WILSONVILLE OREGON

LID Guidebook

Wilsonville LID Guidebook

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OREGON

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Symbols Used in this Guidebook

- Community Benefits
- Site/Layout Considerations
- Water Quality Benefits
- Soil/Vegetation Considerations
- Drainage/Flow Control Benefits
- Maintenance Considerations

Usage Note: This document was developed by the City of Wilsonville to provide guidance to the design community - developers, engineers, landscape architects - related to the selection and design of low impact development practices and facilities. This document is not a design manual. Design standards and approval criteria related to development and stormwater management facilities are contained in the City's Municipal Code and Public Works standards.

SECTION 1

Introduction

Purpose of the guidebook

In Wilsonville, as with many northwest communities, stormwater management prioritizes **low impact development** (LID) practices and facilities. This guidebook provides an overview of LID practices and facilities applicable in the City of Wilsonville.

Stormwater runoff can directly impact Wilsonville's streams and rivers. As land is developed, impervious surface increases and vegetation decreases. These changes increase stormwater runoff during rainfall events, altering the natural hydrologic cycle. Without proper stormwater management, the increase in runoff can erode stream channels and reduce groundwater recharge.

Stormwater runoff that flows over roadways, parking lots, rooftops, and other impervious surfaces, also collects pollutants and moves them through the stormwater system to streams and rivers. **Properly managing stormwater is vital to protecting and preserving local water resources** for use as habitat for fish and wildlife, recreation, and drinking water.

This guidebook is intended to compliment the stormwater design standards outlined in Section 3 of the Wilsonville Public Works Standards and City detail drawings. The design principles included in this guidebook are intended for general reference and will not replace the need for quality engineering in designing stormwater facilities.

What is LID?

LID is an innovative approach to site planning and stormwater management. The goal of LID is to apply techniques that capture, filter, store, evaporate, and infiltrate runoff close to the source to mimic pre-development runoff conditions.

Advantages of LID practices:

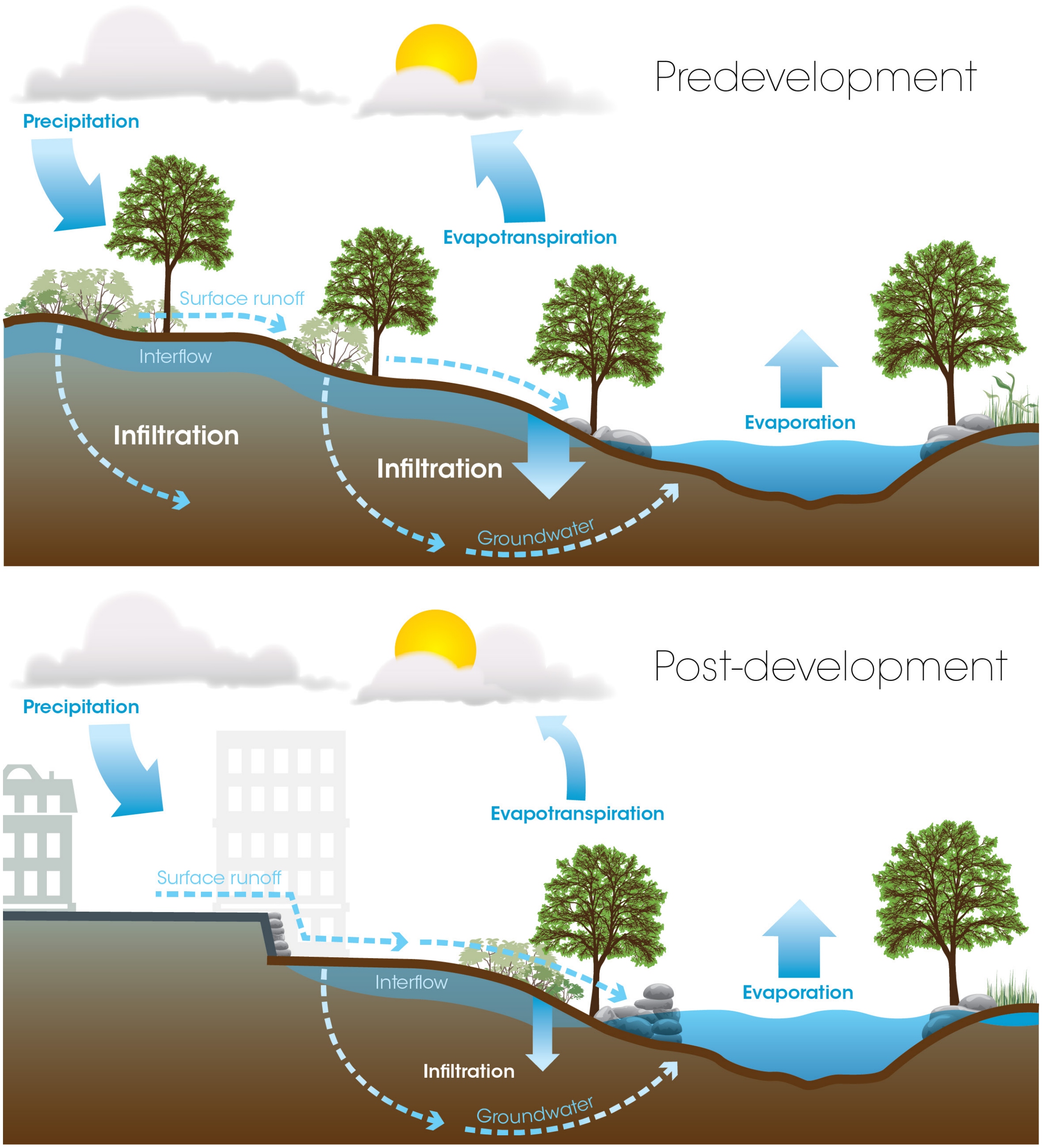
- Improves water quality
- Improves groundwater recharge
- Enhances neighborhood aesthetics
- Reduces volume and peak flows to protect downstream environments
- Integrates stormwater management with landscape features
- Can reduce the cost of underground infrastructure
- Benefits air quality and microclimates
- Provides habitat for wildlife and pollinators

LID facilities in this guidebook:

- Detention Ponds
- Rain Gardens
- Stormwater Planters
- Vegetated Swales
- Filter Strips
- Green Roofs
- Porous Pavement

Conventional development practices convey runoff directly to curb and gutter systems, storm drain inlets, and a network of underground pipes that carry the runoff downstream. When required, stormwater management was applied as an “end of pipe” strategy, using ponds or underground structures to detain and meter flow to natural systems. This conventional approach to stormwater management resulted in increased runoff and pollutant transport to surface waters.

LID differs from a conventional development approach. LID incorporates the use of **site planning strategies** to minimize impervious surfaces and maintain natural vegetation. LID also incorporates the use of **vegetated stormwater management facilities**, such as stormwater planters, rain gardens, swales, and filter strips to manage stormwater. When designed to maximize infiltration, these facilities attenuate flows and take advantage of the natural pollutant removal capabilities of vegetation and soil layers by filtering and settling pollutants before runoff discharges to the natural system.



Impervious areas associated with development reduce interflow and infiltration, resulting in an increased rate, volume, and duration of overland flows. *Source: Brown and Caldwell*

At the site scale, LID practices are used to maintain vegetation and preserve aspects of the natural hydrologic cycle. LID facilities are dispersed throughout a development site to manage runoff close to the source. Small facilities may be applied to every lot in a residential development, or installed as a continuous facility along a roadway corridor. This encourages infiltration at the source and better mimics pre-developed runoff patterns.

Key Strategies

LID practices should be integrated into the planning stage of a development project and continue throughout the design, construction, and maintenance stages (see adjacent flow chart). At all stages of development, the designer should look for opportunities to employ the following **four key strategies**:

1. Conserve and restore native vegetation and soils.

Retain native vegetation and trees; restore vegetation on previously cleared land; preserve well-draining native soils; incorporate compost and soil amendments to enhance infiltration and sustain plant growth; protect and incorporate natural topographic and drainage features into the site design.

2. Design the site to minimize impervious surface area.

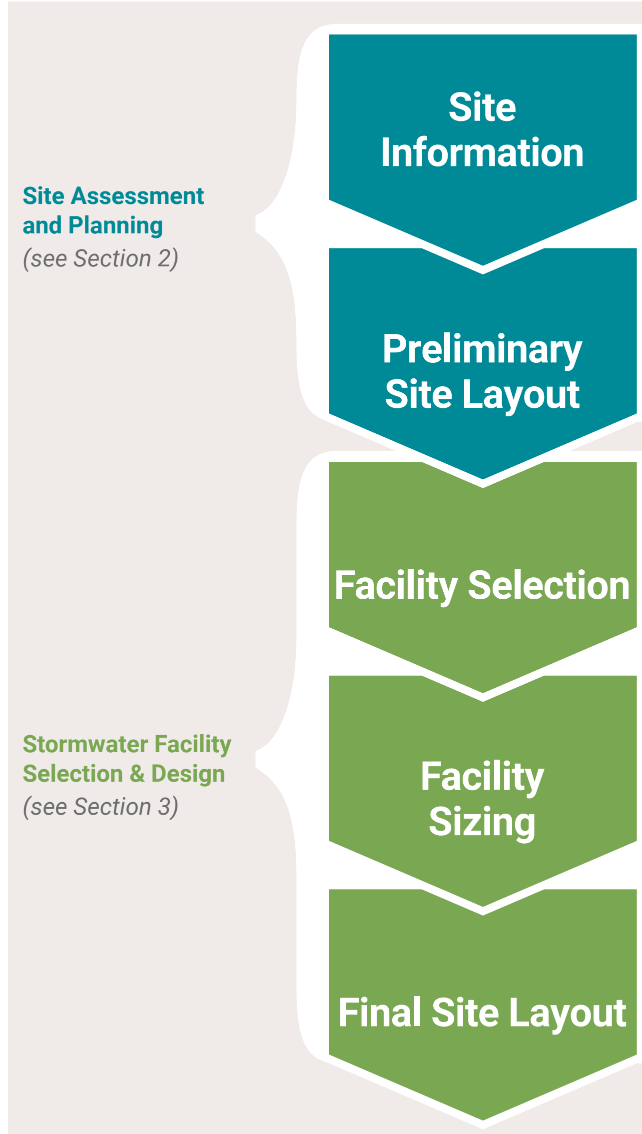
Minimize building and parking footprints; cluster houses and other buildings to reduce the size of roads and driveways; eliminate impervious surfaces by installing vegetated roofs and/or pervious pavements.

3. Manage stormwater close to where the rain falls.

Incorporate landscape features to collect and slow runoff; use multiple small-scale facilities dispersed throughout a development site; integrate stormwater facilities with other landscape features.

4. Provide maintenance and education.

Develop long-term maintenance programs; educate property owners/operators, HOAs and maintenance contractors.



LID in the development process.

Vegetated swale in Wilsonville.

Common LID practices:

- Preserving vegetation
- Clustering development
- Dispersing runoff
- Incorporating soil amendments

Applicability

The City of Wilsonville requires development and redevelopment projects to evaluate and implement LID. Methods for implementing LID practices during site planning are described in **Section 2** of this guidebook. Methods for implementing LID facilities through the selection of stormwater management facilities are described in **Section 3** of this guidebook.

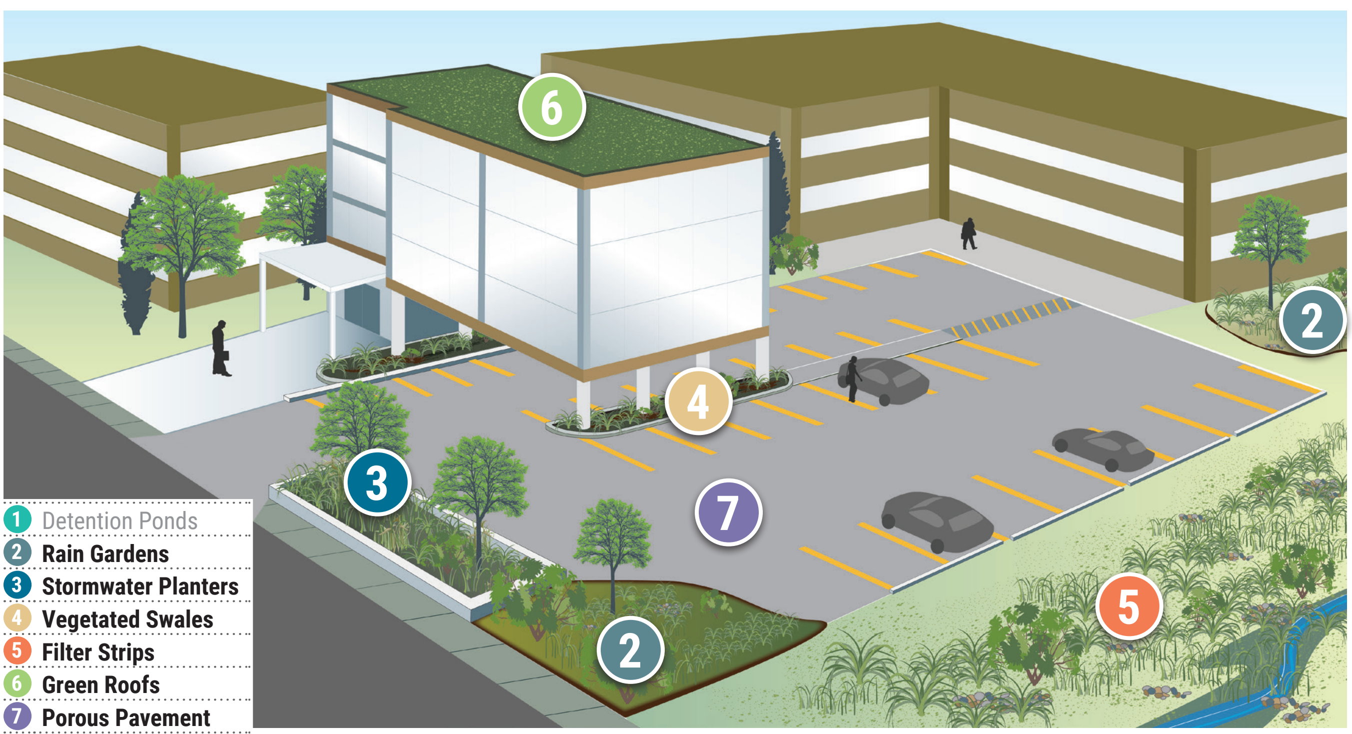
Communities in the Pacific Northwest have been implementing LID practices and facilities for many years. This work has produced a wealth of guidance documents and published research related to designing effective facilities. Design professionals are encouraged to seek out additional resources when developing site layouts and facility designs to manage stormwater.

