Low Impact Development Approaches

Handbook

July 2009

Wherever there's water, there's **Clean Water.**

Clean Water Services

Acknowledgements

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Chapter 1: Introduction

This handbook was developed to promote and encourage Low Impact Development Approaches (LIDAs) to protect precious natural resources. It is a practical tool for those who make or influence development decisions and will be updated as codes and policies change and new techniques and best practices emerge.

The handbook is a collaborative product of the Tualatin Basin Natural Resources Coordinating Committee, which includes the land use jurisdictions within urban Washington County, and Clean Water Services, Tualatin Hills Park and Recreation District and Metro. Clean Water Services (the District) is a water resources management utility in urban areas of the Tualatin River Watershed that builds, maintains and enhances the public drainage system in partnership with Washington County and its member Cities. The District, County and Cities manage stormwater runoff to meet public needs and comply with strict water quality regulations set for the Tualatin River basin by the Oregon Department of Environmental Quality (DEQ).

The District's Design and Construction Standards (the Standards) define the requirements for development to treat and detain stormwater runoff. Stormwater is the runoff from impervious surfaces such as streets, roofs and parking lots that flows to storm drains, ditches and culverts, and then to the nearest river, stream or wetland. When it rains, stormwater runoff may pick up oil, sediment, bacteria, grease and chemicals that can pollute local waterways and the Tualatin River.

LIDAs offer more options to comply with stormwater management requirements, and complement the water quality facilities and vegetated corridors that have been established as part of the Standards. The five objectives of LIDA are to:

1. Conserve Existing Resources
2. Minimize Disturbance
3. Minimize Soil Compaction
4. Minimize Imperviousness
5. Direct Runoff from Impervious Areas onto Pervious Areas

This handbook is a supplement to the Standards and is to be used in conjunction with them and other applicable regulations.

The Handbook is for use by all public agencies within the Tualatin Basin as a reference document. There may be other standards and requirements that are jurisdiction-specific and the users are encouraged to check with the local jurisdiction for additional information.

LIDA swale

Green Roof

Porous Pavement

Vegetated Swale

Extended Dry Basin

Constructed Water Quality Wetland

Infiltration Planter

Flow-Through Planter

Vegetated Filter Strip

1.1 Why Use Low Impact Development Approaches (LIDAs)?

Typically, LIDA facilities are vegetated landscape elements such as planters, vegetated filter strips, and swales that filter and/or infiltrate stormwater. Other types of LIDAs are porous pavements and green roofs that reduce impervious area and runoff volume. LIDAs are integrated with the site landscaping to provide stormwater management, visual amenities and habitat benefits. Low impact site design may preserve trees and vegetation, and conserve water and reuse water. Site design approaches may include lot size averaging, density transfers, clustering or placement of buildings and parking areas to avoid impacts to habitat, vegetation and drainage courses.

In addition to aesthetic and habitat benefits, LIDAs may:

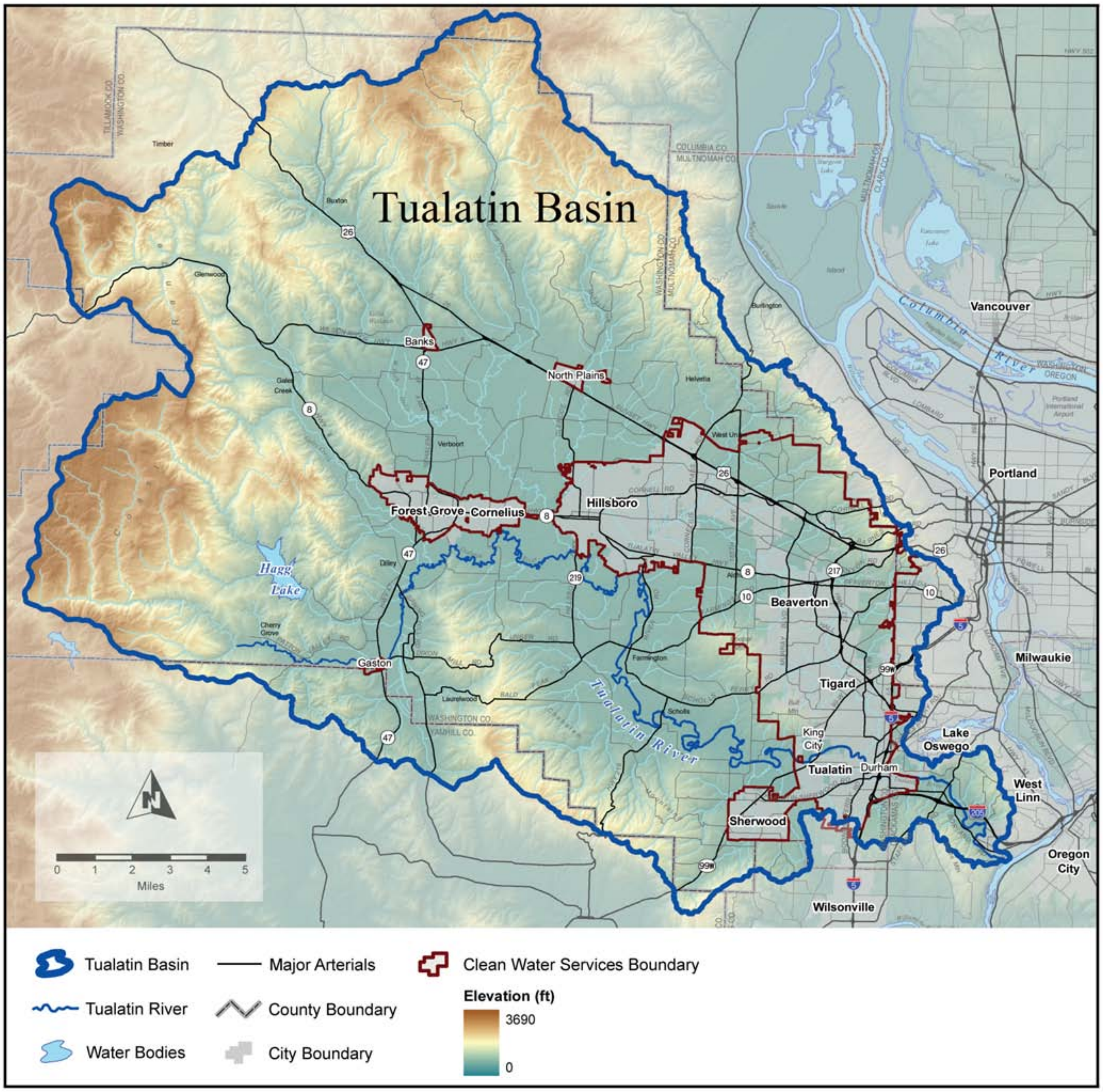
- Meet Clean Water Services' stormwater quality requirements for new development sites and redevelopment
- Reduce area needed for water quality facilities by integrating LIDAs into landscaping, buildings and pavements which may result in more buildable land
- Reduce and slow stormwater runoff for better water quality and less erosion
- Cut project costs by eliminating piping and other engineered structures
- Reduce the piping and excavation needed to manage stormwater runoff because it is conveyed and treated above ground
- Use the same areas for stormwater management and landscaping (e.g. a flow-through planter may count toward required site landscaping)
- Qualify for credits for green building, site design, etc.
- Qualify for development credits such as allowable building height increases, reduced set-backs or reduced lot sizes
- Preserve trees and significant vegetation by incorporating them into LIDA facilities or avoiding them in the site design
- Provide summer shade

None of the LIDA facilities included in this Handbook are considered to be Underground Injection Control (UIC) system. As such, no UIC regulatory requirements are noted. Check with the District or DEQ staff for additional information about UICs.

1.2 How this Handbook Relates to Other Tualatin Basin Regulations

The handbook is intended to encourage the use of LIDAs by providing guidance on their planning, design and maintenance. The District allows and encourages LIDA facilities to meet stormwater quality requirements for development. The District implements stormwater requirements in unincorporated portions of its service area and within the Cities of Banks, Durham, King City, and North Plains. In Beaverton, Cornelius, Forest Grove, Hillsboro, Sherwood, Tigard and Tualatin, the Cities' staff implement and enforce the requirements.

Map of Clean Water Services District Boundaries



This handbook is a reference for all jurisdictions within the Tualatin Basin. Users are encouraged to consult with the local jurisdiction for additional requirements and standards This handbook is a supplement and is to be used in conjunction with the Standards and other applicable regulations. LIDAs do not replace Water Quality Sensitive Areas or Vegetated Corridors.

The requirements included in the Design and Construction Standards protect water quality, floodplains and habitat functions from the impacts of development. Water Quality Sensitive Areas, including streams and wetlands, must be protected by Vegetated Corridors. Always check the County and City planning and development standards for additional site design requirements.

LIDAs are encouraged, but in some cases might not be allowed by the local jurisdiction due to technical constraints, code restrictions or other issues. For example, a LIDA based on infiltration might not be allowed on unstable slopes, areas of high groundwater table, or soils with poor infiltration. Property owners, developers, designers and contractors must check with local permitting authorities to confirm allowed LIDAs for their projects.

LIDAs are intended to reduce and mitigate the environmental impacts of conventional development by mimicking natural hydrology instead of replacing it with imperviousness. LIDAs may meet water quality regulations and stormwater flow management goals, and may also qualify for development credits from local jurisdictions by protecting vegetation and habitat located outside of the required Vegetated Corridors.

Chapter 2: Site Planning for LIDAs

2.1 Site Analysis

The first step in using LIDAs is a thorough site analysis to learn how water moves through the site and how natural hydrologic functions could be preserved. Inventory conditions on and adjacent to the site, including topography, soils, hydrology, and vegetation. The site analysis includes site visits, topographical and vegetation/habitat surveys, review of maps and reports, and development of a site base map.

In the site analysis, the physical attributes of the development or redevelopment site should be reviewed before placing streets, parking lots and buildings to optimize stormwater management and habitat protection. Existing features should be incorporated into the site design by working with rather than against site attributes and constraints. A site layout that integrates site amenities to manage stormwater and protect habitat may reduce permitting delays.

Site analysis should follow the order depicted in Figure 1 and answer the questions below.

1. Topography

Is the site flat, steep, or moderately sloped?

The steeper the slope, the more likely soil erosion or slides could occur. Generally, slopes greater than 25% should be avoided for clearing, grading and building. Steep slopes and slide prone areas are not advisable for infiltration LIDAs. A geotechnical engineering analysis may be necessary to determine appropriate LIDAs.

2. Soils

What is the site soil type, hydrologic group, infiltration capacity, and are groundwater tables high?

Use soil maps, which are available from the Natural Resources Conservation Service (NRCS) Soil Survey for Washington County. Sizing may be adjusted for some LIDAs based on tested infiltration rates unless high groundwater is an issue.

3. Hydrology

What are the flow patterns into, on, and from the site? Where will runoff drain?

Does the site have FEMA floodplains or floodways, drainage hazard areas, or Water Quality Sensitive Areas, seeps or springs?

Working with the site's flow patterns may reduce grading and associated costs.

4. Vegetation & Habitat

Are there trees and vegetation, especially large trees (6" diameter or larger at 4 foot height) or native vegetation on the site?

Native trees and vegetation should be protected. Check local planning and development codes for habitat and tree protection requirements. Local codes also may offer incentives for protecting and avoiding trees and habitat.

