of Seattle projects and initiatives (e.g. Walk/Bike/Ride, Neighborhood Greenways, etc.)
- Objective 5: Provide ways to give voice to those potentially affected stakeholders who are opposed to natural stormwater management, without allowing a small group to derail the design and implementation process.
- Objective 6: Give the affected community enough time and the opportunity to provide input, and adequate information to get to informed consent.
- Objective 7: Be up-front about the results of previous projects (e.g., Ballard Roadside Rain gardens). Explain lessons learned, why some failures occurred, how we've learned from those failures, and how we have adjusted our approach to prevent repeating mistakes.

Goal C: Support Seattle Public Utilities, City Council, and the Mayor's decision-making processes.

- Objective 1: Maintain internal knowledge about and support for the project/program, program goals, program timeline and strategies by providing regular briefings and updates to internal leadership and staff at key project milestones.
- Objective 2: Ensure consistency of communications and smooth delivery of projects by clarifying roles and responsibilities and holding regular project team meetings.
- Objective 3: Clearly show the public engagement process and how public input helped to inform decisions on project siting, design and construction.
- Objective 4: Provide frequent briefings and project information to avoid surprises and provide decision-makers with the information they need to make decisions.

6.4 Natural stormwater management Stakeholder Identification

4.3 Identify and analyze stakeholders and create a community profile describes the process of identifying stakeholders. As with all Protecting Seattle's Waterways projects, it is important to identify stakeholders early.

6.4.1 External stakeholders

Stakeholders of natural stormwater management projects are likely to include:

- Adjacent property owners
- Residents, property owners and businesses in the project community
- Stakeholders who will oppose the project under any circumstances
- Citywide advocacy and environmental organizations

- Micromedia: blogs, newsletters and other media based in the target community
- Schools and faith-based organizations that participate as early adopters of rain garden and cistern projects
- Neighborhood councils, business councils and other community groups in the target community
- Retail and community centers in the target community
- Citywide and regional media
- People who have demonstrated interest in natural stormwater management
- SPU Creeks, Drainage and Wastewater Advisory Committee
- Elected officials who represent the target community or who have demonstrated interest in natural stormwater management

Residents, property owners and businesses in the basin where natural stormwater management is being considered will benefit from these projects, even if they are far from where these projects are located. Therefore, it will be important to extend outreach and communications throughout the basin. However, outreach to and communications with stakeholders should vary in intensity, depending on which tier stakeholders fall within:

- Tier 1: residents and property owners directly adjacent to the area proposed for a roadside rain garden or green alley
- Tier 2: residents and property owners on the affected streets but not adjacent to a proposed project
- Tier 3: residents, property owners and businesses in the affected basin

6.4.2 Internal stakeholders

Because this approach to stormwater and sewage overflow management is relatively new and initial projects resulted in some public controversy, it is essential to maintain good communication within project teams and with key internal stakeholders. These stakeholders include:

- Seattle Public Utilities Executive managers
- City Council and Mayor's Office
- Other City departments (DON, SDOT, DPD)
- Other Seattle Public Utilities branches (PDB, USM, CSB)
- Protecting Seattle's Waterways team
- External consultants
- SPU natural stormwater management team

6.5 Public engagement approach for natural stormwater management

The public engagement approach for natural stormwater management projects mirrors project milestones, from initial site selection through design and construction. SPU will engage the public throughout a project by providing timely, comprehensive information and allowing for early and continuous input.

This section details a public engagement approach for natural stormwater management projects. Because Seattle Public Utilities will lead with RainWise, this approach assumes that residents may already be somewhat familiar with the sewage overflow problem and will be aware of the RainWise program. This public engagement approach should serve as a roadmap for developing a project-specific public engagement plan. We provide these guidelines to encourage consistency in how SPU engages neighborhoods. At different milestones, different public engagement techniques may be appropriate. The tables below provide a menu of options for each stage of the project; it is up to the project team to determine which approach best suits an individual project.

6.5.1 Milestone: Natural stormwater management project initiation

Public engagement objectives

- Identify all potential stakeholders prior to project initiation, including residents and property owners in the area where natural stormwater management is being considered.
- Build and sustain trust with stakeholders by maintaining a consistent project contact and easy access to SPU staff from project initiation through construction.
- Strive for no surprises and make sure the public is aware of the project and opportunities for engagement by communicating early and often.
- Clearly describe the public involvement process: when, where and on which elements people can provide input.

Tasks

- ☐ Review current Neighborhood Plans and identify existing community-based working groups within Neighborhood District Councils that are concerned with drainage issues.
- ☐ Incorporate communications and outreach meetings into the project plan. The purpose of these meetings is to ensure that team members are using consistent messages about the project purpose and need, timeline, and other key points, and that everyone is following and tracking the public engagement plan.
- ☐ Identify and analyze all potential stakeholders and create or update the community profile. See **4.3 Identify and analyze stakeholders and create a community profile**.
- ☐ Conduct a Stakeholder Analysis using the Seattle Public Utilities Equity Planning Toolkit (http://spu-sharepoint/Programs/equityplanning/default.aspx)
- ☐ Determine whether translation and interpretation will be necessary
- ☐ If the project is likely to have substantial and immediate impacts on low-income, minority, or limited-English speaking residents, contact Steve Hamai or Michael Davis with EJSE and identify a public engagement approach that addresses the needs of the affected group
- ☐ Draft or update a project-specific public engagement plan.
- ☐ Develop and maintain a stakeholder database
- ☐ Establish a communications log to track contacts with the public
- ☐ Hold briefings with SPU executive managers to introduce the project and public engagement process. Provide them with talking points on the project purpose and need and public engagement plan so they can brief the Mayor and City Council.

- Hold briefings with the Seattle Department of Transportation (SDOT), Department of Planning and Development (DPD) and Seattle Department of Neighborhoods (DON) to introduce the project and public engagement process. Discuss opportunities to identify overlapping benefits. Determine which City departments and staff members should have more intensive participation in the siting and design processes.
- Offer briefings with an Executive Manager to the Mayor's office and City Council to introduce the project purpose and need and public engagement process.
- Create a project fact sheet with a decision-making process graphic and project timeline (see Chapter 2 of these Public Engagement Guidelines). Include photographs of RainWise projects in the neighborhood on the fact sheet.
- Establish or update a project website and project listserv
- Conduct stakeholder interviews to understand community concerns, identify the most effective outreach strategies and cultivate project champions and potential local area stakeholder group members, organizations or community groups
- Consider establishing a local area stakeholder group of 10-15 key stakeholders, including community leaders, adjacent property owners and residents, bicyclists and other people who may be affected by the project. See **2.7.2 Public engagement or two-way communications** for more information about issues to consider when deciding whether or not to implement a local area stakeholder group.
- Identify and brief micromedia (local newsletters, neighborhood blogs, community council newsletters and other media focused on the project area) about the project.
- Develop key partnerships (community groups, DON, etc.).

6.5.2 Milestone: Preliminary Evaluation of Alternatives

Selection of project area and streets that potentially would be good candidates for natural stormwater management solutions

Public Engagement objectives

- Educate the affected community about the nature and seriousness of the sewage overflow problem.
- Familiarize the affected community with SPU's approach: natural stormwater management solutions first followed by underground storage to control any remaining volumes; and help them understand that the impacts to the neighborhood are not over when the natural stormwater management project is complete.
- Manage the affected community's expectations about how natural stormwater management will look and feel before and during construction.
- Build and sustain trust with stakeholders by maintaining a consistent project contact and easy access to SPU staff from project initiation through construction.
- Explain why implementing natural stormwater management upstream from CSO outfalls is an effective solution.
- Provide stakeholders with meaningful opportunities to discuss with SPU their preferences about the siting and design of natural stormwater management projects.

- Identify for stakeholders the multiple benefits possible from natural stormwater management, such as Walk/Bike/Ride and Neighborhood Greenways initiatives.
- Ensure there are no surprises and the public is aware of the project and opportunities for engagement.
- Gather public input that will support the decision-making process at each project milestone.
- Surface community concerns early in the project, so they can be addressed during the preliminary and detailed evaluation of alternatives and at the 30 percent design phase.
- Align and streamline public engagement and communications with other City of Seattle projects and initiatives (e.g. Walk/Bike/Ride, Neighborhood Greenways, etc.)
- Provide opportunities for input to stakeholders who may be opposed to natural stormwater management, without allowing a small group to derail the design and implementation process.
- Clearly explain the public engagement process and how public input helped to inform decisions on project siting, design and construction.

Tasks

- Apply the Equity Planning Guide for Early Design (http://spu-sharepoint/Programs/equityplanning/default.aspx) to identify potential disparate or unintended impacts of the project
- Hold an introductory meeting with the Neighborhood District Council or its working group concerned with drainage issues before Preliminary Evaluation of Alternatives. Introductory meetings with other community groups or organizations may be necessary if the Neighborhood District Council does not adequately represent the broad array of residents in the targeted neighborhood.
- Develop a Community Guide and display boards for the next public engagement opportunity (see Chapter 2 of these Public Engagement Guidelines) with photographs of existing representative projects and design visualizations.
- Hold an introductory meeting with the local stakeholder group. The purpose of these meetings is to gather information from a broad range of community interests to help inform the siting process and gather input on public engagement materials and outreach tactics.
- Consider going door-to-door on the streets under consideration to introduce the Community Outreach Lead, tell residents the story about the project, let them know that Seattle Public Utilities is in the early stages of planning the project, and give them the heads-up that personalized introductory letter will be sent out. Gather initial information about specific concerns and existing conditions that will inform the site selection process.
- Send personalized introductory letter to residents in the basin to introduce the project purpose and need, describe the proposed solution, introduce a contact person should residents or businesses have questions or concerns, and ask residents to contact Seattle Public Utilities if they have questions or would like a one-on-one briefing. Include the fact sheet and FAQs. Also include a brief survey to gather information about specific concerns that could inform the site selection process.

- Provide briefings to community groups at their regular meetings to introduce the project and project contact and gather input (i.e. community councils, stakeholder groups, citywide NGOs).
- Update micromedia and mainstream media about the project and the upcoming public engagement opportunity.
- Hold a public engagement opportunity, such as door-to-door outreach, staffing an outreach table at a local park or community center, or holding a public meeting or interactive workshop to introduce the project purpose and need, decision process, and criteria for street selection; present the streets that have the most potential for natural stormwater management; and identify opportunities to realize multiple benefits and address community concerns and considerations. If possible show animation of how natural stormwater management upstream works to prevent sewage overflows at downstream outfalls.
- Send email to listserv members, local stakeholder group and meeting participants summarizing the outcomes from the first public engagement activity and how the community input will be considered as SPU narrows the sites under consideration
- Hold internal briefings with SPU Executive Managers and SDOT, DPD, DON, and Parks. Offer briefings with an Executive Manager to the Mayor's office and City Council. Update on the outcomes of the first public engagement activity and how the input was considered and addressed as Seattle Public Utilities narrows the sites under consideration.
- Produce and mail a personalized letter, flyer or postcard to announce fieldwork that could affect residents and businesses, such as geotechnical investigations and surveying. Clarify what residents can expect during the fieldwork (e.g. noise levels, visual effects, parking and access impacts, duration of work, and maintenance after construction is completed).
- Provide project staff and consultants working in the field with business cards for the SPU contact person. Ask project staff and consultants to distribute these cards to anyone who has questions about the project.
- Offer site tours of RainWise participants in the neighborhood.
- Document all public engagement activities and log all communications with the public.

6.5.3 Milestone: Detailed Evaluation of Alternatives

Selection of specific streets and blocks where natural stormwater management project will occur

Public involvement objectives

- Continue to educate the affected community about the nature and seriousness of the sewage overflow problem.
- Continue to familiarize the affected community with natural stormwater management solutions.
- Provide potentially affected stakeholders with meaningful opportunities to discuss their preferences about the siting and design of natural stormwater management with Seattle Public Utilities.
- Demonstrate to the public how their input influenced project decisions.
- Gather public input that will support the evaluation of alternatives.
- Communicate with every adjacent property owner and resident.

- Clearly show the public engagement process and how public input helped to inform decisions around project siting, design and construction.

Tasks

- Revisit the stakeholder analysis and determine whether the PEP needs to be revised based on the alternatives under consideration. Be sure to consider the equity stakeholder analysis and any new impacts on low-income, minority or limited-English residents.
- Update PEP as needed
- Update project collateral to show the narrowed geographic area under consideration
- Send project update mailing to residents and property owners on all potentially affected streets (can be combined with invitation to public meeting)
- Hold second local stakeholder group meeting ahead of the next public engagement opportunity to preview materials and gather input on street selection, design criteria, and other community considerations
- Update micromedia and mainstream media about the project and the upcoming public engagement opportunity
- Hold a public engagement opportunity, such as door-to-door outreach, staffing an outreach table at a local park or community center, or holding a public meeting or interactive workshop to present alternatives for selected streets and provide opportunities for focused input on design features
- Send email to listserv members, local stakeholder group, and meeting participants summarizing the outcomes from the first public engagement activity and how the community input will be considered as Seattle Public Utilities selects streets
- Hold internal briefings with Seattle Public Utilities Executive Managers and SDOT, DPD, DON, and Parks. Offer briefings with an Executive Manager to the Mayor's office and City Council. Update on the outcomes of the first public engagement activity and how the input was considered and addressed as Seattle Public Utilities selects streets
- Update the project materials to show selected streets and graphic information about what the project will look like (i.e. design visualizations, renderings, and photos of similar projects).
- Hold one-on-one outreach events in the community, such as a table at a neighborhood park or grocery store and small meetings hosted in residents' homes (see Chapter 2) to address potential concerns, answer questions, and provide opportunities for focused input on design features
- Document all public engagement activities and log all communications with the public

6.5.4 Milestone: 30%/60%/90% Design

Public engagement objectives

- Continue to educate the affected community about the nature and seriousness of the sewage overflow problem.
- Continue to familiarize the affected community with natural stormwater management solutions.

- Provide potentially affected stakeholders with meaningful opportunities to discuss their preferences about the siting and design of natural stormwater management with Seattle Public Utilities.
- Demonstrate to the public how their input influenced project decisions.
- Gather public input that will support the decision-making process at each milestone, such as site selection and design.
- Educate the community on what they should expect to see, hear, and do during construction.
- Give the affected community enough time, opportunity to provide input, and information to consent to the project.
- Clearly show the public engagement process and how public input helped to inform decisions around project siting, design and construction.

Tasks

- Update project materials as the design advances to show how the project will look
- Send project update mailing (can be combined with invitation to public meeting) to Tier 1 and 2
- Hold a local area stakeholder group meeting ahead of the next public engagement opportunity to preview materials or, as needed, to gather input on design elements or areas of issue or concern
- Update micromedia about the project and to publicize the public engagement opportunity
- Hold a public engagement opportunity, such as door-to-door outreach, staffing an outreach table at a local park or community center, or holding a public meeting or interactive workshop to report back to the community on how their input was considered and addressed in the design. Provide affected residents and businesses with an opportunity to provide input on specific design considerations and anticipated construction impacts.
- Send email to listserv members, local stakeholder group, and meeting participants summarizing the outcomes from the first public engagement activity and how the community input will be considered as Seattle Public Utilities continues with the design process
- Hold internal briefings with SPU Executive Managers and SDOT, DPD, DON, and Parks. Offer briefings with an Executive Manager to the Mayor’s office and City Council. Update on the outcomes of the first public engagement activity and how the input was considered and addressed as Seattle Public Utilities continues with the design process
- If necessary, offer an additional public engagement opportunity
- Offer site tours (see **2.7.2 Public engagement or two-way communications**) to discuss site specific design elements and gather input and identify concerns.
- Conduct another round of door-to-door introductions with Tier 1 to ensure contact is made with all adjacent residents and businesses
- Document all public involvement activities and log all communications with the public

6.5.5 Milestone: Construction

Public engagement objectives

- Build and sustain trust with stakeholders by maintaining a consistent project contact and easy access to Seattle Public Utilities staff from project initiation through construction.
- Educate the community on what they should expect to see, hear, and do during construction.
- Clearly show the public engagement process and how public input helped to inform decisions around project siting, design, and construction.

Tasks

- Send weekly listserv updates and update the website weekly with photos of construction progress and information about what residents should expect to see, hear, and do in the coming week related to construction
- Hold internal briefings with Seattle Public Utilities Executive Managers and SDOT, DPD, DON, and Parks to update them on the plans for construction
- Host small meetings with affected property owners ahead of major construction activities, detours or other invasive work
- Provide construction workers with cards that have the project contact name and contact information, to distribute to anyone who has a question about the project
- Place signage adjacent to construction sites that explain the project purpose and need, timeline, what to expect during construction, and contact information if people have questions.
- Update micromedia about the project.
- Document all public engagement activities and log all communications with the public

6.5.6 Ongoing Communications Tools

In addition to activities at specific project milestones, project communications should be ongoing and frequent. Regular project communications can be achieved through the following tools (see Chapter 2):

Listserv

From project initiation through construction, the project team should follow a tiered approach for sending listserv messages. Residents of the basin should receive a listserv message on a monthly basis. Stakeholders on the streets where projects are located and adjacent to projects should receive listserv messages more frequently, especially before and during key siting, design and construction milestones. Project materials, including the website, fact sheets and business card, should include a message that encourages people to subscribe to the listserv. The purpose of regular listserv messages is to highlight information posted on the project website plus ongoing and upcoming public engagement opportunities. Listserv messages should always include the project contact person’s email address and phone number.

Frequently Asked Questions (FAQs)

At project initiation, the project team should prepare an FAQ that addresses the questions and concerns that have or could arise. Especially in the case of roadside rain gardens, photos and visualizations will be essential tools for answering key questions, such as,

- What will the rain garden look like when it is first planted? During a storm when it is working? In one year? In five years?
- What will the new signage look like?

The project team should update FAQs frequently as new questions and concerns arise. The project team should print FAQs and distribute them with the introductory packet and at public meetings, local stakeholder group meetings, and neighborhood and community briefings; and post them on the project website.

Website updates

From project initiation through construction, the project team should update the website on a regular basis. The website should always have materials for public meetings, summaries from past meetings, project-related documents, current maps, project photographs, frequently asked questions, a link to subscribe to the listserv, links to related media coverage of natural stormwater management projects and instructions for submitting comments or providing input. Project materials, including fact sheets, the business card and listserv messages should encourage people to visit the project website.

Chapter 7 – Public Engagement Evaluation and Reporting

An essential component of informed consent is documenting and reporting all public engagement efforts, public input, and how feedback from the community was considered and addressed in the decision-making process. If a citizen raises concerns to an elected official about a Seattle Public Utilities project, that decision-maker will need to be able to demonstrate that Seattle Public Utilities conducted a thorough and fair public process.

7.1 Tools for evaluation and reporting

7.1.1 Public Engagement Activity Summary

At the conclusion of every public engagement activity, the Community Outreach Lead or Outreach Implementer should complete a brief one-page summary of the activity that documents:

1. The format and content of the activity
2. Who was notified about the activity and how they received notification (e.g.: newspaper advertisement, postcard, personal invitation from the Community Outreach Lead)
3. Number of residents reached
4. Relevant demographic information (such as language groups)
5. Any key themes, issues, and concerns that emerged.

The Community Outreach Lead should also attach all related print collateral that were developed for the activity, such as boards or handouts. It is also a good idea to include photos from events.

7.1.2 Project Milestone Outreach Summary

The Community Outreach Lead should assign specific outreach responsibilities. This includes developing a summary of public engagement activities and outcomes at the conclusion of each project milestone, using the Public Engagement Activity Summaries. The primary audiences for this summary are decision-makers and the public, so the document should be written as an executive summary of public engagement activities during that project milestone; key themes, issues, and concerns that emerged; and how those themes, issues, and concerns were addressed in project decisions.

The Project Specifier or Project Manager will need to participate in developing the summary and providing information about how public input was considered and addressed in project decisions.

7.1.3 EIS Public Comment Summary

After a comment period for an EIS process is closed, the Community Outreach Lead should review an overview of the public engagement activities for the EIS and timing and scope of notifications. The summary should also include all comments received via email, comment forms and on flip charts at public meetings. This summary should be developed following the comment period for a DNS, Scoping, publication of the Draft EIS, and publication of the Final EIS. The primary audiences for this summary are DOE and the public.

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King County
Department of Natural Resources and Parks
Wastewater Treatment Division
201 S. Jackson St., KSC-NR-0505
Seattle, WA 98104-3855

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PERMIT NO 836

Barton Combined Sewer Overflow Control (CSO) Project

Pre-Construction Survey

Please take our survey. When completed, refold the survey so the Business Reply Mail panel is showing, tape it closed, and mail it back to us. Thank you!

SEATTLE WA 98104-9887
201 S JACKSON ST
KSC-NR-0505
KING COUNTY DEPARTMENT OF NATURAL RESOURCES AND PARKS
WASTEWATER TREATMENT DIVISION
ATTN: KRISTINE CRAMER

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NECESSARY
IF MAILED
IN THE
UNITED STATES

King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

Barton Combined Sewer Overflow Control (CSO) Project

Pre-Construction Survey

January 2014

The King County Wastewater Treatment Division (WTD) would like to hear from you prior to the start of construction later this year for the Barton Combined Sewer Overflow (CSO) Control Project. Thank you to all the community members who contributed time and provided input during the project design process. This project will install roadside rain gardens in the planter strips on 15 streets in the Sunrise Heights and Westwood neighborhoods of West Seattle. Roadside rain gardens will protect our environment by keeping stormwater out of the sewer system and reducing sewer overflows into Puget Sound during large storms.

King County wants to minimize disruptions caused by construction as much as possible. The information from this survey will help construction crews work with neighbors and commuters who will be directly impacted by this project.
King County will host a community meeting to share more specific information about the construction schedule and activities on January 23 and 25. Look for a meeting invitation in your mailbox.

Prefer to submit your answers electronically? Visit **www.kingcounty.gov** *and search for "Barton CSO" - the survey will be at the top of the page.*

1. **Please provide your name and contact information** *(we need this information so we can contact you if the contractor has follow up questions about the information you provide here):*

Name

Address

Phone Email

2. **Please indicate any special needs you have that would be helpful for the contractor to know** *(check all that apply):*

- ☐ Disability parking
- ☐ Frequent daytime deliveries
- ☐ Child or elder care
- ☐ Work at night/daytime sleep
- ☐ Other *(please explain)* ______

continues

3. **We plan to keep you informed during construction. You can expect fliers left at your door and email notifications of construction activities if you are on our email listserv. What other methods work well for you for construction updates:** *(check all that apply)*

- ☐ Social media – Facebook, Twitter, etc. *(please specify):* ______
- ☐ Presentation at community group *(please specify):* ______
- ☐ Project sign and flyer box near project area
- ☐ Posted community notices – bulletin boards, library, retail outlets *(please specify):* ______
- ☐ *Other (please specify):* ______

Please provide your contact information above if applicable

4. **What additional comments would you like to share with the project team about upcoming construction?**

Thank you for your time and input!
Please contact Kristine Cramer via phone: **206-477-5415** or e-mail: **kristine.cramer@kingcounty.gov** to share any additional comments.
For more information about the Barton CSO Control Project, visit **www.kingcounty.gov** and search for "**Barton CSO**."

Template for Frequently Asked Questions for GSI CIPs*

*Contact SPU GSI Projects Manager for copy of the word document template for the Project Team to use as a starting point in developing FAQs. FAQs are to be tailored to project specific conditions.

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Appendix C: Project Report Example Outline

- Project Report Example Outline for GSI Projects, Draft August 2018

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(use lead agency's logo) **DRAFT**

Project Report Example Outline for GSI Projects
(Draft August 2018).

Notes to users of this Project Report Outline:

- *Modify outline accordingly for project specific needs.*
- *Users may tailor format setup (style, font, etc).*
- *This document is intended to combine all the various elements of reporting/documentation from Options Analysis through Design phase. Elements/sections may be "clipped" or "excerpted" as needed for submittals/deliverables.*
- *It is intended that this document be updated, amended as the project goes through the different phases from Options Analysis to Design.*
- *Text in red with italics is intended to be instructions to the user describing the type of content to be included in that section. The text is to be removed by the user.*
- Text in red without italics *is example text that should be removed and updated based on project specific information. Or it is text that is to be overwritten and filled in. (i.e. for "Owner" on the cover page insert in who the project's owner/developer/agency.)*
- *For SPU's Options Analysis phase (which is similar to work done on WTD projects for problem definition, alternative analysis, development of preliminary project charter and recommended alternative to move to design), users only complete sections that are highlighted in yellow within this document. For WTD-led GSI projects revise references to "Options Analysis" to WTD terminology.*

Owner
PROJECT NAME

Project Report (Technical and Project Management) for Phase

Date: Month Day, Year

Project Location: Name of site/Address
Watershed

Prepared for:
Seattle Public Utilities/King County Wastewater Treatment Division
Address
PM contact: name, phone, email
SPU/WTD Project Number: #
SPU Project Pathway (if applicable): Co-Siting, or Grassroots

SPU/WTD Partner (if applicable): SDOT/Localized/Resident
Contact: name, phone, email

Prepared by:
Company Name
Address
Contact: PM/Engineer name, phone, email

Insert Engineering Stamps/LA Stamps or include on separate page

Table of Contents

List of Figures:
Suggested Figures for Project Report include:

- Vicinity/Basin Map
- Project Study Area
- Geologic Testing Sites w/n Project Area
- Key Map of Streets Selected for GSI
- Overview street map of footprint of GSI
- Flow diagram for the GSI facilities
- Example cross-sections or excerpts from the design/SIP drawings
- Other

List of Appendices
Suggested list of Appendices

- SPU's Geotechnical Interpretive Report/ WTD Geotechnical Design Report
- Environmental Site Assessment
- Archaeological and Historical Review
- Environmental Review (SEPA, SERP, NEPA etc)
- Public Engagement Plan
- Field Assessment Memo
- Parking Study
- Existing Tree Assessment
- Concept Drawings
- Modeling Report
- Natural Drainage Systems Data Sheet (for use in Creek Watersheds)
- Capital Cost Estimates Details and Assumptions
- Technical Design Memo(s) (e.g. structural, existing sidewalk assessment, MEF for ADA curb ramp restoration)
- Drainage Report for Stormwater Code Compliance (if applicable)
- Life Cycle Cost Estimates and Assumptions
- Approved Drawings (SDOT and other permits)
- Contract Documents
- Permits
- Monitoring plan
- Operations & Maintenance Plan
- *Other as applicable to project*

References

List references used to compile this report

- *Reports listed in SPU's DS&G checklist, as applicable to project*
- Project Management Plan
- City of Seattle Standard Plans and Specifications
- GSI Manual Vol I-V
- *Other*

1 EXECUTIVE SUMMARY

Complete the executive summary section after completing relevant sections of the report

1.1 Project Location and Background

- *State the project location and project type (Roadway, Parcel, etc).*
- *State how/why the project came about (i.e. grass roots site, localized flooding program, etc) and other drivers for the project (SDOT partnering, Long Term Control Plan, etc).*
- *Identify key project goals*

1.2 Project Description

- *State the project extents*
- *Provide a brief summary of the proposed improvements, including stormwater and non-stormwater elements*
- *Summarize how proposed improvements will address key project goals*
- *Summarize GSI potential and why it is being included in the design*
- *Identify relationships to other projects and agency goals*

1.3 Regulatory Requirements

1.4 Summary of Alternatives for Options Analysis

- *For Options Analysis projects, provide a brief description of each alternative, complete the summary table, and provide an explanation of the recommended alternative and why it was selected*

Alternative #	Construction Cost Estimate	Potential Effective Impervious Area mitigated by GSI beyond SW Code	Pros (include benefits)	Cons (include major constraints)
(# and brief description)			*(e.g. benefits)*	*(e.g. major constraints)*

1.5 Scope for Design Phase/Selected Alternative

1.6 Schedule

1.7 Budget/Opinion of Probable Construction Cost

1.8 Next Steps/Other

2 INTRODUCTION

2.1 Purpose of this Document

- *Project overview*
- *Project management*
- *Technical information*

2.2 Project Overview and Background

- *Describe project location*
- *Insert Vicinity Map/Project Study Area Map*
- *Type of project (Roadway, Parcel, NDS retrofit)*
- *Issues or other drivers (CSO Consent Decree, Long Term Control Plan (LTCP), Greenway, GSI policy, etc).*
- *Is project included in CIP or General Sewer Plan?*

2.2.1 Regulatory Requirement

- *List regulatory requirements, consent decree, stormwater code etc*

2.2.2 Project Goals and Objectives

The project's primary goals are to:

- *X*
- *Y*
- *Z*

2.2.3 Project Stormwater Performance Objectives/CSO Control Performance Objectives

Combined Sewer Overflow Event Reduction: *"N/A" if not used*

Combined Sewer Overflow Volume Reduction: *"N/A" if not used*

Stormwater Volume Reduction: *"N/A" if not used*

2-year Peak Flow Reduction: *"N/A" if not used*

Water Quality Treatment: *"N/A" if not used*

Stormwater Conveyance: *"N/A" if not used*

Other: *"N/A" if not used*

2.2.4 Relationship to Other Projects and Agency Goals

This project is a joint partnership with Name Agencies. It will also meet other Agency's goals of describe goals as described in (cite Ped Master Plan, Bike Master Plan, LTCP etc,)

- *Summarize any potential overlaying community or interagency projects/priority areas. Identify if cost-sharing opportunities are known or have been investigated.*
- *What are the partnering opportunities, if any (SDOT, SPU Spot Drainage, etc?)*
- *Are there any indicators that this block is within an underserved community and/or there are potential barriers to participation? Is this block located within the elementary school collection areas with the highest diversity of languages and lowest income? Are there needs for language translation support?*

2.2.5 Stormwater Code Compliance

A Drainage Technical Memorandum/Report was prepared documenting the project's compliance with the City of Seattle Stormwater Code. See Drainage Report/Technical Memorandum/Data Sheets in Appendix ??.

2.2.6 Other Project Design Documentation

Describe other reports/technical memorandums for the design that were completed for the project that are not covered herein. Such as if the project involved a Green for Gray Analysis for the consent decree or Maximum Extent Feasible documentation for curb ramp design for ROW restoration, etc.

3 EXISTING CONDITION

- *This section may be omitted if information is provided as a separate memo (so it can be updated as more information is found) and included in the Appendix.*
- *Describe pre-developed conditions, land use, drainage basin, hydrology and flow patterns (including spot drainage, flooding or conveyance issues), existing infrastructure, point of discharge, groundwater quality, public health concerns, etc.*
- *Provide a subbasin map for the project site(s) and highlight the downstream flow/conveyance system to the outfall in the creek/water body/combined sewe*r

Drainage basin

- *Listed Creek basin?*
- *Non-listed Creek basin?*
- *Designated Receiving Water?*
- *Combined Sewer Service Area?*
- *Current point of discharge*

Environmental critical area:

- *Steep slope*
- *Potential slides*
- *Riparian corridor*
- *Wetland*
- *Liquefaction,*
- *Landfill*
- *Known landslides,*
- *Wildlife,*
- *Endangered species*
- *Peat/Ground water management*
- *Flood Prone (floodplain map)*

3.1.1.1 Project Area Drainage/Combined Sewer Conditions

- *Provide a summary of the project area drainage/combined sewer conditions, including total area, conveyance system to the downstream system, where it overflows/drains to (or potential discharge location)*, *etc.*

- *Note: For SPU Options Analysis projects answer the following spot drainage/flooding questions and reference relevant photos as an Appendix (e.g. impact/flooding area, potential discharge location, contributing flow areas):*

Existing spot drainage and/or flooding issues:

For SPU-led localized flooding projects include the severity and assumed frequency of flooding and a description of affected properties and/or right-of-way areas based on available SPU data or site observations. For bullets below, these are from a specific SPU spot drainage project. Users shall refer to SPU's General Design Guidance document for Drainage Level of Service Design Criteria and revise accordingly.

- Spot drainage issues: identify existing spot drainage issue locations and the probable cause of the spot drainage issue. "N/A" if no issues.
- Flooding of infrastructure: is there flooding of existing infrastructure that, based on available information, indicates a frequency of more than once per 25 years? "N/A" if no issues.
- Flooding of private structures: is there flooding of existing private structures (i.e. garages, residences, etc) that, based on available information, indicates a frequency of more than once per 10 years? "N/A" if no issues.
- Flooding into arterial streets: is there flooding of existing arterial streets that spreads beyond the right-of-way and/or floods half of an arterial street that, based on available information, indicates a frequency of more than once per 10 years? "N/A" if no issues.
- Flooding into non-arterial streets: is there flooding of existing non-arterial streets that spreads beyond the right-of-way and/or floods half of a non-arterial street that, based on available information, indicates a frequency of more than once per 10 years? "N/A" if no issues.
- Ditch overtopping: is there flooding of existing ditches that, based on available information, indicates a frequency of more than once per 5 years? "N/A" if no issues.

Is there likely a need for detention given current conditions and/or under future conditions with increased connectivity?

- *"Yes" or "No". If "Yes," describe. For example, is there a likely need to provide detention to address downstream capacity issues?*

3.1.1.2 Project Area Geologic Conditions

Provide a summary of the geologic area and refer to the geotechnical report for the project for more information.

4 PROPOSED FUTURE CONDITIONS

- *Describe proposed future conditions (such as new sidewalk, road widening, street trees, drainage infrastructure etc), land use (if applicable-subject to change from existing land use), basin etc- similar to what you would talk about in Existing Condition but described what is being proposed.*
- *Are there existing impervious areas that don't contribute to downstream conditions in the existing conditions due to lack of conveyance that will contribute in proposed conditions? if yes, describe these new impervious areas connected to the downstream condition in the proposed condition (e.g. new asphalt thickened edge allows previously ponded area to drain to downstream system)*

5 PROJECT MANAGEMENT

5.1 Scope and Limitations (optional)

- *Describe scope and limitations, for example:*
  - *The scope of the project is based on using ____ to achieve the project goals.*
  - *Conventional treatment is not considered.*

5.2 Project Budget

5.2.1 Opinion of Probable Construction Costs

- *See each agency's standards for developing construction cost estimate.*
- *If SPU-led CIP and involves cost sharing with SDOT, see SPU/SDOT cost sharing procedures or reference MOA if it was developed for cost sharing.*

5.2.2 Opinion of Probable Life Cycle Costs

- *Include capital & O&M costs of selected alternative, and project funding sources*
- *Coordinate with SPU O&M/WTD O&M for their estimates for standard elements in GSI O&M manual in preparation of life cycle cost estimate.*

5.3 Permitting

- *List permits expected for project and challenges*

No.	Permits	Obtain by	Comments
1.	Side Sewer Permit	Contractor	
2.	Street Use Permit	Contractor	
3.			
4.			
5.			

5.4 Environmental Review

- *Discuss environmental review for the preferred alternative (SEPA, SERP or NEPA).*
- *If applying for SRF funding, include SERP or NEPA. Include SEPA, SERP, NEPA in the Appendix of this report.*

5.5 Project Schedule

- *Provide an overview of project schedule. Consider risks and how that affects the project schedule (e.g. plant establishment will be longer if initial plantings occur in the winter). Keep schedule high level if submitted to Ecology*

SPU's Options Analysis	Quarter Year Through Quarter Year
WTD's Problem Definition	Quarter Year Through Quarter Year
WTD's Alternative Analysis	Quarter Year Through Quarter Year
WTD's Preliminary Project Charter	Date completed or Expected.
Design Phase Ecology Draft Review Submittal SDOT Review of Plans and Approval Bidding of Construction Documents	Date completed or Expected. Month Year or Quarter Year Month Year or Quarter Year Month Year or Quarter Year
Construction	Quarter Year Through Quarter Year
Commissioning and Landscape Establishment	Quarter Year
Begin Operations & Maintenance	Quarter Year
Construction Completion per EPA Consent Decree	See consent decree if this is applicable to your project. "N/A" if not applicable.

5.6 Risk Management

- *Provide overview/summary of the risk assessment (e.g. high risks etc) and refer to risk assessment analysis report. Risk register/report to be provided in the Appendix.*

6 TECHNICAL ANALYSIS

6.1 Basis of Design

This BOD addresses design elements for the Options Analysis /Design Phase.

BOD is to be updated to reflect design decisions as the project moves forward.

Users can either enter the BOD in this section or include it as a separate document in the Appendix and note in this section the deviations from the BOD.

For SPU NDS Partnering projects include and reference SPU's General Design Guidance document and put in the Appendix. The following sections in 6.1 will be used to document additional information not covered in the General Design Guidance document and noting any deviations from the General Design Guidance.

6.1.1 Applicable Codes, Standards

The design is based on the most current codes and standards adopted by the Authority Having Jurisdiction (AHJ) as referenced in Section 2.2.1.

The Project will follow *Year* Edition of the City of Seattle Standard Plans and Specification and SPU Design Standards and Guidelines (DS&G) dated Month Year. Additional guidelines we are following that are not referenced in the DS&G are referenced in the following chart:

- *Add or delete items in the chart below as applicable to your project.*
- *Or reference and add chart from NDS Partnering General Design Guidance into the Appendix and delete chart below.*

Standard	Scope Item
Consent Decree between King County and USA & State of Washington, Civil Action No. 2:13-cv-677	CSO Control for King County maintained outfalls.
Consent Decree between City of Seattle and USA & State of Washington, Civil Action No. 2:13-cv-678	CSO control for Seattle maintained outfalls. Appendix C in consent decree describes the requirements for the Engineering Report
City of Seattle, Director's Rule for SMC Chapters 22.800-22.808, SPU Director's Rule DWW-200, DPD DR 21-2015, Volume 3 – Project Stormwater Control, dated January 2016	Code requirement. General GSI design guide.
Seattle's Streets Illustrated (formerly called Right-of-Way Improvements Manual), 2017	Street design requirements

Seattle's Right-of-Way Opening and Restoration Rules, SDOT DR 01-2017	Requirements for street restoration
GSI Manual Volume II – Options Analysis, February 2014	
GSI Manual Volume III – Design, August 2018	GSI facilities in the public ROW that were constructed through SPU/WTD GSI capital projects
Washington Administrative Code 173-160 Minimum Standards for Construction and Maintenance of Wells	
Washington State Department of Ecology 2006 (or most current edition) Guidance for UIC wells that Manage Stormwater	

6.1.2 Deviations from Standards

No.	Deviation	Standards	Approval Authority	Date
1.	(e.g. Maximum street slope for roadside bioretention consideration is 8%)	(e.g. GSI Manual Volume III-Design Section 8.2.3 references 5% or less.)		
2.				
3.				
4.				

6.1.3 Criteria and Assumptions

6.1.3.1 Street Selection Criteria

Aside from meeting the setback and site restrictions noted in Volume 3 of the City of Seattle's Stormwater Manual and guidance in the GSI Manual, the following street selection criteria will be used to assess and prioritize streets for retrofitting existing streets with roadside bioretention.

- *Add or delete items in the chart below as applicable to your project.*
- *For NDS Partnering projects if street selection is described in another document then reference and attach document to Appendix and delete chart below.*

Criteria	Value
Street Classification Type	Residential, Arterial, Neighborhood Yield, Neighborhood Curbless
Streets with longitudinal slope	Not exceeding __%
Minimum existing planter widths	Measurement ft
Roadway pavement material type	Concrete or asphalt pavement
Gutter type	Curb & gutter, asphalt thickened edge, or none
Infiltration feasibility	Yes or No
If swales consolidated at end of block then the planter strip has enough space/continuity at the downstream end of a block where bioretention cells would be placed (minimal obstructions such as driveways, mature trees, power poles, fire hydrants, underground utility main corridors etc)	Yes or No
If swales are distributed throughout a block then there is enough space distributed throughout with minimal obstructions for bioretention cells (such as driveways, mature trees, PP, fire hydrants, underground utility main corridors etc))	Yes or No
A street's contributing effective impervious drainage area to Bioretention meets minimum ____ square feet Interception of Effective Impervious ROW Areas to Bioretention facilities is a minimum _____ square feet	Yes or No EIA for ROW Area=_______ sf
If parking is to be removed, assess parking usage on a street and determine maximum parking spaces to be removed on a block (may vary within project area).	
Minimum ROW width or space needed for bioretention placement	
Overlap with other City goals/partnerships	
Other	

6.1.3.2 Design Criteria

- *See Chapter 8 of SPU's DS&G. Modify list accordingly for project design. Add or delete items in the chart below as applicable to your project.*
- *For SPU's NDS Partnering projects if street selection is described in another document (e.g. NDS partnering General Design Guidance, dated August 2017) then reference and attach document to Appendix and delete chart below.*

No.	Item (source)	Value
1.	Reduce CSO events in basin from Consent Decree	No more than one CSO event per year on a 20-year moving average or maximize CSO control performance given feasibility and cost-benefit of GSI
2.	Stormwater volume reduction target	
3.	Peak flow reduction goal	
4.	Water quality treatment goal	
5.	Conveyance	• Channel vs Pipe • Design Storm • Precipitation • Velocity
6.	Conveyance of Overflow/GSI Bypass flows (downstream of GSI)	
7.	Street Selection Criteria	See above
8.	Facility Discharge Process	Discharge of treated water through bioretention via shallow infiltration; underdrain to deep infiltration UIC screen well; pit drain; and/or underdrain with orifice control.
9.	Facility Discharge Design Criteria – Pit Drain	If approved for use by SPU, pit drains shall be designed by a licensed geotechnical engineer. Pit drain design siting see SPU GSI Design Manual Section 10.2.
10.	Bioretention soil mix type	
11.	Bioretention soil mix thickness	
12.	Bioretention soil mix porosity	

13.	Bioretention soil mix long term design infiltration rate	
14.	Maximum temporary ponding depth from a rain event	
15.	Maximum longitudinal slope of swale bottom	
16.	Minimum longitudinal slope of swale bottom	Zero or __%
17.	Freeboard depth (design maximum water surface to elevation at overflow to street gutter and/or into ROW)	
18.	Underdrain Pipe diameter	
19.	Minimum long term infiltration rate for native soils if using shallow infiltration	
20.	Bioretention plantings	Planted vs Seeded
21.	Bioretention watering method	Irrigation vs Drip vs Hand Water
22.	Side wall type	graded vs 1-wall, 4-wall
23.	Road centerline	Shift or maintain existing. If shifted note design criteria for making change.
24.	Curb bulb with bioretention	• Radii • Length • Width
25.		
26.		
27.		

6.1.3.3 Other Criteria:

The siting of bioretention cells along the street is based on the following:

The siting of curb bulbs along the street is based on the following:

6.1.3.4 Other Assumptions

6.2 Options Analysis

FOR WTD-led CIP, SPU's Options Analysis is similar to work completed during WTD's Problem Definition, Alternative Analysis, development of Preliminary Project Charter and selection of a recommended alternative. Revise title of this section accordingly for WTD terminology.

6.2.1 Geologic/Hydrogeologic Analysis

- *Provide a summary of the shallow infiltration potential based on available geotechnical information; summary may include information related to whether GSI will need to be lined, clearance between bottom of bioretention/permeable pavement section subgrade and groundwater levels, etc.*

For Options Analysis (similar to WTD's Problem Definition and Alternative Analysis Phases):

- *Show a map or schematic of houses below grade along the project block(s)*
- *Show a map of GIS critical areas if known from available records.*
- *Describe any seeps or springs that were observed during field visit and note time of year of field visit.*
- *Note whether the project is located within the SPU's "Areas Unsuitable for Infiltration GIS Map" provided for the project (if available)*

6.2.2 Hydrologic/Hydraulic Modeling

- *Provide overview.*
- *Refer to modeling memo(s) in appendix.*

For development of existing conditions hydrologic/hydraulic model (including calibration and validation) and development of the design model to estimate performance refer to the modeling report by Company/Agency and dated Month Day, Year in Appendix __. Based on the modeling results it is expected that the GSI will meet the performance objectives and regulatory requirements referenced in Section 2 of this report.

Consent Decree requirement for facility plans (if applicable):

- *Discuss predicted CSO frequency at CSO outfall (if applicable) based on long-term simulation modeling using a 20-year period of historical rainfall data, the hydraulic model, the CSO control project design and assuming the CSO control project existed throughout the 20-year period.*

6.2.3 Approach

6.2.3.1 BMP selections

- *How does this project select BMP? Based on COS criteria? Deep infiltration? Shallow infiltration?*

6.2.3.2 Site selections/Alternative

The project will assess the streets within the basin for feasibility of using bioretention cross-sections with graded side slopes and without an underdrain within the existing planter strip width.

- *Provide a brief description of each alternative developed and evaluated and include a completed datasheet for each alternative in the Appendix.*
- *Reference parking study and other analysis as appropriate.*

- *Describe the ranking process/analysis used for street selection/alternatives and final recommended alternative. Criteria may include: soils infiltration rate/capacity, environmental impacts, public acceptability, meeting regulatory compliance, ease of maintenance, capital costs, present worth (including O&M).*
- *If the project includes Ecology funding, include a cost-effective analysis (and address the "cross cutters") of the alternatives.*

6.2.3.3 Feasibility summary

- *Summarize and reference the windshield survey report/comments, which will be included as an appendix*
- *For each block indicate:*
  - *Is the block rated as a High/ Medium / Low feasibility? If multiple blocks, describe each.*
  - *Can the block receive more than its own runoff? Yes / No*
  - *Are there any apparent major utility conflicts within the proposed GSI areas? Specifically, are there significant water mains, especially with cast iron lead joints, gas mains, banks of telecom, fiber or power? Describe conflicts and significance.*

6.3 Design Phase Analysis

6.3.1 Overview

- *Summarize how the design meets the regulatory requirements, project goals and objectives, and stormwater performance requirements referenced in Section 2.*

6.3.2 Geologic/Hydrogeologic

Refer to the geotechnical report by Company/Agency and dated Month Day, Year in Appendix __.

- *Summarize key points such as soil type, infiltration rate/capacity, depth to groundwater, etc.*
- *Geotechnical/Geologist/Hydrogeologist to review design and confirm it meets the geotechnical design report recommendations. If not, document reasons for deviating from geotechnical design report.*

6.3.3 Hydrologic/Hydraulic Modeling

- *Provide overview/summary of results.*
- *Modeling memo(s) (basin, conveyance sizing etc) to go in Appendix.*

Based on the modeling results it is expected that the GSI will meet the performance objectives and regulatory requirements referenced in Section 2 of this report.

6.3.4 Land Use, Street Classification and Street Type

- *Describe existing adjacent land use*
- *Summarize review of land use zoning map (present and future – is it developed as single family but is zoned as Lowrise?).*
- *List industrial and other users/uses in area that may impact stormwater quality.*

- *SDOT street classifications (e.g. non-arterial, minor arterial, collector arterial etc).*
- *SDOT street type (e.g. Urban Village Neighborhood Access, Neighborhood Yield, Neighborhood Curbless, etc)*

6.3.5 Design Approach and Elements

- *In this section and via the sub-bullets below, describe sizing criteria/calculations (e.g. Is it Integrated Plan goal, CSO Consent Decree requirement), what you are using to design and size the elements of the plan, how you are siting and designing the elements within the project area etc.*

6.3.5.1 Survey/Basemap

6.3.5.2 Existing Trees Assessment

If arborist report was prepared include a copy in the appendix.

6.3.5.3 Siting Bioretention Cells on a Street

6.3.5.4 Presettling

6.3.5.5 Method of discharge: UIC Well/Pit Drain/Orifice Control

6.3.5.6 Bioretention Planting and ROW Landscape

The landscape design is an integral element of the bioretention cell design. Not only must the bioretention cells function by way of infiltration, water quality treatment and erosion control but the cells must fit within the character of the established neighborhood and meet the operations and maintenance requirements. The below describes the approach for the bioretention plantings and ROW landscape design for the following areas:

Street Character
Planting Zones
Access between Cells/Crossings
Step Out Zones adjacent to back of curb
Street Trees
Plant Establishment and Watering
Landscape restoration outside bioretention cell zones
????

6.3.5.7 Pavement Restoration/Driveways/On-Street Parking

6.3.5.8 Utility Relocates

Describe approach to utility relocates (gas, water, sewer, storm, underground power, OH power, underground franchise, OH franchise, FH, vaults, other utility structures/distribution/services)

6.3.5.9 Existing side sewer assessment

Describe what was assessed and if they are to be replaced, remain, rerouted etc. See GSI Manual, Volume III for side sewer policy.

6.3.5.10 Other

7 PUBLIC ENGAGEMENT PROCESS

- *Consent Decree for KC – Appendix E- Requires a "description of stakeholder outreach and public participation, implemented and planned, associated with the proposed GSI control measures."*
- *Provide a brief summary of outreach completed as a part of Options Analysis and reference applicable public engagement plans.*
  Provide a brief summary of outreach completed as part of the Design Phase and reference applicable public engagement plans.

A public engagement plan was developed for the project and is included in Appendix __.

8 OPERATIONS AND MAINTENANCE

The green stormwater infrastructure facilities (bioretention cells, pervious concrete pavement paths, UIC screen well, ?????, ?????) will be operated and maintained by Agency/Owner.

- *Include proposed maintenance schedule, life cycle and O&M costs, equipment, skills for new elements and/or deviations from GSI O&M volume. For SPU projects, see Asset Management and template for "Blue Book" for developing O&M.*
- *See GSI Manual Volume V for O&M guidance.*

The following agreements will be in place and enforced by Agency to ensure proper operation and maintenance of the GSI facilities:

- *List Agreements*

- *The above statement is from Seattle's Consent Decree (Appendix C-page 63) and similar language in KC's Consent Decree (page 70 in Appendix E)*

9 POST CONSTRUCTION MONITORING

- *Describe the post-construction monitoring and modeling that will be performed to determine whether the GSI Performance Criteria will be met upon completion of the GSI project. (from Seattle's Consent Decree, Appendix C, page 63 and KC's Consent Decree, Appendix E, page 70)*
- *Indicate the implications if this is an Ecology Document*
- *See GSI Manual Volume VI for post construction monitoring guidance.*

10 REFERENCES

11 APPENDICES

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Appendix D: GSI Details and Concepts

► **GSI Details and Concepts**

- Table D-1: Index List of GSI Details and Concepts in Appendix D and in the City of Seattle Standard Plans
- GSI Concepts and Details
  - Bioretention Cell
  - Bioretention Components
  - Bioretention New Street Tree Planting
  - Permeable Pavement
  - Permeable Pavement Components
  - General GSI Components/Miscellaneous

  For details in COS Standard Plans, see City website: http://www.seattle.gov/Util/Engineering/StandardSpecsPlans/index.htm

  For other GSI concepts, see figures in GSI Manual, Volume III, Design

► Table D-2: IDT Design Guidance Criteria for Porous Pavement Retrofit in Neighborhood Yield and Residential Alleys

► Presettling Requirements for Bioretention in COS SWM & ROWIM, SvR Memorandum dated November 8, 2013. (for Reference only, See 2016 City of Seattle Stormwater Manual for requirements)

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GSI Details and Concepts

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TABLE D-1: List of GSI details and concepts in Appendix D and COS Standard Plans

Updated August 2018

MIG|SvR #12034

NOTES to Users:

This list is for details in Appendix D of GSI Manual Volume III - Design and COS Standard Plans only. See Table of Contents for list of figures in Design Volume.

*Figure Types labeled "Detail" are to be adapted to meet project specific conditions and design requirements (they are not construction details). Figure Types labeled "Concept" and "Detail" were either used on past SPU and or WTD CIP projects OR developed through joint SPU/SDOT/WTD Interdepartmental Team meetings as part of the GSI Program.

See City of Seattle 2017 Standard Plans (Std Plan) at following link:
http://www.seattle.gov/Util/Engineering/StandardSpecsPlans/index.htm

Appendix D # or COS 2017 Std Plan#	Figure Type*	Description/Title
BIORETENTION CELL (B-#)		
Std Plan 292	Std Plan	Infiltrating Bioretention with Sloped Sides
Std Plan 293a	Std Plan	Infiltrating Bioretention with Sloped Sides & Underdrain
Std Plan 293b	Std Plan	Non-Infiltrating Bioretention with Sloped Sides and Underdrain
B-3A	Detail	Bioretention with Sloped Sides, Constant Bottom Width
B-3B	Detail	Bioretention with Sloped Sides, Varying Bottom Width
B-4	Detail	Curb Bulb with Bioretention with Sloped Sides (for Neighborhood Yield Streets)
B-5A	Detail	Presettling Zone for Bioretention with Sloped Sides (for Neighborhood Yield Streets)
Std Plan 299	Std Plan	Presettling Zone (for Neighborhood Yield and Neighborhood Curbless Streets)
B-7	Concept	Bioretention Cell with 1-Sided Vertical Wall & 3 Sloped Sides, Infiltration (for Neighborhood Yield Streets)
BIORETENTION COMPONENTS (BC-#)		
Std Plan 269	Std Plan	Beehive Grate for Bioretention
BC-2	Concept	Bioretention Overflow Structure (Draft Detail)
Std Plan 295a	Std Plan	Typical Drain Curb Cut Location for Bioretention with Sloped sides
Std Plan 295b	Std Plan	Drain Curb Cut Opening Type 1
Std Plan 295c	Std Plan	Drain Curb Cut Opening Type 2
Std Plan 295d	Std Plan	Drain Curb Cut Type 3 [at curb bulbs]
Std Plan 281	Std Plan	Bioretention Underdrain Clean-out and Observation Port
Std Plan 291	Std Plan	PVC Subsurface Drain Pipe
BC-8	Detail	Underdrain Trench Section between Bioretention Cells
BC-9	Detail	Pedestrian Access at Curb Edge - Pervious Concrete
BC-10	Detail	Pedestrian Access Path - Pervious Concrete
BC-11	Detail	Pedestrian Access at Curb Edge - Concrete
BC-12	Detail	Pedestrian Access Path - Concrete
BC-13	Detail	Pedestrian Access at Curb Edge - Wood Chip Mulch
BC-14	Detail	Pedestrian Access Path - Wood Chip Mulch
BC-15	Detail	Pedestrian Access at Curb Edge - Concrete Pavers
BC-16	Detail	Pedestrian Access Path - Concrete Pavers
BC-17	Detail	Pedestrian Access at Curb Edge - Gravel and Grid
BC-18	Detail	Pedestrian Access Path - Gravel and Grid
BC-19	Detail	Pedestrian Access at Curb Edge - Turf Grass
BC-20	Detail	Pedestrian Access Path - Turf Grass
Rain Garden (RG-#)		
CAM 1190	CAM	Rain Gardens for On-Site Stormwater Management of Sidewalk Runoff
		http://www.seattle.gov/util/cs/groups/public/@spu/@dso/documents/webcontent/3_037162.pdf
Conveyance (C-#)		
Std Plan 294	Std Plan	Vegetated Conveyance Swale (Not for Water Quality Treatment)

TABLE D-1: List of GSI details and concepts in Appendix D and COS Standard Plans

Updated August 2018

MIG|SvR #12034

NOTES to Users:

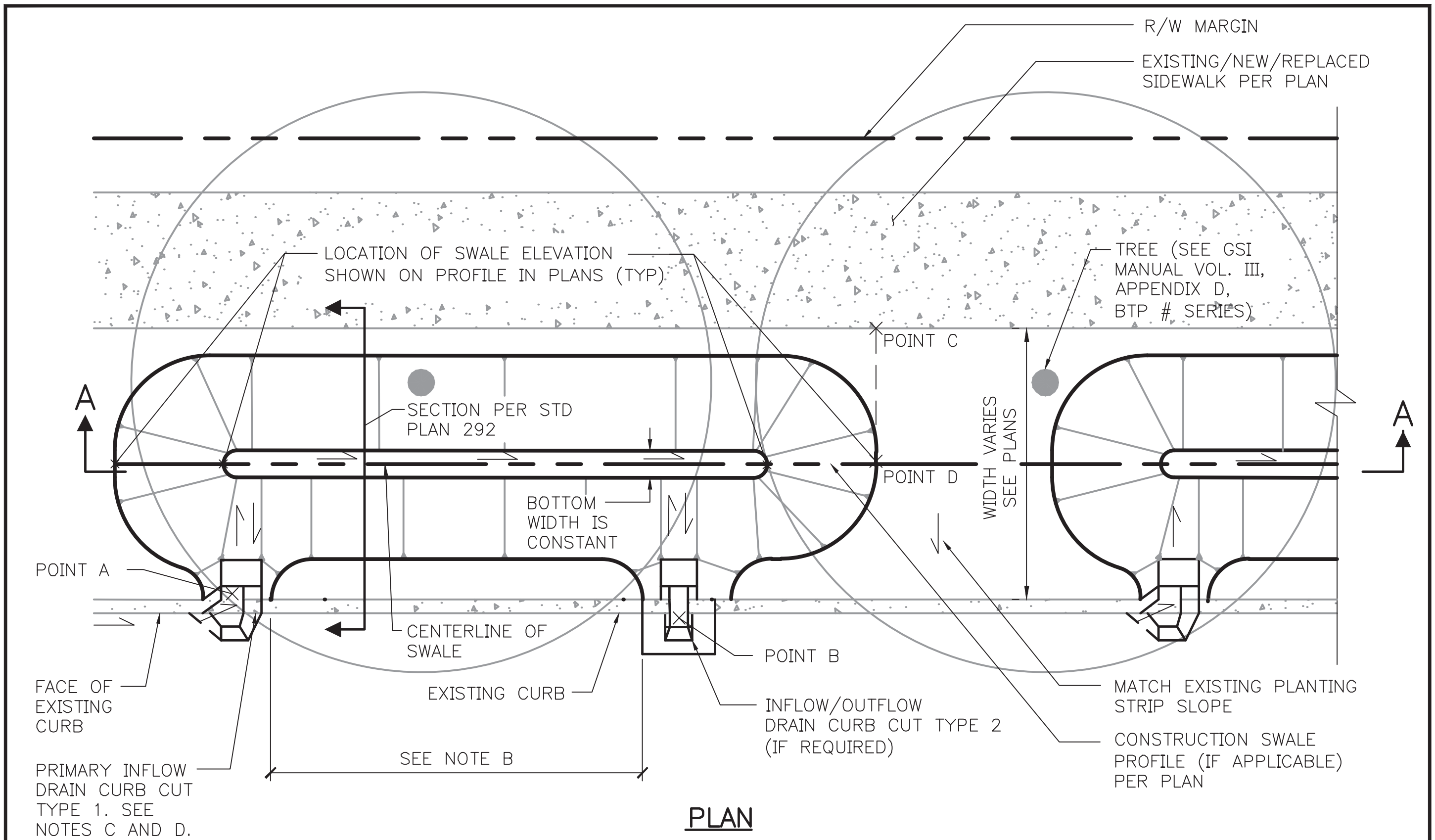
This list is for details in Appendix D of GSI Manual Volume III - Design and COS Standard Plans only. See Table of Contents for list of figures in Design Volume.

*Figure Types labeled "Detail" are to be adapted to meet project specific conditions and design requirements (they are not construction details). Figure Types labeled "Concept" and "Detail" were either used on past SPU and or WTD CIP projects OR developed through joint SPU/SDOT/WTD Interdepartmental Team meetings as part of the GSI Program.

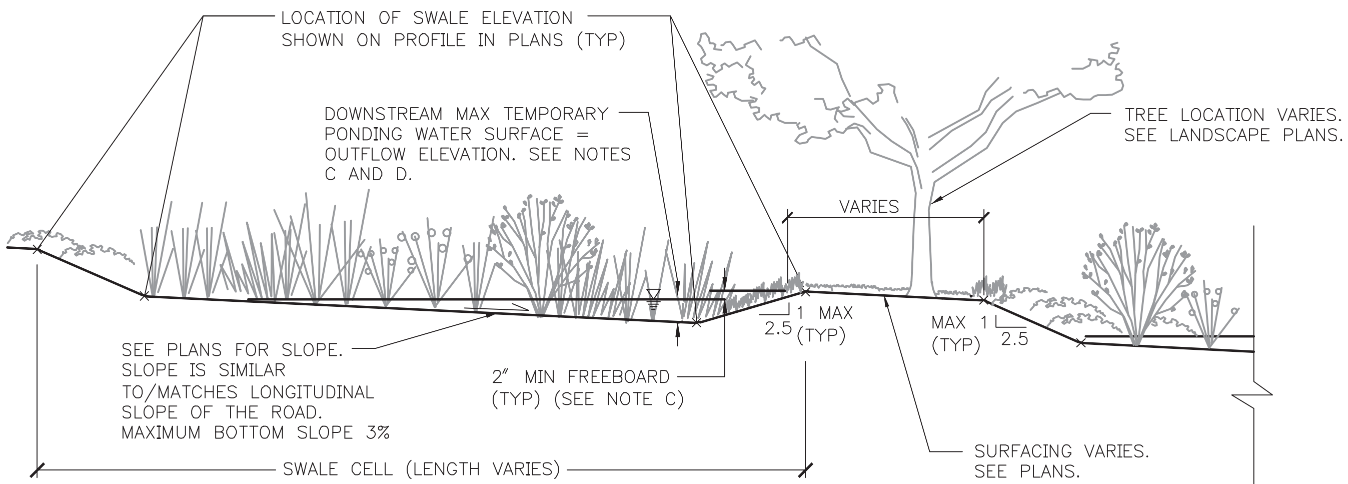
See City of Seattle 2017 Standard Plans (Std Plan) at following link:
http://www.seattle.gov/Util/Engineering/StandardSpecsPlans/index.htm

Appendix D # or COS 2017 Std Plan#	Figure Type*	Description/Title
Bioretention New Street Tree Planting (BTP-#)		
BTP-6	Detail	Tree Planting on Swale Edge Adjacent to Sidewalk
BTP-7	Detail	Tree Planting on Swale Edge Adjacent to Curb
Bioretention Plantings - Related to Standard Plans		
Std Plan 100a	Std Plan	Deciduous Tree Planting in Planting Strip
Std Plan 100b	Std Plan	Tree & Shrub Planting on Slopes
Std Plan 100c	Std Plan	Tree Planting in Amended Trench
Std Plan 101	Std Plan	Coniferous Tree Planting
Std Plan 110	Std Plan	Shrub Planting
Std Plan 111	Std Plan	Ground Cover Planting
Std Plan 112	Std Plan	Planting Pattern
Std Plan 142	Std Plan	Soil Amendment and Depth
Deep Infiltration (DI-#)		
DI-1	Concept	Drilled Drain - Design is project specific. Contact SPU GSI Projects Manager for past project samples.
DI-2	Concept	Pit Drain/Dug Drain - Design is project specific. Contact SPU GSI Projects Manager for past project samples.
DI-3	Concept	Screened Well - Design is project specific. Contact SPU/WTD GSI Projects Manager for past project samples.
Permeable Pavement (PP-#)		
Std Plan 425	Std Plan	Alternative Walkways - Pervious Concrete Sidewalk
PP-2	Concept	Pervious Concrete Pavement Section for Neighborhood Yield Streets
Std Plan 403	Std Plan	Roadway Cement Concrete Alley Pavements (includes section for Pervious Concrete Pavement)
PP-4	Concept	Porous Asphalt Pavement Section for Neighborhood Yield Streets
Permeable Pavement Components (PPC-#)		
PPC-1	Concept	PC Check Dam for Pervious Concrete Streets/Alleys
PPC-2	Concept	Underdrain Overflow Pipe At PC Check Dam for Porous Pavement
PPC-3	Concept	Subsurface Barrier at Interface between Pervious Concrete and Existing Pavement
General GSI Components/Miscellaneous (GC-#)		
Std Plan 030	Std Plan	Standard Locations for Utilities (Residential Streets)
Std Plan 133	Std Plan	Tree Protection During Trenching, Tunneling or Excavation
Std Plan 281	Std Plan	Bioretention Underdrain Clean-out and Observation Port
Std Plan 291	Std Plan	PVC Subsurface Drain Pipe
GC-1	Detail	Utility Trench Dam
GC-2	Detail	Adjustment of Existing Side Sewer (SS) for GSI
GC-3	Detail	Daylight of Existing Curb Discharge into Bioretention with Sloped Sides
GC-4	Detail	GSI Underdrain MH Access Lid

Bioretention Cell (B-#)



PLAN



SECTION A–A

NOTES:

1. SEE CIVIL PLANS FOR LOCATION OF CURB CUTS.
2. SEE LANDSCAPE DETAILS AND PLANS FOR BIORETENTION SWALE PLANTINGS.
3. PROVIDE MOCK-UP OF SWALE GRADING FOR ENGINEER REVIEW.

NOTES TO DESIGNER:

A. INCLUDE MOCKUP OF SWALE GRADING IN SPECS.
B. LOCATION, DISTANCE BETWEEN CURB CUTS, AND NUMBER OF CURB CUTS VARY WITH SWALE LENGTH AND ROAD SLOPE. SEE PLAN FOR LOCATION.
C. ELEVATION OUTFLOW AT DRAIN CURB CUT SHALL BE MINIMUM 2-INCHES BELOW THE LOWEST ELEVATION AT POINT C OR POINT D. OUTFLOW CURB CUT IS CELL SPECIFIC (POINT A OR B).
D. 1ST CURB CUT (POINT A) MAY ALSO BE OUTFLOW WHEN THERE IS ONLY ONE CURB CUT FOR A SWALE CELL.
E. PROVIDE PROFILE OF CELLS WHEN MULTIPLE CELLS ARE CONNECTED IN A SERIES OR CONSTRUCTED ON A BLOCK.
F. IF A DIFFERENT STANDARD PLAN NUMBER THAN 292 IS USED, MODIFY REFERENCES ACCORDINGLY.

REFERENCE GSI MANUAL VOL. III, SECTION 7

Prepared by: MIG | SvR

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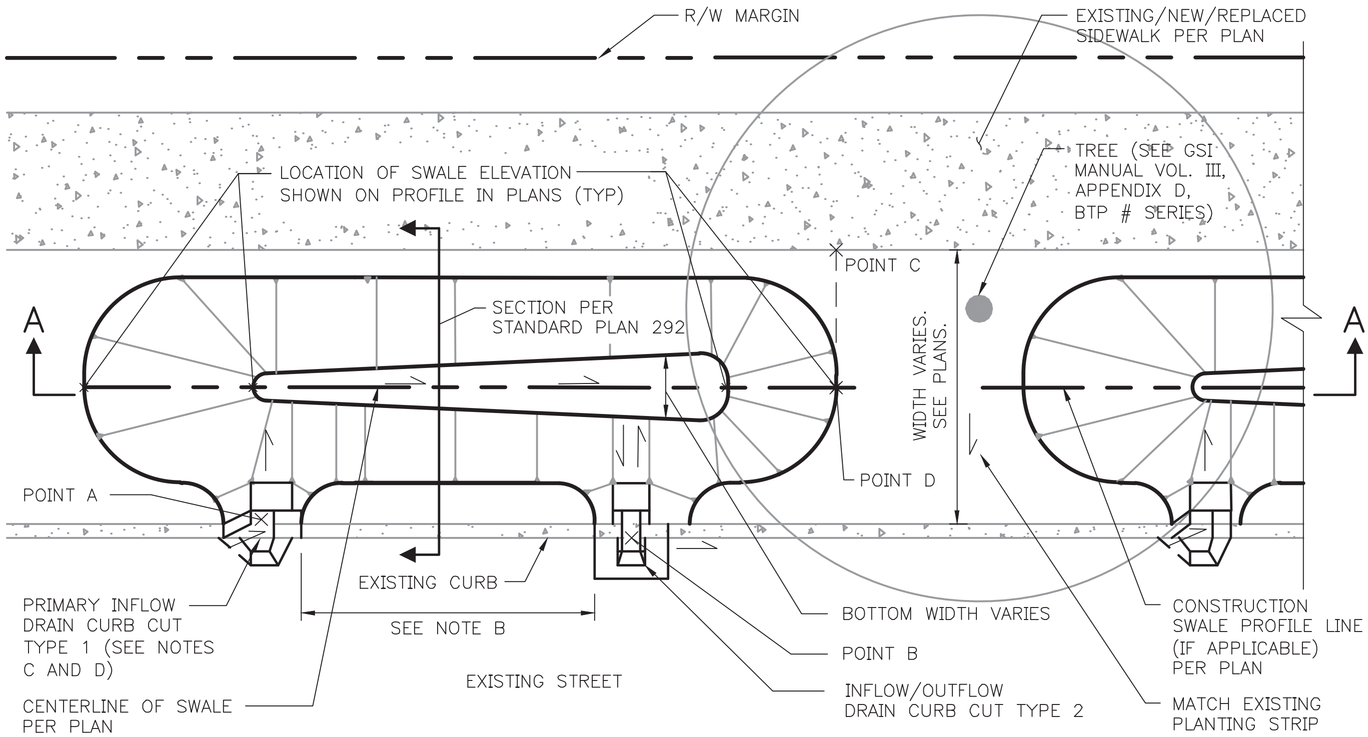
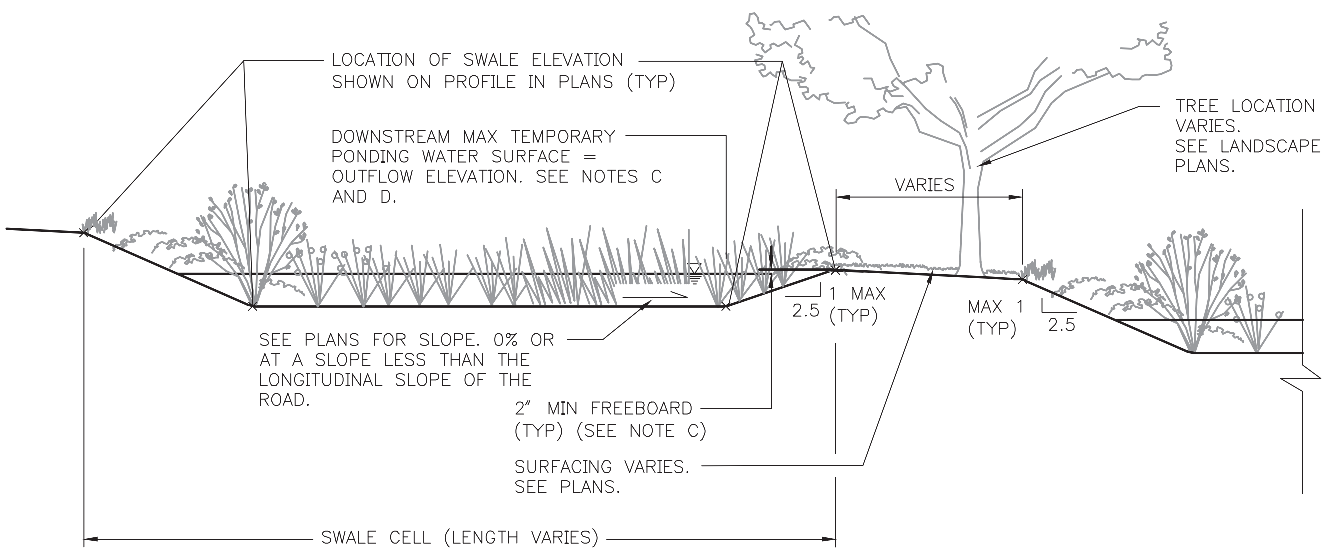
BIORETENTION WITH SLOPED SIDES, CONSTANT BOTTOM WIDTH		GSI MANUAL B-3A
AUGUST 2018	NOT TO SCALE	



PLAN



SECTION A–A

NOTES:

1. SEE CIVIL PLANS FOR LOCATION OF CURB CUTS.
2. SEE LANDSCAPE DETAILS AND PLANS FOR BIORETENTION SWALE PLANTINGS.
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D. 1ST CURB CUT (POINT A) MAY ALSO BE OUTFLOW WHEN THERE IS ONLY ONE CURB CUT FOR A SWALE CELL.
E. PROVIDE PROFILE OF CELLS WHEN MULTIPLE CELLS ARE CONNECTED IN A SERIES OR CONSTRUCTED ON A BLOCK.
F. IF A DIFFERENT STANDARD PLAN NUMBER THAN 292 IS USED, MODIFY REFERENCES ACCORDINGLY.

REFERENCE GSI MANUAL VOL. III, SECTION 7

Prepared by: MIG | SvR

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BIORETENTION WITH SLOPED SIDES, VARYING BOTTOM WIDTH

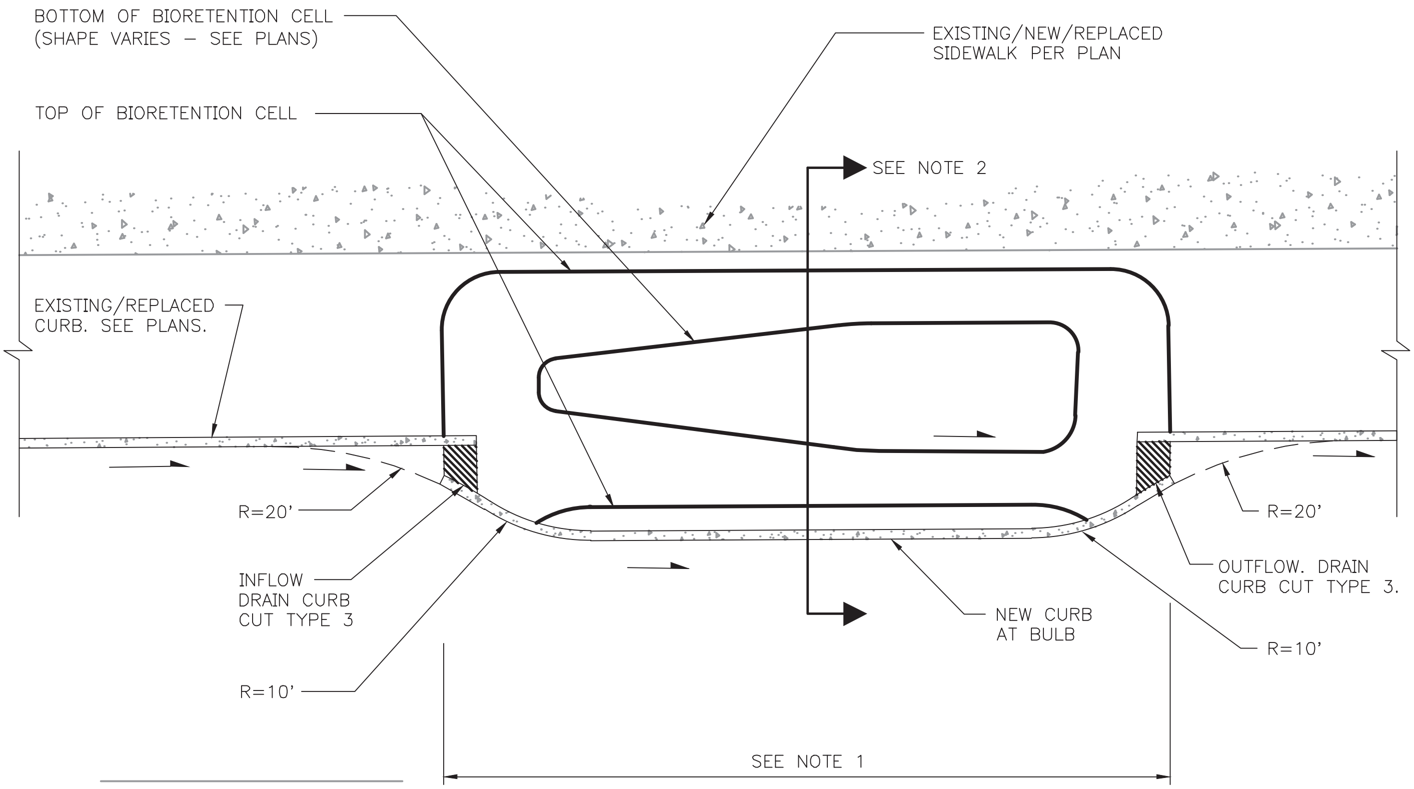
GSI MANUAL

B-3B

AUGUST 2018

NOT TO SCALE

Plotted: Sep 18, 2018 – 1:08:16pm By jordanl
File: G:\12c\12034c SPUGSI\Current\SPU_B-03B_BIORET CELL VARYING BOT WIDTH.dwg Layout: Layout1



NOTES:

1. INSTALL WHITE TYPE 2 RAISED PAVEMENT MARKERS (REFLECTIVE MARKERS) ON TOP OF CURB 5' ON CENTER.
2. SECTION PER PLAN.

NOTES TO DESIGNER:

A. SEE GSI MANUAL VOL. III, APPENDIX D, B–SERIES FOR "BIORETENTION WITH SLOPED SIDES" SECTION.
B. SEE STREETS ILLUSTRATED ROWIM FOR CURB BULB RADIUS DESIGN REQUIREMENTS.