Project designers should refer to **Section 3** of the Wilsonville Public Works Standards and the City's standard details for additional information.

LID practices and facilities can be applied to all project types – residential, commercial, industrial, and municipal development. The strategies work for both new developments and redevelopment projects, though the specific techniques will vary based on individual site conditions.

Common LID facilities:

- Vegetated management facilities (raingardens, ponds, planters, swales, filter strips)
- Green roofs
- Porous pavement



Examples of LID practices and facilities applied to a commercial site. Applicable facilities are **bold**, as not all types of facilities may be used at a site.
Source: Brown and Caldwell

SECTION 2

Site Assessment and Planning

LID practices work to integrate site attributes to manage stormwater. Thus, LID practices address both the quantity and quality of stormwater runoff and provide numerous additional environmental benefits.

This section highlights LID practices that can be conducted during site planning to protect sensitive areas, optimize the size of LID facilities and reduce potential conflicts between site development and stormwater management objectives. **Section 3** covers LID facility selection and design.

Site Assessment

The planning stage of a proposed development starts with a site assessment to identify conditions that may be limiting or more conducive to using LID practices. Wilsonville requires an early site assessment and completion of a site planning checklist to:

1. Identify opportunities to implement LID practices, and
2. Provide the technical basis for designing LID facilities.

The site assessment typically results in a map that documents the following site conditions.

Topography – evaluate and map site slopes

Soils and Groundwater – research and map the site soil groups and depths to groundwater

Infiltration Assessment – determine the capacity for onsite infiltration through infiltration testing

Hydrology – identify natural drainage basins

Natural Features – locate floodplains, wetlands, streams, waterways, and other natural resources

Existing Features – document locations of existing structures and impervious areas

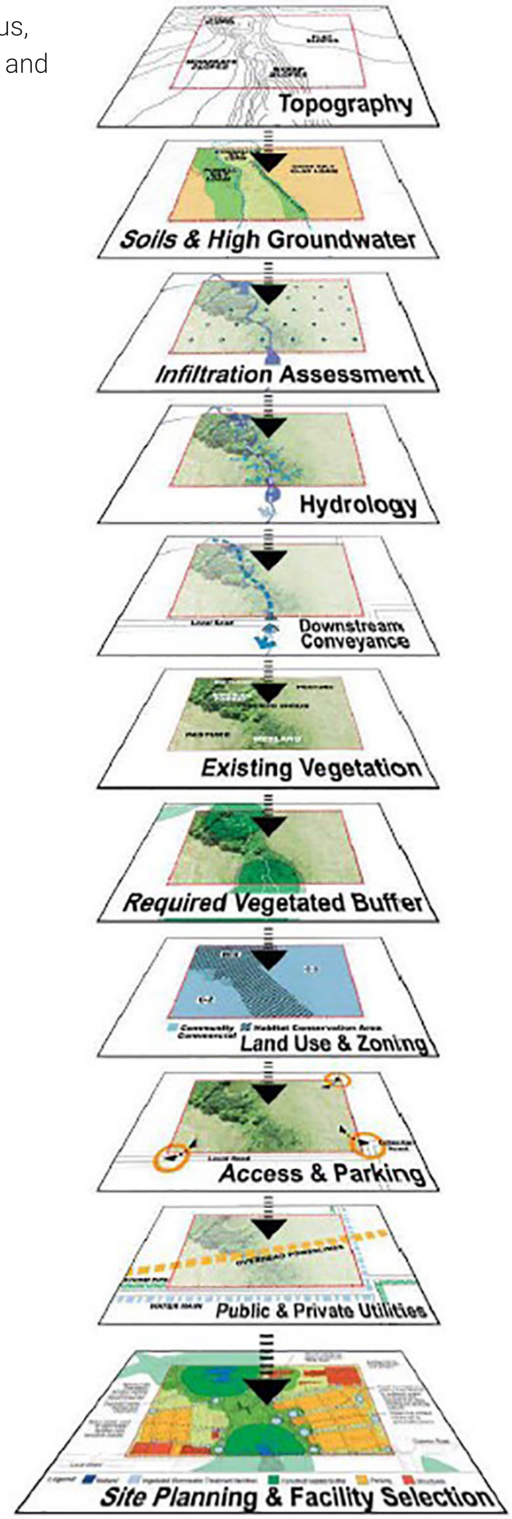
Downstream Conveyance – document locations of existing outfalls and downstream discharge locations

Vegetation – map large trees on the site and document existing vegetation

Setbacks and Buffers – identify setbacks and protection areas associated with natural features and City zoning code

Access and Parking – identify proposed access points for existing and future roadways and parking lots

Utilities – map existing utilities and document the utility needs to serve the proposed development



Example of site assessment process.

Site Planning Checklist

The City requires submittal of a Site Planning Checklist for all projects that create or redevelop 5,000 square feet or more of impervious surface. The purpose of the Site Planning Checklist is to assist planners and design engineers in identifying LID opportunities early in the planning process.

Refer to Wilsonville Public Works Standards, Section 301.3.00 for additional information.

Site Considerations

Site conditions more likely to support a variety of LID practices and facilities include the following:

- Well-draining soils with infiltration rates in excess of 2 inches per hour
- Groundwater levels that provide adequate separation distance for infiltration facilities
- Flat or moderate slopes in areas of proposed stormwater facilities

Site conditions that may limit opportunities for LID practices and facilities include the following:

- High groundwater levels
- Steep slopes in areas of proposed stormwater facilities
- Sites with known, or suspected, contamination
- Sites requiring significant fill or structural measures to establish level building footprints

Site Layout Options

Results of the site assessment will guide the site planning process and influence the layout of roadways, parking areas, and building footprints. At a minimum, designers should seek to preserve existing sensitive areas and minimize site disturbances, soil compaction, and the amount of impervious surfaces.

LID practices attempt to mimic natural systems within the built environment. This increases water quality protection and provides opportunities to integrate the built and natural environments.

An analysis in south Puget Sound found that transportation components accounted for approximately 60 percent of the total impervious surfaces in suburban areas. Designers should investigate ways to minimize planned impervious areas through adjustments to the site layout. Reducing impervious surfaces reduces both the anticipated runoff and the size of stormwater management facilities required for treatment and flow control.

The following sections provide examples of how to apply the minimum site planning measures when developing a site layout.

Site Planning Minimum Measures

- **Preserve sensitive areas and buffers** such as the Significant Resource Overlay Zone (SROZ) and other natural resource areas
- **Minimize site disturbance** by delineating protection areas
- **Minimize soil compaction** to maintain infiltration capacity in areas to be used for stormwater management facilities
- **Minimize impervious area** by identifying impervious area reduction methods

Roadways

The following LID practices may be considered for roadway development applications:

- Cluster homes to reduce overall development area and road length and minimize overall site disturbance.
- Narrow lot frontages to reduce the required road length per home.
- Increase block lengths in grid layouts to reduce the number of cross streets.
- Use looped road designs rather than cul-de-sacs to increase landscaped area.
- Reduce road widths and turn around coverage, as allowed by local land use regulations.
- Incorporate stormwater planters into roadway cross sections.
- Evaluate opportunities for rain gardens as curb bump outs in intersections to aid in traffic control and calming.

Sidewalks and Driveways

The following LID practices may be considered for sidewalks and driveways:

- Reduce front yard setbacks to reduce driveway lengths.
- Minimize driveway widths or use shared driveways.
- For low speed roadways, provide sidewalks on only one side of the road.
- Reduce sidewalk widths, as allowed by local building codes and ADA guidelines.
- Provide parking on only one side of residential roadways or provide parking pull-outs between landscaped areas or stormwater management facilities.
- Consider the use of permeable pavers or pavement to minimize impervious surface.
- Use wheel tracks with vegetated strips instead of fully impervious driveways.

Clustered housing, narrow lot frontages, and looped roadway design can reduce impervious areas and increase open spaces in proposed site layouts.
Source: LID Technical Guidance Manual for Puget Sound

Shared driveways can reduce overall project impervious areas.
Source: LID Technical Guidance Manual for Puget Sound

Parking Areas

The following LID practices may be considered for parking areas:

- Assess parking demand ratios and look for opportunities for shared parking agreements (i.e., between a church and a school or office area not typically open during church activities).
- Dedicate parking areas to compact spaces.
- Reduce impervious surfaces by using a diagonal stall configuration with one-way travel lanes.
- Incorporate permeable pavers or porous pavement.
- Integrate stormwater management facilities into parking layouts to collect stormwater runoff close to the source.

Integrating filter strips with parking areas helps to manage stormwater at the source.
Source: City of Wilsonville

Residential Lot Layout

With conventional development practices, sites are cleared and graded to maximize lot coverage. Stormwater management is generally applied as an "end of pipe" strategy, at the downstream point in each development. Lot layouts using LID practices account for stormwater management throughout the site, allowing natural features to influence the lot layout and building footprints. The following LID practices may be considered when developing residential lot layouts:

- Cluster building footprints or use zero lot line layouts to allow for undisturbed areas between buildings.
- Identify low lying areas for distributed stormwater management facilities closer to the source of runoff.
- Consider the use of individual lot stormwater management facilities for water quality treatment with a downstream detention system for larger site flow control.
- Orient lots to maximize opportunities for onsite infiltration and open conveyance systems.

Buildings clustered around shared facility and open space.
Source: Brown and Caldwell

Impervious Area Reduction Credit

In addition to the site planning practices described above, impervious areas may be reduced through the use of green roofs and pervious pavements (described in **Section 4**). Site planners may also wish to consider the use of rainwater harvesting or roof downspout planter boxes or cisterns. Such practices help manage stormwater runoff closer to the source and reduce impervious areas contributing to stormwater conveyance and management systems.

Tree Credits

The City provides impervious area reduction credits for planting new trees and preserving existing trees that exceed the landscaping requirements outlined by the Planning Division. The tree credit may account for up to 10 percent of the total impervious area proposed on a site.

Green Roof to reduce impervious area.
Source: City of Wilsonville

Local Application

Villebois is a 500-acre master-planned community in the western portion of Wilsonville. The original concept plan reflected an innovative community encompassing over 2,300 homes. A commercial/employment core and an interconnected series of roads and trails.

Now developed, this mixed-use, transit-oriented neighborhood incorporates a number of nature-friendly development practices including rehabilitation of wetlands, redirection of storm water flows to the natural drainage pattern and preservation of 160 acres of parks and open space.

The concept plan and master plan for Villebois incorporated numerous LID site planning techniques, including:

- Clustering homes to preserve large areas of parks and open space
- Zero lot line layouts
- Looped roadway designs without cul-de-sacs
- Narrow lot frontages
- Alley access garages to reduce driveway length
- Retaining low lying areas for stormwater management features

Villebois hosts an innovative rainwater management program that uses a variety of LID practices and facilities dispersed throughout the development. These facilities include swales, stormwater planters, porous pavers and a green roof to mitigate the majority of rainfall runoff occurring at Villebois. Additional LID facilities are provided to further attenuate and treat stormwater runoff. Many of these facilities are incorporated into park and open space areas.

Stormwater planters manage roadway runoff from Boones Ferry Road.
Source: Keller Williams Portland Premier

SECTION 3

Facility Selection and Design Considerations

LID facilities such as planters, swales, rain gardens, and other vegetated facilities are the implemented strategy in Wilsonville to meet the stormwater management requirements for water quality treatment and flow control.