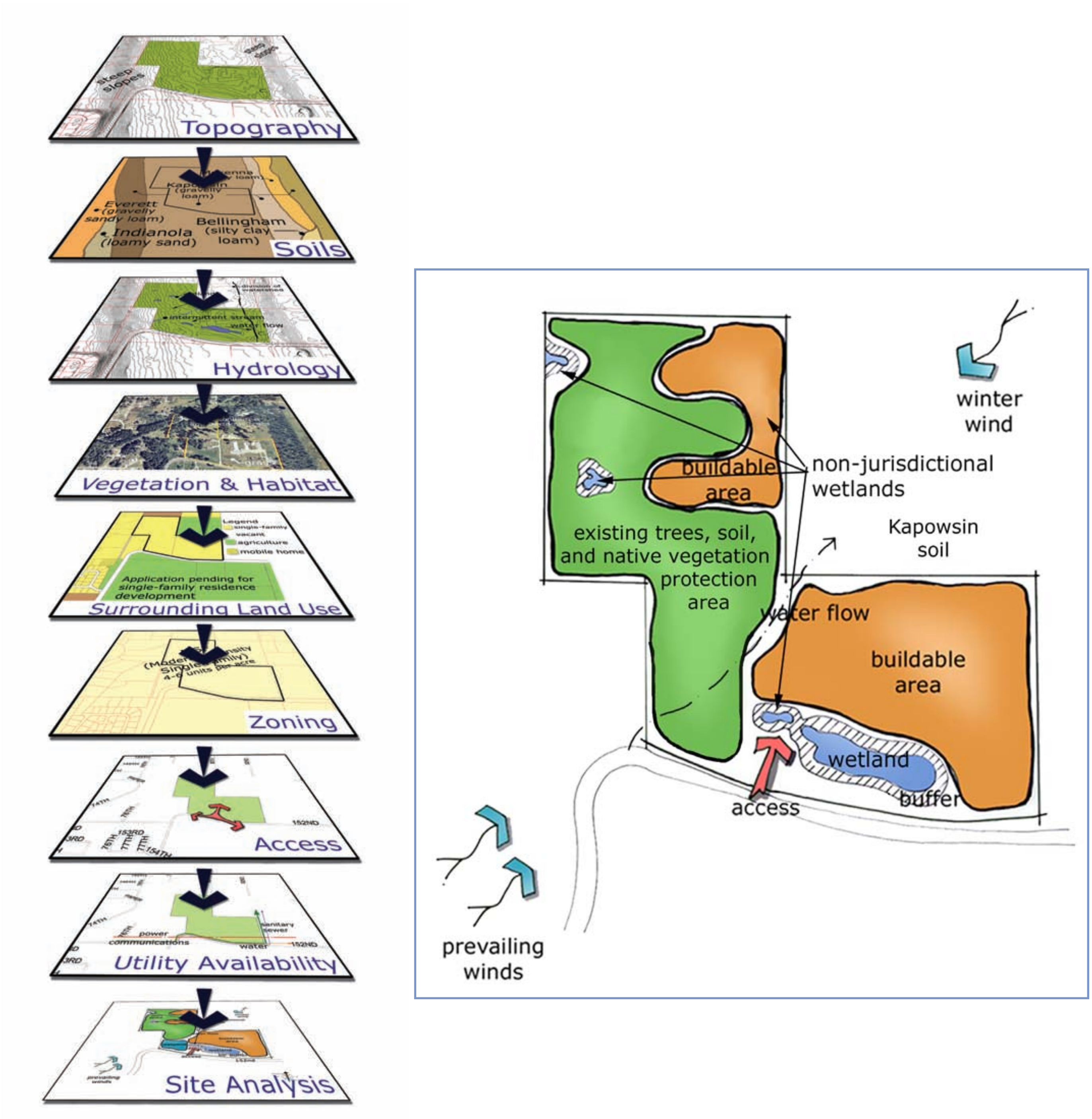


Figure 1 Site Analysis process diagram . Graphic from the LID Technical Guidance Manual for Puget Sound, courtesy of Puget Sound Partnership and AHBC, Inc..

5. Water Quality Sensitive Areas
Are there year-round or intermittent streams or channels or wetlands?
These features are protected by Corps of Engineers or Oregon Department of State Lands (DSL) environmental regulations, and the District Standards require Vegetated Corridors to protect them. Refer to National and Local Wetlands Inventory maps and consult with the District or local jurisdiction.

6. Land Use/Zoning
What type and density of development is allowed/required? Are there special or protective overlay zones? Can development be clustered or lot sizes altered?

7. Access
What are the options for auto, bike and pedestrian access, circulation and parking?

8. Utility Availability and Conflicts
What potential utility conflicts exist? Where are existing utility connections (water, sewer, storm drainage, electricity/phone/cable, etc.)? Where can new utilities be constructed with least impacts?

2.2 Site Planning

After completing the site analysis, prepare a site plan for permit submittal that addresses the five LIDA objectives listed below:

Site planning for LIDAs is based on these objectives, in order of importance:

1. Conserve Existing Resources
2. Minimize Disturbance
3. Minimize Soil Compaction
4. Minimize Imperviousness
5. Direct Runoff from Impervious Areas onto Pervious Areas

1. Conserve Existing Resources
The first and most important step in LIDA site planning is to preserve and protect existing water features and vegetated areas. Although the Standards require permanent protection of Water Quality Sensitive Areas and Vegetated Corridors, protection of other mature trees and vegetation provides habitat, prevents erosion, captures significant rainfall, provides summer shading, and reduces runoff volume and velocity which protects and enhances downstream water quality. Preservation of trees and vegetation may qualify for local incentives, and may reduce a site's ultimate impervious area and the size of required water quality or LIDA facilities.

2. Minimize Disturbance

Protection of existing vegetation provides more water quality benefits than replanting areas that have been cleared. Undisturbed areas provide more rainfall interception, evapo-transpiration and runoff rate attenuation than replanting even with soil amendments. Construction activities that compact native soils significantly reduce infiltration capacity and increase runoff. To minimize disturbances, identify areas required to be protected and other areas that will not be cleared or impacted during construction. On plan submittal drawings, identify site work zones and no-disturbance areas. And, on the site use orange construction fencing to mark work zones, access points, materials storage and areas where no disturbances will be allowed.

3. Minimize Soil Compaction

Avoid any activity that could cause soil compaction in areas designated for infiltration LIDAs. Also avoid or minimize soil compaction where other LIDAs, water quality or detention facilities, or landscaping will be placed. Truck and equipment traffic during construction compacts site soils and areas that will ultimately be landscaped. Clearing, grading and compaction by construction traffic reduces the natural absorption and infiltration capacities of the native soils. Subsequent tilling and/or addition of soil amendments such as compost can help, but will not restore the original infiltration capacity of the soils. To minimize compaction, prepare soil amendments off-site; if prepared onsite, designate an area for soil amendment preparation and use appropriate erosion prevention and sediment control methods.

4. Minimize Imperviousness

Site design layout methods that reduce impervious footprints may include: shared parking areas; clustered buildings that require less driveways and pathways; reduced parking stalls, especially in transit-served areas; adding floors to buildings or parking garages; and, reduced street width if allowed by local planning codes. In site design strive to reduce the actual footprint of buildings and paving to reduce and slow runoff from built surfaces. Green roofs and porous pavement are effectively pervious, although they are not water quality facilities, and they reduce the site impervious area and the volume of stormwater to be treated.

5. Direct Runoff from Impervious Areas onto Pervious Areas

This is the last line of defense against downstream impacts. While the first four objectives prevent runoff and pollution transport, this addresses pollutants in runoff from roofs, parking lots, streets and other impervious surfaces. Most LIDA facilities and water quality facilities fulfill this objective, including: planters, swales, vegetated filter strips, extended dry ponds and constructed water quality wetlands that serve as pervious, landscaped areas designed to receive runoff from impervious areas.

2.3 Selecting LIDAs to Match Site Conditions

LIDA facilities can be constructed on and adjacent to buildings, and integrated into site landscaping and hardscape such as parking lots and along streets. LIDA facilities can be used singly to manage rainfall and runoff from a drainage area, or constructed in a series of multiple facilities. The site analysis helps identify the types of LIDAs best suited to the site. Owners and designers may use Table 1 as a quick reference to match each LIDA with common stormwater management objectives and site constraints to select the most appropriate facilities.

Table 1: LIDA Selection for Site Conditions

	Green Roof	Porous Pavement	Flow-through Planter	Infiltration Planter/ Rain Garden	Vegetated Filter Strip	LIDA Swale
Reduce imperviousness	✓	✓				
Infiltrate		✓		✓	✓	✓
Detention/ flow control		✓		✓		
Provide Habitat			✓	✓	✓	✓
Near Vegetated Corridor			✓	✓	✓	✓
Private property	✓	✓	✓	✓	✓	✓
Private street		✓	✓	✓	✓	✓
Public Street/ROW*			✓		✓	✓
On or next to building	✓		✓			
Parking lot		✓	✓	✓	✓	✓
Landscaped area			✓	✓	✓	✓
Steep slope	✓		✓			
Soils with low infiltration rate	✓	✓	✓		✓	✓
High GW table	✓		✓		✓	✓
Contaminated soils	✓		✓			

* Check with local juristiction about use in ROW

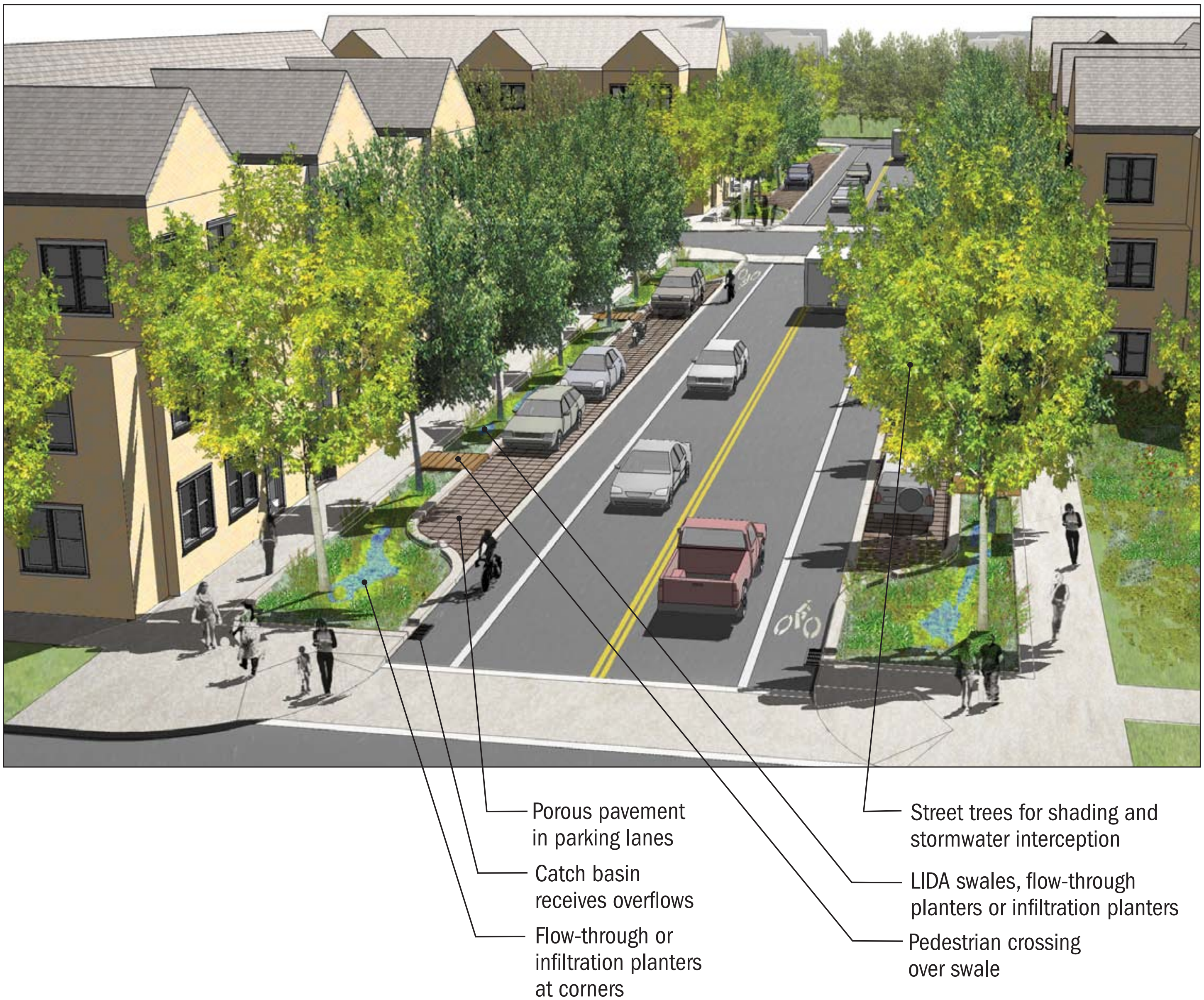
Figures 2, 3 and 4 illustrate how various LIDAs can be integrated into development sites, landscaping and street designs.