REFERENCE GSI MANUAL VOL. III, SECTION 7

Prepared by: MIG I SvR

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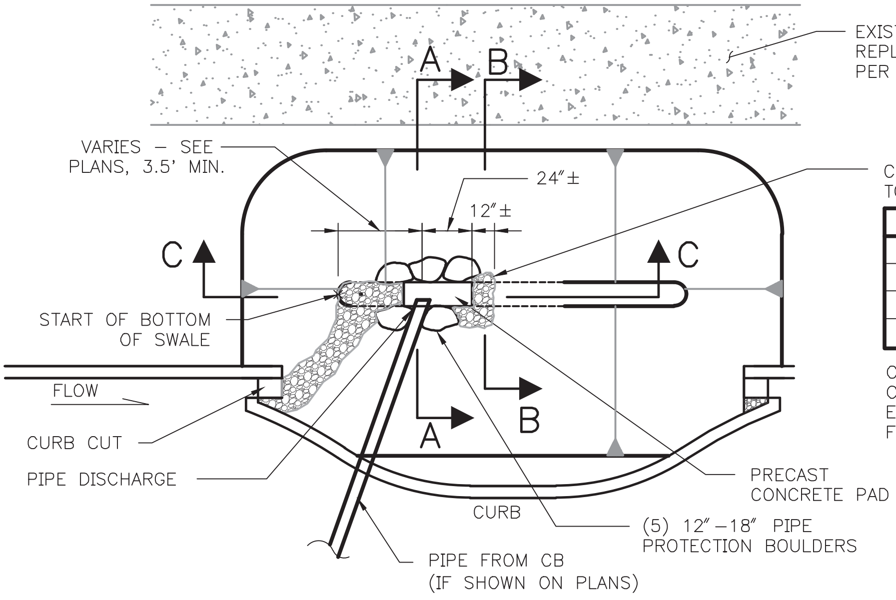
CURB BULB WITH BIORETENTION WITH SLOPED SIDES ON NEIGHBORHOOD YIELD STREET	GSI MANUAL B-4
AUGUST 2018 NOT TO SCALE	

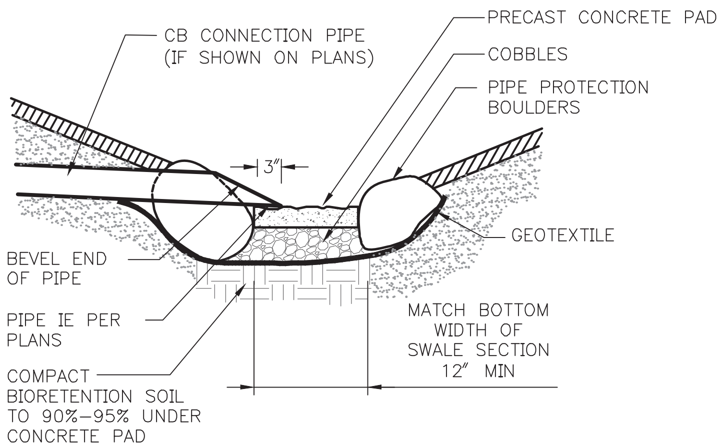


PLAN

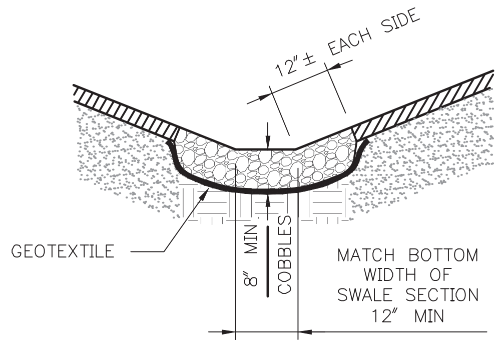
COBBLES (TYP) SHALL CONFORM TO THE FOLLOWING GRADATION:

SIEVE SIZE	PERCENT PASSING
8 INCH	90~ 100
6 INCH	45~ 65
4 INCH	15~ 30
3/4 INCH	0~ 3

COBBLES SHALL BE WASHED, ROUNDED, COBBLESTONE ROCK UNLESS APPROVED BY ENGINEER. COBBLES SHALL NOT BE PROCURED FROM NATURAL STREAM BED CHANNELS.



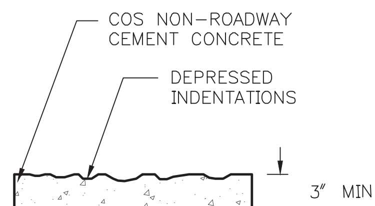
SECTION A–A (ENLARGEMENT)



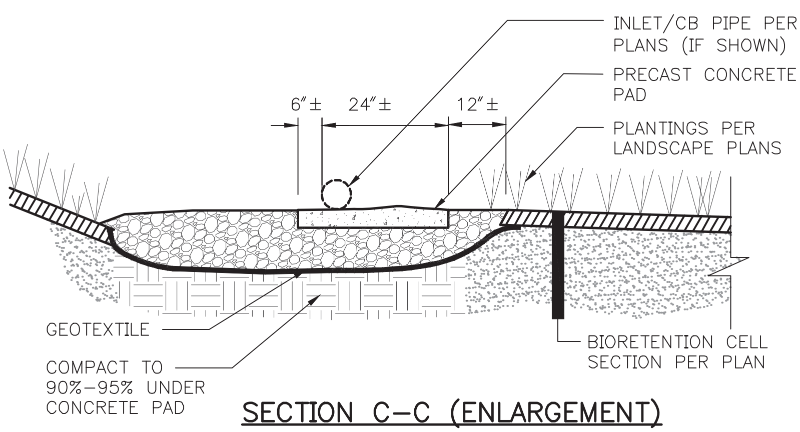
SECTION B–B (ENLARGEMENT)

NOTES:

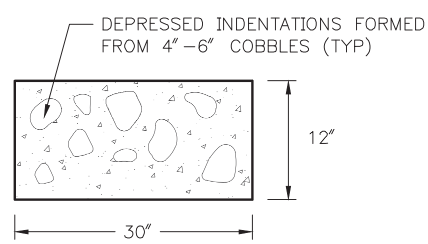
1. PROVIDE MOCK–UP FOR PROJECT REPRESENTATIVE'S REVIEW.
2. SEE LANDSCAPE PLANS AND DETAILS FOR PLANTING IN BIORETENTION SWALE.



PRECAST CONCRETE PAD SECTION



SECTION C–C (ENLARGEMENT)



PRECAST CONCRETE PAD PLAN

REFERENCE GSI MANUAL VOL. III, SECTION 7

Prepared by: MIG I SvR

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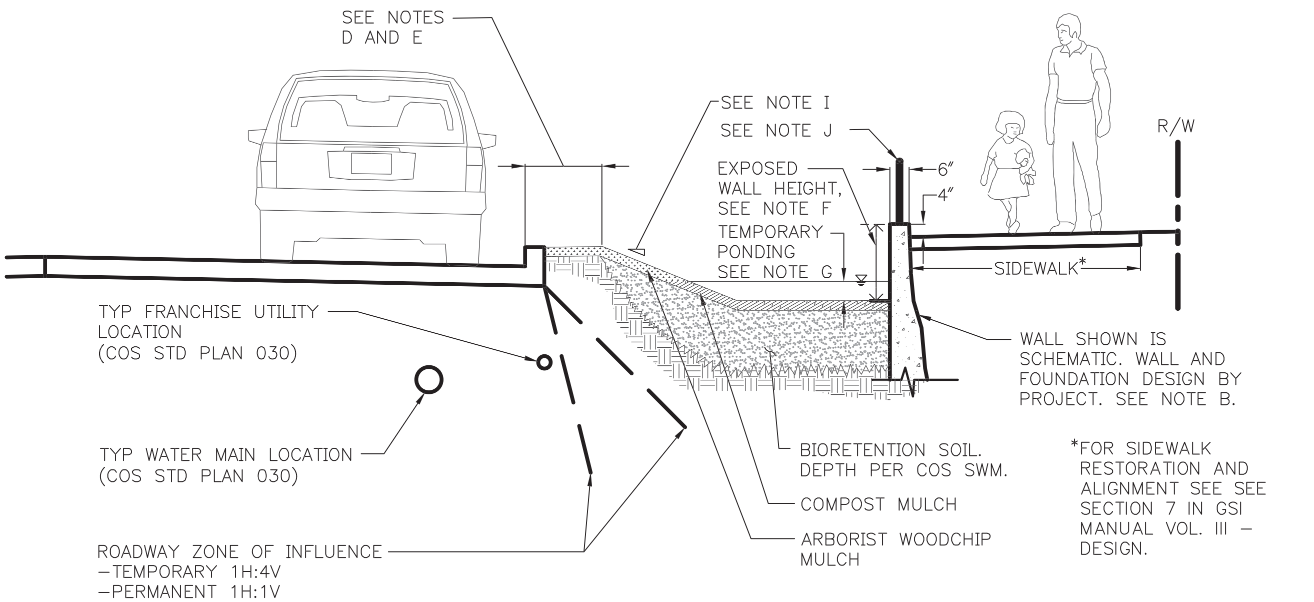
PRESETTLING ZONE FOR BIORETENTION WITH SLOPED SIDES, NEIGHBORHOOD YIELD STREET

AUGUST 2018

NOT TO SCALE

GSI MANUAL

B-5A



NOTES TO DESIGNER:

A. SEE O&M MOA BETWEEN SPU AND SDOT FOR WALL MAINTENANCE RESPONSIBILITY AND SEE STREETS ILLUSTRATED, SEATTLE'S RIGHT–OF WAY IMPROVEMENT MANUAL (ROWIM), SECTION 3.3 DRAINAGE FOR REQUIREMENTS FOR SPU TO MAINTAIN WALL USED IN A BIORETENTION CELL.

B. DESIGN OF VERTICAL WALL AT SIDEWALK:
   1. SHALL BE DEVELOPED UNDER GEOTECHNICAL/STRUCTURAL GUIDANCE. STRUCTURAL REVIEW IS REQUIRED FOR CONCRETE WALLS (STEEL REINFORCEMENT, STRUCTURAL SUPPORT SPANS, ETC).
   2. DESIGN MAY REQUIRE SPECIAL EXCAVATION AND BACKFILL MEASURES TO LOCATE VERTICAL WALL WITH ZERO SETBACK FROM EXISTING SIDEWALK. IT IS PREFERRED THAT THE SIDEWALK ADJACENT TO THE FACILITY BE REPLACED AS PART OF CONSTRUCTION OF THE PROJECT.
   3. FOOTING DESIGN SHALL BE DESIGNED BY SPECIFIC PROJECT GIVEN SITE CONDITIONS.
   4. IF LATERAL SUPPORT FOR WALL IS REQUIRED FOR STRUCTURAL DESIGN, CONSIDER OPPORTUNITIES TO USE LATERAL SUPPORTS AS A DUAL PURPOSE (SUCH AS A WEIR) WITHIN BIORETENTION CELLS. MINIMUM SPACING BETWEEN WEIRS IS DESCRIBED IN SECTION 7.5 OF GSI MANUAL VOLUME III–DESIGN. IF LATERAL SUPPORT HAS MORE FREQUENT SPACING THAN WEIRS, LATERAL SUPPORT SHALL BE BELOW THE BOTTOM (FINISH SURFACE GRADE) OF THE BIORETENTION CELL.

C. UTILITY CLEARANCES AND SETBACKS FOR BIORETENTION AND WALL:
   1. VERTICAL WALL WITHIN 2' OF EXISTING UTILITIES REQUIRES REVIEW AND APPROVAL BY THE UTILITY PROVIDER AND MAY REQUIRE ADDITIONAL MITIGATING MEASURES (SIMILAR TO 2' CLEARANCE BETWEEN FRANCHISE UTILITY SHOWN IN COS STD PLAN 030) AND/OR RELOCATION.
   2. PROJECT ENGINEER TO REVIEW FOR SITE SPECIFIC UTILITY LOCATIONS.
   3. SEE UTILITY SETBACKS AND CLEARANCE IN SECTION 7 OF GSI MANUAL, VOL. III – DESIGN AND STREETS ILLUSTRATED ROWIM.

D. 24″ MINIMUM PER STREETS ILLUSTRATED ROWIM FIGURE P IN SECTION 3.3 DRAINAGE. WHEN DESIGNING BIORETENTION WITH A SIDE SLOPE ADJACENT TO AREAS WITH NO ON–STREET PARKING (CONCEPT NOT SHOWN) THE HORIZONTAL SETBACK OF THE BIORETENTION FROM FACE OF CURB TO TOP OF SLOPE OF THE CELL MAY BE PROPOSED TO BE NARROWER THROUGH A DEVIATION REQUEST. PROPOSED DEVIATION TO BE REVIEWED ON A PROJECT BY PROJECT BASIS WITH SPU/WTD, O&M AND SDOT.

E. CURB/STREET EDGE MATERIALS: SEE SECTION 7 IN GSI MANUAL VOL. III – DESIGN.

F. EXPOSED WALL HEIGHT*:
   1. MAXIMUM:
      12″ (PREFERRED)
      18″ (ALLOWABLE)
   2. AVERAGE: LESS THAN 12″

G. TEMPORARY PONDING DEPTH*:
   1. MAXIMUM: 6″
   2. AVERAGE: LESS THAN MAXIMUM

H. BOTTOM WIDTH MINIMUM*: 3'

I. TYPICAL MAXIMUM SLOPE ALLOWED IS 2.5H:1V. EXCEPT WHEN WALL IS WITHIN 50–FEET OF INTERSECTION, MAXIMUM SLOPE ALLOWED IS 3H:1V.

J. SEE DESIGN VOLUME SECTION 7 ON GUIDANCE FOR WHEN TO USE LOW RAILING ALONG WALL FOR PEDESTRIAN COMFORT ALONG THE SIDEWALK.

K. ALONG THE WALL'S LONGITUDINAL PROFILE, WALL TO EXTEND A MINIMUM 18–INCHES BEYOND THE TOP OF SLOPE AT EACH END OF THE BIORETENTION CELL.

L. END WALLS ARE NOT RECOMMENDED ON NEIGHBORHOOD YIELD STREETS GIVEN SITE CONTEXT.

* THIS IS A REQUIREMENT FOR SPU/WTD GSI CIPs AND IS MORE STRICTER THAN STREETS ILLUSTRATED ROWIM, SECTION 3.3, FIGURE P.

THIS IS A CONCEPT FOR BIORETENTION CELL WITH ONE VERTICAL WALL SIDE (REMAINING SIDES SLOPED) FOR USE ON NEIGHBORHOOD YIELD STREETS. DESIGN OF WALL IS BY A PROJECT. SEE SPU GSI PROJECTS MANAGER FOR SAMPLE WALL DETAILS FROM PAST PROJECTS AND LESSONS LEARNED.

INITIAL CONCEPT OF THIS SKETCH DEVELOPED THROUGH SPU & SDOT IDT MEETINGS IN 2013.

REFERENCE GSI MANUAL VOL III, SECTION 7

Prepared by: MIG I SvR

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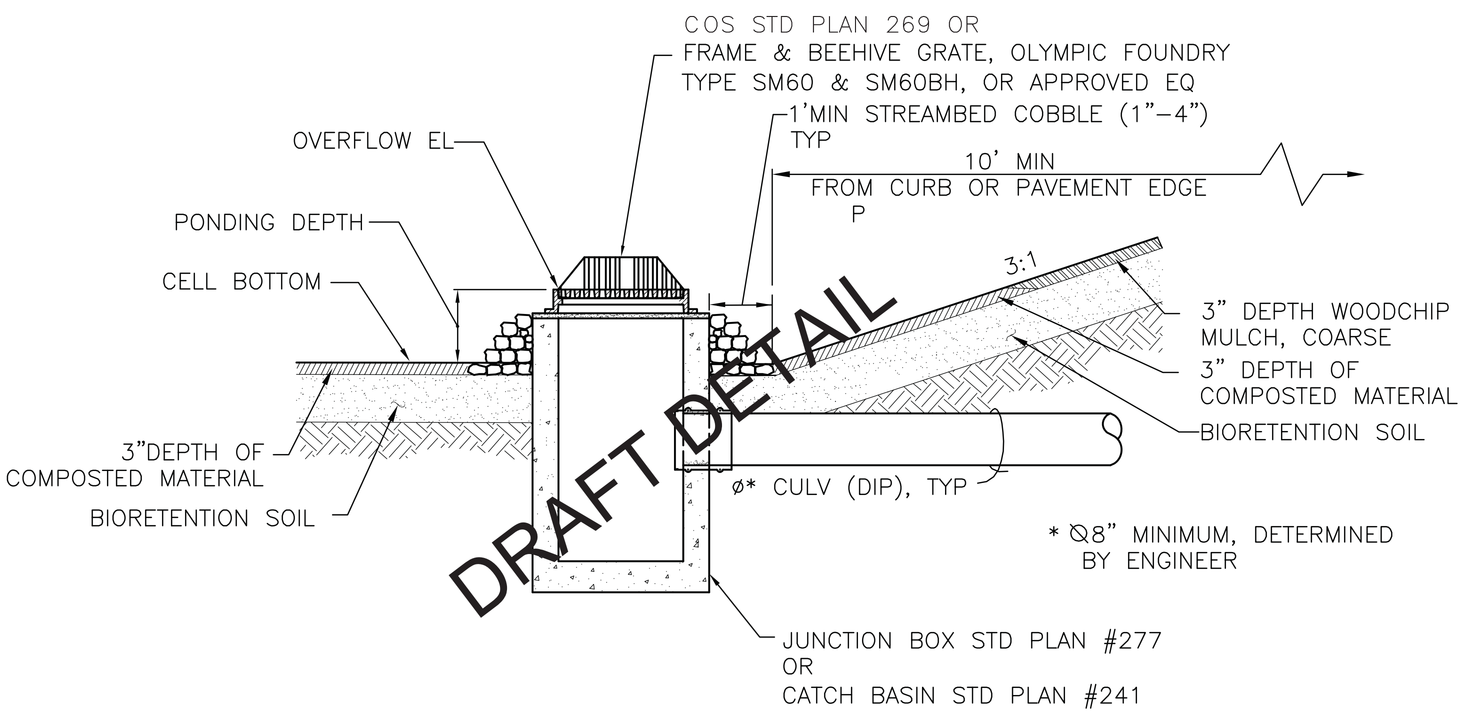
BIORETENTION CELL WITH 1-SIDED VERTICAL WALL AND 3 SLOPED SIDES, INFILTRATION	GSI MANUAL B-7
Updated August 2018 NOT TO SCALE	

Plotted: Sep 18, 2018 – 10:09:04am By jordanl
File: G:\12c\12034c SPUGSI\Current\SPU_B-07_VERTICAL WALLS.dwg Layout: Layout1

Bioretention Components (BC-#)



APPLICATION OF THESE DETAILS REQUIRE APPROVAL FROM SDOT AND SPU.

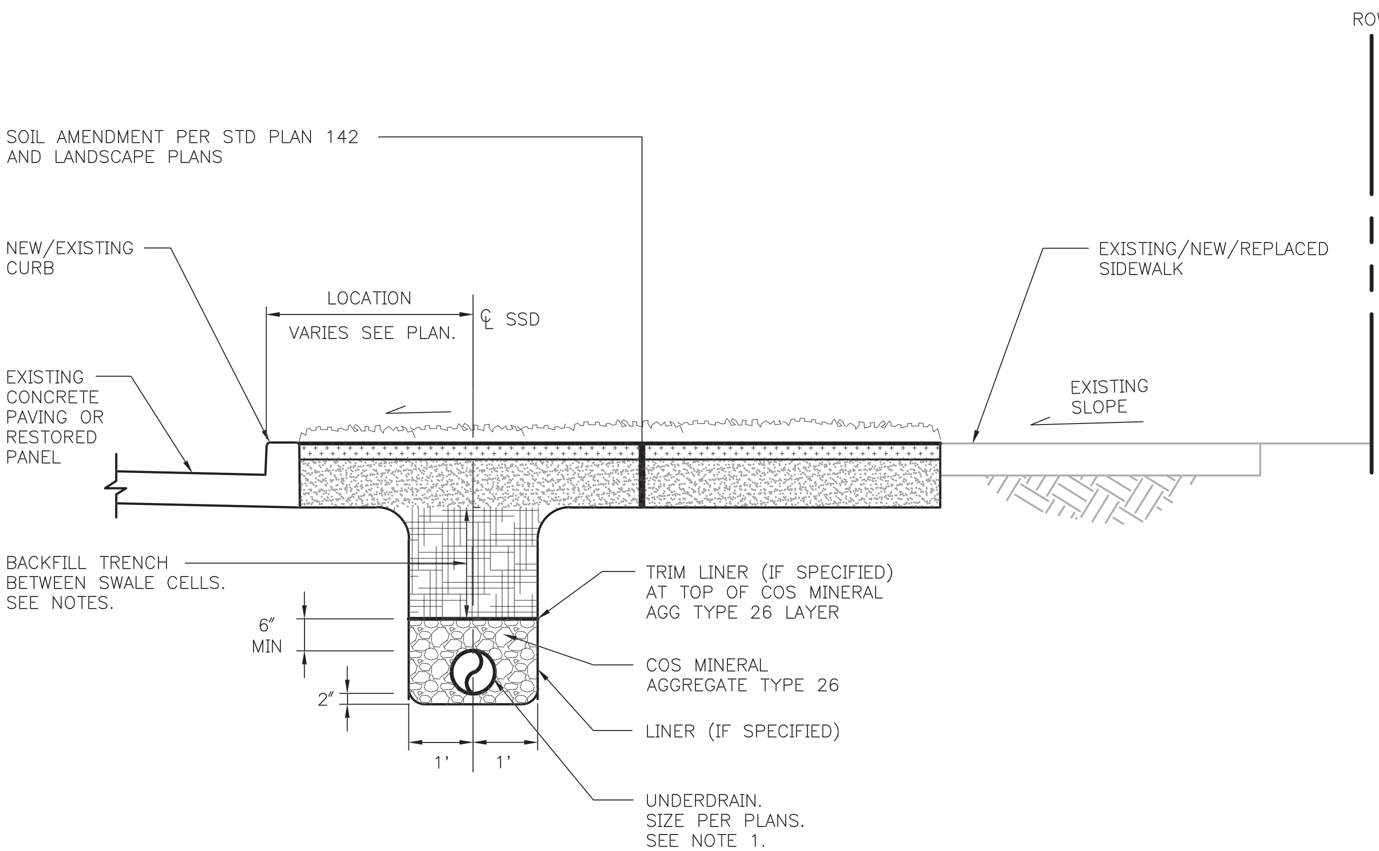
SEATTLE RIGHT-OF-WAY manual

BIORETENTION OVERFLOW STRUCTURE

FIGURE
GSI MANUAL

BC-2

JANUARY 2010



NOTES:

1. SEE PLANS WHERE UNDERDRAIN PIPE TRANSITIONS FROM SLOTTED TO SOLID WALL. PIPE MATERIAL PER STD PLAN 291.
2. IN LANDSCAPE AREAS, BACKFILL TRENCH WITH BIORETENTION SOIL OR SUITABLE NATIVE MATERIAL.
3. IN PAVED AREAS (E.G. WALKS, PATHS, WALLS, DRIVEWAYS), BACKFILL TRENCH WITH COS MINERAL AGG TYPE 17 AND COMPACT.

REFERENCE GSI MANUAL VOL III, SECTION 7

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UNDERDRAIN TRENCH SECTION
BETWEEN BIORETENTION CELLS

AUGUST 2018 NOT TO SCALE

GSI MANUAL

BC-8

Plotted: Sep 18, 2018 – 10:13:29am By jordanl
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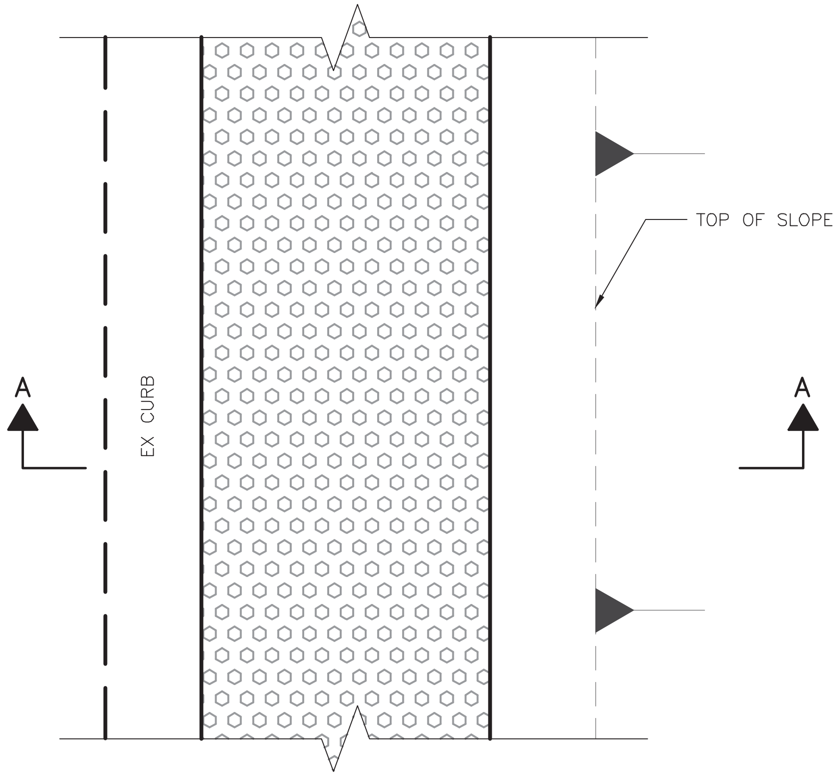
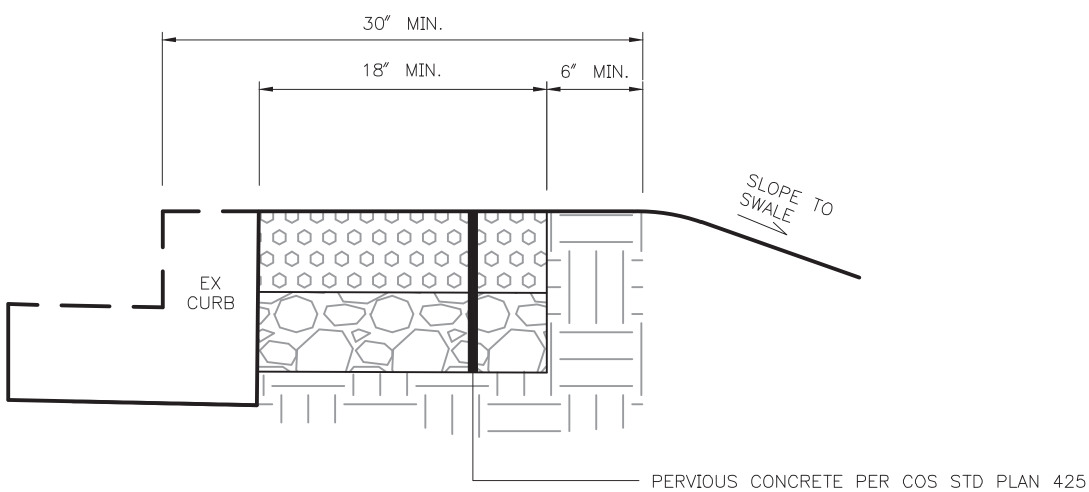


PLAN



SECTION A–A

NOTES TO DESIGNER:

A. 5% MAX. PERVIOUS CEMENT CONCRETE PROFILE GRADE.

REFERENCE GSI MANUAL VOL. III, SECTION 7

Prepared by: MIG | SvR

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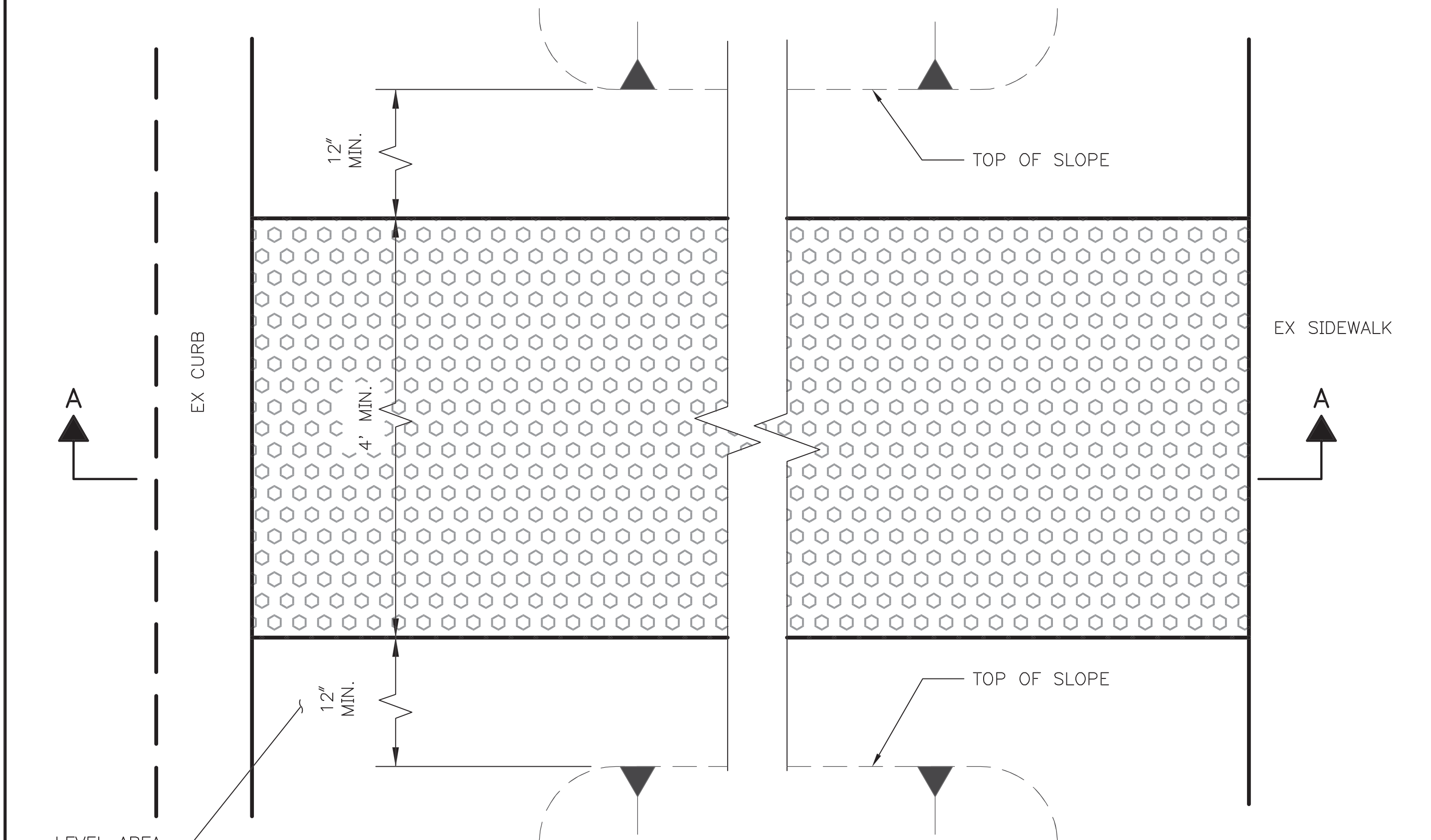
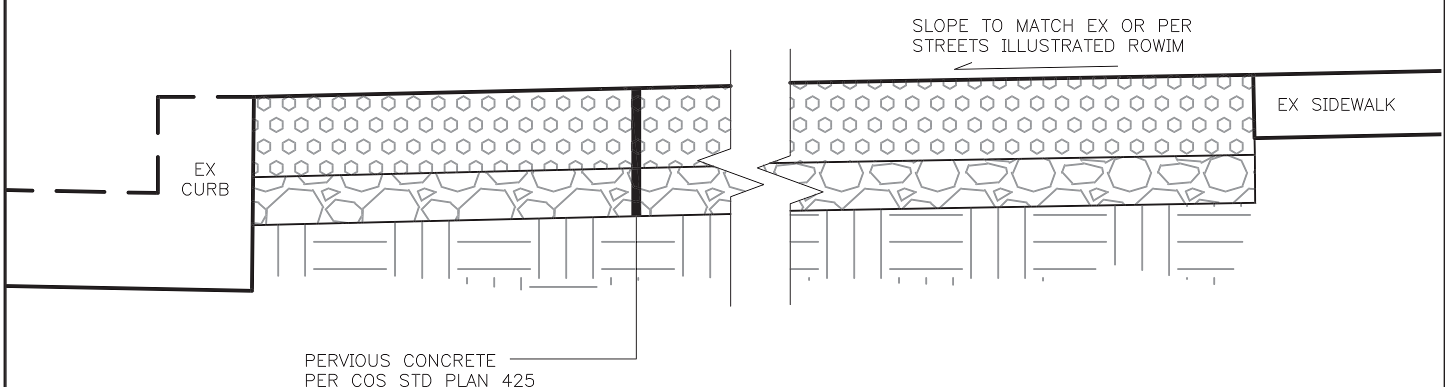
PEDESTRIAN ACCESS AT CURB EDGE - PERVIOUS CONCRETE		GSI MANUAL BC-9
AUGUST 2018	NOT TO SCALE	

Plotted: Sep 18, 2018 – 1:08:36pm By jordanl
File: G:\12c\12034c SPUGSI\Current\SPU_BC-09_PED ACCESS-PERVIOUS CONC AT CURB.dwg Layout: Layout1



PLAN



SECTION A–A

NOTES TO DESIGNER:

A. 5% MAX. PERVIOUS CEMENT CONCRETE PROFILE GRADE.
B. WHEN CITY RECYCLING, YARDWASTE AND GARBAGE CONTAINERS ARE PICKED UP ALONG THE STREET (NOT ALLEY), MODIFY ACCESS WIDTH AND/OR LEVEL AREA ADJACENT TO CELL AS NEEDED TO ACCOMMODATE CONTAINERS. REVIEW OVERALL FRONTAGE CONDITIONS. PICK-UP CAN ALSO OCCUR AT DRIVEWAYS AND NON-GSI PLANTER AREAS IN THE ROW. SEE GSI MANUAL VOLUME III–DESIGN FOR GUIDANCE.

REFERENCE GSI MANUAL VOL III, SECTION 7

Prepared by: MIG I SvR

Seattle Public Utilities · King County Department of Natural Resources and Parks Wastewater Treatment Division · Green Stormwater Infrastructure in Seattle · www.700MillionGallons.org · Working Together to Protect our Waterways	PEDESTRIAN ACCESS PATH - PERVIOUS CONCRETE AUGUST 2018 NOT TO SCALE	GSI MANUAL BC-10

Plotted: Sep 17, 2018 – 2:48:11pm By vsandoval
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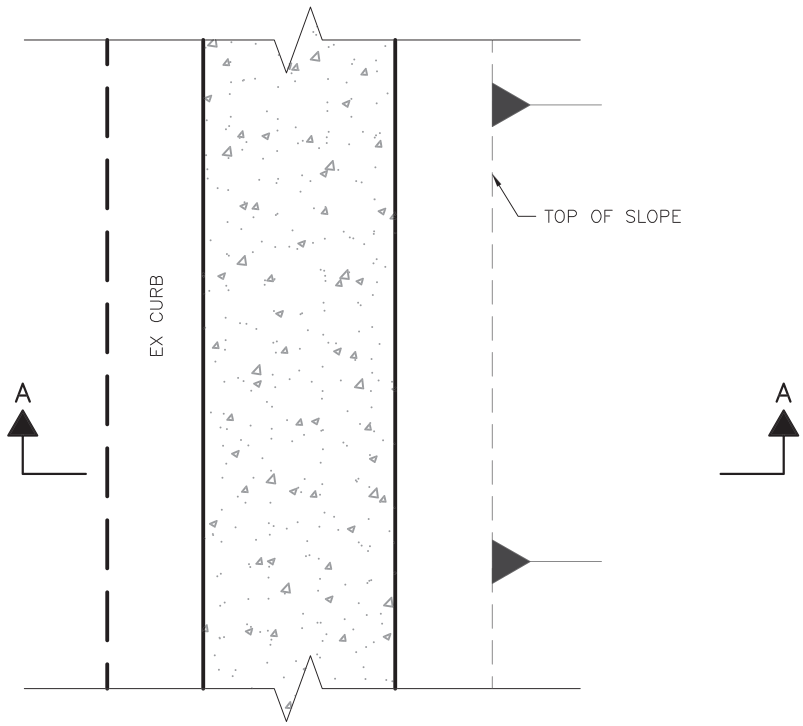
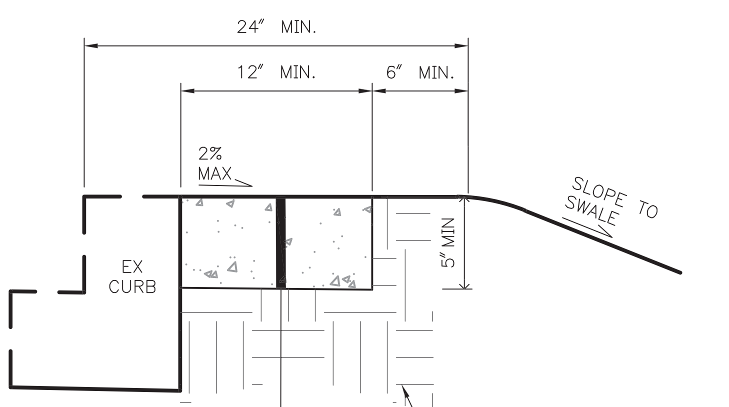


PLAN



CONCRETE PER COS STD PLAN 420 EXCEPT NO MINIMUM SCORING AND DEPTH PER SECTION. JOINTS SHALL BE IN LINE WITH CURB JOINTS.

COMPACTED SUBGRADE

SECTION A–A

Plotted: Sep 17, 2018 – 3:53:38pm By vsandoval
File: G:\12c\12034c SPUGSI\Current\SPU_BC-11_PED ACCESS-CONC AT CURB.dwg Layout: Layout1

REFERENCE GSI MANUAL VOL III, SECTION 7

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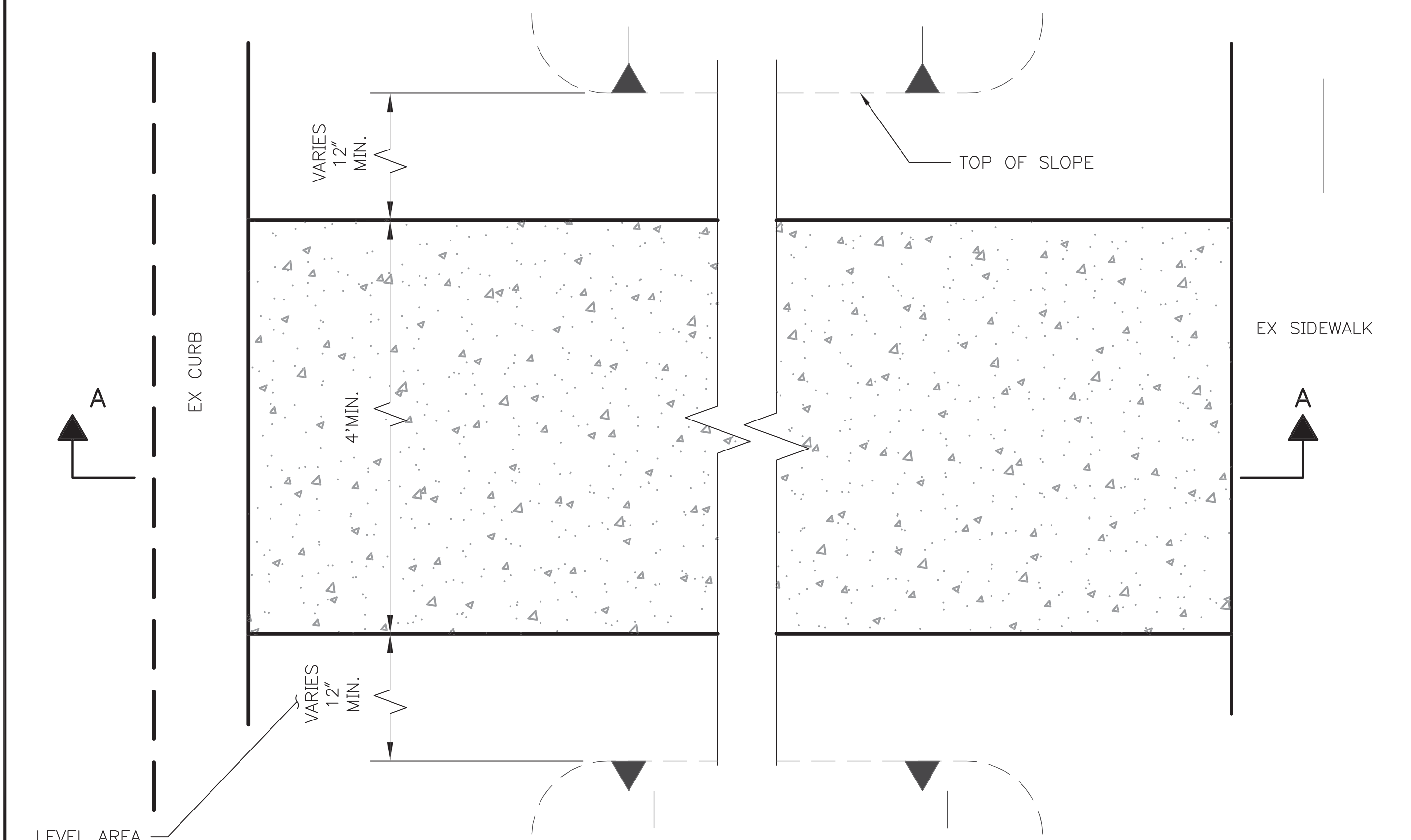
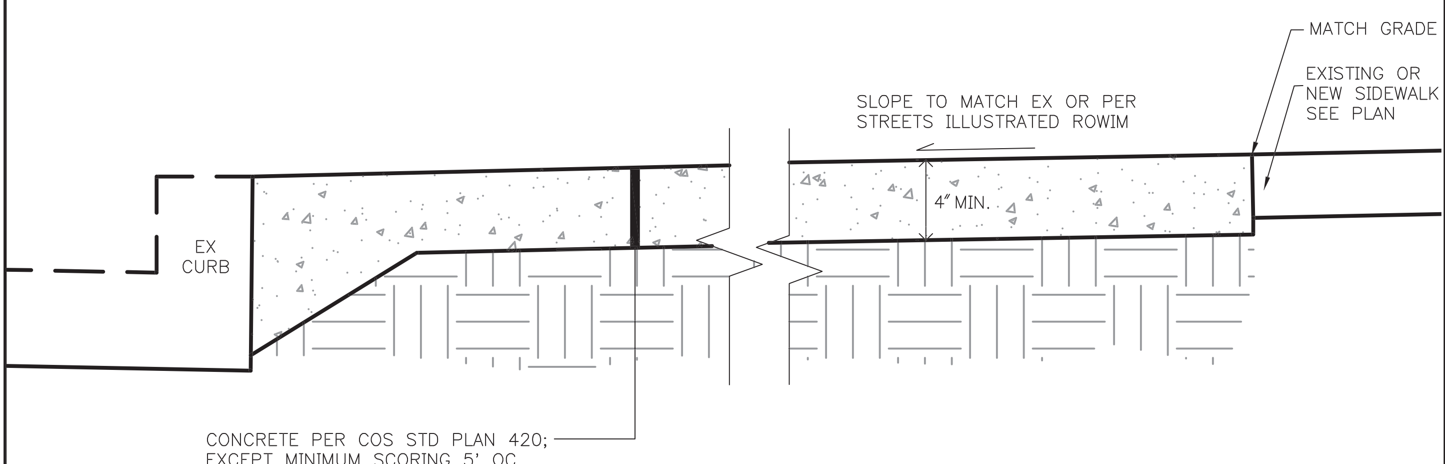
PEDESTRIAN ACCESS AT CURB EDGE - CONCRETE		GSI MANUAL BC-11
AUGUST 2018	NOT TO SCALE	



PLAN



SECTION A–A

NOTES TO DESIGNER:

A. WHEN CITY RECYCLING, YARDWASTE AND GARBAGE CONTAINERS ARE PICKED UP ALONG THE STREET (NOT ALLEY), MODIFY ACCESS WIDTH AND/OR LEVEL AREA ADJACENT TO CELL AS NEEDED TO ACCOMMODATE CONTAINERS. REVIEW OVERALL FRONTAGE CONDITIONS. PICK-UP CAN ALSO OCCUR AT DRIVEWAYS AND NON-GSI PLANTER AREAS IN THE ROW. SEE GSI MANUAL VOLUME III-DESIGN FOR GUIDANCE.

B. DIMENSIONS BETWEEN CELLS VARY DEPENDING ON TREE PLACEMENT AND CONTEXT.

REFERENCE GSI MANUAL VOL III, SECTION 7

Prepared by: MIG I SvR

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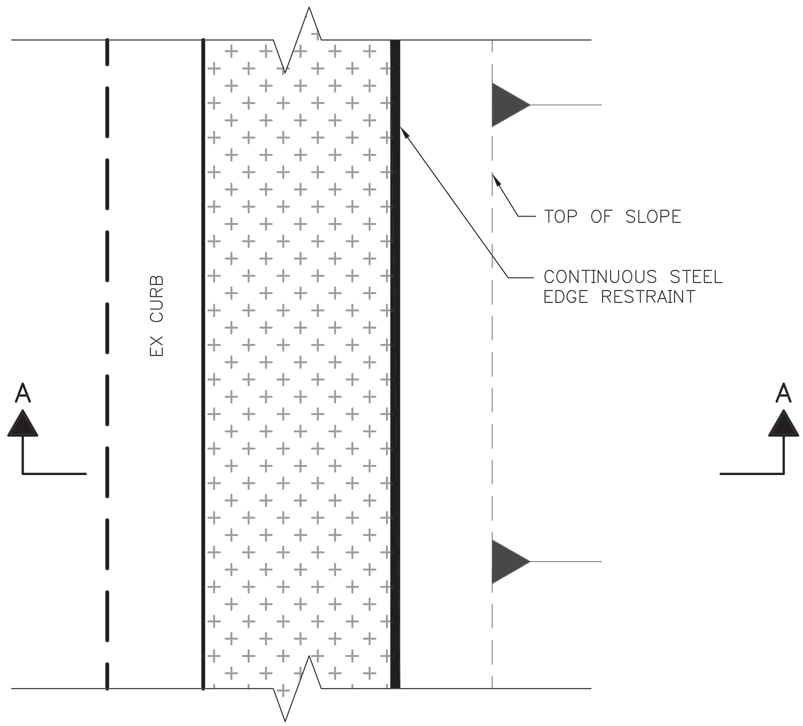
PEDESTRIAN ACCESS PATH - CONCRETE		GSI MANUAL BC-12
AUGUST 2018	NOT TO SCALE	

Plotted: Sep 17, 2018 – 3:55:08pm By vsandoval
File: G:\12c\12034c SPUGSI\Current\SPU_BC-12_PED ACCESS-CONC ACCESS PATH.dwg Layout: Layout1



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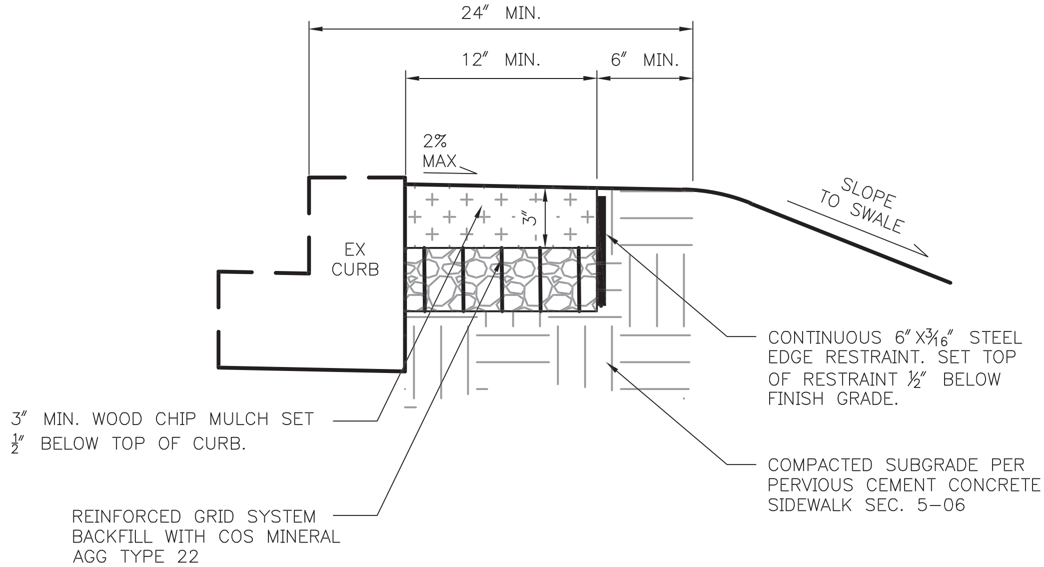

SECTION A–A

REFERENCE GSI MANUAL VOL III, SECTION 7

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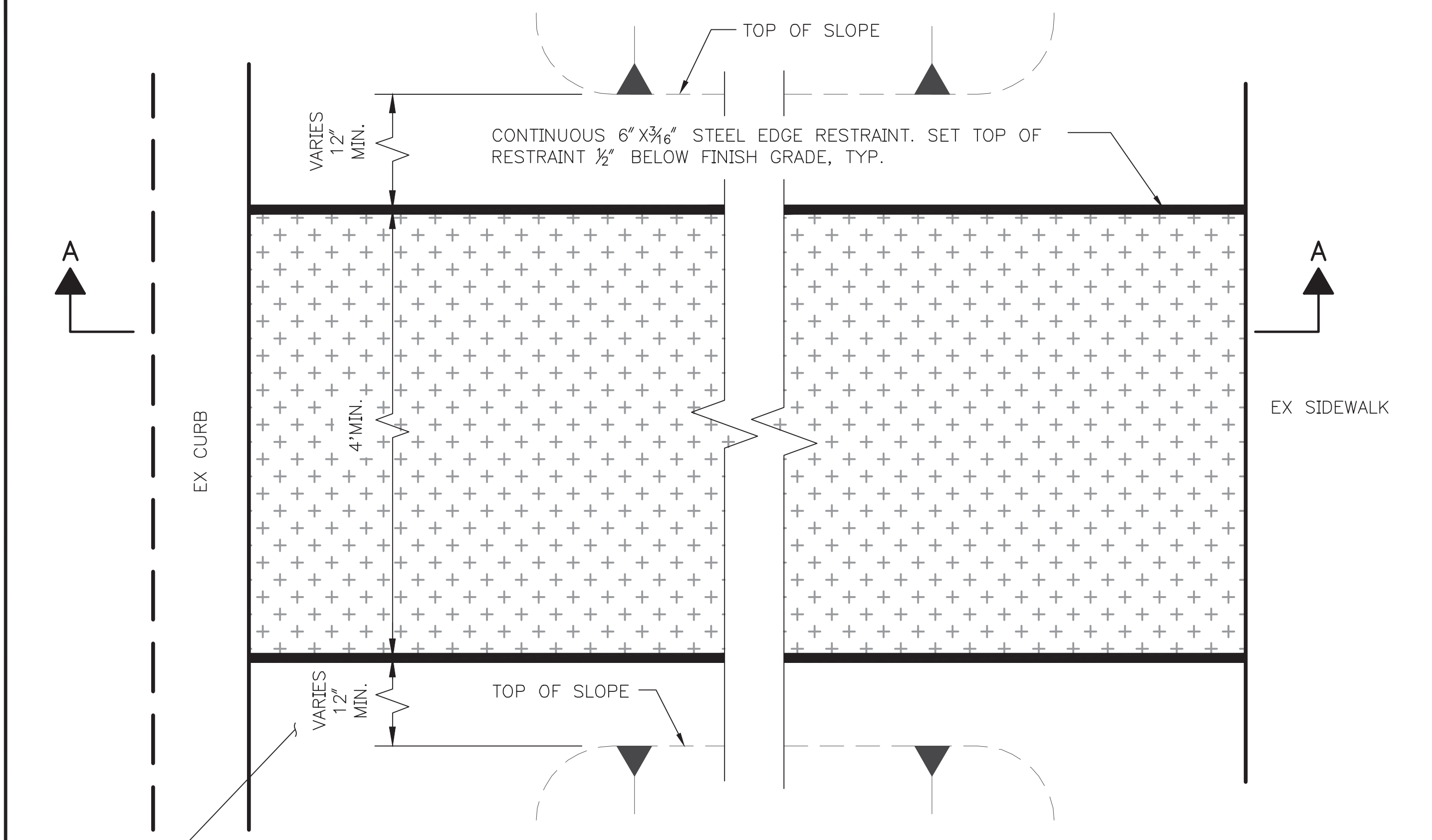
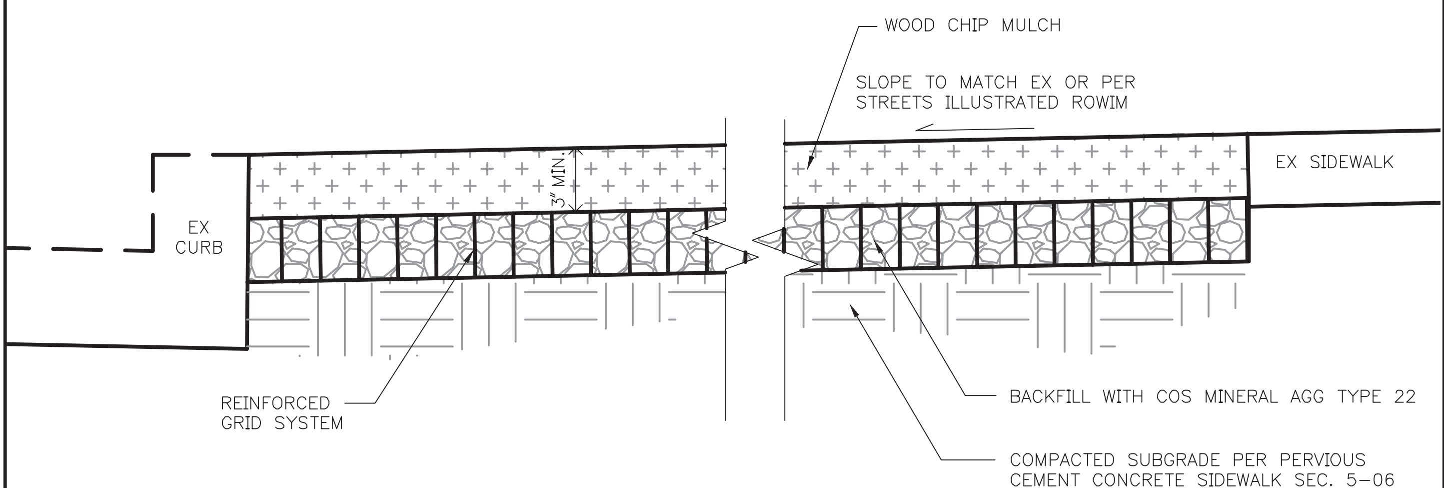
PEDESTRIAN ACCESS AT CURB EDGE - WOOD CHIP MULCH	GSI MANUAL BC-13
AUGUST 2018 — NOT TO SCALE	



PLAN



SECTION A–A

NOTES TO DESIGNER:

A. WHEN CITY RECYCLING, YARDWASTE AND GARBAGE CONTAINERS ARE PICKED UP ALONG THE STREET (NOT ALLEY), MODIFY ACCESS WIDTH AND/OR LEVEL AREA ADJACENT TO CELL AS NEEDED TO ACCOMMODATE CONTAINERS. REVIEW OVERALL FRONTAGE CONDITIONS. PICK-UP CAN ALSO OCCUR AT DRIVEWAYS AND NON-GSI PLANTER AREAS IN THE ROW. SEE GSI MANUAL VOLUME III-DESIGN FOR GUIDANCE.

B. DIMENSIONS BETWEEN CELLS VARY DEPENDING ON TREE PLACEMENT AND CONTEXT.

REFERENCE GSI MANUAL VOL. III, SECTION 7

Prepared by: MIG | SvR

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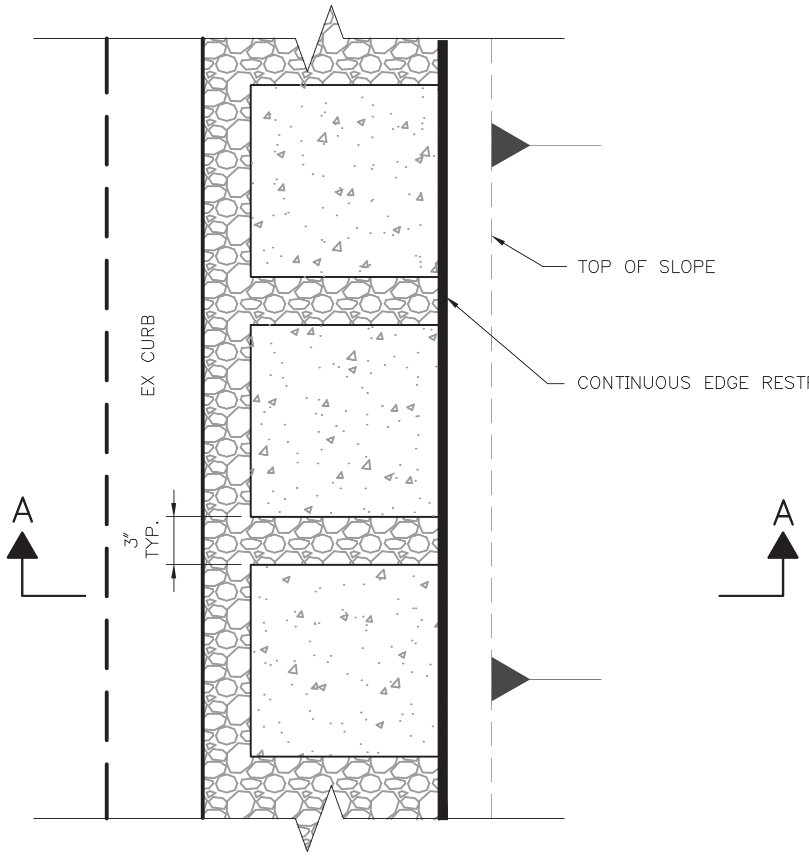
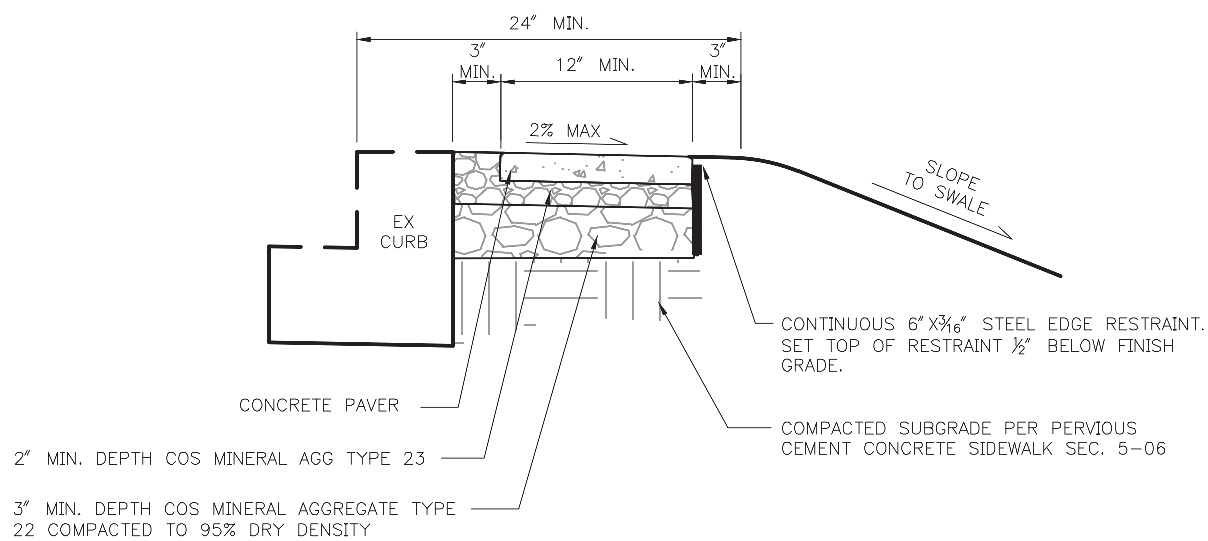
PEDESTRIAN ACCESS PATH - WOOD CHIP MULCH		GSI MANUAL BC-14
AUGUST 2018	NOT TO SCALE	

Plotted: Sep 18, 2018 – 1:08:52pm By jordanl
File: G:\12c\12034c SPUGSI\Current\SPU_BC-14_PED ACCESS-WOOD CHIP PATH.dwg Layout: Layout1



PLAN



SECTION A-A

NOTES TO DESIGNER:

A. 12"X12" OR 16"X16" OR 13"X13" CONCRETE PAVERS ARE ACCEPTABLE, HOWEVER 3" GAP AND EDGING ARE REQUIRED.

REFERENCE GSI MANUAL VOL. III, SECTION 7

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PEDESTRIAN ACCESS
AT CURB EDGE - CONCRETE PAVERS

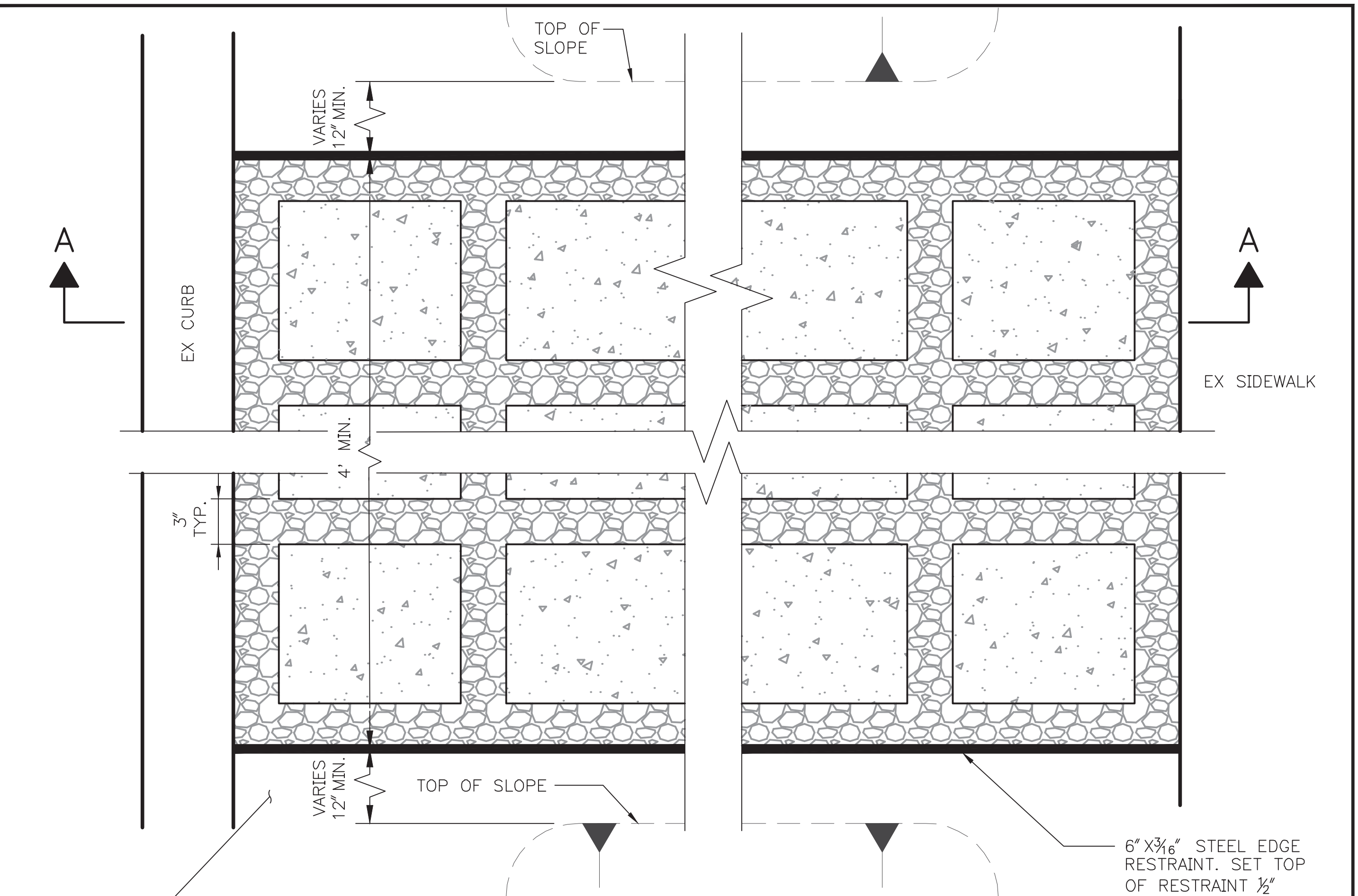
AUGUST 2018

NOT TO SCALE

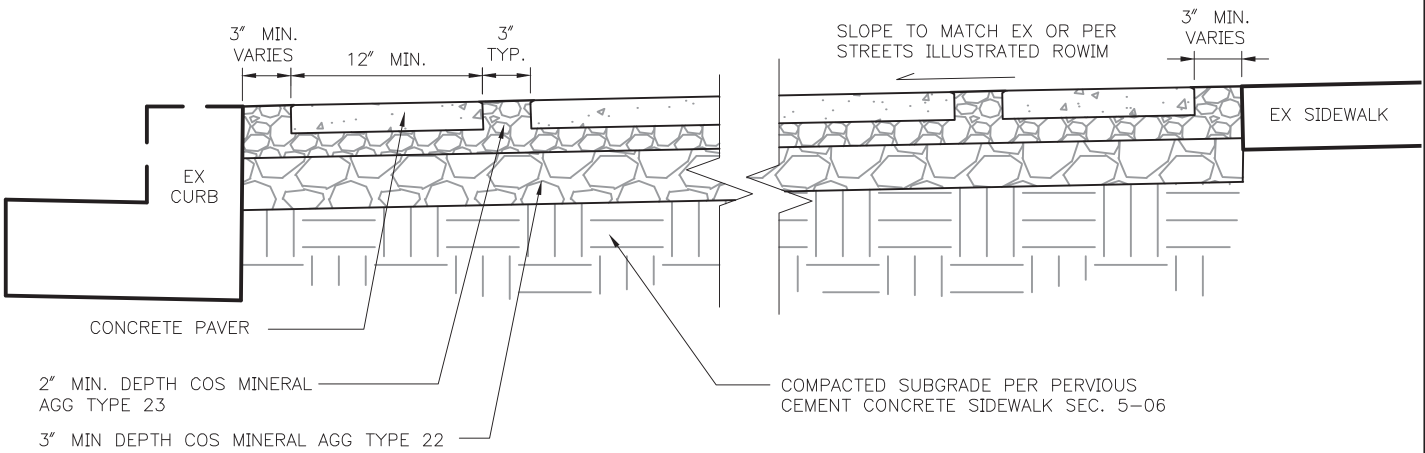
GSI MANUAL

BC-15

Plotted: Sep 18, 2018 - 1:08:56pm By jordanl
File: G:\12c\12034c SPUGSI\Current\SPU_BC-15_PED ACCESS-PAVERS AT CURB EDGE.dwg Layout: Layout1



PLAN



SECTION A—A

NOTES TO DESIGNER:

A. WHEN CITY RECYCLING, YARDWASTE AND GARBAGE CONTAINERS ARE PICKED UP ALONG THE STREET (NOT ALLEY), MODIFY ACCESS WIDTH AND/OR LEVEL AREA ADJACENT TO CELL AS NEEDED TO ACCOMMODATE CONTAINERS. REVIEW OVERALL FRONTAGE CONDITIONS. PICK-UP CAN ALSO OCCUR AT DRIVEWAYS AND NON-GSI PLANTER AREAS IN THE ROW. SEE GSI MANUAL VOLUME III-DESIGN FOR GUIDANCE.
B. DIMENSIONS BETWEEN CELLS VARY DEPENDENT ON TREE PLACEMENT AND CONTEXT.
C. 12"X12" OR 16"X16" OR 13"X13" CONCRETE PAVERS ARE ACCEPTABLE, HOWEVER 3" GAP AND EDGING ARE REQUIRED.

REFERENCE GSI MANUAL VOL. III, SECTION 7

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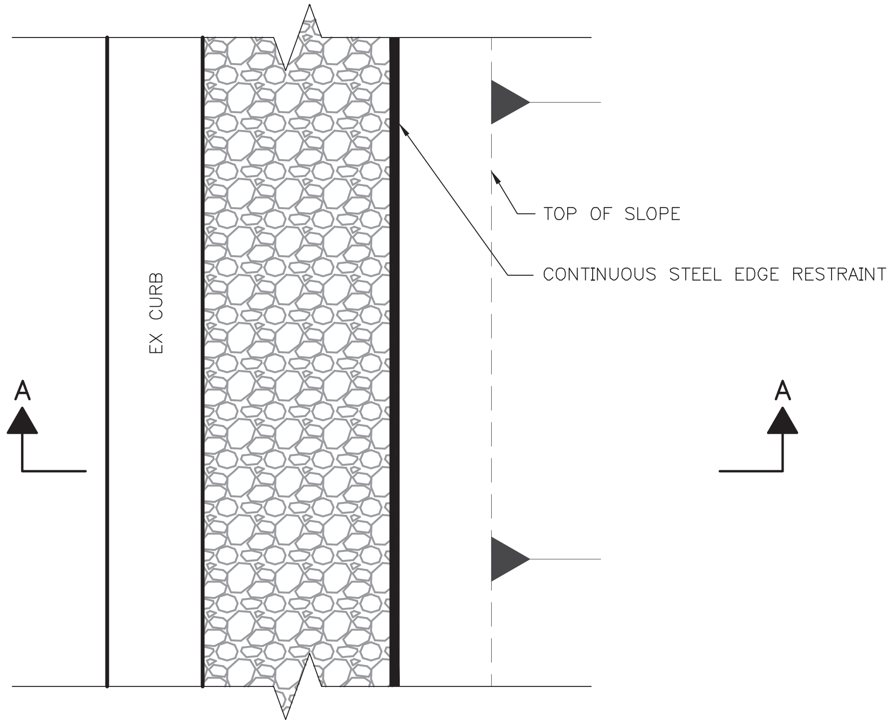
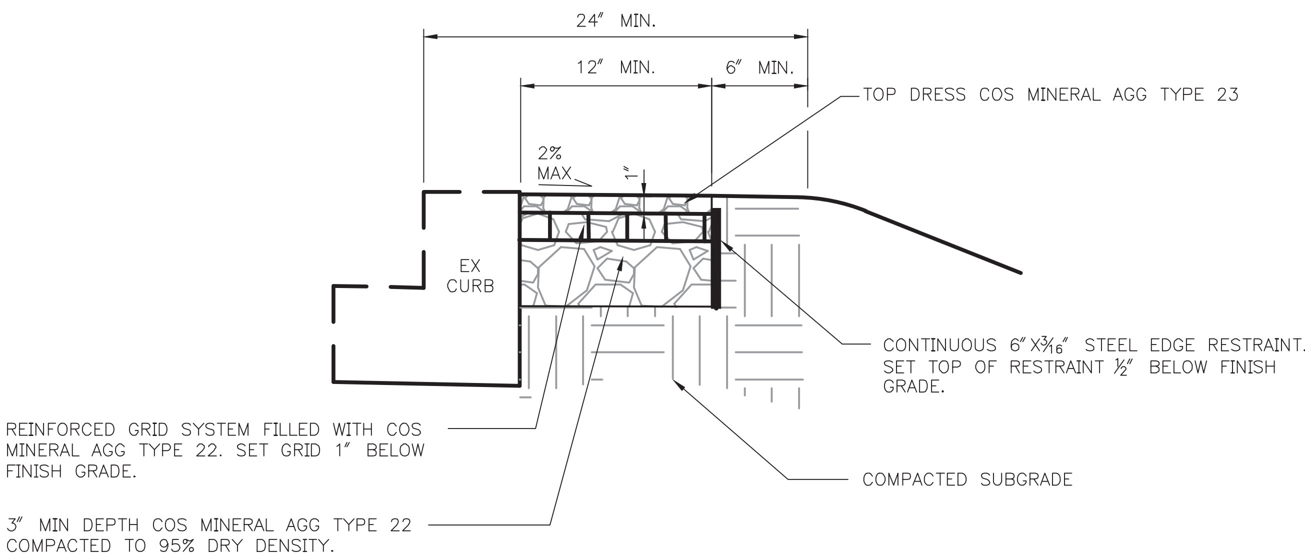
PEDESTRIAN ACCESS PATH - CONCRETE PAVERS	GSI MANUAL BC-16
August 2018 NOT TO SCALE	

Plotted: Sep 18, 2018 – 1:09:00pm By jordanl
File: G:\12c\12034c SPUGSI\Current\SPU_BC-16_PED ACCESS-PAVER ACCESS PATH.dwg Layout: Layout1



PLAN



SECTION A–A

REFERENCE GSI MANUAL VOL. III, SECTION 7

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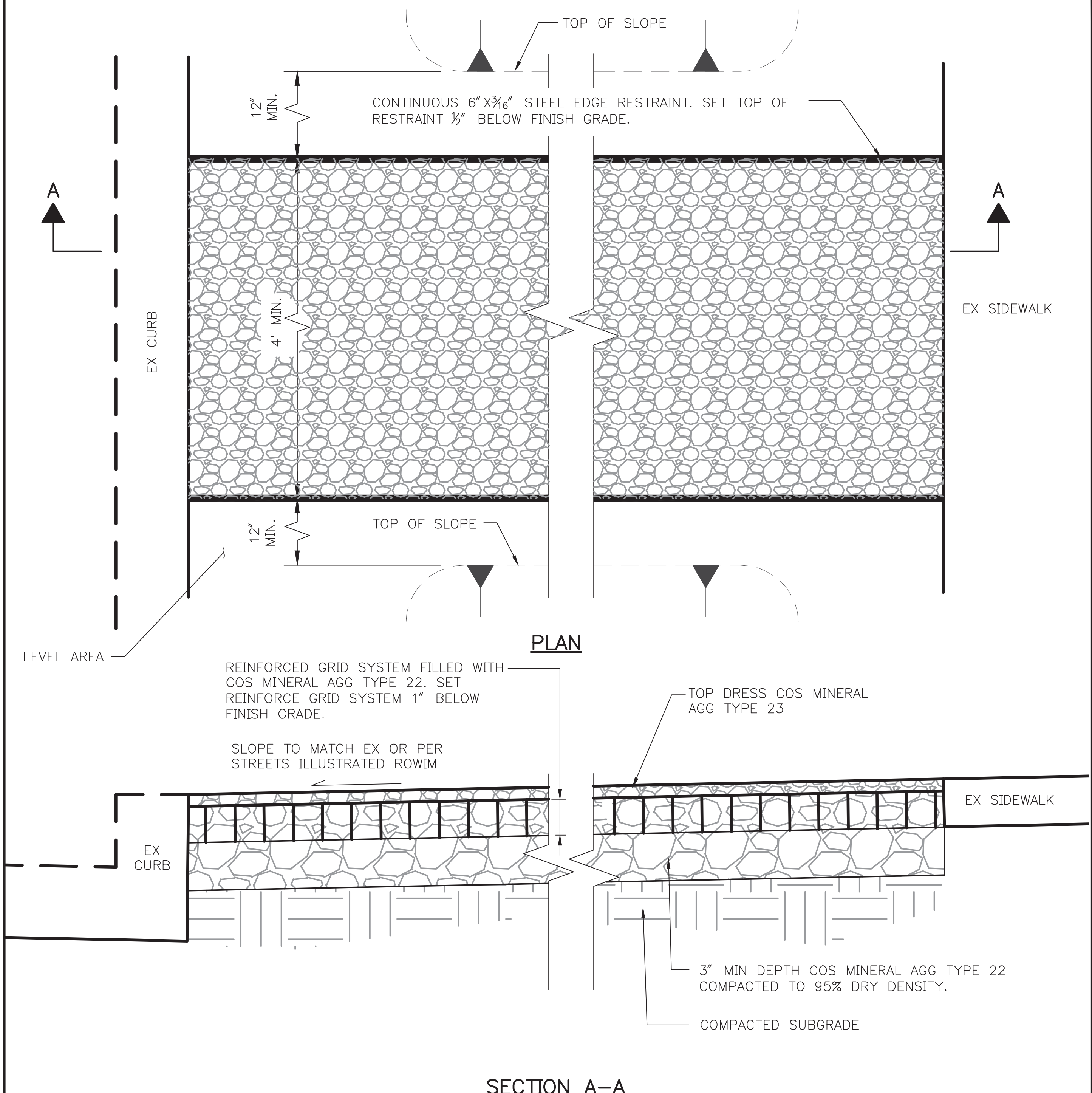
PEDESTRIAN ACCESS AT CURB EDGE - GRAVEL & GRID		GSI MANUAL BC-17
AUGUST 2018	NOT TO SCALE	



NOTES TO DESIGNER:

1. WHEN CITY RECYCLING, YARDWASTE AND GARBAGE CONTAINERS ARE PICKED UP ALONG THE STREET (NOT ALLEY), MODIFY ACCESS WIDTH AND/OR LEVEL AREA ADJACENT TO CELL AS NEEDED TO ACCOMMODATE CONTAINERS. REVIEW OVERALL FRONTAGE CONDITIONS. PICK-UP CAN ALSO OCCUR AT DRIVEWAYS AND NON-GSI PLANTER AREAS IN THE ROW. SEE GSI MANUAL VOLUME III-DESIGN FOR GUIDANCE.