These vegetated facilities employ **key strategies for LID**, such as preserving natural vegetation and managing stormwater close to the source. In addition vegetated facilities create functional and appealing site drainage, aesthetics, and provide habitat for wildlife.

The facilities outlined in this guidebook rely on infiltration, dispersion, retention, and vegetation uptake to manage peak flows/volumes and remove pollutants.

Facility Selection

Development projects that add or replace 5,000 square feet or more of impervious area are required to mitigate the increase in flow (flow control) and the increase in pollutants (water quality). This can be accomplished using LID facilities for stormwater management. Most facilities presented in this guidebook can be designed to provide both water quality treatment and flow control.

During the site planning process, designers should consider opportunities to install smaller, dispersed facilities that can manage stormwater close to the source. In some cases, dispersed facilities may provide only water quality treatment. In these applications, dispersed facilities may be used in conjunction with a downstream detention pond or larger single facility to manage flow control for the larger contributing drainage area. Other developments may benefit from larger, shared facilities that provide both water quality treatment and flow control for multiple lots or owners.

Facility Selection Guidelines Table

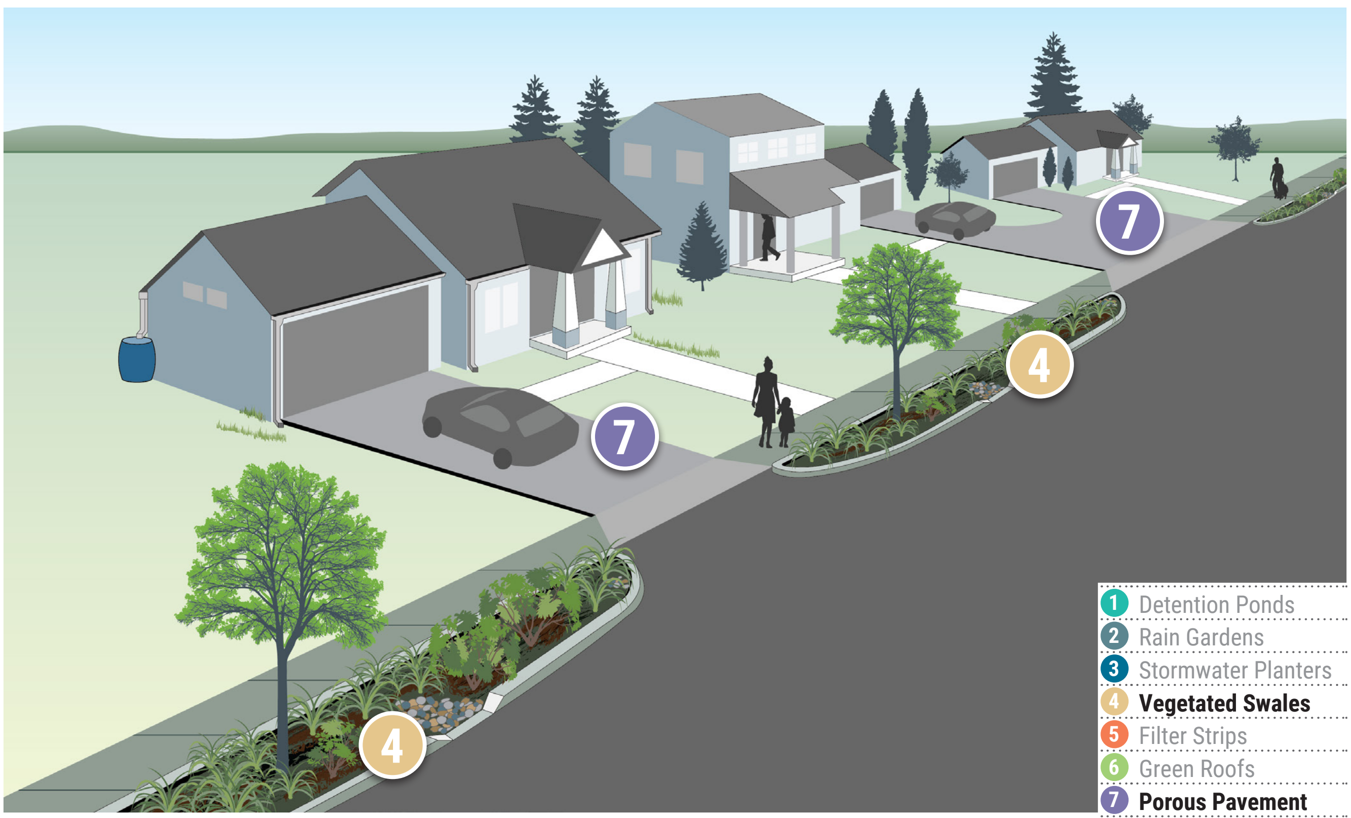
Facility can be used for:	Detention Ponds	Rain Gardens	Stormwater Planters	Vegetated Swales	Filter Strips	Green Roofs	Porous Pavement
Impervious Area Reduction						✓	✓
Flow Control	✓	✓	✓	✓		✓	✓
Water Quality Treatment	✓	✓	✓	✓	✓	✓	✓
Private Property	✓	✓	✓	✓	✓	✓	✓
Public Right-of-Way (ROW)	✓	✓	✓	✓	✓	✓	✓
Steep Slopes						✓	

Impervious Area Thresholds

Green Roofs and Porous Pavements can be used in conjunction with other LID practices to reduce the total impervious area of a site below the 5,000 square foot impervious threshold requiring stormwater management.

Facility selection should be based on site constraints, treatment needs, utility layout, topography, and design aesthetics. The facility selection table on the previous page provides basic selection guidelines. However, several facilities may be appropriate for a given site, so the selection may be based more on designer preference than a specific hierarchy.

Example rain garden applications for multi-family development.
Source: City of Wilsonville



Examples of stormwater facilities used in a residential development. Applicable facilities are highlighted, as not all types of facilities may be used at a site.
Source: Brown and Caldwell

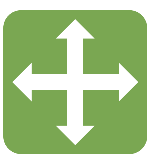
Design Considerations

The facility design fact sheets included in this guidebook provide information related to the selection and design of the stormwater management facilities approved by the City. The fact sheets include benefits and design considerations under the following categories:

Community Benefits: Improvements to aesthetics, wildlife habitat and/or integration with other City planning priorities

Water Quality Benefits: Improvements to water quality through the reduction of pollutants and/or protection of downstream ecosystems

Drainage/Flow Benefits: Reduction in volume of runoff, rate of peak flow, or duration of flow to mimic pre-developed hydrology



Site Planning and Layout Considerations: Constraints and limitations regarding selection and placement of each stormwater management facility

Vegetation and Soil Considerations: Surface and subsurface conditions that impact stormwater facility design

Construction and Maintenance Considerations: Installation and maintenance needs that impact the long-term functionality of stormwater facilities

Example of a rain garden used as traffic calming facility.
Source: City of Wilsonville

Example of a vegetated swale at Wilsonville City Hall.

Example of stormwater management facilities applied to a transportation corridor. Applicable facilities are highlighted, as not all types of facilities may be used at a site.
Source: Brown and Caldwell

Facility Sizing

Sizing stormwater management facilities requires hydrologic calculations to determine runoff rates and volumes associated with pre-development conditions and post-development conditions. Calculations require designers to define drainage management areas and flow patterns. Site-specific impervious areas and soil infiltration rates are also needed.

In Wilsonville, facility sizing can be performed using the BMP Sizing Tool, which has been developed for the unique hydrologic conditions in Clackamas County. The BMP Sizing Tool takes hydrologic input (drainage areas, soil conditions, ground cover) and calculates the required facility sizes.*

Wilsonville Stormwater Performance Standards

Stormwater management facilities designed using the BMP Sizing Tool are assumed to meet Wilsonville's Stormwater Performance Standards:

- Water quality treatment to capture and treat 80 percent of the average annual runoff
- Water quality treatment to achieve 70 percent TSS removal
- Flow control to match the post-developed flow durations to pre-developed flow durations for the range of flows between 42 percent of the 2-year flow and the 10-year flow

** Plans for development and redevelopment projects must also account for proper conveyance of stormwater runoff, which may require additional design calculations.*

Stormwater management facilities sized using the BMP Sizing Tool will typically have a surface area between 4 and 12 percent of the total impervious area of the site. The actual size is dependent on the proposed land coverage and soil conditions of the site and the infiltration rate at the proposed facility location(s). If vegetated facilities are installed with a surface area equal to 10 percent of the total site impervious area, then the facilities are considered to achieve the goals of LID practices.

Designers also have the option of using other available software programs and calculation methods to perform the hydrologic analysis to size facilities. Facilities must either be sized to retain and infiltrate the 10-year (3.4 inch) storm event onsite within 72-hours, or show that facilities will meet both the water quality and flow control standards outlined in the Wilsonville Public Works Standards, **Section 3.**

BMP Sizing Tool

The BMP Sizing Tool can be used to size facilities during initial site planning and during final design. Facilities can be sized for water quality treatment only or for combined water quality treatment and flow control.

The following facilities can be sized using the BMP Sizing Tool:

- Rain Garden – infiltration and filtration
- Stormwater Planter – infiltration and filtration
- Vegetated Swale – infiltration and filtration
- Detention Pond

When defining drainage areas, designers have the option to account for green roofs, porous pavements, and other land cover types that reduce impervious surface. The detention pond sizing module allows the designer to account for upstream LID facilities, such as rain gardens, planters, swales, and infiltrators.

The BMP Sizing Tool and associated users guide can be downloaded from the City website.

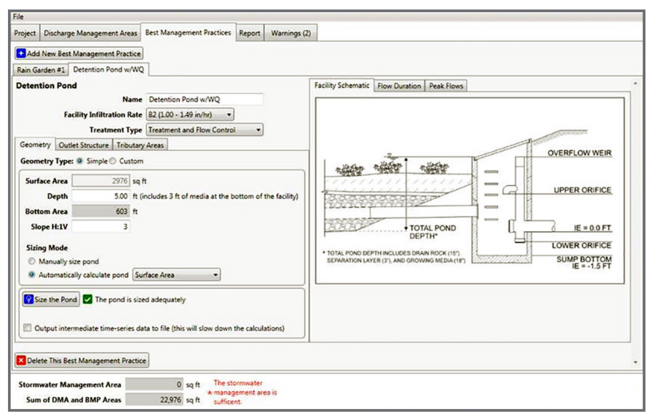
Infiltration Testing

Infiltration testing must be performed during preliminary planning to determine whether the site has capacity to infiltrate stormwater runoff.

For small projects, the infiltration test consists of digging a small hole, filling it with water, and determining how long it takes the water to soak into the soil.

See Wilsonville Public Works Standards, Section 3, Appendix B for infiltration testing guidelines.

Infiltration testing for small projects.
Source: City of Salem



Example screen shot from the BMP sizing tool.

Landscaping/Planting Requirements

Plant selection, if applicable, should consider the microclimates of the proposed facility, which are influenced by facility grading, slopes, standing water level and orientation to sunlight. Landscape plans should incorporate a variety of plant species and layering techniques to create a diverse vegetated environment. Refer to Public Works Standards, **Section 3**, **Appendix A** for design guidance and suggested plant selection.

Stormwater Management Facility Fact Sheets

The following section contains facility fact sheets to summarize the types of stormwater management options available under the City's Public Works Standards. These fact sheets outline design considerations for each facility type and highlight key design features. Guidance is provided related to facility sizing, planting suggestions, and maintenance considerations.

Detention Pond

CITY DETAIL DRAWINGS: ST-6060 & ST-6110

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Description

Detention ponds are large depressions (basins) used to collect and detain stormwater runoff. Historically, detention ponds were used solely for flow control, but with moderate design changes these facilities can be retrofit or converted to LID systems to manage water quality as well. When properly designed, detention ponds can provide water quality treatment, infiltration, and flow control to match pre-developed hydrology.

Detention ponds have traditionally been designed to retain standing water. Wilsonville's detention pond design includes layers of growing media and drain rock to promote below-ground storage and infiltration. The surface area of the pond is heavily landscaped with native plants that thrive in a wet environment. Detention ponds can be used to manage flows from a single development or as a regional facility to serve runoff from multiple properties.

Key Design Features

- Native landscaping
- Deep above-ground storage to manage flow from large contributing areas
- Growing media layer to treat and store runoff
- Drain rock layer to promote infiltration
- Underdrain to support areas with low infiltration rates
- Multi-orifice outlet structure to manage a range of flows

Planting Suggestions

In detention ponds, plants need to be tolerant to a wetland-like environment, with saturated soils and periods of inundation. In some cases, adapted species may be better suited to stormwater management facilities than native species. Temporary irrigation is necessary during the plant establishment period.

Do not apply fertilizers or pesticides.