LIDAs in Parking Areas

Figure 2

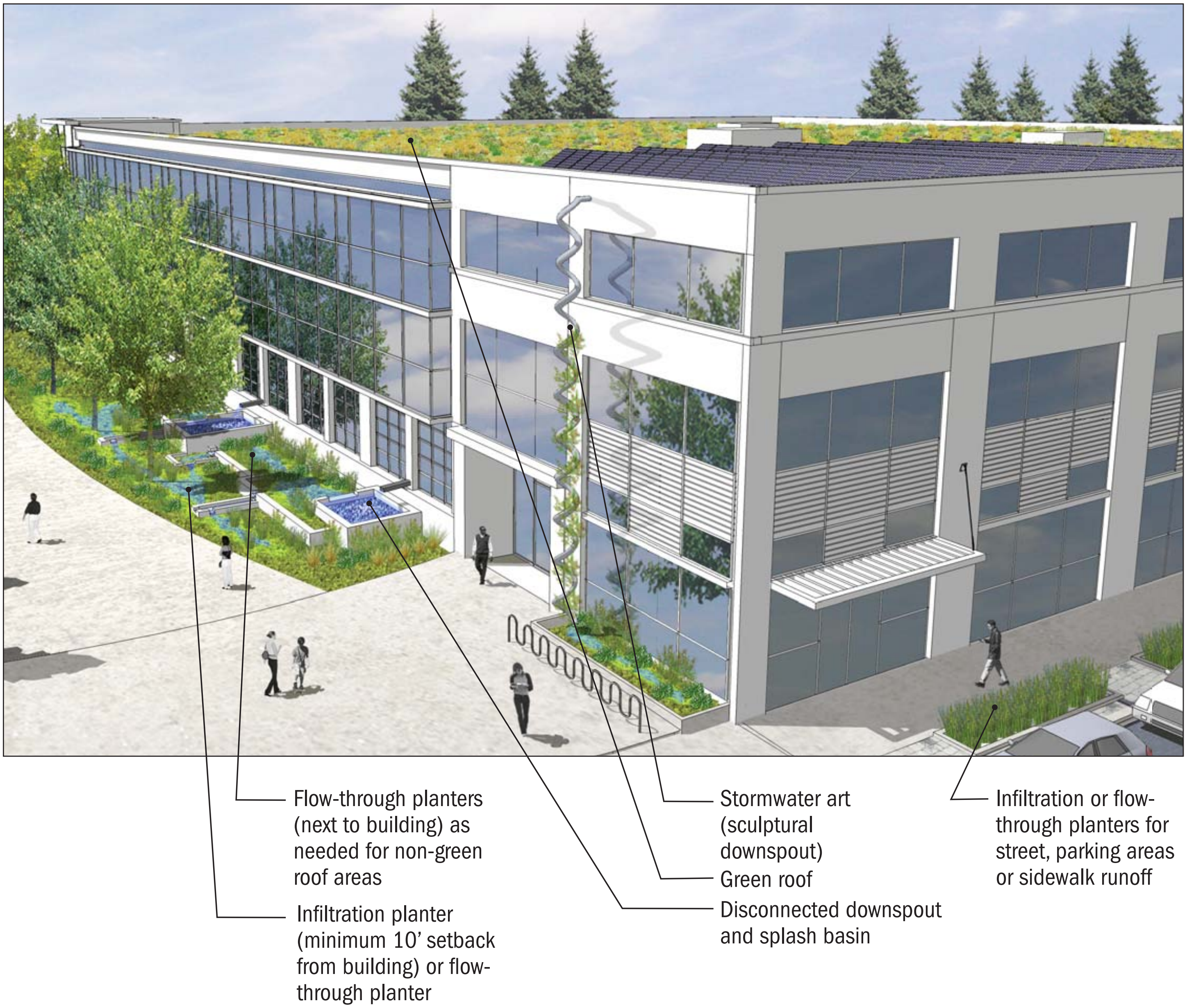
LIDAs for Streets

Figure 3



LIDAs for Buildings and Adjacent Areas

Figure 4



Chapter 3: LIDA Design Process

3.1 Design Basis

Primary goals of LIDA site design are to reduce the volume of stormwater runoff and to treat pollutant loads where they are generated using appropriate site planning and by directing stormwater to small-scale systems throughout the site. LIDAs integrated into landscaping and the site design may reduce the size of or eliminate stormwater ponds in separate land tracts, and may reduce underground piping, curbs, and gutters.

The District requires stormwater treatment for nearly all development and other activities that create new impervious surfaces or increase the amount of stormwater runoff or pollution leaving the site. Refer to the Standards for specific requirements and how to calculate the impervious area requiring LIDA or water quality facilities.

Stormwater treatment to remove pollutants is required in the Tualatin River Basin by the Oregon Department of Environmental Quality to comply with the Clean Water Act. The District's Total Maximum Daily Load (TMDL) and National Pollution Discharge Elimination System (NPDES) Municipal Separate Storm Sewer System (MS4) Permit require new development and redevelopment to reduce pollution from stormwater runoff. This is achieved by constructing water quality facilities to remove pollution, or by using LIDAs to reduce runoff and pollutants.

The water quality storm runoff rate volume calculations for sizing water quality facilities are presented in Chapter 4 of the Design and Construction Standards. To determine the size of LIDA facilities, owners and designers may use the LIDA Sizing Form in Section 3.2. This form is based on the water quality design storm and typical soil conditions. [Retrofit project sizing: For retrofit projects where there has been no stormwater treatment, the sizing requirements must be determined by District and City staff. Do not rely solely on the sizing methods in this manual.]

LIDA facilities are intended as stormwater quality facilities. However, onsite stormwater quantity detention may be incorporated into LIDA facility design in some cases if required. Porous pavement and infiltration planters/rain gardens may be adapted to provide detention storage. Porous pavement may be constructed with vaults or gravel/rock storage galleries to detain excess runoff. Infiltration planters or rain gardens may reduce stormwater runoff volume to meet all or part of a site's detention requirements if there is adequate native soil infiltration (greater than 2 inches per hour). Also, extended dry basins and constructed water quality wetlands (refer to the Water Quality Facilities section of the Design and Construction Standards) may be designed with additional capacity to provide both detention and water quality treatment. **When detention and treatment functions are to be combined, the analysis and design calculations must be done by a professional engineer.**

See the fact sheets in Chapter 4 for specific design criteria, photos and sketches of various LIDA facilities.

3.2 Design Steps for LIDA Facilities

For most development sites, LIDA facilities may be designed using District sizing factors. Complete stormwater plan submittal requirements are detailed in the Design and Construction Standards, and local planning and permitting departments may have additional requirements. For sites less than one acre, the impervious area requiring treatment may be reduced if LIDAs are used. This manual includes a LIDA Sizing Form to assist in sizing. The following steps describe the sizing process.

STEP 1: Determine impervious area requiring treatment

- Refer to Chapter 4 of the Design and Construction Standards for instructions to calculate the impervious area requiring water quality treatment for new development and redevelopment sites.

STEP 2: Deduct impervious area LIDA credits

- Deduct the site areas designed with porous pavement or green roofs from the impervious area calculated in Step 1.
- Check with the local jurisdiction about any additional credits (i.e. rainwater harvesting, tree protection, etc.)

STEP 3: Size LIDA facilities for remaining impervious area

- Use the LIDA Sizing Form to determine the size of LIDA facilities required to treat stormwater runoff from the remaining impervious area.
- Sizing factors for infiltration based LIDAs assume an existing site soil infiltration rate of less than 2 inches per hour. Fact sheets for these facilities (in Chapter 4) provide information about soil infiltration testing that may be performed if the designer believes site soils have greater infiltration capacity and wants to produce information to support a smaller sizing factor.
- If more than one LIDA facility is used on the development site, each facility must be sized for the amount of impervious area draining into it.

STEP 4: If needed, design water quality facilities for large impervious areas or remaining untreated impervious area

- The sizing factors noted in this Handbook shall not be used for LIDA facilities treating runoff from more than 15,000 square feet of impervious area.
- For large development sites and impervious areas, a large water quality facility (vegetated swale, extended dry basin or constructed water quality wetland) or proprietary facility may be appropriate.

Clean Water Services LIDA Sizing Form

Project Title: ____________________

Project Location: ____________________

Contact Name/Title/Company: ____________________

Phone/e-mail: ____________________

STEP 1: Determine Impervious Area Requiring Treatment

Total Site Area (acres): [ ]

Total Existing Impervious Area (sq.ft.): [ ]

Proposed New Impervious Area (sq.ft.): [ ]

Impervious Area Requiring Treatment (sq.ft.) [ ]
(Refer to Design & Construction Standards Chapter 4 for instructions to calculate this area, which will be less than or equal to the new plus existing site impervious area.)

STEP 2: Deduct Impervious Area LIDA Credits

Porous Pavement (sq. ft.): [ ]

Green Roof (sq. ft.): [ ]

Other Credits as approved (sq. ft.): [ ]

Total Credits (sq. ft.): [ ]

Remaining Impervious area (sq. ft.)
(Total from Step 1 – Total Credits): [ ]

STEP 3: Size LIDA Facilities for Remaining Impervious Area

	IA: Impervious area treated (sq.ft.)	SF, Sizing Factor	LIDA facility size (sq.ft.) (IA x SF)
Infiltration Planters/Rain Garden		0.06	
Flow-through Planter		0.06	
LIDA Swale		0.06	
Vegetated Filter Strip		0.06	

Total Impervious Area treated (sq.ft.) [ ]

(*Must equal total from Step 2 or additional LIDA facilities or Water Quality Facilities must be added.)