REFERENCE GSI MANUAL VOL. III, SECTION 7

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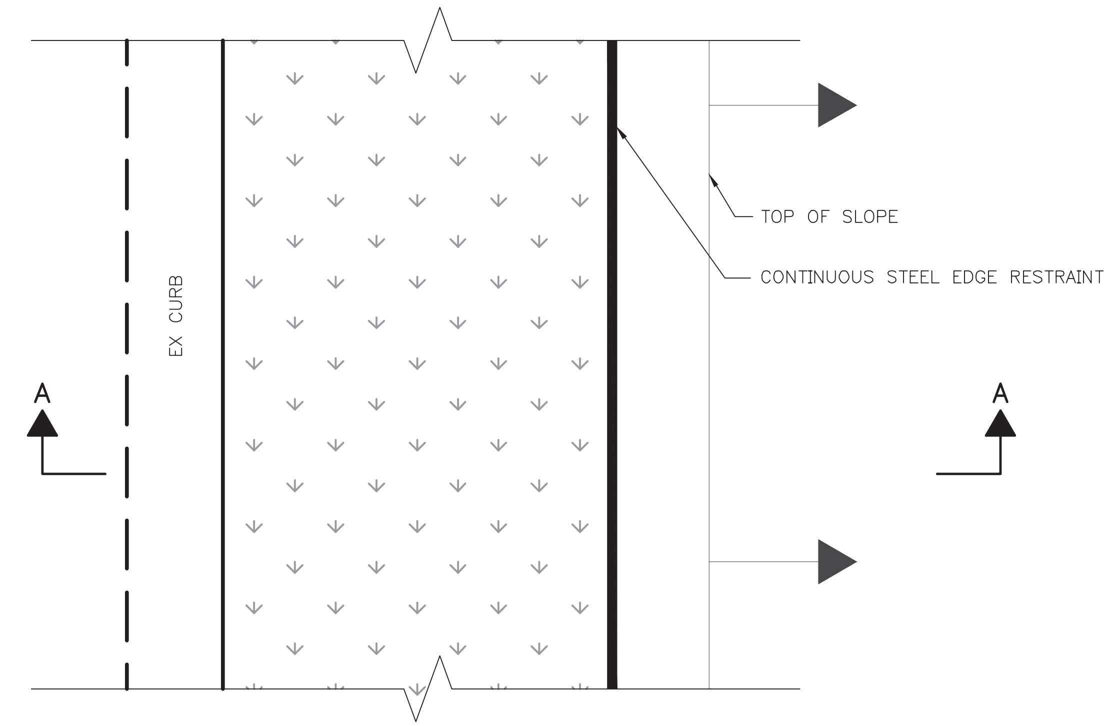
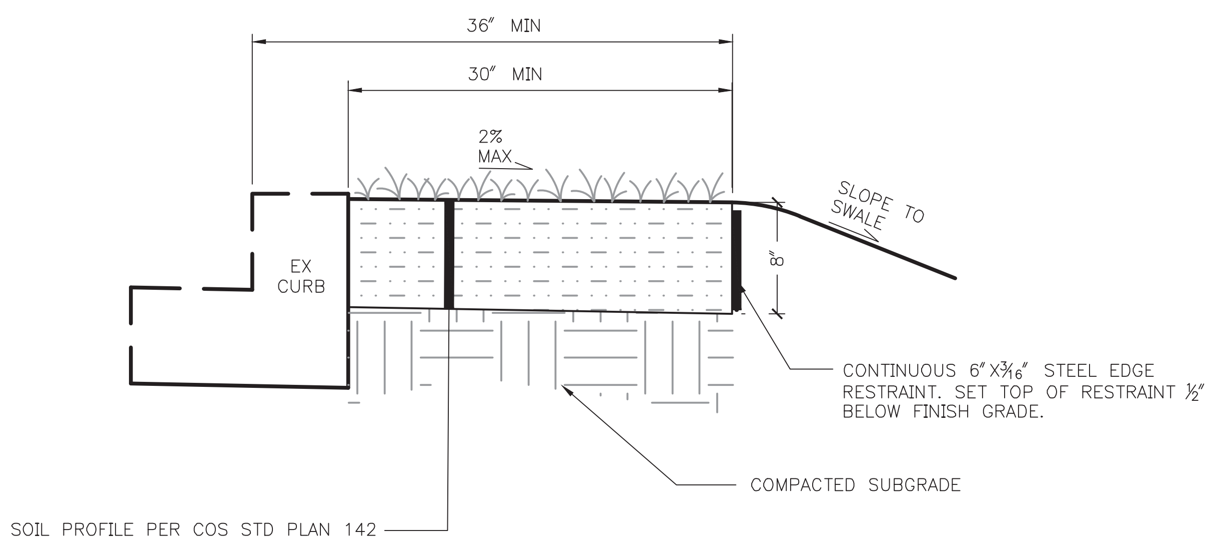
PEDESTRIAN ACCESS PATH - GRAVEL & GRID		GSI MANUAL BC-18
AUGUST 2018	NOT TO SCALE	

Plotted: Sep 18, 2018 – 1:09:08pm By jordanl
File: G:\12c\12034c SPUGSI\Current\SPU_BC-18_PED ACCESS-GRAVEL AND GRID ACCESS PATH.dwg Layout: Layout1



PLAN



SECTION A–A

REFERENCE GSI MANUAL VOL. III, SECTION 7

Prepared by: MIG I SvR

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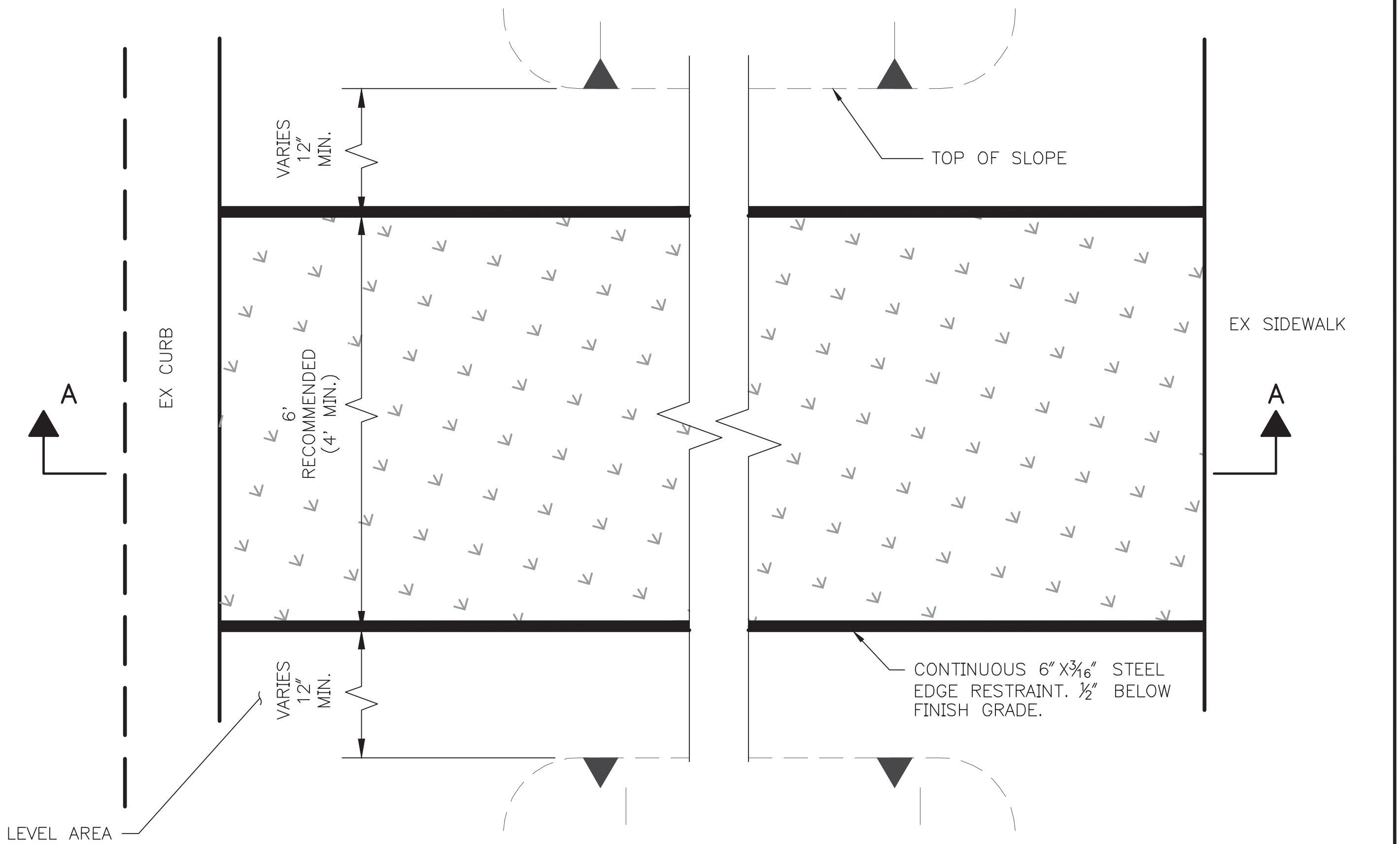
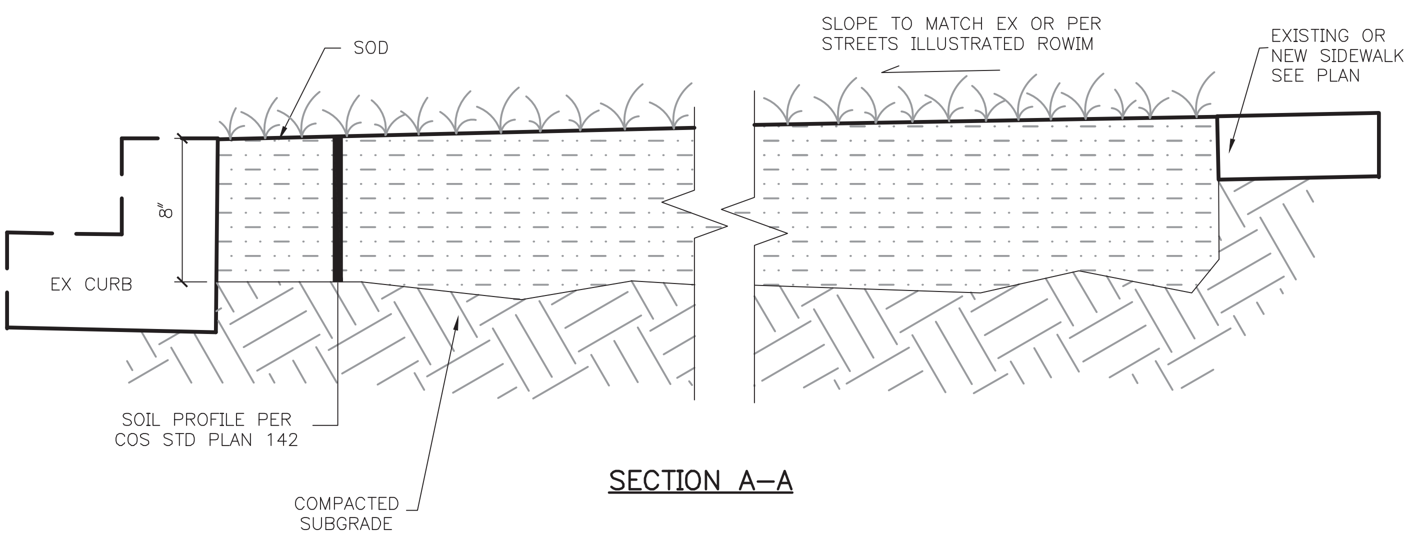
PEDESTRIAN ACCESS AT CURB EDGE - TURF GRASS		GSI MANUAL BC-19
AUGUST 2018	NOT TO SCALE	



PLAN



SECTION A–A

NOTES TO DESIGNER:

A. WHEN CITY RECYCLING, YARDWASTE AND GARBAGE CONTAINERS ARE PICKED UP ALONG THE STREET (NOT ALLEY), MODIFY ACCESS WIDTH AND/OR LEVEL AREA ADJACENT TO CELL AS NEEDED TO ACCOMMODATE CONTAINERS. REVIEW OVERALL FRONTAGE CONDITIONS. PICK–UP CAN ALSO OCCUR AT DRIVEWAYS AND NON–GSI PLANTER AREAS IN THE ROW. SEE GSI MANUAL VOLUME III–DESIGN FOR GUIDANCE.
B. DIMENSION BETWEEN CELLS VARY DEPENDING ON TREE PLACEMENT AND CONTEXT.

REFERENCE GSI MANUAL VOL. III, SECTION 7

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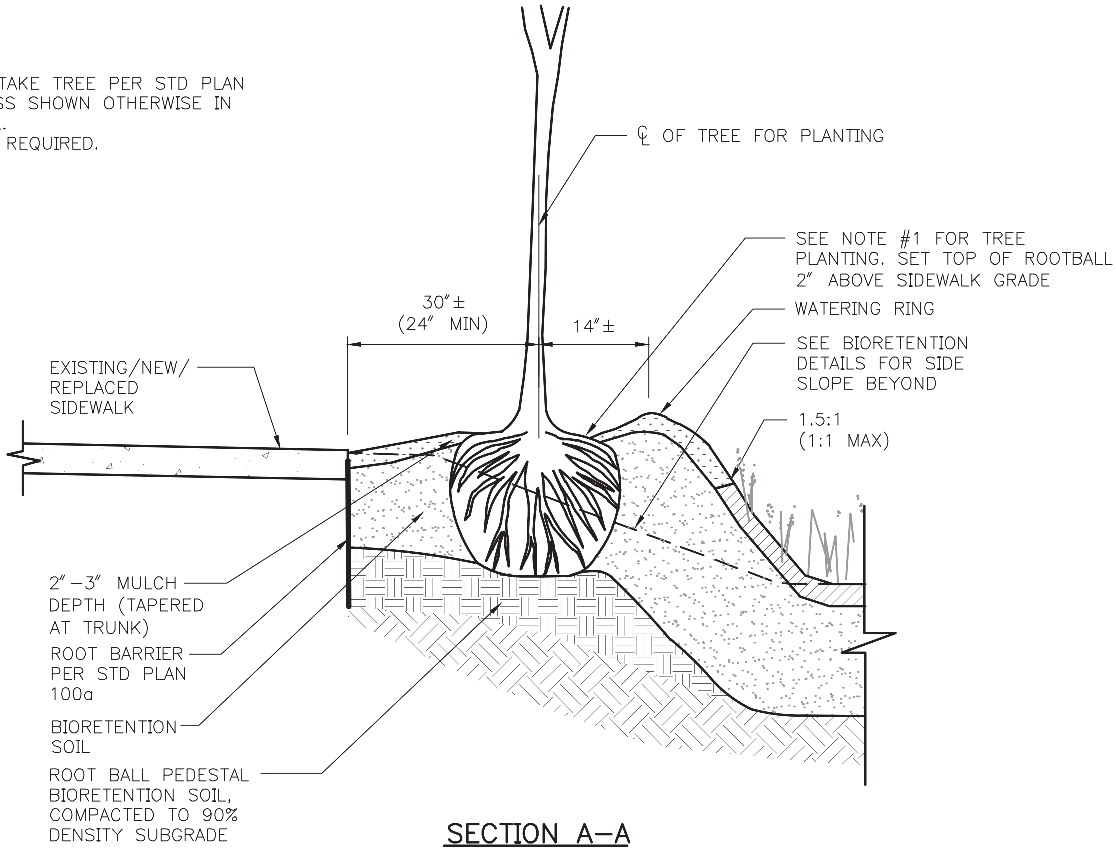
PEDESTRIAN ACCESS PATH - TURF GRASS		GSI MANUAL BC-20
AUGUST 2018	NOT TO SCALE	

Plotted: Sep 18, 2018 – 1:09:12pm By jordanl
File: G:\12c\12034c SPUGSI\Current\SPU_BC-20_PED ACCESS-GRASS ACCESS PATH.dwg Layout: Layout1

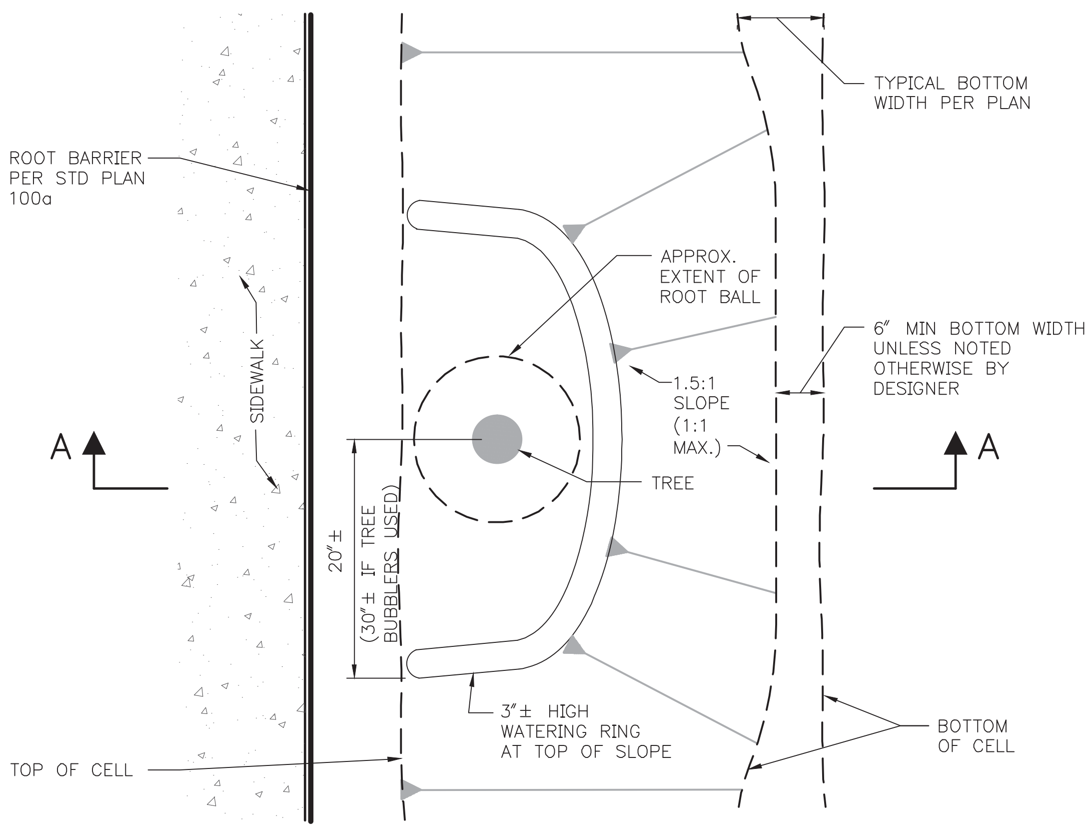
Bioretention New Street Tree Planting (BTP-#)

NOTES:

1. PLANT & STAKE TREE PER STD PLAN 100a UNLESS SHOWN OTHERWISE IN THIS DETAIL.
2. TREE BAGS REQUIRED.



SECTION A–A



PLAN VIEW

REFERENCE GSI MANUAL VOL. III, SECTION 7

Prepared by: MIG | SvR

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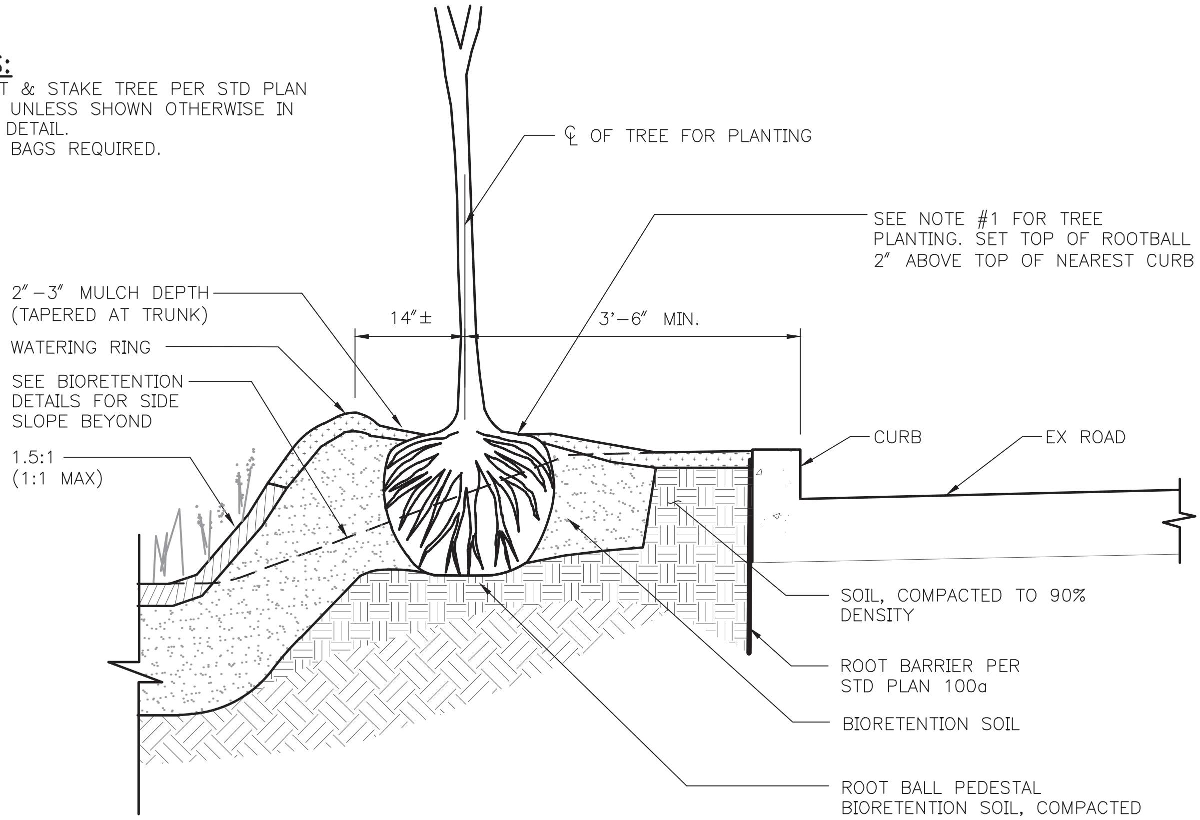
TREE PLANTING ON SWALE EDGE ADJACENT TO SIDEWALK	GSI MANUAL
APRIL 2015 — NOT TO SCALE	BTP-6

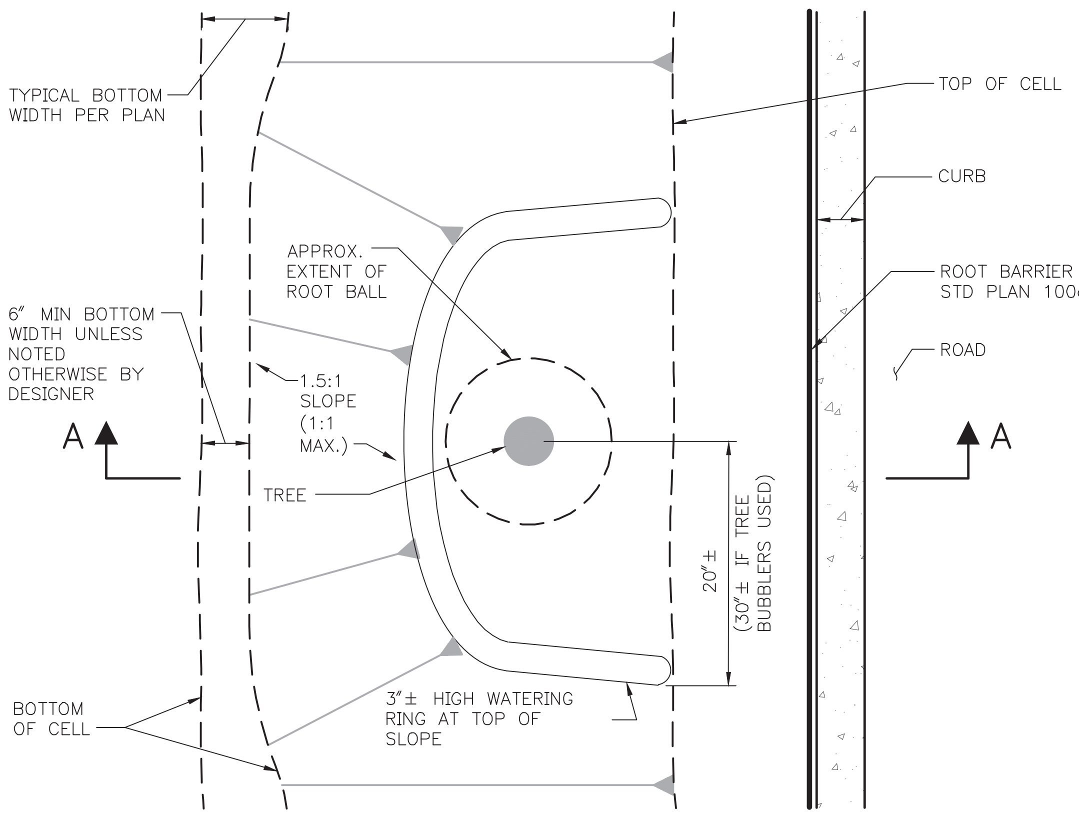
Plotted: Sep 18, 2018 – 1:09:16pm By jordanl

File: G:\12c\12034c SPUGSI\Current\SPU_BTP-6_TREE AT SIDEWALK.dwg Layout: BTP-6 SWLK

NOTES:
1. PLANT & STAKE TREE PER STD PLAN 100a UNLESS SHOWN OTHERWISE IN THIS DETAIL.
2. TREE BAGS REQUIRED.



SECTION A–A



PLAN VIEW

REFERENCE GSI MANUAL VOL. III, SECTION 7

Prepared by: MIG | SvR

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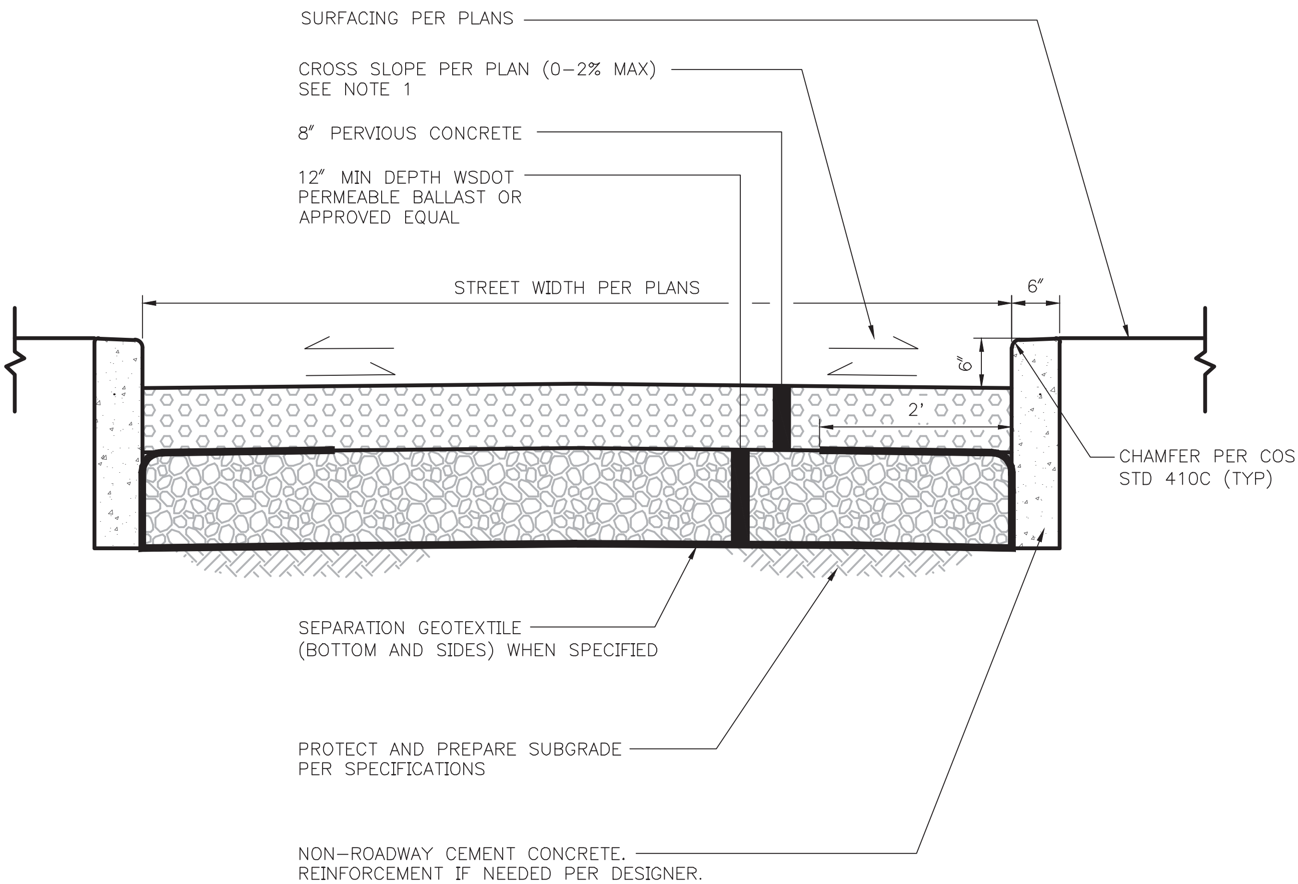
TREE PLANTING ON SWALE EDGE ADJACENT TO CURB	GSI MANUAL
APRIL 2015 — NOT TO SCALE	BTP-7

Plotted: Sep 18, 2018 – 1:09:21pm By jordanl
File: G:\12c\12034c SPUGSI\Current\SPU_BTP-7_TREE AT CURB.dwg Layout: BTP-7 CURB

Permeable Pavement (PP-#)



NOTES TO DESIGNER:

1. STREET CROSS SECTION CAN BE CROWNED OR THROWN DEPENDING UPON SITE CONDITIONS.
2. LONGITUDINAL SLOPE (PROFILE OF ROAD) SHALL NOT EXCEED 5% UNLESS APPROVED OTHERWISE.
3. SEE GSI MANUAL VOLUME III – DESIGN FOR WHERE PERVIOUS CONCRETE MAY BE USED IN ROW.

REFERENCE GSI MANUAL VOL. III, SECTION 9

Prepared by: MIG | SvR

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PERVIOUS CONCRETE PAVEMENT SECTION FOR NEIGHBORHOOD YIELD STREETS

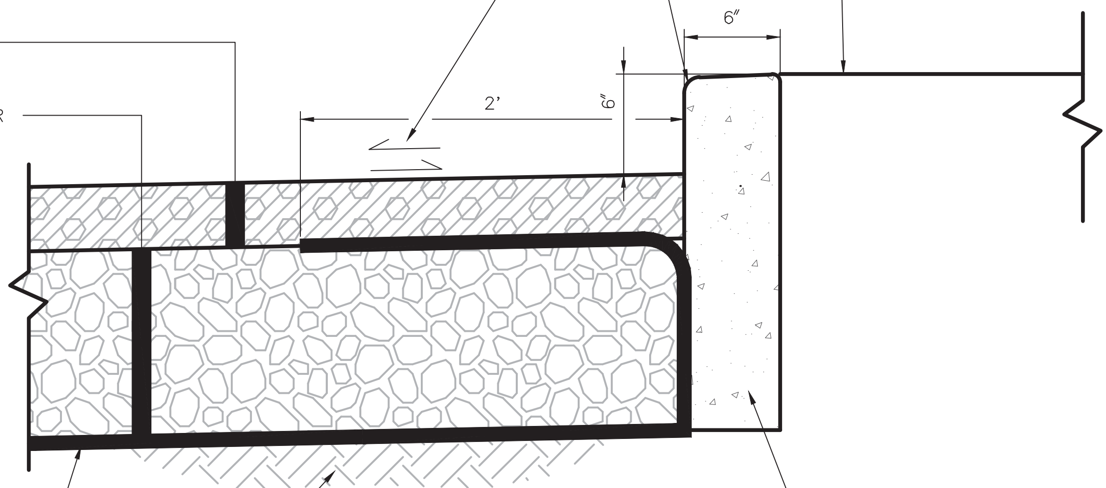
July 15, 2014

NOT TO SCALE

GSI MANUAL

PP-2

Plotted: Sep 18, 2018 – 1:45:55pm By jordanl
File: C:\Users\jordanl\appdata\local\temp\AcPublish_8584\SPU_PP-02_PERVIOUS CONC SECTION.dwg Layout: Layout1



NOTES TO DESIGNER:

1. DESIGN OF POROUS ASPHALT TO BE BY AGENCY RESPONSIBLE FOR MAINTENANCE.
2. SDOT DOES NOT APPROVE POROUS ASPHALT FOR STREETS/ALLEYS MAINTAINED BY SDOT.
3. STREET CROSS SECTION CAN BE 0 TO 2% MAX AND MAY BE THROWN TO ONE SIDE OR CROWNED DEPENDING UPON SITE CONDITIONS. SLOPE IS PER PLAN.
4. LONGITUDINAL SLOPE (PROFILE OF ROAD) SHALL NOT EXCEED 5% UNLESS APPROVED OTHERWISE.

Plotted: Sep 18, 2018 – 1:45:58pm By jordanl
File: C:\Users\jordanl\appdata\local\temp\AcPublish_8584\SPU_PP-04_POROUS ASPH SECTION.dwg Layout: Layout1

REFERENCE GSI MANUAL VOL. III, SECTION 9

Prepared by: MIG I SvR

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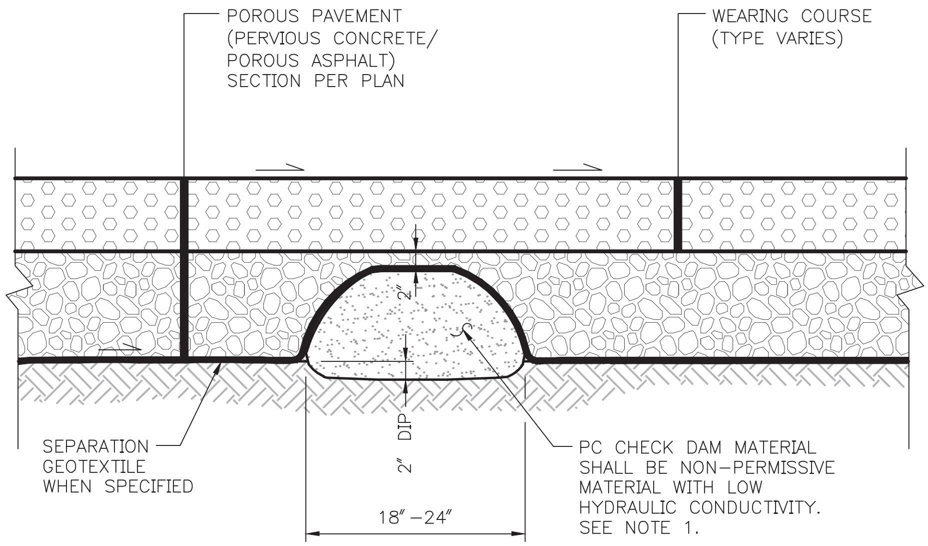
POROUS ASPHALT PAVEMENT SECTION FOR NEIGHBORHOOD YIELD STREETS		GSI MANUAL
July 15, 2014	NOT TO SCALE	PP-4

Permeable Pavement Components (PPC-#)



NOTES TO DESIGNER:

1. PC CHECK DAM MATERIAL SHALL BE A MATERIAL WITH HYDRAULIC CONDUCTIVITY LESS THAN 4×10^{-6} INCHES/SEC ($\sim 1 \times 10^{-5}$ CM/SEC) ACCORDING TO ASTM D-5084 AND NON-PERMISSIVE MATERIAL. THE FOLLOWING MATERIALS COULD BE USED: CONTROLLED DENSITY FILL PER COS SECTION 2-10.2(3)A2, NATIVE TILL EXCAVATED ON SITE THAT HAS A MINIMUM OF 20 PERCENT PASSING #200 STANDARD SIEVE SCREEN, OR OTHER MATERIAL APPROVED BY GEOTECHNICAL ENGINEER.

REFERENCE GSI MANUAL VOL. III, SECTION 9

Prepared by: MIG I SvR

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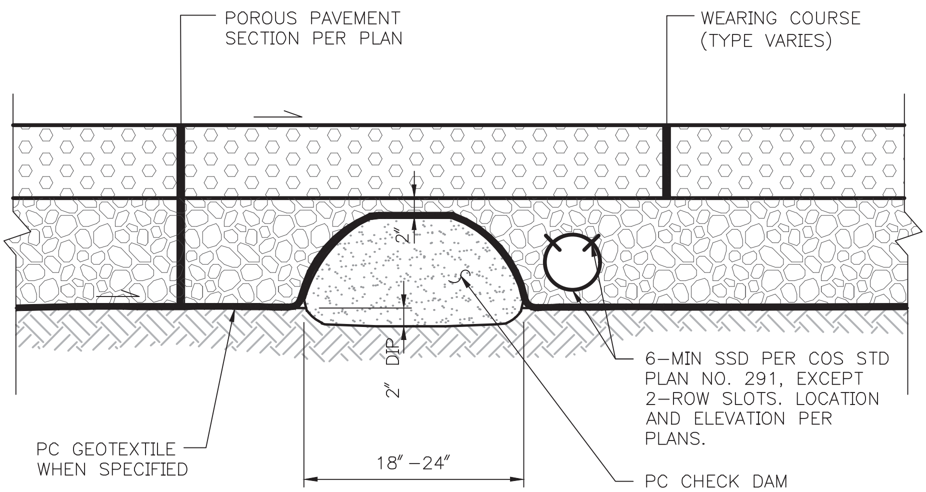
PC CHECKDAM FOR PERVIOUS CONCRETE STREETS/ALLEYS

GSI MANUAL

PPC-1

July 15, 2014

NOT TO SCALE



NOTES TO DESIGNER:

1. SEE GSI MANUAL, VOL. III, APPENDIX D, DETAIL PPC-1 FOR PC CHECK DAM CONCEPT DETAIL.

REFERENCE GSI MANUAL VOL. III, SECTION 9

Prepared by: MIG I SvR

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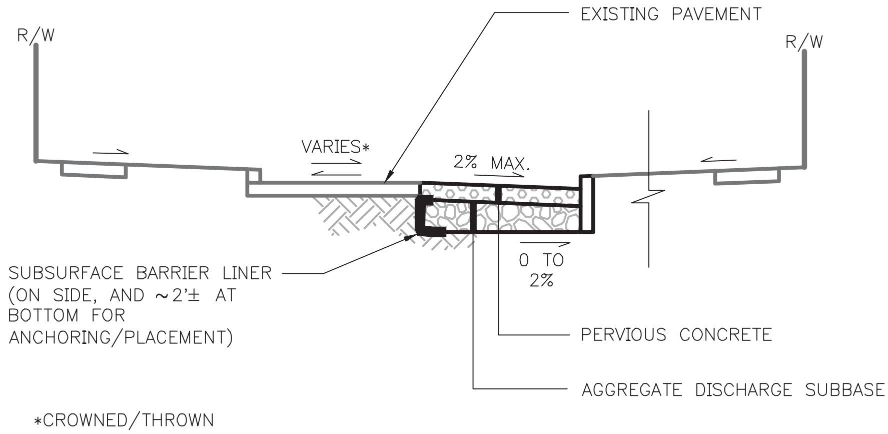
UNDERDRAIN OVERFLOW PIPE AT PC CHECK DAM FOR POROUS PAVEMENT

GSI MANUAL

PPC-2

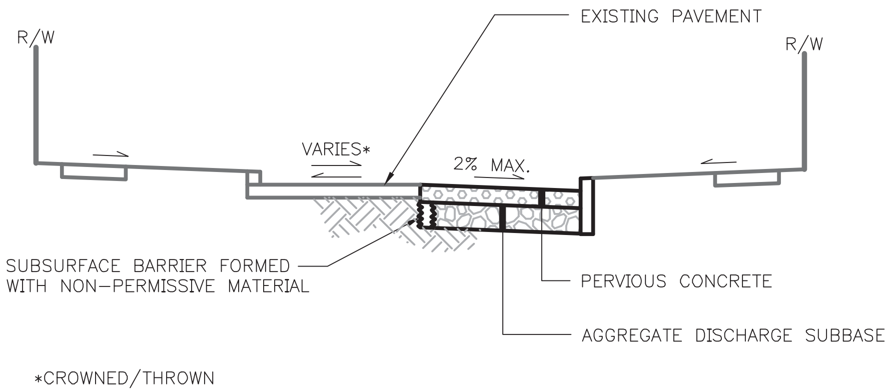
March 20, 2015

NOT TO SCALE



SUBSURFACE BARRIER – LINER

OR



SUBSURFACE BARRIER – FORMED WITH NON-PERMISSIVE MATERIAL

NOTES TO DESIGNER:

1. HALF WIDTH RESTORATION NOT APPROVED BY SDOT MAINTENANCE. MAY BE USED BY OTHERS RESPONSIBLE FOR MAINTENANCE PENDING MOA.
2. SUBSURFACE BARRIER IS TO MINIMIZE MIGRATION OF WATER INTO THE ADJACENT SUBBASE OF THE EXISTING CONVENTIONAL PAVEMENT AND UNDERMINING IT. SUBSURFACE BARRIER COULD BE PVC LINER, NON-PERMISSIVE MATERIAL SUCH AS CDF, NATIVE TILL, OR MATERIAL WITH HYDRAULIC CONDUCTIVITY OF 1×10^{-5} CM/SEC.

REFERENCE GSI MANUAL VOL. III, SECTION 9

Prepared by: MIG | SvR

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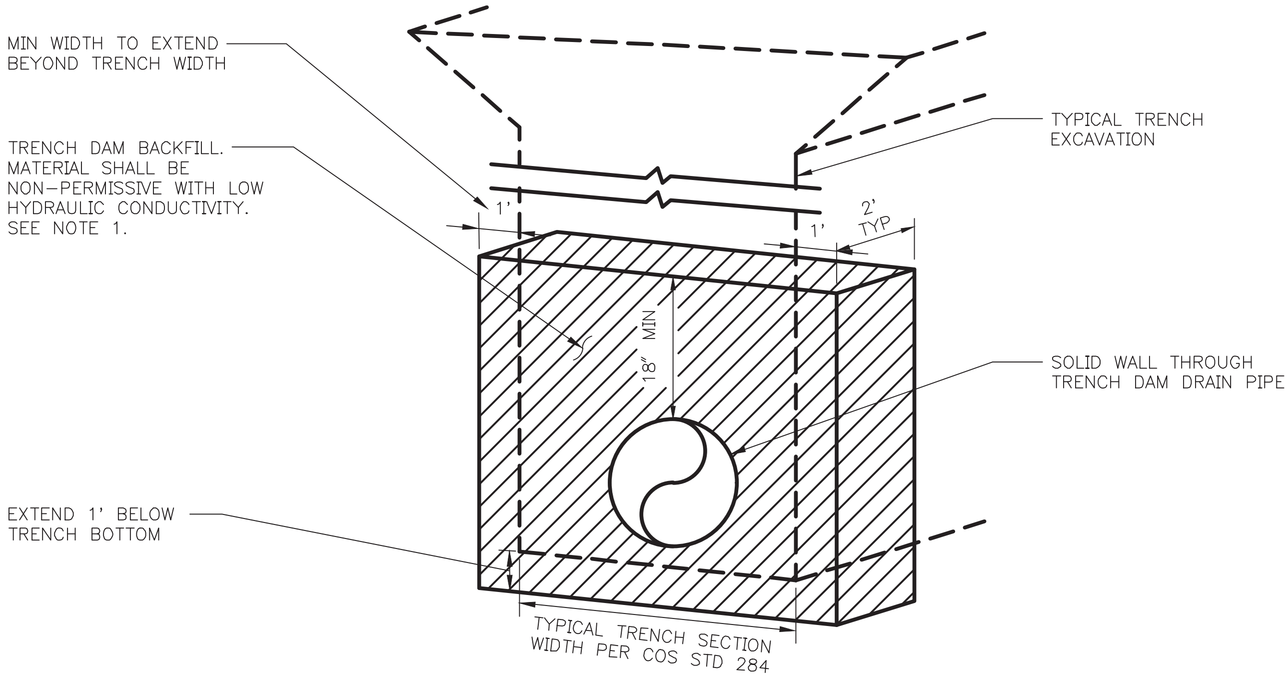
SUBSURFACE BARRIER AT INTERFACE BETWEEN PERVIOUS CONCRETE AND EXISTING PAVEMENT		GSI MANUAL PPC-3
July 15, 2014	NOT TO SCALE	

General GSI Components/Miscellaneous (GC-#)



NOTES:

1. TRENCH DAM BACKFILL SHALL BE A MATERIAL WITH HYDRAULIC CONDUCTIVITY LESS THAT $4x10^{-6}$ INCHES/SECOND ACCORDING TO ASTM D–5084 AND NON–PERMISSIVE MATERIAL. MATERIAL SUCH AS CONTROLLED DENSITY FILL PER COS SECTION 2–10.2(3)A2, NATIVE TILL EXCAVATED ON SITE THAT HAS A MINIMUM OF 20 PERCENT PASSING #200 STANDARD SIEVE SCREEN, OR OTHER MATERIAL APPROVED BY GEOTECHNICAL ENGINEER.

REFERENCE GSI MANUAL VOL. III, SECTION 7 & 9

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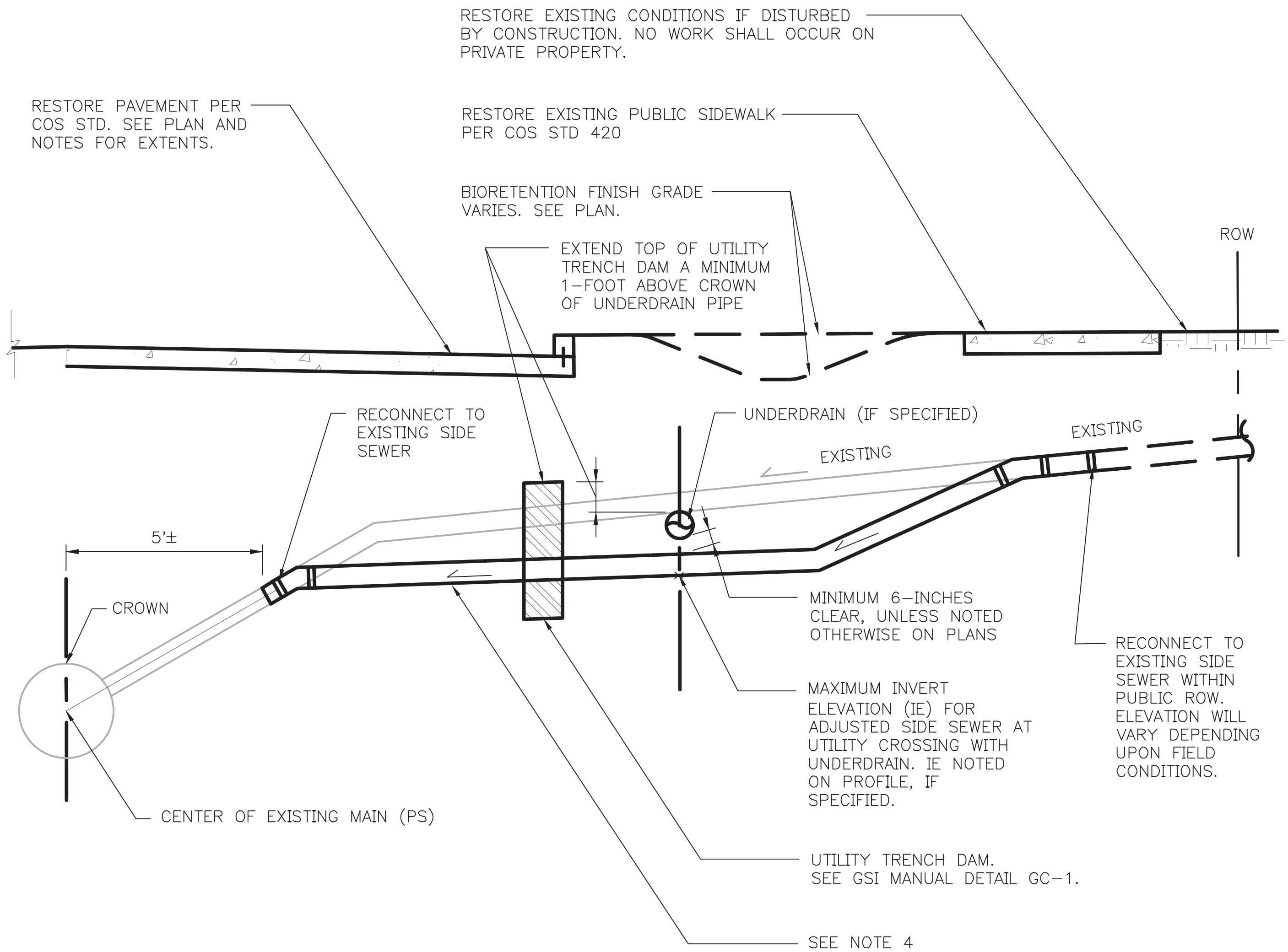
UTILITY TRENCH DAM	GSI MANUAL
	GC-1
April 2015 NOT TO SCALE	



NOTES:

1. PROVIDE TEST TEES AND FITTINGS AS REQUIRED PER COS STD. PLAN 283.
2. DOCUMENT ALL AS-BUILT INVERT ELEVATIONS AND LOCATION (STATION AND OFFSET) ON RECORD DRAWINGS.
3. MAXIMUM BEND FITTINGS SHALL BE 45°.
4. REPLACED SIDE SEWER SHALL HAVE MINIMUM SLOPE OF 2%.
5. ADJUSTED SIDE SEWER SHALL MEET THE REQUIREMENTS OF DPD DIRECTOR'S RULE 4-2011 and SPU DIRECTOR'S RULE 2011-004.
6. LOCATION SHOWN FOR EXISTING SIDE SEWER IS SCHEMATIC IN DETAIL. ACTUAL FITTINGS AND BENDS ARE UNKNOWN AND WILL VARY.
7. PROVIDE FITTINGS AND ADJUST SIDE SEWER TO CLEAR UNDER UNDERDRAIN AND RECONNECT TO EXISTING SIDE SEWER WITHIN THE PUBLIC RIGHT-OF-WAY.
8. ADJUSTMENT OF SIDE SEWERS IS UNDER A SEPARATE PERMIT WITH DPD.

REFERENCE GSI MANUAL VOL. III, SECTION 7

Prepared by: MIG I SvR

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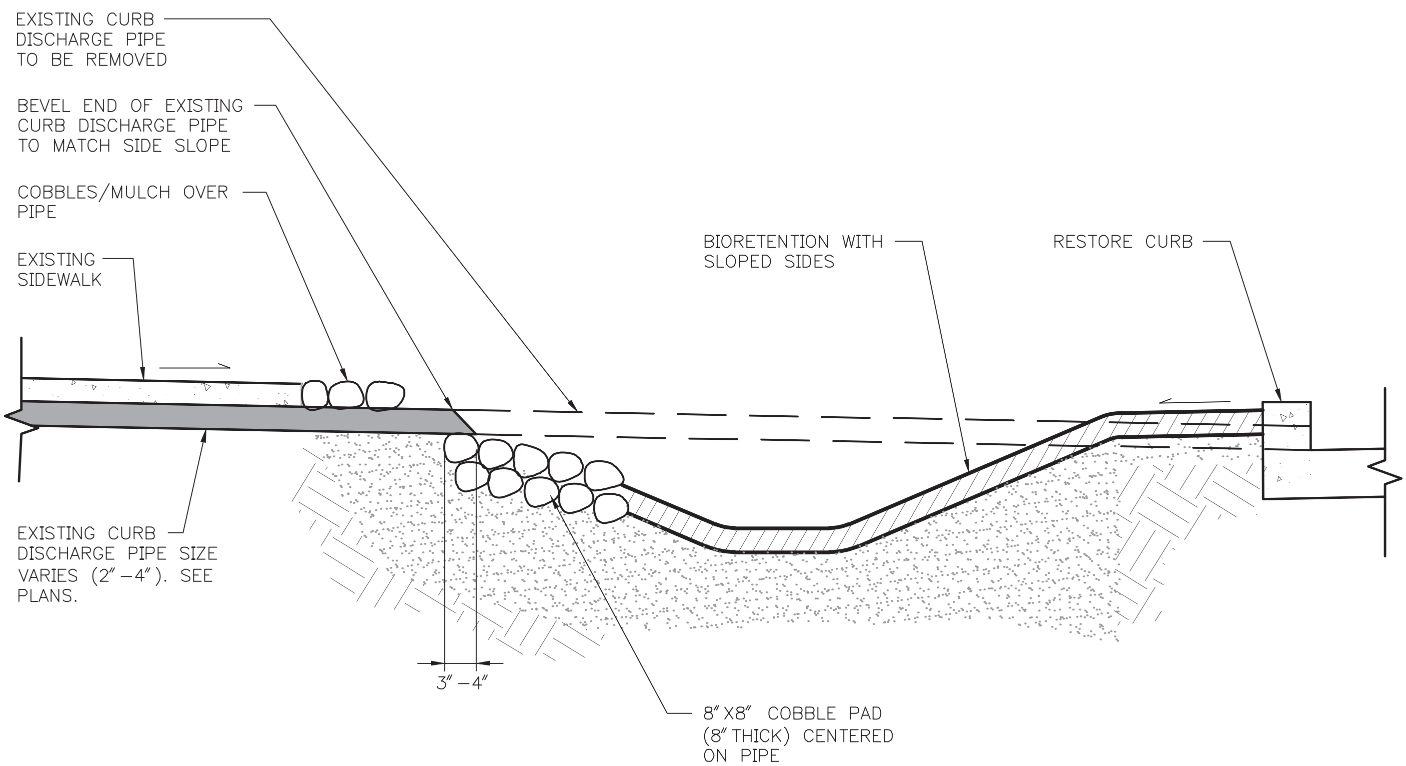
ADJUSTMENT OF EXISTING SIDE SEWER (SS) FOR GSI	GSI MANUAL GC-2
April 2015 — NOT TO SCALE	



REFERENCE GSI MANUAL VOL. III, SECTION 7

Prepared by: MIG | SvR

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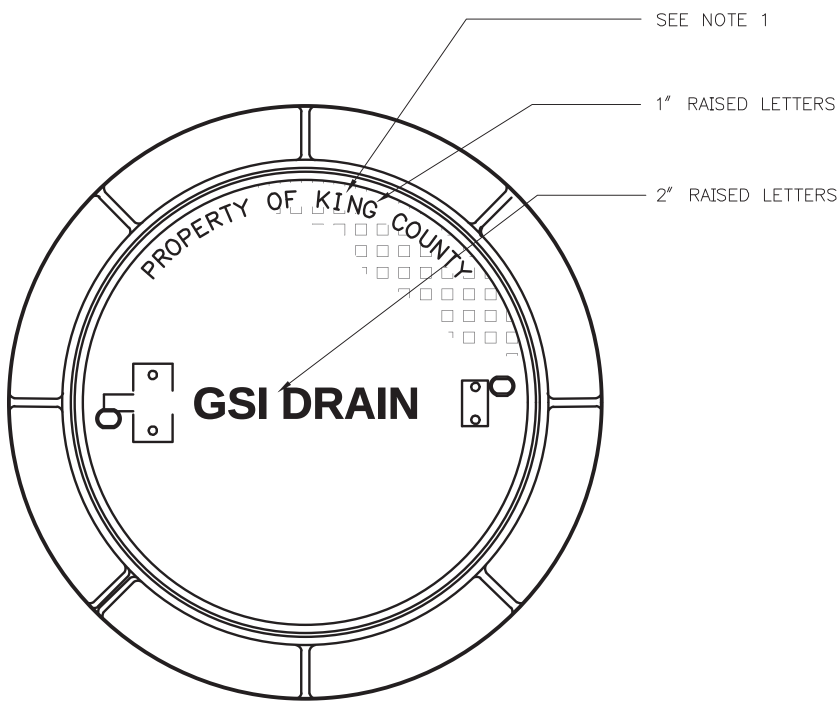
DAYLIGHT OF EXISTING CURB DISCHARGE		GSI MANUAL GC-3
April 2015	NOT TO SCALE	

Plotted: Sep 18, 2018 – 1:27:20pm By jordanl
File: G:\12c\12034c SPUGSI\Current\SPU_GC-03_DAYLIGHT OF EX CURB DISCHARGE.dwg Layout: Layout1



NOTES TO DESIGNER:

1. ACCESS LID SHALL BE PER COS STD 230L BUT WITH ENGRAVING AS NOTED FOR WTD. IF SPU PROJECT, LABEL "PROPERTY OF CITY OF SEATTLE".

REFERENCE GSI MANUAL VOL. III, SECTION 7 & 10

Prepared by: MIG I SvR

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GSI UNDERDRAIN MH ACCESS LID		GSI MANUAL GC-4
March 20, 2015	NOT TO SCALE	

Plotted: Sep 18, 2018 – 1:26:56pm By jordanl
File: G:\12c\12034c SPUGSI\Current\SPU_GC-04_GSI UNDERDRAIN MH ACCESS LID.dwg Layout: Layout1

Table D-2: IDT Design Guidance Criteria for Porous Pavement Retrofit in Neighborhood Yield and Residential Alleys*

*This document was the result of joint interdepartmental meeting discussions between Seattle Public Utilities, Seattle Department of Transportation and King County Wastewater Treatment Division in 2014. It is included for reference and background information. See also Section 9 of the Volume III-Design.

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King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Seattle Public Utilities

SvR DESIGN COMPANY

SPU KCWTD GSI Program

Table D-2: Design Guidance Criteria for Porous Pavement Retrofit in Neighborhood Streets and Alleys

Prepared: 7-14-2014, By: IDT Permeable Pavement Working Group, Compiled by: KG
SvR#12034

Type refers to if the design guidance is applicable to a project based who is responsible for maintenance. If its noted as SDOT, then the design guidance criteria applies. If its noted as all, regardless of who maintains the porous, the design guidance applies to all types of street retrofit CIP projects.

SDOT = SDOT is responsible for maintenance and funding maintenance

Other=Other City department and/or another agency is responsible for maintenance and funding of maintenance

ALL=Design guidance applies to ALL types of projects regardlesss if SDOT maintains or another City department/agency is responsible for maintenance.

#	Type	Design Guidance	Notes/Rationale
1	ALL	Site does not meet infeasibility criteria cited in City of Seattle Stormwater Manual	Site must meet regulatory requirements for the drainage code/manual.
2	ALL	Maximum longitudinal slope of street or alley (along the centerline of the street) is 5% (subbase and top wearing coarse surface grade). Maximum cross slope is 2%.	Longitudinal slopes over 5% increase excavation, more frequent spacing of check dams and design cost for pavement and are not as efficient use of space for providing temporary storage of stormwater.
3	ALL	Adjacent cross streets are not an arterial/street that will be sanded during the winter.	See SDOT mapping for designated streets. The tracking of sand from adjacent streets via vehicles turning onto the street will impact the stormwater performance for the first few panels.
4	SDOT	Full block (intersection to intersection)/full alley shall be replaced and not discontinuous panels or sections within the roadway/alley. Currently there is no interdepartmental agreement on long term maintenance of porous pavement in the public roadway.	SDOT does not have the funding in place required for maintenance of the porous pavements. Partial block installations are problematic for SDOT road maintenance for the following reasons: • In piecemeal installations, there will be difficulty maneuvering sweepers and other maintenance equipment form spot to spot and around parked cars. • Systematically, it will be difficult to establish discrete management units. Management of maintenance and other work like utility cut restorations will be difficult with two different pavement types along a single block. • Saturation of the subgrade for infiltration will weaken any conventional pavement that remains adjacent to the new permeable. A barrier may mitigate this, but the barrier becomes an issue in a utility cut restorations and with joints. • The introduction of additional joints in the retrofit scenario where partial panel is replaced may further compormise the pavement structure and create a hazard for users, especially bicyclists. • Difficult utility clearance issues, mainly working around shallow lines (and their required bedding) with the deep reservoir layer, are likely to arise on partial block installations. • In a partial block application, particularly an alley, it will be difficult to regrade and address edge conditions to prevent sediment loading from adjacent properties.
5	SDOT	Full block shall be pervious concrete regardless if the existing pavement is conventional concrete or asphalt. Currently there is not interdepartmental agreement on long term maintenance of porous pavement in the public roadway.	Material shall be continuous throughout the block. City lab pavement engineer does not recommend use of porous asphalt in the public roadway at this time because porous asphalt mix design has not been developed enough to increase confidence that pavement system will last for 20-30 years; the higher grade asphalt (PG70-22) for porous asphalt is not as readily available in our area, costs more and requires large projects (such as a city block) to obtain material; and porous asphalt is more susceptible to rutting and degradation from oil and grease and to wear and tear from studded tires as compared to pervious concrete. Permeable interlocking pavers was not reviewed by the working group at this time. Once concept for pervious concrete is developed then it will be determined if working group is to look at permeable interlocking pavers.
6	Other	For porous streets maintained by others, full block replacement is not required. For **thrown** streets (sloped to one side), porous pavement retrofit may be on the downslope side of the street (half the roadway width) for a continuous section along the full block. -for existing asphalt streets porous pavement shall be porous asphalt. For half street retrofits, a new joint between the porous asphalt and the existing asphalt may be created (at approximately the centerline of the road). -for existing concrete streets porous pavement shall be pervious concrete and follow existing joints.	To provide continuity and ease of identification for maintenance. Want to minimize adding new joints which could affect other users. The additional joints could be a place where a bicycle tire could get caught and affect bicycle safety. Pavement materials shall be similar to conventional for continuity and for jointing between the materials.

SPU KCWTD GSI Program

Table D-2: Design Guidance Criteria for Porous Pavement Retrofit in Neighborhood Streets and Alleys

Prepared: 7-14-2014, By: IDT Permeable Pavement Working Group, Compiled by: KG
SvR#12034

Type refers to if the design guidance is applicable to a project based who is responsible for maintenance. If its noted as SDOT, then the design guidance criteria applies. If its noted as all, regardless of who maintains the porous, the design guidance applies to all types of street retrofit CIP projects.

SDOT = SDOT is responsible for maintenance and funding maintenance

Other=Other City department and/or another agency is responsible for maintenance and funding of maintenance

ALL=Design guidance applies to ALL types of projects regardlesss if SDOT maintains or another City department/agency is responsible for maintenance.

#	Type	Design Guidance	Notes/Rationale
7	Other	For porous streets maintained by others, full block replacement is not required. For **crowned** streets, porous pavement retrofit may be on either half of the crowned street or the full road width. Panels/Porous sections shall be continuous and not intermittent along a street length. -for existing asphalt streets porous pavement shall be porous asphalt. For half street retrofits, a new joint between the porous asphalt and the existing asphalt may be created (at approximately the centerline of the road). -for existing concrete streets porous pavement shall be pervious concrete and follow existing joints.	To provide continuity and ease of identification for maintenance. Want to minimize adding new joints which could affect other users. The additional joints could be a place where a bicycle tire could get caught and affect bicycle safety. Pavement materials shall be similar to conventional for continuity and for jointing between the materials.
8	ALL	Pervious concrete shall follow existing joints and not add new joints to a roadway section.	Want to minimize adding new joints which could affect other users. The additional joints could be a place where a bicycle tire could get caught and affect bicycle safety.
9	ALL	Porous pavement shall not be installed through intersections along neighborhood streets.	More challenging to clean with a vacuum sweeper through intersections. The multi-directional turning of traffic may increase potential for raveling.
10	ALL	No porous pavement within 20-feet from PC/PT of the curb return.	The stopping and starting and wheel turning may impact the long term peformance of the pervious pavement (potential increase for raveling).
11	Other	For porous streets maintained by others and with partial porous pavement along the street, then for cleaning it is recommended that the full street be closed during the annual/semi-annual vacuum cleaning so that sediment on the porous and non-porous sections be vacuum swept.	To allow for ease of maintenance without having intermittent parked cars to weave around along the street.
12	ALL	It is recommended that residential driveways in ROW be paved (in accordance with COS Standards) from property line to edge of street.	Gravel driveways will track debris and increase maintenance frequency of the porous section. To reduce tracking provide paved driveway with conventional pavement.
13	ALL	For porous adjacent to curb no gutter is required.	To maximize the area in the roadway that is porous.
14	ALL	If curb and gutter is installed adjacent to pervious, gutter can be reversed slope to allow for runoff to flow into the porous pavement. Transition gutter and road slope at end of the street to match into existing grades.	To allow for sheet flow runoff to drain onto the porous pavement.
15	SDOT & Other	For full alley porous asphalt and pervious concrete retrofits, inverted cross slope may be at 2% as long as 25-year conveyance is provided within the alley and not flow onto private property. Match existing grade along ROW line (each side). Transition to existing grade at start and end of alley.	The less steep cross slope (than the city 4.7% standard) will allow for easier construction of the pavement and also make it more efficient for infiltrating the stormwater on less steep slope. Conveyance calculations can account for the infiltration through the pavement and subsurface temporary storage.
16	ALL	Provide emergency overflow conveyance.	To provide conveyance in extreme storm events. Review flow path at downstream end of porous pavement. The emergency overflow may include flow to a bioretention facility, conveyance channel, existing storm drain catch basin/inlet or other approved drainage system.
17	ALL	Neighborhood street & alley pervious concrete setion: Shall be 8-inches of pervious concrete over minimum 12-inches of aggregate discharge subbase. If less depth is used provide structural calculations to demonstrate otherwise. Design life assumed to be 30 years.	There are no installations locally that are older than 10-years in the public ROW streets. Nationally pervious concrete has been used in building construction in past 60 years but few installations older than 20-30+ years in the roadway. Based on discussions with industry, assume 30+years.
18	Other	Neighborhood street and alley porous asphalt section: Shall be designed for the loading typical for the City's neighborhood streets and alleys (i.e. recycling/garbage/yard waste trucks, fire trucks, delivery trucks etc)	Porous asphalt is not to be used for streets maintained by SDOT so design is to be done by others to support the loading in the public street.
19	ALL	Pavement section (including check dams) shall be designed so that the maximum temporary ponding depth does not include the top wearing course of the pavement system. Temporary ponding is within the aggregate discharge subbase (storage subbase layer).	To avoid having the top wearing course become fully saturated.
20	ALL	At the downstream end of the block, check dam/liner shall be installed at the interface with conventional pavement and provide a subsurface overflow slotted drain pipe to collect overflow. This pipe shall be connected to City drainage system.	To protect the adjacent conventional pavement's subgrade from becoming saturated from the water filtering through the porous pavement section.
21	ALL	A utility trench dam is required for new wet utilities installed below the porous pavement (such as side sewers, service drains).	To minimize piping in the backfill/bedding of the new utility trench. Utility trench is not required for existing utility trenches that are left undisturbed.

Presettling Requirements for Bioretention in COS SWM & ROWIM, SvR Memorandum dated November 8, 2013.*

*NOTE: This memorandum is included for background reference. See City of Seattle Standard Plans and 2016 City of Seattle Stormwater Manual for presettling zone standard plans and design requirements.

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MEMORANDUM

NOTE: THIS MEMO IS FOR BACKGROUND REFERENCE. SEE COS 2016 STORMWATER MANUAL FOR PRESETTLING ZONE REQUIREMENTS.

DATE: November 8, 2013

FROM: Nathan Polanski, PE, SvR Design Company
Kathryn Gwilym, PE, SvR Design Company

TO: Shanti Colwell, PE, SPU

CC: Tracy Tackett, PE, SPU
John Phillips, KCWTD

RE: **Presettling Requirements for Bioretention in COS SWM & ROWIM GSI Program TASK 2-4f and TASK 7**

This memo is to follow-up on the discussion from the meeting on October 22, 2013 discussing the presettling recommendations that SvR outlined in its memorandum dated October 3, 2013. The following was decided from the meeting:

1. Presettling requirements noted for private parcels on Table 1 (see attached) could be incorporated into the Stormwater Manual update.
2. Presettling requirements for bioretention in the City's right-of-way will be described in the Right-of-Way Improvement manual but thresholds will be provided in the City of Seattle's stormwater manual. Avoid use of cobbles or other loose erosion protection material in presettling cells in the right-of-way but use precast concrete pad for ease of SPU's Maintenance crews in using a vactor to clean out the sediment. If cobbles are used around the precast concrete pad for aesthetics then cobbles shall be minimum 4" in size for vactoring around pad.

Tables 1-3 (attached) have been revised to incorporate comments from the October 22nd meeting for defining the requirements for the "presettling zone" for bioretention systems for input into the COS Stormwater Manual update. It is assumed that for SPU/WTD capital projects in the public right-of-way the presettling zone will be maintained to a SPU Level of Service C or greater whereas private facilities can vary in the level of service.

Also attached is a document showing track changes of the recommendations incorporated into the Stormwater Manual Volume III – Sections 4.2 and 5.3. The format/style/terminology will need to be reviewed/revised as needed for consistency with other sections of the manual.

Next Steps
1. SPU to review text edits to Stormwater Manual and make revisions as needed.
2. SPU to determine next steps for incorporating into the ROWIM details for presettling.

<u>Attachments:</u>
Table 1 – Presettling for Bioretention on Private Parcels and Maintained by Property Owner
Table 2 – Presettling for Roadside Bioretention along Residential Streets in City ROW and Maintained by SPU/WTD
Table 3 – Presettling for Roadside Bioretention along Arterial Streets in City ROW and Maintained by SPU/WTD

DRAFT - FOR INTERNAL DISCUSSION PURPOSES

King County
Department of
Natural Resources and Parks
Wastewater Treatment Division

Seattle Public Utilities

SPU WTD GSI Program

Task 2 - 4f (2) - Recommendations for Presettling for Bioretention

SvR#12034, Prepared: 9-09-2013, Revised 11-8-2013, by: NP Ck'd: KG, MRS

SvR DESIGN COMPANY

Table I: Presettling for Bioretention on Private Parcels and maintained by Property Owner

Impervious Areas thresholds at entrance to cell(s)for Presettling.[5]	Recommendation for Presettling Zone in first cell[1, 2]	Rationale
≤ 5000 square feet	No presettling requirement. Provide erosion protection and flow dispersion for runoff entering the system at each inlet/curb cut. Designer to determine if site specific presettling is needed based on upstream area conditions.	Tributary area is small and assume facility will be maintained. Observations of existing built facilities do not indicate a presettling zone is needed.
5000 < x ≤ 10,000 square feet	The bottom of the first 2-3 feet of the upstream bioretention cell shall be designated the Presettling Zone. This bottom area of the swale shall be constructed of cobbles, concrete open celled paving grids or plastic lattices filled with gravel or groundcover vegetation, a pre-cast concrete pad or similar for collection of sediment. A catch basin (such as COS 241, 240) with a minimum 2' sump may also be used as the presettling zone. Where the pipe from the CB daylights into the bioretention cell, provide energy dissipator pad .	Upstream impervious areas are stabilized and opportunity for sediment transport is limited. Observations of existing built facilities indicate only a small Presettling Zone is needed. Examples: If 5000 sf of impervious area discharges into the cell at one location then the entrance shall be the presettling zone. If 7000 sf drains to one cell and the flows are split such that each tributary area is equal to or less than 5000 sf then no presettling is required.
> 10,000 square feet	Project specific; to be determined by designer and approved by SPU Director. If impervious area is less than 10,000 sf discharging at a single location then see above categories.	Larger contributing areas may result in steeper slopes, greater flow velocities, and larger volumes creating a greater potential for resuspension of existing sediment and erosion within the bioretention cell.