Design Considerations

Community Benefits

- Increases landscaping and green space
- Wildlife habitat

Water Quality Benefits

- Removes settleable pollutants
- Removes nutrients due to plant uptake
- May be designed to meet water quality treatment requirements

Drainage/Flow Control Benefits

- Reduces runoff rate and duration
- Designed to meet flow control requirements

Site/Layout Considerations

- Ideal for large contributing areas
- Not suitable on steep slopes
- Avoid placement over utilities

Soil/Vegetation Considerations

- Install underdrain in areas of limited infiltration
- Requires careful selection of plants and soil media

Maintenance Considerations

- Two year plant establishment period
- Requires maintenance agreement for private applications
- Quarterly maintenance and annual reporting

Facility Sizing Methods

BMP Sizing Tool: Utilize the BMP Sizing Tool to analyze proposed site conditions and determine the minimum facility size. Facility side slopes should be 3H:1V minimum. The maximum above ground storage depth is 4 feet (total facility depth of 7 feet, including growing media and rock layer).

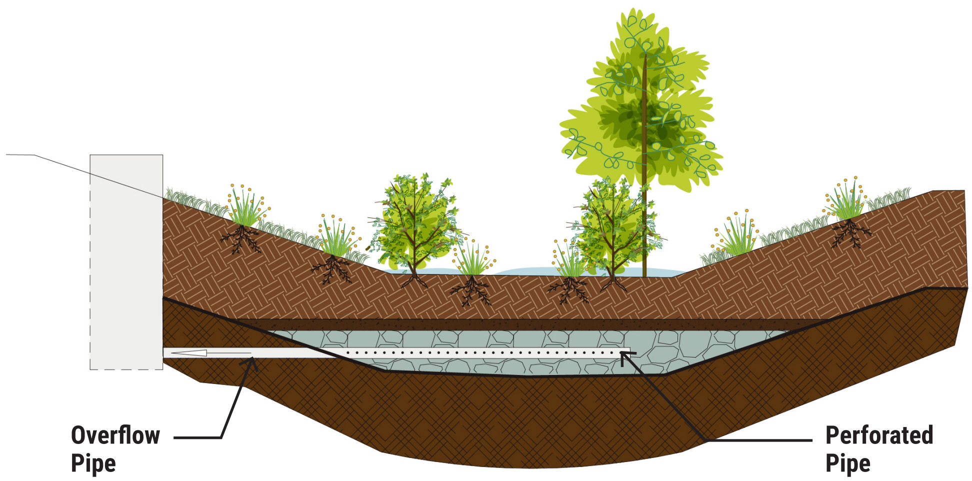
Engineered Method: Utilize engineering tools to size the facility to treat 80% of the average annual runoff volume and manage flow duration based on continuous simulation for the range of flows between 42% of the 2-year and the 10-year peak flow.

Detention Pond

CITY DETAIL DRAWINGS: ST-6060 & ST-6110

Maintenance Considerations

Detention ponds require periodic plant, soil, and mulch layer maintenance to maintain infiltration, storage, and pollutant removal capabilities. Designers should prepare a maintenance plan that includes a recommended inspection schedule and recommended maintenance actions. Routine maintenance activities include removal of trash and debris from the pond bottom and control structures, replacement of plants and soil in eroded areas, pruning and removal of dead vegetation, removal of invasive and nuisance weeds, and repair of structural elements.



Detention Pond

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See the Wilsonville Public Works Standards, Section 3 for additional information.

Rain Garden

CITY DETAIL DRAWINGS: ST-6020, ST-6025, & ST-6120

Description

Rain gardens are shallow depressions (basins) that are used to collect, filter, and infiltrate stormwater runoff and provide both flow control and water quality treatment for small drainage areas.

Rain gardens may be designed in many configurations to serve residential, commercial and industrial developments. They may be used as a stand-alone facility serving a single lot or a larger facility serving multiple lots in a development.

Key Design Features

- Flat bottom to promote infiltration
- Native landscaping
- Shallow above-ground storage area
- Growing media layer to treat and store runoff
- Drain rock layer to promote infiltration
- Underdrain and overflow in areas with low infiltration rates
- Single orifice outlet structure to manage peak flow and flow durations

Infiltration rain gardens should be designed in areas where the design infiltration rate exceeds 0.5 inches per hour. In areas of reduced infiltration capacity, a filtration rain garden with an underdrain connection to the downstream conveyance system should be installed.

Planting Suggestions

For rain gardens, vegetation is categorized according to the degree of soil moisture that will be encountered. Consideration of these various planting zones will enhance success of the planting design. In some cases, adapted species may be better suited to stormwater management facilities than native species. Temporary irrigation is necessary during the plant establishment period.

Do not apply fertilizers or pesticides.

Design Considerations

Community Benefits
- Enhances site aesthetics
- May be used to retrofit developed areas
- Provides landscaping/ wildlife/ pollinator habitat

Water Quality Benefits
- Removes settleable and dissolved pollutants
- May decrease runoff temperature
- Removes nutrients due to plant uptake

Drainage/Flow Control Benefits
- Reduces runoff rate and duration
- May be designed to infiltrate and reduce runoff volume

Site/Layout Considerations
- May be distributed throughout the site
- Not suitable in high groundwater areas
- Potential parking impacts in roadway applications
- Not suitable on steep slopes
- Avoid placement over utilities

Soil/Vegetation Considerations
- Install underdrain in areas of limited infiltration
- Requires careful selection of plants and soil media

Maintenance Considerations
- Two year plant establishment period
- Requires maintenance agreement for private applications
- Quarterly maintenance and annual reporting

Facility Sizing Methods

BMP Sizing Tool: Utilize the BMP Sizing Tool to analyze proposed site conditions and determine minimum facility size. Facility side slopes should be 3H:1V minimum. Facility surface area may be reduced if the depth of growing media is increased (see Public Works Standards, Section 301.4.05.a.5).

Engineered Method: Utilize engineering tools to size the facility to treat 80% of the average annual runoff volume and manage flow duration based on continuous simulation for the range of flows from 42% of the 2-year and the 10-year peak flow.

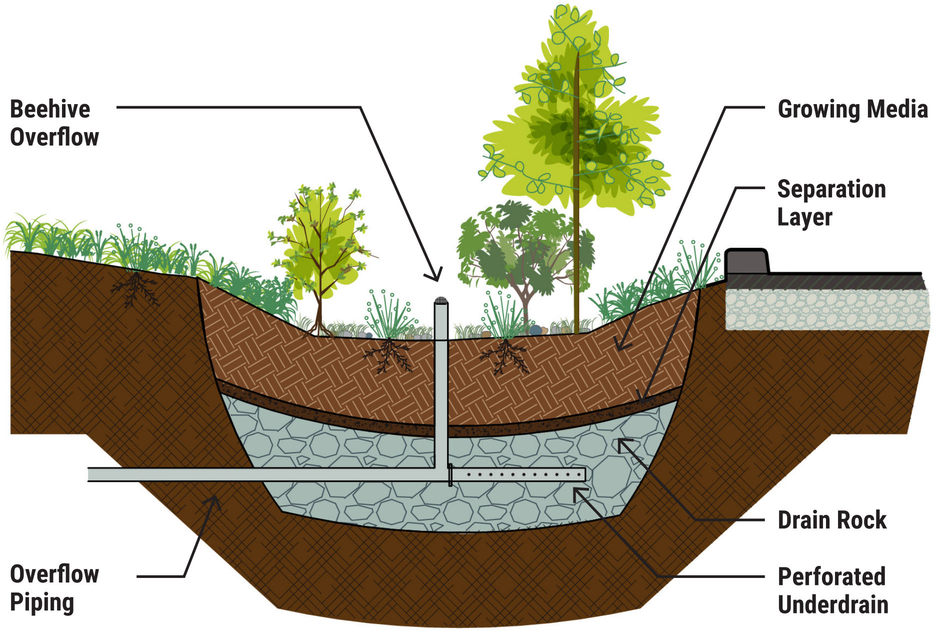
Simplified Sizing: Size the rain garden surface area to be equal to 10% of the total site impervious area.

Rain Garden

CITY DETAIL DRAWINGS: ST-6020, ST-6025, & ST-6120

Maintenance Considerations

Rain gardens require periodic maintenance to ensure continual infiltration, storage, and pollutant removal capabilities. Routine maintenance activities include removal of trash and debris from the rain garden bottom and control structures, replacement of plants and soil in eroded areas, pruning and removal of dead vegetation, removal of invasive and nuisance weeds, and repair of structural elements. Designers should prepare a maintenance plan that includes a recommended inspection schedule to identify needed maintenance activities.



Filtration Rain Garden

Rain gardens used for stormwater management.

Source: City of Wilsonville (Villebois)

See the Wilsonville Public Works Standards, Section 3 for additional information.

Stormwater Planter

CITY DETAIL DRAWINGS: ST-6005, ST-6010, & ST-6120

Description

Stormwater planters are small structural facilities, typically constructed with curbs and concrete walls, used to collect, filter, and infiltrate stormwater runoff. They are heavily landscaped with deep layers of growing media to promote treatment, infiltration, and flow control.

The structural elements allow planters to be located in areas with tight physical constraints, making them ideal for urban environments.

Key Design Features

- Flat bottom to promote stormwater retention and infiltration
- Native landscaping
- Shallow above-ground storage area
- Growing media layer to treat and store runoff
- Drain rock layer to promote infiltration
- Underdrain and overflow in areas with low infiltration rates
- Structural elements, including concrete walls
- Single orifice outlet structure to manage peak flow and flow duration

Infiltration stormwater planters should be designed in areas where the design infiltration rate exceeds 0.5 inches per hour. In areas of reduced infiltration capacity, a filtration rain garden with an underdrain connection to the downstream conveyance system should be installed.

Planting Suggestions

For stormwater planters, vegetation must tolerate short periods of inundation, saturated conditions, and periods of limited rainfall/irrigation. Consideration of these various planting zones will enhance success of the planting design. In some cases, adapted species may be better suited to stormwater management facilities than native species. Temporary irrigation is necessary during the plant establishment period.

Do not apply fertilizers or pesticides.

Design Considerations

Community Benefits

- Enhances site aesthetics
- May be used for traffic calming
- May be used to retrofit developed areas
- Provides landscaping/ wildlife/ pollinator habitat

Water Quality Benefits

- Removes settleable and dissolved pollutants
- May decrease runoff temperature
- Removes nutrients due to plant uptake

Drainage/Flow Control Benefits

- Reduces runoff rate and duration
- May be designed to infiltrate and reduce runoff volume

Site/Layout Considerations

- May be distributed throughout the site
- Requires minimal space
- Not suitable in high groundwater areas
- Potential parking impacts in roadway applications
- Avoid placement over utilities

Soil/Vegetation Considerations

- Install underdrain in areas of limited infiltration
- Requires careful selection of plants and soil media

Maintenance Considerations

- Two year plant establishment period
- Requires maintenance agreement for private applications
- Quarterly maintenance and annual reporting

Facility Sizing Methods

BMP Sizing Tool: Use the BMP Sizing Tool to analyze proposed site conditions and determine minimum facility size. Facility sides are vertical. Facility surface area may be reduced if the depth of growing media is increased (see Public Works Standards, Section 301.4.05.a.5).

Engineered Method: Use engineering tools to size the facility to treat 80% of the average annual runoff volume and manage flow duration using continuous simulation for the range of flows between 42% of the 2-year and the 10-year peak flow.

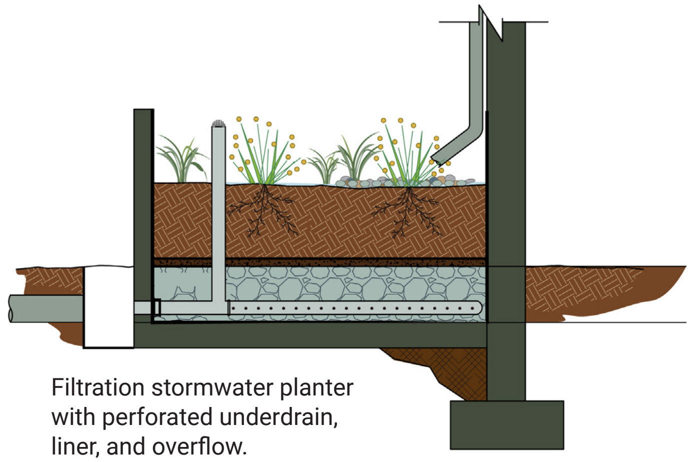
Simplified Sizing: Size the surface area of the planter to equal 10% of the total site impervious area.