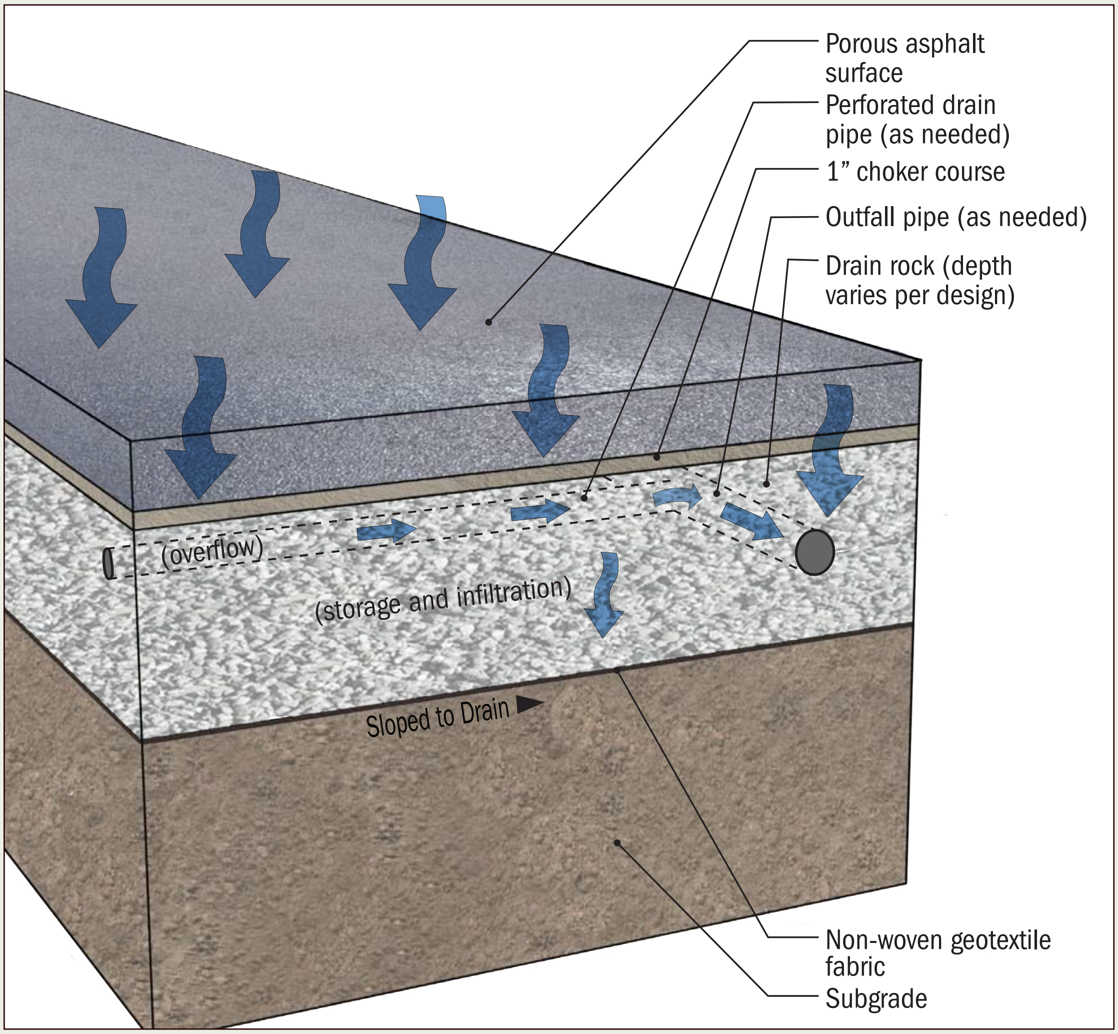
Chapter 4: LIDA Fact Sheets

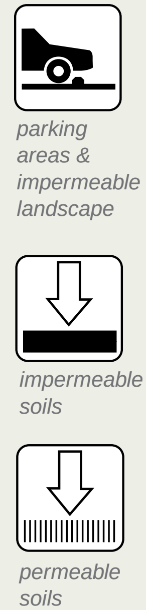
These fact sheets provide example photos, design layout sketches, use and design criteria, planting and maintenance information for the types of LIDAs allowed by District Standards. Table 2 lists the fact sheet content and whether to use the LIDA sizing form for a particular LIDA.

Table 2: LIDA Fact Sheet Table

FACT SHEET TITLE	CONTENTS	USE LIDA SIZING FORM?
Porous Pavement	Impervious area reduction using porous pavers, pervious asphalt or concrete	Yes
Green Roof	Impervious area reduction using green roof technology, for roofs with 1:3 pitch or flatter	Yes
Infiltration Planter/Rain Garden	Planters, rain gardens, vegetated infiltration basins, for native soils with adequate infiltration	Yes
Flow-Through Planter	Planters for low infiltration soils or next to buildings, with liner as needed	Yes
LIDA Swale	Short swales for street-side, parking lots, landscaping	Yes
Vegetated Filter Strip	Landscaped areas designed to receive distributed flow from impervious surfaces	Yes
Vegetated Swale	District water quality facility for larger drainage areas, minimum 100 foot length	No
Extended Dry Basin	District water quality facility for larger drainage areas, 2-cell design, 48-hour draw-down	No
Constructed Water Quality Wetland	District water quality facility for larger drainage areas, 2-cell design with permanent pool	No
Conveyance and Stormwater Art	Ideas for integrating LIDAs and related stormwater conveyance facilities into landscape, hardscape for aesthetics	n/a
Planting Design & Habitat	Plant selection criteria for LIDAs, including ideas for urban habitat creation	n/a

Porous Pavement





Description

Porous pavement is a water-permeable structural groundcover that infiltrates precipitation, attenuates stormwater runoff flows and volumes, and reduces temperatures. Porous pavement provides a stable load-bearing surface without increasing a project’s total impervious area.

The two main categories of porous pavements are 1) pervious concrete and asphalt, and 2) permeable pavers. Pervious concrete and asphalt are poured in place and resemble their solid counterparts, except the fines (sand and finer material) are removed to create more void space for water to flow through. Permeable pavers are solid, discrete units typically made of pre-cast concrete, brick, stone, or cobbles and set to allow water to flow between them.

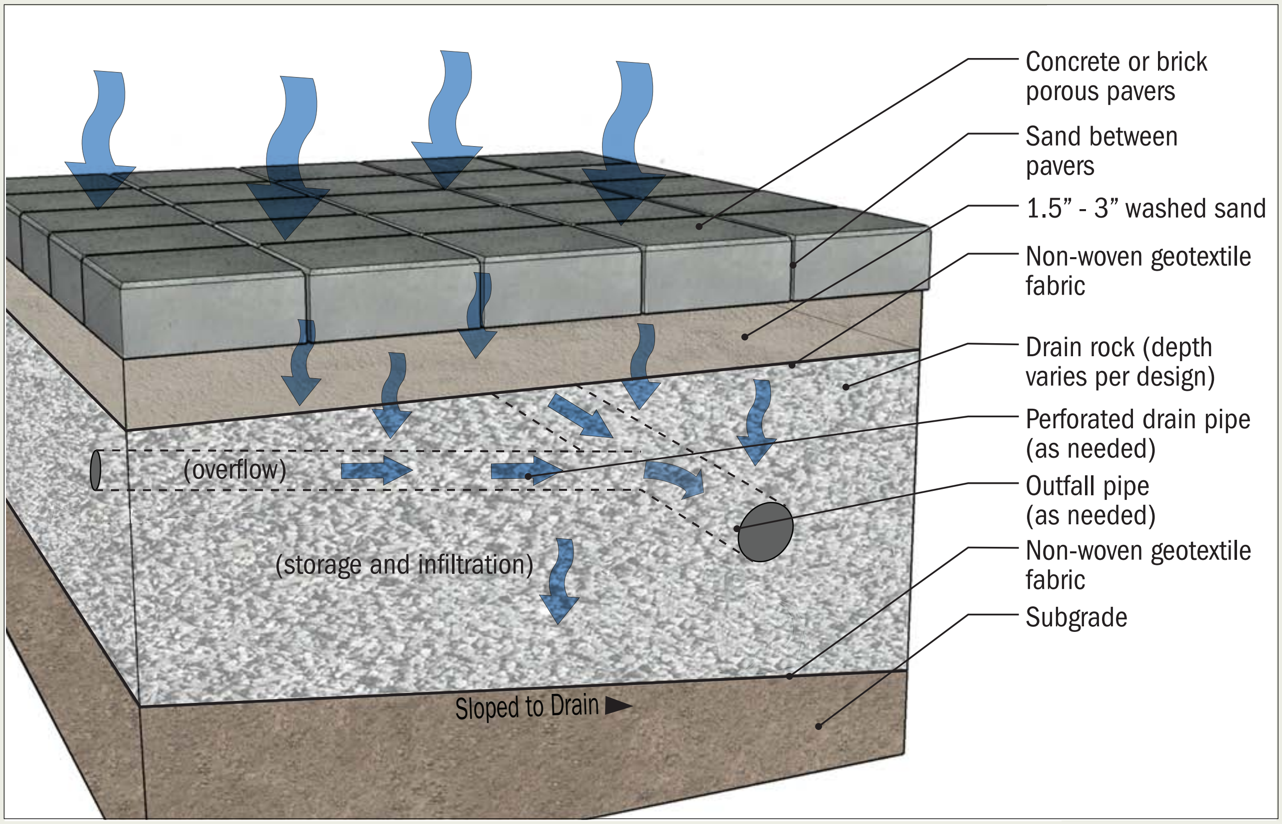
Application & Limitations

Porous pavement is not considered a water quality facility to provide treatment of runoff from other impervious surfaces. However, pollutants captured from direct rainfall on the porous pavement area are treated through filtration, absorption, and other microbial degradation actions in the subgrade. Porous pavement area may be considered 100% pervious in water quality calculations, thus reducing the size of required water quality facilities.

Pervious asphalt, pervious concrete, and permeable pavers can be used in most pedestrian areas, residential driveways, public sidewalks, and parking lots. Local jurisdictions may approve pervious asphalt and concrete for private streets and public roadways on a case-by-case basis.

Porous pavements should not be located over cisterns, utility vaults, underground parking or other impervious surfaces and should be applied only where the seasonal high water table is at least 10 feet beneath the facility’s bottom or drain rock layer. Porous pavement should not be applied in locations where there is a high risk of chemical spillage.

Porous Pavement



Design Factors

Sizing
Porous pavement replaces impervious area at a 1:1 ratio. All stormwater from the porous pavement surface must infiltrate directly into a crushed rock storage layer. To deter clogging over time, porous pavement should capture only direct rainfall. If approved by the local jurisdiction, detention storage may be constructed beneath the porous pavement and sized by approved calculation. Water quality treatment must be provided for any stormwater flowing from adjacent impervious areas across the porous pavement.

Slopes
In general, porous pavement should not be used on slopes greater than 20H: 1V.

Piping
As needed, and where existing soils have low permeability and an infiltration rate of 0.5" per hour or less, provide an under-drain to an approved outlet structure.

Setbacks
Check with the local building department to confirm site-specific requirements. Impermeable liners are recommended between base rock and adjacent foundations and conventional Asphalt Cement Concrete (ACC) or Portland Cement Concrete (PCC) pavement.

Porous Pavement Design
For specific design mix, use the following references:
- Pervious asphalt
  ODOT 2008 Standard Specification, or as updated. See National Asphalt Pavement Association Information Series 131 for additional information.
- Pervious concrete
  Stormwater Management Manual, Chapter 2, Pervious Pavement section, City of Portland Bureau of Environmental Services, 2008 or as updated.
- Pavers
  Interlocking Concrete Pavement Institute specifications and Portland Department of Transportation 2007 Standard Specification Section 00760.00 or as updated.

Porous Pavers, Portland Community College, Rock Creek Campus

Porous Pavers

Porous Asphalt

Porous Concrete

Porous Recycled Concrete

Design Factors (Continued)

Bedding Course
The bedding course beneath pervious asphalt or concrete pavement consists of clean 1" or greater choker course meeting AASHTO No. 57.