Notes:

1. The designated Presettling Zone does not count as part of the required area for flow control or water quality treatment and should be clearly called out on the Drawings as a Presettling Zone.
2. Rationale is based on engineering judgment and observations of existing facilities and gutter flows. Deviations from the recommended requirements may be approved with a project specific operations and maintenance plan that provides greater frequency of maintenance than the minimum requirements outlined in the GSI Manual, Volume V - Operations and Maintenance.
3. Presettling for sites with upstream impervious gravel area (e.g. unimproved alleys, shoulders, etc) as part of final site conditions shall be designed on a project specific basis to address potential for increased sediment loading and erosion.
4. Plants should not be located in the hard bottomed area to facilitate operations and maintenance. Planting along the side is required and provides an opportunity to conceal the hard bottom and improve aesthetics of the presettling zone.
5. The designated presettling zone could be the first cell in a series of interconnected cells or a portion of one large cell designed to treat the tributary area entering at a single location.

King County Department of Natural Resources and Parks Wastewater Treatment Division

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Task 2 - 4f (2) - Recommendations for Presettling for Bioretention

SvR#12034, Prepared: 9-09-2013, Revised 11-8-2013, by: NP Ck'd: KG, MRS

SvR DESIGN COMPANY

Table 2: Presettling for Roadside Bioretention along Residential Streets in City ROW and Maintained by SPU/WTD

Longitudinal length of street draining to facility (assumes contributing impervious area is half of a crowned 25' wide street and 5' sidewalk on each side, with bioretention cells in a series)[2]	**Recommendation for Presettling Zone in first cell[1, 2]**	**Rationale**
≤ 360 linear feet of gutter OR ≤ 6700 square feet of ROW Impervious Area (Road, Sidewalk[5])	No presettling requirement. Provide erosion protection and flow dispersion for runoff entering the system at each inlet/curb cut. Designer to determine if site specific presettling is needed based on upstream area conditions.	Tributary area is small and assume facility will be maintained. Observations of existing built facilities do not indicate a presettling zone is needed.
360 < x ≤ 660 linear feet of gutter OR 6700 < x ≤ 12,300 square feet of ROW Impervious Area (Road & Sidewalk[5])	The bottom of the first 2-3 linear feet of the upstream bioretention cell shall be designated the Presettling Zone. This bottom area shall be constructed of a pre-cast concrete pad surrounded by cobbles per detail in ROWIM.	Upstream impervious areas are stabilized and opportunity for sediment transport is limited. Observations of existing built facilities indicate only a small presettling zone is needed. Requirement is similar to that used on KC Barton Basin CSO Control Project (see details 7 and 8 on D9 of the Barton SIP set)
> 660 linear feet of gutter OR > 12,300 square feet of ROW Impervious Area (Road & Sidewalk[5])	Project specific; to be determined by designer and approved by SPU Director	Larger contributing areas may result in steeper slopes, greater flow velocities, and larger volumes creating a greater potential for resuspension of existing sediment and erosion within the bioretention cell.

Notes:

1. The designated Presettling Zone does not count as part of the required area for flow control or water quality treatment and should be clearly called out on the Drawings as a Presettling Zone.
2. Rationale is based on engineering judgment and observations of existing facilities and gutter flows. Deviations from the recommended requirements may be approved with a project specific operations and maintenance plan that provides greater frequency of maintenance than the minimum requirements outlined in the GSI Manual, Volume V - Operations and Maintenance.
3. Presettling for sites with upstream impervious gravel area (e.g. unimproved alleys, shoulders, etc) as part of final site conditions shall be designed on a project specific basis to address potential for increased sediment loading and erosion.
4. Plants should not be located in the hard bottomed area to facilitate operations and maintenance. Planting along the side is required and provides an opportunity to conceal the hard bottom and improve aesthetics of the presettling zone.
5. Street width is based on common City of Seattle Residential pavement widths. Area has allowance for driveway(s)/curb cuts in ROW.
6. At designated point discharges into a bioretention cell (such as pipes daylighting into bioretention swale), the designer to provide flow dispersion. The presettling zone could be used in part as the flow dispersion but designer to evaluate. Example of pipe discharge protection used in combination with presettling zone is shown in detail 6 on D9 in Barton's SIP set.

King County
Department of Natural Resources and Parks
Wastewater Treatment Division

Seattle Public Utilities

SPU WTD GSI Program

Task 2 - 4f (2) - Recommendations for Presettling for Bioretention

SvR#12034, Prepared: 9-09-2013, Revised 11-8-2013, by: NP Ck'd: KG, MRS

SvR DESIGN COMPANY

Table 3: Presettling for Roadside Bioretention along Arterial Streets in City ROW and Maintained by SPU/WTD

Longitudinal length of street draining to facility (assumes contributing impervious area based half of a crowned 32-36' wide street plus 5'-6' sidewalk on each side, with bioretention cells in series)[2]	**Recommendation for Presettling Zone in first cell[1, 2]**	**Rationale**
≤ 360 linear feet of gutter OR ≤ 9000 square feet of ROW Impervious Area (Road, Sidewalk[5]).	The bottom of the first 2-3 linear feet of the upstream bioretention cell shall be designated the Presettling Zone. This bottom area shall be constructed of a pre-cast concrete pad surrounded by cobbles per detail in ROWIM.	Sediment and grit accumulation along even short lengths of arterial streets is significant due to traffic volumes and types of vehicles using the corridor (e.g. construction vehicles, buses, trucks, etc). The porous weir helps to contain sediment and grit in designated Presettling Zone.
360 < x ≤ 660 linear feet of gutter OR 9000 < x ≤ 16,500 square feet of ROW Impervious Area (Road & Sidewalk[5]).	The full length of the first cell (in a series), which should have a bottom length of 8-10 feet designated as the "presettling zone". The bottom of the first 2-3 feet of this "presettling zone" shall have pre-cast concrete pad. This initial bottom area should be followed by a porous weir that allows water to be temporarily detained and slowed down, such as a row of boulders set low (a few inches above the bottom of bioretention cell). See ROWIM detail.	More sediment and grit accumulation occurs along arterial streets compared to residential streets. A designated presettling zone in the first cell provides a greater factor safety for sediment that may become resuspended as a result of flow velocities and volumes from upstream impervious areas. The porous weir helps to contain sediment and grit in upper portion of the presettling zone.
> 660 linear feet of gutter OR > 16,500 square feet of ROW Impervious Area (Road & Sidewalk[5])	Project specific; to be determined by designer and approved by SPU Director	Projects with large contributing impervious areas may vary greatly depending on the upstream slope among other things.

Notes:

1. The designated Presettling Zone does not count as part of the required area for flow control or water quality treatment and should be clearly called out on the Drawings as a Presettling Zone.
2. Rationale is based on engineering judgment and observations of existing facilities and gutter flows. Deviations from the recommended requirements may be approved with a project specific operations and maintenance plan that provides greater frequency of maintenance than the minimum requirements outlined in the GSI Manual, Volume V - Operations and Maintenance.
3. Presettling for sites with upstream impervious gravel area (e.g. unimproved alleys, shoulders, etc) as part of final site conditions shall be designed on a project specific basis to address potential for increased sediment loading and erosion.
4. Plants should not be located in the hard bottomed area to facilitate operations and maintenance. Planting along the side is required and provides an opportunity to conceal the hard bottom and improve aesthetics of the presettling zone.
5. Street width is based on common City of Seattle Minor Arterial width. Area has allowance for driveway(s)/curb cuts in the ROW.
6. At designated point discharges into a bioretention cell (such as pipes daylighting into bioretention swale), the designer to provide flow dispersion. The presettling zone could be used in part as the flow dispersion but designer to evaluate. Example of pipe discharge protection used in combination with presettling zone is shown in detail 6 on D9 in Barton's SIP set.
7. The above table is specific to land use areas requiring "basic" or "enhanced water quality" treatment. For areas requiring higher threshold or other water quality treatment, presettling design to be by the project's designer and approved by SPU Director.

Appendix E: Procedures for Preparing GSI Design for O&M and Asset Management

- GSI Component Design Checklist for O&M Approval during Design Phase
- GSI Project Information Form (http://www.seattle.gov/util/cs/groups/public/@spu/@dso/documents /webcontent/3_038018.pdf)
- Chapter 9 Develop the Total O&M Cost*
- Appendix E – O&M Cost Estimating*
- SPU Basis of O&M Cost Estimate**

*These are excerpts from SPU's Cost Estimating Guide 8-23-2017. See website for latest and contact SPU's FOM for templates.
https://www.seattle.gov/util/Engineering/Consulting_Resources/CostEstimatingGuide/index.htm
http://www.seattle.gov/util/cs/groups/public/@spu/@engineering/documents/webcontent/02_015864.pdf
**Contact SPU's FOM for latest version for these templates in SPU's Cost Estimating Guide.

See GSI Manual Volume V for "Supplemental Information for Project Specific O&M" to be completed for new GSI components/technologies.

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King County
Department of
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Wastewater Treatment Division

Seattle Public Utilities

Revision Date: 9/30/2014,
Updated 6/17/2015, 8/2018

GSI COMPONENT DESIGN CHECKLIST FOR O&M APPROVAL

Purpose: Preparation for O&M and asset management coordination. This is to be initially submitted at 30% and updated for each phase of a project to confirm approach is consistent with agency O&M procedures.

This version is Bioretention focused - placeholders are included for other GSI components. If you are adding new components, then insert new line item within the appropriate category. Contact GSI Program for copy of excel file for completing this document.

Document Prepared By (Name, Company): ____ Date Submitted: ________________

Design Phase (circle which applies): 30% 60% 90% Other:______

	GSI Facility Component		CHECK yes/no			NEW Component/ Asset Type	PURPOSE & ADDITIONAL INFO	APPROVED FOR USE		
			Is it defined in GSI Manual Vol V- O&M? If no then go to NEW type column.	Meets SPU Standard?	Meets WTD Standard?	GSI Tool, Technology , Design revision, Location, Material etc	Reason for modification of component standard and/or adding a new component/asset	SPU / WTD PM	SPU / WTD PE	O&M Mgr
▲ ▲ ▲ A. Facility Footprint ▲ ▲ ▲										
A1	Cell Type (Overview)	Bioretention -graded side slopes								
		Bioretention -graded side slopes w/ underdrain								
		Bioretention -vertical wall(s)								
		Bioretention -vertical wall(s) w/ underdrain								
		Bioretention - combo vertical wall & graded side slopes								
		Biofiltration (conveyance)								
		Other								
A2	Soils	COS Bioretention Soil Mix per COS Specs Type _____								
		COS Bioretention Soil Mix per COS Specs Type _____								
		ECY Bioretention Soil Mix - Type x								
		COS Mineral Aggregate Type 26								
		COS Mineral Aggregate Type 24								
		COS Mineral Aggregate Type 6								

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Document Prepared By (Name, Company): ____________________ Date Submitted: ____________

Design Phase (circle which applies): 30% 60% 90% Other:______

	GSI Facility Component		CHECK yes/no			NEW Component/ Asset Type	PURPOSE & ADDITIONAL INFO	APPROVED FOR USE		
			Is it defined in GSI Manual Vol V-O&M? If no then go to NEW type column.	Meets SPU Standard?	Meets WTD Standard?	GSI Tool, Technology , Design revision, Location, Material etc	Reason for modification of component standard and/or adding a new component/asset	SPU / WTD PM	SPU / WTD PE	O&M Mgr
▲ ▲ ▲ A. Facility Footprint, continued ▲ ▲ ▲										
A3	Check Dams	Surface -Rock								
		Subsurface- Bentonite								
		Subsurface Concrete								
A4	Weirs	Concrete								
		Wood or Composite								
		Boulder/stone								
		Segmental								
		Metal								
		Other ____________								
A5	Vertical Walls - single side	Concrete								
		Segmental								
		Rockery								
		Steel								
		Other ____________								
A6	Vertical Walls - enclosed cell	Concrete								
		Segmental								
		Rockery								
		Steel								
		Other____________								

GSI COMPONENT DESIGN CHECKLIST FOR O&M APPROVAL

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Document Prepared By (Name, Company): ______________________________ Date Submitted: ____________

Design Phase (circle which applies): 30% 60% 90% Other:______

	GSI Facility Component		CHECK yes/no			NEW Component/ Asset Type	PURPOSE & ADDITIONAL INFO	APPROVED FOR USE		
			Is it defined in GSI Manual Vol V-O&M? If no then go to NEW type column.	Meets SPU Standard?	Meets WTD Standard?	GSI Tool, Technology , Design revision, Location, Material etc	Reason for modification of component standard and/or adding a new component/asset	SPU / WTD PM	SPU / WTD PE	O&M Mgr
▲	▲	▲ B. Inlets/Outlets/Pipes - Surface ▲	▲	▲						
B1	Grates, Trash Racks, Drain Curb Cuts,	Drain Curb Cut Type 1 COS Std 295b								
		Drain Curb Cut Type 2 COS Std 295c								
		Drain Curb Cut Type 3 COS Std 295d								
		Drain Curb Cut Type _								
		Beehive Grate COS Std 269								
		COS Grate Std Plan _____								
		Special Grate								
		Trash Rack								
		Cobbles								
B2	Presetting zone	Presettling Zone COS Std 299								
		Concrete Precast Pad								
		Cobbles								
		Boulders								
		None								
B3	Catch Basins (CB's) with pipes conveying flow to cells	See C1								

King County
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Wastewater Treatment
Division

Seattle Public Utilities

Revision Date: 9/30/2014,
Updated 6/17/2015, 8/2018

GSI COMPONENT DESIGN CHECKLIST FOR O&M APPROVAL

Purpose: Preparation for O&M and asset management coordination. This is to be initially submitted at 30% and updated for each phase of a project to confirm approach is consistent with agency O&M procedures.

This version is Bioretention focused - placeholders are included for other GSI components. If you are adding new components, then insert new line item within the appropriate category. Contact GSI Program for copy of excel file for completing this document.

Document Prepared By (Name, Company): ____________________ Date Submitted: ____________

Design Phase (circle which applies): 30% 60% 90% Other:______

	GSI Facility Component		CHECK yes/no			NEW Component/ Asset Type	PURPOSE & ADDITIONAL INFO	APPROVED FOR USE		
			Is it defined in GSI Manual Vol V-O&M? If no then go to NEW type column.	Meets SPU Standard?	Meets WTD Standard?	GSI Tool, Technology , Design revision, Location, Material etc	Reason for modification of component standard and/or adding a new component/asset	SPU / WTD PM	SPU / WTD PE	O&M Mgr
▼ ▼ ▼ C. Subsurface - Inlets/Outlets/Pipes Etc. ▼ ▼ ▼										
C1	Catch Basins (CB) and Storm Drains Discharging to Swales	Inlet type ____ per COS								
		CB type ____ per COS								
		CB type ____ per COS								
		MH type ____ per COS								
		Storm Drain Pipe								
		Private Storm Drain Pipe								
C2	Bioretention Underdrain System	Underdrain pipe per COS std plan ____								
		Underdrain MH Type ___ per COS								
		Underdrain MH Type ___ with ___ feet sump per COS								
		Underdrain Pipe Bedding and Backfill per COS Type 26								
		Cleanout/Observation Port per COS std plan 281								
C3	Liners	PVC __ ml								
		Clay blanket								
		Other ____________								

GSI COMPONENT DESIGN CHECKLIST FOR O&M APPROVAL

Purpose: Preparation for O&M and asset management coordination. This is to be initially submitted at 30% and updated for each phase of a project to confirm approach is consistent with agency O&M procedures.

This version is Bioretention focused - placeholders are included for other GSI components. If you are adding new components, then insert new line item within the appropriate category. Contact GSI Program for copy of excel file for completing this document.

Document Prepared By (Name, Company): ______________________________ Date Submitted: ____________________

Design Phase (circle which applies): 30% 60% 90% Other:______

	GSI Facility Component		CHECK yes/no			NEW Component/ Asset Type	PURPOSE & ADDITIONAL INFO	APPROVED FOR USE		
			Is it defined in GSI Manual Vol V-O&M? If no then go to NEW type column.	Meets SPU Standard?	Meets WTD Standard?	GSI Tool, Technology , Design revision, Location, Material etc	Reason for modification of component standard and/or adding a new component/asset	SPU / WTD PM	SPU / WTD PE	O&M Mgr
▼	▼	▼ C. Subsurface - Inlets/Outlets/Pipes Etc, continued ▼	▼	▼						
C4	Pipe daylighting to Swale crossing road	Ductile Iron								
		Presettling Zone at Pipe Outlet -See B2								
C5	Flow Splitter	CB type ____ per COS								
		MH type ____ per COS								
C6	Geotextile Fabric	Coir Fabric per COS ___								
		Soil Separation Non-woven COS Type ___								
C7	Soil Cell (Silva Cell [R])	Placeholder								

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	GSI Facility Component		CHECK yes/no			NEW Component/ Asset Type	PURPOSE & ADDITIONAL INFO	APPROVED FOR USE		
			Is it defined in GSI Manual Vol V-O&M? If no then go to NEW type column.	Meets SPU Standard?	Meets WTD Standard?	GSI Tool, Technology , Design revision, Location, Material etc	Reason for modification of component standard and/or adding a new component/asset	SPU / WTD PM	SPU / WTD PE	O&M Mgr
▲ ▲ ▲ D. Vegetation ▲ ▲ ▲										
D1	Vegetation in cell bottom area and lower slope - Zone 1, 2	Evergreen Grasses/Sedges								
		Deciduous grasses								
		Shrubs								
		Trees (see D6)								
D2	Vegetation in cell upper slope and adjacent to sidewalk - Zone 3	Ground covers								
		Perennials and Deciduous Grasses								
		Low/med shrubs								
		Lg shrubs								
		Fruiting non-native shrubs								
		Trees (see D6)								
D3	Vegetation adjacent to intesection, driveway access Zone 4	Ground covers/ sedums								
		Dwarf grasses								
		Low shrubs								
D4	Vegetation/ surfacing at curb edge, crossing areas, step out zones Zone 5	Ground covers/ sedums								
		Dwarf grasses								
		Grass lawn								
		Mulch only								
		Trees (see D6)								
D5	Vegetation in a gap between facility areas	Vegetated								
		Grass lawn								

GSI COMPONENT DESIGN CHECKLIST FOR O&M APPROVAL

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Document Prepared By (Name, Company): ______________________ Date Submitted: ______________

Design Phase (circle which applies): 30% 60% 90% Other:______

	GSI Facility Component		CHECK yes/no			NEW Component/ Asset Type	PURPOSE & ADDITIONAL INFO	APPROVED FOR USE		
			Is it defined in GSI Manual Vol V-O&M? If no then go to NEW type column.	Meets SPU Standard?	Meets WTD Standard?	GSI Tool, Technology , Design revision, Location, Material etc	Reason for modification of component standard and/or adding a new component/asset	SPU / WTD PM	SPU / WTD PE	O&M Mgr
▲ ▲ ▲ D. Vegetation, cont. ▲ ▲ ▲										
D6	Trees within facility limits	Lg. Deciduous								
		Lg. Conifer								
		Med. Deciduous								
		Med. Evergreen								
		Columnar Deciduous								
		Small Ornamental								
		Fruit bearing								
D7	Trees outside of facilitiy limits*	*verify long term responsibility								
▲ ▲ ▲ E. Mulch ▲ ▲ ▲										
E1	Mulch	COS Compost Mulch __								
		COS Type ______								
		Arborist wood chips								
		Shredded bark								
		Special								

GSI COMPONENT DESIGN CHECKLIST FOR O&M APPROVAL

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Document Prepared By (Name, Company): ____________________ Date Submitted: ____________

Design Phase (circle which applies): 30% 60% 90% Other:______

	GSI Facility Component		CHECK yes/no			NEW Component/ Asset Type	PURPOSE & ADDITIONAL INFO	APPROVED FOR USE		
			Is it defined in GSI Manual Vol V-O&M? If no then go to NEW type column.	Meets SPU Standard?	Meets WTD Standard?	GSI Tool, Technology , Design revision, Location, Material etc	Reason for modification of component standard and/or adding a new component/asset	SPU / WTD PM	SPU / WTD PE	O&M Mgr
▲ ▲ ▲ F. Watering ▲ ▲ ▲										
F1	Watering (hand from nearby source or truck)									
F2	Irrigation system	Quick coupler								
		Spray heads								
		Tree bubblers								
		Drip								
		Backflow Assembly								

GSI COMPONENT DESIGN CHECKLIST FOR O&M APPROVAL

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Document Prepared By (Name, Company): ____ Date Submitted: ________________

Design Phase (circle which applies): 30% 60% 90% Other:______

	GSI Facility Component		CHECK yes/no			NEW Component/ Asset Type	PURPOSE & ADDITIONAL INFO	APPROVED FOR USE		
			Is it defined in GSI Manual Vol V-O&M? If no then go to NEW type column.	Meets SPU Standard?	Meets WTD Standard?	GSI Tool, Technology , Design revision, Location, Material etc	Reason for modification of component standard and/or adding a new component/asset	SPU / WTD PM	SPU / WTD PE	O&M Mgr
▼	▼	▼ G. Deep Infiltration (over 6 Feet) PLACEHOLDER	▼	▼	▼					
G1	Screen Well & Maintenance Hole (MH) and Upstream Maintenance Holes	Screen Well Type___								
		Screen Well MH COS Std Plan _____								
		MH Access Opening COS Std Plan __								
		Upstream MH with __ feet sump per COS Std Plan ___								
		See underdrain system C2								
		Observation Port								
G2	Pit Drain System	Pit Drain Type								
		See underdrain pipe C2								
		Aggregate Backfill COS Type ____								
		Observation Port per COS Std Plan ____								
G3	Drilled Drain System	Drilled Drain Type ____								
		Drilled Drain Access MH COS Type _____								
		See underdrain pipe C2								
		Mineral Aggregate Backfill COS Type ____								
		Mineral Aggregate Backfill Other ____								
		Observation Port								

GSI COMPONENT DESIGN CHECKLIST FOR O&M APPROVAL

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Document Prepared By (Name, Company): ____________________ Date Submitted: ____________

Design Phase (circle which applies): 30% 60% 90% Other:______

	GSI Facility Component		CHECK yes/no			NEW Component/ Asset Type	PURPOSE & ADDITIONAL INFO	APPROVED FOR USE		
			Is it defined in GSI Manual Vol V-O&M? If no then go to NEW type column.	Meets SPU Standard?	Meets WTD Standard?	GSI Tool, Technology , Design revision, Location, Material etc	Reason for modification of component standard and/or adding a new component/asset	SPU / WTD PM	SPU / WTD PE	O&M Mgr
▲ ▲ ▲ H. Permeable Pavement Facility PLACEHOLDER ▲ ▲ ▲										
H1	Full Street Length & Width	Pervious concrete								
		Porous asphalt								
H2	Half Street Retrofit (Half Length or Half Width) with existing pavement type	Pervious concrete with conventional concrete								
		Pervious concrete with conventional asphalt								
		Porous asphalt with conventional concrete								
		Porous asphalt with conventional asphalt								
H3	Full Alley	Pervious Concrete COS Std Plan 403								
		Porous Asphalt								
H4	Half Alley Retrofit (Half Length) with existing pavement type	Pervious Concrete with Conventional Concrete								
		Pervious Concrete with Conventional Asphalt								
		Pervious Concrete with compacted gravel								
		Porous Asphalt with Conventional Concrete								
		Porous Asphalt with Conventional Asphalt								
		Porous Asphalt with compacted gravel								

GSI COMPONENT DESIGN CHECKLIST FOR O&M APPROVAL

Purpose: Preparation for O&M and asset management coordination. This is to be initially submitted at 30% and updated for each phase of a project to confirm approach is consistent with agency O&M procedures.

This version is Bioretention focused - placeholders are included for other GSI components. If you are adding new components, then insert new line item within the appropriate category. Contact GSI Program for copy of excel file for completing this document.

Document Prepared By (Name, Company): ____________________ Date Submitted: ____________

Design Phase (circle which applies): 30% 60% 90% Other:______

	GSI Facility Component		CHECK yes/no			NEW Component/ Asset Type	PURPOSE & ADDITIONAL INFO	APPROVED FOR USE		
			Is it defined in GSI Manual Vol V-O&M? If no then go to NEW type column.	Meets SPU Standard?	Meets WTD Standard?	GSI Tool, Technology , Design revision, Location, Material etc	Reason for modification of component standard and/or adding a new component/asset	SPU / WTD PM	SPU / WTD PE	O&M Mgr
▲ ▲ ▲ H. Permeable Pavement Facility continued PLACEHOLDER ▲ ▲ ▲										
H5	Sidewalks	Pervious concrete COS Std 425								
H6	Subsurface Check Dams	Material Type ___								
H7	Subsurface Barriers	Concrete Barrier								
		Liner - PVC								
		COS CDF Type _____								
H8	Underdrain/ Overflow Subsurface System	Pipe Material ___								
		Cleanout per COS Std ___								
		Utility Trench Dam Material____								
H9	Observation Port	Cleanout per COS Std ___								
H10	Geotextile	Non-woven COS Type/Spec #_____								

King County
Department of
Natural Resources and Parks
Wastewater Treatment
Division

Seattle Public Utilities

GSI COMPONENT DESIGN CHECKLIST FOR O&M APPROVAL

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Document Prepared By (Name, Company): ____________________ Date Submitted: ____________

Design Phase (circle which applies): 30% 60% 90% Other:______

	GSI Facility Component		CHECK yes/no			NEW Component/ Asset Type	PURPOSE & ADDITIONAL INFO	APPROVED FOR USE		
			Is it defined in GSI Manual Vol V-O&M? If no then go to NEW type column.	Meets SPU Standard?	Meets WTD Standard?	GSI Tool, Technology , Design revision, Location, Material etc	Reason for modification of component standard and/or adding a new component/asset	SPU / WTD PM	SPU / WTD PE	O&M Mgr
▲	▲	▲ I. Hardscape/Specialty Elements ▲	▲	▲						
I1	Street Surface	Specialty pavement								
		Special scoring								
I2	Sidewalks	Standard concrete								
		Pervious concrete								
		Standard asphalt								
		Special								
I3	Paved/unpaved access surfacing, step out zones, edges of facility	Arborist wood chips								
		Cedar Play Chips								
		Steppable plants								
		Concrete Pavers with Large Gravel Gaps								
		Open-Celled Grid w/Gravel								
		Pervious Concrete								
		Concrete								
		Specialty								
I4	Signage/striping	Street								
		Warning								
		Reflectors on curb								
		Specialty								
I5	Street Furnishings / Public Art	Benches								
		Trash/ Pet receptacles								
		Interpretive Signs								
		Specialty								

Seattle Public Utilities

This document is for Private Developers installing GSI in ROW under SDOT Street Improvement Permitting (SIP). However, metrics denoted in Part 4 and 5. are tracked for all projects. For City/WTD led CIP projects, provide information denoted in Part 2, 3, 4 and 5.

GREEN STORMWATER INFRASTRUCTURE (GSI) PROJECT INFORMATION FORM

Document prepared by:

NAME

PHONE

EMAIL

DATE

This document shall be completed by the applicant project team for GSI facilities installed in the ROW and submitted to SDOT Street Use after the improvements have been constructed.

PART 1: PROJECT INFORMATION

SIP Project # / Permit #:

☐ Final Acceptance date: (SDOT TO COMPLETE)

☐ Warranty end (1 year post acceptance) date: (SDOT TO COMPLETE)

Project Name:

Project Address: City: Zip:

Engineer of Record: Company:

Phone #: Email:

PART 2: FUNDER

Project Funder (of capital costs to build) (SELECT ONE):

○ Seattle Public Utilities (SPU)

○ Seattle Parks & Recreation (PRK)

○ Private Developer for Stormwater Code (SWC)

○ King County Wastewater Treatment Division (WTD)

○ Seattle Department of Transportation (SDOT)

○ Adjacent parcel owner for Stormwater Code (SWC)

PART 3: PROJECT TYPE & PURPOSE

Type of Project (SELECT ONE):

○ Roadway

○ Trail/Sidewalk

Basin (SELECT ONE):

○ Listed Creek Basin

○ Non-Listed Creek Basin

○ Combined Sewer Service Area

○ Designated Receiving Water

○ Wetland

○ Small Lake Basin

Purpose of GSI Installation (CHECK ALL THAT APPLY):

☐ Agency-led Retrofit

☐ Stormwater Code compliance for On-site Stormwater Management SMC 22.805.070

☐ Stormwater Code compliance for Flow Control (FC) SMC 22.805.080

☐ Stormwater Code compliance for Water Quality Treatment (WQ) SMC 22.805.090

☐ Voluntary Installation

PART 4: PROJECT METRICS

Metric Description	BMP TYPE				
	Infiltrating Bioretention	Non-Infiltrating Bioretention	Rain Garden[4]	Permeable Pavement Surface	Permeable Pavement Facility
Infiltration Bottom Area (square feet)[1]					
Total Volume Managed On-Site (gallons per year)[2]					
Estimated Total Contributing Drainage Area to each BMP Type (square feet)[2]					
Total Vegetated Facility Top Area (square feet)[3]				N/A	N/A
Total number of new street trees planted (in right-of-way):					

[1] For bioretention facilities, this is the bottom area of the facility (for graded bioretention facilities do not include side slopes in the calculation of this metric). For permeable pavement surfaces, this is the footprint of the permeable pavement. For permeable pavement facilities, this is the footprint area of the permeable pavement that is used for infiltration.

[2] If using multiple BMPs, provide total for each BMP type. See "BMP Sizing" tabs in On-site Stormwater Management Calculator to obtain information.

[3] This area is to be calculated based on a sum of all the bioretention cells/rain gardens. Calculate area from top of slope to top of slope of each bioretention/rain garden cell.

[4] Complete column only when rain gardens are installed to meet on-site stormwater management.

PART 5: PROJECT SPECIFICS

For the bioretention facilities, note if the facility has any of the following (CHECK ALL THAT APPLY)**:**

- ☐ Presettling Zone/Cell
- ☐ Vertical Walls. Total wall length perimeter in feet:
- ☐ Impermeable Liner

Type of Liner:

Purpose/Function:

O&M (Must include repair methods or manufacturer's manual)

- ☐ Other specialty elements such as art, fencing, signage, benches, etc.

9. Develop the Total O&M Cost

This chapter provides templates and directions for preparing Operations and Maintenance (O&M) cost estimates for capital projects. Involve subject matter experts early in the project development lifecycle to represent the O&M perspective and help determine O&M estimates. If the project involves a design consultant, the firm shall utilize this guide and tools.

It is the expectation that O&M budget additions and efficiencies will be documented. The O&M Basis of Cost Estimate document (MS Word) explains assumptions made to come up with estimates for future O&M costs. The O&M Cost Estimate Spreadsheet (MS Excel) includes future O&M SPU Labor and Non-Labor in dollars and Full Time Equivalents (FTE).

If you cannot find the answers to your cost estimating questions in this guide, contact the Cost Estimating Guide support team at SPU_CEG@seattle.gov. Additionally, each Line of Business (LOB) has a point of contact to serve as a reviewer, as a coach, and provide a feedback mechanism for continuous process improvements.

Cost estimates prepared using this guide are used for the following purposes:

- Evaluating options for Stage Gate, value management, and other business decisions
- Developing proposed rates
- Developing SPU's O&M budget
- Determining labor needs and staffing
- Communicating total project costs

There is a checklist that can help navigate the business process.

Tools and Templates

O&M Cost Estimating Checklist

9.1. O&M Cost Estimate Updates

During Project Initiation (pre-Stage Gate 1), the Branch/Line of Business should start thinking about the O&M needs for the most obvious options to be analyzed during the Options Analysis Phase. No further action for O&M is required at SG 1. After SG 1 approval, high-level O&M estimates need to be prepared for each option as part of the total lifecycle cost. During Options Analysis (SG 2), these O&M cost estimates, and capital estimates, are used by the Economist to calculate the present value of Triple Bottom Line (financial, social, and environmental) lifecycle costs for each option. After the One Team selects a preferred option, the O&M tools are applied to the recommended option. After SG 2 is approved, the Design Phase commences. At 30% Design Phase the project is baselined with the PMP and O&M is updated. At 60%/90%/Final Design, O&M estimates become more precise. If there are no O&M estimate changes from the previous Stage Gate, Change Management, or Phase, document that in the O&M Basis of Cost Estimate and move forward.

The Budget, Planning and Forecasting (BPF) system needs to be updated per BPF Business Rules (quarterly) and when use of O&M cost estimating tools reveal a change from the previous update. By the time the Construction Phase is complete and the asset is accepted, O&M Labor and Non-Labor costs should be well understood, confirmed, and included in SG 5. At each update, input Non-Labor estimates into BPF to feed into the O&M Budget. SPU Finance will track the incremental additions and efficiencies separately.

Note: Even if Labor and Non-Labor O&M cost estimates are justified for the capital project, this does not guarantee that new staff positions or money will be automatically included in the O&M Budget or future Strategic Business Plan.

O&M cost estimates are prepared and updated using the O&M Basis of Cost Estimate document and the O&M Cost Estimate Spreadsheet. O&M Cost Estimates are tracked and reviewed in the EMPS, Stage Gates, and BPF systems at the following times:

Table 9-1 O&M Estimate Update Requirements

Project Lifecycle Phase & Stage Gate	Record of O&M Estimate & Responsible Party*	Team Involvement & Concurrence**
Options Analysis (SG 2)	**BPF–**LOB Rep **SG 2**–LOB Rep **EPMS–**Governance Analyst	LOB Rep, PM & SME's (incl. Economist)
30% Design: SG Change Gate or Establish the Baseline (with a PMP)	**BPF–**LOB Rep **SG Change**–LOB Rep **EPMS–**Governance Analyst	LOB Rep, PM & SME's
60% Design: if O&M cost changes	**BPF–**LOB Rep	LOB Rep, PM & SME's
90% Design: if O&M cost changes	**BPF–**LOB Rep	LOB Rep, PM & SME's
Final Plan Design (SG 3: Approval to Advertise)	**BPF–**LOB Rep **SG 3**–LOB Rep **EPMS–**Governance Analyst	LOB Rep, PM & SME's
Following bid opening (SG 4: Approval to Award), if O&M cost changes or need to rebaseline.	**BPF–**LOB Rep **SG 4**–LOB Rep **EPMS–**Governance Analyst	LOB Rep, PM & SME's
Closeout (SG 5)	**BPF–**LOB Rep **SG 5**–LOB Rep **EPMS–**Governance Analyst	LOB Rep, PM & SME's
Stage Gate Change Management	**BPF–**LOB Rep **EPMS–**Governance Analyst	LOB Rep, PM& SME's
Quarterly per BPF Business Rules	**BPF**—LOB Rep No Governance, unless combined with SG or Change Management.	LOB Rep & SME's

*LOB/Branches may designate an alternate person or role to update BPF and to lead the cost estimating.
**Each SG has a Gate Coach to assist staff with that phase to ultimately gain approval. The Gate Coach provides system QC, project QA, and is a resource to help projects move forward. Here is the link to the SG SharePoint site to find your Gate Coach.

9.2. Document the O&M Basis of Estimate

The O&M Basis of Cost Estimate uses words to explain cost estimate numerical data. It summarizes assumptions and methodology used to develop O&M data for a project cost estimate. Revise the O&M Basis of Cost Estimate at the same time as the Capital Basis of Estimate update, typically at each Stage Gate from SG 2 through SG 5, Change Management, and each Design Phase. During the Options Analysis Phase, complete one O&M Basis of Cost Estimate and one O&M Cost Estimate Spreadsheet for the recommended option. Use the SG 2 Options Summary section to note O&M differences between alternatives so the complexity of the O&M component can be understood completely.

Use historical data and best professional judgment to determine the appropriate level of detail in the O&M Basis of Cost Estimate. Consider the project size, complexity and the degree of project definition (well-defined versus conceptual). Involve Subject Matter Experts (SME's), including Planning and Scheduling Staff, early in the estimation process. The Maximo Team can help provide data, including information surrounding specific asset classes and like assets. The O&M Basis of Cost Estimate should include enough detail to communicate key assumptions, to enable independent review of the estimate, and to provide a basis for change management, as necessary. O&M risks are described in the O&M Basis of Cost Estimate, but not monetized. See Appendix E for more detail regarding SPU Labor and Non-Labor information.

If the O&M Estimate has not changed since the previous estimate, document that nothing has changed in the O&M Basis of Cost Estimate.

Tools and Templates

O&M Basis of Cost Estimate

9.3. Calculate the O&M Cost Estimate

The O&M Cost Estimate Spreadsheet is used in conjunction with the O&M Basis of Cost Estimate document to summarize the O&M component of a project estimate. Use the spreadsheet completed by the Economist for the recommended option at SG 2 as the starting point for future Gate and Phase updates (Named: Sheet 1 SG 2 Econ Analysis). The team Economist will provide the O&M Cost Estimate spreadsheet to the LOB Representative to use for future refinements.

During Options Analysis, it is the LOB Rep's responsibility to seek input from the project team, including SME's, and to provide the Economist with the Total Lifecycle Cost, which includes Capital and O&M costs for each option. The estimate includes Annual, Periodic, and Operating and Replacement Costs for the expected life of the asset. The LOB Rep is also responsible for ensuring that the O&M Cost Estimate Spreadsheet is populated and that BPF is updated for the recommended option and this information is updated from SG 2 through SG 5 and Change Management. (Named: Sheet 2 Master). See Appendix A for more detail.

It is the PM's responsibility to coordinate with the Project Engineer, the LOB Rep and O&M staff to ensure Maximo Equipment numbers have been included on the design plans.

Each time an estimate is updated, revise the O&M Cost Estimate Spreadsheet to show what has changed. (Named: Sheet 2 Master). If nothing changes, then document that nothing has changed. The O&M Cost Estimating Spreadsheet should include enough detail to communicate key assumptions, to enable independent review of the estimate, and to provide a basis for change management, as necessary.

During the Design Phase, after the Maximo Equipment Numbers are assigned, insert the Asset Document Data Worksheet that PDEB Design Section completes. (Named: Sheet 3. Asset Doc Data). Update this as the project progresses and as assets are constructed.

The fourth sheet of the O&M Cost Estimating Spreadsheet (Named 4. Estimate Labor FTE) includes information regarding asset/activity, task description, craft completing the work, quantities of assets and frequency of inspections or preventative maintenance/year.

Additionally, there is a sheet (Named: Labor Rates) that contain annual Labor Rates (raw and loaded), Labor Assumptions, etc.…this information should be updated annually.

Tools and Templates

O&M Cost Estimate Spreadsheet

9.4. Review the O&M Cost Estimate

Estimates are checked for quality, accuracy, and to ensure they are organized correctly and include all required information.

9.4.1. Determine the Appropriate Type of Review

All O&M estimate reviews start with a first level or supervisor's review. Each step is scaled to be commensurate with size and complexity of future O&M of the SPU asset. Cost estimates for large, complex, or non-standard assets may also be reviewed by other internal groups, external reviewers, and management. Work with LOB/Branch chain of command to determine who the best reviewers are for specific asset classes or facilities. Independent estimates may also be prepared by consultants, as needed. Review of consultant estimates should be completed as determined in Roles and Responsibilities. Always include the LOB Rep, O&M SME's, and PM in O&M estimate development and review conversations. If you have questions, contact the LOB point of contact.

9.4.2. Review the Estimate

Usually the supervisor of the person who prepared the O&M estimate conducts this review, but the role may be assigned to a designated person with cost estimating experience or O&M staff with cost estimating experience. O&M Managers where the budget implications impact should also have an opportunity to review the O&M estimate so they can plan for future needs with Planning and Scheduling staff.

A. O&M Basis of Cost Estimate: Ensure that scope, assumptions, estimating approach and methodologies are described clearly, that backup information is meaningful, and that significant changes from previous estimates are identified and explained.

B. O&M Cost Estimate Spreadsheet: Ensure that quantities, prices and arithmetic are correct. Spot-check formulas and totals. Confirm that the O&M cost is reasonable for the project scope/size/location/complexity. Consider if assets are non-standard or standard, and if SPU crews or contract will maintain it. When possible, validate the O&M estimate by comparison to similar past projects.

C. Spot check any cost items that would have significant cost impacts if estimated incorrectly. Consult with the LOB Rep, Crew Leader, O&M Managers or SME's on specialty equipment, non-standard assets, and if there are questions. On expensive or repetitive cost items within larger projects, multiple assets, or facilities, a spot check may need to include a quick review or takeoff from the pertinent plans or a separate estimate using a different estimating methodology.

D. Contact the SPU Fleets and Warehousing Division Director if replacement parts, fleet, or equipment needs are included in the estimating or if proposed to be stored in the warehouse.

E. Document findings and return the estimate to the O&M cost estimator who, if necessary, is responsible for reconciling and revising the estimate in response to reviewer comments; and to the LOB Rep who originated the cost estimate and is responsible for finalizing the estimates. Ensures that the latest iteration of the tools are updated and BPF is updated.

9.4.3. Review O&M Estimates Prepared by Others

When arrangements are made to have O&M estimates prepared by other departments or consultants, the SPU LOB Rep must provide clear expectations (regarding level of detail, estimating methodology, extent of documentation, etc.) and must confirm who will conduct the reviews. O&M Managers where the budget implications impact should also have an opportunity to review the O&M estimate so they can plan for future needs with Planning and Scheduling staff. Once the O&M cost estimate is complete and reviewed, the LOB Rep must also check the O&M cost estimate, including:

A. Confirm that the O&M Basis of Cost Estimate and O&M Cost Estimate Spreadsheet are complete, in the proper format, at an appropriate level of detail for stage of the estimate and that significant changes from previous estimates are identified and explained.
B. Spot check the math and confirm that the overall O&M cost is reasonable for the project scope, size, location and complexity.
C. Act as a liaison to ensure the LOB/Branch O&M management understands and agrees with the future SPU Labor and Non-Labor implications.
D. Document findings and return the estimate to the O&M cost estimator, if needed, to respond to review comments.

9.5. O&M Cost Estimate Expectations

9.5.1. Project Team

O&M SME's, PM, LOB Rep and LOB Management collaborate on each O&M estimate. The Line of Business/Branch is responsible for unit cost information, determining FTE needs, and inputting information into BPF. The LOB Rep is responsible for obtaining information, completing the O&M tools and refining the O&M Tools as the project progresses. The LOB Planning and Scheduling groups and the Maximo Work Management Support Team can provide detailed asset information, including O&M costs. The LOB Planning Manager responsible for the estimate provides guidance, reviews, and helps to resolve any discrepancies or issues. The LOB O&M Manager where the budget implications impact the O&M Budget provides guidance, reviews, and helps to resolve any discrepancies or issues. The Project Manager is responsible for ensuring the documents are complete and included in the governance document. If you have questions, contact the LOB point of contact.

9.5.2. Budget, Planning and Forecasting (BPF)

LOB Rep or Planning & Scheduling staff update O&M estimates in BPF as Business Rules dictate (quarterly), and at specified SG and project lifecycle milestones. The LOB Rep is responsible for sending the link or the document to Planning & Scheduling for input into BPF, if Planning and Scheduling is tasked with updating BPF. Also, a project may have O&M Budget implications to multiple budgets. Make sure all the affected Planning and Scheduling sections have been provided the updated O&M Cost Estimate Spreadsheet. E.g. DWW pump stations can affect the Shared Services and the DWW Systems Maintenance budgets.

9.5.3. Enterprise Project Management System (EPMS)

Approved SG O&M estimates are entered in EPMS in the Project Decision O&M Tab by the Governance Analyst (Corporate Services Division) and quality checked by the PM.

9.5.4. Stage Gate Change Management

As a project is refined during design, construction and closeout phases, estimates are updated. Significant changes in Capital project scope/schedule/cost require approval through SPU’s Stage Gate Change Management Process. There are currently no O&M change thresholds. If a project is proposing to rebaseline due to Capital changes, then the respective O&M should be updated and reviewed concurrently.

Appendix E–O&M Cost Estimating

SPU's Finance and Administration Branch has defined multiple Amount Classes for O&M activities. SPU and the City's Department of Finance & Administrative Services track O&M expenditures by Amount Classes in Summit. All O&M cost estimates must be categorized into Amount Classes. The top SPU Labor and Non-Labor Amount Classes are itemized below. If the project has a cost implication that does not fit into one of the Amount Classes, contact the Budget Analyst assigned to the LOB.

Note: The incremental Labor additions or efficiencies are tracked by Finance. The Non-Labor cost estimates are recorded in Budget, Planning and Forecasting (BPF) for the next six years in uninflated dollar amounts.

Work done by SPU crews itemized by specific craft (labor) is expressed in dollars and is expressed in hours or percentage of an FTE in the Basis of O&M Estimate, O&M Cost Estimate Spreadsheet and the SG documents. Labor dollars and FTE's are not input into BPF. Each project requires discussion with O&M staff, managers, and executives to determine if a project surpasses the tipping point for resources, such as staff, equipment, or other. These decisions are reflected in each of the Stage Gate documents.

SPU Labor

If an O&M requirement includes an **increase** in the overall labor for SPU staff, a decision must be made as to how that labor increase will be handled. Consider the following:

- Determine the overall FTE/hourly addition that is required
- Explore options for absorbing this labor within current staff (overtime, unused pockets)
- Overtime
- Explore options for shifting labor to non-SPU staff (contract, temporary)
- Defer project or other O&M Work.

If the only viable option is to **add** FTE's or partial FTE's, contact the Branch Budget Analyst and LOB/Branch Deputy Director to discuss the possibility of adding positions. If the project requires additional FTE's, **adding the corresponding dollars to BPF or a SG document does not equate to new FTE being approved**.

If an O&M requirement results in an overall **decrease** in SPU labor (efficiencies), contact the Branch Budget Analyst and LOB Rep to discuss how the savings will be portrayed.

Do not enter or update SPU Labor in BPF.

SPU Finance will be tracking incremental additions and efficiencies to SPU Labor separately and periodically notifying each LOB/Branch.

Other Labor that is not completed by SPU staff is included in a Non-Labor Amount Class discussed below.

Non-Labor

This appendix lists, defines, and provides examples for the amount classes most relevant to Non-Labor Amount Classes to help categorize costs into the correct amount class. Contact the LOB/Branch Budget Analyst if an O&M Cost does not fit into one of these categories.

Capital Outlay

The Capital Outlay Amount Class is used for large purchases in excess of $5K. For example, a new vactor truck or a porous pavement vacuum.

Equipment Purchases

Minor equipment purchases (less than $5K) that are not capitalized. Examples include tools, shovels, chain saws, etc. Contact the Fleets and Warehousing Division Director prior to ordering equipment or accepting inventory from SPU contractors that would be housed in an SPU warehouse or tool room.

Fleet

Vehicle use, fuel, vehicle maintenance, and vehicle rentals that are not capitalized. Vehicle purchases would be included as part of the capital project or as capital outlay. Contact the Fleets and Warehousing Division Director with fleet questions.

Inventory & Warehouse

Costs of items that would be purchased through the SPU Warehouse. Contact the Fleets and Warehousing Division Director prior to ordering equipment or accepting inventory from SPU contractors that would be housed in an SPU warehouse or tool room.

License and Permits

Use for future permit(s) needed to maintain the asset. Examples include a Street Use Permit to access maintenance holes from a traffic lane.

Maintenance

Services (contracts) and supplies that will be used for maintenance of an SPU asset. Examples include periodic (repetitive) maintenance, landscaping, hardscape maintenance, tool repairs, etc. The contract that SPU and Seattle Department of Parks & Recreation has for the Seattle Conservation Corps to maintain GSI is included in this category.

Rentals

Costs to rent equipment, buildings, or vehicles.

Services

Professional services provided by another City department, private business, or non-SPU employee falls into this category. Examples include infrequent consultant contract for UIC inspection, monitoring or testing, or decant disposal.

Supplies and Purchases

Materials used to maintain the incoming asset that are not capitalizable. Examples include supplies for daily production and output; water quality chemicals that are not stocked in the warehouse or by the line of business. Contact the Fleets and Warehousing Division

Director prior to ordering equipment or accepting inventory from SPU contractors that would be housed in an SPU warehouse or tool room.

Utilities

Any utility costs that may be added due to an asset coming online and requiring the consumption of electrical power, water, sewer service, or other utility. This could be a single event or reoccurring.

Basis of O&M Estimate

Purpose

The purpose of the Basis of Operations and Maintenance (O&M) Estimate Word Document is to identify new and updated cost estimates for the O&M component of capital projects. Use this document, in addition to the O&M Cost Estimate Spreadsheet to explain the planned, future O&M component of the project. This document explains the numbers in the O&M Cost Estimate Spreadsheet. Include both O&M increases, as well as efficiencies. The project's Line of Business (LOB) Representative leads this effort in collaboration with the PM and O&M SME's.

This document should be housed on the O&M Resourcing SharePoint site. Complete this document and then update and save for each Project Phase or Stage Gate. Do not recreate a new document with each update.

Provide the information or instruction described in red and then delete the red text.

Date Estimate Reviewed / Approved	
Name of Person Who Prepared this document	
Project Phase	<<e.g. Initiation, Options Analysis, 30% Design, Stage Gate 3>>

1. Project Information

Project Name	
Activity Number	
O&M SME's (if differs from above)	
LOB Representative	
Project Manager	
O&M Cost Estimator(s)	
O&M Estimate Reviewer(s) and date(s) of review / approval	

2. Objectives

Provide a brief, concise description of the project. This information should match the "Problem/Opportunity Statement" section of the Stage Gate 2. Cut and paste from SG 2.

3. O&M Scope

Provide a description of the O&M components of the project. Note whether new technology is being used, if SPU crews or contractors will be maintaining the asset, if new vehicles or equipment need to be purchased, etc. Identify non-standard SPU assets. What are the assets and what are the O&M activities that need to be performed? What is the frequency of O&M? If the project results in lower O&M costs, please provide a description. Do not duplicate information in Section 6, that is the more detailed Section regarding how costs were assumed.

In the SG document, insert a link or add an Appendix if there is a standard O&M Manual or Asset Management Plan (AMP) for regular O&M of a specific asset or group of assets.

Document any changes since the last estimate was completed.

O&M Scope:

AMP: If assumptions are made based on an AMP, note what the assumptions are here.

4. Location

Describe the project location, site constraints that may affect O&M access (e.g. closure of a travel lane, arterial, or parking constraints), and any significant site issues that must be addressed (e.g., stream, wetlands, slopes, easement, private property access, permits need to be obtained), etc. Note if any information has changed since the last estimate was completed.

5. Schedule

This information should include estimated date of asset turnover from the contractor to O&M and planned Closeout (SG 5 approval). If there is vegetation establishment, include the one year post-SG 5 establishment date when the plants become O&M (not capitalizable). Year 2 and Year 3 of plant establishment is O&M and work associated is under N# or P#. Also, projects may have multiple warranties, monitoring, and vegetation establishment that should be included. Customize the table and add additional lines to the table, as needed.

Document any changes since the last estimate was completed.

Project Specific Information	LOB/Section or responsible craft(s)	Anticipated date Asset is on line or LOB O&M ownership starts	Comment
Ex: Vegetation Establishment and Maintenance	Grounds Maint.		
Stage Gate 5	PM		Baseline Finish Date from EPMS or actual Finish Date

6. Data Sources and Calculation Assumptions

Include costing assumptions here. Examples include raw rates, load factors, uncertainty factor, hours worked/year, etc.

7. O&M Labor Resourcing Strategy

Identify how O&M work will be performed by SPU and which work elements will be performed by contractors or other agencies. For work to be performed by SPU, identify which branch and division will provide the resources and fund them. For work to be performed by contractors or other agencies, describe the approach, e.g. MOA, contract and schedule to procure services. Identify field crew resources by trade or craft that will be needed. If known, describe assumptions regarding work week schedule and overtime.

Identify resources and how work will be completed, e.g. the vegetation in this Green Stormwater Infrastructure asset will be maintained via contract with Seattle Conservation Corps. Include the estimated unit cost and annual hours to complete the work. It is acceptable to cut and paste from BOE spreadsheet. Customize the table and add additional lines to table, as needed.

If there are SPU Labor reductions or efficiencies as a result of the project, describe the addition and the reduction (not the net difference) here and indicate how the labor will be handled. Will the labor be repurposed for new work or to decrease an existing backlog, or other job duty?

Body of Work/ Asset Class	SPU Craft Responsible	Contract work	Unit Cost	Annual Hours	Comment
Ex: GSI Vegetation		SCC			
Underground Injection Control Well	DWW Underground Storage				Wall in a swale
Conveyance/ Ditch	DWW Surface Water Mgmt.				
Underdrains	DWW CCTV				

How will O&M be accomplished for this project? Check all boxes that apply and add an explanation, if necessary or use the box below. It is acceptable to cut and paste this section and insert it into the corresponding Stage Gate.

NOTE: SPU O&M management should be consulted to determine how labor resourcing will be accomplished.

Full Time Equivalent (FTE) information comes from the O&M Cost Estimate Spreadsheet.

	Absorb into existing workload. Finance will track the estimated increase of ___ FTE. (e.g. 0.06 FTE)
	Efficiency. Finance will track the estimated reduction of ___ FTE.
	Overtime for existing staff.
	Contract outside of SPU.
	Increase ___ FTE.
	Reduce ___ FTE.
	Other (explain)

NOTE: ¼ or .25 FTE works one quarter time or 10 hours per week.

Identify additional assumptions that may affect the O&M cost estimate, including any assumptions about work that will be, delayed, reprioritized, or not performed, etc. Include a contingency strategy. Document any changes since the last estimate was completed.

8. Other Resources

The intent of this section is to deliberately think about non-Labor Resources as they relate to a specific project. Include non-Labor Resources in the table below. See Appendix A in the O&M Cost Estimating Guide for definitions of each of the Amount Classes and most common future O&M expenditures. It is acceptable to copy and paste from O&M Cost Estimate Spreadsheet.

Document any changes since the last estimate was completed.

NOTE: SPU O&M management should be consulted to determine timing and how costly, non-routine resources will be procured. Consult the Fleets & Warehousing Division Director if materials or spare parts will be stored in the warehouse or tool room. See Appendix A in the O&M Cost Estimating Guide for definitions related to the Amount Classes. If the project has a non-labor cost that does not fit into one of the Amount Classes, contact the Budget Analyst for the correct Amount Class.

Amount Class	Total Cost and Frequency	Comment
Capital Outlay		
Equipment Purchases		
Fleet		
License and Permits		
Maintenance		
Rentals		
Services		
Supplies and Purchases		
Utilities		

9. Risks

This information should include the "Key Risks & Issues" section of the Stage Gate 2 if there are known O&M risks. After SG 2, include any O&M risks that are not in the capital Risk Register. Identify any part of the O&M cost estimate having significant risk. Include risk of not completing or deferring the O&M, including financial risk. Specifically, identify the O&M cost and schedule elements that have high or critical risk values. E.g. this includes the risk of contract O&M instead of crew O&M.

Document any changes since the last estimate was completed.

Risk	Cost/ Time	Schedule/ Frequency	Level of Certainty C/H/M/L	Comments

10. O&M Estimate Reviews

Describe all O&M estimate reviews to date and the results. Identify any additional planned estimate reviews. Use this section to note if no changes or updates are needed. Amend the table to add new lines as necessary.

Product Development Phase or SG	Date of Review	Comments

11. How and Why the O&M Estimate Has Changed

Summarize the differences between the original O&M estimate and each update, so that the reader understands how the O&M estimate has changed and why. A detailed reconciliation or cost trending report may be included as an additional attachment if necessary on large, complex projects.

12. O&M Benchmarking

Describe any O&M cost benchmarking performed with similar projects and the results. Explain any significant differences in cost or efficiency. E.g. the cost of GSI vegetation maintenance per SF differs from contractor actuals, RS Means, private industry cost.

13. Appendix

Include any attachments or links referred to in the Basis of O&M Estimate to substantiate future O&M Costs.

List attachments or links:

Instructions:
All project Source Documents and subsequent estimates, including the O&M Cost Estimating Spreadsheet shall be housed on the Stage Gate SharePoint site.

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Appendix F: Supplemental Plan Notes for GSI CIP/SIP

- Sample SPU General Notes for Abandonment of Existing Catch Basins for GSI Projects, draft January 2014.
- Bioretention and LID Facilities Protection Notes
- Underdrain Notes

*See SDOT website for Standard Notes for Street Improvement Plans
http://www.seattle.gov/transportation/stuse_sip.htm for

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Example of SPU General Notes for Abandonment of Existing Catch Basin for GSI projects (draft January 2014)

Note to Users: The following general notes is an example from past project. These notes were included on the SIP Plans to abandon of mid-block catch basin on a ~660' long Neighborhood Yield Street for diverting gutter flow to bioretention facilities in the right-of-way downstream of the existing mid-block CB. These notes are from WTD's approved SIP (SDOT #163005) for Barton CSO control project with GSI. These notes and material specifications were developed and approved by SPU so that if the CB were to come back on line it could be more easily restored as compared to constructing a new CB (which would involve road, curb paving etc.).

Review requirements with SPU for updates if abandonment of existing CBs is being considered on future SPU/WTD led CIP projects.

SPU ABANDONMENT OF EXISTING CATCH BASINS NOTES

CATCH BASINS AND INLETS NOTED TO BE ABANDONED SHALL REMAIN IN SERVICE UNTIL AFTER SWALE PLANTINGS ARE ESTABLISHED AND PAVEMENT RESTORATION IS COMPLETED. WHERE EXISTING CATCH BASINS ARE NOTED TO BE ABANDONED ON THE DRAWINGS THE FOLLOWING WORK SHALL BE DONE:

1. REMOVE OUTLET TRAP AND INSTALL CAP ON EXISTING OUTLET PIPE. EXISTING FRAME AND GRATE TO REMAIN ON STRUCTURE AND STAY AT EXISTING RIM ELEVATION.

2. CLEAN OUT SEDIMENT/DEBRIS/WATER IN SUMP OF STRUCTURE AND DISPOSE OF MATERIAL. DO NOT FLUSH DOWNSTREAM.

3. FILL STRUCTURE WITH SAND (MINERAL AGGREGATE TYPE 6) TO APPROXIMATELY THIRTEEN INCHES (13") FROM TOP OF RISERS.

4. FILL REMAINING PORTION OF STRUCTURE WITH LIGHT DUTY CONCRETE. CONCRETE TO BE FILLED FLUSH WITH EXISTING STREETS PAVEMENT PANELS. SET GRATE IN LIGHT DUTY CONCRETE AND STRIKE OFF EXCESS CONCRETE. FRAME AND GRATE TO REMAIN IN PLACE.

Protection of GSI Facilities Notes
(draft February 2015)

Note to Users: The following general notes shall be included on the SIP Plans for GSI Projects on Neighborhood Yield streets to protect bioretention facilities and porous pavements as they are being constructed and/or when upstream areas are being constructed (to avoid construction water flowing into the newly constructed cells). These notes were derived from WTD's approved SIP (SDOT #163005) for Barton CSO control project with GSI. Also review and modify specifications in Project Manual (Special Provisions for SPU led CIP /CSI specs for WTD led projects) accordingly if including these notes on the plans.

<u>BIORETENTION AND LID FACILITIES PROTECTION NOTES</u>

1. REDIRECT SHEET FLOW, BLOCK DRAIN INLETS AND/OR CURB OPENINGS IN PAVEMENT AND INSTALL FLOW DIVERSION MEASURES TO PREVENT CONSTRUCTION SILT LADEN WATER, CONSTRUCTION STORMWATER AND DEBRIS FROM ENTERING EXCAVATIONS AND FINISH SURFACES FOR BIORETENTION FACILITIES AND POROUS PAVEMENTS.

2. WHERE AMENDED SOILS, BIORETENTION FACILITIES AND POROUS PAVEMENTS ARE INSTALLED, THESE AREAS MUST BE PROTECTED AT ALL TIMES FROM BEING OVER COMPACTED. IF AREAS BECOME COMPACTED, REMEDIATE AND TILL SOIL IN ACCORDANCE WITH CITY OF SEATTLE REQUIREMENTS AT NO ADDITIONAL COST IN ORDER TO RESTORE THE SYSTEM'S ABILITY TO INFILTRATE.

3. INSTALL FLOW DIVERSION MEASURES OUTSIDE OF THE CRITICAL ROOT ZONE OF TREES TO BE PROTECTED. AT NO TIME SHALL CONSTRUCTION STORMWATER BE DIRECTED TOWARDS TREES TO BE PROTECTED. CONSTRUCTION STORMWATER SHALL NOT POND WITHIN A TREE'S CRITICAL ROOT ZONE.

Underdrain Notes
(draft May 2015)

Note to Users: The following general notes shall be included on the SIP Plans for underdrain pipes used in GSI facilities. Note projects shall define the slot orientations (2 rows on top? 4 rows?). Notes highlighted shall be edited accordingly by project team. Also review and modify specifications in Project Manual (Special Provisions for SPU led CIP /CSI specs for WTD led projects) accordingly if including these notes on the plans. TD=solid wall section of an underdrain pipe run. SSD=slotted drain pipe section of an underdrain pipe run.

UNDERDRAIN NOTES

1. UNDERDRAIN PIPE (SSD) AND FITTINGS SHALL BE PER COS STD PLAN 291 EXCEPT SLOT ORIENTATION AND PIPE DIAMETER SHALL BE PER DETAIL xx ON PLANS.
2. TIGHTLINED UNDERDRAIN (TD) SHALL BE SAME MATERIAL AS SSD EXCEPT SOLID WALL UNLESS NOTED OTHERWISE ON PLAN.
3. UNDERDRAIN PIPE WITHIN TWO FEET (MEASURED FROM EXTERIOR OF MH) OF ALL MAINTENANCE HOLES SHALL BE TD, UNLESS NOTED OTHERWISE ON PLAN.
4. TRANSITION UNDERDRAIN PIPE FROM SSD TO TD UPSTREAM OF UTILITY TRENCH DAM PER DETAILS XX AND XX, UNLESS STATIONED OTHERWISE ON PLANS.
5. UPON COMPLETION OF IMPROVEMENTS OVER UNDERDRAIN PIPE (INCLUDING BUT NOT LIMITED TO BIORETENTION CELLS, PAVING, STRUCTURES, PLANTINGS, UTILITY ADJUSTMENTS), VIDEOTAPE UNDERDRAIN PIPE RUN FROM STRUCTURE TO STRUCTURE AND SUBMIT TO ENGINEER FOR REVIEW. REPAIR AND/OR REPLACE UNDERDRAIN PIPE RUNS IDENTIFIED AS NON-CONFORMING TO THE SPECIFICATIONS AND AS DIRECTED BY THE ENGINEER AT NO ADDITIONAL COST TO THE OWNER. ONCE REPAIRS ARE COMPLETED RE-VIDEOTAPE UNDERDRAIN PIPE RUN AND SUBMIT VIDEOTAPE TO ENGINEER FOR REVIEW.

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Appendix G: Bioretention Plant and Tree Lists

- Figure G-1: ROW Planting Zone diagram for Bioretention Cells with graded side slopes
- Figure G-2: ROW Planting Zone diagram for Bioretention Cells with vertical wall(s)
- Notes and References re. Development of the Bioretention Plant Lists
- Bioretention Plant List for Development of Palettes in the Right-of-Way
  - Part Shade List *(for bioretention cells with graded side slopes)*
  - Sun List *(for bioretention cells with graded side slopes)*
  - Native List *(for bioretention cells with graded side slopes)*
  - Intersection & Sightline List (under 24" Ht.) *(for bioretention cells with graded side slopes)*
  - Plant List for Bioretention Cells with Vertical Wall(s) (primarily Evergreen)
  - Pollinator Plant List
  - Short Term Infill Plant List
  - Vertical Shrubs and Accent Plant List
  - Groundcover Plant List (if low profile is required)
  - Steppable Plants List
  - Low Nutrient Bioretention Soil Mix Plants, Vertical Accent Shrubs and Trees List *(for bioretention cells with graded side slopes)*
- Tree Lists for Bioretention in the Right-of-Way
  - Conifers (Deciduous & Evergreen)
  - Medium/Large Broad-Leaved Evergreen Trees
  - Large Deciduous Columnar Trees
  - Large Deciduous Trees
  - Medium/Large Deciduous Trees
  - Medium Columnar Deciduous Trees
  - Medium Deciduous Trees
  - Small Conifer/Broad-Leaved Evergreen Trees
  - Small Deciduous Trees
- Template for Vegetation Management Plan

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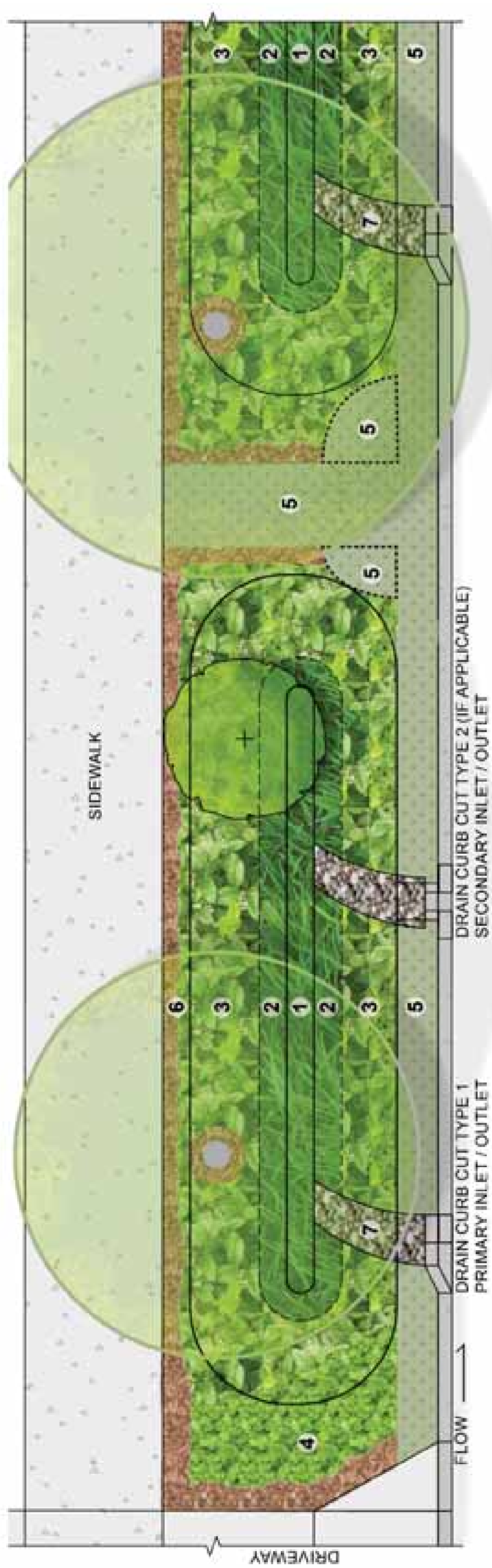
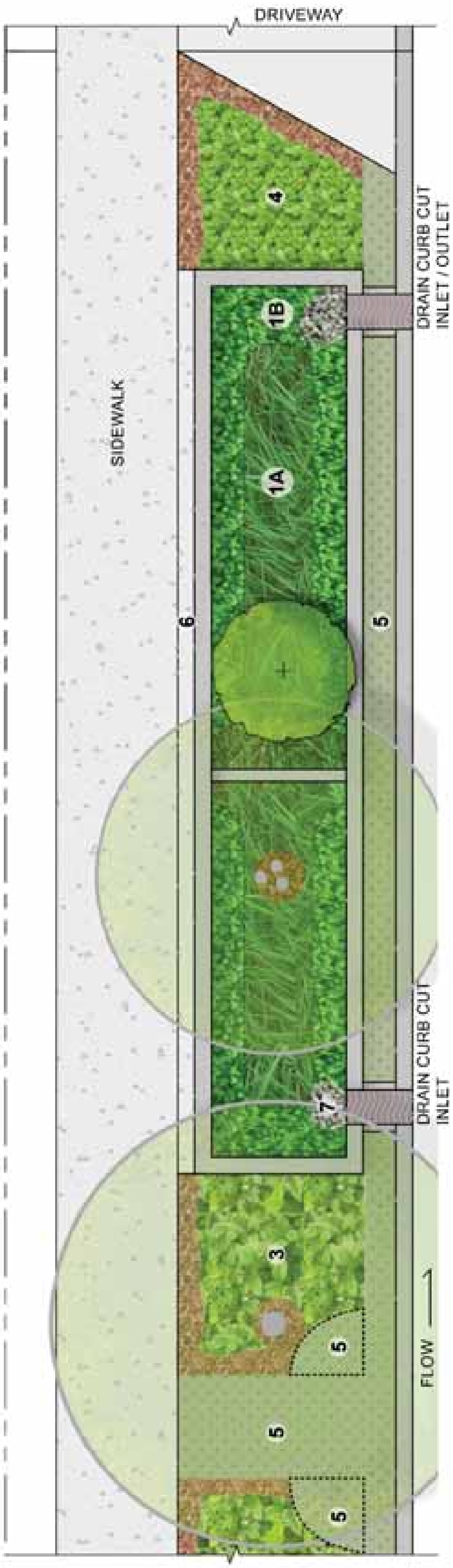
Figure G-1: ROW Planting Zone diagram for Bioretention Cells with graded side slopes



SYMBOL	ZONE	PLANT TYPE / TREATMENT	LOCATION	FUNCTION	PLANT NOTES
	1,2	Emergents, Perennials & Low Shrubs	Cell Bottom / Lower Slope	Water Quality Treatment	30" max. height above sidewalk
	3	Groundcovers & Shrubs	Upper Slope / Adjacent to Cell	Accent / Border	6"-30" height
	4	Grass / Low Plantings	Driveway / Intersection	Sight Clearance / Durable	24" max. height
	5	Access Surfacing	Crossings / Road Edge / Step-Out Zones / Upper Slope	Access	None
	5	Access Surfacing	Site for Each Parcel per Waste Pick-up Route	Solid Waste Pick-Up Space	None
	6	Sidewalk Setback / Arborist Wood Chip Mulch	Along Sidewalk Edge	Maintain Edge	None
	7	Inlet Cobbles	Inlet to Cell Bottom	Sediment Capture	None
	1,2,3	Tall Accent Shrub	Sidewalk Side of Cell	Accent	4'-8' +/- height range
		Tree (trunk)	Crossing / Sidewalk / Upper Slope (sited for clearances and out of liner zone)	Shade / Water Retention / Urban Forestry	20'-50' - varies based on power line location

Note: For more information, see GSI Manual Vol. III - Design, Chapter 7

Figure G-2: ROW Planting Zone diagram for Bioretention Cells with vertical wall(s)



SYMBOL	ZONE	PLANT TYPE / TREATMENT	LOCATION	FUNCTION	PLANT NOTES
	1A	Emergents & Perennials	Planter Bottom (Center Areas)	Water Quality Treatment	30" max. height above sidewalk
	1B	Low Shrubs, Emergents & Perennials	Planter Bottom (Edge Areas)	Water Quality Treatment	30" max. height above sidewalk
	3	Groundcovers & Shrubs	Adjacent to Planter	Accent / Border	6"-30" max. height
	4	Grass / Low Plantings	Driveway / Intersection	Sight Clearance/ Durable	24" max. height
	5	Access Surfacing	Curb Edge / Step-Out Zones / Crossings	Steppable	None
	5	Access Surfacing	Site for Each Parcel per Waste Pick-up Route	Solid Waste Pick-Up Space	None
	6	Sidewalk Setback	Along Sidewalk Edge	See notes	None
	7	Inlet Cobbles	At Inlet Drop	Sediment Capture	No plants within 12"
		Arborist Wood Chip Mulch	Along Edge of Cells	Maintain Edge	None
	1A,1B,3	Tall Accent Shrub	Crossing / Planter Bottom	Accent	4'-8' +/- height range
	1A,1B	Small Tree (trunk)	Planter Bottom (Unlined)	Shade / Water Retention / Urban Forestry	Height varies; Consider power line location
	3	Medium / Large Tree (trunk)	Crossings / Sidewalk Grade	Shade / Water Retention / Urban Forestry	Height varies; Consider power line location

Note: For more information, see GSI Manual Vol. III - Design, Chapter 7

NOTES AND REFERENCES REGARDING DEVELOPMENT OF THE BIORETENTION PLANT LISTS

The bioretention plant lists are not intended to be all encompassing but rather bioretention facility plants were selected for the purpose of:

- Facilitating design for specific conditions
- Allowing variety in the streetscape
- Providing some consistency for construction inspectors and O&M staff to gain familiarity with the plants
- Facilitating review and QC
- Providing industry with the list to improve availability
- Addressing the specific requirements of plants within the public right-of-way (e.g. height and sight lines)

The bioretention plant lists and related notes have been developed and updated several times over the past 20 years and are based on feedback from agency discipline staff, O&M staff, horticulturalists, landscape architects, arborists, community members and plant growers. Plants were also reviewed and cross checked across several references, including books and web-based resources. These include but are not limited to:

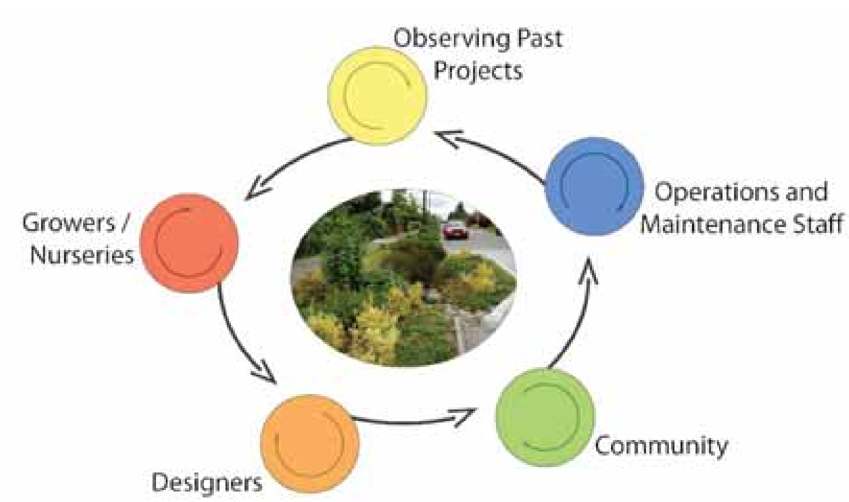


Figure 1. Bioretention Plant Lists Development and Feedback Loop

Book References:

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- Creso, Irene. Vascular Plants of Western Washington. Tacoma, WA: I. Creso, 1984.
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- Wasson, Ernie. *The Complete Encyclopedia of Trees and Shrubs*. San Diego, CA: Thunder Bay Press, 2003.