Stormwater Planter

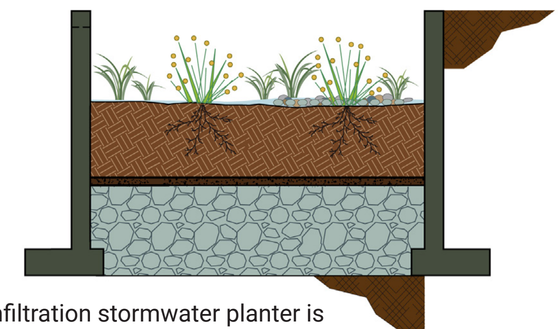
CITY DETAIL DRAWINGS: ST-6005, ST-6010, & ST-6120

Maintenance Considerations

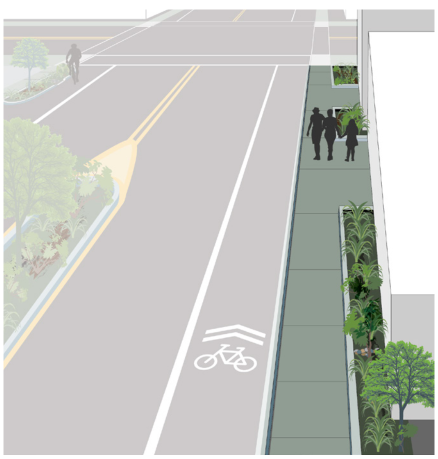
Stormwater planters require periodic plant, and soil layer maintenance to maintain infiltration, storage, and pollutant removal capabilities. Routine maintenance activities include removal of trash and debris from the planter bottom and control structures, replacement of plants and soil in eroded areas, pruning and removal of dead vegetation, removal of invasive and nuisance weeds, and repair of structural elements. Designers should prepare a maintenance plan that includes a recommended inspection schedule to identify needed maintenance activities.



Filtration stormwater planter with perforated underdrain, liner, and overflow.



Infiltration stormwater planter is unlined to promote infiltration.



Planters used for roadway and rooftop stormwater management.

See the Wilsonville Public Works Standards, Section 3 for additional information.

Vegetated Swale

CITY DETAIL DRAWINGS: ST-6045, ST-6050, & ST-6120

Description

Vegetated swales are linear landscaped depressions, designed with a gentle longitudinal slope to provide treatment and stormwater conveyance. Similar to both rain gardens and stormwater planters, vegetated swales collect, filter, and infiltrate stormwater runoff.

Swales may be designed with a straight or meandering flow path to integrate with the surrounding topography. Swales are heavily landscaped with deep growing media to provide water quality treatment and promote infiltration.

Key Design Features

- Sloped bottom to convey runoff
- Native landscaping
- Shallow above-ground storage area
- Growing media layer to treat and store runoff
- Drain rock layer to promote infiltration
- Underdrain and overflow in areas with low infiltration rates
- Single orifice outlet structure to manage peak flow and flow duration
- Check dams to prevent erosion, detain flow and promote infiltration

Infiltration vegetated swales should be designed in areas where the design infiltration rate exceeds 0.5 inches per hour. In areas of reduced infiltration capacity, a filtration rain garden with an underdrain connection to the downstream conveyance system should be installed.

Planting Suggestions

For vegetated swales, vegetation is categorized according to the degree of soil moisture that will be encountered. Consideration of these various planting zones will enhance success of the planting design. In some cases, adapted species may be better suited to stormwater management facilities than native species. Temporary irrigation is necessary during the plant establishment period.

Do not apply fertilizers or pesticides.

Design Considerations

Community Benefits

- Enhances site and roadway aesthetics
- May be used to retrofit developed areas
- Provides landscaping/ wildlife/ pollinator habitat

Water Quality Benefits

- Removes settleable pollutants
- May decrease runoff temperature
- Removes nutrients due to plant uptake

Drainage/Flow Control Benefits

- Reduces runoff rate and duration

Site/Layout Considerations

- May be distributed throughout the site
- May be used for stormwater conveyance
- Not suitable on steep slopes

Soil/Vegetation Considerations

- Install underdrain in areas of limited infiltration
- Requires careful selection of plants and soil media

Maintenance Considerations

- Two year plant establishment period
- Requires maintenance agreement for private applications
- Quarterly maintenance and annual reporting

Facility Sizing Methods

BMP Sizing Tool: Utilize the BMP Sizing Tool to analyze proposed site conditions and determine minimum facility size. Account for facility longitudinal slope and side slopes. Facility surface area may be reduced if the depth of growing media is increased (see Public Works Standards, Section 301.4.05.a.5).

Engineered Method: Utilize engineering tools to size the facility to treat 80% of the average annual runoff volume and manage flow duration using continuous simulation for the range of flows between 42% of the 2-year and the 10-year peak flow.

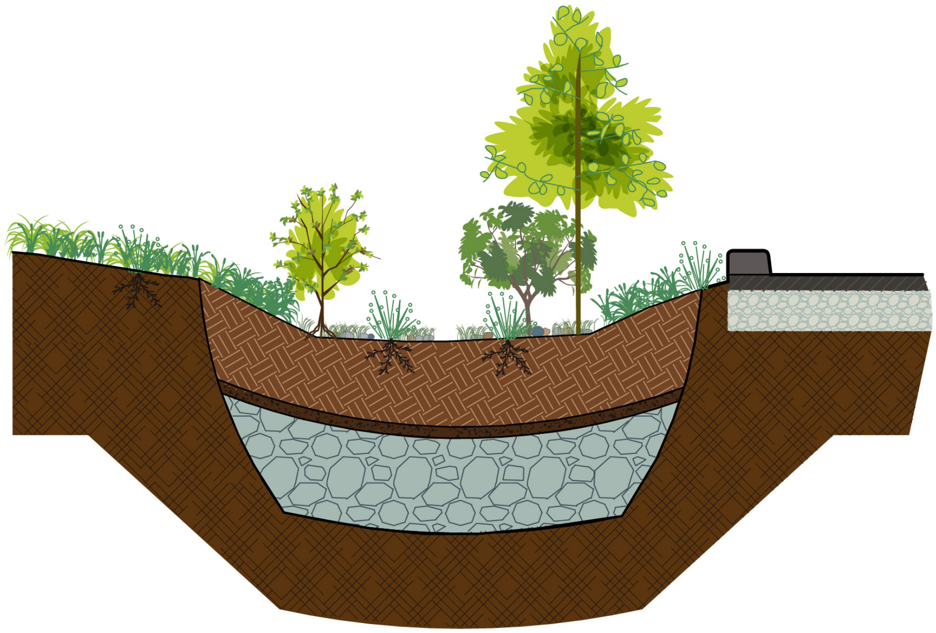
Simplified Sizing: Size the surface area of the swale to equal 10% of the total site impervious area.

Vegetated Swale

CITY DETAIL DRAWINGS: ST-6045, ST-6050, & ST-6120

Maintenance Considerations

Vegetated swales require periodic plant, and soil layer maintenance to maintain conveyance infiltration, storage, and pollutant removal capabilities. Routine maintenance activities include removal of trash and debris from the swale bottom and control structures, replacement of plants and soil in eroded areas, pruning and removal of dead vegetation, removal of invasive and nuisance weeds, and repair of structural elements. Fertilizing should not be required. Designers should prepare a maintenance plan that includes a recommended inspection schedule to identify needed maintenance activities.



Infiltration Swale

Vegetated swales used for treatment and conveyance in residential and transportation settings.
Source: City of Wilsonville (Canyon Creek)

WILSONVILLE
OREGON

See the Wilsonville Public Works Standards, Section 3 for additional information.

Filter Strip

CITY DETAIL DRAWING: ST-6035

WILSONVILLE OREGON

Description

Filter strips are stormwater management facilities that utilize the natural ability of vegetated surfaces to filter stormwater runoff. Filter strips are best used in locations where water can sheet flow from adjacent impervious surfaces, such as roadways, parking lots, sidewalks, and paths towards a gradual natural or constructed slope. Filter strips rely primarily on vegetation to treat stormwater runoff. Infiltration through amended growing media provides additional water quality benefits and some flow control.

Key Design Features

- Consistent facility slope/grade
- Native landscaping
- Growing media layer to treat and store runoff
- Overflow connection to downstream conveyance system
- Requires dispersion mechanism at top of slope to maintain sheet flow drainage pattern
- Check dams prevent erosion, detain flow and promote infiltration

Planting Suggestions

Filter strips typically have dry to moderate soil moisture with uniformly graded slopes. Landscape plans should incorporate a variety of plant species and layering techniques to create a diverse vegetated environment. Temporary irrigation is necessary during the plant establishment period.

Do not apply fertilizers or pesticides.

Design Considerations

Community Benefits

- May be used to retrofit developed areas
- Increases landscaping/ wildlife/ pollinator habitat

Water Quality Benefits

- Removes settleable pollutants
- May decrease runoff temperature
- Removes nutrients due to plant uptake

Drainage/Flow Control Benefits

- Provides flow dispersion

Site/Layout Considerations

- Optimal location is adjacent to linear impervious surfaces (sidewalks, trails, alleys)

Soil/Vegetation Considerations

- Requires careful selection of plants and soil media

Maintenance Considerations

- Two year plant establishment period
- Requires maintenance agreement for private applications
- Quarterly maintenance and annual reporting

Facility Sizing Methods

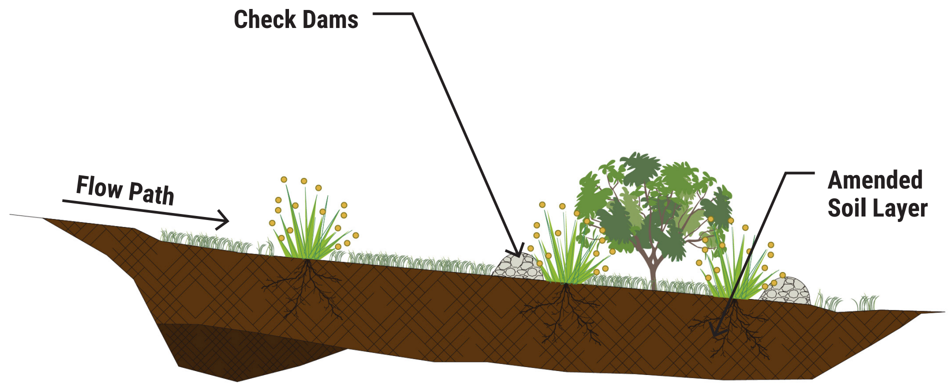
Filter strip sizing is based on the length of the flow path from the contributing impervious area and the slope of the proposed filter strip. The maximum allowable length for the contributing flow path is 30 feet. Filter strips may be placed on slopes as flat as 2 percent up to 15 percent, though the size of the facility increases with increased slopes. See City Detail Drawing ST-6035 for a facility sizing table.

Filter Strip

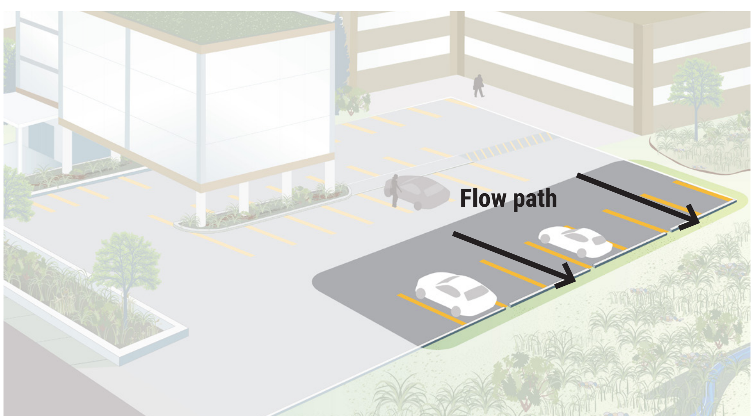
CITY DETAIL DRAWING: ST-6035

Maintenance Considerations

Filter strips require periodic plant, and soil layer maintenance to maintain infiltration, storage, and pollutant removal capabilities. Routine maintenance activities include trash removal, mowing, replacement of plants and soil in eroded areas, pruning and removal of dead vegetation, removal of invasive and nuisance weeds, and repair of structural elements. Designers should prepare a maintenance plan that includes a recommended inspection schedule to identify needed maintenance activities.



Filter Strip



Filter strip application at the edge of a parking area.

Roadway embankments and sidewalks provide opportunity to install filter strips to treat runoff from adjoining impervious areas.
Source: City of Wilsonville (Canyon Creek)

WILSONVILLE
OREGON

See the Wilsonville Public Works Standards, Section 3 for additional information.

Green Roof

CITY DETAIL DRAWING: ST-6090

WILSONVILLE OREGON

Description

Green roofs are vegetated roof systems designed to capture and treat rainwater before it reaches an impervious surface. Green roofs are considered to be both an LID practice and a stormwater management facility, as they help minimize impervious area while also providing treatment. They help mitigate runoff temperature by retaining runoff during the warmer months of the year. A green roof is typically comprised of a waterproof material, covered with a soil system and vegetated layers. Green roofs often use structural cells to contain the soil and vegetation layers.

Green roofs can be used in conjunction with other site planning practices to reduce the total impervious area of a site below the 5,000 square foot impervious threshold. This would eliminate the need to install additional stormwater facilities.

Key Design Features

- Professional structural design required to account for increased roof loading (typically an additional 15-30 pounds/sf for saturated weight)
- Waterproof membrane
- Root barriers
- Underdrain systems
- Growing media to support vegetation
- Drought tolerant vegetation

Planting Suggestions

Green roofs require landscape plans that are customized to the unique growing environment. Plants must have shallow root systems and the ability to survive without irrigation. Sedums and succulents are best suited for use in green roofs, along with some small herbaceous plants. As with other stormwater management facilities, landscape plans for green roofs should incorporate a variety of plant species and layering techniques to create a diverse vegetated environment. Public Works Standards, Section 3, Appendix A has planting guidance and suggested plant species for green roofs.