Aggregate Base
The base course consists of washed, 3/4" to 2" uniformly graded aggregate. The depth of the aggregate base course will vary per design.

Geotextile Fabric
Non-woven geotextile fabric should be placed between the subgrade (native soil) and the aggregate base for proper separation.

Subgrade
Excavate to the bed bottom elevation. Care should be taken to avoid compaction of the subgrade surface and all construction equipment should be kept off the subgrade. If based on the soil type, the excavation of the surface has been sealed, the surface should be lightly scarified or raked to provide infiltration values consistent with the design.

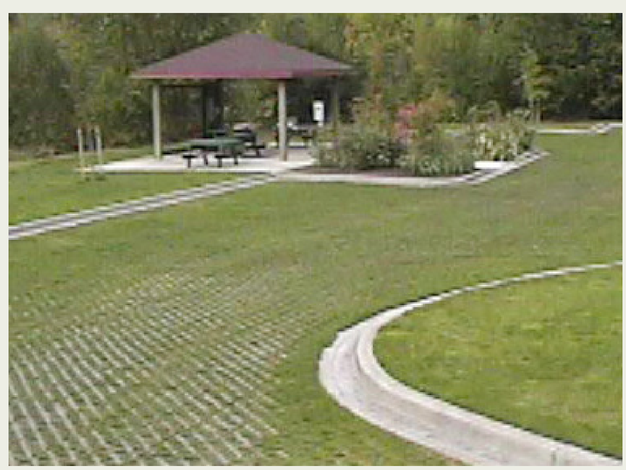
For traffic areas, compact the subgrade soil for public roadways, private streets, parking lots, and fire lanes to ensure structural stability and minimize rutting. Compaction should be to 95%. Because compaction reduces soil permeability it should be done with caution and scarified prior to setting the aggregate base. Protect the subgrade from truck traffic. It is imperative to protect the porous pavement subgrade from over-compaction. If the subgrade is to be compacted, infiltration testing should be conducted during design of porous pavement to adequately account for reduced soil permeability.

Construction
Porous pavement is to be protected from fines infiltration during site construction by covering with visqueen or similar impervious material.

Porous Concrete, SW Broadway and Lombard, Beaverton

Porous Pavers, Tigard Library

Porous Concrete, Clean Water Services Field Operations Center



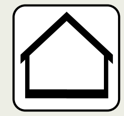
Porous Pavers, West Linn Willamette Park

Maintenance

- Check with the local jurisdiction about use of porous pavement for public facilities.
- If approved for use in the public right-of-way, the permittee must comply with local jurisdiction requirements for a maintenance assurance period. If private, the property owner is responsible for ongoing maintenance per a recorded maintenance agreement (see Appendix for example maintenance agreement). Porous pavement on private roads must be in a separate tract.
- Porous pavement requires regenerative air style vacuuming at least once a year, but twice a year is recommended to remove fine particulates from the infiltration spaces. Without this ongoing maintenance, the facility may become impervious. Over time, settling may occur and aggregate base, washed sand, and/or pavers may need to be replaced or repaired.
- Sealing is a common maintenance practice with conventional asphalt. Pervious asphalt must not be sealed or it will lose its pervious function. Owners should take extra care not to seal pervious asphalt pavement. If porous pavement is sealed, additional stormwater treatment may be required.
- See Appendix for detailed maintenance checklist.

References

- Clean Water Services Design and Construction Standards
- Stormwater Management Manual; City of Portland Bureau of Environmental Services, 2008.


buildings

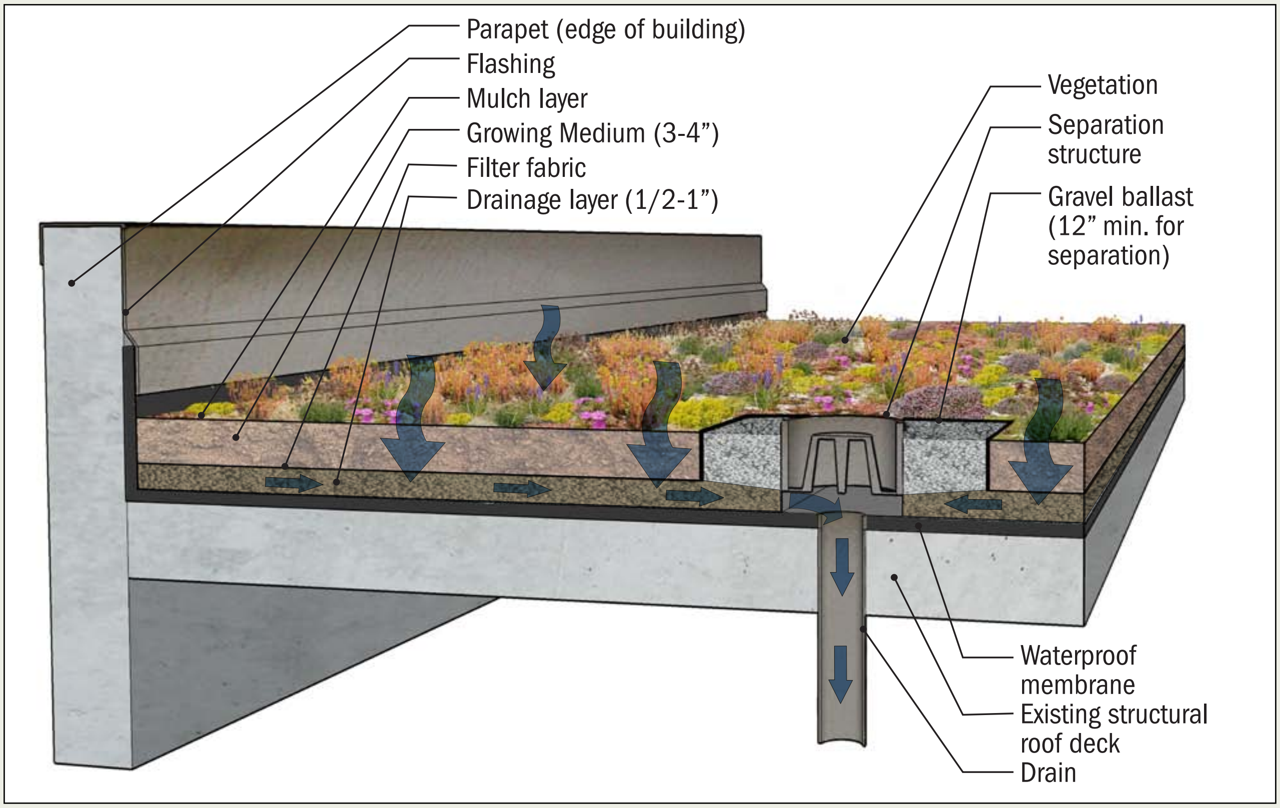
Clean Water Services Field Operations

Description

A green roof (or ecoroof) is a lightweight vegetated roof system with waterproofing material, drainage, growing medium, and specially selected plants. A green roof can reduce site impervious area and manage stormwater runoff. Green roofs reduce peak runoff to near pre-development rates and reduce annual runoff volume by at least 50% (Cost Benefit Evaluation of Ecoroofs, Portland Bureau of Environmental Services, 2008). Green roofs also help mitigate runoff temperatures by keeping roofs cool and retaining most of the runoff in dry seasons. Green roofs typically have thin layers of lightweight growing medium (4 to 8 inches) and low-growing succulent vegetation. Alternatively, roof gardens that are designed to be walked on have deeper soils (8+ inches) and are more heavily planted. Professional design consultation may be necessary to ensure the structural requirements of building codes are met. The design must be low maintenance and use irrigation only to sustain the health of vegetation.

Application & Limitations

Green roofs may be considered 100% pervious in water quality calculations, thus reducing the size of water quality facilities. Green roofs can be applied to a range of building types, from 'flat' rooftops (minimum of 1/4" slope per foot) to sloped rooftops with up to 4:12 pitch (3H:1V slope) or higher with adequate slope control. Depending on configuration and structure of the roof, the vegetated area may be partial or 100% coverage. The structural roof support must hold the additional weight of the green roof. Greater flexibility and options are available for new buildings, but retrofits are possible. For retrofit projects, an architect, structural engineer, or roof consultant can determine the condition of the existing building structure and what might be needed to support a green roof. Generally, the building structure must hold an additional 15 to 30 pounds per square foot for saturated weight.



Design Factors

Sizing
Green roofs replace impervious area at a 1:1 ratio. They may not receive water from other impervious areas such as an adjacent conventional roof.

Slope
Maximum roof pitch is 4:12 (3H:1V slope) unless the applicant provides documentation of runoff retention and erosion control on steeper slopes.

Waterproofing
On the roof surface, use a good waterproofing material such as modified asphalt, synthetic rubber, or reinforced thermal plastics. Waterproofing materials also may act as a root barrier. Waterproof membranes should be thoroughly tested to identify and remedy potential defects and leaks prior to installation of any green roof components.

Protection boards or materials (recommended)
These materials protect the waterproof membrane from damage and are usually made of soft fibrous materials. They may be required to maintain the waterproofing warranty, depending on the membrane used. Consult with roofing manufacturer for requirements.

Ballast (optional)
Gravel ballast may be placed along the roof perimeter and at air vents or other vertical elements to separate roofing elements and vegetation. The need for ballast depends on the type of roof and rooftop flashing details. Ballast or rooftop pavers may be used to provide access, especially to vertical elements that require maintenance.

Header/separation board (optional)
If needed, a header or separation board may be placed between gravel ballast and soil or drains.

Root barrier
A root barrier may be required, depending on the waterproofing material, warranty requirements, and the types of vegetation proposed. Root barriers impregnated with pesticides, metals, or other chemicals that could leach into stormwater should not be applied unless documentation that leaching does not occur is provided. If a root barrier is used it must extend under any gravel ballast and the growing medium, and up the side of any vertical elements.

Hamilton Apartments, Portland

Beranger Condominiums, Gresham

Design Factors (continued)

Drainage
A method of drainage should allow excess water to flow into drains when soils are saturated. A manufactured drain mat, filter fabric, aggregate or gravel layers, or the growing medium itself may be used if water drains when soils are saturated. Every green roof should have an approved discharge location and drain or drains. Check with the local jurisdiction.

Growing medium
The growing medium depth is 3 to 4 inches or more, depending on the project. This material should be lightweight and provide a good base for plant growth. Mixes range from 5% organic/95% inorganic to 30% organic/70% inorganic, depending on specific vegetation needs.

Growing media should be stable over time and not break down into fine particles that might increase compaction and clog drainage layers. Components include pumice, perlite, paper pulp, digested organic fiber, and water retention components such as expanded slate, diatomaceous earth, or polymers. For growing media specification, include all constituent elements and their % composition, and a saturated weight per cubic foot (pcf) that has been tested by a third party lab.

Vegetation and coverage
Green roof vegetation traits:

- Adapted to seasonal drought, excess heat, cold and high winds and other harsh conditions
- Fire resistant
- Requires little or no irrigation once established
- Predominately self-sustaining, low maintenance, with minimal fertilizer
- Perennial or self-sowing annuals that are dense and mat-forming
- Diverse palette to increase survivability and good coverage

Examples of appropriate species: Sedum, ice plant, blue fescue, sempervivum and creeping thyme. Other herbs, forbs, grasses, and low groundcovers can provide additional benefits and aesthetics, but may need more watering and maintenance to survive and may be prone to additional fire risk if allowed to dry out. Planting lists should be District approved and based on reliable sources from this region including local growers and plant suppliers.