Website References:

- American Meadows. https://www.americanmeadows.com
- Dave's Garden - Tips and Advice on Outdoor Gardening. https://davesgarden.com/
- Gardening for Wildlife. Attract Birds, Butterflies and Small Mammals. http://www.gardening-for-wildlife.com
- Gardening in Washington State | Washington State University. 2020. http://gardening.wsu.edu
- Great Plant Picks: Unbeatable Plants for the Maritime Northwest Garden. http://www.greatplantpicks.org
- Landscape Plants | Oregon State University. https://landscapeplants.oregonstate.edu
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Prepared by MIG|SvR for the GSI Manual. 2/21/2020

Bioretention Plant List for Development of Palettes in the Right of Way

Notes:
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- SDOT's Streets Illustrated recommends low plantings in rights-of-way. Plant height within 30 feet of an intersection (as measured from the corner face of the curb) is 24 inches above curb elevation. The remaining planting strip should have plants that can be easily maintained to 30 inches with the exception of accent shrubs. Review height of blooms or spikes that may be higher than noted.
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- Size/Spacing: initial planting of smaller sizes of emergents, closer on center (o.c..) is suggested especially in Zones 1 & 2 to achieve the desired coverage.

Planting Zone Code - See Planting Zone Diagram, GSI Manual Vol. III, Section 7

Zone 1 plants are typically tolerant of both wet and dry conditions. Zone 1 plants are typically used for filtration and water quality. Some trees are able to be viable in this zone.
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Part Shade List *(for bioretention cells with graded side slopes)*

Guidance Statement: Designer should group plants for maintenance needs to allow ease of pruning and weed control.

EG	DT	NWN	Height from Ground	Scientific Name	Common Name	Planting Zone	Size/Spacing (see notes)	Exposure	Design Comments	O&M Code	Additional O & M Comments
SEMI			<24"	*Abelia x grandiflora* 'Prostrata'	Prostrate white abelia	3,4	1 Gal. ./ 30" o.c..	☼,∅	Spreading by rhizomes. Place min 3 feet back of curb or sidewalk; min group of 3	E	
	DT		18"-36"	*Aster divaricatus*	White wood aster	3	1 Gal. ./ 24" o.c..	∅	Place min 3 feet back of curb or sidewalk; min group of 3	B	Observe growth habit - height exceeds 3 feet suggest removing
EG	DT		12"-18"	*Carex divulsa*	Eurpoean Grey sedge	1,2,	10 Cu. In. Plug/ 10" o.c..	☼,∅	Lower option - ok with wet feet	DS	Cut back in spring
			<24"	*Carex elata* 'Bowles Golden'	Bowles Golden sedge	1,2	10 Cu. In. Plug/ 10" o.c..	☼,∅	Limit to areas of approx. 36"x36"	B	
EG			<24"	*Carex laxiculmis 'Hobb'*	Bunny Blue sedge	1,2	Cu. In. Plug/ 3 inch pots 10" o	∅	Select for shady areas	C	
EG	DT	NWN	24"-60"+	*Carex obnupta*	Slough sedge	1	10 Cu. In. Plug/10" o.c..	☼,∅	. Recommend only for wider facilities >12 ft due to the large and floppy nature. Locate in center of cell. Select adjacent plants that support/frame the floppy foliage. Do not intermix with other emergents. Do not plant near intersections. Not recommended for planting in walled cells as the floppy appearance has triggered maintenance comments from residents.	C	Can be sheared more frequently if overcrowding other occurs.
SEMI		NWN	24"-36"	*Carex stipata*	Beaked sedge	1,2	10 Cu. In. Plug/ 10" o.c..	☼,∅	Limit to areas of approx. 36"x36"	B	
EG			18"-30"	*Carex testacea or dispacea*	Orange New Zealand or Autumn Sedge	1,2	10 Cu. In. Plug/ 10" o.c..	☼,∅	Avoid areas with sun and wind as they need water	C	Can be lightly sheared in spring
	DT		24"-36"	*Cornus sericea 'Kelseyii'*	Kelsey redstem dogwood	1,2	5 Gal. / 48" o.c.. 1 Gal. /24 " oc	☼,∅	Plant 2 Gal. at 30" o.c.. if used to support emergent grasses. May be planted in zone 3 if in a wide cell	E	Stems fragile until established.
			36"	*Fuchsia magellanica* 'Aurea'	Dwarf Hardy Fuchsia	3	2 Gal. ./ 30" o.c..	☼,∅	Place minimum 3 feet back of curb, accent	E	Dormant in winter
			<24"	*Galanthus elwesii*	Giant Snowdrop	3,4	Bulb	☼,∅	Prefers part shade. May be short-lived if too hot.	F	
EG	DT	NWN	24"-36"+	*Gaultheria shallon*	Salal	3	1 Gal. ./ 24" o.c..	☼,∅	Recommend placement only along sidewalk side due to potential height or if along streetside place back 4 feet from face of curb. Note groupings as it will spread and takes time to establish.	E	Salal take 3+ years to get established; if used see short review additional weeding with O&M budget. If height appears to be a problem, Salal can be sheared to 12 inches with hedge trimmer.
EG			<24"	*Geum flore-plena* 'Blazing Sunset'	Blazing Sunset Avens	3,4	1 Gal. ./ 10" o.c..	☼,∅	Plant in groups for effect and a minimum of 24 inches from curb and 18 inches from sidewalk.	DS	May require trimming back along curbs or sidewalks
EG			24"	*Iris pallida 'Variegata'*	Variegated sweet iris	3	1 Gal. ./ 18" o.c..	☼,∅	Plant 30 inches from edge of walks and curb zone	DS	If spreading more than desired thin rhizomes
EG	DT	NWN	<24"	*Mahonia repens*	Creeping Oregon grape	3,4	1 Gal. ./ 18" o.c..	☼,∅	Mix sizes; Will not do well in heat exposure or in drying winds	E	Requires water during full establishment period
EG	DR	NWN	24"-36"	*Polystichum munitum*	Western swordfern	3	2 Gal. / 24" o.c. 5 Gal. / 48" o.c.	☼,∅	Limit to group of 5, plant min 3 feet back of sidewalk. Do not plant within 4 feet of curb to allow curb edge (step out zone) and room for "flop". There are some cultivars that are smaller but availability varies.	B	If looks messy along walks and curbs, cut back old fronds in winter before new fronds appear. Key plant for winter green color; be cognizant if reports of sword fern pathogens increase.
EG	DT		24"-36"	*Prunus laurocerasus* 'Mount Vernon'	Mount Vernon cherry laurel	3	2 Gal. ./ 36" o.c..	☼,∅	May be used along edge of floppy plants to hold up. Plant 18 inches from top of step out zone	E	Habit can vary with clones - some plants may need pruning
EG			36"	*Rhododendron* Yak Hybrids, such as 'Ken Janeck'	Yak Hybrid	3	2 Gal. ./ 24" o.c..	☼,∅	Several other Yak hybrids stay low and neat; plant minimum 24 inches from sidewalk edge and 36 inches from curb	E	OA: May produce more flowers if pruned and/or deadheaded after blooming
EG	DT		<24"	*Sarcococca hookeriana humilis*	Himalayan Sweet Box	3	2 Gal. ./ 24" o.c..	∅	Winter fragrance; plant 36 inches minimum back of pavement	E	May get leggy, ok to prune
EG			30"	*Taxus* 'Emerald Spreader'	Emerald Spreader Yew	3	2 Gal. ./ 36" o.c..	☼,∅	Intial spacing tighter for stronger impact	E	prune or remove some pkants after 10 years; spreading
		NWN	<24"	*Tolmiea menziesii*	Youth on Age	1,2,3	quart / 18" o.c..	∅	Group in fives	G	if spreading, ok to remove some plants
EG	DT		<24"	*Veronica liwanensis*	Speedwell	3,4,5	4" Pot/ 12" o.c..	☼,∅	Low groundcover, plant minium 18 inches back of curb and 12 inches back of sidewalk	E	OA: Cut back for neater appearance.

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DR = Drought Resistant
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☼ = Full Sun
∅= Part Sun/ Part Shade
OA = Optional Attention

O&M Code
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C = Hand-rake in spring (Mid-January to Mid-March) before new growth emerges. Cut back to ground or thin every 2-3 years as needed.
DS = Deadhead perennials or remove faded foliage in spring/summer to encourage reblooming/ new leaves and for neater appearance. Deadheading not required for function.
DF = Deadhead perennials in fall for neater appearance and to prevent re-sowing. Deadheading not required for function.
E = Cut back or prune of over sidewalk or clear zones. Remove deadwood anytime fall to spring.
F = May need replacing every 5+/- years. (Replacement not required if vegetation coverage meets requirements)
G = May need dividing every few years. Reasons for division include dieback in center and to increase coverage.

King County Department of Natural Resources and Parks Wastewater Treatment Division

Seattle Public Utilities

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Sun List (*for bioretention cells with graded side slopes)*

Guidance Statement: Designer should group plants for maintenance needs to allow ease of pruning and weed control.. Bulbs and perennials that are tough, long-lived and minimal maintenance can be added at designer's discretion.

EG	DT	NWN	Height from Ground	Scientific Name	Common Name	Planting Zone	Size/Spacing	Exposure	Design Comments	O&M Code	Additional O & M Comments
SEMI			<24"	*Abelia x grandiflora* 'Prostrata'	Prostrate white abelia	3,4	1 Gal. / 30" o.c.	☼,∅	Spreading by rhizomes. Place min 3 feet back of curb or sidewalk; min group of 3	E	
	DT		<24"	*Aster novi-belgii* 'Wood's Blue'	Wood's Blue New York Aster	3	1 Gal./ 18" o.c.	☼	Place min 3 feet back of curb or sidewalk; min group of 3	B, G	
			24"-36"	*Carex muskingumensis*	Palm sedge	1,2	10 Cu. In. Plug/ 10" o.c.	☼,∅	Limit to areas of approx. 36"x36"	B	
			24"-36"	*Carex elata* 'Bowles Golden'	Bowles Golden Sedge	1,2,3	10 Cu. In. Plug/ 10" o.c.	☼,∅	Limit to areas of approx. 36"x36"	B	
			24"-36"+	*Carex grayi*	Gray's sedge	1,2	10 Cu. In. Plug/ 10" o.c.	☼,∅	Limit to areas of approx. 36"x36"	B	
		NWN	24"-36"	*Carex stipata*	Beaked sedge	1,2	10 Cu. In. Plug/ 10" o.c.	☼,∅	Limit to areas of approx. 36"x36"	B	
EG			24"-30"	*Carex testacea or dispacea*	Orange New Zealand or Autumn Sedge	1,2,3	10 Cu. In. Plug/ 10" o.c.	☼,∅	Avoid areas with sun and wind as they need water	C	
	DT		24"-36"	*Caryopteris incana* 'Sunshine Blue'	Sunshine Blue Bluebeard	3,4	1 Gal. ./ 18" o.c..	☼		B/D/F	Cut back to about 18" above the ground or by half in early spring after new leaves are visible
	DT	NWN	24"-30"	*Cornus sericea* 'Kelseyii'	Kelsey redstem dogwood	1,2	5 Gal. / 48" o.c. 1 Gal. / 24" o.c.	☼,∅	Plant 2 Gal. at 30" o.c.. if used to support emergent grasses. May be planted in zone 3 if in a wide cell	E	Stems fragile until established.
	DR		24"-36"	*Echinacea purpurea*	Coneflower	3	1 Gal./ 18" o.c.	☼	Use if irrigation system; plant in groups of 3 min	B	difficult to establish OA: For neater appearance deadhead.
EG	DT	NWN	24"-36"+	*Gaultheria shallon*	Salal	3	1 Gal. / 24" o.c.	☼,∅	Recommend placement only along sidewalk side due to potential height or if along streetside place back 4 feet from face of curb. Note groupings as it will spread and takes time to establish.	E	If height is a problem, Salal can be sheared with hedge trimmer.
EG	DT		24"-36"	*Hebe 'Red Edge'*	Red Edge Hebe	3,4	1 Gal. / 24" o.c..	☼		E	Shear if floppy or too woody
	DT		<24"	*Hemerocallis* - Later Flowering Varieties	Later Flowering Daylily varieties	3,4	1 Gal. / 15" o.c.	☼,∅	Later flowering varieties are not as susceptible to Day lily Gall Midge.	A	OA: For neater appearance deadhead.
EG	DT		<24"	*Geranium x candareens* 'Cambridge'	Perennial Geranium	3,4	1 Gal. ./ 15" o.c..	☼,∅		B	
SEMI	DT		<24"	*Helianthemum* 'Henfield Brilliant'	Sunrose	3,4	1 Gal. / 10" o.c.	☼		B	
EG	DT		24"-36"	*Helictotrichon sempervirens*	Blue oat grass	3	1 Gal. ./ 18" o.c..	☼	Use sparingly as maintenance intensive	C	Rake annually; may be short lived
EG	DT		<24"	*Ilex x* 'Mondo'	Little Rascal Holly	3,4	1 Gal. / 18" o.c.	☼,∅		E	
EG	DT	NWN	<24"	*Iris douglasiana*	Pacific Coast Iris	3,4	1 Gal. / 18" o.c.	☼	Groups of 3, Many colors available.	G	OA: For neater appearance cut back dead leaves and flower stalks.
SEMI	DT	NWN	<24"	*Iris missouriensis*	Rocky Mountain Iris	1,2	1 Gal. / 12" o.c.	☼		G	OA: For neater appearance cut back dead leaves and flower stalks.
SEMI			12"-24"	*Iris sibirica dwarf* cultivars such as *'BabySister'*	Dwarf Siberian Iris	1,2,3	1 Gal. / 18" o.c.	☼,∅	Note - review use of Iris with agency O&M staff. This is a smaller version	G	OA: For neater appearance cut back dead leaves and flower stalks.
EG		NWN	12"-36"	*Juncus balticus*	Baltic rush	1	10 Cu. In. Plug/ 10" o.c.	☼	Locate in center of plants that will support foliage.	C	May want some water in drought conditions. OA: Can be sheared more frequently if foliage collapses.
EG		NWN	18"-36"	*Juncus effusus 'Quartz Creek'*	Quartz Creek Soft Rush	1	10 Cu. In. Plug/ 10" o.c.	☼	Locate in center of plants that will support foliage.	C	OA: Can be sheared more frequently if foliage collapses. This plant has a spreading nature however dry summer months should help to control. May go brown in drought conditions
EG	DT		<24"	*Juniperus communis 'Mondap'*	Alpine carpet juniper	4, 5	1 Gal./ 24" o.c.	☼		E	May require pruning in edge conditions
EG	DT		<24"	*Juniperus conferta 'Blue Pacific'*	Blue Pacific Shore juniper	3,4	1 Gal. / 3' o.c.	☼		E	
EG	DT	NWN	<24"	*Mahonia repens*	Creeping Oregon grape	3,4	1 Gal. / 18" o.c.	☼,∅		E	Requires water during full establishment period
	DR		36"	*Miscanthus sinensis 'Little Kitten'*	Little Kitten Maiden Grass	3	1 Gal. /15" o.c.	☼		B	
	DT		30"	*Nepeta 'Walker's Low'*	Catmint	3	1 Gal. / 18" o.c.	☼,∅		B	
EG			36"	*Rhododendron* Yak Hybrids, such as 'Ken Janeck'	Yak Hybrid	3,4	2 Gal. / 30" o.c.	☼,∅	Several other Yak hybrids stay low and neat	E	OA: May produce more flowers if pruned and/or deadheaded after blooming
	DT		24"-36"	*Rudbeckia fulgida* 'Goldsturm'	Black-Eyed Susan	3,4	1 Gal./ 18" o.c.	☼	Late season color accent.	A/B	
	DT		<24"	*Sedum* 'Autumn Joy' or 'Matrona'	Stonecrop	3,4	1 Gal./ 12" o.c.	☼		G	OA: Can be cut back by half in June to prevent flopping.
	DT	NWN	<24"	*Solidago canadensis* 'Baby Gold' or *Solidago hybrida* 'Dansolitlem'	Baby Gold or Little Lemon Goldenrod	3,4	1 Gal. / 18" o.c.	☼	Late season color accent.	A	
		NWN	24"-48"	*Spiraea betulifolia or Spiraea betulifolia* 'Tor'	Birchleaf spirea	3	1 Gal. / 24" o.c.	☼		E	
EG	DT	NWN	<24"	*Sedum oreganum*	Stonecrop	3,4,5	4" Pot / 12" o.c.	☼	Tolerates hot dry sites.	E	
EG	DT		<24"	*Teucrium chamaedrys*	Wall germander	3,4	1 Gal. / 18" o.c.	☼	Spreading; plant 2 ft back of pavement and 3 feet back of curb	E	OA: For neater appearance trim spent flowers in spring. If aggressive and requires frequent pruning or if herbaceous weed growth control is an issue then pull out.
EG	DT		<24"	*Thymus serpyllum* 'Elfin'	Elfin creeping thyme	3,4,5	4" Pot/ 12" o.c.	☼		F	If herbaceous weed growth control is an issue then pull out and replace with stonecrop

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King County Department of Natural Resources and Parks Wastewater Treatment Division · Seattle Public Utilities · MIG · SvR · McNicol · stormy designs

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Native List - (Sun to Part Shade, Includes Cultivars) *(for bioretention cells with graded side slopes)*

Guidance Statement: Designer should group plants for maintenance needs to allow ease of pruning and weed control. Plants with mature heights over 24 inches (intersections & driveways) /30 inches (along) to be located in downslope conditions where height rquirements from curb stay under the 24"/30" height criteria. Exception: singular plants used as accent shrub. Native bulbs and perennials that are within height criteria, are tough, are long-lived and require minimal maintenance (2 x /yr) can be added at designer's discretion.

EG	DT	NWN	Height from Ground	Scientific Name	Common Name	Planting Zone	Size/Spacing	Exposure	Design Comments	O&M Code	Additional O & M Comments	Abbreviations/Legend/O&M Code
	DR	NWN	24"-36"	*Aquilegia formosa*	Western Columbine	2,3	1 Gal. ./ 18" o.c..	☼,∅	Group in fives	DF		**Abbreviations/Legend** **EG** = Evergreen **SEMI** = Semi-Evergreen **DT** = Drought Tolerant **DR** = Drought Resistant **NWN** = Northwest Natives or cultivars **UF** = Urban Frontage (Mixed Use/Commercial) appropriate plants ☼ = Full Sun ∅ = Part Sun/ Part Shade **OA** = Optional Attention **O&M Code** **A** = Cut back these perennials to 4- 6" above ground in Fall (October/November) **B** = Leave foliage and seedheads for winter interest/provide food for birds and cut back if foliage collapses. Cut back in spring (Mid-January to Mid-March) before new growth emerges. **C** = Hand-rake in spring (Mid-January to Mid-March) before new growth emerges. Cut back to ground or thin every 2-3 years as needed. **DS** = Deadhead perennials or remove faded foliage in spring/summer to encourage reblooming/ new leaves and for neater appearance. Deadheading not required for function. **DF** = Deadhead perennials in fall for neater appearance and to prevent re-sowing. Deadheading not required for function. **E** = Cut back or prune of over sidewalk or clear zones. Remove deadwood anytime fall to spring. **F** = May need replacing every 5+/- years. (Replacement not required if vegetation coverage meets requirements) **G** = May need dividing every few years. Reasons for division include dieback in center and to increase coverage.
EG	DT	NWN	<12"	*Arctostaphylos uva-ursi 'Massachusetts' or 'Pt. Reyes'*	Kinnickinnick	3,4	1 Gal. ./ 24" o.c.. 4 inch pots / 12" o.c..	☼,∅	Possible use at vertical wall or single use low accent. Requires approval by Project Manager and Maintenance prior to use.	E	"Kinnikinnik" is the longest palindrome (a word spelled the same forwards or backwards) in the English language	
	DT	NWN	36"	*Asclepias speciosa*	Showy Milkweed	1,2	3" pots	☼	Mix with rush. Do not use the common form because it can be too invasive	B	ok to pull out if it spreads too much	
	DT	NWN	18"-25" (36")	*Camus leichtlinii or Camus quamash*	Great Camus or Common Camus	2,3,4	Bulbs in fall 1 Gal. ./ 12" o.c..	☼,∅	Fall plant for in groups of 15+ bulbs for effect and maintenance visibility. Can be planted as a bulb. Consider installing marker for location until grouping is established or plant near Rocky Mountain Iris to mark locations.	DF	Suggest reviewing field locations if you see this on plan as they die back and if not located might be pulled as weeds when they emerge.	
EG		NWN	30"	*Carex densa*	Dense sedge	1,2	10 Cu. In. Plug/ 10" o.c..	☼		C		
	DR	NWN	26"(48")	*Carex deweyana v. leptopoda*	Slender-foot Dewey's sedge	1,2	10 Cu. In. Plug/ 10" o.c..	∅	If using the species limit to areas of approx. 36"x36"	B		
		NWN	30"	*Carex lenticularis. Lipocarpa*	Shore Sedge	1	10 Cu. In. Plug/ 10" o.c..	☼	Tolerates water fluctuations but prefers wet			
	DT	NWN	24"-36"	*Carex pachystachya*	Chamisso sedge	1,2	10 Cu. In. Plug/ 10" o.c..	☼,∅	Limit to areas of approx. 36"x36"	B		
		NWN	24"-40"	*Carex stipata*	Beaked sedge	1	10 Cu. In. Plug/ 10" o.c..	☼,∅	Limit to areas of approx. 36"x36"	B		
	DT	NWN	24"-30"	*Cornus sericea 'Kelseyii'*	Kelsey redstem dogwood	1,2,3	2 Gal. ./ 36" o.c..	☼,∅		E	Stems fragile until established.	
	DT	NWN	12"	*Dodecatheon hendersonii*	Broad-leaved shooting star	2,3,4	1 quart/ 18"o.c.	☼,∅	Perennial, magenta to pink blooms			
	DT	NWN	<24"	*Erigeron peregrinus*	subalpine fleabane daisy	3,4	1 Gal. ./ 12" o.c.	☼	Use minimum of 3	DF		
	DT	NWN	36"	*Festuca idahoensis*	Idaho fescue	3,4	1 Gal. / 18" o.c.	☼		DF		
EG	DT	NWN	24"-36" (60"+)	*Gaultheria shallon*	Salal	2,3,4	1 Gal./ 30" o.c. 4" pots / 18 " o.c.	∅	Slow to establish, suggest planting with short term mix to cover bare soil until established . If Wintergreen is desired or substituted, note it is difficult to establish.		If height is a problem, can be sheared with hedge trimmer.	
EG	DT	NWN	<24"	*Iris douglasiana*	Pacific Coast Iris	3,4	1 Gal. ./ 18" o.c..	☼	Many colors available.	G	OA: For neater appearance cut back dead leaves and flower stalks.	
SEMI	DT	NWN	<24"	*Iris missouriensis*	Rocky Mountain Iris	1,2	1 Gal. ./ 12" o.c..	☼		G	OA: For neater appearance cut back dead leaves and flower stalks.	
EG		NWN	<24"	*Juncus balticus*	Baltic rush	1	10 Cu. In. Plug/ 9" o.c.	☼	Locate in center of plants that will support foliage.	C	OA: Can be sheared more frequently if foliage collapses.	
EG		NWN	24"-48"	*Juncus effusus*	Common rush	1	10 Cu. In. Plug/ 9" o.c. 1 Gal./ 30" o.c.	☼	Selective use in cells that will be wetter, locate in center of cell surrounded by plants that will support foliage. Do not intermix with other emergents.	C	Cut back in early spring, spreading nature; dry summer months should help to control. May go brown in drought conditions	
EG		NWN	<24"	*Juncus ensifolius*	Dagger-leaf rush	1,2	10 Cu. In. Plug/ 9" o.c.	☼	Locate in center of plants that will support foliage. Limit to areas of approx. 36"x36"	B		
EG	DT	NWN	<24"	*Lewisia cotyledon or cultivars*	Siskiyou lewisia	3,4	1 Gal. / 12" o.c.	☼		E		
EG		NWN	36"	*Mahonia aquifolium 'Orange Flame' or 'Compacta'*	Compact tall Oregon grape	3	1 Gal. /36" o.c.	☼,∅		E		
EG	DT	NWN	<24"	*Mahonia repens*	Creeping Oregon grape	3,4	4" pots / 12 " o.c. 1 Gal./ 18" o.c.	☼,∅	Mix sizes; Will not do well in heat exposure or in drying winds	E	Requires water during full establishment period	
	DT	NWN	<24"	*Maianthemum dilatatum*	False Lily of the Valley	1,2,3,4	4" Pot/ 12" o.c.	∅	Note tendency to spread	E	OA: Remove dead foliage in fall.	
		NWN	24"-36"	*Mimulus guttatus*	Yellow monkey-flower	1,2	1 Gal./ 18" o.c.	☼,∅		DF		
EG	DT	NWN	36"	*Pachistima myrsinites*	Oregon Boxwood	3	1 Gal. /36" o.c.	☼,∅		E		
		NWN	<24"	*Potentilla fruticosa 'Sunset'*	Frosty potentilla	3,4	2 Gal. / 30" o.c.	∅		E		
	DT	NWN	<24"	*Potentilla glandulosa or Potentilla gracilis*	Sticky cinquefoil or slender cinquefoil	3,4	1 Gal. / 18" o.c.	☼,∅		DF		
EG		NWN	24"-36"	*Polystichum imbricans or Polystichum lonchitis*	Narrow-leaf sword fern or Northern holly fern	3,4	2 Gal./ 30" o.c.	☼,∅	If Polystichum munitum is substituted limit groups to 3 and prune yearly	B	Cut back before fronds appear.	
EG	DR	NWN	24"-36"	*Polystichum munitum*	Western swordfern	3	1 Gal./ 24" o.c.. 2 Gal./36" o.c.	∅	Limit to group of 5, plant min 3 ft back of sidewalk. Do not plant within 4 ft of curb to allow curb edge (step out zone) and room for "flop".	B	key plant for winter green color; be aware if reports of sword fern pathogens increase.	
	DT	NWN	<24"	*Solidago canadensis 'Baby Gold' or Solidago hybrida 'Dansolitlem'*	Baby Gold or Little Lemon Goldenrod	3,4	1 Gal. / 18" o.c.	☼	Late season color accent.	A		
		NWN	24"-36"	*Spiraea betulifolia 'Tor'*	Birchleaf spirea	3	1 Gal. / 24" o.c.	☼	Use 'Tor' because of spreading of other varieties.	E		
EG	DT	NWN	<24"	*Sedum divergens or oreganum*	Stonecrop	3,4	4" Pot/ 12" o.c..	☼,∅	Tolerates hot dry sites.	E	OA: For neater appearance deadhead.	
EG	DT	NWN	24"-36"	*Xerophyllum tenax*	Bear grass	3	1 Gal. / 18" o.c.	☼	Tolerates hot dry sites.	E		

King County Department of Natural Resources and Parks Wastewater Treatment Division | Seattle Public Utilities

Bioretention Plant List for Development of Palettes in the Right of Way

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- SDOT's Streets Illustrated recommends low plantings in rights-of-way. Plant height within 30 feet of an intersection (as measured from the corner face of the curb) is 24 inches above curb elevation. The remaining planting strip should have plants that can be easily maintained to 30 inches with the exception of accent shrubs. Review height of blooms or spikes that may be higher than noted.
- No plants are to be used if they are on the current King Co Noxious Weed List, WA Noxious Weed Control Board List and WA Dept of Ag Prohibited Plant List.
- Size/Spacing: initial planting of smaller sizes of emergents, closer on center (o.c..) is suggested especially in Zones 1 & 2 to achieve the desired coverage.

Planting Zone Code - See Planting Zone Diagram, GSI Manual Vol. III, Section 7

Zone 1 plants are typically tolerant of both wet and dry conditions. Zone 1 plants are typically used for filtration and water quality. Some trees are able to be viable in this zone.
Zone 2 plants are located in the lower slopes/ wetted or ponded side area of the bioretention facilities. Zone 2 plants are also typically used for water quality /filtration.
Zone 3 includes plant species (30 inch mature height) appropriate for planting at the upper slopes of the of bioretention areas. Zone 3 may include limited vertical accent plants and trees.
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Intersection & Sightline List (under 24" Ht.) *(for bioretention cells with graded side slopes)*

Guidance Statement: Maximum plant height within 30 feet of an intersection (as measured from the corner of the curb) is 24 inches. Careful placement in the sightline zones so grass stems are transparent; depending on plant a group of three may be the maximum number to maintain open sightlines. Designer should group plants for maintenance needs to allow ease of pruning and weed control.

EG	DT	NWN	Height from Ground	Scientific Name	Common Name	Planting Zone	Size/Spacing	Exposure	Design Comments	O&M Code	Additional O & M Comments
			<24"	*Chrysanthemum 'Peach Centerpiece' or 'Bienchen'*	Peach Centerpiece or golden Chrysanthemum	3,4	1 Gal. ./ 15" o.c..	☼	Late season color accent.	B & G	Pull if scraggly.
	DT		<24"	*Coreopsis lanceolata 'Sterntaler'*	Tickseed	3,4	1 Gal. ./ 15" o.c..	☼		B & G	
	DT		24"-30"	*Cornus sericea* 'Kelseyii'	Kelsey red stem dogwood	1,2,	1 Gal. ./ 28" o.c.. 2 Gal. / 36"o.c.	☼,∅	Plant in bottom areas for sightlines. Can be used to support emergent grasses.	E	Stems fragile until established.
EG	DT		<24"	*Epimedium rubrum or sulphurescens*	Barrenwort	3,4	4" Pot/ 12" o.c.. 1 Gal. / 24" o.c.	∅	Part shade to shade only without irrigation.	B	Cut back before flower stalks appear.
EG	DT		<24"	*Euonymus fortunei* ' Interbolwi'	Blondy wintercreeper	3,4	1 Gal. ./ 18" o.c..	☼,∅		E	
	DT		<24"	*Geranium* 'Gerwat' *Rozanne*	Rozanne geranium	3,4	1 Gal. ./ 24" o.c..	☼,∅		A	OA: Can be sheared for neater appearance.
EG			<24"	*Geum flore pleno* 'Blazing Sunset'	Blazing Sunset Avens	3,4	1 Gal. ./ 18" o.c..	☼,∅		DS	
EG			<24"	*Hebe x* 'Champion'	Champion Hebe	3,4	1 Gal. ./ 18" o.c..	☼,∅		E	
SEMI	DT		<24"	*Helianthemum nummularium 'Wisley Primrose'*	Yellow Sunrose	3,4	1 Gal. ./ 12" o.c..	☼		B	Cut back in the spring to prevent woody structure
EG	DT		24"-36"	*Helictotrichon sempervirens*	Blue oat grass	3	1 Gal. ./ 18" o.c..	☼	36" height only when in flower. Airy flowers. Groups of 3 maximum. Plant min. 36 inches back of curb and sidewalk	C	
EG	DT		<24"	*Ilex x 'Mondo'*	Little Rascal Holly	3,4	1 Gal. ./ 18" o.c..	☼,∅		E	
EG		NWN	<24"	*Juncus effusus* 'Carmen's Japan'	Carmen's Japanese Rush	1,2	10 Cu. In. Plug/ 10" o.c..	☼,∅	Locate in center between plants that will support foliage.	C	
EG			<24"	*Juncus effusus* 'Spiralis'	Corkscrew soft rush	1,2	10 Cu. In. Plug/ 10" o.c..	☼,∅	Locate in center between plants that will support foliage.	C	OA: Can be sheared more frequently if foliage collapses.
EG	DT		18"-30"	*Juncus patens*	California gray rush	1,2	10 Cu. In. Plug/ 10" o.c..	☼,∅	Locate in center between plants that will support foliage. Plant in bottom areas for sightlines. Use J.patens 'Elk blue' if blue tone is desired	C	OA: Can be sheared more frequently if foliage collapses.
EG			<24"	*Liriope muscari and cultivars*	Lily Turf	3,4	4" Pot/ 12" o.c..	☼,∅	Might consider for short term infill	C	OK to pull clumps for ease of weed control.
EG	DT		24"	*Lonicera pileata*	Box leaf honeysuckle	3,4	1 Gal. ./ 36" o.c..	☼,∅	Suitable for large end area as spread can go 4 to 8 feet but tough fast growth	E	
EG	DT	NWN	<24"	*Mahonia repens*	Creeping Oregon grape	3,4	1 Quart/ 24" o.c.. 4" pots /12 " o.c.	☼,Æ	Mix sizes; Will not do well in heat exposure or in drying winds	E	Requires water during full establishment period
	DT		<24"	*Narcissus* 'Dutch Master' *or* 'King Alfred'	Daffodil	3,4	Bulb/ As Shown	☼,∅		DS	Cut back foliage in summer.
		NWN	<24"	*Potentilla fruticosa* 'Sunset'	Frosty potentilla	3,4	2 Gal. ./ 30" o.c..	☼,∅		E	
EG	DT		<24"	*Veronica liwanensis*	Speedwell	3,4,5	4" Pot/ 12" o.c..	☼,∅	Low groundcover, plant minium 18 inches back of curb and 12 inches back of sidewalk	E	OA: Cut back for neater appearance.

Abbreviations/Legend/O&M Code

Abbreviations/Legend
EG = Evergreen
SEMI = Semi-Evergreen
DT = Drought Tolerant
DR = Drought Resistant
NWN = Northwest Natives or cultivars
UF = Urban Frontage (Mixed Use/Commercial) appropriate plants
☼ = Full Sun
∅ = Part Sun/ Part Shade
OA = Optional Attention

O&M Code
A = Cut back these perennials to 4- 6" above ground in Fall (October/November)
B = Leave foliage and seedheads for winter interest/provide food for birds and cut back if foliage collapses. Cut back in spring (Mid-January to Mid-March) before new growth emerges.
C = Hand-rake in spring (Mid-January to Mid-March) before new growth emerges. Cut back to ground or thin every 2-3 years as needed.
DS = Deadhead perennials or remove faded foliage in spring/summer to encourage reblooming/ new leaves and for neater appearance. Deadheading not required for function.
DF = Deadhead perennials in fall for neater appearance and to prevent re-sowing. Deadheading not required for function.
E = Cut back or prune of over sidewalk or clear zones. Remove deadwood anytime fall to spring.
F = May need replacing every 5+/- years. (Replacement not required if vegetation coverage meets requirements)
G = May need dividing every few years. Reasons for division include dieback in center and to increase coverage.

King County Department of Natural Resources and Parks Wastewater Treatment Division | Seattle Public Utilities

Bioretention Plant List for Development of Palettes in the Right of Way

Notes:

- This plant list was developed to provide consistency in the right of way for installation and long term operations and maintenance. The trees and plants have been reviewed and approved by SDOT Urban Forestry and Landscape Architecture, SPU GSI O&M, SPU/SDOT IDT, and KCWTD Water Quality and O&M staff.
- SDOT's Streets Illustrated recommends low plantings in rights-of-way. Plant height within 30 feet of an intersection (as measured from the corner face of the curb) is 24 inches above curb elevation. The remaining planting strip should have plants that can be easily maintained to 30 inches with the exception of accent shrubs. Review height of blooms or spikes that may be higher than noted.
- No plants are to be used if they are on the current King Co Noxious Weed List, WA Noxious Weed Control Board List and WA Dept of Ag Prohibited Plant List.
- Size/Spacing: initial planting of smaller sizes of emergents, closer on center (o.c..) is suggested especially in Zones 1 & 2 to achieve the desired coverage.

Planting Zone Code - See Planting Zone Diagram, GSI Manual Vol. III, Section 7

Zone 1 plants are typically tolerant of both wet and dry conditions. Zone 1 plants are typically used for filtration and water quality. Some trees are able to be viable in this zone.
Zone 2 plants are located in the lower slopes/ wetted or ponded side area of the bioretention facilities. Zone 2 plants are also typically used for water quality /filtration.
Zone 3 includes plant species (30 inch mature height) appropriate for planting at the upper slopes of the of bioretention areas. Zone 3 may include limited vertical accent plants and trees.
Zone 4 plants are low, durable and drought tolerant. Plants (under 24") are used in sight clearance areas or as accents at the edge of the facility.
Zone 5 is the designation for plants used in the crossing zones and access areas along the curb.

Plant List for Bioretention Cells with Vertical Wall(s) (Primarily Evergreen)

Guidance Statement: Bioretention Cells with Vertical Wall(s) (also referred to as Stormwater planters) typically have3 to 4 walled sides, creating a condition that may be wetter and shadier than a graded cell or dryer in the summer (from heat off walls). A majority of the plants in cell with wall(s) should be evergreen or have a winter presence and majority of plant foliage should be at least 18 inches above the sidewalk grade to mark the extents of the stormwater planter year-round. Plants over 24/30 inches mature height may be used as long as their foliage is not taller than 24-inches above sidewalk at intersections/view restriction locations or taller than 30-inches above sidewalk at all other locations. Provide a mix of container sizes at initial planting (i.e. 2/3 mix of plugs and 1/3 mix Gallon containers) to provide immediate plant presence. Locate larger container plants along wall. Plants noted for lined planting zone tolerate wet/saturated conditions. Plants noted for unlined planting zone do better if the soil drains periodically.

EG	DT	NWN	Height from Ground	Scientific Name	Common Name	Planting Zone	Size/Spacing	Exposure	Design Comments	O&M Code	Additional O & M Comments	Abbreviations/Legend/O&M Code
	DT		48"-72"	*Calamagrostis x acutiflora 'Avalanche'*	Variegated feather reed grass	Unlined	1 Gal. / 24" o.c.	☼,∅	Place min. 18 inches from sidewalk edge of wall or centerline of planter if wider than 4 feet. Leave gap in cell to see across planting strip	B	If height or thicket forms sheared to 36 inch and remove plants for clearance.	**Abbreviations/Legend** **EG** = Evergreen **SEMI** = Semi-Evergreen **DT** = Drought Tolerant **DR** = Drought Resistant **NWN** = Northwest Natives or cultivars **UF** = Urban Frontage (Mixed Use/Commercial) appropriate plants ☼ = Full Sun ∅ = Part Sun/ Part Shade **OA** = Optional Attention **O&M Code** **A** = Cut back these perennials to 4- 6" above ground in Fall (October/November) **B** = Leave foliage and seedheads for winter interest/provide food for birds and cut back if foliage collapses. Cut back in spring (Mid-January to Mid-March) before new growth emerges. **C** = Hand-rake in spring (Mid-January to Mid-March) before new growth emerges. Cut back to ground or thin every 2-3 years as needed. **DS** = Deadhead perennials or remove faded foliage in spring/summer to encourage reblooming/ new leaves and for neater appearance. Deadheading not required for function. **DF** = Deadhead perennials in fall for neater appearance and to prevent re-sowing. Deadheading not required for function. **E** = Cut back or prune of over sidewalk or clear zones. Remove deadwood anytime fall to spring. **F** = May need replacing every 5+/- years. (Replacement not required if vegetation coverage meets requirements) **G** = May need dividing every few years. Reasons for division include dieback in center and to increase coverage.
	DR	NWN	24"-36"	*Camus leichtlinii or Camus quamash*	Great Camus or Common Camus	Lined & Unlined	Bulb / 6" o.c. 1 Gal. / 18" o.c..	☼,∅	Plant a minimum of 15 bulbs in each group. Plant with Geranium or Carex testacea to mark locations.	DF	Hard to see may want to place marker stake if used until established. Blooms spring to early summer. Do not cut down spent blooms to allow to reseed.	
EG	DT		12"-18"	*Carex divulsa*	European Grey Sedge	Lined & Unlined	1 Gal. / 24"o.c.	☼,∅	Shallow planters			
EG	DT	NWN	24"-60"	*Carex obnupta*	Slough sedge	Lined & Unlined	10 Cu. In. Plug/ 10" o.c.. & 1 Gal. / 18" o.c.	☼,∅	Use only in industrial zones where the floppy nature does not draw comments for maintenance staff. Not recommended for planting in walled cells as the floppy appearance has triggered maintenance comments from residents. Locate in center of plants that will support foliage. Do not intermix with other emergents. Do not plant near intersections as blooms may reach 5 feet.	C	Can be sheared more frequently if overcrowding other occurs.	
EG			24"-30"	*Carex testacea or dispacea*	Orange New Zealand or Autumn Sedge	Lined & Unlined	10 Cu. In. Plug/ 10" o.c.. & 1 Gal. ./ 18" o.c..	☼,∅	Plant with Camas. Do not plant adjacent to wall (Too low).	C		
	DR	NWN	24"-36"	*Cornus sericea 'Kelseyi'*	Kelsey redstem dogwood	Lined & Unlined	2 Gal. ./ 36" o.c.. 1 Gal. . / 24' o.c..	☼,∅	Can be used to support emergent grasses.	E	Stems fragile until established.	
	DT	NWN	36"-48"	*Cornus stolonifera 'Neil Z'*	Pucker Up Redtwig Dogwood	Lined & Unlined	5 Gal. if 1-2 plants in cell 36"o.c. if group then 2 Gal. / 30" o.c..	☼,∅	Place 18" from edge of wall	E		
EG	DT		<12"	*Epidmedium s.*	Bishop's hat	Outside of walled cell	1 Gal. / 18 o.c.	∅	Use along pedestrian access between planter wall and hard surface.	E		
EG	DT	NWN	24"-36"+	*Gaultheria shallon*	Salal	Unlined	1 Gal./ 24" o.c.	☼,∅	Can be used to support emergent grasses.	E	If height is a problem, shear to 22" with hedge trimmer to encourage compact growth.	
SEMI			12"	*Geranium × candareens 'Biokovo'*	Biokovo geranium	Unlined	4" Pots / 12" o.c. 1 Gal. / 18" o.c.	☼,∅	Plant with Camas. Do not plant adjacent to wall along sidewalk (too low).	B		
SEMI	DT	NWN	<24"	*Heuchera sp.*	Coral Bells	Outside of walled cell	1 quart / 18 inches o.c..	∅	Use along pedestrian access between planter wall and hard surface.			
EG	DT		<24"	*Iris foetidissima*	Gladwyn iris	Unlined	1 Gal. ./ 18" o.c..	☼,∅	Plant can be toxic to people and pets	G		
EG	DT	NWN	24"-48"+	*Juncus effusus*	Common rush	Lined & Unlined	10 Cu. In. Plug/ 10" o.c.. 1 Gal. ./ 18" o.c..	☼,∅	Select for wide/deep cells only; plant 5 gal in deep cells. Do not intermix with other emergents. Do not plant near intersections.	C	shear in winter especially if floppy	
EG		NWN	24"-36"	*Juncus effusus 'Quartz Creek'*	Quartz Creek Soft Rush	Lined & Unlined	10 Cu. In. Plug/ 10" o.c.. & 1 Gal. ./ 18" o.c..	☼,∅	Locate in center of plants that will support foliage.	C	OA: Can be sheared more frequently if foliage collapses.	
EG		NWN	<24"	*Juncus ensifolius*	Dagger-leaf rush	Lined & Unlined	10 Cu. In. Plug/ 10" o.c.. & 1 Gal. ./ 18" o.c..	☼,∅	Locate in center of plants that will support foliage. Limit to areas of approx. 36"x36" due to winter dormancy	B		
EG	DT		18"-36"	*Juncus patens or Juncus patens 'Elk blue'*	California gray rush	Lined & Unlined	10 Cu. In. Plug/10" o.c.. & 1 Gal. ./ 18" o.c..	☼,∅	Plant in bottom zone for sightlines; Use J. patens "Elk blue" if blue tone is desired	C	May need summer water until established OA: Can be sheared more frequently if foliage collapses.	
	DT		<12"	*Liriope muscari*	Lily turf	Outside of walled cell	1 Gal. / 18 o.c..	∅	Use along pedestrian access between planter wall and hard surface.			
EG		NWN	36"	*Mahonia aquifolium 'Orange Flame' or 'Compacta'*	Compact tall Oregon grape	Unlined	1 Gal. ./36" o.c..	☼,∅	Plant minimum two feet from wall	E		
EG	DT	NWN	24"	*Mahonia nervosa*	Low/Longleaf Oregon grape	Unlined	1 Gal. / 18" o.c.	☼,∅	Minimum of 5	E		
EG	DT		48"	*Nandina domestica 'Compacta' or 'Sienna Sunrise'*	Heavenly Bamboo	Unlined	2 Gal. / 24" o.c.	☼,∅	Can be used to support emergent grasses. Plant 2' from edge of wall.	E	OA: Prune out oldest canes once a year.	
		NWN	36"	*Spiraea densiflora var. densiflora*	Mountain spirea	Lined & Unlined	1 Gal.. & 2 Gal./36" o.c.	☼,∅	Do not confuse or substitute with Spiraea douglasii which forms dense thickets.	E		
		NWN	6'	*Symphoricarpos albus*	Snowberry	Unlined	2 Gal.	☼,∅	Plant in center , minimum two feet from wall.	E	Forms thickets will need windowing/ thinning.	
EG		NWN	6'	*Vaccinium ovatum*	Evergreen Huckleberry	Unlined	5 Gal.	☼,∅	Plant as single specimen - no groups in cells due to sightlines	E	Prune as needed to maintain form	

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Pollinator Plant List

Guidance Statement: plants 24 inches max for intersection/driveway and plants under 30 inch max for rest; you can suggest 3-4‘ "spike" plants – it taller shrubs but they should not aggressively spread and become a thicket (ie dogwood – willow not allowed). Recommend signing pollinator planting areas to inform public and maintenance staff of the planting purpose as these tend to have more perennials.See Native Plant List for Zone 1.

EG	DT	NWN	Height from Ground	Scientific Name	Common Name	Planting Zone	Size/Spacing	Exposure	Design Comments	O&M Code	Additional O & M Comments
	DT	NWN	12-24"	*Achillea millefolium*	Common yarrow	3,4	1 Gal./ 18" o.c.	☼,∅	Flowers excellent for pollinators	DS	
	DT		24"-36"	*Agastache 'Blue Fortune'*	Anise Hyssop	3	1 Gal. / 18" o.c.	☼	Attracts hummingbirds, bees	DF	
	DT	NWN	12"-18"	*Allium spp.*	Ornamental Onion	3,4	Bulb/ 6"-12" o.c.	☼,∅	Attracts hummingbirds, bees, plant in groups	DS	
	DR	NWN	24"-36"	*Aquilegia formosa*	Western Columbine	1,2,3,4	1 Gal. / 18" o.c.	☼,∅	Plant in group of 3; Attracts hummingbirds, bees, butterflies	DF	
EG	DT	NWN	<24"	*Arctostaphylos uva-ursi 'Massachusetts' or 'Pt. Reyes'*	Kinnickinnick	3,4	4" Pots 12"o.c. 1 Gal. / 24" o.c..	☼,∅	Needs room; groups 7+ plants, ok to mix with short term plants (see list) for filler. Do not mix with grasses and shrubs due to maintenance	E	Generally requires wider planting strip
	DT	NWN	12"	*Armeria maritima*	Thrift sea pink	3,4	4" Pots / 12" o.c. 1 Gal. / 12" o.c..	☼	Border plant	G	
	DT	NWN	36"	*Asclepias speciosa*	Showy Milkweed	1,2	3" pots	☼	Mix with rush Do not use the common form because it can be too invasive	B	ok to pull out if it spreads too much
	DT		<24"	*Aster novi-belgii 'Wood's Blue'*	Wood's Blue New York Aster	3,4	1 Gal./ 18" o.c..	☼	Flowers late	B, G	
	DR	NWN	24"-36"	*Camus leichtlinii or Camus quamash*	Great Camus or Common Camus	1,2,3,4	Bulb/ 8" o.c. 1 Gal. / 18" o.c..	☼,∅	Plant a minimum of 15 bulbs in each group. Plant with Geranium or Carex testacea to mark locations.	DF	Blooms spring to early summer. Do not cut down spent blooms to allow to reseed.
	DR		24"-36"	*Echinacea purpurea*	Coneflower	3	1 Gal. / 18" o.c.	☼	Flowers spring to summer however difficult to establish	B	OA: For neater appearance deadhead.
	DT		30"	*Eryngium alpinum or Eryngium amethustinum*	Sea Holly	3	4" Pots/ 12"o.c. 1 Gal./ 18" o.c.	☼	Flowers excellent for pollinators	DS	
EG	DT	NWN	18"	*Festuca idahoensis 'Siskiyou Blue'*	Idaho fescue	3,4	1 Gal. / 18" o.c.	☼		DF	
			36"	*Fuchsia magellanica 'Aurea'*	Dwarf Hardy Fuchsia	3,4	2 Gal./ 30" o.c.	∅		E	
EG	DT	NWN	24"-36"+	*Gaultheria shallon*	Salal	3	1 Gal. / 24" o.c.	☼,∅		E	If height is a problem, Salal can be sheared with hedge trimmer.
SEMI	DT		12"	*Geranium × candareens 'Biokovo'*	Biokovo geranium	2	1 Gal./ 18" o.c.	☼,∅		B	
SEMI	DT	NWN	<24"	*Iris douglasiana*	Pacific Coast Iris	3,4	1 Gal. / 18" o.c.	☼	Many colors available.	G	OA: Neater if dead leaves / flower stalks cut back.
EG	DT		18"	*Lavandula angustifolia 'Hidcote'*	Lavender	3,4	1 Gal./ 18" o.c.	☼		DS	Cut back just below top of green foliage in spring to prevent woody growth.
		NWN	24"-36"	*Lupinus arcticus or sericeus*	Arctic lupine / Silky lupine	2,3	1 Gal. / 18" o.c.	☼,∅	Flowers early	DF	Short-lived. Will reseed if not deadheaded. Some Lupine are toxic
	DT		30"	*Nepeta 'Walker's Low'*	Catmint	3	1 Gal./ 18" o.c.	☼,∅		B	
	DT	NWN	30"	*Penstemon serrulatus*	Cascade Beard-Tongue	2,3	4" Pots or 1 Gal. ./ 18" o.c..	☼,∅	Attracts hummingbirds, bees, moths	B	
	DT		<24"	*Perovskia atriplicifolia 'Lacey Blue'*	Compact Russian Sage	3,4	1 Gal. / 24" o.c..	☼	Low Maintenance, Accent Plant	B	
		NWN	<20"	*Prunella vulgaris lanceolata*	Selfheal	3,4	1 Quart / 18" o.c.	☼,∅	Highly attractive to various polinators. Deep roots, use sparingly in groups of three as they may become aggressive.	E	If too aggressive, pull out to keep in a limited 3'x3' area.
EG	DT		48"+	*Rosmarinus officinalis 'Hill Hardy'*	Rosemary	3	1 Gal. / 36" o.c.	☼	Plant as single specimen - no groups.	E	
	DT		24"-30"	*Rudbeckia fulgida 'Goldsturm'*	Black-Eyed Susan	3,4	1 Gal./ 18" o.c.	☼	Late season color accent.	B	
	DT		24"-30"	*Salvia nemorosa 'Caradonna'*	Salvia species	3,4	1 Gal. / 24" o.c.	☼		B	
EG	DT	NWN	<24"	*Sedum divergens or Sedum oreganum*	Stonecrop	3,4	4" Pot/ 12" o.c.	☼,∅	Tolerates hot dry sites.	E	OA: For neater appearance deadhead.
		NWN	<12"	*Sidalcea malviflora 'Palustre'*	Dwarf Checker-mallow	3,4	4" Pots /12" o.c..	☼	Regular watering, long-lived plant blooms attractive to butterflies	E	OA Will go dormant in summer drought conditions.
	DT	NWN	<24"	*Solidago canadensis 'Baby Gold' or Solidago hybrida 'Dansolitlem'*	Baby Gold or Little Lemon Goldenrod	3,4	1 Gal. / 18" o.c.	☼	Late season color accent.	B	
	DT		36"-48"	*Spiraea x bumalda 'Goldflame'*	Goldflame Spirea	2,3	2 Gal.	☼,∅	Accent plant as single use 36" from curb	E	
EG	DT		<24"	*Teucrium chamaedrys*	Wall germander	3,4	1 Gal. / 18" o.c.	☼	Spreading, plant 24 inches back of pavement and 36 inches back of curb	E	OA: For neater appearance trim spent flowers in spring. If aggressive and requires frequent pruning or if herbaceous weed growth control is an issue then pull out.
EG	DT		<24"	*Thymus serpyllum 'Elfin'*	Elfin creeping thyme	3,4,5	4" Pot/ 12" o.c..	☼		F	aceous weed growth control is an issue then pull out and replace with ston
EG		NWN	6'	*Vaccinium ovatum*	Evergreen Huckleberry	1,2,3	5 Gal.	☼,∅	Plant as single specimen - no groups in cells due to sightlines	E	Prune as needed to maintain form

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Short Term Infill Plant List

Guidance Statement: The plants in this palette are annuals or short-lived plants to enhance the cells at the time of installation. These plants are used to quickly fill in and cover the bare soil after construction.

EG	DT	NWN	Height from Ground	Scientific Name	Common Name	Planting Zone	Size/Spacing	Exposure	Design Comments	O&M Code	Additional O & M Comments
EG	DT		18"-24" (30")	*Carex testacea (or dipsacea)*	Orange New Zealand (or Autumn Sedge)	1,2,3	4" Pot/18" o.c..	☼,∅		C	Will gently reseed; could remove when other plantings infill.
	DT		<24"	*Crocus spp.*	Crocus	3,4	Bulb groups of 10	☼,∅			Fall and spring blooming species
		NWN	<24"	*Dicentra formosa 'Bacchanal'*	Bleeding Heart	1,2	4" Pot/ 12" o.c..	∅		E	Spring to summer blooming. Will go dormant if dry in summer. May naturalize
	DT		24" (24-48")	*Oenothera lindheimeri*	Gaura v.	2,3	1 Quart / 24"o.c.	☼,∅	Herbaceous perennial blooms all summer, pollinator but can be short lived	E	
SEMI			<24"	*Iberis amara*	Rocket candytuft	3,4	6-Pack Plugs or 4" pot/ 12" o.c..	☼			Annual
SEMI	DT		<24"	*Iberis sempervirens*	Candytuft	3,4	6-Pack Plugs or 4" pot/ 12" o.c..	☼,∅		E	
	DT		<24"	*Narcissus 'Dutch Master' or 'King Alfred'*	Daffodil	3,4	Bulb/ As Shown	∅	Plant in fall	DS	Cut back foliage in summer.
EG	DT	NWN	<24"	*Sedum oreganum*	Stonecrop	2,3,4,5	4" Pot/ 12" o.c..	☼	Tolerates hot dry sites.	E	
			<24"	*Tropaeolum majus 'Alaska Mix'*	Nasturtium	3,4	Seeds or 6-Pack Plugs/ 12" o.c..	☼,∅	Plant in spring after frost or September, for summer flowering	E	Annual, Blooms summer to fall.
			<24"	*Viola x wittrockiana*	Winter Pansy	3,4	4" Pot/ 12" o.c..	☼,∅	Plant in fall	E	Annual

Vertical Shrubs & Accent Plant List

Guidance Statement: Generally single accent plant however unless noted no more than 3 accent plants in a group to preserve sight lines. Generally not on street side of cell. Prefer large sizes to start.

EG	DT	NWN	Height from Ground	Scientific Name	Common Name	Planting Zone	Size/Spacing	Exposure	Design Comments	O&M Code	Additional O & M Comments
	DR	NWN	25'	*Amelanchier alnifolia*	Service Berry	1,2	Multi-stem, B&B, 5'-6' ht.	∅	Single use , Multi-stems are common.	E	May need windowing/ thinning.
			5'	*Cornus sanguinea 'Midwinter Fire'*	Midwinter Fire Dogwood	1,2,3	5 Gal.	☼,∅	Single use , Multi-stems are common.	E	Prune 2/3 of all (older) branches to 8" above ground in March to keep in bounds & to maintain yellow twigs.
		NWN	6' to 8'	*Cornus sericea 'Flaviramea'*	Yellow-Twig Dogwood	1,2,3	5 Gal.	∅	Single use , Multi-stems are common.	E	Prune 2/3 of all (older) branches to 8" above ground in March to keep in bounds & to maintain red twigs.
	DR	NWN	4'-12"	*Corylus cornuta v. californica*	Beaked Hazelnut	3,4	5 Gal.	☼,∅			
			10'	*Hamamelis x intermedia 'Pallida'*	Witch Hazel	3	10 Gal.	☼,∅	Vase-shaped open growing form, not on street side of swale	E	Prune to keep narrow form
			5'	*Hydrangea quercifolia 'Pee Wee'*	Oak-Leaf Hydrangea	3	5 Gal.	∅	Late summer flowers. Fall color. Bold leaves in winter.	E	OA., May need windowing/ thinning. Branches break easily
EG			3'-4'	*Ilex glabra 'Shamrock'*	Inkberry	1,2	5 Gal. .	☼,∅		E	Female plants need a male pollinator to produce berries.
			3'-12'	*Ilex verticillata & cultivated varieties*	Winterberry	1,2	5 Gal. .	☼,∅		E	Female plants need a male pollinator to produce berries.
EG	DR		8' - 12'	*Mahonia 'Arthur Menzies'*	Ornamental Mahonia	3	5 Gal.	☼,∅	Upright multi-stemmed. Plant only in wider plantings strips	E	Prune to keep narrow form and under 6 feet
EG	DR	NWN	6'-10'	*Mahonia aquifolium*	Oregon grape	3	5 Gal.	☼,∅	Single plant, upright multi-stemmed. Plant on sidewalk side only	E	Prune to keep 4 feet narrow form and under 8 feet
EG			5'	*Osmanthus 'Goshiki'*	Variegated Osmanthus	3	5 Gal.	∅	4' wide. Considered dwarf. New foliage is colorful.	E	May need windowing/ thinning.
			6'	*Physocarpus opulifolius 'Nanus'*	Dwarf Ninebark	1,2	5 Gal.	☼,∅	Single - even dwarf form may be tall & wide.	E	May need windowing/ thinning.
EG			4'	*Pieris japonica 'Little Heath'*	Little Heath Lily of the Valley	3	3 Gal. .	∅	Variegated foliage that emerges pink in spring. Flowers in winter	E	May need windowing/ thinning.
	DR	NWN	8'	*Ribes sanguineum & cultivated varieties*	Red Flowering Currant	3	5 Gal.	∅	Attracts hummingbirds	E	Can spread may need windowing/ thinning.
EG	DR	NWN	6'-20'	*Rhododendron macrophyllum*	Pacific Rhody	3,4	5 Gal.	∅	Provide space for mature growth and surround with understory		Will need pruning for tree form
			15'-20'	*Salix integra 'Hakuro Nishiki'*	Dappled Willow	1,2	5 Gal. .	☼,∅	Single	E	Specify tree form; Prune to ground every other year to keep smaller
			8'-15'	*Sambucus nigra 'Gerda'*	Black Beauty Black Elder	1,2	5 Gal. .	☼,∅	Single plant on sidewalk side of cell; may be suitable in walled lined planter depending on depth of soil	E	
	DT	NWN	6'	*Symphoricarpos albus*	Snowberry	1,2	5 Gal.	☼,∅	Forms thickets.	E	May need windowing/ thinning.
			6'	*Taxodium distichum 'Peve Minaret'*	Dwarf bald cypress	1,2,3	5 Gal.	☼,∅		E	
EG	DR	NWN	6'	*Vaccinium ovatum*	Evergreen Huckleberry	1,2,3	5 Gal.	∅		E	Prune to keep 6 foot height
			6'	*Vaccinium 'Sunshine Blue'*	Blueberry	3	5 Gal.	☼,∅	Self-pollinating edible fruits. Good fall color.	E	
EG			10'	*Viburnum cinnamomifolium*	Cinnamon Viburnum	3	10 Gal.	☼,∅	Single, plant on sidewalk side of cell only	E	May need windowing/ thinning.
		NWN	7'-12'	*Viburnum edule*	Highbush cranberry	1,2	5 Gal. .	☼,∅	Single	E	

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King County Department of Natural Resources and Parks Wastewater Treatment Division — Seattle Public Utilities — MIG — SvR — Sue Nicol — Osmosis Designs

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Groundcover Plant List (if Low Profile is Required)

Guidance Statement: Do not mix groundcovers - plant in groups of 9 to 12 minimum to provide clarity for maintenance.

EG	DT	NWN	Height from Ground	Scientific Name	Common Name	Planting Zone	Size/Spacing	Exposure	Design Comments	O&M Code	Additional O & M Comments
EG	DT		<24"	*Ajuga reptens*	Bugleweed	3,4	4" Pot/ 12" o.c..	☼,∅		E	Can be pulled if grows beyond desired boundaries.
EG	DT		<24"	*Epimedium rubrum* or *sulphurescens* or *cultivars*	Barrenwort	3,4	4" Pot/ 12" o.c.. 1 Gal. / 24" o.c.	∅		B	Cut back foliage before flower stalks appear.
EG	DT		<24"	*Euonymus fortunei 'Kewensis'*	Wintercreeper euonymous	3,4	1 Gal. / 18" o.c.	☼,∅		E	Can be pulled out or mowed to keep low.
EG	DT	NWN	<12"	*Fragaria chiloensis*	Native Strawberry	See Comments		☼,∅	Fragaria is cautiously included in this list however it requires a large >12' wide area or commitment to controlling because it has been too aggressive in the planting strip bioretention cell conditions.		If planted then observe edges and prune frequently if exceeding boundaries; if problem then remove
SEMI	DT		<24"	*Geranium macrorrhizum 'Album'* or other cultivars	Hardy Geranium	3,4	1 Gal. ./ 18" o.c..	☼,∅		B	
	DT	NWN	<24"	*Maianthemum dilatatum*	False Lily of the Valley	1,2,3,4	4" Pot/ 12" o.c..	∅	Note tendency to spread	E	OA: Remove dead foliage in fall.
EG	DT		<24"	*Pachysandra terminalis*	Japanese Spurge	3,4	4" Pot/ 12" o.c..	∅		C	
EG	DT		<24"	*Sibbaldiopsis tridentata (=Potentilla tridentata)*	Three-toothed Cinquefoil	3,4	4" Pot/ 12" o.c..	∅		E	
EG	DT		<24"	*Rubus tricolor*	Creeping Chinese Bramble	3,4	4" Pot/ 12" o.c..	∅	Tolerates deep shade. Not as aggressive or spiny as other Rubus groundcovers. Red fuzzy stems & shiny leaves.	E	
EG	DT	NWN	<24"	*Sedum divergens*	Stonecrop	3,4	4" Pot/ 12" o.c..	☼,∅	Tolerates hot dry sites.	E	OA: For neater appearance deadhead.
EG	DT		<24"	*Sedum requieni*	Miniature Stonecrop	3,4,5	4" Pot/ 12" o.c..	☼,∅	Tolerates hot dry sites.	E	
	DT	NWN	<24"	*Vancouveria hexandra*	Inside Out Flower	3,4	4" Pot/ 12" o.c..	∅		E	
SEMI			<24"	*Potentilla neumanniana 'Nana'*	Dwarf cinquefoil	3,4,5	4" Pot/ 12" o.c..	☼,∅		E	
EG			<24"	*Ophiopogon japonicus 'Nanus'*	Dwarf mondo grass	3,4,5	4" Pot/ 15" o.c..	☼,∅		E	

Steppable Plants

Guidance Statement: The following are plants that can tolerate some foot traffic.

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SEMI			<24"	*Potentilla neumanniana 'Nana'*	Dwarf cinquefoil	3,4,5	4" Pot/ 12" o.c..	☼,∅		E	
EG	DT	NWN	<24"	*Sedum oreganum*	Stonecrop	3,4,5	4" Pot/ 12" o.c..	☼	Tolerates hot dry sites.	E	
EG	DT		<24"	*Sedum requieni*	Miniature Stonecrop	3,4,5	4" Pot/ 12" o.c..	☼,∅	Tolerates hot dry sites.	E	
EG	DT		<24"	*Thymus serpyllum 'Elfin'*	Elfin creeping thyme	3,4,5	4" Pot/ 12" o.c..	☼	Place along curb or sidewalk; Could also be used above discharge points to soften exposed pipe. Group in a length of 8 feet along walks.	F	If height is an issue can mow in spring. To fill in bare spotds crews may divide once established.
EG	DT		<24"	*Veronica liwanensis*	Speedwell	3,4,5	4" Pot/ 12" o.c..	∅		E	OA: Cut back for neater appearance.

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Low Nutrient Bioretention Soil Mix Plants, Vertical Accent Shrubs and Trees List *(for bioretention cells with graded side slopes)*

Guidance Statement: The following are plants that can tolerate low nutrient condition (this palette is an early list that should be observed and refined as the new low nutrient soils are used) of the bioretention soil media (little to no compost).

EG	DT	NWN	Height from Ground	Scientific Name	Common Name	Planting Zone	Size/Spacing	Exposure	Design Comments	O&M Code	Additional O & M Comments
Trees and Vertical Accent Shrubs (see also Tree list for Bioretention)											
		NWN	25'	*Acer circinatum*	Vine maple		10 gal	Æ	Vertical shrub, only use in unlined areas; SDOT does not consider a tree		Prune lower branches for 0 to 4 foot clearance
EG			10 TO 15'	*Arbutus unedo*	Strawberry tree		10 gal	☼,Æ	Drought tolerant when established		Prune lower branches as it grows; can take additional branch pruning to tighten
EG	DT		6'-10'	*Arctostaphylos pajaroensis 'Lester Rowndtree*	Lester rowntree manzanita	1,2,3	10 gal	☼	Vertical shrub 8 feet wide; use between cells.		prune lower branches once established to achieve small tree form
EG	DT		H=6'-8' W=10'	*Grevillea victoriae*	Royal grevillea	1.2, 4	5 gal	☼	Use as a single shrub where a tree will not fit or at end of a wide cell. Do not use near intersections or driveways. Do not use in high nutrient BSM.		Grows fast, Will take pruning to keep tighter ; has cluster roots just below surface, dDrought tolerant except does better with monthy soaking in summer
EG	DR	NWN	6'-10'	*Mahonia aquifolium*	Oregon grape	3	3 or 5 Gal.	☼,Æ	Single plant, upright multi-stemmed. Plant 3 feet back, on sidewalk side only	E	Prune to keep 4 feet narrow form and under 8 feet
D	DT	NWN	2'-6'	*Rosa gymnocarpa*	Baldhip (Wood) rose	3	1 Gal./ 24" o.c..	☼,Æ	Tough plant can handle wide range including wet/dry conditions; could mix with Salal in areas where infrequent maintenance; don't use along active areas such as commercial or intense residential.		Has thorns or prickles
	DT	NWN	6'	*Symphoricarpos albus*	Snowberry	1,2	3 Gal.	☼,Æ	Plant maximum of 3 because it forms thickets.	E	Will need windowing/ thinning after 3 to 5 years.
EG		NWN	6' to 13'	*Vaccinium ovatum*	Evergreen Huckleberry	1,2,3	3 or 5 Gal.	☼,Æ	Vertical shrub use one once per cell and on sidewalk side of cell.		May need pruning if leggy after 5 or 6 years
EG	DT		3' to 5'	*Zauschneria californica 'Catalina'*	Catalina California Fuchsia	1,2	3 or 5 Gal.	☼,Æ	Plant on sidewalk side; 3 feet back, year-round interest	E	Mounding habit; prune if spreading onto pavement
Shrubs and Groundcovers											
	DT	NWN	4" to 14"	*Allium acuminatum*	Tapertip onion	2, 3,4	Bulb/ groups of 7	☼,Æ	Drought tolerant once established, prefer sandy loam soil, and prefer soil PH to be slightly acidic. Bulbs should not remain in wet soil for too long	DS	Be aware some people may notice the "onion" smell
EG	DT	NWN	<24"	*Arctostaphylos uva-ursi 'Massachusetts' or 'Pt. Reyes'*	Kinnickinnick	3,4	4" Pots 12"o.c. 1 Gal./ 24" o.c.	☼,Æ	Mix sizes; Plant in groups of 7+, ok to mix with short term plants (see list) for filler weed control until this fills in. Do not mix with grasses and shrubs due to difficult weeding	E	Generally requires wider (+4 feet)planting space to allow spreading
EG			8" to 18"	*Blechnum spicant*	Deer fern	2,3,	Quart - 18" o.c.	Æ	Group minimum of 3 plants		May need to replace some plants if extreme weather
	DT	NWN	30" plus flowers	*Bouteloua curtipendula var. curtipendula*	Sideoats grama	3,4	3'-4' o.c.	☼	Clumping perennial. Suitable for large wide cells, happy in clay, sandy or gravelly soils, on slopes and in extreme drought. Pair with Echinacea & Rudbeckia. Not for standard planting strips	A	cut low - 8-12 " in late winter
Semi	DT		8-18"	*Epimedium x versicolor "sulfureum'*	Bishops Hat Clumping	3, 4	4" Pots 12"o.c. 1 Gal./ 24" o.c.	Æ	perennial, yellow flowers; could test in Zone 2 in low nutrient BSM		
EG	DT	NWN	24"-36"+ can get 5 ft	*Gaultheria shallon*	Salal	3	1 Gal./ 24" o.c. Quart / 18 in o.c.	☼,Æ	Recommend placement only along sidewalk side due to potential height or if along streetside place back 4 feet from face of curb. Note groupings as it will spread and takes time to establish.	E	Salal take 3+ years to get established; if used budget for additional eastablishment weeding. If height appears to be a problem, Salal can be sheared to 12 inches with hedge trimmer.
EG	DT		2' (4'w)	*Grevillea juniperina 'Pink Lady'*	Pink Lady grevillea	2,3,4	1 Gal / 24" o.c.	☼	Plant as feature on slope; slow growing		
	DT	NWN	6" to 1'	*Gymnocarpium dryopteris*	Western Oak Fern	1,2	Quart , 12 " o.c.	Æ	Group plants possibly with low oregon grape and sedums		winter dieback - carefulnot to remove.
EG	DT		3'	*Halimium lasianthum 'Sandling'*	Yellow Rock Rose	3	1 Gal /24" o.c.'	☼	drought/heat tolerant, pollinator, yellow flower, spreading, along sidewalk	E	May see leaf burn in winter but should regrow
EG	DT		<24"	*Liriope muscari*	Lily turf	2, 3	4" pots 12"o.c. Quart 24" o.c.		Place min 24 inches back of curb		If spreading beyond desired area, pull out some plants
EG	DT	NWN	24"	*Mahonia nervosa*	Low/Longleaf Oregon grape	1,2,3	Quart / 18" o.c.	Æ	Group minimum of 5 plants		
EG	DT	NWN	<24"	*Mahonia repens*	Creeping Oregon grape	3,4	1 Quart/ 24" o.c.. 4" pots /12 " o.c.	☼,Æ	Mix sizes; Will not do well in heat exposure or in drying winds	E	Requires water during 3 yr establishment period
				Ophiopogon japonicus	Dwarf Mondo grass	2, 3	4"pots - 8-12 o.c.	Æ	Plant along pavement and edge of narrow cells		
EG	DT	NWN	<24"	*Sedum oreganum*	Stonecrop	2,3,4,5	4" Pot/ 12" o.c.	☼	spread 12 to 23", Soil PH Neutral or Alkakine or Acid. Grows in range of soil incl. sandy or clay soil	E	
	DT		<24"	*Sedum -tall*	Dynomite, Frosted Fire,	3,4,5	4" Pot/ 18" o.c.		use as accent; group minimum of 5	DS	expect winter dieback
EG	DT		<24"	*Thymus serpyllum 'Elfin'*	Elfin creeping thyme	3,4,5	4" Pot/ 12" o.c.	☼	Place along curb or sidewalk; Could also be used above discharge points to soften exposed pipe. Group in a length of 8 feet along walks.	F	If height is an issue can mow in spring. To fill in bare spotds crews may divide once established.

Abbreviations/Legend/O&M Code

Abbreviations/Legend
EG = Evergreen
SEMI = Semi-Evergreen
DT = Drought Tolerant
DR = Drought Resistant
NWN = Northwest Natives or cultivars
UF = Urban Frontage (Mixed Use/Commercial) appropriate plants
☼ = Full Sun
Æ = Part Sun/ Part Shade
OA = Optional Attention

O&M Code
A = Cut back these perennials to 4- 6" above ground in Fall (October/November)
B = Leave foliage and seedheads for winter interest/provide food for birds and cut back if foliage collapses. Cut back in spring (Mid-January to Mid-March) before new growth emerges.
C = Hand-rake in spring (Mid-January to Mid-March) before new growth emerges. Cut back to ground or thin every 2-3 years as needed.
DS = Deadhead perennials or remove faded foliage in spring/summer to encourage reblooming/ new leaves and for neater appearance. Deadheading not required for function.
DF = Deadhead perennials in fall for neater appearance and to prevent re-sowing. Deadheading not required for function.
E = Cut back or prune of over sidewalk or clear zones. Remove deadwood anytime fall to spring.
F = May need replacing every 5+/- years. (Replacement not required if vegetation coverage meets requirements)
G = May need dividing every few years. Reasons for division include dieback in center and to increase coverage.

Tree Lists for Bioretention in the Right-of-Way

Issued: August 2018 / Updated February 2020

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Conifers (Deciduous & Evergreen)

Guidance Statement: Plant larger sizes in order to be able to limb them up to 36" minimum clearance.

General O&M Statement: Prune up yearly until sight clearance achieved.

Scientific & Common Name	Mature Urban Height	Spread	Under Wires?	Min Strip Width	Planting Zone	Fall Color	SDOT List	Design Comments
Calocedrus decurrens, Incense Cedar	75	15	No	8	3			
Metasequoia glyptostroboides Dawn Redwood	50	25	No	6	1,2,3	Yes		Fast growing deciduous conifer.
Pinus contorta contorta Shore Pine	45	30	No	5	1,2,3			
Taxodium distichum Bald Cypress	55	35	No	8	1,2,3	Yes		A deciduous conifer, broadly spreading when mature – columnar when young.
Taxodium distichum 'Mickelson' Shawnee Brave Bald Cypress	55	20	No	6	1,2,3	Yes	x	Deciduous conifer - tolerates city conditions
Thuja plicata 'Excelsa' or 'Hogan' Western Red Cedar	40	15-20	No	8	1,2,3			Narrow columnar form.

Medium/Large Broad-Leaved Evergreen Trees

Guidance Statement: Ornamental in appearance, provides year-round function.

General O&M Statement: Prune up yearly until sight clearance achieved.

Scientific & Common Name	Mature Height	Spread	Under Wires?	Min Strip Width	Planting Zone	Fall Color	SDOT List	Design Comments
Lithocarpus densiflorus Tanoak	50	20	No	6	3			
Quercus Ilex Holly Oak	40	30	No	5	3	N/A	x	Underside of leaf is silvery-white. Often has a prominent umbrella form. Prune for form.
Umbellularia californica Oregon Myrtlewood	60	30	No	5	1,2,3			Drought tolerant native in S. OR.