Design Considerations

Community Benefits

- May be used to retrofit developed areas
- Optimizes developable area
- May meet landscaping requirements

Water Quality Benefits

- Removes settleable and dissolved pollutants
- May decrease runoff temperature
- Removes nutrients due to plant uptake

Drainage/Flow Control Benefits

- Reduces runoff rate

Site/Layout Considerations

- Reduces impervious area requiring stormwater treatment
- Requires structural analysis
- Can be used in areas with steep slopes

Soil/Vegetation Considerations

- Requires detailed planting plant and soil media design
- May be used in areas with low infiltration rates, high water tables, and soil contamination

Maintenance Considerations

- Two year plant establishment period
- Requires detailed construction oversight during installation to ensure optimal performance
- Requires maintenance agreement for private applications
- Annual inspections and reporting

Facility Sizing Methods

The size of the green roof is dependent on architectural and structural constraints. All roof area managed using green roofs is assumed to meet full water quality treatment and flow control requirements because the roof surface is no longer a contributing impervious surface.

If green roofs are used, the footprint of the green roof is not counted towards the impervious area total requiring flow control and water quality treatment.

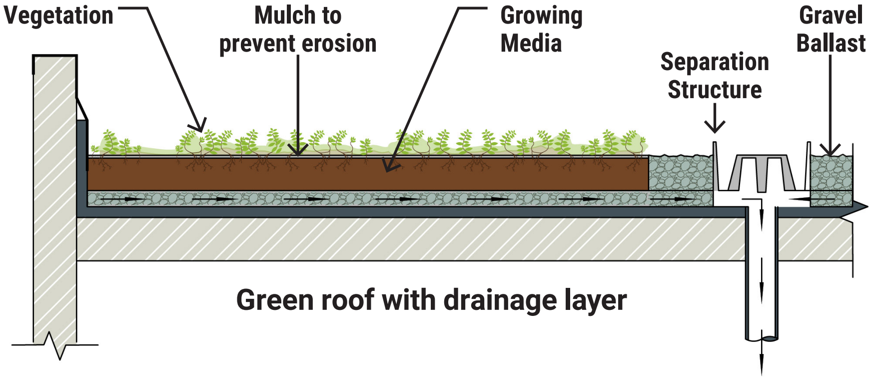
Green Roof

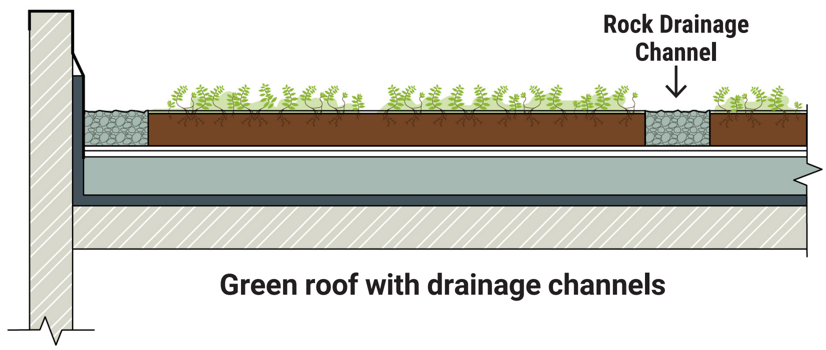
CITY DETAIL DRAWING: ST-6090

Maintenance Considerations

As with other stormwater management facilities, green roofs require periodic plant, soil, and mulch layer maintenance to maintain storage and pollutant removal capabilities. Maintenance access must be incorporated into the building design and may impact the extent to which green roofs can be used on some building structures.

Routine maintenance activities include replacing plants and growing media in eroded areas, removing debris and dead vegetation, removal of invasive and nuisance weeds, and repair of structural elements. Designers should prepare a maintenance plan that includes a recommended inspection schedule to identify needed maintenance activities.





Green roof for commercial buildings

See the Wilsonville Public Works Standards, Section 3 for additional information.

Porous Pavement

CITY DETAIL DRAWING: ST-6080

WILSONVILLE OREGON

Description

Porous pavement is a structural groundcover that allows stormwater to infiltrate while providing a load bearing surface for pedestrian and vehicular traffic. Porous pavement is considered to be both an LID practice and a stormwater management facility, as the pavements minimize impervious area while also managing runoff. They are typically installed either as paver systems or as an open graded asphalt design and prevent the generation of stormwater runoff by directly infiltrating rainfall into the subgrade and underlying soil layers. These systems require careful design of the roadway subgrade to provide adequate storage for peak flows.

In Wilsonville, porous pavements can be used on both public streets and private parking areas and can provide drainage solutions in confined areas. Porous pavement can be used in conjunction with other site planning practices to reduce the total impervious area of a site below the 5,000 square foot impervious threshold. This would eliminate the need to install additional stormwater facilities.

Key Design Features

- Permeable pavers or open graded asphalt mix
- Engineered base, drain rock, and subgrade layers to promote infiltration
- Depth of base materials dependent on storage capacity required
- Moderate to high native soil infiltration rates
- Surrounding areas should not be highly susceptible to spills or heavy sediment loads

Planting Suggestions

Not Applicable.

Design Considerations

Community Benefits

- Optimizes developable area
- Reduces standing water on pavement
- May be used to retrofit developed areas

Water Quality Benefits

- Removes settleable and dissolved pollutants

Drainage/Flow Control Benefits

- Reduces runoff rate and volume

Site/Layout Considerations

- Reduces impervious area requiring stormwater treatment
- Not suitable in high groundwater areas
- Not suitable in high risk spill areas
- Not suitable downslope of erosion-prone areas

Soil/Vegetation Considerations

- Requires detailed pavement and subgrade design

Maintenance Considerations

- Requires more maintenance than conventional pavements
- Requires detailed construction oversight during installation to ensure optimal performance
- Requires maintenance agreement for private applications
- Annual inspections and reporting

Facility Sizing Methods

The size of the porous pavement area depends on site constraints and traffic patterns. To meet full water quality and flow control requirements, porous pavement should be designed with drain rock layers and infiltration capacity to fully infiltrate the 10-year design storm. Areas with lower infiltration rates will need overflow paths with connections to downstream stormwater management facilities and the conveyance system.

If porous pavement is used, the footprint of the porous pavement does not count towards the impervious area total requiring flow control and water quality treatment (See Wilsonville Public Works Standards 301.4.03).

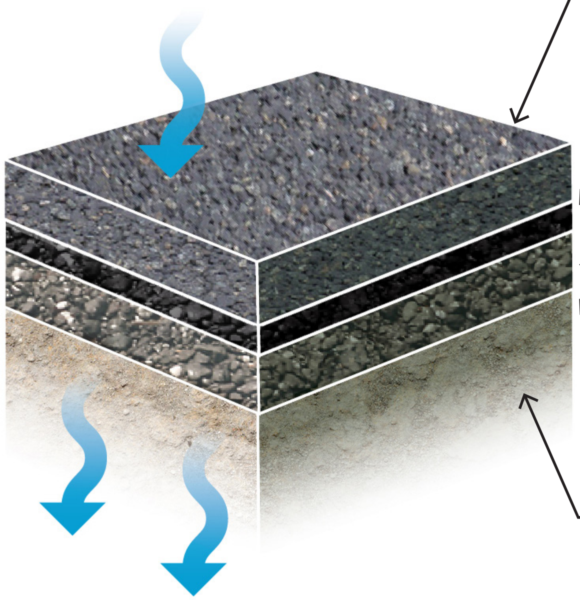
Porous Pavement

CITY DETAIL DRAWING: ST-6080

Maintenance Considerations

Pervious pavement systems require more maintenance attention than traditional asphalt or concrete roadways. The surrounding areas should be inspected regularly for potential sediment sources, as heavy sediment loads can clog pores and reduce infiltration capacity. Vacuuming and sweeping frequency should be increased over that of traditional pavement systems. Routine maintenance activities include sediment removal and replacement of broken pavers.

Deicing and sand applications are not recommended for pervious pavements. Permeable pavements can be plowed during ice and snow events, though a higher blade height is recommended to avoid damaging pavers.



Gaps in the pavers allow water to soak into the ground.
Source: Mutual Materials

Porous concrete application in Wilsonville.

WILSONVILLE OREGON

See the Wilsonville Public Works Standards, Section 3 for additional information.

Case Studies

The following section contains examples of LID development and redevelopment projects that are representative of the types of development that occur in Wilsonville. These case studies incorporate LID site planning practices to reduce impervious surfaces. Stormwater management facility selection and design follow the City's Public Works Standards and are consistent with the LID fact sheets presented in the previous section.

SITE PLANNING AND FACILITY DESIGN CASE STUDY

Commercial Project

Project Description

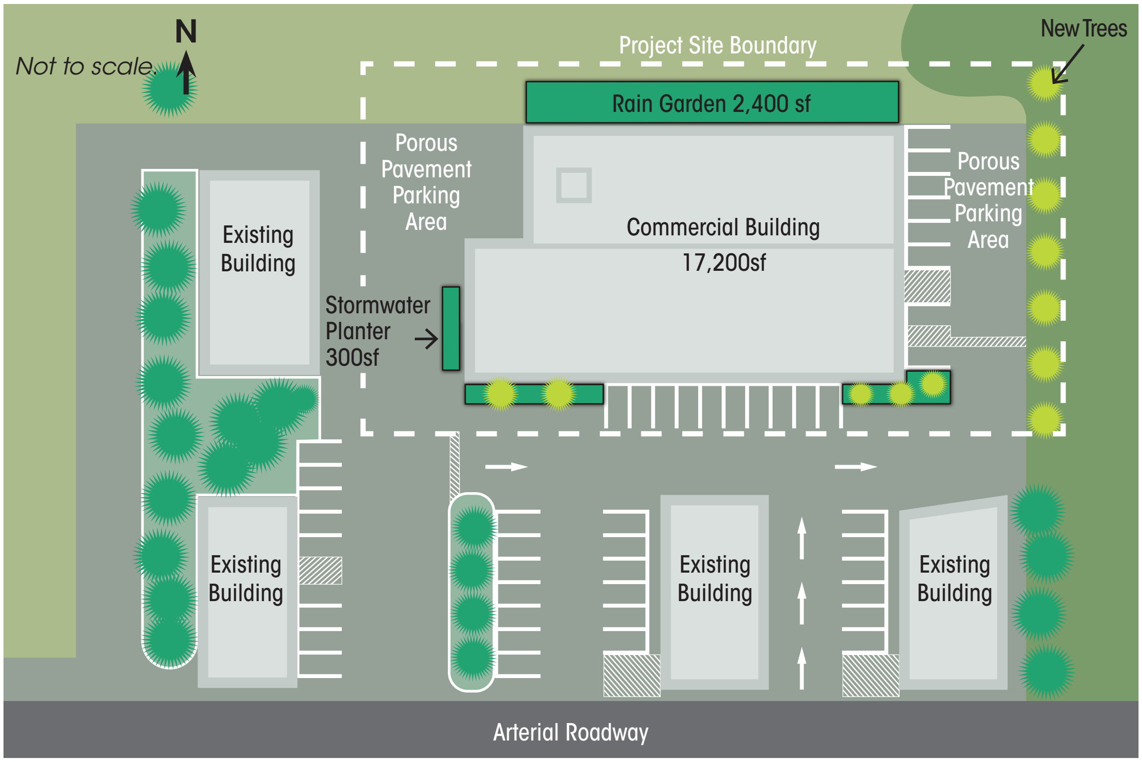
The project is a commercial facility in Wilsonville. The project site was previously designed and constructed with conventional site planning approaches and underground stormwater management facilities.

For this commercial case study, an alternative project design that utilizes LID practices and facilities is evaluated. The BMP Sizing Tool is used to size stormwater management, facilities including a stormwater planter and an infiltration raingarden to maximize infiltration and provide flow control and water quality treatment.

Site Assessment

The site assessment identified the following information related to site planning and facility design:

- Prior to development, the site consisted of a single small structure with gravel access road. There were no existing natural resources, protection areas, or trees on the site.
- The conventional site planning approach maximized impervious surface coverage. A large storage building and parking areas were constructed to the property line.
- Topography is relatively flat, with slight slopes to both east and west. This provides opportunity to locate stormwater management facilities at any location on the site.
- According to the NRCS Soil Survey, the project area soils are primarily Willamette silt loam, classified as hydrologic soil group B. Group B soils tend to have moderate infiltration rates and may be appropriate for the use of infiltration-based stormwater facilities.
- The site is served by existing underground utilities in a nearby arterial roadway.



Alternative site design using LID practices to maintain the consistent site usage as the conventional design.

Site Planning

The alternative site design (see figure) will use the following LID practices to maintain consistent site usage as the conventional design (i.e., same size building and parking area):

- Incorporate porous pavement in the proposed parking areas. Porous pavement allows for consistent site usage, while managing stormwater runoff through infiltration.
- Install new trees to provide an impervious area reduction credit.

Another option for this site would be to incorporate a green roof for a portion of or all of the proposed building. Coupled together, porous pavement and green roofs could eliminate the need for other stormwater management facilities.