Achieve 90% plant coverage within the 2 year maintenance period. At least 70% of the green roof should be evergreen species. No more than 10% of the green roof may be non-vegetated components such as gravel ballast or pavers for maintenance access. Mechanical units may protrude through the green roof, but are not considered elements of the green roof and may be removed from square foot totals.

Exposed areas during establishment periods should be mulched with an approved, biodegradable mesh blanket, straw, gravel, and pebbles or pumice to protect exposed soil from erosion.

Bethany Athletic Club, Beaverton

Multnomah County Office Building, Portland

Maintenance

The owner is responsible for ongoing maintenance per a recorded maintenance agreement (see Appendix for example maintenance agreement).

Green roofs should be low maintenance but will require some scheduled maintenance to avoid or resolve problems. The level of maintenance will vary depending on soil depth, vegetation type, and location.

- During the winter rainy season, check drains monthly and remove any accumulated debris.
- Remove dead plants and replant as needed in spring and fall to maintain the required 90% plant coverage.
- During the first growing season remove weeds and undesirable plant growth monthly, and in late spring and early fall in subsequent years.

Due to the low level of organic material, fertilizers may be required for plant growth. These should be non-chemical, organic and slow release as approved by the District. Pesticides and herbicides of any kind are prohibited, unless approved by the District to contain a detrimental outbreak of weeds or other pests.

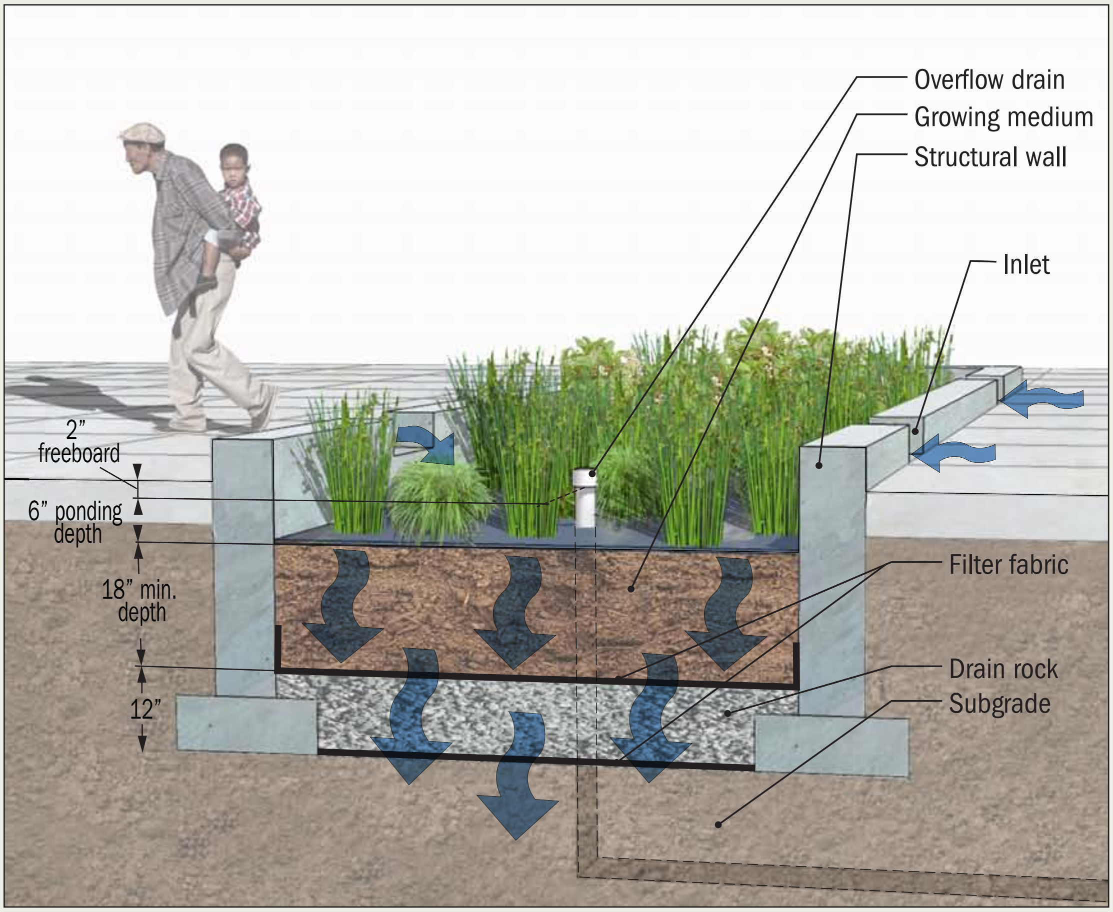
Minimal irrigation may be necessary to maintain vegetation health and ecological function of green roofs. Harvested rainwater is highly recommended for landscape irrigation. Green roofs larger than 1,000 square feet should have an automatic irrigation system for more efficient coverage and to eliminate the need for hand watering. Those larger than 5,000 square feet also should have an irrigation flow meter to monitor water usage. Irrigation during the 2-year establishment period should not exceed ½ inch of water per week (7 days) for the irrigation season (May through October). Post-establishment irrigation should not exceed ¼ inch of water every 10 days during the irrigation season.

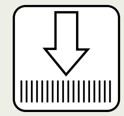
Clean Water Services Field Operations

References

- Clean Water Services Design and Construction Standards
- Stormwater Management Manual; City of Portland Bureau of Environmental Services, 2008

Infiltration Planter/Rain Garden





Description

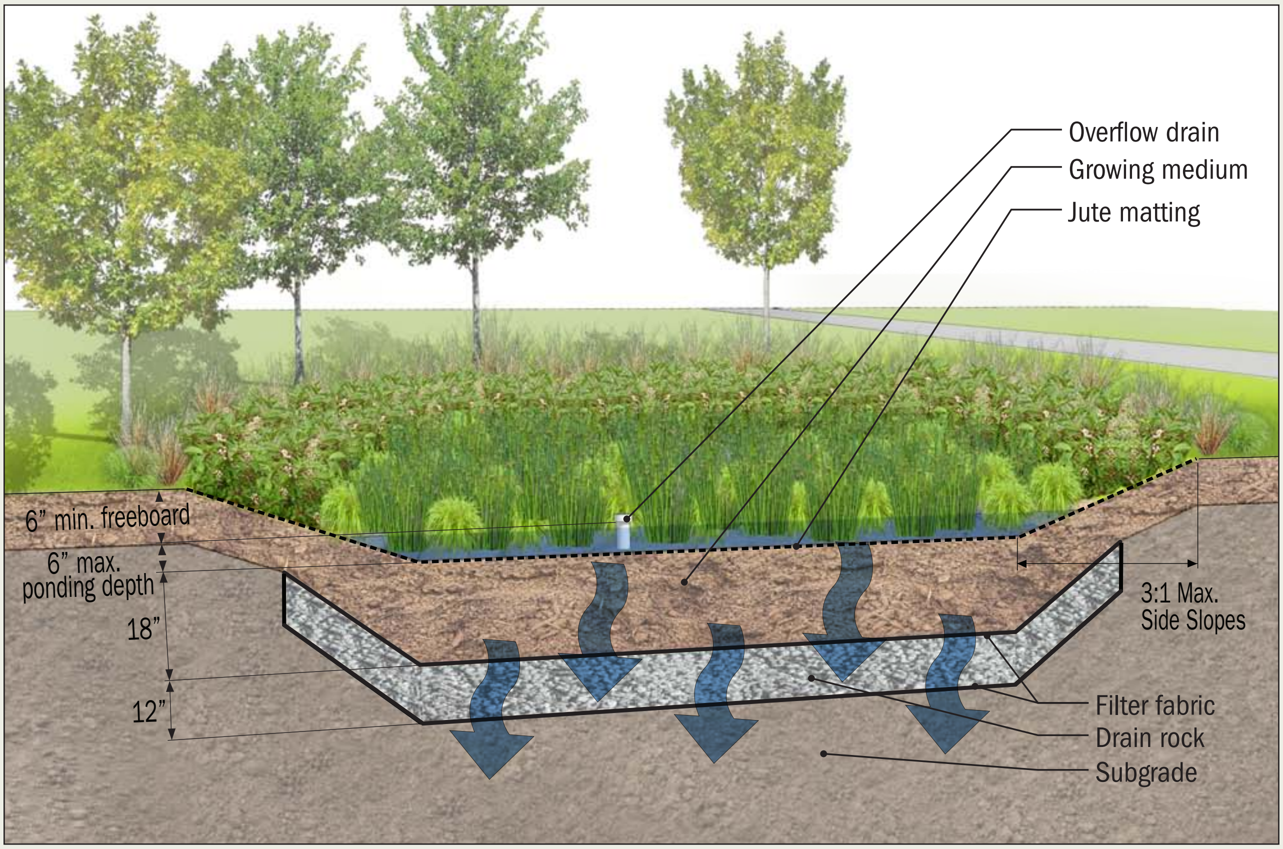
Infiltration Planters (also known as rain gardens) are landscaped reservoirs that collect, filter, and infiltrate stormwater runoff, allowing pollutants to settle and filter out as the water percolates through planter soil and infiltrates into the ground. Infiltration planters typically require less piping than flow-through planters and a smaller facility size than traditional swales where native soils allow for infiltration. Depending on the site, infiltration planters can vary in shape and construction, with or without walls to contain the facility, or formed as a shallow, basin-like depression.

Application & Limitations

Infiltration planters should be integrated into the overall site design and may help fulfill the landscaping area requirement. Infiltration planters can be used to manage stormwater flowing from all types of impervious surfaces, from private property and within the public right-of-way. Check with the local jurisdiction if proposing to use infiltration planters in the public right-of-way. The size, depth, and use of infiltration planters are determined by the infiltration rates of the site's existing soils.

Beaumont Village Lofts, NE Portland

Infiltration Planter/Rain Garden



Design Factors

Soil Suitability and Facility Sizing
The size and depth of the infiltration planter will depend upon the infiltration rate of existing soils. A sizing factor of 0.06 assumes the site infiltration rate is less than 2 in/hr.

For example, the size of an infiltration planter managing 1,500 square feet of total impervious area would be 90 square feet (1,500 x 0.06).

Size may be decreased if:

- Demonstrated infiltration rate is greater than 2 in/hr using ASTM D3395-09 method; or
- Amended soil depth is increased

Geometry/Slopes
The shape may be circular, square, rectangular, etc. to suit the site design requirements. Regardless of the shape, a minimum planter width of 30 inches is needed to achieve sufficient time for treatment and avoid short-circuiting. Planters in a relatively flat landscaped open area should not slope more than 0.5% in any direction.

Piping for Infiltration Planters
Follow Plumbing Code requirements for piping that directs stormwater from impervious surfaces to planters. Stormwater may flow directly from the public street right-of-way or adjacent parking lot areas via curb openings. For infiltration planters with walls, install an overflow drain to allow not more than 6 inches of water to pond. Infiltration planters with side slopes, such as rain gardens, need an overflow drain to ensure no more than 6 inches of water will pond. On private property, follow Plumbing Code requirements for this overflow drain and piping, and direct excess stormwater to an approved disposal point as identified on permit drawings. Check with local jurisdiction or use Clean Water Services Design and Construction Standards for additional information on piping material for use in the public right-of-way.

Setbacks
Check with the local building department to confirm site-specific requirements.

- Generally, a minimum setback of 10 feet from building structures is recommended.
- Planters should not be located immediately upslope of building structures.