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Large Deciduous Columnar Trees

***Guidance Statement:** Use columnar trees only in areas that have restricted space or near wires.*

Scientific & Common Name	Mature Height	Spread	Under Wires?	Min Strip Width	Planting Zone	Fall Color	SDOT List	Design Comments
Acer nigrum 'Green Column' Green Column Black Sugar Maple	50	10	No	6	3	Yes	x	
Ginko biloba 'Princeton Sentry' Princeton Sentry Ginkgo	40	15	No	6	3	Yes	x	Prune for form
Quercus robur 'fastigiata' Skyrocket Oak	40	15	No	6	3	N/A	x	

Large Deciduous Trees

Guidance Statement: Broad canopy trees provide greater stormwater function and increased shade.

Scientific & Common Name	Mature Height	Spread	Under Wires?	Min Strip Width	Planting Zone	Fall Color	SDOT List	Design Comments
Acer saccharum 'Commemoration' or 'Bonnfire' Commemoration or Bonfire Sugar Maple	50	35	No	6	1,2,3	Yes	x	Resistant to leaf tatter.
Fagus sylvatica Green Beech	50	40	No	6	3	Yes	x	Silvery-grey bark. Can't handle root disturbance.
Fagus sylvatica 'Asplenifolia' Fernleaf Beech	60	50	No	6	3	Yes	x	Can't handle root disturbance.
Ginkgo biloba 'Magyar' Magyar Ginkgo	50	25	No	6	3	Yes	x	More upright and narrow than 'Autumn Gold'. Needs training when young.
Liriodendron tulipifera Tulip Tree	60+	30	No	8	1,2,3	Yes	x	Fast-growing tree.
Platanus x acerifolia 'Bloodgood' Bloodgood London Planetree	50+	40	No	8	1,2,3	N/A	x	More anthracnose resistant than other varieties – large tree that needs space.
Quercus bicolor Swamp White Oak	60	45	No	8	1,2,3	N/A	x	Shaggy peeling bark. Wet-soil tolerant.
Quercus coccinea Scarlet Oak	60	40	No	6	3	Yes	x	Good fall color
Quercus imbricaria Shingle Oak	60	50	No	6	3	N/A	x	Leaves can persist throughout the winter
Quercus rubra Red Oak	60	45	No	8	1,2,3	Yes	x	Fast growing oak – large tree that needs space. Heavy acorn producer.
Tilia tomentosa Silver Linden	60	50	No	6	3	Yes		Larger leaves than Littleleaf Linden. Fragrant flowers.
Ulmus 'Frontier' or 'Morton Glossy' Frontier or Triumph Elm	50	35	No	6	1,2,3	Yes	x	Resistant to Dutch elm disease
Zelkova serrata 'Greenvase' or 'Village Green' Green Vase or Village Green Zelkova	45	40	No	6	3	Yes	x	Exfoliating bark. Dark green leaves turn orange-red and purple in Fall.

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Medium / Large Deciduous Trees

Guidance Statement: Broad canopy trees provide greater stormwater function and increased shade.

Scientific & Common Name	Mature Height	Spread	Under Wires?	Min Strip Width	Planting Zone	Fall Color	SDOT List	Design Comments
Acer campestre 'Evelyn' Queen Elizabeth Hedge Maple	40	30	No	5	1,2,3	Yes	x	More upright branching than the species.
Acer freemanii 'Autumn Blaze' Autumn Blaze Maple	50	40	No	6	1,2,3	Yes	x	Cross between red and silver maple – fast growing with good fall color
Acer rubrum 'Scarsen' Scarlet Sentinel Maple	40	25	No	6	1,2,3	Yes	x	Leaves are darker green and larger than those of other Red Maples and hold up well in summer heat. Upright branch habit.
Aesculus x carnea 'Briottii' Red Horsechestnut	30	35	No	6	3	N/A	x	Do not use near greenways or bicycle routes due to litter. Resists heat and drought better than other horsechestnuts
Betula nigra River Birch	40	30	No	5	1,2,3	Yes		Excellent flaky bark. Resistant to Bronze Birch Borer
Cercidiphyllum japonicum Katsura tree	45	40	No	8	1,2,3	Yes		
Eucommia ulmoides Hardy Rubber Tree	50	40	No	6	3	N/A	x	Dark green, very shiny leaves – insignificant fall color
Fagus sylvatica 'Rohanii' Purple Oak Leaf Beech	50	30	No	6	3	N/A	x	Purple leaves with wavy margins.
Ginko biloba 'Autumn Gold' Autumn Gold Ginkgo	45	35	No	6	3	Yes	x	Narrow when young.
Nothofagus antarctica Antarctic Beech	50	35	No	5	3	No	x	Rugged twisted branching and petite foliage.
Quercus frainetto Italian Oak	50	30	No	6	3	N/A	X	Drought resistant – green, glossy leaves in summer.
Sophora japonica 'Regent' Japanese Pagodatree	45	40	No	6	3	Yes	x	Has a rapid growth rate and tolerates city conditions, heat, and drought.
Tilia cordata 'Greenspire' Greenspire Linden	40	30	No	6	3	Yes	x	Symmetrical, pyramidal form. Fragrant flowers.
Ulmus parvifolia 'Emer II' Allee Elm	45	35	No	5	1,2,3	Yes	x	Exfoliating bark and good fall color – Resistant to Dutch Elm Disease

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Medium Columnar Deciduous Trees

Guidance Statement: ***Use columnar trees only in areas that have very restricted space or near wires.***

Scientific & Common Name	Mature Height	Spread	Under Wires?	Min Strip Width	Planting Zone	Fall Color	SDOT List	Design Comments
Acer rubrum 'Bowhall' Bowhall Maple	40	20	No	6	1,2,3	Yes	x	Upright, pyramidal form
Carpinus betulus 'Fastigiata' Pyramidal European Hornbeam	40	15	No	5	1,2,3	Yes	x	Broadens when older.
Fagus sylvatica 'Dawyck Purple' Dawyck Purple Beech	40	12	No	6	3	Yes	x	Purple foliage.
Oxydendron arboreum Sourwood	35	12	No	5	3	Yes	x	Consistent and brilliant fall color.
Nyssa sylvatica Tupelo	40	20	No	6	1,2,3	Yes	X	Chunky bark. Takes standing water and drought.

Medium Deciduous Trees

Guidance Statement: ***Use medium deciduous trees where large trees cannot fit or to increase species variety.***

Scientific & Common Name	Mature Height	Spread	Under Wires?	Min Strip Width	Planting Zone	Fall Color	SDOT List	Design Comments
Acer rubrum 'Karpick' Karpick Maple	40	20	No	6	1,2,3	Yes	x	Finer texture than other narrow forms of columnar maple.
Acer truncatum x A. platanoides 'Keithsform' or 'Warrenred' Norwegian or Pacific Sunset Maple	35	25	No	5	3	Yes	x	Reliable reddish orange fall color.
Cladrastis kentukea Yellowwood	40	40	No	5	3	Yes	x	White flowers in spring, resembling wisteria flower – blooms profusely only every 2 to 4 years – yellow/gold fall color
Cornus controversa 'June Snow' Giant Dogwood	40	30	No	5	3	Yes	x	Frothy, 6-inch clusters of white flowers in June
Corylus colurna Turkish Filbert	40	25	No	5	3	Yes	x	Tight, formal, dense crown. Nice central leader. Not for mixed use areas with high ped traffic due to significant debris from nuts. Drought tolerant. Plant smaller sizes in order to facilitate establishment.
Magnolia denudata Yulan Magnolia	40	40	No	5	3	N/A	x	6" inch fragrant white flowers in spring.
Ostrya virginiana Ironwood	40	25	No	5	3	Yes	x	Hop like fruit – slow growing
Pterostyrax hispida Fragrant Epaulette Tree	40	30	No	5	3	Yes	x	Pendulous creamy white flowers – fragrant
Ulmus parvifolia 'Emer I' Athena Classic Elm	30	35	No	5	1,2,3	Yes	x	High resistance to Dutch Elm Disease. Drought resistant. Cinnamon colored exfoliating bark.

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Small Conifer /Broad-Leaved Evergreen Trees

Guidance Statement: Ornamental in appearance, provides year-round function.

General O&M Statement: Prune up yearly for sight clearance.

Scientific & Common Name	Mature Height	Spread	Under Wires?	Min Strip Width	Planting Zone	Fall Color	SDOT List	Design Comments
Chamaecyparis obtusa gracilis Slender Hinoki False Cypress	15	6	Yes	5	3			Drought tolerant when established.
Embothrium coccineum Chilean Flame Tree	30	15	No	5	3			Brilliant orange red flowers in late spring. Tree can sucker.
Eucryphia glutinosa Brushbush	25	15	Yes	5	3			Semi-evergreen. Best in part shade.
Magnolia grandiflora 'Edith Bogue' Edith Bogue Magnolia	18	12	Yes	5	1,2,3			Excellent BLE magnolia due to hardiness.
Magnolia grandiflora 'Victoria' Victoria Evergreen Magnolia	25	20	Yes	5	1,2,3	N/A	x	
Magnolia maudiae (=Michelia maudiae) NCN	25	20	Yes	5	3			
Magnolia virginiana Sweetbay	35	35		5	1,2,3		x	
Quercus hypoleucoides Silverleaf Oak	30	15	No	5	3			
Quercus myrsinifolia Chinese Evergreen Oak	30	15	No	5	3			

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- This tree list has been adapted from the SDOT Street Tree List, with trees added and removed for conditions of bioretention.
- Tree size at planting shall be project specific. Intent is to be 1½" caliper when possible.
- The trees have been reviewed and approved by SDOT Urban Forestry and Landscape Architecture, SPU GSI O&M, SPU/SDOT ITD, KCWTD Water Quality and O&M staff.
- This plant list was developed to provide consistency in the right of way for installation and long term operations and maintenance.
- No plants on the current King County Noxious Weed List, the WA Noxious Weed Control Board List and the WA Dept. of Ag. Prohibited Plant List are to be used.
- Designers should review each neighborhood for tree species diversity and select species to provide variety.
- See GSI Manual Vol III. Design, Section 7, GSI Planting Design.

Planting Zone Code - See Planting Zone Diagram, GSI Manual Vol. III, Section 7

Zone 1 plants are typically tolerant of both wet and dry conditions. Zone 1 plants are typically used for filtration and water quality in the bottoms of the bioretention facilities. Some trees are able to be viable in this zone.

Zone 2 plants are located in the lower slopes / wetted or ponded side area of the bioretention facilities. Zone 2 plants are also typically used for water quality/ filtration.

Zone 3 includes plant species (30 inch mature height) appropriate for planting at the upper slopes of the of bioretention areas. Zone 3 may include limited vertical accent plants and trees.

Zone 4 plants (under 24") are used in sight clearance areas or as accents at the edge of the facility.

Zone 5 is the designation for plants used in the crossing zones and access areas along the curb. Trees in this zone shall be planted when there is enough room for both the access and the tree.

Small Deciduous Trees

***Guidance Statement:** Use small trees only in areas that have restricted space, under wires or possibly if room as a large accent shrub. Try to select a species that would add variety to the streetscape.*

Scientific & Common Name	Mature Height	Spread	Under Wires?	Min Strip Width	Planting Zone	Fall Color	SDOT List	Design Comments
Acer buegerianum Trident Maple	30	30	Yes	5	3	Yes	x	Must train to a single stem – interesting bark.
Acer circinatum Vine Maple	25	25	Yes	5	3	Yes	x	Avoid using on harsh sites - native tree.
Acer griseum Paperbark Maple	30	20	Yes	5	3	Yes	x	Peeling cinnamon colored bark.
Acer tartaricum Tartarian Maple	20	20	Yes	5	3	Yes		
Acer triflorum Three-Flower Maple	25	20	Yes	5	3	Yes	x	Multi seasonal interest with tan, exfoliating bark and red, orange/red fall color.
Amelanchier laevis 'Snowcloud' Snowcloud Serviceberry	25	15	Yes	4	3	Yes		
Asimina triloba Paw Paw	30	20	Yes	5	1,2,3	N/A	x	Burgundy flower in spring before leaves.
Betula nigra 'Little King' Little King River Birch	10	12	Yes	5	1,2,3	Yes		Suitable for enclosed vertical walls
Carpinus caroliniana American Hornbeam	25	20	Yes	5	1,2,3	Yes	x	Good fall color (variable – yellow, orange, red)
Cornus kousa x nuttallii 'Starlight' Starlight Dogwood	20	20	Yes	4	3	Yes		
Lagerstroemia 'tuscarora' Tuscarora Hybrid Crape Myrtle	20	20	Yes	4	3	Yes	x	Light cinnamon brown bark lends year round interest – drought resistant – likes a warm site
Maackia amurensis Amur Maackia	30	20	Yes	5	3	N/A	x	Exfoliating bark – flowering in June or July - varies in intensity from year to year
Magnolia 'Elizabeth' Elizabeth Magnolia	30	20	Yes	5	3	N/A	x	Yellowish to cream colored flower in spring.
Magnolia 'Galaxy' Galaxy Magnolia	25	25	Yes	5	1,2,3	Yes	x	Suitable for enclosed vertical walls. Showy pink flowers.
Magnolia kobus 'Wada's Memory' Wada's Memory Magnolia'	30	20	Yes	5	3	Yes	x	Drought tolerant. Does not flower well when young.
Malus 'Lancelot' ('Lanzam') Lancelot Crabapple	15	15	Yes	4	3	Yes	x	Red flower buds, blooming white – red persistent fruit
Parrotia persica Persian Parrotia	30	20	No	5	3	Yes		Blooms before it leafs out – drought tolerant - Varied fall color - reds, oranges and yellows.
Rhamnus purshiana Cascara	30	20	Yes	5	1,2,3	Yes	x	Suitable for enclosed vertical walls
Salix matsudana 'Tortuosa' Corkscrew willow	30	15	Yes	5	1,2,3	Yes		Do not use with underdrain.
Stewartia pseudocamellia Japanese Stewartia	25	15	Yes	5	3	Yes		Camellia-like flowers in summer. Interesting bark. Slow grower.
Styrax japonica Japanese Snowbell	25	25	Yes	5	3	Yes	x	Reliable and easy to grow, it has plentiful, green ½ in. seeds. Flowers similar to lily in the valley.
Tilia cordata 'Chancole' or 'De Groot' Chancellor or De Groot Littleleaf Linden	30+	20	No	C=6, D=5	3	Yes	x	Pyramidal when young. Fragrant flowers that attract bees. One of the smaller stature littleleaf lindens.

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SAMPLE document

Agency name

VEGETATION MANAGEMENT PLAN

Project Location – Project Name
Agency Project # if applicable

Date xx-xx-xxxx Revision xx-xx-xxxx

Suggest insert photo of site or location map

[Note to Users of this SAMPLE document: This is a template for developing a Vegetation Management Plan to document the project's approach for managing aggressive/invasive vegetation near a bioretention cell asset both prior to construction and into operations and maintenance. This document is intended to explain the why, how, when, who for managing the vegetation. This document was prepared by MIG|SvR under the SPU/WTD GSI program management contract in 2019. Contact SPU GSI Program Manager for editable document in Microsoft Office Word. Project designers shall tailor this document for their project's specific site conditions.]

Prepared for:
name
Project Manager
Agency
address

Seattle, WA 981xx-xxxx

Prime Company name
Address

Sub Company name

Contact: name

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LIST OF TABLES

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1.0 PROJECT OVERVIEW

1.1 Summary

This Vegetation Management Plan is prepared xxxx
Incl reference to reports such as geotech, ECA, wetlands, arboreal, archaeological, wetland, cultural etc.

The project site is located on xxxxxx (parcel number xxxxxx) and consists of approximately xx acres that were previously used as xxxxxx. The site is currently xxxxx

Planned improvements include: xxxxxxx

The project mitigation plan (if applicable) will help to meet some of the goals of this Vegetation Management Plan (see Section 2 for VMP goals). The Conceptual Mitigation Plan will guide the future development of the mitigation plan, as well as a plan drawing (sheet xx) outlining proposed mitigation area. The Vegetation Management Plan will concentrate on the areas and activities not covered by the mitigation plan, focusing on anticipated project construction areas (outlined within the "Approximate Project Vegetation Management Boundary" in Figure #1), including construction impacts (clearing, revegetation), xxxxx and future maintenance for these and adjacent areas.

Geotechnical considerations (as applicable) for the proposed project plans, including in particular recommendations for grading materials and methods and work in erosion hazard, landslide hazard, and steep slope hazard areas (as defined insert xxxx agency code ref) are addressed in the Technical Memorandum prepared for the project by name /agency/ company, dated xxxxxx.

1.2 Existing Vegetation

The existing vegetation types generally follow the xxxxxxxxxxxxxxxx
Figure xx (in the Appendix) documents the existing vegetation and Table xx.x lists the existing plant species observed by xxxxxxxxxxx, xxxxxx, and/or xxxxxx. Dominant native species and occurrence of noxious weeds are noted by area.

The site (Areas xx, xx, and xx) consists of xxxxx. These areas are dominated by (*fill in* such as western red cedar, alder, black cottonwood, salmonberry, horsetail, red osier dogwood, slough sedge, ivy, blackberry etc)., refer to xxx Technical Memorandum for more information.

Table 1.a – Existing Vegetation

The table (EXAMPLE) below lists the existing on-site vegetation by area with Dominant Vegetation denoted with an X and invasive species with Limited Presence denoted with an L.
The list is based on xxxxx site visit, and xxxxx report and xxxx site visits. Additional species may be present on site.

Legend	
X= Dominant Vegetation	Non-native invasive weed
L= Limited Presence Invasive	Ornamental plant not invasive

Scientific Name	Common Name	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
Acer circinatum	vine maple	X		X				X		X	X		
Acer macrophyllum	bigleaf maple				X		X	X		X	X		X
Adiantum pedatum	northern maidenhair fern												
Alnus rubra	red alder	X	X	X	X			X		X	X	X	X
Athyrium cyclosorum	western lady fern												
Buddleja davidii	butterfly bush											X	
Carex deweyana	Dewey sedge												
Carex obnupta	slough sedge		X										
Cornus sericea	red osier dogwood	X		X									
Corylus cornuta	beaked hazelnut			X									
Cotoneaster	cotoneaster								X				
Culluna vulgaris	heather								X				
Cupressus x leylandii	Leyland cypress												
Equisetum arvense	common horsetail	X										X	
Equisetum telmateia	giant horsetail	X											
Gaultheria shallon	salal												
Geranium robertianum	herb-Robert				L		L						
Hedera helix	English ivy			L	X			X		L			L
Ilex aquifolium	holly	L											L
Impatiens noli-tangere	touch-me-not balsam			L									
Iris pseudoacorus	yellow flag iris (confirm)	L	L										
Juncus effusus	soft rush												
Lamium galeobdolon	yellow archangel				L								
Lonicera involucrata	twinberry												
Lysichiton americanum	skunk cabbage			X									

Scientific Name	Common Name	A1	A2	A3	A4	A5	A6	A7	A8	A9	A10	A11	A12
Mahonia nervosa	low oregon grape				X			X		X	X		X
Oemleria cerasiformis	Indian plum or osoberry							X		X	X		
Oplopanax horridus	devil's club												
Phalaris arundinacea	reed canary grass												
Picea sitchensis	Sitka spruce												
Polypdium glycyrrhiza	licorice fern										X		X
Polystichum munitum	sword fern				X	X	X	X		X	X	X	X
Populas balsamifera	cottonwood	X											
Prunus laurocerasus	English laurel					L							
Pseudotsuga menziesii	Douglas fir						X						
Pteridium aquilinum	bracken fern												
Ranunculus repens	creeping buttercup	X	X	L	X	X	L	X		X	X		
Rhamnus purshiana	cascara			X									
Rhododendron	rhododendron								X				
Ribes lacustre (bracteosum)	prickly currant												
Rubus armeniacus	Himalayan blackberry	X	L	L		L	L				L	X	L
Rubus laciniatus	cut-leaf blackberry												L
Rubus parviflorus	thimbleberry												
Rubus spectabilis	salmonberry	X	X	X						X	X		
Rubus ursinus	trailing blackberry				X					X	X		
Salix spp.	willow												
Sambucus racemosa	red elderberry												
Sequoiadendron giganteum	giant sequoia												
Symphoricarpos albus	common snowberry												
Tolmiea menziesii	piggy back plant		X	X							X		
Thuja plicata	Western red cedar	X	X	X	X	X	X	X	X	X	X		X
Tsuga heterophylla	Western hemlock				X								
Vaccinium parvifolium	red huckleberry										X		
Vinca minor	vinca				L								

2.0 GOALS AND OBJECTIVES EXAMPLE

2.1 Wildlife habitat protection and enhancement

1. Remove extensive monocultures of noxious weeds to allow opportunities for regrowth of native species to enhance habitat. See Sections 3 & 4.

2. Provide snags and large woody debris to enhance habitat.
See Section 4.

3. Retain duff and woody debris on site. See Section 4.

2.2 Water quality protection and enhancement

1. Remove extensive monocultures of noxious weeds to allow infiltration of stormwater and improve water quality. See Sections 3 & 4.

2. Maintain or restore site soils to prevent erosion and maintain or improve soil moisture capacity. See Section 4.

2.3 Protecting the public health and safety from geologic hazards and erosion

1. Stabilize slopes during construction, maintenance and noxious weed removal. See Sections 3 & 4.

2. Remove hazard trees near sidewalks, structures, streets, roads, trails, parking etc.
See Section 5.

2.4 Maintaining or improving hydrologic conditions

1. Restore and maintain site vegetation in conjunction with permitted drainage improvements to match or mimic existing hydrologic conditions (forested). See Section 6.

3.0 NOXIOUS WEED MANAGEMENT

3.1 Existing Noxious Weeds EXAMPLE

Table 3.a, below, lists existing noxious identified on the site, locations observed, weed class (per King County- update per current year and confirm if Seattle specific adds) and control requirements.

Table 3.a – Existing Noxious Weeds

Scientific Name	Common Name	Location Dominant*	Location Limited Presence*	King County Class	Control
Buddleja davidii	butterfly bush	A11		B	Recommended
Geranium robertianum	herb-robert		**A4, A7**	B	Recommended
Hedera helix	English ivy	**A4, A7**	A3, A9, A12	C	Strongly Recommended
Ilex aquifolium	holly		**A1**, A12	None	Recommended
Impatiens capensis (noli-tangere)	touch-me-not balsam		A3	None	Recommended
Iris pseudoacorus	yellow flag iris (confirm)		**A1, A2**	C	Recommended
Lamium galeobdolon	yellow archangel		**A4**	B	Recommended
Phalaris arundinacea	reed canary grass	**A1**	**A5**	C	Recommended
Prunus laurocerasus	English laurel		**A5**	None	Recommended
Ranunculus repens	creeping buttercup	**A1, A2, A4, A5, A7**, A9, A10	A3, A6	None	Recommended
Rubus armeniacus	Himalayan blackberry	**A1**, A11	**A2**, A3, **A5**, A6, A10, A12	C	Recommended
Rubus laciniatus	cut-leaf blackberry		A12	C	Recommended
Vinca minor	vinca		**A4**	None	Recommended

* See Figure #1 for location key. Locations shown in **BOLD** include areas within the Approximate Project Vegetation Management Boundary and/or Mitigation Areas. These areas include A1, A2, A4, A5, A7, and A8.

3.2 Noxious Weed Control EXAMPLE

There are multiple noxious weeds species on-site as noted above in Table 3.a. King

County defines three classes of noxious weeds, of which only Class A legally requires removal/control by the property owner. The classes are defined by King County as follows (King County, 2017- UPDATE WITH CURRENT):

- Class A Weeds: Non-native species whose distribution in Washington is still limited. Preventing new infestations and eradicating existing infestations are the highest priority. *Eradication of all Class A plants is required by law throughout Washington.*
- Class B Weeds: Non-native species presently limited to portions of Washington. Species are designated for control in regions where they are not yet widespread. Preventing new infestations in these areas is a high priority. In regions where a Class B species is already abundant, control is decided at the local level, with containment as the primary goal.
- Class C Weeds: Noxious weeds that are typically widespread in Washington or are of special interest to the state's agricultural industry. The Class C status allows counties to require control if locally desired or to choose to provide education or technical consultation.

(insert as applicable ….None, or a few or several) of the weeds identified on the project site are listed as Class A, and thus none or xxx require removal, but all are recommended for removal and/or control, particularly in natural environments. Controlling weeds means not letting weeds reproduce. Usually, that means not letting them go to seed. "Legally, control means *to prevent the dispersal of all propagating parts capable of forming a new plant*." (King County, 2017) The King County noxious weed web site lists control methods.

If feasible, projects should take advantage of the site clearing and grading operations and combine removal of invasives/weeds in large areas with the construction project or removals prior to construction. Follow up removals should occur at least 2x during construction. Clearing smaller areas may be effective if they are contiguous with other work and performed yearly.

Refer to King County Noxious Weed List for removal methods.

http://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/laws/list.aspx

Noxious weed removal should focus on areas impacted by proposed project, including the area identified as Project Vegetation Management Area in Figure #1 of this VMP, as well as areas identified for mitigation planting or other mitigation or critical areas measures as identified in xxxxxx Report. These are the areas generally referred to below as the "site". Weed control and removal beyond these areas would include that related to regular maintenance of areas as legally required (e.g. Class A weeds) or deemed necessary by the project manager or Asset Manager. The following is recommended in prioritizing weed removal:

A. Mitigation Areas

See the mitigation plan for description of invasive weed removal in mitigation areas. If feasible, remove additional infestation in project or critical areas adjacent to (within xx feet of) the mitigation and replant as noted in the adjacent mitigation area.

(insert area description, phot and specific issues as applicable)

B. Landslide and Steep Slope Areas Requiring Stabilization

There is currently an infestation of xxxxxxxxxxxxxxxx

After removal place a biodegradable erosion control blanket such as GreenC125BN (2 yr) or C700BN (4 yr) per manufacturer's recommendations. Pocket plant by cutting a cross in the fabric. Replant the area with plants noted on the plant replacement list (Table 4.a EXAMPLE).

If resources are limited remove and replant smaller areas in a sequenced or phased approach starting at the top of the slope and working downhill. If small areas (under 8 foot wide linear strip) are removed an erosion control blanket should not be required. Apply concentrated xxx check current recommendations, per King County Noxious Weed List Website.

Care should be taken when using herbicides as the water flows into a wetland at the base of the hill. Follow BMP's and obtain required permits when using herbicides.

Plant using a benching technique (see Section 4 for recommended plants for revegetation). Monitor areas for seedling repopulation for 3 to 5 years after removal. Dispose of all plant materials off site. Review King County noxious weed site for additional information.

Insert photos as applicable

C. *Hedera helix* (English Ivy) Areas

Removal of *Hedera helix* (English ivy) Remove from trees first, then ground areas, starting in the areas of limited presence within the site, and within or adjacent to mitigation areas. English ivy control and removal will require a moderate but sustained effort. A heavy mulch layer (particularly with an underlayment of cardboard, e.g. sheet mulching) after removal on the ground can be effective in combating its spread. See additional guidance on English ivy removal from King County at http://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/weed-identification/english-ivy.aspx.

Hedera helix (English ivy) *spreading in forest area*

D. Areas with Limited Presence (L)

Remove weeds from areas with limited weed/invasive presence to avoid having to deal with many different plant species and large land areas. Many of the invasive plants have seeds that can stay viable for several years. Removing the small patches will minimize a large seed base and plants spreading to other areas. See Table 3.a above for plants and areas to target first. If possible, document the removal on a map and return each year to review if the plants have been fully removed for a 3 to 5 years after the removal

Lamium galeobdolon (yellow archangel)

E. Areas with a Dominant Presence (X)

The future Cougar Squak Corridor Trailhead and Parking Lot mitigation plan (to be developed) will address the removal of dominant invasive weeds from critical areas and mitigation areas. EXAMPLE The *Ranunculus repens* (creeping buttercup) is quite prevalent throughout the site due to all the disturbed old campsite areas. The seeds are viable for more than 20 years so complete removal is nearly impossible. The plant depletes potassium in the soils. Remove, dispose, improve soil nutrient and replant as much of the area(s) as feasible. If removing manually be sure to remove the entire plant, including roots. When replanting choose taller, fast-growing shrubs from the mitigation plan or if in the steep slope areas choose from the plant replacement list (Table 4.a). This will provide for a more diverse habitat even if the *Ranunculus repens* is still present.

3.3 Review for New Invasive Weeds

Approximately every 3 years the entire site should be reviewed for invasive plants. Seeds travel by wind, water, mammals, insects and birds from the surrounding areas. Also, occasionally a native species can act invasive and completely dominate an area, limiting habitat diversity. Review mitigation goals and adjust maintenance practices as needed. Watch for slides and eroded areas – these bare earth areas are prime sites for colonization by invasive weeds. This review can help inform maintenance practices on for the site, and can help control spread of invasive plants into or out of the Project Vegetation Management Area, Mitigation Areas, Critical Areas, and other areas of the site.

4.0 VEGETATION REPLACEMENT & WOODY DEBRIS

4.1 Vegetation Clearing & Soil Management

Re-development of the site will require some amount of vegetation removal, as well as soil management. This section contains recommendations for proceeding with these topics.

Further development of project plans should include development of a tree, soil and vegetation protection plan. This plan should identify areas of soil and vegetation to be protected, trees to be preserved, and should provide guidance on how to protect these resources, as well as working around the identified trees and protection zones.

Existing vegetation should be cleared only in designated work areas, and as required for noxious weed removal or mitigation plantings. Noxious weed materials should be removed and disposed of off-site in an approved facility. Project designers should review whether the project construction areas have viable native plants for salvaging, and plan for doing so if feasible. Woody native materials or non-invasive trees may also be chipped on site and the wood chips used as mulch in restoration and erosion control areas.

Soil materials (forest duff and topsoil) should be preserved and re-used on site, *except* in cases where they had supported significant amounts of noxious weeds. Soils in the project area with any amount of English ivy roots or other parts, reed canary grass, or likely seed accumulation from other noxious weeds, should be left in the original location and treated per the noxious weed removal guidelines, or removed from the site and disposed of at an approved facility. Other topsoil and duff in the project area should be protected from compaction. It may be stockpiled during construction activities replaced at depths to be recommended by project designers.

Any soils or subgrade materials exposed during construction should be covered and protected from erosion per regulatory requirements and accepted best management practices.

See general guidelines at Seattle's website
xxxxx

See general guidelines at King County's website - http://www.kingcounty.gov/depts/permitting-environmental-review/info/SpecialInterest/ConstructionIndustry/ErosionControl/ErosionControlBMPs.aspx. More specific information on these practices is given in the King County Surface Water Design Manual, Appendix D – Construction Stormwater Pollution Prevention Standards. If using seeding, straw, or other organic materials as part of temporary erosion control measures, take care to ensure that these measures do not introduce unwanted (weedy) species to the site (e.g. species from temporary erosion control seed mixes that become difficult to remove).

Imported planting soil, and/or compost may be necessary to supplement preserved site topsoils in areas to be revegetated. If this is the case, imported compost and soil materials should be certified as weed free, and should be blended into native materials to better mimic the natural soil profiles of the site.

See the Geotechnical Technical Memorandum or Report for recommendations on soil management and preparation in landslide hazard, erosion hazard and steep slope hazard areas.

4.2 Plant Replacement - General

Plants selected for use in revegetation areas should be native species suitable to the site conditions. Avoid aggressive native species that are likely to form a monoculture. One starting point for plant selection may be King County's Native Plant Guide website, which can be found at https://green2.kingcounty.gov/gonative/index.aspx. A qualified professional should help select and plan the plantings as development designs progress.

If necessary, climatically-adapted and non-invasive species (e.g. drought and cold tolerant, non-spreading) may be used near developed areas of the site (e.g. if there are not appropriate native species).

Plants should be selected and located for reduced maintenance needs, as well as ability to establish and thrive in the site conditions, and contribute to site diversity and habitat value. Lastly, plants should be selected to help stabilize slopes and prevent erosion where necessary – by developing robust root systems, leaf and branch structures that help intercept rainfall, and providing year-round benefits.

4.3 Plant Replacement for Steep Slope Areas

Plant replacement will be required as part of site development, after noxious weed removal, and for slope stabilization. Refer to the mitigation plan for plant replacement within mitigation areas. Plant selection for general site areas impacted by site development is addressed in the previous section.

Table 4.a below lists some specific species that are recommended for use in revegetating steep slope and trail edge areas. Species listed for landslide or other steep areas are native species that can tolerate poorer soils and more exposed sites, and should develop robust root structures. Species listed for trail edges are native species that will stay lower in height and not encroach as readily on trails as many larger native species.

Table 4.a – Plant Replacement List for Steep Slope and Edge Areas EXAMPLE

Common Name	Scientific Name	Spacing	Size*
Landslide Area or Other Steep Areas Away From Trail Edge			
vine maple	*Acer circinatum*	10' O.C.	1 gallon or bareroot
Indian plum or osoberry	*Oemleria cerasiformis*	4' O.C.	1 gallon
salmonberry	*Rubus spectabilis*	4' O.C.	1 gallon or bareroot plant
red elderberry	*Sambucus racemosa*	4' O.C.	1 gallon or bareroot
common snowberry	*Symphoricarpos albus*	2' O.C.	1 gallon or bareroot
Project or Sidewalk Edges – Within 3' to 5' from Edge			
sword fern	*Polystichum munitum*	2' O.C.	1 gallon
trailing blackberry	*Rubus ursinus*	2' O.C.	1 gallon or bareroot
trailing snowberry	*Symphoricarpos mollis*	2' O.C.	1 gallon or bareroot
false lily of the valley	*Maianthemum dilatatum*	18" O.C.	4 inch pot
fringe cup	*Tellima grandiflora*	18" O.C.	4 inch pot, or plug
redwood sorrel	*Oxalis oregana*	18" O.C.	4 inch pot

*Plants available bare root are an option for fall or winter planting

4.4 Woody Debris and Snags

Construction on the site will require tree removal. If timber harvesting is not occurring the trees can be used as mulch, woody debris and snags.

Bury woody debris a minimum of a 1/3 the diameter and burying the snags a minimum of a third of the height. Snags should be a maximum of 10 feet above ground. Locate the snags at least 12 feet from the edge of the sidewalk. Plants can be added behind the log edge so the soil is stabilized after the logs degrade.

5.0 HAZARD TREES

5.1 Hazard Tree Review and Removal

Consult with an ISA-certified arborist do an assessment (review agency hazard tree requirements) of the tree health within approximately 50 feet of project area. The review should identify and include trees that may be infected by root rot, especially Douglas fir.

This can help identify trees that are, or may become hazardous near expected use areas, which could be flagged for pruning, snagging or removal during construction, even if not directly impacted by construction activities.

The proposed site plan should be reviewed prior to grading submittal for impacts to existing trees. Modify layout and grading plans and adjust tree removal plans as necessary, based on balance or site development needs and regulations versus tree preservation priorities. Sometimes additional trees can be preserved at little to no cost, or at additional project expense (such as through reducing grading extents by adding rockery/walls etc).

Review site conditions following construction for impacts that may require additional removal. Thereafter review trees on a regular time frame in accordance with agency routine maintenance requirements. As feasible, review and removal should occur during the dry months so that damage to soils will be minimized.

6.0 HYDROLOGIC CONDITIONS

6.1 Existing Hydrology

Insert xxx
The proposed project improvements will maintain, change , alter the existing hydrologic condition (e.g. forested) through use of a xxxxxx, and/or other drainage features to be approved by permitting agencies.

6.2 Drainage-Related Site and Vegetation Maintenance

During maintenance operations remove any blockages that develop at the ends of the culverts, drainage structures, or other drainage infrastructure to ensure drainage is free flowing. Review the site for signs of erosion and stabilize areas that have bare earth.

Vegetation and soils maintenance operations related to drainage conditions may also include slope mowing or weeding, dry and wet ditch cleaning, repair and replacement of damaged culverts, etc. Maintenance personnel should follow agency approved practices and BMPs, and requirements established by any other regulatory agencies, including Army Corps of Engineers, as part of the permitting and site development process. For example, see those outlined in the 20xx King County Surface Water Design Manual, Appendix A - Maintenance Requirements for Flow Control, Conveyance and Water Quality Facilities.

7.0 MONITORING

7.1 Annual Review and Documentation

Recommend that a basic annual review of the site is conducted during normal maintenance activities. Document approximate quantities, locations, and species of noxious weeds removed and methods of removal. Include review of specific plant replacement areas and keep a general log of revegetation plantings and mortality rate. Since every site is a little different, keeping a log of the effectiveness of each maintenance activity will help ensure the goals of this plan are met, as well as ensuring the most ecologically- and economically-effective noxious weed control/removal and revegetation practices are being used.

8.0 REFERENCES UPDATE

King County. May 2017. Noxious Weed Lists and Laws. http://www.kingcounty.gov/services/environment/animals-and-plants/noxious-weeds/laws.aspx (accessed June 28, 2017)

King County. Oct 2014. King County Noxious Weed Control Program. Best Management Practices. www.kingcounty.gov/weeds.

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ADD reports, memos etc

9.0 APPENDIX

9.1 Figure 1 – Existing Vegetation Areas

Appendix H: GSI Modeling Methods

- Green Stormwater Infrastructure Modeling Methods, March 2020

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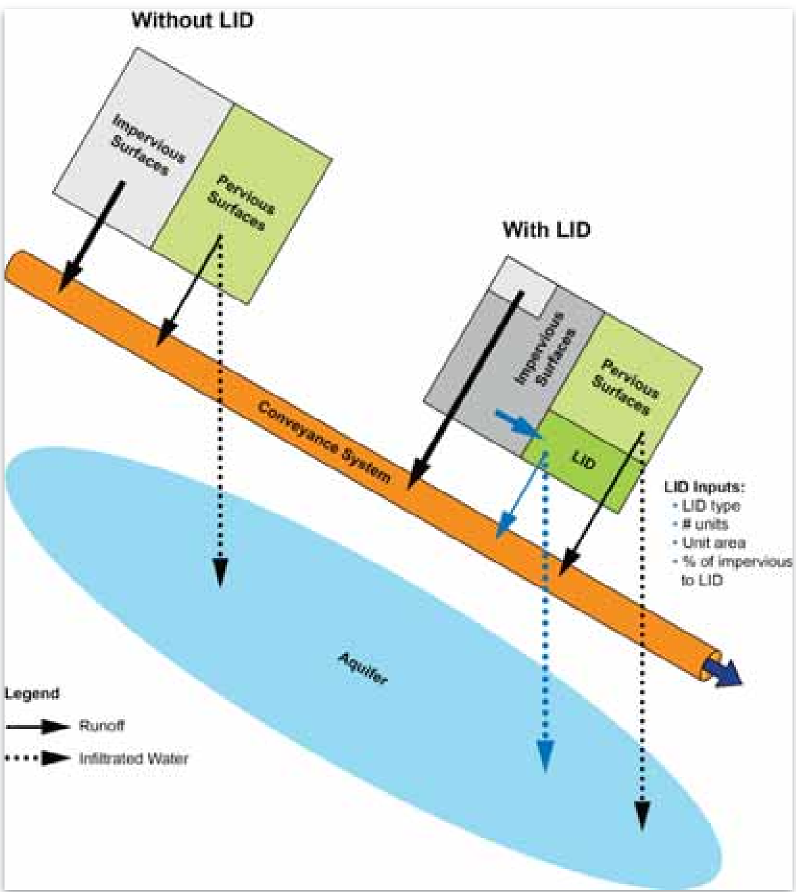
Green Stormwater Infrastructure Modeling Methods

Updated March 2020



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List of Abbreviations

Term	Definition
BLDG	Building
BMP	best management practice
C	parcel catchment
CAD	computer-assisted design
CIP	capital improvement plan
CSO	combined sewer overflow
CV	control volume
DS&G	[Seattle Public Utilities] *Design Standards and Guidelines*
EPA	Environmental Protection Agency
GIS	geographical information system
GSI	green stormwater infrastructure
H/H	hydraulic/hydrology
HSPF	Hydrological Simulation Program-Fortran
KC	King County
LID	low impact development
LTCP	long-term control plan
MH	maintenance hole
DHI MOUSE	MOdel for Urban SEwers
QA	quality assurance
QC	quality control
ROW	right-of-way
SPU	Seattle Public Utilities
SWMM5	Stormwater Management Model version 5
UD	underdrain
UIC	underground injection control
WTD	King County Wastewater Treatment Division

Section 1

Overview of Green Stormwater Infrastructure Modeling

1.1 Overview

Green Stormwater Infrastructure (GSI) features stormwater infrastructure that is designed to reduce runoff and pollutants using natural processes such as infiltration and evapotranspiration. This document provides guidelines for hydraulic and hydrologic (H/H) modeling of GSI for Seattle Public Utilities (SPU) and King County (KC) Wastewater Treatment Division (WTD) capital projects (i.e. projects in the right-of-way). This document focuses on the GSI practice of retrofitting bioretention facilities into the City's right-of-way (ROW) with some guidance on the lesser used permeable pavement. As such, where GSI is referenced in this document it is in regard to both permeable pavement and bioretention facilities in the City's right-of-way, unless otherwise noted. GSI models are used to help inform the Project Initiation, Options Analysis or Problem Definition, and Design Phases following SPU and WTD's Gate processes. This document supplements, and mirrors the structure of, SPU's *Design Standards and Guidelines* (DS&G; 2012), Chapter 7, Drainage and Wastewater System Modeling. In general, the DS&G applies to SPU projects. Projects delivered for WTD might require following additional guidelines. DS&G Chapter 7 is referenced herein for non-GSI-specific content to avoid redundancy. **[GAP]** *WTD to provide guidance.*

These guidelines describe steps to:

- Develop a GSI modeling plan
- Obtain and modify an existing calibrated combined sewer model to include GSI solutions
- Develop a new model (for some WTD combined sewer basins and separated systems elsewhere in the city)
- Analyze scenarios and optimize designs to meet target performance

See Figures 1-1 and 1-2 for an overview of the GSI modeling procedures for the Project Initiation, Options Analysis/Problem Definition, and Design phases.

Any references to gaps (e.g., due to current model limitations) are in *italics* and preceded by "**[GAP]**". These will be addressed after a project has worked through a design and then it is determined by the SPU & WTD GSI program to add it in a future update of this document. For non-GSI related modeling protocols for WTD, refer to the KC WTD Hydraulic Modeling and Monitoring Protocols, Model History, Appendix B, of KC's 2012 Long-Term CSO Control Plan

Amendment (dated October 2012). For projects on private parcels and not in the public right-of-way and/or for other GIS practices, please refer to the City of Seattle Stormwater Manual (City of Seattle 2016).

The recommended modeling procedures and goals vary, depending on current planning or design phase, lead agency (WTD or SPU), and system type (combined sewer or separated system). The Phase of a project dictates the level of detail necessary for modeling and the tools required.

- The Project Initiation Phase of a project is intended to determine the extent of a problem and to estimate the extent to which GSI could potentially address that need.
- The Options Analysis/Problem Definition Phase is intended to identify alternatives. These are narrowed down to a recommended project solution, which is then demonstrated through the business case. Therefore, GSI modeling must be able to analyze the range of options, evaluate the performance against objectives, establish the basis of sizing for practices to be considered in evaluating feasibility of GSI and developing concept design, and establish the basis of sizing for design (e.g., manage 95% average annual volume from the contributing area).
- In the Design Phase, GSI modeling is intended to establish the sizing requirements and estimate the performance of the project toward meeting regulatory goals.

1.2 Goals

Each agency's goals for GSI are dictated by its service areas, business needs, and regulatory commitments. For WTD projects, the goals for GSI are limited to combined sewer system basins (CSS) to help reduce combined sewer overflows (CSO) and maximize what Best Management Practices (BMPs) can be cost-effectively implemented in the basin for CSO control. Modeling for WTD projects is generally aimed at assuring that GSI is designed to function and to provide cost-effective reduction of CSO. CSO reduction and overall GSI benefits should be monitored post-construction to evaluate the performance before supplementing with gray infrastructure solutions.

For SPU projects within the combined sewer system, SPU intends to design and model GSI to meet a basin-wide objective for CSO reduction. SPU also may implement GSI in separated systems, for which several objectives may be targeted, including, but not limited to, peak flow reduction, duration-exceedance matching for creek protection, annual volume reduction, and water quality improvement. See Section 2 for a more detailed description of performance goals for GSI.

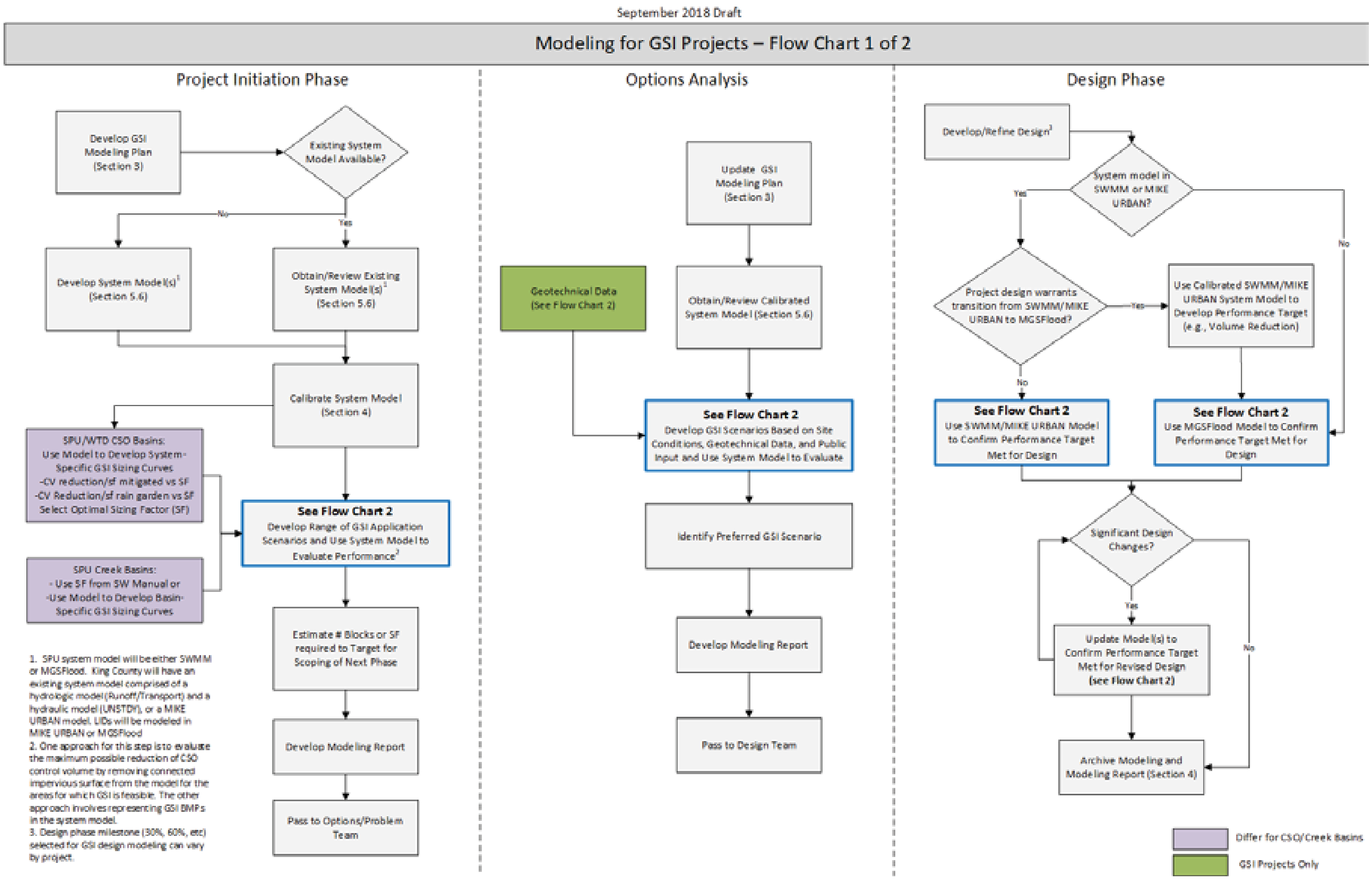


Figure 1-1. Flowchart for GSI Modeling for the Project Initiation, Options Analysis/Problem Definition, and Design Phases

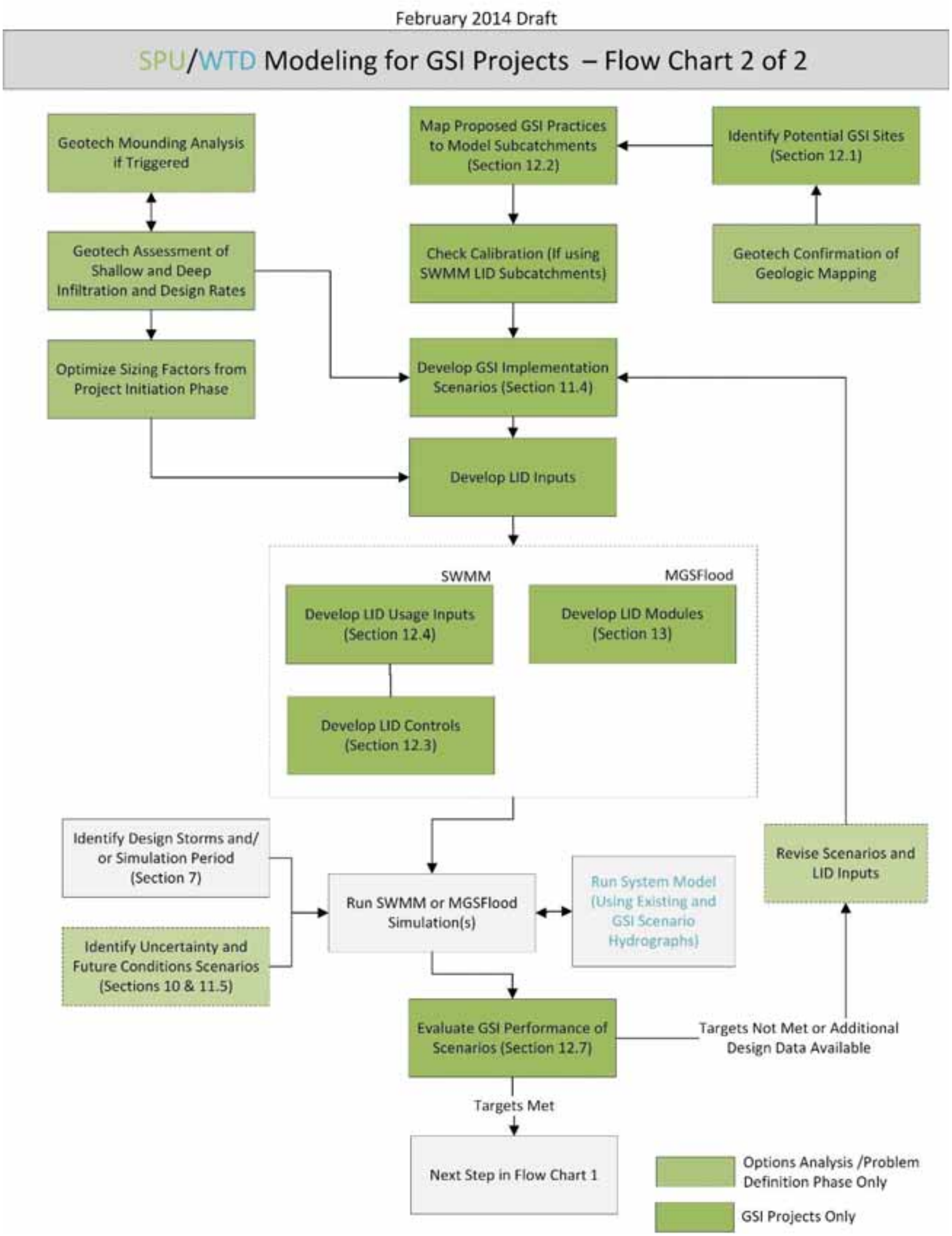


FIGURE 1-2. FLOWCHART FOR GSI MODEL CONSTRUCTION

Section 2
General Information

Section 2 covers general information for H/H modeling for GSI projects.

2.1 Modeling Concepts

GSI projects that use bioretention are small and distributed stormwater management practices to control flow into drainage or combined sewer systems. The modeling methods and procedures for these types of GSI projects can vary from those of traditional drainage and sewer projects because:

- GSI projects are comprised of numerous bioretention facilities distributed across a basin, rather than centralized facilities (such as storage facilities)
- Modeling approaches must be able to simulate natural physical processes (e.g., filtration, infiltration)

The subsections below discuss the performance goals for various system types. The performance goals provide important context for the modeling goals.

2.1.1 Combined Sewer System Performance Goals

The goals for SPU GSI projects within CSS with CSOs may vary, depending on the level of CSO control provided by other related projects. SPU's long-term control plan (LTCP) lays out the following strategies (listed in order of priority):

- **fix** - retrofit existing systems.
- **reduce** - implement GSI to reduce flows to the system, or
- **store** - implement gray infrastructure project to store overflows.

GSI goals may vary based on the selected strategy and the extent to which retrofits and storage projects can meet the regulatory compliance targets. Table 2-1 summarizes each GSI performance target corresponding to the LTCP solution.

Table 2-1. SPU GSI Performance Targets for Long-Term Control Plan Solutions

LTCP Solution	GSI Performance Target
• Retrofit solution (gray infrastructure) can meet permit compliance, but not under climate change scenarios	• Maximize reduction in CSO control volume (one overflow per year calculated on 20-year average) with both climate change and retrofit model

Table 2-1. SPU GSI Performance Targets for Long-Term Control Plan Solutions

LTCP Solution	GSI Performance Target
	• Maximize reduction in total average annual flow to the downstream system
• No retrofit solution (gray infrastructure), or retrofit cannot meet permit compliance under existing conditions	• Maximize reduction in CSO control volume reduction (one overflow per year calculated on a 20-year average) without climate change but with retrofit model

For WTD projects, the goals for GSI performance within CSO basins are to maximize control volume reduction. WTD modeling standard is to run the long-term average and the maximum twenty-year average with and without a climate change. Volume reduction targets and project sizing decisions are made as part of the gate 2 process..

2.1.2 Separated System Performance Goals

Goals for separated systems vary by project, depending on the program, business need, and receiving water body. The goals may include the following:

- **Water quality improvement** – This goal largely applies to projects associated with SPU's Integrated Plan. Water quality performance goals typically will treat (e.g., flow through bioretention soils) or infiltrate 72% to 91% of the average annual runoff volume.
- **Peak flow reduction –** Separated systems that discharge to traditional piped conveyance systems or to creek watersheds with potential flooding issues will be required to reduce peaks to the extent feasible.
- **Duration-exceedance matching –** Projects that discharge to urban creeks will be required to provide duration-exceedance matching to protect against channel erosion.
- **Volume reduction –** This goal is to reduce average annual discharge volume.

2.1.3 Creek Basin System Performance Goals

Goals for projects that discharge to creek basins vary by receiving creek (Listed or Non-Listed), existing and future land use, and project specific goals. The performance goals for creek basins are similar to separated system basins.

2.2 Modeling Platforms

Modeling platform selection will vary on size and scope of project and several factors must be considered to choose the appropriate modeling platform. Modeling platform selection is discussed in detail below.

2.2.1 Model Structure and Scale

Three model scales, each with its own structure, are described below and illustrated in Figure 2-1. The model structure and scale for evaluating the performance of GSI alternatives should be selected based on the project's phase, available resources (e.g., existing models, monitoring data), and level of detail sought in the analysis.

Trunk/Hydrograph Model Skeletal Model Detailed Model

Figure 2-1. Example Model Structures and Scales

Trunk/Hydrograph Models. These consist primarily of a main trunk conveyance system with hydrology input as hydrographs at load points in the system, i.e., WTD's system-wide model. Such models can be useful for performing high-level analysis of GSI's potential to reduce CSOs and peak flows in the system. GSI is evaluated by manipulating the inflow hydrographs to represent the flow reduction due to GSI (e.g., reducing the impervious area to represent disconnection and infiltration of the runoff from those surfaces). This modeling scale is most applicable to the Project Initiation Phase and may be extended into the Options Analysis/Problem Definition Phase.

Skeletal Models (or Lumped Catchment Models). These consist of large subcatchment areas (typically delineated by flow monitoring points) and connecting conveyance systems. WTD basin models developed in the MIKE URBAN platform are typically constructed at this level of detail. GSI is simulated either through hydrograph manipulation or by routing flow through GSI facilities in the model software's low impact development [LID] modules. Skeletal models are typically appropriate for Project Initiation and Options Analysis/Problem Definition Phases, and, in some cases, Design Phase.

Detailed System Models. These consist of the entire collection network (typically above a specified pipe size, e.g., 8 inches) and high-resolution subcatchments. SPU's combined sewer models have been constructed at this scale. GSI is simulated by routing flow through GSI facilities in the model software's LID modules. This scale offers the greatest precision for simulated GSI based on site-specific locations and enables evaluation of performance and impacts at several locations within the system. Detailed system models may require significant computational resources and extended simulation run times for some levels of analysis. This scale is appropriate for Options Analysis/Problem Definition and Design Phases of projects. Where existing models are available, these may be used for the Project Initiation Phase.

2.2.2 H/H Modeling Software

2.2.2.1 SWMM5

The Environmental Protection Agency's (EPA's) Stormwater Management Model version 5 (SWMM5) is a public domain software that requires no licensing and can be downloaded from the EPA website. Current versions of the program (including version 5.1.012) include LID controls that allow specific modeling of GSI facilities. Computational Hydraulic Institute's (CHI) PCSWMM software represents a useful shell interface to edit SWMM5 parameters. This is currently the standard platform for all SPU basin wide modeling.

2.2.2.2 MGSFlood

MGSFlood developed by MGS Engineering (MGS) is a continuous rainfall-runoff computer model developed for the Washington State Department of Transportation specifically for stormwater facility design in Western Washington. The program uses the Hydrological Simulation Program-Fortran (HSPF) routine for computing runoff from rainfall. GSI facilities can be explicitly modeled as stand-alone practices and in series. In addition to recurrence interval flows, MGSFlood develops flow duration curves for evaluation of compliance with creek protection standards.

2.2.2.3 MIKE URBAN with DHI MOUSE H/H Engine

The MOUSE (MOdel for Urban SEwers) model (within the MIKE URBAN shell) is proprietary software produced by DHI. MOUSE has a rainfall-runoff module for modeling basin hydrology and a hydraulic module for modeling the sewer network. The 2016 version of MIKE URBAN introduced the ability to model BMPs and LIDs. This is the standard platform for all WTD modeling and joint SPU/WTD modeling (e.g. Ship Canal Water Quality Project).

2.2.2.4 Model Selection

SPU and WTD have agency specific standards for recommended modeling software depending on the basin type and project phase. The modeling software standards are summarized in Table 2-2.

Table 2-2. Model Selection by Project Phase

Agency	Basin Type	Phase		
		Project Initiation	Options Analysis/ Problem Definition	Design
SPU	CSO	SWMM5	SWMM5 or MIKE URBAN	SWMM5 or MGSFlood or MIKE URBAN

Table 2-2. Model Selection by Project Phase

Agency	Basin Type	Phase		
		Project Initiation	**Options Analysis/ Problem Definition**	**Design**
	Separated	SWMM5	SWMM5	SWMM5 or MGSFlood
		MGSFlood	MGSFlood	MGSFlood
WTD[1]	CSO	MIKE URBAN	MIKE URBAN	MIKE URBAN

[1]In some instances, WTD modeling may be supplemented by SPU SWMM5 model due to higher hydraulic resolution in those models than are typically found in WTD MIKE URBAN models

Seattle Public Utilities (SPU)

SPU requires the EPA SWMM5 version 5.1.012 (or current version) modeling software platform for modeling CSO basins. Proprietary software such as PCSWMM that uses the EPA SWMM5 engine may be used if the software can export the entire model back into EPA SWMM5 model format and can be run in the EPA SWMM5 version 5.1.012 (or current version) graphical user interface without the need to rely on the proprietary software to view and run the model.

SWMM5 basin models have been developed for all CSS basins within the City of Seattle, including those areas that are tributary to WTD CSO outfalls. These models should be used for the Project Initiation and Options Analysis Phases, including any necessary GSI modeling. There is more flexibility for model selection during the GSI Design Phase for CSS basins and for all phases of separated system GSI projects. GSI Model limitations should be considered when selecting appropriate platform as one software may be better suited to accommodate proposed design details than another.

King County Wastewater Treatment Division (WTD)

WTD uses a fully dynamic hydraulic model called UNSTDY to simulate the entire sewer system network flowing to West Point Treatment Plant and the various CSO outfalls. Over 400 basins contribute sanitary sewer and stormwater flows to the West Point system. Inflow hydrographs for UNSTDY were generated with the “Runoff/Transport” hydrologic model and with other models. As part of the 2012 CSO Control Program Review, King County updated the UNSTDY model, incorporated updates to some of the Runoff/Transport model basins, and replaced some portions of both models with inflows from KC models using DHI MOUSE and from SPU models. WTD has made significant progress in the past few years in developing CSS basin models complete with hydrology, hydraulics, and controls in MIKE URBAN. As such, MIKE URBAN is used for most CSS analysis.

In 2016, DHI introduced the ability to model BMPs and LIDs in MIKE URBAN.

[GAP] *This section should be refined after WTD completes a project using the BMP and LID module in MIKE URBAN*. The on-going University GSI project is a likely candidate.

2.2.2.5 Model Selection and Transitioning Between Models

Either SWMM5 or MGSFlood can be used for Seattle's separated basins and for CSO basins in the Design Phase. Table 2-3 lists benefits of each model to aid in model selection.

Table 2-3. Model Benefits

Model	Benefits
EPA SWMM5	• Represents complex flow routing (important for larger, piped basins) • CSS basins will have existing conditions model already developed and calibrated for Project Initiation and Options Analysis/Problem Definition Phases • Ability to evaluate basin level impacts (i.e. the impact of GSI on CSO control)
MGSFlood	• Easier to represent GSI function accurately o Bioretention cells in series connected by pipes o Bioretention facilities with underdrains o Bioretention infiltration on earthen side slopes • Easier to evaluate performance relative to flow duration standards (typically applicable to separated creek basins)

In some cases, it will be prudent to transition from a SWMM5 model developed to support the Project Initiation and Options Analysis/Problem Definition Phases to an MGSFlood model to support the Design Phase of a project. MGSFlood might be selected for the Design Phase when the project aims to meet a duration control standard or the designer wishes to more accurately represent certain practices (often called BMPs) or practice configurations (see Table 2-3).

Transitioning from a SWMM5 model to an MGSFlood model involves the following steps:

- Establish the project performance target using the SWMM5 model. Targets could include metrics such as runoff volume reduction, flow duration control, and/or reduction in the 1-year recurrence interval flow.
- Build the model in MGSFlood. Because the model will be used to design the GSI facilities (not to represent basin-wide performance), the model need only include the land surfaces contributing runoff to the practices. If these surfaces are primarily effective impervious surfaces, calibration of the MGSFlood model is likely unnecessary. If these surfaces include significant pervious areas, the runoff calibration should be checked at this stage (SWMM5 and MGSFlood use different runoff routines for pervious areas).
- Size the practices, overflow, and conveyance system in MGSFlood and demonstrate that the performance target is achieved.

2.3 GSI Practices

GSI practices can be implemented either on private property, typically through the RainWise incentive-based program and/or through code compliance with redevelopment, or within the right-of-way through capital improvement plan (CIP) projects and/or private development street improvements. The guidance described herein is intended for modeling the GSI practice, specifically roadside bioretention, that is typically installed within the right-of-way through a City of Seattle or WTD led CIP project.

2.3.1 Bioretention Practices

Bioretention practices are shallow depressions with a designed soil mix and plants adapted to the local climate and soil moisture conditions. Bioretention cells may be connected in series, with the overflows of upstream cells directed to downstream cells to provide both flow control, treatment, and conveyance. Variations in bioretention cells are described below.

2.3.1.1 Bioretention Geometry

Bioretention practices can be single cells or multiple cells connected in series. Cells may have sloped or vertical walls. When bioretention practices are installed on a slope, intermittent weirs are used to create ponding areas.

2.3.1.2 Underdrains

Underdrains may be installed in an aggregate bed beneath the designed soil mix to improve drainage where the native soils have limited infiltration capacity.

2.3.1.3 Deep Infiltration Techniques

In locations where poorly draining native soils at the surface are underlain by higher permeability soils at depth, an underdrain that discharges to a downstream underground injection control (UIC) well may be used. Similarly, pit drains or drilled drains may be installed within the cell footprint to route infiltrated flows to deeper permeable layers.

2.3.1.4 Non-infiltrating Bioretention

Non-infiltrating bioretention cells are confined in an impermeable reservoir or underlain by an impermeable liner, and must include an underdrain. In the context of CSO basins, these are primarily used for providing water quality treatment prior to discharge to a UIC well or as storage to reduce peak flows to the combined sewer when designed with a flow control orifice.

2.3.2 Permeable Pavement

Permeable pavement is a paving system that allows rainfall to percolate into an underlying soil or aggregate storage reservoir, where stormwater is stored and infiltrated to underlying subgrade or removed by an overflow drainage system. Unlike bioretention, it is less commonly used in the City’s right-of-way (except for new/replaced contiguous sidewalks) and is limited by Code in how much “run-on” from adjacent impervious areas can drain onto the permeable pavement. Because of its limited use, this document does not focus in on the modeling guidance for this GSI practice which is covered in limited detail in Sections 11 and 12. See City of Seattle Stormwater Manual for more guidance on modeling the performance of permeable pavement systems.

Section 3
Basis of Design for Modeling

3.1 Modeling Plan

A modeling plan is critical in establishing the guidelines for the development, calibration, and use for a given model. If an existing model is used, the existing basin modeling documentation must be obtained and reviewed (All SPU basin models have a modeling plan and report, WTD basin models have a *Design Flow Criteria* technical memorandum from modeling that is updated from Problem Definition and through design). Modeling stops at gate 3 and is redone at the end of construction for compliance. A supplemental GSI modeling plan must be prepared to describe the proposed plan for modifying and analyzing the existing model.

The modeling (or supplemental modeling) plan will have, at a minimum, the following sections:

- Project Background
- Study Area
- Goals and Objectives
- Review of Previous Modeling (only applicable if a model exists)
- Proposed GSI
- Other Proposed Gray Infrastructure
- Subcatchment Revisions Impacted by GSIs
- Observed Flow and Rainfall Data to Be Used
- Expected Outcomes and Contingency Plans for Unforeseen Results

See SPU DS&G Appendix A for more details for the Modeling Plan required for SPU projects.

3.2 Quality Assurance Milestones

The quality assurance (QA) milestones that must be incorporated into each SPU project with H/H modeling are shown in Table 3-1. Milestones are considered to have been achieved when a phase is complete.

Table 3-1. GSI H/H Modeling Quality Assurance Milestones

Milestone	Step	Activity
1	GSI supplemental modeling plan	Project team must review; project manager should assign reviewers
2	Model development and construction	The quality assurance check should be completed by an independent senior member of the modeling team.

Table 3-1. GSI H/H Modeling Quality Assurance Milestones

Milestone	Step	Activity
		Consider model archiving, updating, and documentation.
3	Alternative analysis	Reviewed by an independent senior member of the modeling team
4	Model documentation	Reviewed by an independent senior member of the modeling team

Section 4

Model Archiving, Update, and Report

Model archiving, updating, and documentation must all be considered before an H/H model is developed.

4.1 Model Archiving

See DS&G Section 7.4.1.

4.2 Model Update

See DS&G Section 7.4.2.

The only updates to existing models anticipated due to inclusion of GSI are potential revisions to subcatchment delineations. See Section 5.3 and Section 11.1 of these guidelines for further discussion.

4.3 Modeling Report

A modeling report describes the model and the conclusions drawn from its use. The report provides a record to assess the model's suitability for other projects.

H/H modeling work must be documented in a modeling report. Deviations from the modeling plan must be approved by SPU/WTD and documented in the modeling report. At a minimum, the modeling report must include the following sections:

- Model development
- Model validation
- Alternatives analysis
- Conclusions and recommendations

See DS&G Appendix A for more details for the Modeling Report.

Section 5
Model Construction

To evaluate the performance of GSI in combined sewer systems, it is necessary to build GSI modules within an existing system (baseline) model. DS&G Section 7.5 gives guidance on constructing the baseline model for SPU projects, while this section supplements DS&G, providing information on modifying the baseline model so it can be used as a GSI alternatives model. WTD staff often develop baseline models for WTD CSO basins. Specific steps for modeling GSI in H/H software after the baseline model has been prepared for adding GSI features are given in Section 11 (SWMM5), Section 12 (MGSFlood), and Section 13 (MIKE URBAN) of these guidelines.

5.1 Data Sources and Requirements

See DS&G Section 7.5.1 for SPU projects. REFERENCE: King County WTD Hydraulic Modeling and Monitoring Protocols May 2012

5.2 Hydraulic Conveyance System Model Data

See DS&G Section 7.5.2 for SPU projects. REFERENCE: King County WTD Hydraulic Modeling and Monitoring Protocols May 2012

5.3 Hydrologic Model

GSI is intended to reduce the direct contribution of surface runoff (particularly runoff from impervious areas) to the downstream system through a combination of infiltration, evapotranspiration, reuse, storage, and slow release to the piped system. Therefore, modeling of GSI is linked primarily to the impervious surface sub-model of the surface runoff model. In general, system models are required to separate surface runoff into pervious and impervious sub-models. In some cases, the impervious model may be further subdivided into additional runoff surface categories such as buildings and ROW. The GSI modeling plan and DS&G Chapter 7 recommend delineating impervious area to the extent practical to result in 100% connectivity and require documentation where imperviousness is determined to be less than 97%. Figure 7.4 of DS&G Chapter 7 is a flow chart for determining impervious versus pervious areas from geographical information system (GIS) data when delineating runoff surfaces.

The system model may group various runoff surfaces together, resulting in an averaging of the parameters across multiple runoff surface types. The calibrated hydrologic model, including QA/QC, should be reviewed for anomalies.

Where calibrated models are available, the GSI model should use the calibrated values for impervious area. Where a calibrated model or monitoring data for calibration of model inputs are not available, Table 5-1 can be used as a reference to estimate the effective impervious surface area from GIS data or site surveys. Note that scaling factors have a significant impact on the number of bioretention cells that are required, therefore they should be confirmed on a project by project basis. See documents included in attachment dated June 2, 2017 by MIG|SvR to Shanti Colwell, for more background information about the scaling factors in Table 5-1. If assumptions that were used to derive the scaling factors in Table 5-1 differ for a project's subbasin characteristics, then it is recommended that the Project Team adjust accordingly based on engineering judgment.

Table 5-1. Estimating Effective Impervious Surface Area

Surface Type	Area to multiply by Scaling Factor (TIA)	Scaling Factor(s) (%)	Effective Impervious Surface (TIA × Scaling Factor)
ROW – with curb and gutter/Asphalt thickened edge/extruded curb	ROW Impervious Area	95%[1]	Calculated
ROW – Street no curb and gutter	ROW Impervious Area	61%[2]	Calculated
Full Reconstructed Street regardless of street edge condition	ROW Impervious Area	95%[3]	Calculated
Parcel – w/existing IMP surface discharges directly (i.e. connected) to the public drainage system through a pipe or surface channel.	Total Parcel Area draining to PSD	56%[4]	Calculated
Parcel – Existing developed single family lots for determining effective impervious area draining to the ROW based on total lot area (pervious and impervious) and factoring in "unconnected" (sheet flows to ROW)	Total Parcel Area draining to ROW	12%[5]	Calculated

GIS = geographic information system   IMP = impervious   ROW = right-of-way   TIA = total impervious area

[1, 3]This assumption is based on all the flow from the impervious area in the ROW flowing to the street and is effective. If there are discontinuity (e.g. uneven pavement, gaps/cracks between pavement joints that re-direct flow, etc.) then scaling factor should be reduced based on engineering judgment of conditions.
[2]This assumptions was derived from SPU work in looking at basins in Pipers Creek and Broadview (January 15, 2014 SPU email from Dave Jacobs to Tracy Tackett and Scott Struck of Geosyntec).
[4]This assumptions was derivFigure
ed from SPU work in CSO basins for Ballard, NUB, Montlake (January 15, 2014 SPU email from Dave Jacobs to Tracy Tackett and Scott Struck of Geosyntec).

[5]From SPU meeting notes January 27, 2017, 12% scaling factor of total parcel area was derived from earlier SPU work in the CSO basins. Based on City blocks in Barton CSS basin (single family zoning) and other areas (through review of the blocks via GIS and field), the estimate of parcel impervious area (buildings, walks etc.) was 43%. Then of that 43%, it was estimated that 28% of it was effective (i.e. 43% x 28% = 12% of the parcel area = EIA.) The 28% was derived by SPU from looking at Ballard, NUB, Fremont and Pipers Creek Basins (January 15, 2014 SPU email from Dave Jacobs to Tracy Tackett and Scott Struck of Geosyntec).

5.4 Boundary Conditions

See DS&G Section 7.5.4. REFERENCE: King County WTD Hydraulic Modeling and Monitoring Protocols May 2012

5.5 Dry Weather Flow Model Data

See DS&G Section 7.5.5. REFERENCE: King County WTD Hydraulic Modeling and Monitoring Protocols May 2012

5.6 Operational and Observational Data

See DS&G Section 7.5.7. REFERENCE: King County WTD Hydraulic Modeling and Monitoring Protocols May 2012

5.7 Quality Assurance/Quality Control

See DS&G Section 7.5.9 for baseline model QA/QC of SPU projects and supplemental information in Section 11.6 of this guide. REFERENCE: King County WTD Hydraulic Modeling and Monitoring Protocols May 2012

Section 6
Precipitation

Precipitation time series for modeling of GSI facilities will be dependent on project phase, modeling platform, project goal, and agency. Analysis conducted in SWMM5 and MIKE URBAN models should use time series data from SPU and King County rain gauges. For those projects that use MGSFlood, the Seattle 158-year, 5 minutes rainfall time series should be used. Projects that are considering GSI for CSO control should use precipitation data from the rain gauge network.

6.1 Permanent Rain Gauge Network

See DS&G Section 7.7.1. REFERENCE: King County WTD Hydraulic Modeling and Monitoring Protocols May 2012

6.2 Selecting City of Seattle Rain Gauge

See DS&G Section 7.7.2.

6.3 Temporary or Project-Specific Rain Gauges

See DS&G Section 7.7.3.

6.4 Other Sources of Precipitation Data

See DS&G Section 7.7.4.