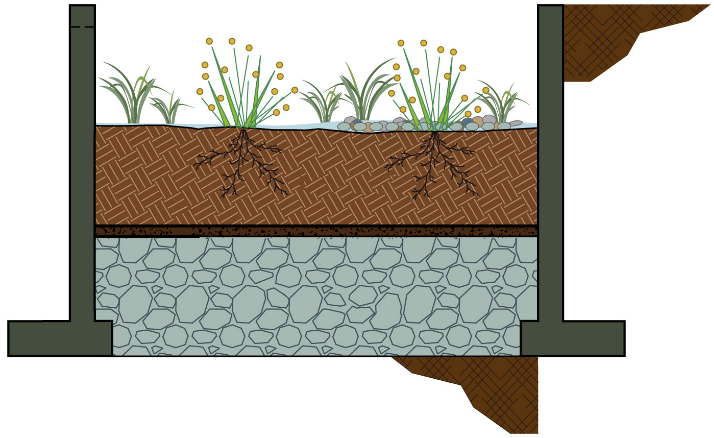
Facility Selection

The site has moderate infiltration rates, allowing for use of infiltration-based stormwater management facilities to meet water quality and flow control requirements.

Based on infiltration rates, the parking areas could be managed through the use of porous pavement. The front of the building has an existing landscape area that could be converted to an infiltration stormwater planter. This facility would manage runoff from a portion of the building roof.

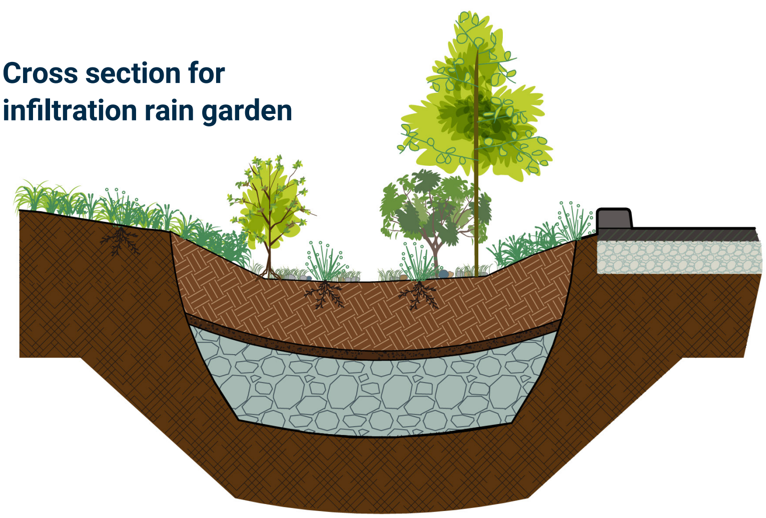
An infiltration rain garden could be placed adjacent to the east parking area to provide water quality treatment and flow control for the remaining roof area. Moderate infiltration rates may allow for full infiltration of runoff, eliminating the need for a piped conveyance system away from the facility. The rain garden could be expanded in the future to manage runoff from future development of adjacent parcels.

Cross-section for infiltration planter

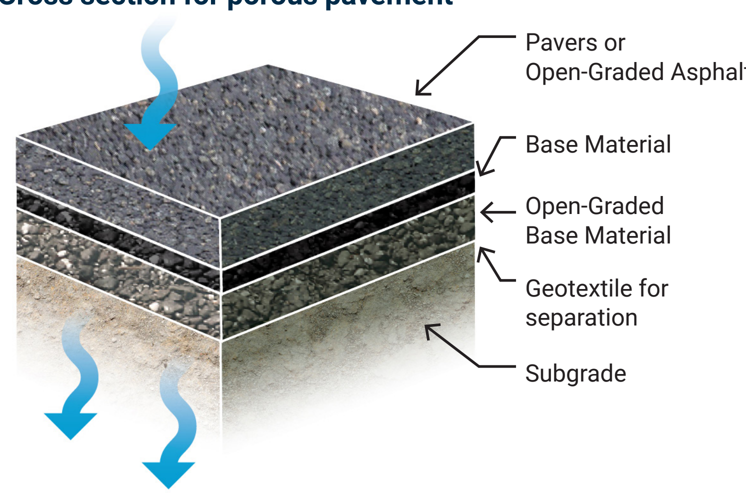


Infiltration planters installed adjacent to building footage and foundations should be installed with a waterproof liner between the facility and building.

Cross section for infiltration rain garden



Cross section for porous pavement



Facility Design

The stormwater management facilities were sized using the BMP Sizing Tool (see table). The sizing tool determined the required facility volume and surface area to manage the expected runoff.

Facility design assumptions are as follows:

- The developed site is divided into three drainage management areas: Roof, West Parking, East Parking.
- The West Parking and East Parking areas, totaling 14,600 SF, are managed through porous pavement, reducing the amount of impervious area requiring stormwater treatment.
- Pre-developed conditions for the building area were modeled as 50% grass and 50% forested to simulate runoff from an Oak Savannah.
- Pre-developed and post-developed conditions for the roof/ building area were modeled assuming hydrologic soil group B to represent the NRCS soil survey classifications.
- Tree credits reduce the impervious roof area from 17,200 SF to 16, 000 SF. The total tree credit is 1200 square feet.
- The proposed stormwater management facilities are an infiltration stormwater planter and an infiltration rain garden with a design infiltration rate of 1.0 to 1.5 inches per hour.
- The stormwater planter will have vertical walls to fit the facility into the small landscaped area at the front of the building. A waterproof liner should be used between the facility and the building foundation. The stormwater planter design will be based on City Detail Drawing ST-6010.
- The infiltration rain garden has 3V:1H side slopes. The rain garden design will be based on City Detail Drawing ST-6025.

BMP Sizing Tool Summary

Drainage Management Area	Land Cover	Area (sf)	Proposed Facility Type	Proposed Facility Surface Area (sf)
West Parking	Porous Pavement	8,700	N/A	N/A
Building Roof	Roof (impervious)	16,000*	Infiltration Stormwater Planter	300
			Infiltration Rain Garden	2,400
East Parking	Porous Pavement	5,900	N/A	N/A

** Total impervious area reduced by 1,200 SF through installation of 12 new trees on the site.*

Example of raingarden planting.

Porous concrete application in Wilsonville.

SITE PLANNING AND FACILITY DESIGN CASE STUDY

Residential Development

Project Description

The project is a residential infill development in Wilsonville, Oregon. The project will subdivide two existing parcels into 14 residential lots with detached homes. A new interior street will be constructed along with public utility improvements within the project area.

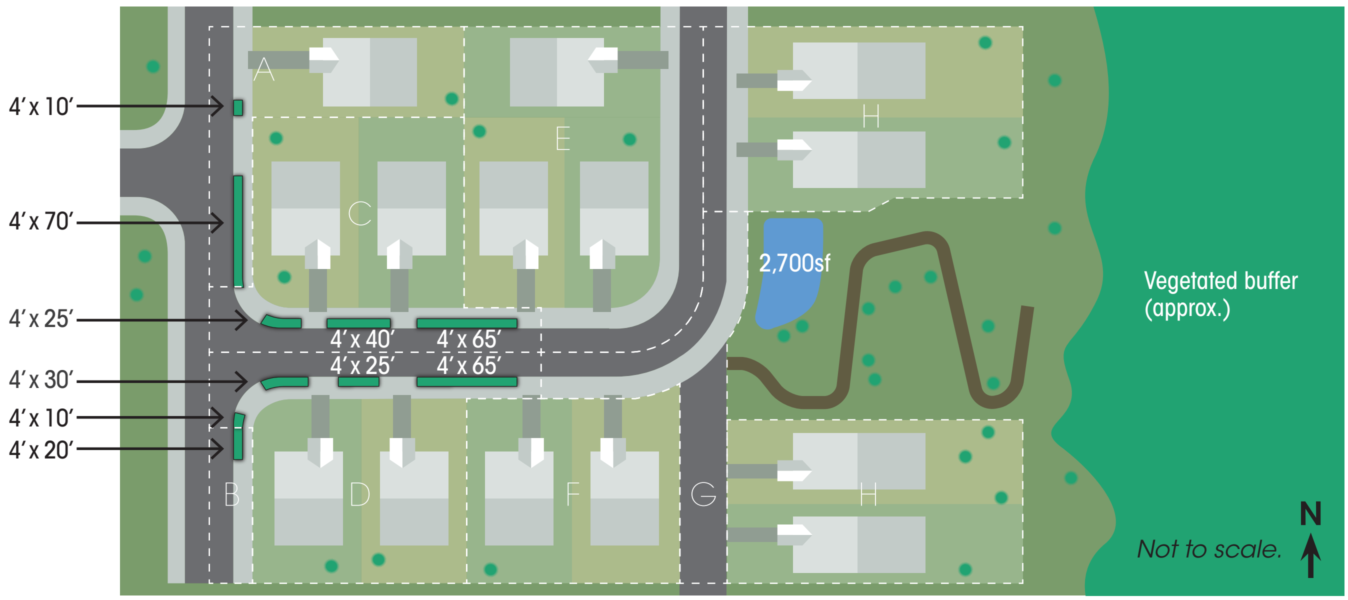
Project site planning will incorporate LID practices. For this residential case study, the BMP Sizing Tool is used to size stormwater management facilities, stormwater planters and an infiltration rain garden to maximize infiltration and provide flow control and water quality treatment.

This case study shows the importance of conducting onsite infiltration tests, as site soils showed significantly higher infiltration capacity, compared to what would be expected based on the NRCS soil survey classification.

Site Assessment

The site assessment identified the following information related to site planning and facility design:

- The property is currently two large lots with single family homes.
- The site is adjacent to Boeckman Creek, which has mapped riparian wetlands. Environmental setbacks and buffers have been located.
- The current ground cover is primarily landscaped open space. Several large trees are located in and adjacent to the environmental setback areas.
- Topography includes minimal slopes at the west (frontage) end of the property and steeper slopes toward Boeckman Creek to the east.
- Current runoff patterns consist of overland flow toward Boeckman Creek. There are no existing stormwater open channels or piped conveyance on the property.
- According to the NRCS Soil Survey, the project area soils are primarily hydrologic soil group C, though onsite infiltration testing measured infiltration rates of 3.0 inches per hour in the vicinity of the proposed facilities.
- The site is served by existing utilities in an adjacent roadway.



Site Planning

The project will use the following LID practices:

- Preserve sensitive areas with appropriate buffers around Boeckman Creek and wetland areas.
- Maintain existing trees and a dedicated open space tract through the east portion of the development.
- Locate lots close to the frontage road to cluster impervious surfaces.
- Use looped roadway design to ensure project site connectivity with future development to the north.
- Use narrow lot frontages and minimal front yard setbacks to minimize roadway and driveway length and impervious surfaces.
- Use shared driveways and a private access alley to minimize roadway and driveway impervious surface.
- Incorporate infiltrating stormwater planters into the right-of-way to manage stormwater close to the source.

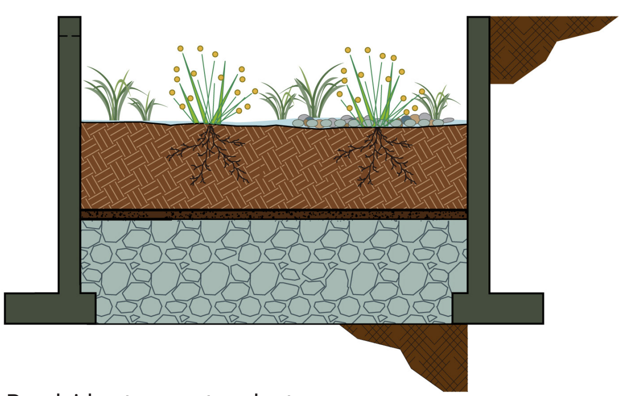
Sample planting scheme for roadside stormwater planters.

Facility Selection

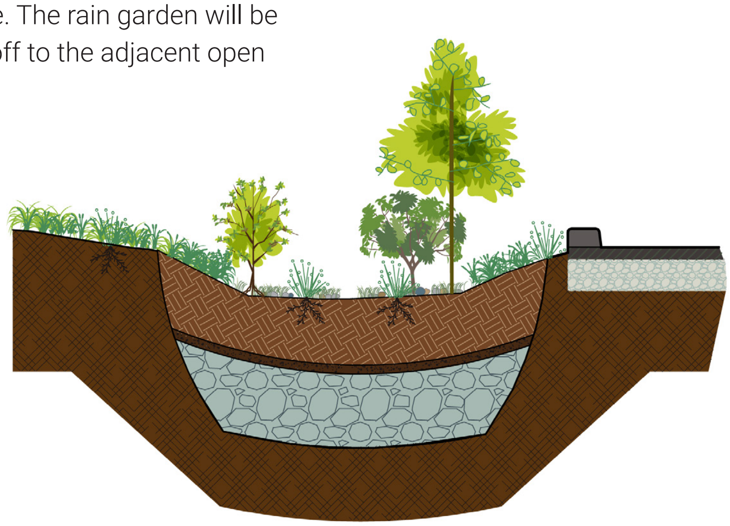
The site has moderate infiltration rates, allowing for use of infiltration-based facilities to meet water quality and flow control requirements.