Before site work begins, clearly mark infiltration planter areas to avoid soil disturbance during construction. No vehicular traffic should be allowed within 10 feet of

Buckman Terrace Apartments, Portland

New Seasons, 20th and SE Division St., Portland

Design Factors (continued)

infiltration planter areas, except as necessary to construct the facility. Consider construction of infiltration planter areas before construction of other impervious surfaces to avoid unnecessary traffic loads.

Soil Amendment/Mulch
Amended soils with appropriate compost and sand provide numerous benefits: infiltration; detention; retention; better plant establishment and growth; reduced summer irrigation needs; reduced fertilizer need; increased physical/chemical/microbial pollution reduction; and, reduced erosion potential. Primary treatment will occur in the top 18 inches of the infiltration planter. Amended soil in the treatment area is composed of equal parts of organic compost, gravelly sand and topsoil. Compost is weed-free, decomposed, non-woody plant material; animal waste is not allowed. Check with the local jurisdiction or Clean Water Services for Seal of Testing Approval Program (STA) Compost provider.

To avoid erosion, use approved erosion control BMPs for non-structural infiltration planters.

Vegetation
Planted vegetation helps to attenuate stormwater flows and break down pollutants by interactions with bacteria, fungi, and other organisms in the planter soil. Vegetation also traps sediments, reduces erosion, and limits the spread of weeds. Appropriate, carefully selected plantings enhance the aesthetic and habitat value.

The entire water quality treatment area should be planted appropriately for the soil conditions. Walled infiltration run-on planters will be inundated periodically. Therefore the entire planter should be planted with herbaceous rushes, sedges, perennials, ferns and shrubs that are well-suited to wet-to-moist soil conditions.

If the infiltration planter has side slopes (basin without vertical walls), soil conditions will vary from wet to relatively dry; several planting zones should be considered. The flat bottom area will be moist-to-wet, and the side slopes will vary from moist at the bottom to relatively dry near the top where inundation rarely occurs. The moisture gradient will depend upon the designed maximum water depth, total depth of the planter, and steepness of the side slopes. This moisture gradient is a transition zone and should be planted with species that tolerate occasional standing water, and plants that prefer drier conditions toward the top of the slope. Areas above the side slopes, immediately adjacent to the basin, and above the designed high water line will not be inundated and should be planted with self-sustaining, low maintenance grasses, perennials, and shrubs suitable for the local climate.

All vegetation should be planted densely and evenly to ensure proper hydrological function of the infiltration planter. Quantities per 100 square feet:

- 115 herbaceous plants, 1’ on center spacing, ½-gal container size; or
- 100 herbaceous plants, 1’ on center, and 4 shrubs, 1-gal container size 2’ on center.

Trees are optional; if used, minimum 2 gallon by 2 feet tall.

Trees are allowed in infiltration planters and should be selected by their adaptability to wet-to-moist conditions and full size at maturity. An area twice the width of tree rootball and the depth of the rootball plus 12” (or total depth of 30”, whichever is greater) should be backfilled with amended soil for optimal growth, with no sub-surface rock layer. For infiltration planters with side slopes, trees should be placed along the side slopes of the facility rather than at the bottom.

Mississippi Commons, NE Portland

Fowler Middle School, Tigard

Maintenance

- Water-efficient irrigation should be applied for the first two years after construction of the facility, particularly during the dry summer months, while plantings become established. Irrigation after these two years is at the discretion of the owner.
- If public, the permittee is responsible for the maintenance of the infiltration planter for a minimum of two years following construction and acceptance of the facility. All publicly maintained facilities not located in the public right-of-way must have a public easement. If private, the property owner will be responsible for ongoing maintenance per a recorded maintenance agreement (see Appendix for example maintenance agreement).
- Water should drain through the planter within 24 hours after a major storm event.
- All planter components should be inspected for proper operation quarterly, and within 24 hours of each major storm event
- Remove nuisance or invasive plants such as weeds or blackberry and ivy when discovered.
- Remove and replace damaged or dead plants.
- Provide insect and rodent control measures as necessary.
- See Appendix for detailed maintenance checklist.

12th and Montgomery St., Portland

References

- Clean Water Services Design and Construction Standards
- Green Development Practices for Stormwater Management; City of Gresham, 2007.
- Stormwater Management Manual; City of Portland Bureau of Environmental Services, 2008.

Flow-Through Planter

buildings

parking areas & impermeable landscape

impermeable soils

Description

Flow-through planters are structural landscaped reservoirs that collect stormwater and filter out pollutants as the water percolates through the vegetation, growing medium, and gravel. These are appropriate where soils do not drain well or there are site constraints. A liner may be required when located adjacent to buildings, over contaminated soils, and on unstable slopes. Excess stormwater collects in a perforated pipe at the bottom of the flow-through planter and drains to an approved discharge point.

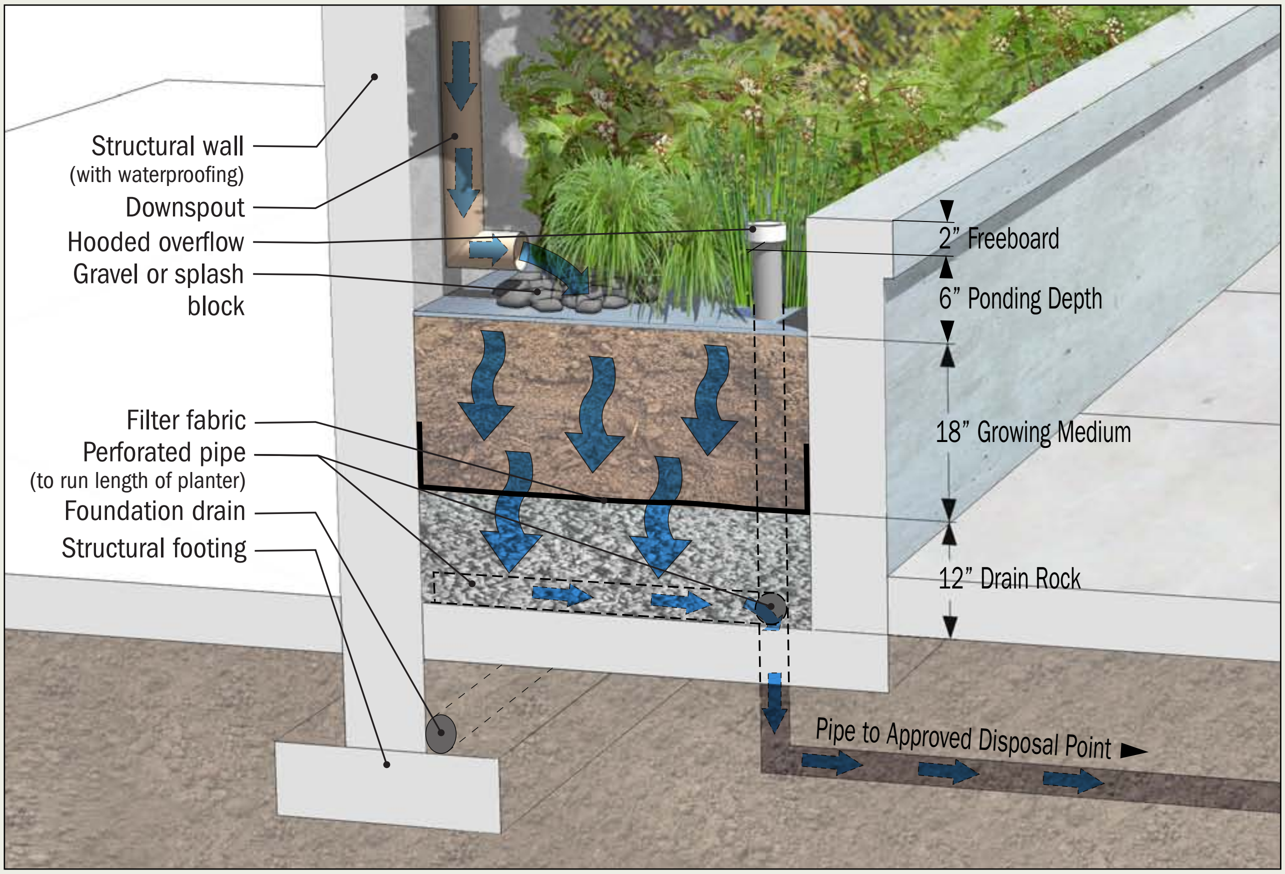
Tree box filters are flow-through planters with a concrete “box” that contains filtering growing media and a tree or large shrub. Tree box filters are used singly or in multiples, often adjacent to streets where runoff is directed to them to treat stormwater runoff before it enters a catch basin.

Application & Limitations

Flow-through planters may help fulfill a site’s landscaping area requirement and can be used to manage stormwater runoff from all types of impervious surfaces on private property and within the public right-of-way. Check with the local jurisdiction if proposing to use a flow-through planter in the public right-of-way. Flow-through planters can be placed next to buildings and are ideal for sites with poorly draining soils, steep slopes or other constraints. Design variations of shape, wall treatment, and planting scheme will fit the character of any site.

Headwaters at Tryon Creek, Portland

Flow-Through Planter



Design Factors

Sizing
To calculate the planter size, multiply the impervious surface (rooftops, driveways, parking lots, etc.) area by 6%. The square footage is the peak water surface prior to overflow. For example, a 1,200 sf rooftop and 300 sf driveway (1,500 sf total impervious area) requires a 90 sf stormwater planter (1,500 x 0.06). This could be accomplished with one 9-foot by 10-foot flow-through planter.

Geometry/Slopes

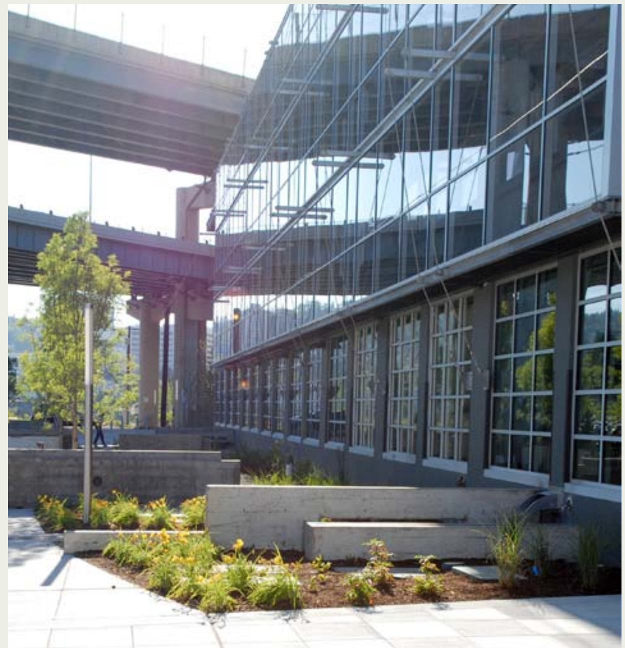
- Stormwater planters may be any shape, and can be designed as square, rectangular, circular, oblong, or irregular.
- Regardless of the shape, a minimum planter width of 30 inches is needed to achieve sufficient time for treatment and to avoid short-circuiting.
- The minimum treatment depth of 18 inches is achieved in the growing medium.
- Planters are designed to evenly distribute and filter flows. Surface longitudinal slopes should be less than 0.5%.

Piping for Flow Through Planters
Follow Plumbing Code requirements for piping that directs stormwater from impervious surfaces to flow-through planters. Stormwater may flow directly from the public street right-of-way or adjacent parking lot areas via curb openings. The overflow drain allows not more than 6 inches of water to pond in the planter prior to overflow. A perforated pipe system under the planter drains water that has filtered through the topsoil to prevent long-term ponding. On private property, the overflow drain and piping must meet Plumbing Code requirements and direct excess and filtered stormwater to an approved disposal point. Check with the local jurisdiction or use Clean Water Services Design and Construction Standards for additional information on piping material for use in the public right-of-way.