6.5 Climate Change

[GAP] *Section to be updated once a project is completed that includes climate changes for GSI projects.*

6.6 Design Storms

The City's stormwater code and combined sewer general modeling require use of continuous simulation modeling instead of design storms. Evaluating compliance with the regulatory goals for combined sewer systems requires use of long-term simulations; therefore, these simulations are also required when evaluating GSI facilities. However, it is recognized that the data management and simulation time necessary to run long-term simulations for model iterations (e.g., sizing and scenario analysis) can be cost (or resource) prohibitive. Therefore, it is acceptable to simulate a shorter time series (e.g., 5 years) for iterative modeling procedures and then confirm through a full long-term simulation.

More detailed information on design storm hyetographs and their use can be found in SPU's Stormwater Manual Appendix F.

Section 7
Flow Monitoring

See DS&G Section 7.8 for general flow monitoring guidelines.

REFERENCE: King County WTD Hydraulic Modeling and Monitoring Protocols May 2012

Section 8
Model Calibration and Validation

[GAP] *Section to be updated once a project is completed that conducts model calibration and validation of GSI facilities.*

8.1 Levels of Calibration

See DS&G Section 7.9.1. REFERENCE: King County WTD Hydraulic Modeling and Monitoring Protocols May 2012

8.2 Calibration to Flow Monitoring Data

See DS&G Section 7.9.2.

8.3 Validating a Model Calibration

See DS&G Section 7.9.3.

8.4 Flow Estimation in Absence of Flow Monitoring

See DS&G Section 7.9.4.

Section 9
Uncertainty/Level of Accuracy

Uncertainty and allowable variance in determining the level of accuracy should be considered when using modeling for GSI projects in order to provide proper context for evaluation and assist in decision making. The level of accuracy of a calibrated model is determined by allowable variance between the observed and the predicted data. However, the accuracy of observed data depends on the accuracy of instrumentation used in collecting that data. Similarly, mathematical models used in H/H modeling of collection systems may also have inherent limitations. Uncertainties are therefore implicit in the overall process when modeling GSI and the user should be aware of them. Failure to account for uncertainty and level of accuracy could result in inaccurate design that could be over- or under-sized. These concepts should be discussed during project scoping and considered through the life of the project. Neither SPU nor WTD currently has guidance specific to GSI modeling in this area, there are notes below pertaining to each agency, however.

SPU has developed an Uncertainty Analysis (UA) procedure which attempts to capture four areas of uncertainty:

1. Uncertainties in historic precipitation (stationary climate) – How representative is the historic rainfall record for use in prediction of future flows?
2. Uncertainties in predictions from watershed modeling – Values determined from quality of model calibration in terms of flow prediction (depth data can also be used in the absence of flow).
3. Climate change uncertainty – Climate change accounted for by using a set of perturbed rainfall timeseries that represent what the climate has been or what it could resemble three different climate epochs (current, 2035, and 2100).
4. Residual uncertainties – Serves as a “catch-all” for uncertainties not captured in the other three categories.

The UA process uses statistical analysis facilitated with the use of the Automated Calibration and Uncertainty Analysis for Storm Water Management Model (ACU-SWMM) software package developed for SPU by MGS Consultants and Aqualyze, Inc. This process can be applied to SPU GSI projects, but it should be discussed with city staff prior to implementation. It can be a resource intensive process that involves numerous model simulations. See DS&G Section 7.10 for general guidelines and more information.

WTD does not currently have an established methodology to account for uncertainty in sizing facilities. Overall CSO sizing protocols are discussed in the 2012 King County Long-term Combined Sewer Overflow Control Plan Amendment, October 2012. Appendix B of that document titled King County WTD Hydraulic Modeling and Monitoring Protocols, Model History dated May 2012 discuss WTD modeling procedures more specifically. There are sections “Safety Factors” and “Uncertainties Affecting Facility Sizing” pertaining to separated systems, but no direct guidance is provided. Thus, concepts of level of accuracy and uncertainty should be discussed with the project team in the early project stages to ensure proper consideration in consideration with the above referenced documents.

[GAP] *Section to be updated once a project is completed that conducts model calibration and validation of GSI facilities, or once a GSI project that explicitly addresses uncertainty and level of accuracy directly has been completed.*

Section 10

Capacity Assessment and Alternatives Analysis

10.1 Existing System Capacity Assessment Elements

See DS&G Section 7.11.1. REFERENCE: King County WTD Hydraulic Modeling and Monitoring Protocols May 2012

10.2 Capacity Assessments for New Development Projects

See DS&G Section 7.11.2.

10.3 Capacity Assessments for CIP Projects

See DS&G Section 7.11.3.

10.4 Developing Upgrade Options or Alternative Analysis

GSI alternatives will vary depending on the project phase (Project Initiation, Options Analysis/Problem Definition, or Design). GSI alternatives should be developed to evaluate and maximize benefits versus cost to meet either a business case or chartered project goals (such as removing volume from flowing into the combined sewer system during an overflow event or reducing the number of CSO events/year over a rolling average). Table 10-1 shows potential variables that may be combined to develop GSI alternatives in the various phases.

Table 10-1. Potential Variables for Developing GSI Alternatives by Phase

Project Initiation	• Mix of practices (e.g., bioretention,) • Implementation areas (e.g., ROW, partnerships) • Implementation levels (e.g., participation estimates) • Assumed infiltration rates or other input variables
Options Analysis/ Problem Definition	• Blocks to be implemented • Surface geometry (area) of practices • Infiltration technology (shallow, deep infiltration (screen wells, drilled drains, pit drains), or underdrain-controlled) • Sizing factors
Design	• Location of practice • Detailed geometry of practice (e.g. vertical walls versus graded side slopes)

10.5 Data Sources and Requirements

This section provides information about data sources and requirements supplemental to those needed for baseline model construction (as described in DS&G Chapter 7). Information specific to GSI evaluation at each phase of analysis (Project Initiation, Options Analysis/Problem Definition, and Design) is provided.

10.5.1 GSI Feasibility Evaluation in the Project Initiation Phase (GIS Layers and Databases)

In the Project Initiation Phase, potential siting of GSI facilities are typically estimated at a very high level (i.e. basin or neighborhood scale). The modeling effort should be conducted at a similarly high level to inform the project team on scope for future phases. This could be achieved in a desktop (i.e. spreadsheet) or by using an existing model of the basin (if one exists). Analysis should focus on the area to be managed, the goal of the project (i.e. CSO control), and project feasibility (i.e. can enough area be captured to achieve the project goals).

10.5.2 Options Analysis/Problem Definition Scenarios

More refined than scenarios in the Project Initiation Phase, the Options Analysis/Problem Definition Phase scenarios are typically estimated at the block scale by the Project team using various tools as described in the GSI Manual, Volume II: GSI Options Analysis/Problem Definition. During this phase, the modeler estimates the tributary area for each block using available GIS maps, information from site reconnaissance and other data sources. If a SWMM5 or MIKE URBAN model is being used, the block should be mapped to the appropriate model subcatchment for each scenario. Spreadsheet documentation should be developed to track the tributary area for each block and the relative size and type of bioretention cells and method of discharge of the filtered stormwater (shallow infiltration, deep infiltration technologies or discharge into downstream conveyance system, piped or channeled) to be input into the model being used. Section 11, Section 12, and Section 13 provide information on translating data to model inputs. See GSI Manual, Volume III-Design Phase for more description about methods for discharge of stormwater after it has passed through the bioretention facility.

10.5.3 GSI Design Data

In the Design Phase, the selected GSI facilities are to be modeled as the design is refined. Therefore, the tributary area to each facility is delineated and calculated using computer-aided design (CAD)/GIS. Each model scenario will be developed in an Excel workbook that includes the tributary area for each block and the relative size and type of practices to be input into the model. Section 11, Section 12, and Section 13 provide information on translating data to model inputs.

10.6 Characterizing Future Conditions

See DS&G Section 7.11.5.

Section 11
GSI Modeling in SWMM5

This section provides specific guidance for modeling GSI in SWMM5, including data sources and requirements supplemental to those necessary for baseline model construction. DS&G Chapter 7 provides guidelines on baseline model construction, and Section 5 of this guide shows modifications and checks to be made to the baseline model prior to constructing the GSI alternatives model.

Because SWMM5 uses the term Low Impact Development or "LID" for GSI facilities, "LID" will be used in this section when referring to GSI in context of SWMM5 functionality. In SWMM5, GSI facilities are modeled by routing a portion of the impervious area in the subcatchment to LID controls. Each LID control represents a specific cross-section configuration of a GSI facility. The model can include multiple LID controls within the same subcatchment to represent different GSI facilities or multiple iterations of a GSI facilities that have different cross-sections. The model can also include multiple "replicate units" of a given GSI facility that all have the same cross-section. The specific LID controls used in each subcatchment, including replicate units, are defined in the SWMM5 LID Usage Editor for each subcatchment. It is recommended that all GSI facilities of the same type (e.g., all bioretention cells) be represented with a common cross-section and represented by an equivalent LID for each subcatchment during the Options Analysis Phase. At the Design Phase, if necessary, more detailed GSI modeling should be performed as appropriate to achieve design goals.

SWMM5 converts runoff from the impervious surface into a unit inflow (depth) that is modeled through the LID control. Infiltrated runoff from the LID control is then routed to the mapped aquifer for the subcatchment. Outflow from the LID control (either overflow or underdrain discharge) is then directed either to the pervious portion of the subcatchment or to the downstream piped collection system.

SWMM5 does not allow discharge from one LID control to another, and therefore cannot directly model GSI facilities in series (refer to Section 11.1 for modifications that can be made to the baseline subcatchment delineations to represent use of GSI facilities in series).

Specific steps required for constructing the GSI alternatives model from the baseline model are:

- Obtain input data (tributary areas and practice types) from the feasibility evaluation for GSI scenarios appropriate to later phases of analysis (Options Analysis/Problem Definition and Design; see Section 11.1)
- Map input data to model sub-basin delineations and flow assignments (see Section 11.2)
- Develop LID controls (see Section 11.3)

- Enter LID usage data for each subcatchment into SWMM5 model (see Section 11.4)

The overall concept of GSI modeling in SWMM5 is graphically depicted in Figure 11-1. As shown in the figure, before GSI features (LID controls) are added to the model, all the runoff from both impervious and pervious area drains directly to the conveyance system. After addition of GSI features (LID controls), runoff from a percentage of the impervious area is routed to the LID controls before discharge to the conveyance system.

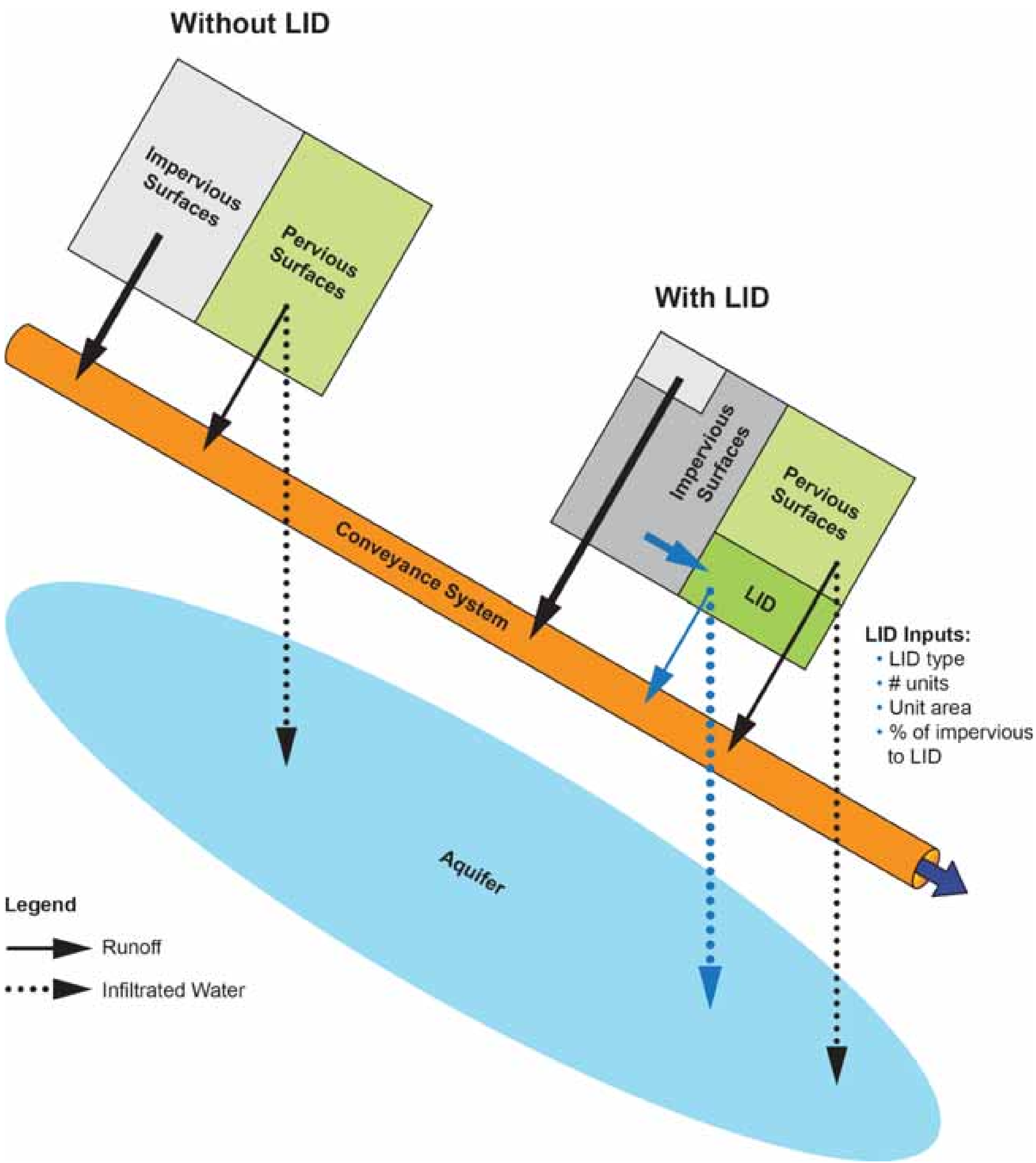


FIGURE 11-1. CONCEPTUAL REPRESENTATION OF GSI MODELING IN SWMM5

11.1 Mapping Input Data to Model Subcatchments

Steps for mapping input data:

1. Baseline model subcatchment layers are compared with project input data and feasible GSI locations are assigned to subcatchments.

2. Model parameters, such as impervious and total contributing area should be compared against field and GIS data for consistency with LID assumptions.

3. Further refinement to model subcatchments may be needed. See additional discussion below.

11.1.1 Sub-Basin Delineation and Flow Assignment

For Detailed System models, sub-basin delineation and flow assignment are typically already completed during the system model development and calibration. This subsection describes verifications and possible modifications to the baseline model that should be made before constructing the GSI alternatives model. In addition, the guidelines herein should apply to development or modification of existing models at the trunk/hydrograph and skeletal model scales. Modifications to the subcatchment delineations and flow assignments should produce results that are comparative and that are within the same calibration bounds as those required of the un-modified baseline model.

The subcatchment delineation and calibrated parameters should be reviewed for:

- Unique conditions or discrepancies identified in baseline model construction and QA/quality assurance (QC) that relate to GSI.
- Subcatchment delineation should be at the scale appropriate to evaluate GSI performance. Typically, this is at the block scale or at the scale of an area that discharges to an individual maintenance hole (MH).

Flow monitoring basins (the basis for grouping and calibrating subcatchment runoff parameters in the baseline model) are typically delineated based on system type and hydraulics, and therefore several land uses (e.g., commercial vs. residential, right-of-way vs. parcel) and soil types are often grouped together. The resulting calibrated model parameters are often an averaged value over the extent of the flow monitoring basin and are not representative of individual runoff surfaces within the model.

Subcatchment delineation within the existing basin models will require adjustments to account for GSI options (in general, these adjustments should not be necessary during the Project Initiation Phase). The baseline simulation results should remain the same after the subcatchment delineation adjustments. Typically, SPU-calibrated models have three types of subcatchments that represent the tributary area to an MH: parcel catchment (C), building (BLDG), and right-of-way (ROW). The three individual subcatchment areas should add up to the total tributary area of the sub-basin. For fully separated systems, none of the three subcatchment areas are connected to the sewer system; for partially separated systems, only the BLDG portion is connected to the sewer system; for fully combined systems, all three portions are connected to the sewer system. The modeler should determine the subcatchment connectivity prior to revising the model.

11.1.2 Selecting a Methodology to Model LIDs in SWMM

Two modeling approaches can be used to model LIDs in SWMM. Considerations include but are not limited to, effective area and effective impervious area delineation to LID, desired resolution of LID modeling, and intended future model usage. Description of each approach and criteria for selecting an approach are discussed below.

- Approach 1 – Create new subcatchment (can do multiple based on contributing area type) that represents area tributary to LID and new subcatchment that represents only the LID (LID occupies 100 percent of new catchment area).
    - Pros – Direct input of contributing area to LID and ease of tracking model results on an individual LID level. Can separate out LIDs within a block.
    - Cons – Addition of subcatchments requires intermediate modeling step for area balancing and validation. Future changes to contributing area will require additional area balancing.
    - Recommended use – When evaluating individual performance of each LID is desired and contributing area and impervious area was delineated with high resolution with no future changes.
- Approach 2 – Apportion a percentage of each subcatchment area to an LID within each existing subcatchment
    - Pros – No addition of new subcatchments which is more conducive for future changes to contributing area and impervious area parameters.
    - Cons – LIDs are limited based on contributing area type (C, BLDG, and ROW), as each LID will receive runoff from a specific subcatchment type. This approach is more cumbersome in evaluating LIDs that receives runoff from multiple surface types. This approach is largely dependent on inherited subcatchment delineation.
    - Recommended use – When contributing area and impervious area was delineated with lower resolution and could be used as calibration parameter for directly connected impervious area. This approach can be further refined as part of future model revisions for contributing effective area and effective impervious areas to LIDs.

A schematic representation of each approach is show in Figure 11-2 below. Each approach is discussed in more detail.

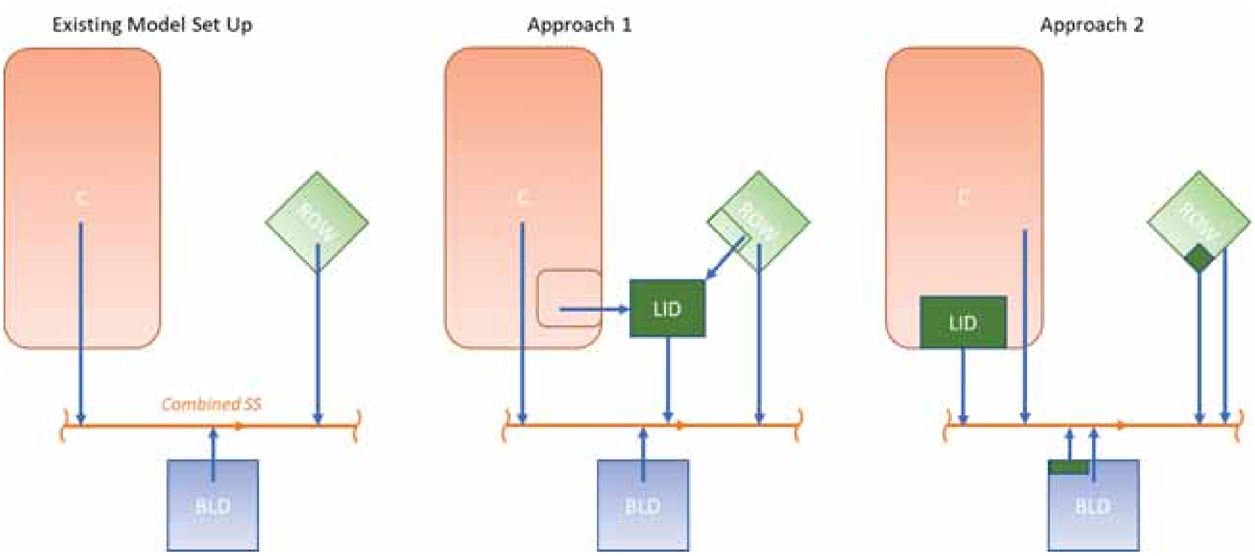


FIGURE 11-2. RECOMMENDED LID MODELING APPROACHES IN SWMM5

11.1.3 SWMM 5 Modeling - Approach 1

This approach to modeling LIDs requires a detailed delineation of contributing area to the LID. To update the baseline model subcatchment delineation to prepare for inclusion of the LID, the following procedure is recommended:

- Delineate area tributary to the proposed GSI facility and compute relevant subcatchment parameters including total area, percentage of imperviousness, percentage of slope, and hydraulic subcatchment width. Since the GSI will be in the ROW, update the existing ROW subcatchment and balance the total area with the C subcatchment. Total model areas should be balanced to maintain the calibrated total and impervious areas. Create a new subcatchment that represents the contributing area and effective impervious area. Multiple subcatchments can be created if contributing areas are desired to be kept separate by contributing area type (BLD, ROW, C). For example, ROW_111-111 could be split to be ROW_111-111 and ROW_111-111_*LIDName* to keep track of subcatchment that area was removed from.
- Run the baseline model with the subcatchment revisions and compare the calibration flow hydrographs of the original model with those of the revised model. Any revised subcatchments should produce predicted flows that fall within DS&G Chapter 7 calibration guidelines, or produce comparable flows to the existing basin model (with approval from modeling team)
- The existing calibrated model should be reviewed to understand how various land use types are delineated, and the model should be compared with known physical

characteristics of the basin under consideration. Any adjustments to the estimated impervious connectivity that may be necessary based on the GSI solutions being evaluated should be identified. For example, if the calibrated imperviousness percentage in SWMM5 is low but the proposed GSI solutions have higher connectivity of tributary impervious area, it may be necessary to adjust the impervious area within the subcatchment's parcel, ROW, BLDGs, and LID components. Recommendations for specific adjustments should be consistent with those provided in Table 5-1. Adjustments must be made manually, and care must be taken to not alter baseline results outside the bounds of DS&G calibration guidelines.

- The key calibration parameters of the baseline model are the percentage of imperviousness and sub-area flow routing. Therefore, if baseline model results do not match those of the revised model, adjust the percentage of imperviousness and the sub-area flow routing to make the model results match better. In situations in which the percentage of imperviousness value or sub-area flow routing area such that they cannot be altered to sufficiently improve results for both peak flows and volume, other subcatchment parameters, including percentage of slope and hydraulic width, should be revised to match peak flows.
- Create a separate subcatchment with a recognizable prefix identifier (such as LID) to represent a single LID unit or multiple LID units tributary to the outlet node to which the ROW (or BLDG/C subcatchments if evaluating GSI on private property) discharges. Typically, this comprises a single city block. The aggregate area of all GSI units within the tributary area should be the total area of the GSI subcatchment, and the same should be removed from the ROW subcatchments, thus preserving the total sub-basin area.
- Modeling every GSI unit is not recommended. The volume of water entering a GSI inlet may differ from place to place depending on the velocity (which is a function of subcatchment slope). Modeling multiple GSI units within a single block in series may not necessarily provide the best representation of their behavior in the field. Therefore, it is recommended to model multiple units with similar sizing factors within the same block and on the same side of the street as one equivalent unit. Where sizing factors differ significantly, GSI units should be modeled separately.
- If the required level of detail dictates including all GSI units in the model, whether in series or not, model each unit as a subcatchment the size of the individual GSI footprint. Check the box to indicate that the LID occupies the entire unit. Since the subcatchment can be discharged to any node or another subcatchment in the model, use the subcatchment connectivity to indicate where the non-infiltrated flow from the LID should go. Before implementing this approach, test sensitivity by studying the various outputs generated by SWMM5, including the detailed text file that can be exported from the LID Usage Editor for a particular unit. One known issue with this approach is that the underdrain outflow from an upstream LID subcatchment that is routed to another LID/subcatchment downstream will infiltrate through the media first, rather than going

directly to the next underdrain. A workaround model setup to address this issue is presented in Section 11.1.3.

11.1.3.1 Routing Runoff to LID

The LID is modeled as a separate subcatchment with the LID occupying 100% of the subcatchment area. This approach allows the flexibility to direct the LID discharge to another node. The surface runoff from the ROW subcatchment is first routed to the LID subcatchment. Using the LID controls, the model uses the runoff volume to route flow through the soil media and provide infiltration. If the rate of flow into the GSI exceeds the maximum flow rate of the media and infiltration capacity of the soil, the GSI overflows to the combined sewer system.

Modeling one equivalent GSI per block gives high enough resolution for planning purposes. However, if higher resolution is required, an alternative approach is recommended, as presented in Figure 11-2.

The block is divided so that the number of small subcatchments equals the number of GSI facilities to be modeled. The ROW subcatchment is directed to its respective LID subcatchment. The LID subcatchment is discharged to a dummy node connected to a pipe representing the underdrain of the GSI unit. The process is repeated for each LID to be modeled. The last dummy node will be connected to the combined sewer system. One drawback of this approach is that if in reality the inlet capacity is exceeded, the runoff will travel to the next downstream GSI unit, and this approach has no allowance for such a case. However, depending on the project needs, additional dummy nodes and conduits can be added to depict this behavior. Concepts from Figures 11-3 and 11-4 can be combined to represent the final connectivity to the combined sewer system according to the needs of a given project.

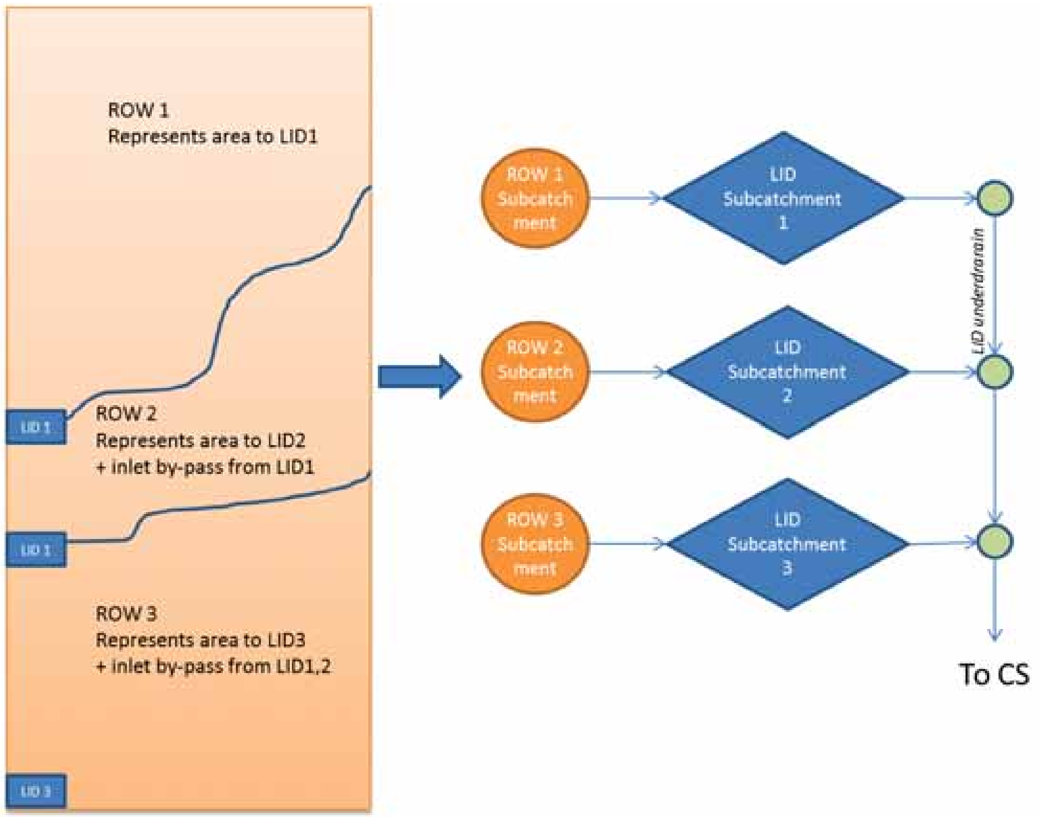


FIGURE 11-3. MODELING FOR HIGHER RESOLUTION

11.1.4 SWMM5 Modeling – Approach 2

This approach to modeling LIDs is bounded by the original delineation of subcatchments and allows for evaluation of LIDs at the inherited delineation scale. This is due to portions of each subcatchment being routed to an LID facility. This approach allows for flexibility in analysis of contributing area and future model updates. In updating the baseline model subcatchment delineation to prepare for inclusion of the GSI, the following procedure is recommended:

- The existing calibrated model should be reviewed to understand how various land use types are delineated, and the model should be compared with known physical characteristics of the basin under consideration. Any adjustments to the estimated impervious connectivity that may be necessary based on the GSI solutions being evaluated should be identified. For example, if the calibrated imperviousness percentage in SWMM5 is low but the proposed GSI solutions have higher connectivity of tributary impervious area, it may be necessary to adjust the impervious area within the subcatchment's parcel, ROW, and BLDGs components. Recommendations for specific adjustments should be consistent with those provided in Table 5-1. Adjustments must be made manually, and care must be taken to not alter baseline results outside the bounds of DS&G calibration guidelines.

- One or multiple LIDs can treat a percentage of impervious area for a given subcatchment. The number of LIDs used per subcatchment should be indicative of the LIDs that fall within the existing delineated subcatchment. LIDs can be combined if their characteristics are the same for each treatment area. The percentage of impervious area treated for a given subcatchment type (BLD, ROW, C) should also correspond to the area of each LID (more discussion in LID usage).

11.1.4.1 Routing Runoff to LID

In Approach 2, The LID is modeled as a fraction of the subcatchment with the LID occupying a percentage of the subcatchment area that represents the LID footprint to treat the runoff from a given subcatchment. This approach allows the flexibility to vary the LID footprint area and balance with other subcatchments and vary the amount of impervious area treated. The surface runoff from the specified impervious area is first routed to the LID portion of the subcatchment. Using the LID controls, the model uses the runoff volume to route flow through the soil media and provide infiltration. If the rate of flow into the GSI exceeds the maximum flow rate of the media and infiltration capacity of the soil, the GSI overflows to the receiving node. Multiple LIDs per subcatchment (e.g. block level delineation of ROW, BLD, and C with multiple LID units on the block) can be used to model multiple LIDs within a given area where different percentages of impervious area for a subcatchment can be routed to multiple LIDs. Modeling one equivalent GSI per block gives high enough resolution for planning purposes.

11.1.5 Modeling UIC Screen Wells for Discharge of Stormwater

When a design uses an Underground Injection Control (UIC) well for deep infiltration discharge of the stormwater that has filtered through the bioretention facility with an underdrain, this section describes the flow routing for that approach. The flow routing scheme shown in Figure 11-3 depicts the interaction of the ROW subcatchment, the LID subcatchment, infiltration through soil, to either a deep infiltration UIC well (See GSI Manual, Volume III-Design for examples of UIC wells used in designs with bioretention) or the existing conveyance system. If the UIC capacity is exceeded, the flow would discharge (“by-pass”) into the existing combined sewer system. To represent this flow routing scenario in SWMM5, two intermediate nodes, a new outfall, and four new pipes for each proposed GSI will be added to the model. Two of the new pipes represent the LID connection to the UIC well, which is represented by the new outfall. The first of these pipes has the media maximum flow rate of the GSI applied as the conduit’s maximum allowable flow in SWMM5. The second pipe has the UIC well maximum infiltration rate set as the conduit’s maximum allowable flow. The placement of the two “dummy” nodes allows for an overflow path if either of these maximum allowable flows is exceeded. Thus, a pipe is added that connects each “dummy” node to the nearest combined sewer system maintenance hole. The two by-pass pipes may be modeled as open channel trapezoidal links depicting flow running along the side of the street. Depending on the specific project application, any or all components shown in Figure 11-4 may be modeled.

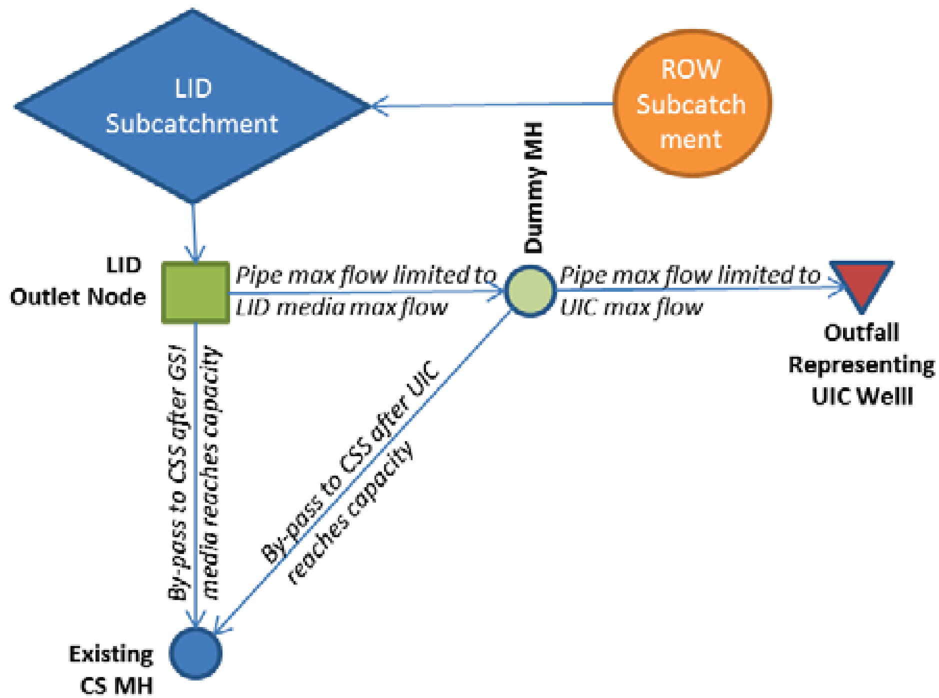
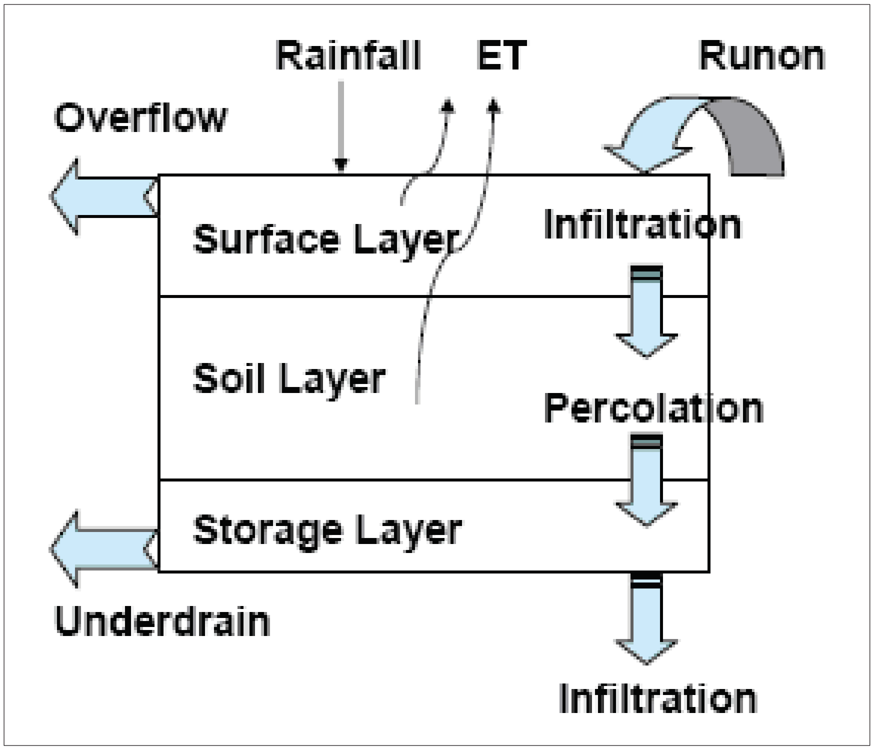


FIGURE 11-4. FLOW ROUTING SCHEME FOR UIC WELLS

11.2 LID Controls

GSI facilities are added to the baseline SWMM5 model by adding new SWMM5 LID controls. The LID controls include a combination of vertical layers whose properties are defined on a per-unit-area basis.

The vertical process layer options include a surface layer, pavement layer, soil layer, storage layer, and underdrain layer. Depending on the physical composition of each GSI type, various combinations of layers will be applied. During a simulation, SWMM5 performs a moisture balance that keeps track of how much water moves between layers or is stored within each layer. For example, Figure 11-5 from the SWMM5 user's guide is a conceptual construct of the layers and flow pathways for a bioretention cell. More information on each layer can be found in the user's guide (Rossman, 2010).



Source: SWMM5 User's Guide

FIGURE 11-5. FLOW PATHWAYS BETWEEN VERTICAL LAYERS REPRESENTING BIORETENTION

GSI facilities are represented by specifying properties for each layer of the LID control (thickness, void volume, hydraulic conductivity, underdrain characteristics, and the like). The graphical user interface for the LID Control Editor is shown in Figure 11-6. Typical LID input parameters for various types are listed in the following sections.

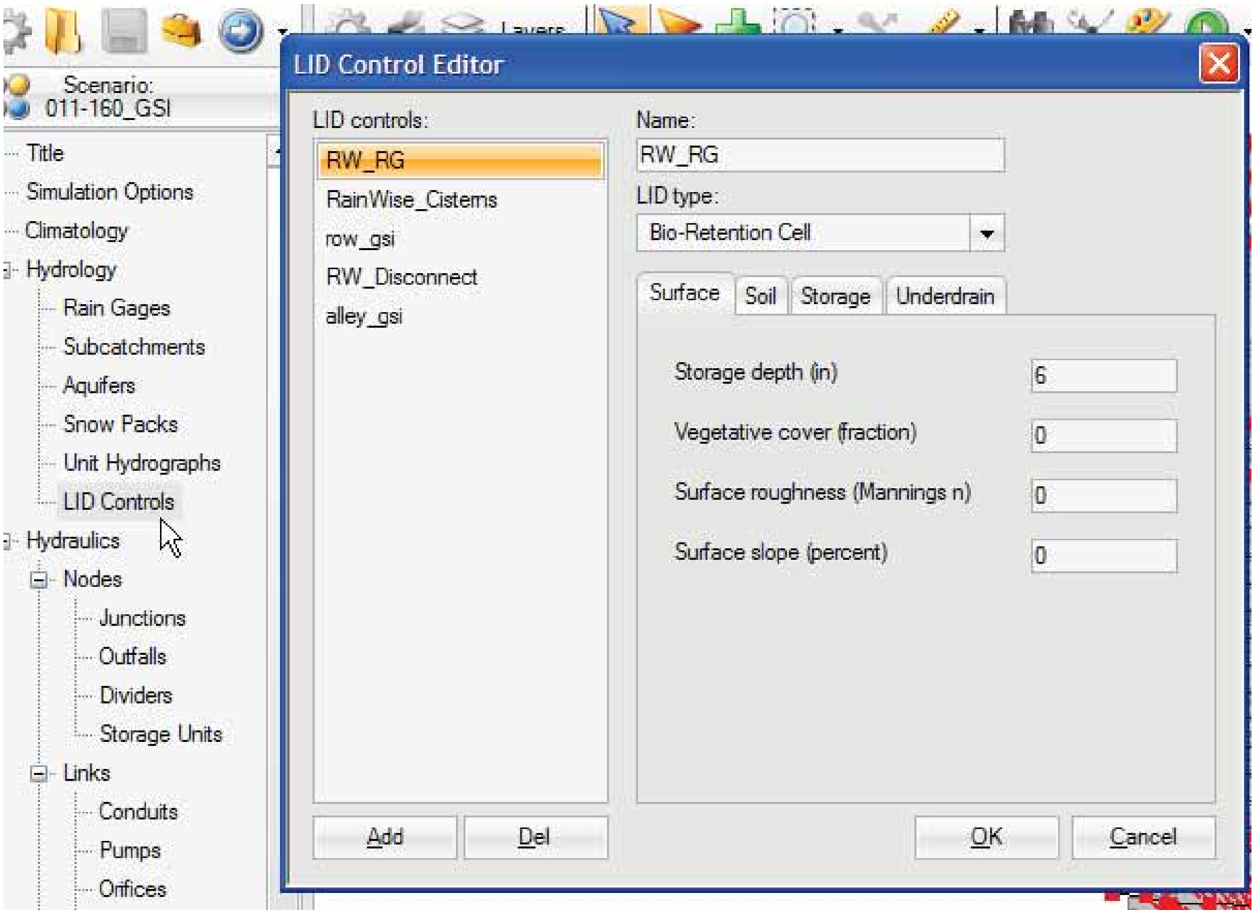


FIGURE 11-6. PCSWMM GRAPHICAL USER INTERFACE FOR THE SWMM5 LID CONTROL EDITOR

11.2.1 Bioretention Cell Parameters

Bioretention cells are modeled in SWMM5 using the “bioretention cell” LID control type. Table 11-2 gives typical parameters for modeling bioretention in a SWMM5 model (note that SWMM5 models all bioretention areas assuming vertical sides). To account for the side sloped area, it is recommended to model a sloped bioretention as a vertical walled facility with a footprint equal to the wetted footprint of the facility when at 50% of the maximum ponding depth. This preserves the total ponded volume and accounts for side slope infiltration. It is assumed that the LID structure will be properly maintained for the purposes of modeling and the H/H parameters will remain constant for the model simulation period.

Table 11-2. SWMM5 Input Parameters for Bioretention Cell LID

Vertical Layer	Property	Description	Unit, Field ID, or Data Type	Example Value	Data Source
Surface	Berm Height	Ponding depth (do not include freeboard)	Inches	6 to 12	Per the Design.
	Vegetation volume fraction	Fraction of layer volume filled with vegetation	Fraction	0.1	Per the design.
	Surface Roughness	Manning's n for overland flow	Manning's n	0.21	
	Surface Slope	Slope of bioretention cell surface	Percent		
Soil	Thickness	Thickness of the bioretention soil layer (not including mulch)	Inches	12 to 18	Per the design.
	Porosity	Volume of pore space relative to total soil volume	Fraction	0.4	Rawls et al., 1998
	Field capacity	Volume of pore water relative to total volume after the soil has drained fully by gravity	Fraction	0.13	Rawls et al., 1998, for loamy sand texture
	Wilting point	Volume of pore water relative to total volume for a well-dried soil in which only bound water remains	Fraction	0.04	Rawls et al., 1998, data; difference between total and effective porosity
	Conductivity	Hydraulic conductivity for the fully saturated bioretention soil	Inches/hour	6	See Table 5.21 in COS SWMM5, Volume 3.
	Conductivity slope	Slope of the curve of log conductivity versus soil moisture content	Dimensionless	10	See COS SWWM5 guidance; average of value for sand plus value for silt loam
	Suction head	Soil capillary suction along the wetting front	Inches	2.42	Assumed; loamy sand

Table 11-2. SWMM5 Input Parameters for Bioretention Cell LID

Vertical Layer	Property	Description	Unit, Field ID, or Data Type	Example Value	Data Source
Storage	Thickness	Height of a gravel layer below the soil layer	Inches	1 (without UD) 6 (with UD)[1]	Per the design.
	Void ratio	Volume of void space relative to the volume of solids in the layer	Ratio	0.667	(Equivalent to 0.4 porosity)
	Seepage Rate	Rate at which water infiltrates into the native soil below the storage layer	Inches/hour	Depends on background soil	To be provided by hydrogeologist/ geotechnical engineer based on soil analysis
	Clogging factor	Total volume of treated runoff it takes to completely clog the bottom of the layer divided by the void volume of the layer	Dimensionless	0	Not used, assume proper maintenance and performance
Underdrain	Drain coefficient	Coefficient of the equation that calculates the flow rate through the underdrain as a function of water level above the drain height	Inches/hour	Depends on outlet size	Per the design.
	Drain exponent	Exponent of head in SWWM drain equation	Dimensionless	0.5 (orifice drain)	SWMM5 guidance
	Drain offset height	Height of underdrain pipe from the bottom of the layer	Inches	6	Per the design.

UD = underdrain

[1]*Parameter must be greater than 0 in SWMM5. 6 is per SPU standard plans*

11.2.2 Permeable Pavements

Input parameters for modeling permeable pavements are provided in Table 11-3. Permeable pavements are referred to as porous pavement in SWMM5; in construction, “porous” is generally used to refer to asphalt pavements. Therefore, the word “permeable” has been retained in these guidelines to underscore applicability to all pavement types. It is assumed that the LID structure will be properly maintained for the purposes of modeling and the hydraulic/hydrologic parameters will remain constant for the model simulation period.

Table 11-3. SWMM5 Input Parameters for Permeable Pavement Facility GSI

Vertical Layer	Property	Description	Unit, Field ID, or Data Type	Example Value	Data Source
Surface	Berm Height	Surface depression storage	Inches	0.1	Per the design. Value will vary.
	Surface roughness	Manning's n for overland flow	Dimensionless	0.0115	SWMM5 guidance
	Vegetated volume	Proportion of surface that is vegetated	%	0 for pavements	SWMM5 guidance
	Surface slope	Slope of pavement surface	%	<5%	Per the design. Value will vary.
Pavement	Thickness	Thickness of the soil layer	Inches	4 to 8	Per the design. Value will vary based on wearing course material.
	Void ratio	Volume of pore space relative to total soil volume	Fraction	TBD	Value varies based on top wearing course material used.
	Impervious surface fraction	Ratio of impervious paver material to total area	Fraction	TBD	Value varies based on top wearing course material used.
	Permeability	Permeability of the pavement layer	Inches/hour	TBD (use long term design rate not initial)	Value varies based on top wearing course material used.
	Clogging factor	Number of pavement layer void volumes of runoff treated it takes to completely clog the pavement	Number	0	Not used, assume proper maintenance and performance

Table 11-3. SWMM5 Input Parameters for Permeable Pavement Facility GSI

Vertical Layer	Property	Description	Unit, Field ID, or Data Type	Example Value	Data Source
Storage	Height	Height of a gravel layer below the soil layer	Inches	TBD	Value depends on the design of the section.
	Void ratio	Volume of void space relative to the volume of solids in the layer	Ratio	TBD	Depends on material used for subbase. See Geotechnical Engineer. (a value of 0.667 is equivalent to 0.4 porosity)
	Infiltration rate	Rate at which water infiltrates into the native soil below the storage layer	Inches/hour	TBD	To be provided by hydrogeologist/geotechnical engineer based on soil analysis
	Clogging factor	Total volume of treated runoff it takes to completely clog the bottom of the layer divided by the void volume of the layer	Dimensionless	0	Not used

11.3 LID Usage

The SWMM5 LID Usage Editor (Figure 11-7) is used to define which LID controls are used in each subcatchment. After the LID Controls have been defined in accordance with Section 11.2, the number and size of each practice must be determined, as well as the percentage of subcatchment impervious area that is routed to the practice. Initial saturation conditions and routing of flows (either to pervious area or to combined sewer collection system) must also be defined in the Usage Editor.

Specific guidelines for determining each LID Usage Editor input are provided in Section 11.3.1. Guidelines for a suggested methodology using spreadsheet tools to facilitate data entry are provided in Section 11.3.2.

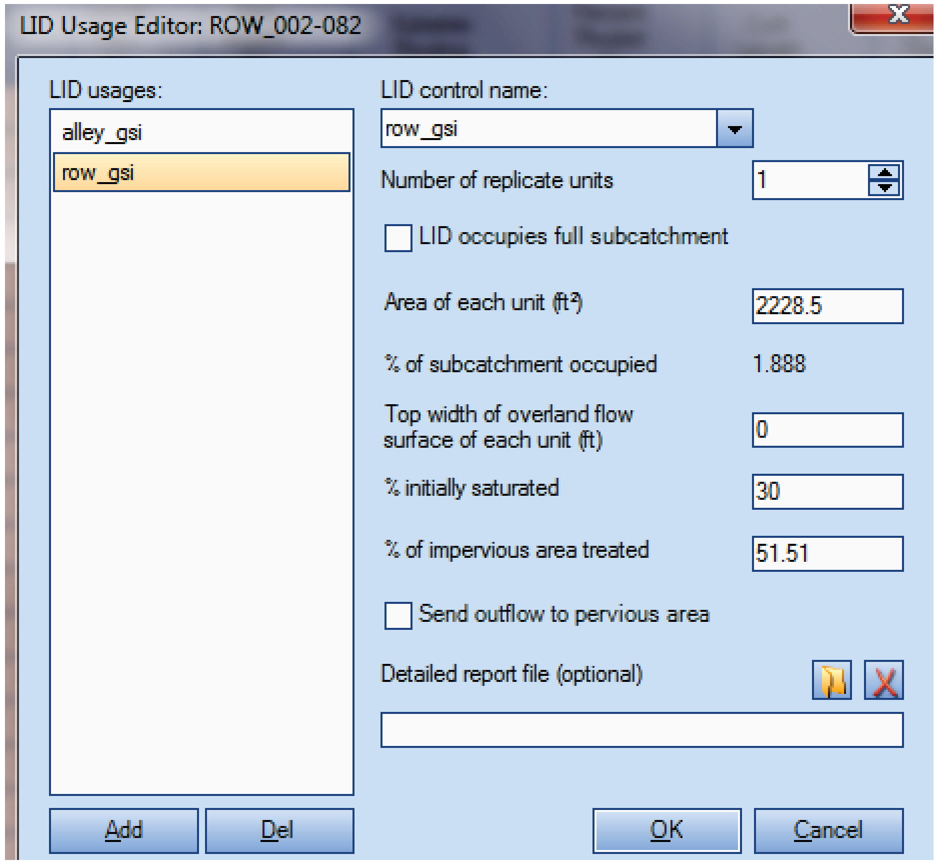


FIGURE 11-7. LID USAGE EDITOR

11.3.1 LID Usage Editor Inputs

11.3.1.1 Replicate Units

Generally, all GSI facilities of the same type (e.g., all bioretention cells) are represented with a common cross-section and are aggregated and represented by one GSI facility for each subcatchment during the Options Analysis/Project Definition Phase. In the Design Phase, when more detail is known about individual cross-sections for each GSI facility, individual GSI facilities may be represented by their own unique LID control depending on the level of detail in the analysis; if identical facilities are used, these can be entered as replicate units or remain aggregated for simplicity.

11.3.1.2 Area of Each Unit, and Percentage of Impervious Area Treated

Input parameters for the area of each unit and percentage of tributary impervious area treated depend on the practice type and analysis phase. Phase-specific guidelines for these parameters are provided in Table 11-4.

Table 11-4. Phase-Specific Guidelines for Determining Replicate Units, Area of Each Unit, and Percentage of Impervious Area Treated

	Project Initiation	Options Analysis/Problem Definition	Design
Percentage of impervious area treated	Use feasibility analysis to determine the percentage of feasible area[a] within each subcatchment and multiply by estimated percentage of participation.	Use GIS or Aerial mapping to estimate the area of each block to be implemented[a] under each scenario and divide by the impervious area of the subcatchment	Directly calculate the tributary area[a] to each LID control in CAD and divide by the total impervious area of the subcatchment.
Area of each Unit	Catchment area × Impervious % × % of impervious area treated × sizing factor[b]	Multiply calculated impervious area by sizing factor[b,c,d]	Multiply calculated impervious area by sizing factor[c]

[a] Percentage of impervious area treated should also consider the proportion of effective impervious area that can be captured by the GSI practices, e.g., proportion of effective impervious area that is overland flow that may be captured by natural drainage systems in the right-of-way, as opposed to area directly connected to the conveyance system through a side sewer or lateral.

[b] One LID is applied to each catchment where applicable. The size of the LID area varies according to the tributary area, e.g., a sizing factor of 7.4% represents a LID with a bottom area equal to 7.4% the size of the impervious tributary area draining to it.

[c] For GSI practices without underdrains, the size of each practice should be varied so that the actual sizing factor is preserved without being affected by rounding of the number of practices. However, for practices with underdrains and orifice controls, during the Project Initiation/Options Analysis Phase in which individual practices have not yet been designed, it is recommended that individual practices be entered with identical areas; otherwise, the drain coefficient would be incorrect. Whereas the orifice size for most practices may be fixed (e.g., a minimum of 0.25 inches for cisterns and of 0.5 inches for bioretention), the drain coefficient depends on the size of the practice; therefore, if the practices size changes, the drain coefficient also changes. In design, orifice size can be adjusted (above the minimum required size) using an iterative process to match a calculated drain rate.

11.3.1.3 Initial Saturation

Initial saturation is assumed to be 3%.

11.3.1.4 Discharge to Pervious Area

This option is typically not checked, as GSI models in combined systems typically discharge directly to the combined system.

11.3.1.5 Top Width of Overland Flow

Typically not a factor in design; however, set as the typical facility width.

11.3.2 Guidelines for Entering LID Control and LID Usage Data Directly to SWMM5 Input File

As an alternative to entering LID controls using the graphical user interface, entry data can be copied from a template input file or Excel spreadsheet to a text editor, and the file is then uploaded as the new input file for the model currently being evaluated. A copy of the original input, with suffix.inp, file should be archived prior to attempting any modifications. A screen capture of an input file is shown in Figure 11-8. Data for LID controls are located immediately before data for LID usage. LID usage is located immediately before the data for aquifers. To enter LID controls and LID usage data into a text file for a model that did not previously contain them, search for “Aquifer” in the text editor and paste the data for LID usage and LID controls directly above the data for aquifers.

```
[LID_CONTROLS]
;;              Type/Layer Parameters
;;-------------- ---------- ----------
ROW_GSI_Block BC
ROW_GSI_Block SURFACE    6       0        0          0          3
ROW_GSI_Block SOIL       11      0.4      0.13       0.04       1.5        10         2.42
ROW_GSI_Block STORAGE    1       0.667    0.25       0
ROW_GSI_Block DRAIN      0       0        0          6
```

Figure 11-8. Model Input File Accessed from the Details Tab of the Model Interface

Entering the LID usage data individually for each subcatchment can be cumbersome and difficult to QA/QC at the basin scale; therefore, entry data should be calculated separately in a spreadsheet that is linked to the planning or design data (Section 11.1) and the basin subcatchments (Section 11.1), and imported into the model.

An example Excel worksheet, developed from the basic assumptions for sizing GSI facilities, is shown in Figure 11-9. The example worksheet is for RainWise Raingardens and is based on a model that included an upper and lower portion; these data are shown in Column A of the example, but are not included in the input file for a new model. A similar worksheet should be developed (or copied from a template workbook) for each GSI facility. Care should be taken to reconnect appropriate formulas when copying from a template workbook. To update data, delete the data to be replaced and then paste in the new data. SWMM5 will automatically resort based on the subcatchment ID, so all the data for buildings and ROW will need to be replaced, as the various practices will be intermingled in the text file.

Assumptions and formulas for sizing are phase-specific; refer to Table 11-4.

	A	B	C	D	E	F	G	H	I	J
1										
2		[LID_USAGE]								
3	Model	;;Subcatchme	LID Process	Number	Area	Width	InitSatu	FromIm	ToPerv	Report I
272	Upper 15	BLD_002-234	RW_RG	1	1.85	0	30	1.73	0	
273	Upper	Model:	RW_RG	1	2.96	0	30	2.12	0	
274	Upper	Equals "Upper 150"	RW_RG	1	1.59	0	30	0.93	0	
275	Upper 150	BLD_002-237	RW_RG	1	3.06	0	30	2.06	0	
276	Upper 150	BLD_002-238	RW_RG	1	2.57	0	30	2.08	0	
277	Upper 150	BLD_002-239	RW_RG	1	3.18	0	30	1.81	0	
278	Upper 150	BLD_002-240	RW_RG	1	1.64	0	30	1.75	0	
279	Upper 150	BLD_002-241	RW_RG	1	2.10	0	30	1.77	0	
280	Upper 150	BLD_002-242	RW_RG	1	1.94	0	30	1.75	0	
281	Upper 150	BLD_002-243	RW_RG	1	1.56	0	30	2.25	0	
282	Upper 150	BLD_002-244	RW_RG	1	1.18	0	30	1.97	0	
283	Upper 150	BLD_002-245	RW_RG	1	1.50	0	30	1.81	0	
284	Upper 150	BLD_002-246	RW_RG	1	1.62	0	30	1.98	0	
285	Upper 150	BLD_002-247	RW_RG	1	2.71	0	30	1.98	0	
286	Upper 150	BLD_002-248	RW_RG	1	2.09	0	30	1.75	0	
287	Upper 150	BLD_002-249	RW_RG	1	2.56	0	30	1.91	0	
288	Upper 150	BLD_002-250	RW_RG	1	2.49	0	30	1.83	0	
289	Upper 150	BLD_002-251	RW_RG	1	1.86	0	30	1.90	0	
290	Upper 150	BLD_002-252	RW_RG	1	2.71	0	30	1.84	0	
291	Upper 150	BLD_002-253	RW_RG	1	1.58	0	30	1.75	0	
292	Upper 150	BLD_002-254	RW_RG	1	1.38	0	30	1.80	0	
293	Upper 150	BLD_002-255	RW_RG	1	1.88	0	30	1.79	0	
294	Upper 150	BLD_002-256	RW_RG	1	2.96	0	30	1.90	0	
295	Upper 150	BLD_002-257	RW_RG	1	2.53	0	30	1.87	0	
296	Upper 150	BLD_002-258	RW_RG	1	1.58	0	30	1.34	0	
297	Upper 150	BLD_002-259	RW_RG	1	2.03	0	30	1.77	0	

FIGURE 11-9. EXAMPLE SPREADSHEET FOR COPYING LID USAGE DATA DIRECTLY INTO AN INPUT FILE

11.4 Initial SWMM5 GSI Model Testing

After the addition of LID usage and LID controls, the revised model is complete. The modeler should now perform initial tests to ensure that the model functions as intended. In addition to the initial testing described in DS&G Section 7.6, check the following:

- Does the LID results table include results for all subcatchments/GSI facilities?
- Is the sizing factor applied correctly? Check total inflow (inches) in the LID results table by dividing the total precipitation (in inches) for the subcatchment by the sizing factor (ratio of practice area to tributary area) for corresponding GSI facility and subcatchment.
- Does the model show GSI reducing surface runoff? Check “surface runoff” in “runoff quantity continuity” for baseline vs. GSI model run.
- Once the model run is complete, summary data for each practice can be viewed in the simulation report file and scrolling down to “LID performance summary.” Verify that the

percentage of error (“pcnt. error”) is low and that the model is simulating infiltration loss for infiltrating LIDs (or drain outflow for non-infiltrating LIDs). For undersized practices, “surface outflow” should be greater than zero.

Additional modeling standards can be found under DS&G section 7.6.

11.5 Quality Assurance/Quality Control

See DS&G Section 7.5.9.

11.6 GSI Model Simulation Evaluation

Compare hydrographs vs. non-GSI models (process assumes PCSWMM graphing software is being used):

1. Export a hydrograph from the non-GSI model run to a time series file
2. Open the time series file for the GSI model run
3. To change the format of the non-GSI hydrograph, go to the time series manager, right-click on the new profile, and select “properties”
4. Change the name of the time series and the properties of the line color

To review the LID report file, open it as tab-delimited in Excel. The file will show the various parameter values for each water balance and storage term for the practice. Plotting these data will show a relative mass balance for the practice and indicate whether overflow is occurring due to lack of surface infiltration (e.g., too much flow to get into the practice) or from saturation of the bottom (e.g., native soil restricts infiltration and the facility cannot drain).

11.7 Evaluation of Control Volume in GSI Projects

GSI projects in CSO basins should be evaluated on their ability to reduce runoff and overflows between baseline (non-GSI) and GSI models (in order of priority):

- CSO control volume (defined as occurring only once per year over a 20-year average)
- Annual CSO volume
- Annual runoff volume

A SWMM5 or MIKE URBAN model should be used to evaluate CSO performance. Evaluate the performance of the GSI scenarios for CSO control by implementing the following steps:

- Map model to record flow for CSO outfall links (for evaluation of CSO control volume and annual CSO reduction) and links upstream of CSO structures (for evaluation of total systems runoff volume).

- Run long-term simulation (typically greater than 20 years, depending on available precipitation record) of baseline (non-GSI model). Note that some projects may require evaluation of GSI in the context of other system improvements such as storage, retrofits, or capacity improvements, which will require simulation of those improvements in the baseline model.
- Run long-term simulation of GSI model(s).
- Calculate overflow and flow statistics using on each outfall or link hydrograph for the baseline and GSI simulations.
    - CSO Control volume:

      Calculate and rank overflow volume from each discrete overflow event. (defined by a 24-hour inter-event period without overflow). Calculate the 20th ranked overflow over a running 20-year period. The resulting control volume is the highest value in each 20-year period over the entire simulation period.
    - Annual CSO volume:

      Calculate the total volume discharged through each CSO outfall link and divide by the simulation period.
    - Annual runoff volume:

      Calculate the total volume discharged through each link immediately upstream of a CSO structure and divide by the simulation period.
- Check CSO control volume (CV) reduction, annual CSO volume and annual runoff volume efficiency.
    - Calculate the volume managed per square foot of impervious area managed by GSI.
    - CV reduction typically is in the range of 0.5 to 1.0 gallons/square foot managed. Annual CSO volume reduction may vary significantly. Annual runoff reduction is typically approximately 15 to 19 gallons/square foot managed (approximately equivalent to 24 to 30 inches of rainfall) or may be smaller where baseline model impervious connectivity is low.
    - Deviations from these values typically result from variations in:
        - Percentage of connected impervious area in the baseline model (lower percent connected will result in lower reduction efficiency)
        - Duration and extents of overflows within the baseline model (more frequent/longer duration overflows will result in higher reduction efficiency)
        - Presence of storage within the baseline model

Section 12
GSI Modeling in MGS Flood

The features and GSI facilities discussed in this section of the report are based on the MGSFloodV4 build of MGSFlood. MGSFlood is a continuous rainfall-runoff computer model developed for the Washington State Department of Transportation specifically for stormwater facility design in Western Washington. The program uses the Hydrological Simulation Program-Fortran (HSPF) routine for computing runoff from rainfall. The public domain version of the program includes a routing routine that uses a stage-storage-discharge rating table to define a stormwater retention/detention facility or reservoir, routines for computing streamflow magnitude-frequency and duration statistics, and graphics routines for plotting hydrographs and streamflow frequency and duration characteristics. The program meets the requirements of the 2014 Washington State Department of Ecology Stormwater Management Manual for Western Washington and the Seattle Stormwater Manual.

12.1 Model Set-Up

MGSFlood is best suited for analysis of individual GSI facilities and comparison of flow contributing to a combined or separated system. Detailed pipe networks are not required as in a detailed system model, and modeling inputs can be limited to contributing runoff area and proposed GSI facility components. Contributing areas can be broken down by surface type and GSI facility parameters can be input to evaluate GSI effectiveness.

12.1.1 Surface Runoff Parameters

HSPF surface runoff parameters for pervious areas are represented by PERLNDS categories and impervious areas are represented by IMPLND categories. The parameters are used in the computation of runoff and infiltration in the model. Default HSPF parameters are included as part of the MGSFlood program. These parameters can be updated to user defined values. Values may need to be updated as part of calibration, site investigation, or other recommended values for modeling. This may include but is not limited to physically based parameters such as LSUR (length of surface flow) to account for differences in contributing area flow lengths and NSUR (Manning's roughness coefficient of surface flow) to account for differences in surface type roughness. Figure 12-1 below shows the Subbasin table, on top, where areal measurements for the available PERLNDS and IMPLNDS can be entered, and the HSPF Runoff Parameters table, on the bottom, where these land use types can be edited.

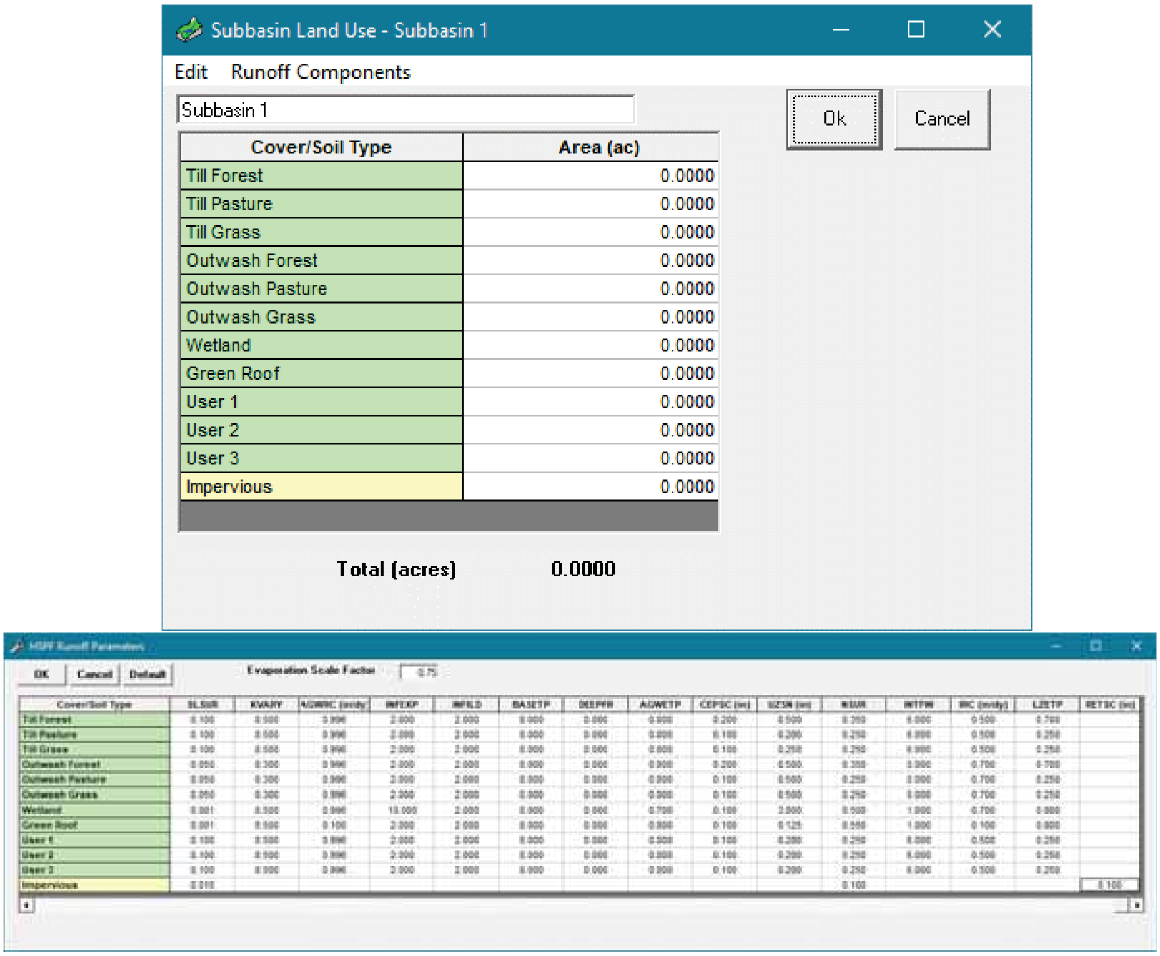


FIGURE 12-1 PERLNDS AND IMPLND PARAMETERS

12.1.2 Modeling Scenarios - Predeveloped and Postdeveloped Conditions

MGSFlood compares Predeveloped and Postdeveloped conditions, and as such, both scenarios must be populated in order for the model to run. Figure 12-2 shows an example MGSFlood project's Predeveloped condition without any BMPs, and a Postdeveloped conditions including a Bioretention BMP.

Once the system is modeled in the Scenario editor, a Point of Compliance (POC) must be set for use in the Predeveloped and Postdeveloped conditions comparison. The POC is the which will be used in the post processing comparison default reporting plots and statistics.

FIGURE 12-2 EXAMPLE PROJECT

12.1.3 Precipitation

Project rainfall is defined in the project location tab of the MGSFlood GUI. There are options to select from long term rainfall timeseries or short-term rainfall time series. It is recommended to use the Seattle 158-year, 5-minute time series. The rain gauge selected by MGSFlood is based on the project Latitude and Longitude that is provided to MGSFlood in the Project Location Tab. User-specified rainfall can also be used as input to the model.

12.2 GSI Controls

MGSFlood has a variety of system objects that can be linked together to model complicated systems. The majority of these objects are specifically designed to handle GSI designs.

Infiltration is explicitly represented in all the GSI facilities included in MGS Flood. Infiltration can be simulated by the Massmann infiltration method or a constant infiltration method. The Massmann equations are based on field observations of infiltration ponds in western Washington (See Section 16 of the MGSFlood User Manual). This infiltration approach accounts for the side slope geometry of the pond, pond aspect (length to width ratio), the proximity of the pond to the regional groundwater table, and the potential for soil clogging and fouling. Inputs include; Soil Hydraulic Conductivity (inches/hour), Depth to the Regional Water Table (ft), whether bio-fouling potential is low, and whether average or better maintenance is performed. Infiltrated moisture is lost from the system and does not contribute to the discharge rate at the downstream end of the link. The fixed infiltration option uses a constant user defined infiltration rate, that is applied to the bottom and side slopes of the GSI.

For GSI design, it is common to use a constant infiltration rate to assess how the system performs long-term conditions. Table 12-1 shows the parameters used in both infiltration methodologies.

Table 12-1. Infiltration Parameters

Infiltration Parameters	Infiltration Method	Note	Data Source
Hydraulic Conductivity (in/hr)	Massmann		Design
Depth to Water Table (ft)	Massmann		Field Exploration
Low Bio-Fouling Potential	Massmann	check box	GSI Design
Average or Better Maintenance	Massmann	check box	GSI Design
Constant Infiltration Rate (in/hr)	Constant		Field Survey

12.2.1 Bioretention

MGSFlood models bioretention facilities (can also model rain gardens and cascades) by simulating surface detention, surface outflow, infiltration, and return flow from an underdrain. The underdrain return flow is entered as a percentage of the infiltrated moisture. This percentage is then added to the link outflow. Infiltration can either be simulated using a constant rate or by using Massmann's equations. It should be noted that with this GSI, precipitation and evapotranspiration are applied to the facility, so the area occupied by the bioretention facility should not be included in the Subbasin Area input. Figure 12-3 below shows the bioretention parameterization window. Modeling assumptions will vary based on bioretention facility characteristics. Table 12-2 shows a description of each field to be populated when using this tool, as well as sources of model inputs and typical values.

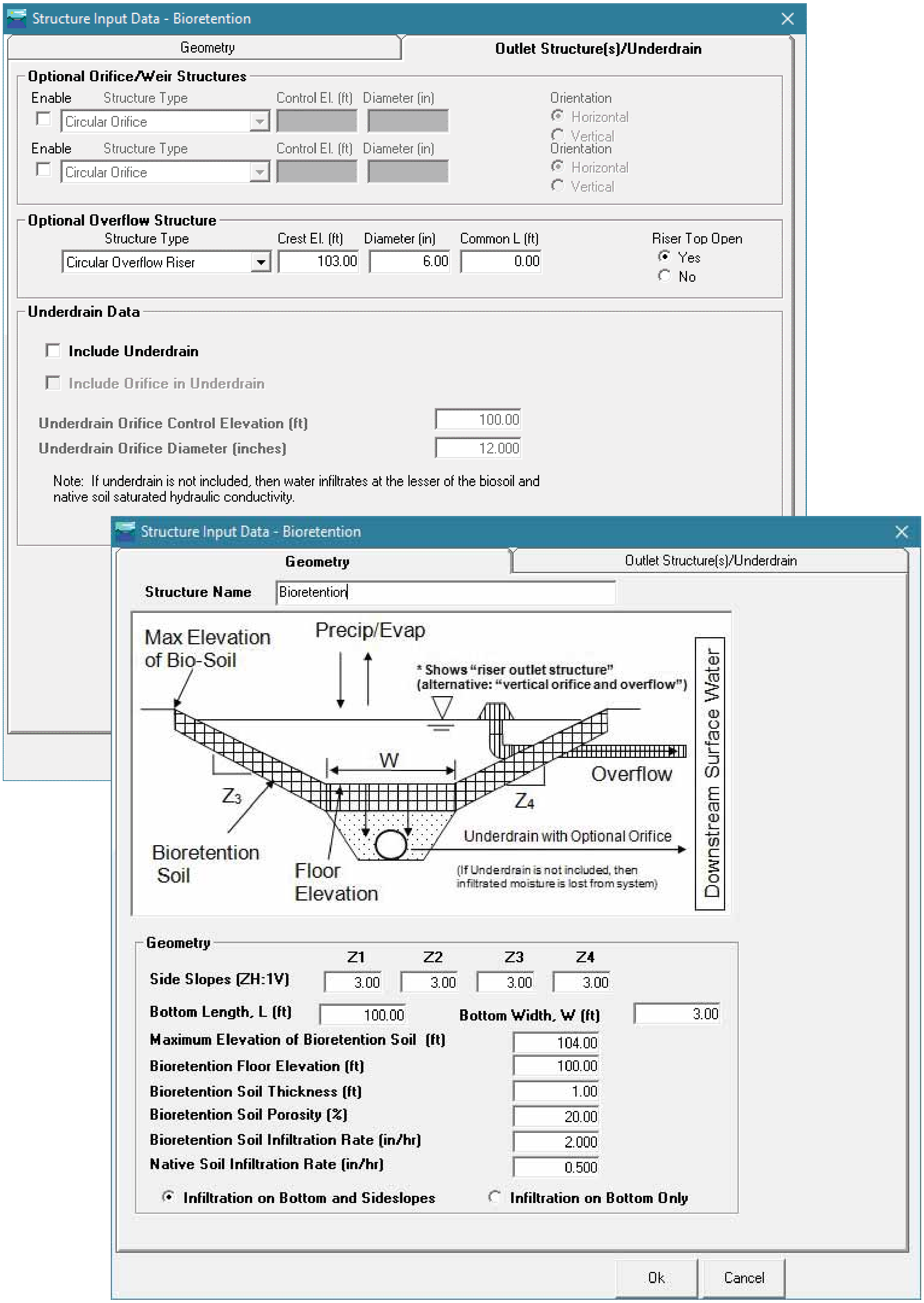


FIGURE 12-3 BIORETENTION FACILITY DEFINITION WINDOW

Table 12-2. Bioretention Parameters

Bioretention	Note	Data Source
Side Slopes (ZH: 1V)	Required	GSI Design, 2.5:1 Max
Bottom Length, L (ft)	Required	GSI Design
Bottom Width, W (ft)	Required	GSI Design
Maximum Elevation of Bioretention Soil (ft)	Required	GSI Design, Max 2” above overflow invert
Bioretention Floor Elevation (ft)	Required	GSI Design
Bioretention Soil Thickness (ft)	Required	GSI Design, typical value 18"
Bioretention Soil Porosity (%)	Required	30%
Bioretention Soil Infiltration Rate (in/hr)	Required	6in/hr (corrected rate)
Native Soil Infiltration Rate (in/hr)	Required	Field Test (corrected rate)
Infiltration on Bottom and Side Slopes	Required	GSI Design
Orifice/Weir Structure	Optional control structures, up to 2 orifices or weirs	GSI Design
Overflow Structure	Optional	GSI Design, 18” diameter)
Underdrain Orifice Control Elevation (ft)	Optional	GSI Design
Underdrain Orifice Diameter (inches)	Optional	Varies by location, 4”-6” typical

Sources: SPU Stormwater Manual Table 5.21; Sizing Factor for SPU NDS Projects Task 7.1.1 – SPU GSI Technical Analysis Support Technical Memorandum, June 2, 2017

12.2.1.1 UIC Modeling for Bioretention

MGSFlood does not have a way to explicitly model UIC wells, and the underdrain and overflow go to the same discharge point. There are two viable methods to represent UIC wells in MGSFlood.