Infiltration stormwater planters were selected to manage stormwater runoff along the western portion of the development because they can be incorporated into narrow spaces, have appropriate pollutant removal capabilities, and will enhance roadway aesthetics. Planters will be located within the road right-of way, between shared driveways. Because of the infiltration capabilities of the soil, the planters can be installed without an underdrain and overflow and can replace the need for a piped conveyance system for most of the development.

A single infiltration rain garden will be installed to manage stormwater runoff from the east end of the development. The raingarden will provide infiltration, water quality treatment, and flow control and can be integrated into the open space tract, providing an additional landscape feature. The rain garden will be constructed with an overflow to disperse excess runoff to the adjacent open



Roadside stormwater planter cross section example.



Raingarden cross section example.

space area that drains toward Boeckman Creek. This maintains the pre-development drainage patterns of the property.

Facility Design

The stormwater management facilities were sized using the BMP Sizing Tool (see table). The sizing tool determines the required facility storage volume and surface area to manage the expected runoff.

Facility design assumptions are as follows:

- The developed site is divided into 8 drainage management areas.
- Pre-developed conditions are modeled as 50% grass and 50% forested to simulate runoff from an Oak Savannah predevelopment land cover.
- Pre-developed and post-developed conditions are modeled assuming hydrologic soil group C representing the NRCS soil survey classifications. Alternatively, if site-wide infiltration testing was conducted, the assumed hydrologic soil classification should align with the design infiltration rate.
- The developed site is modeled assuming 2,750 sf impervious area (driveway and roof) on each lot with the remainder landscaping. Per Wilsonvilles Public Works Standards, roadways and sidewalks are modeled as 100% impervious.
- The proposed stormwater management facilities are infiltration stormwater planters and an infiltration rain garden with a design infiltration rate of 1.5 inches per hour (based on measured infiltration rates and application of a correction factor).
- Stormwater planters will have vertical walls to maximize the facility space along the shoulder of the roadways. Stormwater planter design will be based on City Detail Drawing ST-6010.
- The infiltration raingarden has 3V:1H side slopes. The rain garden design will be based on City Detail Drawing ST-6025.

BMP Sizing Tool Summary

Drainage Management Area	Land Cover	Area (sf)	Proposed Facility Type	Required Facility Surface Area (sf)	Proposed Facility Surface Area (sf)”
A	Roof/Road	5582	Infiltration Stormwater Planter	300	320
	Landscape	3850			
B	Roof/Road	1654	Infiltration Stormwater Planter	70	80
C	Roof/Road	9080	Infiltration Stormwater Planter	510	520
	Landscape	7700			
D	Roof/Road	9226	Infiltration Stormwater Planter	510	520
	Landscape	7700			
E	Roof/Road	11906	Infiltration Rain Garden	2700	2700
	Landscape	11550			
F	Roof/Road	6100			
	Landscape	7700			
G	Roof/Road	7326			
H	Roof/Road	11000			
	Landscape	15400			

SITE PLANNING AND FACILITY DESIGN CASE STUDY

Transportation Improvements

Project Description

The project is a series of roadway and frontage improvements adjacent to support future development in Wilsonville, Oregon. The public roadway improvements include construction of two new roadways to extend existing access routes to new development areas. Frontage improvements will widen an existing roadway and replace areas of deficient pavement.

Project site planning will incorporate LID practices. However, low infiltration rates and roadway design requirements limit the use of some key LID strategies. For this transportation case study, the BMP Sizing Tool is used to size stormwater management (stormwater planters and vegetated filtration swales) to provide flow control and water quality treatment for the new and replaced roadway area.

Site Assessment

The site assessment identified the following information related to site planning and facility design:

- The site is currently agricultural land.
- The current ground cover is tall grasses and rotating agricultural crops. The land is regularly cleared and there are no major trees within the project area.
- Most of the site slopes gently to the southwest, toward an existing vegetated area east of an existing roadway. A small drainage channel runs through the vegetated area south to the Willamette River. The eastern portion of the site slopes gently southeast toward another small drainage channel to the Willamette River.
- According to the NRCS Soil Survey, the project area soils are primarily Aloha Silt Loam, which is classified as hydrologic soil group D.
- Eight infiltration tests were conducted across the project area. Infiltration rates were minimal, ranging from 0 to 0.25 inches/hour. The site conditions limit the use of infiltration-based stormwater management facilities.

Site Planning

The project scope presents limited opportunities to incorporate LID practices during site planning.

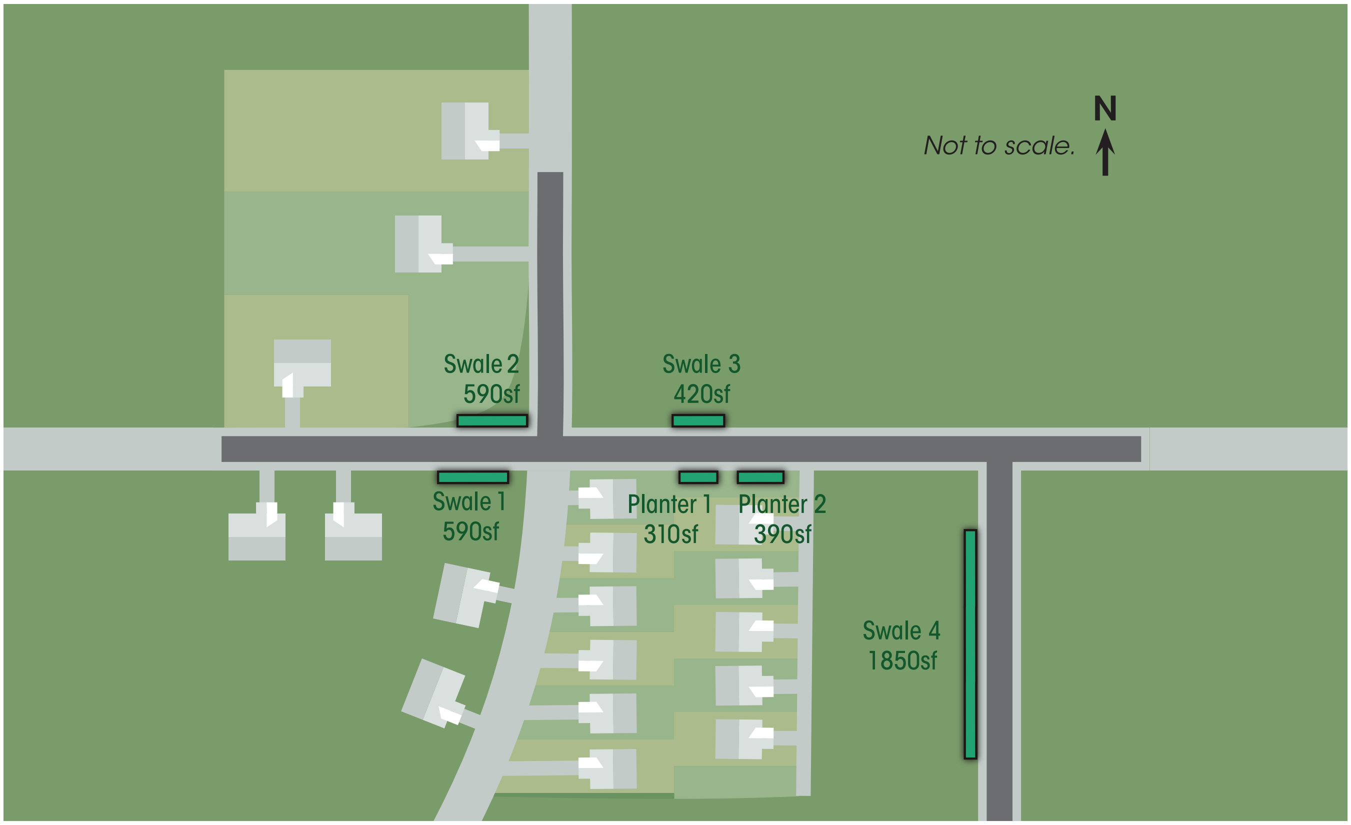
On this site, roadways have been designed to meet the City's minimum width requirements, but there are not additional opportunities to reduce pavement. Porous pavement is not appropriate based on the limited infiltration capability of the underlying soils.

Vegetated swales and stormwater planters with underdrains are proposed in the right-of-way to manage stormwater close to the source. Using multiple dispersed facilities throughout the project area eliminates the need for a separate parcel to manage stormwater runoff.

Facility Selection

The site has limited infiltration capabilities, so stormwater facilities will be designed with underdrain and overflow structures. Filtration planters and swales can be designed to meet both water quality and flow control requirements.

Stormwater planters and vegetated swales were selected to manage stormwater runoff throughout the project area due to their minimal space requirements, pollutant removal capabilities, and their enhancement to roadway aesthetics. Facilities will be located within the road right-of way, between driveways. Planters and swales can also be installed to help meet landscaping requirements.



Example site layout schematic with offsite drainage areas defined.

Facility Design

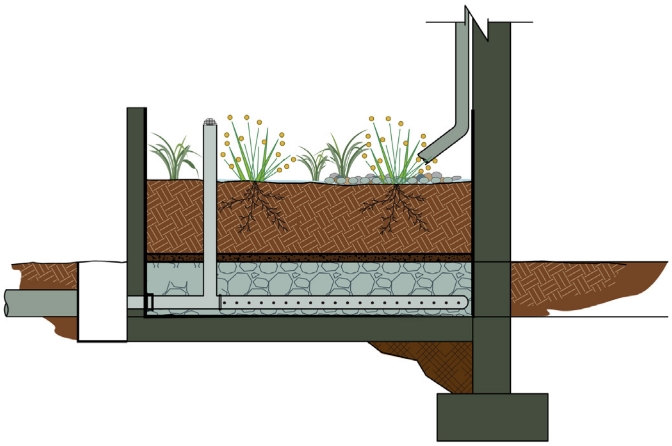
The stormwater management facilities were sized using the BMP Sizing Tool (see table). The sizing tool determines the required facility storage volume and surface area to manage the expected runoff.

Facility design assumptions are as follows:

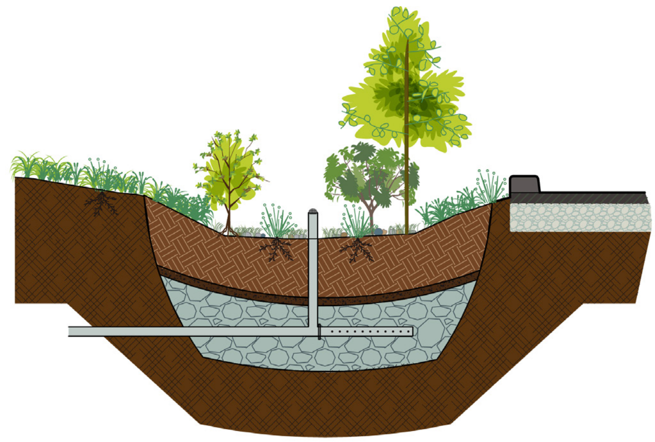
- The developed site is divided into 6 drainage management areas based on existing and proposed topography of the roadway. Each area will be served by an LID facility.*
- Roadway runoff will enter swales and planters through curb cuts.
- Pre-developed and post-developed conditions are modeled assuming hydrologic soil group D to represent the NRCS soil survey classifications. All facilities will be constructed with underdrain and connection to downstream conveyance systems.
- Each facility will have a single orifice control to meet flow control requirements to match pre-development flow durations from 42% of the 2-year through the 10-year peak flow.
- Stormwater planters will have vertical walls to maximize the facility space along the shoulder of the roadways. Stormwater planter design will be based on City Detail Drawing ST-6005.
- Vegetated swale design will be based on City Detail Drawing ST-6045.

The resulting facilities have a required surface area equivalent to approximately 8 percent of the total proposed impervious area of the project.

** Offsite basins, including developed and undeveloped parcels outside the project area, should be considered in calculating peak flows for sizing the public conveyance system, but not for sizing of LID facilities.*



Example cross section for filtration stormwater planter



Filtration vegetated swale, typical cross section.

BMP Sizing Tool Summary

Drainage Management Area*	Land Cover	Area (sf)	Proposed Facility Type	Proposed Facility Surface Area	Orifice Size (inch)
Swale 1	Conventional Concrete	14,654	Vegetated Swale with Type D Soil	590	1.4
Swale 2	Conventional Concrete	10,537	Vegetated Swale with Type D Soil	560	1.3
Swale 3	Conventional Concrete	13,981	Vegetated Swale with Type D Soil	420	1.1
Planter 1	Conventional Concrete	10,247	Stormwater Planter with Type D Soil	310	1.1
Planter 2	Conventional Concrete	13,026	Stormwater Planter with Type D Soil	390	1.3
Swale 4	Conventional Concrete	46,300	Vegetated Swale with Type D Soil	1,850	2.4

Example of vegetated swale to manage roadway runoff.

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