The first method utilizes flow splitters to send flows to different outlet locations. This option allows the user to develop a relationship between inflows and outflows to different locations. This relationship will be determined by the underdrain capacity, with excess flows going to the overflow point. This approach is effective in cases where the UIC well infiltration capacity has potential to be exceeded by the inflow rate.

Alternatively, the infiltration rate on the bioretention facility bottom can be set to represent a composite value of any side slope infiltration and unrestricted UIC well infiltration. This value should be determined through geotechnical engineering efforts. This approach is effective in cases where the UIC well has potential to infiltrate all inflows to the bioretention facility.

12.2.2 Porous Pavement

The porous pavement object in MGSFlood allows for design parameters for porous pavement to be entered to model parking area, access roads, sidewalks, sport courts and other such typically impervious area. Check dams can be explicitly represented to provide surface ponding and promote infiltration. Figure 12-4 shows the model input window and Table 12-3 shows the input parameters. See Table 5.25 in Volume 3: Project Stormwater Control of the City of Seattle Stormwater Manual, August 2017for additional modeling assumptions.

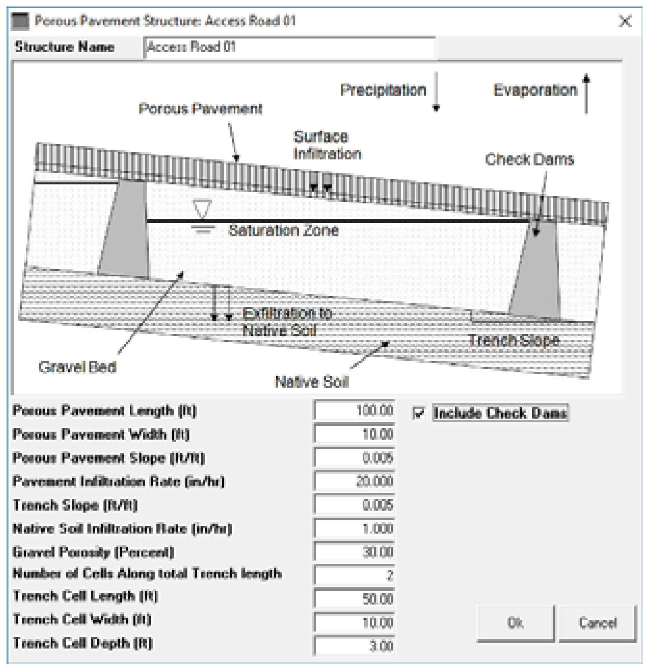


FIGURE 12-4 POROUS PAVEMENT DEFINITION WINDOW

Table 12-3. Porous Pavement Parameters

Porous Pavement	**Data Source**
Porous Pavement Length (ft)	GSI Design
Porous Pavement Width (ft)	GSI Design
Porous Pavement Slope (ft/ft)	GSI Design
Pavement Infiltration Rate (in/hr)	GSI Design
Trench Slope (ft/ft)	GSI Design
Native Soil Infiltration Rate (in/hr)	Field Test, GSI Design
Gravel Porosity (Percent)	GSI Design, 25% typical
Number of Cells Along total Trench length	GSI Design
Trench Cell Length (ft)	GSI Design
Trench Cell Width (ft)	GSI Design

Porous Pavement	Data Source
Trench Cell Depth (ft)	GSI Design
Check Dams option	GSI Design, optional

12.3 GSI facilities Evaluation of Flow and Volume Reduction

After running the simulation, the results can be accessed in the Graphs tab or in the Summary report. The default results will show the comparisons between the Predevelopment and Postdevelopment POC.

In order to evaluate the individual performance of GSI facilities, additional inflow and outflow data can be retrieved using the Full Output option under report level in the Summary Report Window. In order to use this functionality, the “Compute Stats for Compliance Subbasin/LinkOnly” radial button must be selected in the Compute Runoff and Route Through Network section of the Simulate Tab. From the full output data, the inflows to a modeled GSI facility can be compared to the model outflow to assess model performance. Comparing the inflow and outflow from an object in MGSFlood is limited to the exceedance probability in the time domain and will require the use of an external software that can handle the data analysis.

Infiltration as well as outflow data can be extracted to determine volume reduction being routed away from the combined sewer system. This information can be used in conjunction with basin wide models to aid in evaluation of CSO volume reduction. It is recommended that the model output be used for planning level purposes only, and that CSO volume reduction be more rigorously evaluated using basin wide SWMM5 or MIKE URBAN models.

Section 13

GSI Modeling in MIKE URBAN

[GAP] *WTD to comment and add detail on how they plan to incorporate GSI modeling in MIKE URBAN.*

Section 14
References

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Appendix I: GSI Plan Circulation Checklists & GSI QA/QC Checklists

- Table I-1: Checklists for Plan Review Circulation
- Table I-2: CIP Deliverables Checklist for SDOT review
- Table I-3: Project Deliverables Checklist for CIP Lead Agency Review
- SPU's QA/QC Checklist
- SDCI and SPU DSO Plan Reviewers' Post Construction Soil Amendment SIP Checklist, October 2017
- SPU DSO Plan Reviewer's Bioretention with Sloped Sides in Right-of-Way SIP Checklist, October 2017
- SPU DSO Plan Reviewer's Pervious Concrete Sidewalks in Right-of-Way SIP Checklist, October 2017

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CIP Plan Circulation Checklists

Project Team shall review plans and documents to confirm that they are in accordance with the requirements (text, tables) set forth in the GSI Manual Volume III-Design. In addition, this section includes CIP Plan Circulation Checklists to assist the Project Team when compiling deliverables:

- Table I-1: Checklist for Plan Review Circulation
- Table I-2: CIP Plan Deliverables Checklist for SDOT review
- Table I-3: Project Deliverables Checklists at 30/60/90/100 percent design.

See also each agency's respective project deliverables list for 30/60/90/10 percent design.

Table I-1: Checklists for Plan Review Circulation

CHECKLISTS	Design Review			
	30 Percent	60 Percent	90 Percent	100 Percent/ Mylars
SDOT X% SIP Checklist	X	X	X	
SDOT Survey Checklist	X	Resubmit		
SDOT Base Map Checklist	X	Resubmit		
SPU's DSO Plan Reviewer Guidance for Stormwater Code Compliance Checklists (if applicable) (for constructing new City assets in ROW by private developer)				
• Bioretention with Slopes Sides in Right-of-Way		X	X	
• Pervious concrete sidewalks in right-of-way		X	X	

Table I-2 is a list of deliverables required conducting interdepartmental review (including SDOT) of plans for CIP led by SPU or WTD. This list is based in part of SDOT SIP checklists

Table I-2: CIP Deliverables Checklist for SDOT review

DELIVERABLES	**30 Percent**	**60 Percent**	**Resubmit 60 Percent***	**90 Percent**	**Resubmit 90 Percent***	**100 Percent**
SDOT Transmittal Form (if applicable)	X	X	X	X	X	X
Documents listed on SDOT Transmittal Form	X	X	X	X	X	X
Site Photos (on a disc/electronic submittal)[1]	If req'd					
SDOT Checklists (See SDOT Transmittal Form & Table I-1)	X	X		X		X
Base Map/Survey	X	Resubmit?		Update?		
Design Drawings	X	X[2]	X?	X[2]	X?	X
Geotechnical Design Report	If req'd by SDOT	If req'd by SDOT				
Responses to previous SDOT review comments		X	X		X	X
Memorandum on sidewalk restoration analysis (See GSI Manual, Vol. III, Section 7)		X				
Vehicle Turning Movement Analysis at curb bulbs/ revisions to road alignment (See GSI Manual, Vol. III, Section 7)	If req'd by SDOT	If req'd by SDOT				
SPU-SDOT Cost Sharing Analysis (if applicable)	draft	draft		X		X

[1]See SDOT SIP Material Transmittal for Design Guidance Submittals (http://www.seattle.gov/transportation/stuse_sip.htm) and Section 4 in GSI Manual, Vol. III-Design.

[2]Design drawings shall include the elements defined in SDOT's Complete Street Improvement Plan Checklist for 60% and 90%. https://www.seattle.gov/transportation/permits-and-services/permits/street-improvement-permits#sipchecklistsandpreconstructionmaterials . See also Section 2 in GSI Manual, Vol. III-Design, for 30/60/90 Design reviews.

Table I-3 is a sample list of project deliverables for each phase of the design for the CIP's lead agency (i.e. WTD or SPU) review of the GSI project. Actual deliverables may vary depending upon project specific regulatory/permit requirements.

Table I-3: Project Deliverables Checklist for CIP Lead Agency Review

Project Deliverable	30 Percent	60 Percent	Resubmit 60	90 Percent	Resubmit 90	100 Percent
Transmittal	X	X	X	X	X	X
Basis of Design Plan Sheet (SPU-led projects)	X	X		X		X
Project Report (includes BOD, Engineer Report, etc)	X	X		If needed		X
Modeling Report	X	X		If needed		
Geotechnical Design Report	Final[2]	Final[2]				
Hydrogeologic Report	Final[2]					
Design Drawings[1]	X	X	If needed	X	If needed	X
Cadd Design Files		Draft				X
Specifications	Outline	Draft		X		X
Response to previous PS&E milestone review comments		X		X		X
Response to WTD /SPU internal review comments		X	X	X	X	X
Risk Register/ Risk Assessment	X	update		update		final

Table Continues on Next Page

[1]Design Drawings would include drawings, planting plans, and other drawings that would be part of the bid package.

[2] Draft Geotechnical Design Report (GDR) to be completed during Options Analysis. Included in the draft GDR is a final Hydrogeologic Assessment and Basis of Design Report. See Section 5 of GSI Manual, Volume III-Design.

[3]See GSI Manual, Vol. III, Appendix E

[4]Provide draft O&M using format for charts in GSI Manual Volume V for new elements that are currently not covered/developed/deviate from GSI Manual.

"If needed" = to be submitted if there has been significant change in the results/report from previous issuance.

CONTINUED Table I-3: Project Deliverables Checklist

Project Deliverable	30 Percent	60 Percent	Resubmit 60	90 Percent	Resubmit 90	100 Percent
Updated Public Engagement Plan	X	X		If needed		
Cost Estimate	X	X		X		X
Structural Calculations (if applicable)		X		X		X
Copies of submittals for SDOT review (see Table I-2)	X	X	X	X	X	X
Existing Tree Assessment	X			If needed		
Construction Stormwater Pollution Prevention Plan				X		
GSI Component Design Checklist for O&M Approval[3]	X	X		X		
Draft O&M for GSI elements currently not in GSI Manual, Vol V[4]		Outline		Draft		X
GSI Project Information Form for GIS[3]						X
Other documentation required for permits, grants, (i.e. SEPA etc)	Depends on Permit					

[1]Design Drawings would include SIP/SDOT drawings, planting plans, and other drawings that would be part of the bid package.

[2] Draft Geotechnical Report to be completed during Options Analysis. Included in the draft GDR is a final Hydrogeologic Assessment and Basis of Design Report. See Section 5 of GSI Manual, Volume III-Design.

[3]See GSI Manual, Vol. III, Appendix E or http://www.seattle.gov/util/cs/groups/public/@spu/@dso/documents/webcontent/3_038018.pdf

[4]Provide draft O&M using format for charts in GSI Manual Volume V for new elements that are currently not covered/developed/deviate from GSI Manual.

"If needed" = to be submitted if there has been significant change in the results/report from previous issuance.

PLACEHOLDER

Contact SPU Project Manager for SPU QA/QC Checklist for GSI CIP projects. See also SPU's Design Standards & Guidelines.

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Seattle Public Utilities

SDCI AND SPU DSO PLAN REVIEWER CHECKLIST

POST-CONSTRUCTION SOIL AMENDMENT

Plan Reviewer (Name & Department):	
Date of Review:	
SDOT Project # (if applicable):	SDCI Project # (if applicable):
Site Address:	Type of Project:

This checklist is intended to highlight items critical to the performance of post-construction soil amendment that need to be verified by a City of Seattle (COS) Seattle Public Utilities (SPU) plan reviewer or a designated representative. This checklist is for both soil amendment in the public right-of-way (as reviewed by SPU) and on private parcels (as reviewed by Seattle Department of Construction and Inspection (SDCI)). Some items have detailed requirements that may not be explicitly stated; refer to the Stormwater Manual, Volume 3, Section 5.1 (SWWM BMP 5.1), for specifics. This BMP is required for all sites.

TECHNOLOGY DESCRIPTION

All areas subject to clearing, grading or compaction (including construction laydown areas) that have not been covered with impervious surface, incorporated into a drainage facility, or engineered as structural fill or slope, shall meet the soil amendment BMP. Post-construction soil amendment helps a site to regain stormwater function; re-establish a healthy soil ecosystem; provide increased treatment of pollutants and sediments that result from development and habitation; and minimize need for landscaping chemicals.

DESIGN REQUIREMENTS (MANUAL VOLUME 3, SECTION 5.1)

CHOOSE Y FOR YES, N FOR NO, OR NA FOR NOT APPLICABLE. PROVIDE ADDITIONAL INFORMATION WHERE REQUESTED.

RESPONSE	REVIEW ITEM
	A. General—Plans
○Y ○N ○NA	1. Retain and Protect Undisturbed Soil: Plans indicate that areas of vegetation and soil that will be left undisturbed are protected from compaction and materials storage during construction.
○Y ○N ○NA	2. Plans show soil amendment in all disturbed areas (including construction staging areas) except in areas where it does not apply (i.e., paved areas, drainage facilities, engineered structural fill or slope, root zones where tree roots limit the depth of incorporation).
	B. Public ROW (Sidewalk, Trail and Roadway Projects)
○Y ○N ○NA	1. Plans reference COS Std Plan 142 for soil amendment and depth.

RESPONSE	REVIEW ITEM
	C. Private Parcels (SDCI review)
	1. General
○Y ○N ○NA	a. Plans show a cross section or describe through notes how soil amendment is to be provided.
○Y ○N ○NA	b. Scarify: Plans show to scarify (loosen) subsoil 4 inches below amended layer to produce 12-inch depth of un-compacted soil.
○Y ○N ○NA	c. Soil Amendment layer: Plans identify if using Amend Soil, Stockpile Soil and/or Import Soil for layer above scarified subsoil zone.
○Y ○N ○NA	d. Surfacing mulching: Plans show, after placing amended soil and planting, to apply 2 to 4 inches of arborist wood chip or compost mulch to planting beds. (Note: Coarse bark mulch may be used but has lower benefits to plants and soil. Fine bark mulch and fine compost are not allowed.)
○Y ○N ○NA	2. Soil Amendment: plans identify source for amending soil after the subsoil has been scarified. Indicate all that apply: ☐ Amend Soil ☐ Stockpile Soil ☐ Import Soil
	a. **Amend Soil** (complete this section if Amend Soil is selected for the amended layer).
○Y ○N ○NA	i. Plans denote that site topsoil or subsoils are to be amended either at default "pre-approved" rates or at custom calculated rates to meet the soil quality guidelines (see SWMM BMP 5.1) based on engineering tests of the soil and amendment.
	• Indicate all that is proposed: ☐ "Pre-approved rates" ☐ "Custom calculated rates"
	ii. If using default "pre-approved rates," plans indicate:
○Y ○N ○NA	• In planting beds, minimum 3 inches of compost is tilled in to an 8 inch depth
○Y ○N ○NA	• In turf areas, minimum 1.75 inches of compost is tilled in to an 8 inch depth
	b. **Stockpile Soil** (complete this section if Stockpile Soil is selected as the amended layer).
○Y ○N ○NA	i. Plans denote that existing topsoil will be stockpiled during grading and replaced prior to planting.
○Y ○N ○NA	ii. Plans include a note that stockpile soil must demonstrate that it meets organic matter or depth requirements either at the default "pre-approved" rate or a "custom calculated rate" or other method as approved in SWMM BMP 5.1
○Y ○N ○NA	iii. Plans denote 8-inch minimum depth of soil amendment layer using stockpile soils.
	c. **Import Soil** (complete this section if Import Soil is selected and the applicant intends to use the default pre-approved rates for import topsoils).
○Y ○N ○NA	i. For planting beds: plans show a mix by volume of 35 percent compost with 65 percent mineral soil is pre-approved to achieve the requirement of a minimum 8 percent (target 10 percent) organic matter by loss-on-ignition test.
○Y ○N ○NA	ii. For turf areas: plans show a mix by volume of 20 percent compost with 80 percent mineral soil is pre-approved to achieve the requirement of a minimum 4 percent (target 5 percent) organic matter by loss-on-ignition test.
○Y ○N ○NA	iii. Plans denote 8-inch minimum depth of soil amendment layer using import soils.

RESPONSE	REVIEW ITEM
	D. Soil Quality
	1. Topsoil Layer meets following requirements
◯Y ◯N ◯NA	a. Plans reference that topsoil layer is to be per COS Standard Specifications
	i. **Indicate** all that apply: ☐ *9-14.1(1) Topsoil Type A—Imported* ☐ *9-14.1(2) Reused Amended Site Soil* ☐ *9-14.1(4) Planting Soil* ☐ *9-14.1(5) General Turf Area Soil*
◯Y ◯N ◯NA	b. Private Parcels: If plans do not reference COS Standard Specifications, then plans denote topsoil layer is to meet following requirements:
◯Y ◯N ◯NA	i. Planting beds: Topsoil shall have an organic matter content by the loss-on-ignition test of a minimum 8 percent (target 10 percent) dry weight. Test methods per SWMM BMP 5.1
◯Y ◯N ◯NA	ii. Turf areas: Topsoil shall have an organic matter content by the loss-on ignition test of a minimum 4 percent (target 5 percent) dry weight. Test methods per SWMM BMP 5.1
◯Y ◯N ◯NA	iii. A pH from 6.0 to 8.0 or matching the pH of the original undisturbed soil.
◯Y ◯N ◯NA	c. Plan shows that the Topsoil layer shall have a minimum depth of 8 inches.
	2. Compost
◯Y ◯N ◯NA	a. If using the “pre-approved” amendment rates, plans indicate that the compost must meet the definition of “Composted Materials” in WAC 173-350 section 220.
◯Y ◯N ◯NA	b. ROW: Plans note that compost used in ROW shall meet requirements noted in COS Std Plan 142.
◯Y ◯N ◯NA	c. Private Parcels: Plans note that compost meets City of Seattle Specification 9-14.4(8) (recommended but not required). Compost shall have an organic matter content of 40 percent to 65 percent, a carbon to nitrogen ratio (C/N) below 25:1. As an exception, the C/N may be as high as 35:1 for plantings composed entirely of plants native to Puget Sound Lowlands region.
◯Y ◯N ◯NA	d. For private parcels, “Calculated amendment rates” are provided if not using “pre-approved” amendment rates. See SWMM BMP 5.1.
	E. Soil Management Plan is submitted and includes:
◯Y ◯N ◯NA	1. A site map showing areas to be fenced and left undisturbed during construction, and areas that will be amended at the turf or planting bed rates.
◯Y ◯N ◯NA	2. Calculations of the amounts of compost, compost amended topsoil, and mulch to be used on the site.

Other Plan Reviewer Comments (if needed):

Resources:

- Soil Amendment BMP 5.1 as described in City of Seattle Stormwater Manual Volume 3, Section 5.1, January 2016 http://www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web_informational/p2358280.pdf
- Stormwater Code, Director's Rules, On-site Stormwater Management—List Approach Calculator, Pre-Sized Flow Control Calculator, Memorandum of Drainage Control, http://www.seattle.gov/dpd/codesrules/codes/stormwater/
- Seattle Right-of-Way Improvements Manual http://www.seattle.gov/transportation/rowmanual/manual/
- City of Seattle Standard Specifications and Plans http://www.seattle.gov/Util/Engineering/StandardSpecsPlans/index.htm
- Green Stormwater Infrastructure http://www.seattle.gov/util/greeninfrastructure

Seattle Public Utilities

SPU DSO PLAN REVIEWER CHECKLIST

BIORETENTION WITH SLOPED SIDES IN RIGHT-OF-WAY

Plan Reviewer (Name & Department):			
Date of Review:		SDOT Project #:	
Site Address:		Type of Project:	

This checklist highlights items critical to the performance of a bioretention system that need to be verified by a Seattle Public Utilities (SPU) plan reviewer. It covers infiltrating and non-infiltrating bioretention cells with and without underdrains per City of Seattle (COS) Standard Plan (Std) 292 and COS Std Plans 293a and 293b.

TECHNOLOGY DESCRIPTION

Bioretention facilities are shallow earthen depressions with a designed soil mix and plants adapted to the local climate and soil moisture conditions. A bioretention facility can be an individual cell or multiple cells connected in a series, with the overflows of cells directed to downstream cells. Non-infiltrating bioretention cells have a liner and an underdrain.

DESIGN REQUIREMENTS

CHOOSE Y FOR YES, N FOR NO, OR NA FOR NOT APPLICABLE. PROVIDE ADDITIONAL INFORMATION WHERE REQUESTED.

RESPONSE	REVIEW ITEM
	A. If On-Site List Approach
○Y ○N ○NA	1. Applicant has submitted the On-site Stormwater Management—List Approach Calculator and confirmed bioretention facility meets feasibility requirements.
	B. Plans
○Y ○N ○NA	1. Plans include COS standard SIP notes for bioretention.
○Y ○N ○NA	2. Plans reference appropriate COS Std Plan for Bioretention with Sloped Sides.
	a. Indicate which standard plan(s) are used: ☐ *292* ☐ *293a* ☐ *293b* ☐ *and/or* ______.
	3. Plans include a cross section with the bioretention cell (from ~middle of road to property line) showing:
○Y ○N ○NA	a. Minimum horizontal dimension from cell's top of slope to road edge/face of curb (Step out zone): *2 feet non-arterial, 4 feet major arterial*
○Y ○N ○NA	b. Side slope on road side: *2.5H:1V except 3H:1V w/n 50' of intersection or curbless street.*
○Y ○N ○NA	c. Bottom width average: *Minimum 18 inches*
○Y ○N ○NA	d. Temporary ponding depth: *Maximum 12 inches*
○Y ○N ○NA	e. Side slope on sidewalk side: *2.5H:1V*
○Y ○N ○NA	f. Minimum horizontal dimension sidewalk to cell's top of slope: *1-foot*

RESPONSE	REVIEW ITEM
	4. Review cross section dimensions with plan view layout for each cell.
○Y ○N ○NA	a. Confirm cell section horizontally fits within planting strip given design grades and meets setbacks per COS Std Plan.
○Y ○N ○NA	b. Confirm offsets from road to top of slope and from sidewalk to top of slope are met and consistent with detail for cross section and dimensions stated on COS Std Plan.
○Y ○N ○NA	c. Confirm there is adequate space for transitioning from the cell's top of slope to the existing grades at the property line if there is no sidewalk as shown on COS Std Plans.
	C. Common Siting/Layout, Plan Shows
○Y ○N ○NA	1. Cell(s) are sited in ROW where it will receive flow (avoid upstream end of blocks if there is no point discharge). Check road cross section topography and grades to ensure sheet flow goes to cell.
○Y ○N ○NA	2. Cell(s) are sited outside designated disabled parking space.
○Y ○N ○NA	3. Cell(s) are set back from structures, features, and utilities per ROWIM.
○Y ○N ○NA	4. Setbacks for cell's infiltration area to structures/property lines meet Stormwater Manual Volume 3 requirements.
○Y ○N ○NA	5. Cell(s) are sited to allow for periodic pedestrian access to road edge and do not inhibit access to parcels.
	D. Contributing Area and Sizing
○Y ○N ○NA	1. Cell(s)' sizing shown on plan appears consistent with Drainage Report.
○Y ○N ○NA	2. Cell meets minimum size for ROW applications.
	E. Geotech
○Y ○N ○NA	1. Geotechnical information noted in the Drainage Report or Geotechnical Report is reflected in the notes and details on the plans.
○Y ○N ○NA	2. Liner is specified on plan if required for non-infiltrating bioretention (applies to Std Plan 293b)
○Y ○N ○NA	3. For infiltrating cells, confirm that, given design grades and a cell's cross section shown on the plan, adequate separation between elevation of the bottom of cell's section and groundwater elevation or hydraulically restrictive layer elevation (see Std Plans 292 and 293a) is provided.
	a. Separation vertical distance = ____________ feet.
	F. Presettling Zone
○Y ○N ○NA	1. Presettling Zone (if required due to tributary area) is identified on plans (see Std Plan 299 and Table 5.16 in SWMV3). http://www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web_informational/p2358280.pdf#page=134
	G. Flow Entrance
○Y ○N ○NA	1. For streets with curbs, plan shows that flow entrance and overflow are to be in accordance with Std Plans 295a, 295b, 295c, 295d as applicable.
○Y ○N ○NA	2. For streets that are cement concrete, plan shows that drain curb cut is not located within concrete panel's joint *(Note: concrete panel joints in a drain curb cut can cause sheetflow to bypass the curb cut by flowing into the joint and around the drain curb cut).*
○Y ○N ○NA	3. Plan shows that flow entrance is sited where it will intercept gutter flow (i.e., check street grades and cross slope).

RESPONSE	REVIEW ITEM
	H. Ponding Depth, Freeboard and Overflow
◯Y ◯N ◯NA	1. Plan shows that proposed grades of cells do not exceed max. ponding depth. *(Note: Compare cell bottom elevation to elevation at outflow, i.e., drain curb cut or CB rim elevation to confirm it is less or equal to max. ponding depth.)*
	a. Max. ponding depth = ______ inches
◯Y ◯N ◯NA	2. Plan shows that freeboard is provided and meets code minimum. (Maximum design water surface and overflow elevation is lower than sidewalk/property elevation or elevation at downstream berm. Freeboard is the difference between these elements).
	a. Freeboard = ______ inches
◯Y ◯N ◯NA	3. Review plan to confirm overflow pathway is set such that downstream sheet flow path stays in ROW and not onto private property or onto public sidewalks.
	I. Side Slopes
◯Y ◯N ◯NA	1. Maximum side slopes shown on plan do not exceed requirements in COS Std Plans 292, 293a and 293b, except note that where trees are planted, side slope may be steeper (1H:1V) and bottom width may narrow.
	a. Side slope on road side: ______
	b. Side slope on sidewalk side/property line side: ______
	J. Drainage /Utility Structures
◯Y ◯N ◯NA	1. Plan shows cleanouts and MH lids are located outside of bioretention cells (not in bottom or on side slopes of cell).
◯Y ◯N ◯NA	2. If CB is used for overflow and located within cell, plan shows beehive grate (per COS Std 269) noted and elevation at top of frame (base of beehive) is at max design water surface.
◯Y ◯N ◯NA	3. Plan shows that overflow CB is not sited on side slopes of bioretention (for ease of O&M access).
◯Y ◯N ◯NA	4. Plan shows that water meters, valves, vaults, etc., are located outside of bioretention cell.
	K. Access between Multiple Cells in a Series across Planting Strip
◯Y ◯N ◯NA	1. Plan shows one level access area (*minimum 5-foot level zone*) across planting strip (sidewalk to roadway) between cells is provided for each parcel. Align with private access path if feasible. (*Note: If there is no on-street parking, this requirement may not be needed but consider O&M access.*)
◯Y ◯N ◯NA	2. If private property has accessible designation access path that intersects with public sidewalk adjacent to bioretention cell, review if path from public sidewalk to on-street parking needs to be designed to meet ADA standards.

RESPONSE	REVIEW ITEM
	L. Plants for Bioretention Facility
○Y ○N ○NA	1. Plants for ROW bioretention cells and street trees shown on plan are in accordance with ROWIM and list in Appendix E of Stormwater Manual Volume 3.
○Y ○N ○NA	2. Facilities receiving runoff from 5,000 square feet or more of hard surface have been designed and plans stamped by a licensed professional landscape architect.
○Y ○N ○NA	3. Plan shows that plants' spacing and placement do not block flow entrances and overflows.
○Y ○N ○NA	4. If facility is lined, plan shows that trees and accent shrubs are located outside of the lined bioretention (Std Plan 293b) unless determined otherwise with Urban Forestry and adequate soil volume is provided.
○Y ○N ○NA	5. Plan shows that plantings/surface materials at level areas/step out zones from cell's top of slope to street edge/sidewalk are in accordance with ROWIM.
	M. Mulch
○Y ○N ○NA	1. Plan notes that mulch adheres to COS Std Plans.
	N. Cells with Underdrains (Std Plans 293a and 293b)
○Y ○N ○NA	1. Underdrain pipe to CB is shown on plan.
○Y ○N ○NA	2. Plan shows required clearance between street trees and underdrain pipe.
	O. Green Stormwater Infrastructure Project Information Form
○Y ○N ○NA	1. Applicant has been provided a copy of the Project Information Form to complete for the ROW GSI facilities (e.g., bioretention, pervious concrete sidewalks, etc.) at post construction. Inform applicant of form in your review comments.
○Y ○N ○NA	2. Applicant has been notified of the CAM for Bioretention Special Inspection for facilities installed in the ROW. Inform applicant of CAM in your review comments.

Other Plan Reviewer Comments (if needed):

Resources:

- Infiltrating bioretention as described in City of Seattle Stormwater Manual Volume 3, Section 5.4.4, January 2016 http://www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web_informational/p2358280.pdf#page=127
- Non-Infiltrating bioretention as described in City of Seattle Stormwater Manual Volume 3, Section 5.8.2, January 2016 http://www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web_informational/p2358280.pdf#page=239
- Stormwater Code, Director's Rules, On-site Stormwater Management—List Approach Calculator, Pre-Sized Flow Control Calculator, Memorandum of Drainage Control, http://www.seattle.gov/dpd/codesrules/codes/stormwater/
- Seattle Right-of-Way Improvements Manual http://www.seattle.gov/transportation/rowmanual/manual/
- City of Seattle Standard Plans and Specifications http://www.seattle.gov/Util/Engineering/StandardSpecsPlans/index.htm
- Green Stormwater Infrastructure http://www.seattle.gov/util/greeninfrastructure

Seattle Public Utilities

SPU DSO PLAN REVIEWER CHECKLIST
PERVIOUS CONCRETE SIDEWALKS IN RIGHT-OF-WAY

Plan Reviewer (Name & Department):			
Date of Review:		SDOT Project #:	
Site Address:		Type of Project:	

This checklist highlights items critical to the performance of pervious concrete sidewalks in the City's ROW to be addressed in the design plans and verified by a Seattle Public Utilities (SPU) plan reviewer. It covers pervious concrete sidewalks per City of Seattle (COS) Standard (Std) Plan 425.

TECHNOLOGY DESCRIPTION

Pervious concrete sidewalks allow for infiltration of stormwater while providing a stable surface suitable for pedestrian loads. This pavement contains sufficient void space to infiltrate runoff into the underlying subbase and native soils. Public pervious concrete sidewalks are considered **Permeable Pavement Surfaces** (as opposed to **Facilities**) because they are designed only to manage the water which falls directly upon it (SWMV3, 5.6.2).

DESIGN REQUIREMENTS

CHOOSE Y FOR YES, N FOR NO, OR NA FOR NOT APPLICABLE. PROVIDE ADDITIONAL INFORMATION WHERE REQUESTED.

RESPONSE	REVIEW ITEM
	A. If On-Site List Approach
◯Y ◯N ◯NA	1. Applicant has submitted the On-site Stormwater Management—List Approach Calculator and confirmed pervious concrete sidewalk meets feasibility requirements.
	B. Plans
◯Y ◯N ◯NA	1. Plans reference COS Std Plan 425.
◯Y ◯N ◯NA	2. If pervious concrete sidewalk interfaces with a residential driveway (COS Std Plan 430A), plan includes a note to reference transition at driveways per COS Std Plan 425.
	C. Symbols
◯Y ◯N ◯NA	1. Plan shows that symbols and hatches for pervious concrete sidewalks match COS Std Plan 003 F&G for implementation and asset tracking.
	D. Catchment Area
◯Y ◯N ◯NA	1. Plan shows that the sidewalk does not receive run-on from impervious surfaces greater than 10% of the pervious sidewalk area. *(Note: Review grading and paving plan for contributing area to sidewalk.)*
◯Y ◯N ◯NA	2. Plan shows that any run-on is dispersed and not concentrated at one location. *(Note: Check grading plan for possible concentrated flow discharges onto the pavement. And check drainage plan for possible point discharges from pipes or other conveyance systems daylighting onto pavement. If found, inform they need to revise so not concentrated.)*
◯Y ◯N ◯NA	3. Plan shows that the sidewalk does not receive run-on from pollution generating surfaces.

RESPONSE	REVIEW ITEM
	E. Siting and Grades, plan shows:
◯Y ◯N ◯NA	1. Pervious concrete sidewalk area is not less than 250 square feet.
◯Y ◯N ◯NA	2. Sidewalk cross slope is consistent with COS Std Plan 425.
◯Y ◯N ◯NA	3. Longitudinal slope of sidewalk (profile grade) does not exceed 6% per COS Std Plan 425.
◯Y ◯N ◯NA	4. If longitudinal slope is between 5% and 6%, subsurface check dams are provided if applicable, unless determined otherwise by licensed professional. See manual for examples of check dams.
◯Y ◯N ◯NA	5. Seven-foot (7') setback is provided from pervious pavement to travel lane of arterial roads & other City streets (such as neighborhood streets near schools and public facilities) that are treated/sanded in the winter (See City of Seattle Stormwater Manual Volume 3, January 2016, Sections 5.6.2.4 & 5.4.6.4).
◯Y ◯N ◯NA	6. Adjacent property use does not carry risk of pollutant spills, gas stations, car washes, vehicle maintenance, material storage etc. that could be tracked (i.e. vehicle tires) or drain onto pervious pavement.
	F. Geotechnical & Hydrogeologic conditions
◯Y ◯N ◯NA	1. Geotechnical information noted in the Drainage Report or Geotechnical Report is reflected in the notes and details on the plan.
◯Y ◯N ◯NA	2. Plan shows that the elevation of pavement section's subgrade is 1' or 3' from seasonal high groundwater/hydraulic restrictive layer. Estimated seasonal high groundwater elevation is noted on the plan.
	G. Drainage/Utility Structures
◯Y ◯N ◯NA	1. Where utility structures/castings are located in pavement, the plan shows that the width of the pervious pavement from the cast to the edge of the pervious concrete walk is a minimum of ~6".
	H. Contraction Joint Spacing
◯Y ◯N ◯NA	1. Plan shows that the contraction joint spacing does not exceed 15' (for 6' walk).
	I. Green Stormwater Infrastructure (GSI) Project Information Form
◯Y ◯N ◯NA	1. Applicant has been provided a copy of the Project Information Form to complete for the ROW GSI facilities (e.g., pervious concrete sidewalks, rain gardens, bioretention) at post construction. Inform applicant of form in your review comments.

Other Plan Reviewer Comments (if needed):

Resources:

- Permeable Pavement Surfaces as described in City of Seattle Stormwater Manual Volume 3, Section 5.6.2, January 2016 http://www.seattle.gov/dpd/cs/groups/pan/@pan/documents/web_informational/p2358280.pdf#page=207
- Stormwater Code, Director's Rules, On-site Stormwater Management—List Approach Calculator, Pre-Sized Flow Control Calculator, Memorandum of Drainage Control, http://www.seattle.gov/dpd/codesrules/codes/stormwater/
- Seattle Right-of-Way Improvements Manual http://www.seattle.gov/transportation/rowmanual/manual/
- City of Seattle Standard Specifications and Plans http://www.seattle.gov/Util/Engineering/StandardSpecsPlans/index.htm
- Green Stormwater Infrastructure http://www.seattle.gov/util/greeninfrastructure

Appendix J: Comparison of Watering Methods Analysis Example

- King County Barton Memo #21 – Irrigation Approach and Comparison Analysis, June, 28, 2012*
  *This example was for a design that consolidated the bioretention cells at the end of a block.

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SvR DESIGN COMPANY

EXAMPLE

MEMORANDUM # 21

FOR INTERNAL DISCUSSION PURPOSES

DATE: June 28, 2012

TO: Mary Wohleb, PMP, King County WTD
Chris Tiffany, King County WTD
Harold Perry, King County WTD

FROM: Jennifer Lathrop, PLA
Peg Staeheli, PLA

RE: **Task #1320 – Irrigation Approach & Comparison Analysis**
KC WTD - BARTON CSO CONTROL PROJECT WITH GSI (E00222E11)
SvR # 11021

MEMORANDUM PURPOSE

This memorandum has been prepared for King County Wastewater Treatment Division (KCWTD)'s Barton Combined Sewer Overflow (CSO) control project with Green Stormwater Infrastructure (GSI) as part of TASK #1320.

The purpose of the memorandum is to provide King County Wastewater Treatment Division (KC WTD) with the basis of methodology and assumptions used in developing a matrix comparing irrigation/watering alternatives for new landscape areas for the GSI systems and provide a recommended approach for irrigating/watering the GSI systems. The matrix is based on the 30% conceptual design for Barton CSO Control project with GSI.

PROJECT BACKGROUND

In 2008 KCWTD reported that the Barton CSO facility had four overflows per year on average that discharge a total of four million gallons into Puget Sound near the Fauntleroy Ferry Terminal in West Seattle. A CSO event is when a mixture of raw sewage and stormwater discharges into local water bodies. In order to provide CSO control of no more than one overflow per year for compliance with Department of Ecology requirements (Ecology), the project proposes to utilize Green Stormwater Infrastructure (GSI) to filter and infiltrate combined sewer conveyance system. The reduction in stormwater runoff volume will reduce the CSO overflow events.

The GSI approach includes installing bioretention swales along multiple streets within the Project Area in order to intercept, treat and reduce the amount of stormwater discharging into the combined sewer pipes. Once the stormwater has filtered through the bioretention soil, it will discharge into an

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underdrain that then conveys the flows to a structure (UIC well) for deep infiltration into a soil layer identified as Vashon Advance Outwash. The Project Area for implementing GSI for Barton's CSO control is an area within Barton 416 Subbasin. The Project Area is from SW Othello Street to SW Barton Street and from an alley just west of 34th Avenue SW to approximately 30th Avenue SW.

COMPARISION OF FOUR ALTERNATIVES FOR WATERING

Four alternative approaches for watering the GSI systems were used for this comparative analysis. They include:

- Fixed spray sprinkler circuits
- Low volume drip circuits
- Quick-coupling valve systems
- Manual watering via water trucks

For the comparative analysis we looked at the following areas:

- Ease of implementation, including familiarity of proposed irrigation system components with construction personnel.
- Expected maintenance and repair criteria.
- Maintenance labor intensity.
- Neighborhood impacts (post construction).
- Operational needs.
- Maintenance needs.
- Water connections.
- Power sources (assumes implementation of battery-operated controllers and/or battery-operated valves).
- Watering frequency and efficiency.
- Watering hours.
- Expected life cycle.
- Potential obstructions.
- Establishment versus long-term considerations.

The comparison of the four approaches used the material, labor, equipment and watering costs developed for retrofitting four streets with GSI as templates (see SDOT Design Guidance Meeting materials dated 12/20/2011). These costs were extrapolated to a total of 31 retrofitted streets (shown in the 30% SIP drawings issued 4/6/2012) from 1st year implementation and maintenance, through plant establishment (currently planned as years 2 through 4), post plant establishment (years 5 through 10) and beyond through year 15. We selected 15 years as the cut off for this comparative analysis because of the expected lifespan of typical drip irrigation components. Escalation was not included in the costs and the estimate was based on Spring 2012 material, equipment, labor and SPU water rates.

SUMMARY

A summary of the results for each of the areas reviewed in the comparison analysis of the four systems is shown on the attached matrix. Some areas to highlight include the following:

Cost comparisons:
The projected material, labor and water costs within the matrix yielded the following total per square foot costs for a 15-year period beginning at initial installation.

- Fixed spray sprinkler circuits: $3.75 to $4.50
- Low volume drip circuits: $4.25 to $5.50
- Quick-coupling valve systems: $16.00 to $18.00
- Watering truck: $19.00 to $22.25

Community Impacts:
Implementation of the GSI retrofits may be perceived as disruptive to the existing Sunrise Heights and Westwood Community neighborhoods, including the chosen irrigation watering approach for new planting areas. The following summarizes potential impacts from four approaches to irrigation:

Low impacts:
- Operation of fixed spray irrigation circuits may introduce "white noise" from sprinkler spray nozzles.
- Broken sprinkler heads could create localized puddles and runoff of water during operation.
- Drip tubing can become exposed and accessible visually and physically.
- Trees could be watered by gators bags minimizing labor and improving effectiveness.

Medium impacts:
- Maintenance personnel would be present during daylight hours two to three times a week during establishment to conduct hand watering of plants.
- Pulling of hoses along the ground plane can pose a tripping hazard.
- Pulling of hoses could damage some plantings.

High impacts:
- Parking and maneuvering of watering trucks during daylight hours could be disruptive to neighborhood vehicular and pedestrian circulation.
- Maneuvering of water trucks may result in uneven irrigation.
- Truck and water pump noise and exhaust levels need to be considered.

NEXT STEPS

While it appears that a fixed spray approach is most cost effective in the long run there are design and management issues that require additional consideration. Project sequencing, adjacency of GSI between blocks, length of GSI within the block, plant selection and establishment contract all factor into the best value decision. The approach will also need to be viewed in the context of activity in the neighborhood. There may be advantages to a watering truck or hybrid approach as that will put additional eyes on the system to review function and other maintenance issues. It is our recommendation that the project continue to carry to cost of a fixed spray system into Phase 2 with the understanding that it is a placeholder to be reviewed following 60%.

Next steps to be undertaken include:

1. Coordinate with agency and lead operations and maintenance personnel for watering recommendations within the context of the design variables.
2. Confirm agency internal, other agency or contract approach for routine maintenance.
3. Confirm estimated costs and lifecycle.
4. Review life cycle expectancy of specific irrigation components.
5. Consider and address potential neighborhood impacts.

If you have any questions or comments, please give us a call/email.

Attachment: Irrigation Approach & Comparison Analysis Matrix

EXAMPLE

King County Department of Natural Resources and Parks Wastewater Treatment Division

SvR DESIGN COMPANY

BARTON CSO CONTROL PROJECT WITH GSI (E00222E11)

SvR Memo #21 – Task 1320, Irrigation Approach & Comparison Analysis

June 28, 2012

SvR# 11021

Item	Fixed Spray Sprinkler Circuits	Low Volume Drip Circuits	Quick-Coupling Valve System	Watering Truck
Description	Spray heads on circuit zones per planting type. Circuits are activated by remote control valves on timers. Water is from a potable water source and is separately metered. Spray heads are set flush to grade and "pop-up" during operation.	Drip tubing with built-in drip emitters on circuit zones per planting type. Circuits are activated by remote control valves on timers. Water is from a potable water source and is separately metered. Drip tubing set below mulch and is not visible during operation.	Quick-coupling valves on irrigation mains provide a remote water source to connect a hose for manual watering. Quick-coupling valves are activated by valve keys. Water is from a potable water source and is separately metered. Quick-coupling valves are set slightly below grade and are enclosed within valve access boxes set flush to grade.	Includes water tanks and water pumps on the back of a flat-bed or heavy-duty truck. Water is from a nearby hydrant or other separately metered potable source. Hoses connect to the tank/pump assembly for manual watering.
Implementation	Construction and maintenance personnel need to be familiar with typical right of way fixed spray system components, installation and operation.	Construction and maintenance personnel need to be familiar with typical right of way drip system components, installation and operation.	Construction and maintenance personnel need to be familiar with typical quick-coupling components, installation and operation. Maintenance personnel need to be familiar with plant watering needs and function of soils within bioretention areas. Requires procurement of hoses (not included).	Maintenance personnel need to be familiar with plant watering needs and function of soils within bioretention areas. Requires procurement or securing of trucks, water tanks, pumps and hoses (not included).
Maintenance / Repair Criteria	Allows for easy visual observation of system and circuit operations and water coverage. Breaks in piping, clogged nozzles, malfunctioning or damaged heads or valves can be easily identified, isolated and repaired. Maturing shrub canopy growth could possibly block spray patterns.	Due to subsurface installation, drip tubing circuits do not allow for easy visual observation of proper operation and water coverage. Damaged or severed drip tubing and/or clogged drip emitters are typically only identified after plant materials exhibit signs of significant stressed or are dying due to lack of water. Shrub canopy growth won't affect water coverage.	Breaks in piping or malfunctioning quick-coupling valves can be easily identified, isolated and repaired. General routine maintenance of hoses and valves are needed.	General routine maintenance of trucks, water tanks, pumps, hoses and valves are needed.
Maintenance/ Labor Intensity	Intensive at initial installation only, then monthly inspections of circuit operation during growing season. Affords significant reduction in labor hours when compared to hand-watering via quick-coupling system or watering truck, though personnel need to be familiar with irrigation components.	Somewhat intensive at initial installation only (due to reduced trenching afforded by drip tubing), then periodic inspections of circuits monthly during growing season. Affords significant reduction in labor hours when compared to hand-watering via quick-coupling system or watering truck, though personnel need to be familiar with irrigation components.	Minimally intensive at initial installation (trenching for mains, sub-mains and quick-coupling valves at 50' to 100' spacings). Very labor intensive, assumes minimum 3x per week for 10 weeks through plant establishment and post-plant establishment phases, then 2x per week for 10 weeks thereafter. Each site visit requires travel to site, set-up of hoses and hand watering of plants. Assume 2 laborers each watering occurrence.	Very labor intensive, assumes minimum 3x per week for 10 weeks through plant establishment and post-plant establishment phases, then 2x per week for 10 weeks thereafter. Each site visit requires travel to site, travel to water source location, water tank fill-up, and hand watering of plants. Assume 2 laborers each watering occurrence.
Neighbor Impacts (Post Construction)	Low: Circuits would be operational from midnight to 6:00am. System activation results in gentle "white noise" from sprinkler spray nozzles.	None. Circuits could be operational any time of day, but late evening/early morning hours are preferred. System activation results in no noticeable noise.	Moderate: Maintenance personnel would be present during daylight hours to conduct hand watering of plants. Hoses can pose a tripping hazard.	High: Parking and maneuvering of watering trucks during daylight hours would be disruptive to neighborhood vehicular and pedestrian circulation. Truck and water pump noise and exhaust levels need to be considered. Hoses can pose a tripping hazard.
Operational Needs	Periodic status reports. Coordination with agency staff. Annual battery replacements for controllers and/or control valves.	Periodic status reports. Coordination with agency staff. Annual battery replacements for controllers and/or control valves.	General routine maintenance of maintenance vehicles, hoses and valves are needed. Periodic status reports. Coordination with agency staff.	Fuel for water truck and water pumps. General routine maintenance of trucks, water tanks, pumps, hoses and valves are needed. Periodic status reports. Coordination with agency staff.

King County
Department of
Natural Resources and Parks
Wastewater Treatment
Division

SvR DESIGN COMPANY

Item	Fixed Spray Sprinkler Circuits	Low Volume Drip Circuits	Quick-Coupling Valve System	Watering Truck
Maintenance Needs	Pop-up spray heads can be susceptible to vandalism. Possible breakage of pipes could occur with excavations exceeding 10” depth.	Drip tubing is susceptible to damage and vandalism if mulch is displaced and tubing exposed (such as in areas of concentrated pedestrian crossings). Once exposed, large amounts of drip tubing could be easily pulled out of the ground by vandals. Possible severing of drip tubing could occur with shallow excavation work. Possible breakage of pipes could occur with excavations exceeding 10” depth.	General routine maintenance of hoses and valves are needed.	General routine maintenance of trucks, water tanks, pumps, hoses and valves are needed.
Water Source	Options are for rainwater harvesting or traditional potable water. 1. Rainwater harvesting would require multiple vaults and likely supplemental water would be needed during peak summer months. 2. Traditional potable water requires connections to public water mains and installation of water meters and backflow preventions at each water source connection.	Options are for rainwater harvesting or traditional potable water. 1. Rainwater harvesting would require multiple vaults and likely supplemental water would be needed during peak summer months. 2. Traditional potable water requires connections to public water mains and installation of water meters and backflow preventions at each water source connection.	Options are for rainwater harvesting or traditional potable water. 1. Rainwater harvesting would require multiple vaults and likely supplemental water would be needed during peak summer months. 2. Traditional potable water requires connections to public water mains and installation of water meters and backflow preventions at each water source connection.	Options are for rainwater harvesting or traditional potable water. 1. Rainwater harvesting would require multiple vaults and likely supplemental water would be needed during peak summer months. 2. Traditional potable water requires connections to public water mains and installation of water meters and backflow preventions at each water source connection.
Power Sources	System design will specify battery-operated controllers and/or circuit valves (assumed for costs below), eliminating the need for power connections, electrical meter and above-grade cabinets. Conversion to solar powered controllers will be further explored in the next phase of design.	System design will specify battery-operated controllers and/or circuit valves (assumed for costs below), eliminating the need for power connections, electrical meter and above-grade cabinets. Conversion to solar powered controllers will be further explored in the next phase of design.	N/A	N/A
Watering Frequency & Efficiency	System can provide multiple start-soak times for optimum water application without wasted runoff. Typical fixed spray systems are approx 65-70% efficient in terms of water use.	System can provide multiple start-soak times for optimum water application without wasted runoff. Typical drip systems are approx 90-92% efficient in terms of water use.	Requires multiple watering cycles for each watering event to provide deep root watering and to reduce runoff. (Note: Bioretention soils with underdrain will drain readily and don’t “hold” water as typical landscape soils.) Each site visit requires travel to site, and hand watering of plants. Estimate below assumes 2 laborers each watering occurrence.	Requires multiple watering cycles for each watering event to provide deep root watering and to reduce runoff. (Note: Bioretention soils with underdrain will drain readily and don’t “hold” water as typical landscape soils.) Each site visit requires travel to site, travel to water source location, water tank fill-up, and hand watering of plants. Estimate below assumes 2 laborers each watering occurrence.
Watering Hours	Midnight to 6:00am	Ideally midnight to 6:00am, but can be operational any time of day	During daylight hours and in accordance with City of Seattle SMC 25.08 noise ordinance for residential zones.	During daylight hours and in accordance with City of Seattle SMC 25.08 noise ordinance for residential zones.
Life Cycle	Components are durable and long lasting (20+ years) with standard maintenance, repairs and care.	Components are durable and long lasting (15+ years) with standard maintenance, repairs and care.	Components are durable and long lasting (30+ years) with standard maintenance, repairs and care. Requires routine maintenance of quick-coupling valves and hoses.	Requires routine maintenance of trucks, water tanks, pumps, and hoses. Trucks and pumps, depending on routine maintenance, may need replacement.

King County Department of Natural Resources and Parks
Wastewater Treatment Division

SvR DESIGN COMPANY

Item	Fixed Spray Sprinkler Circuits	Low Volume Drip Circuits	Quick-Coupling Valve System	Watering Truck
Potential Obstructions	All components are installed flush with or below finish grade.	All components are installed flush with or below finish grade. Drip tubing can become exposed if mulch covering is displaced. Exposed drip tubing could pose a tripping hazard to pedestrians.	Piping and valve components are installed flush with or below finish grade. Hoses, pulled along the ground plane during watering cycles can pose a tripping hazard to pedestrians.	Broadcast spray from hoses could overthrow water onto adjacent vehicles, walkways and private properties. Hoses, pulled along the ground plane during watering cycles can pose a tripping hazard to pedestrians.
Establishment versus Long-Term	System reactivation after 3 to 5 years of non-use is easily achievable with minimal costs.	System reactivation after 3 to 5 years of non-use could be significant, depending on exposure of drip tubing and damage to drip irrigation components.	System reactivation after 3 to 5 years of non-use is easily achievable with minimal costs. Crews can be dispatched at most any time depending on need.	Crews can be dispatched at most any time depending on need.

Estimated Labor and Water Costs

Item	Fixed Spray Sprinkler Circuits	Low Volume Drip Circuits	Quick-Coupling Valve System	Watering Truck
Installation & Labor Costs – 1st year	$1.45 to $1.75 per square foot	$0.95 to $1.25 per square foot	$2.04 to $2.33 per square foot	$1.60 to $1.80 per square foot
Labor Costs – Plant Establishment (2 to 4 yrs)	$0.07 to $0.09 per square foot	$0.10 to $0.13 per square foot	$1.22 to $1.38 per square foot	$1.44 to $1.62 per square foot
Labor Costs – Post Plant Establishment (5 to 10 yrs)	$0.12 to $0.14 per square foot	$0.19 to $0.25 per square foot	$1.02 to $1.15 per square foot	$1.20 to $1.35 per square foot
Labor Costs – 11-15 yrs	$0.15 to $0.18 per square foot	$0.29 to $0.38 per square foot	$1.02 to $1.15 per square foot	$1.20 to $1.35 per square foot
Water Cost – each year (based on SPU 2012 water rates)	$0.04 per square foot	$0.027 per square foot	$0.05 per square foot	$0.05 per square foot
Total Accumulative Costs After 15 years	**$3.75 to $4.50 per square foot**	**$4.25 to $5.50 per square foot**	**$16.00 to $18.00 per square foot**	**$20.00 to $22.25 per square foot**

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Appendix K: Carbon Accounting for GSI CIP Guidance Memo

- Carbon Accounting for GSI Projects Guidance Memo

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PLACEHOLDER

Carbon Accounting for GSI Projects Guidance Memo from King County WTD was not available at time of issuance Design Volume update in October 2017

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Appendix L: Guidance on Side Sewer Repairs for GSI CIPs

- Guidance on when to repair side sewers as part of Green Stormwater Infrastructure CIPs, May 29, 2015
- SPU's Draft "Acknowledgement to reconstruct a private side sewer in the public right-of-way agreement" for SPU led CIP

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Guidance on when to repair side sewers as part of Green Stormwater Infrastructure CIPs
May 29, 2015

Project Team: Shanti Colwell (lead), Grace Manzano, April Mills, Don Anderson
Reviewers: Lizzie Brodeen-Kuo (SPU Claims), Stephen Karbowski (City Attorney's Office), Ede Courtenay (DPD)
Decision Makers: Tracy Tackett

Objective: Provide guidance documents for project team to use when determining if a portion of a side sewer should be replaced in the ROW during construction of SPU's green stormwater infrastructure (GSI) facilities.

Guidance: Side sewers are owned by the private property owner which they serve, per the Side Sewer Code (SMC 21.16.190). The side sewer, also known as lateral, is a utility line located from the wye off the public sewer main to the property owner's home or structure. Under SMC 21.16.190, any maintenance work (including repairs and all associated costs) are the responsibility of the property owner, not the City of Seattle. However, due to the rationale listed below, it has been determined by the GSI Program that in a limited number of Natural Drainage System (NDS) projects, SPU may agree to perform side sewer repairs and cover some or all of the costs of such repairs and relocations, if: 1) the condition of the side sewer is determined to be moderate to poor by a qualified SPU reviewer; 2) the side sewer is physically located under or adjacent to the proposed bioretention facilities, and 3) there is clear benefit(s) to the utility to do so. The rationale includes:

1) Side sewers identified as being in moderate to poor condition (as defined below) have the potential to fail within 10 years. If a bioretention facility was installed as part of a NDS project without any repairs to the side sewer under the facility and some years later the side sewer requires maintenance/repair work, then the property owner may need to excavate through the project to conduct the side sewer repair work. The property owner would be required to restore the bioretention facility back to its previous condition. However, since the repair would not be under SPU oversight, there is concern about the quality of the repair to both the side sewer and the impact on the bioretention facility performance.
2) The objective of NDS projects is removing stormwater from SPU's drainage and sewer systems, which has a downstream benefit from lower flows in the system. If repairs to side sewers in moderate to poor condition are not performed, the relatively shallow condition allows a conduit for water to infiltrate through the bioretention cell and re-enter the combined system through cracks in the side sewer. This has the potential to reduce the overall performance of the NDS project.
3) Side sewer repair cost can be substantial (approximately $10K-$40K). If private property owners are required to bear the cost of repairing their side sewer identified in moderate to poor condition over which a bioretention facility will be constructed, this may result in lower than expected owner and community support for such NDS projects.

The table below provides criteria for side sewer repair or protection as part of an NDS project.

Assumptions:

1. No heavy equipment is allowed in the cell.
2. A clay dam is required for all side sewers within 3’ vertically of the facility excavation that fall under the “Mitigate for potential impacts” category below. The clay dam shall not be placed directly under the bottom of the bioretention cell bottom area because it would restrict infiltration.
3. Standard covers and clearances are maintained.
4. A 1’ separation between the bottom of a vertical wall and side sewer is maintained, unless the side sewer is encased in ductile iron pipe.
5. The side sewers under bioretention cells will be CCTVed before (after locations are well defined, 30-60% design) and after construction. The video will be reviewed for significant defects that warrant immediate action and observation coding documented, but the lines won’t have a coded conditions assessment (M3R structural algorithm scoring) performed.
6. During construction, all side sewers that appear to be under bioretention cells will be potholed and the Project Action per the table below will be taken.
7. Any side sewers that are determined to need repair will get a signed letter from the homeowner acknowledging this work and acceptance of ownership of the reconstructed side sewer after completion. In addition, the homeowner will release, indemnify and hold the City and SPU harmless from claims or damages related to SPU’s repair, reconstruction or relocation of the side sewer.
8. The GSI project covers the one-time cost of the protection, repair, or relining of a side sewer pipe within the public right-of-way. The extent of the repair shall be for the area under the bioretention facility to meet the rationale stated above and does not assume extension of the work into the street or onto private property. If it is determined that the work needs to extend onto private property, either a Temporary Construction Easement from the property owner would have to be obtained for SPU to do the work on the private property, or the property owner will do the work instead.
9. There is a quantifiable benefit to the utility from performing the side sewer repair or protection work as part of an NDS project.

Project Action	Vertical distance to the top of the side sewer from bottom of facility excavation:	
	> 3’	< 3’
Side sewer is in good condition		
Protect in place		X
Do nothing	X	
Side sewer is in moderate to poor condition		
Mitigate for potential impacts (may include, repair, relining, encase, etc)		X
Do nothing	X	

City of Seattle
Seattle Public Utilities

ACKNOWLEDGEMENT TO RECONSTRUCT A PRIVATE SIDE SEWER IN THE PUBLIC RIGHT-OF-WAY
AND
WAIVER AND INDEMNITY AGREEMENT

Acknowledgement is hereby granted to the City of Seattle, its authorized agents and/or contractors, to perform repair, reconstruction and relocation work on a private side sewer within the public right-of-way serving the following property:

Property Owner:	*Owner Name(s)*
Property Address:	_______ *17th Avenue SW*
Property Tax Parcel No.:	*123456-9999*
Project Name:	Delridge Natural Drainage Systems (NDS) Project, Project #C312056 (a.k.a. Delridge Roadside Raingardens 2015)

FOR THE PURPOSES OF: [Moving, repairing, replacing, protecting] a private side sewer in order to accommodate public works improvements within the public right-of-way. These public improvements include but are not limited to: raingardens, drainage pipes, vertical concrete walls, reconstructed sidewalks, curbs and gutters, and concrete roadway panels, all associated with the [Delridge Natural Drainage System (NDS) Project, which is a project to install roadside raingardens within the planting strip of the public right-of-way to keep stormwater out of the combined sewer system]. All construction work will occur only within the public right-of-way.

Comment [SKCAO1]: What happens if the side sewer work extends onto private property? Need to provide permission for that as well (Temporary Construction Easement would be most appropriate)

As part of this effort, Seattle Public Utilities (SPU) employees, agents and/or contractors shall perform all necessary construction work. Temporary, intermittent interruptions to side sewer service are expected to occur as part of the reconstruction, and SPU and its agents and contractors shall coordinate with the property owner as needed for this pipeline work. All access and all work shall be within the public right-of-way.

Comment [SKCAO2]: Again, what happens if SPU work needs access on private property to do the work?

SPU is responsible for and will pay all reconstruction and/or relocation costs of those portions of the private side sewer that are determined by SPU to be in conflict with the Delridge NDS Project public improvements (generally that part of the side sewer underneath the future raingarden in the public right of way) and for the re-connection of the reconstructed or relocated side sewer to the remaining existing side sewer. SPU is not responsible and will not pay for work on any elements of the private side sewer not in conflict with or impacted by the Project, nor any portion of the private side sewer that is not within the public right of way. SPU will meet all city codes, policies and requirements for side sewer design and construction, and good engineering practice.

By signing this acknowledgement, the property owner agrees to accept the reconstructed or relocated side sewer for private ownership and maintenance at the time the construction work is physically accepted by SPU from its contractor (completion of the Delridge NDS Project).

Owner acknowledges that the City is not responsible for the adequacy or performance of Owner's Side Sewer, and agrees on behalf of Owner and on behalf of Owner's heirs, successors and assigns to:

a) accept any and all risk of loss, damage and injury associated with the installation, operation and maintenance of the side sewer;

b) waive any and all right to assert any and all present and future claims against the City, whether known or unknown, for any harm, loss or damage, including without limitation personal injury, death, property damage, and loss of use by reason of, arising out of, or related to the installation, operation or maintenance of the side sewer or to drainage or erosion on or off the property described above, except for such losses that directly result from the sole negligence of the City; and

c) indemnify, hold harmless and defend the City and its officers, agents and employees from and against any and all claims, losses, costs and damages including without limitation personal injury, death, property damage, loss of use, and attorneys' fees, arising out of, relating to, or resulting from the installation, operation and maintenance of the side sewer or to drainage or erosion on or off the property described above, except to the extent such damages or other losses are caused by or result from the negligence of the City, its agents or employees. This indemnity obligation shall survive the termination of this acknowledgment or the completion and acceptance of the reconstructed or relocated side sewer by the Owner.

For more information about this work, please contact [Don Anderson, project manager, (206) 233-1086, or donald.anderson@seattle.gov].

Property Owner:

_________________________________ _________________________________

Type Name Date

_________________________________ _________________________________

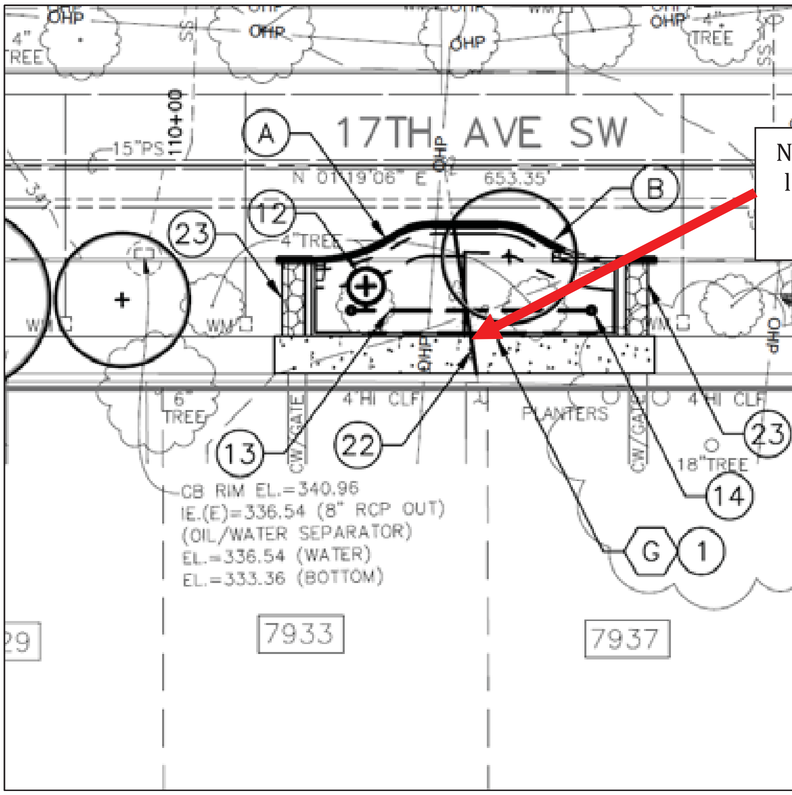
Type Name Date

____

Daytime Phone Number

General Location of Side Sewer Work (not to scale)

customize excerpt of Plan to be included for specific property



Note 22 calls out the location of the side sewer to be reconstructed

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Appendix M: Guidance for Encroachments

- Seattle Public Utilities DRAFT Project Guidance for Dealing with Encroachments in the Right of Way Related to the Siting of Natural Drainage System Projects, September 26, 2018.

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September 26, 2018

DRAFT Project Guidance for Dealing with Encroachments in the Right of Way Related to the Siting of Natural Drainage System Projects

During the course of siting bioretention projects in city owned right of way, Seattle Public Utilities staff and contractors frequently encounter private encroachments in the form of plantings, fences, walls, paving, additional driveways, and structures. In order to provide for consistent treatment of private property owners citywide, the following policies will guide how SPU treats various encroachment situations.

Encroachments that don't interfere with our designs will be left as is.

Encroachments that interfere with our design by a minimal amount, up to approximately 18 inches, will be reviewed to ascertain if a change in facility dimensions can be accommodated without excessively compromising performance or design. This is to be compared against the cost to move the encroachment and will be measured on an economic comparison basis.

Fence encroachments will be treated as follows:

1) The resident can move and replace the fence themselves. This provides them the opportunity to control how it is done and supports property owner choice of materials and timing up to the remove by date.
2) If adjacent swales are deep enough to require a vertical fence for safety per SDOT requirements, SPU will replace with one of two standard fence designs.
3) If property owners don't remove the encroachment, SPU will remove the fence and discard the materials.

If the encroachment is something more substantial than the fence such as a wall, pavement or structure, SPU will give them time to remove it as they'd like or if it is not removed by the specified date, the project contractor will demolish it as part of the construction contract.

In the case of small trees and shrub encroachments, property owners will be given a date up to which they can move and replant on their own. After that date, if requested, SPU will remove it from the project area and place it on their property.

In the case of multiple driveways or driveways larger than the 10-foot-wide standard, driveways of over 10 feet will be demolished to fit bioretention and/or sidewalk elements in accordance with code standards. Driveway demolition and reconstruction will be executed in conjunction with bioretention and/or sidewalk work.

Document provided by Shanti Colwell, SPU on December 27, 2019.

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Appendix N: Deep Infiltration

- Example Screen Well Development Specification Language
- Case Study: Screen well biofouling impacts related to flushing of bioretention soil media and sand filter layer
- Biofouling and Bioretention for Pretreatment Options

Note: Documents in this appendix were developed through a joint SPU and WTD Underground Injection Control (UIC) working group in the fall of 2019 based on review of past projects and recent SPU testing and study (funded in part by King County Waterworks grant). Contact SPU GSI Program Manager for more information.

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Note to Users: The following example was developed by the joint SPU and WTD UIC Work Group in the fall of 2019. Project Teams will need to modify it accordingly for adapting to specific project design in coordination with each agency's construction and specification specialists.

Sample Screen Well Development Specification Language

A. Development of the well shall be performed by a well driller licensed per RCW 18.104 to remove sediment from the soil formation penetrated by the well screen and to stabilize the remaining sand and fine material in the soil formation.

B. UIC well development shall consist of a combination of surging incremental segments of the well screen and periodically removing fine sediment and sand produced during the well development process, while maintaining an inflow of potable water to maintain a water level inside the well casing that is above the well screen. Potable water supply, water storage tanks, and water disposal are the responsibility of the Contractor. As turbid and sediment-laden water is produced during well development, the turbid water shall be removed from the well with a submersible pump, vacuum truck, or equivalent method. The process shall be repeated as needed to achieve a developed condition prior to infiltration testing. Final well development shall be determined by the results of infiltration testing.

C. The Contractor shall maintain a daily record of well development activities. The record shall include: the number of passes up and down the well screen, the amount of sediment produced or developed into the well, the approximate volume of water discharged into the well, and the total hours developed daily.

Note to Users: The following case study was prepared by the joint SPU and WTD UIC Work Group in the fall of 2019. Contact Shanti Colwell, SPU or John Abdalkhani, WTD for outcomes from the UIC Workgroup.

Case Study: Screen well biofouling impacts related to flushing of bioretention soil media and sand filter layer

For this Case Study, roadside bioretention cells with underdrains draining to UIC screen wells were retrofitted in planting strips along Neighborhood Yield street typologies in City of Seattle. Please see Seattle's Streets Illustrated Right-of-Way Improvement Manual for a description of street typologies. A UIC screen well was constructed at the end of each street for deep infiltration. Bioretention cells upstream of the screen well received sheet flow from the road and parcels from a single City block (typically 660' long intersection to intersection). Parcels adjacent to the retrofit were single family residential.

The bioretention cell section consisted of:

- Bioretention plantings
- 3-inches of mulch
- 18-inches of City of Seattle 2013 Standard Specifications (COS) bioretention soil media
- 6-inches of COS Mineral Aggregate Type 6 sand layer
- a minimum 8-inch layer of COS Mineral Aggregate Type 26.

Installed in the Type 26 layer was a slotted underdrain pipe. A PVC liner was installed in the trench for the underdrain pipe at the interface between the bioretention soil media and native soils. Purpose of the liner was to direct filtered water into the underdrain pipe. At most cell installations, a partial liner was installed for the depth of the underdrain (COS Type 26) layer/trench. A few cells were fully lined (liner extended above the underdrain trench and up the side slopes of the subgrade of the bioretention soil media to deter lateral movement of the filtered water.

The underdrain pipe discharged into an underdrain maintenance hole with a sump. From the underdrain maintenance hole, flows were discharged through an outfall pipe with a downturned elbow to a UIC maintenance hole. Housed in the UIC maintenance hole was a conveyance assembly. Beneath the UIC maintenance hole, at varying depths for each installation depending upon soil conditions, was the UIC screen well. Consisting of a downturned elbow and a drop pipe, the conveyance assembly discharged to the UIC screen well. The screen wells were designed with a 5-foot sump at the bottom. The well's drop pipe extended to the top of that sump. The well screen extended down through the sump section of the well. The well depths were between 65 and 100 feet with well screen lengths varying from 20 to 40 feet (not including the sump).

The bioretention cells had automatic irrigation systems to water plants during plant establishment and for watering during the dry periods for maintenance. Due to construction sequencing and requirements of the construction contract, the bioretention cells on each block, for varying durations, had different amounts of water pass through them from irrigation and rainfall (that fell upon the bioretention cells) before the UIC wells were put into service. Water passing through the bioretention soil 'flushed' or leached resulted in some of the nutrients in the bioretention soil media/section to flow into the filtered water into the underdrain.

Plant establishment period began after the last plant was installed. Per the terms of the construction contract, the underdrain pipe inlet to the UIC well maintenance holes were required to be plugged for a minimum of three weeks into the 70 day 'plant establishment' period (occurring in spring/summer) so that no water reached the UIC wells. The drain curb cuts along the road were plugged for the full plant establishment period designated in the contract. In some instances, due to construction sequencing, UIC wells remained offline for longer than the minimum requirement. During the timeframe the UIC wells were offline, water that accumulated in the underdrain maintenance hole was periodically pumped out and discharged into the existing combined sewer system. The actual length of time that the bioretention soil was passively flushed with irrigation water/rainfall prior to the wells coming online varied from about 6 weeks to 4 months. Streets with cells constructed in the second year of the project had flow into the UIC well blocked/off-line longer than those constructed in the first year.

When water was initially allowed to flow into the UIC wells, the primary water level response within the UIC wells was related to inflow from potable irrigation water applied during the early mornings of late spring and/or summer. Inflow from the irrigation water was nutrient-laden mostly from the compost in the bioretention cell soil media. Water level data indicated some of the wells did not fully drain between irrigation events, leaving a column of standing water in the sump of the well screen. The height of the water column generally fluctuated, rising after the start of irrigation, reaching a peak, and then falling, but not draining out. This daily regular up and down movement of the top of the water column was referred to as the 'irrigation flux' zone.

After the first wet season where the bioretention cells and UIC screen well received flow from the street's drainage area, several the wells were video-taped using a down-hole camera to review the well and well screen. Biofouling was visible on portions of the well screens and in the sump zone of the well. Biofouling consisted of smearing of algal/biologic growth on the screen in several wells and apparent compost fragments in one well. Biofouling was particularly heavy in the 'irrigation flux' zone of wells with the least amount of flushing period (where flow into the wells was blocked), or in other words, the most-nutrient-enriched, relative to the other blocks. This interpretation is supported by observations of cleaner well screen, less biofouling, below the irrigation flux zone.

Biofouling and Bioretention for Pretreatment *(From 2019 SPU & WTD UIC working group. Supplement to GSI Manual, Volume III: Design, Section 10.7.2)*

Biofouling can be accelerated by introducing nutrient- and particulate-laden water into the screen well. Increased biofouling can occur if stormwater conveyed to a bioretention facility for pretreatment picks up nutrients from the current, standard bioretention soil media (BSM) formulation that has compost as one of its components. Project teams should carefully consider the pretreatment methods for UIC screen wells. While bioretention facilities are a beneficial GSI pretreatment tool that also provides community and habitat benefits, the project team should also evaluate other pretreatment means that may result in less potential for delivering nutrient load to UICs and the associated increase in biofouling and rehabilitation costs, such as adding a polishing layer below the bioretention soil media to capture the nutrients or "flushing" the BSM.

Polishing layer: A polishing layer could be added below the bioretention soil media and above the COS Type 26 media to remove nutrients from flowing into the underdrain pipe and into the well.

Flush the bioretention soils that use compost in the media: "Bench" studies conducted by Washington State University-Puyallup and University of Washington document that the current Ecology bioretention mix (gravelly sand and compost mix) produces nutrients and particulate matter after initial installation. Based on these results projects utilizing bioretention facilities for pretreatment should plan for flushing the bioretention soil media (that has compost) prior to placing the UICs on-line. Some suggestions from the SPU/WTD UIC working group in 2019 included:

- Flushing the bioretention soil media with a water volume equal to 50% of the average annual precipitation prior to discharging the treated water to the UIC. In separated systems, this can be accomplished by placing the UICs offline and naturally flushing the bioretention facilities (fully constructed with established plantings) with precipitation. The stormwater that flushes through the facility will enter the underdrain and flow into the separated system.

- Alternatively, for projects that do not have separated systems or there are challenges with pumping out the underdrain structures upstream of the plugged UICs through a wet season, the bioretention soils may be able to be flushed synthetically by using a water volume equal to 50% of the average annual precipitation via a potable water source such as a fire hydrant (with applicable permits).The flushing would occur after bioretention soil placement and before planting. The contract should limit the flow rate that can be used for synthetic flushing and require that water is distributed evenly over the footprint of the bioretention cell. The flushed water must be discharged to the sewer (with applicable permits) or treated prior to discharge to the well.

****For more information about the use of polishing layer and/or flushing bioretention soil media and lessons learned from past projects contact SPU GSI Program Manager.****