Portland Rebuilding Center

Flow-Through Planter

PSU Stephen Epler Hall, Portland



RiverEast Center, SE Portland

Design Factors (continued)

Setbacks
Check with the local building department to confirm site-specific requirements.

- For planters without an impermeable liner, generally the minimum setback from building structures is 10 feet.
- Typically, no building setback is required for planters lined with waterproofed concrete or 60 mil. PVC liner to prevent infiltration.

Soil Amendment/Mulch
Amended soils with appropriate compost serve numerous benefits: infiltration; detention; retention; better plant establishment and growth; reduced summer irrigation needs; reduced fertilizer need; increased physical/ chemical/microbial pollution reduction; and reduced erosion potential. Primary treatment will occur in the top 18 inches of the infiltration planter. Amended soil in the treatment area is composed of imported soil, mix of one part organic compost, one part gravelly sand, and one part top soil. Compost is weed-free, decomposed, non-woody plant material; animal waste is not allowed. Check with the local jurisdiction or Clean Water Services for Seal of Testing Approval Program (STA) Compost provider.

To avoid erosion, use approved erosion control BMPs for non-structural infiltration planters.

Vegetation
Planted vegetation helps to attenuate stormwater flows and break down pollutants by interactions with bacteria, fungi, and other organisms in the planter soil. Vegetation also traps sediments, reduces erosion, and limits the spread of weeds. Appropriate and carefully considered plantings enhance the aesthetic and habitat value of a flow-through planter.

Because the entire facility will be inundated periodically, plant the water quality treatment area with herbaceous species such as rushes, sedges, perennials, ferns and shrubs appropriate for wet-to-moist soil conditions. Most moisture-tolerant plants can withstand seasonal droughts during the dry summer months and do not need irrigation after they become established.

Native plants are encouraged, but non-invasive ornamentals that add aesthetic and functional values are acceptable. Vegetation should be planted densely and evenly for proper hydrological function of the flow-through planter and to prevent erosion.

Quantities per 100 square feet:

- 115 Herbaceous plants, 1’ on center spacing, ½-gal container size; or
- 100 Herbaceous plants, 1’ on center, and 4 shrubs, 1-gal container size, 2’ on center

Flow-Through Planter

Rose Quarter parking structure, NE Portland

Washougal Town Square

Aloha Dog and Cat Clinic, Washington County

Maintenance

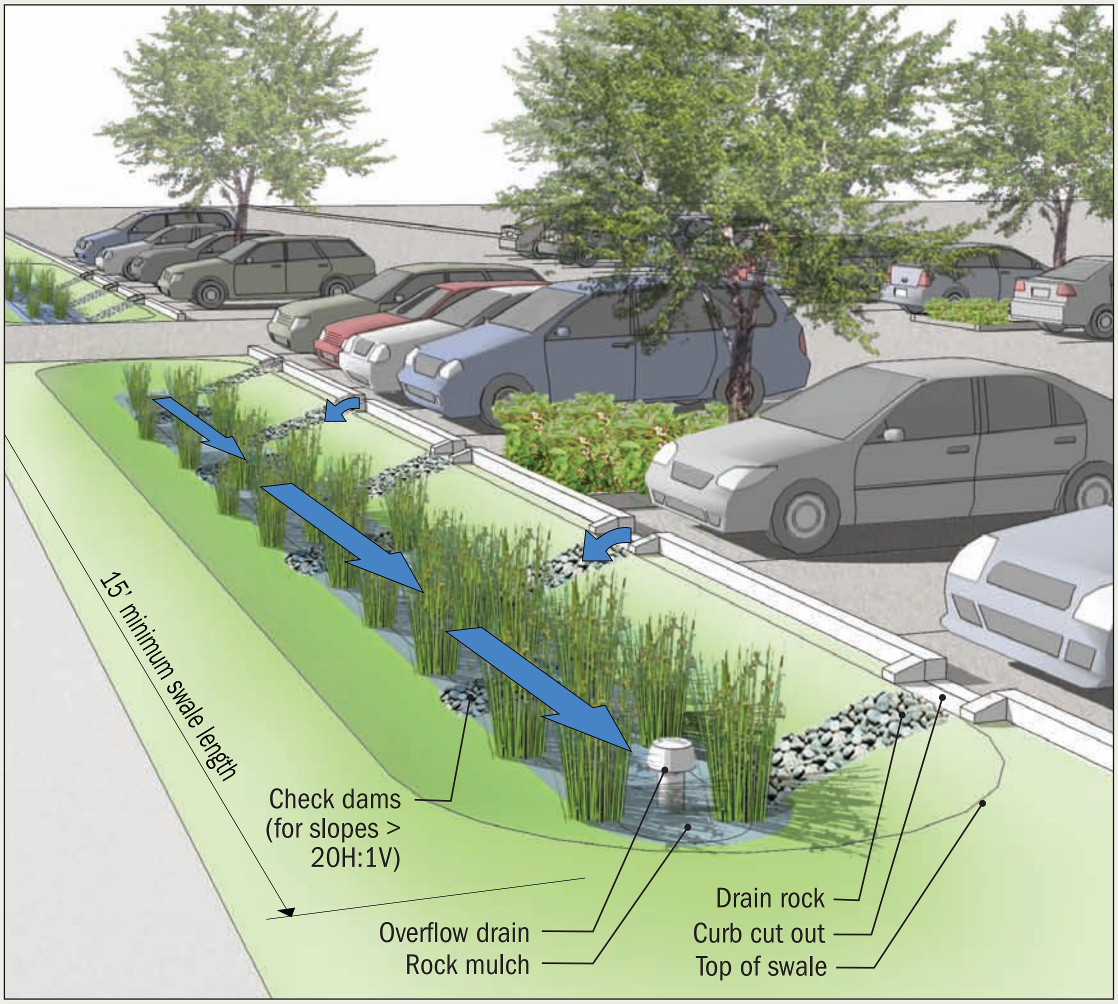
- Water efficient irrigation should be applied the first two years after construction of the facility, particularly during dry summer months, while plantings become established. After that, irrigation is at the owner's discretion.
- If public, the permittee is responsible for the maintenance of the flow-through planter for a minimum of two years following construction and acceptance of the facility. All publicly maintained facilities, not in the public right-of-way must have a public easement. If private, the property owner will be responsible for ongoing maintenance per a recorded maintenance agreement (see Appendix for example maintenance agreement).
- Water should drain through the planter within 24 hours after a major storm event.
- All planter components should be inspected for proper operation during major storm events.
- Remove nuisance or invasive plants such as weeds or blackberry and ivy when discovered.
- Remove and replace damaged or dead plants.
- Provide insect and rodent control as necessary.
- See Appendix for detailed maintenance checklist.

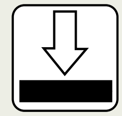
Buckman Terrace Apartments, Portland

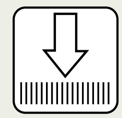
References

- Clean Water Services Design and Construction Standards
- Green Development Practices for Stormwater Management; City of Gresham, 2007.
- Stormwater Management Manual; City of Portland Bureau of Environmental Services, 2008.

LIDA Swale







Description

A LIDA swale is a narrow, gently sloping landscaped depression that collects and conveys stormwater runoff. The densely planted LIDA swale filters stormwater as it flows the length of the swale and allows infiltration of water into the ground. The LIDA swale discharges to a storm sewer or other approved discharge point.

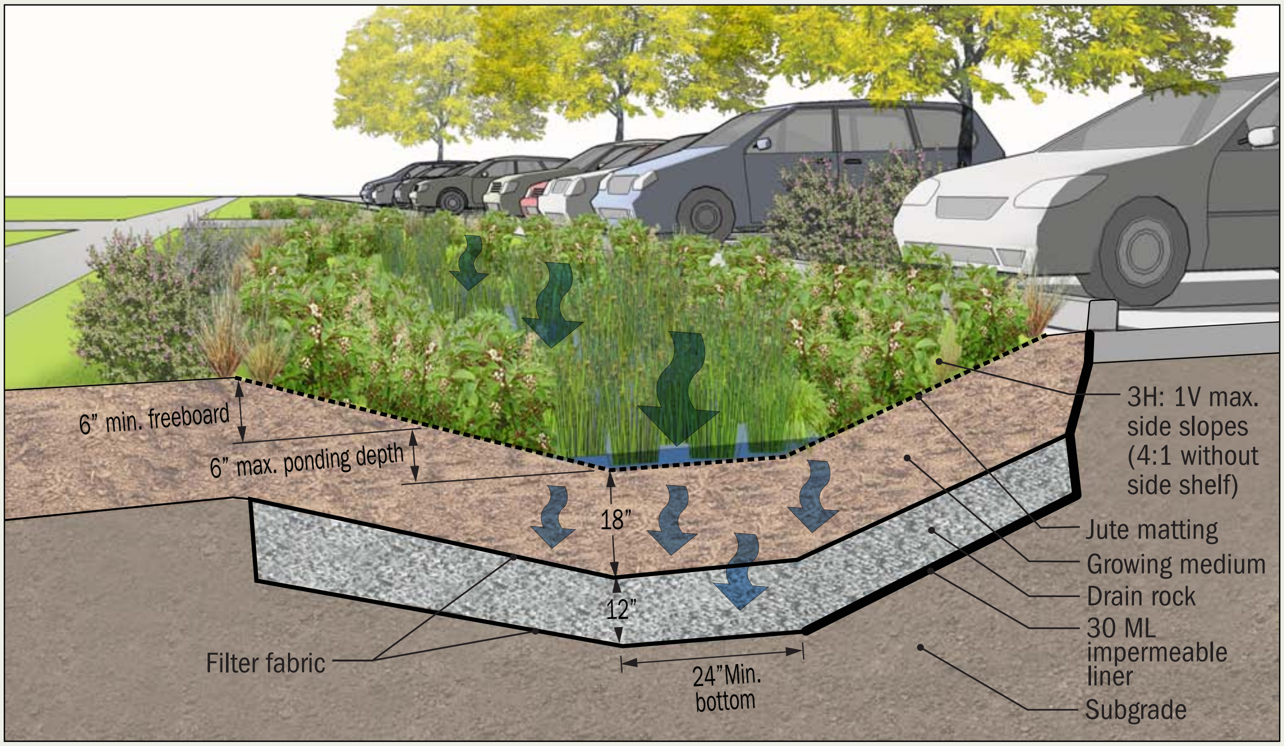
Compared to vegetated swales, LIDA swales may be shorter and narrower, but require deeper levels of amended soil and a subsurface drain rock layer to compensate for the smaller size and to function effectively.

Application & Limitations

A LIDA swale may help fulfill a site's landscaping area requirement. LIDA swales are approved to treat stormwater flowing from all types of impervious surfaces including private property and the public right-of-way, rooftops, parking lots, and streets. Check with the local jurisdiction if proposing to use a LIDA swale in the public right-of-way.

Boeckman Road, Wilsonville

LIDA Swale



Design Factors

Sizing
The size of the LIDA swale will depend upon the infiltration rate of existing soils. A sizing factor of 0.06 assumes the site infiltration rate is less than 2 in/hr.

For example, the size of a LIDA swale managing 1,500 square feet of total impervious area would be 90 square feet (1,500 x 0.06).

Size may be decreased if:

- Demonstrated infiltration rate is greater than 2 in/hr using ASTM D3395-09 method; or
- Amended soil depth is increased

Geometry/Slopes
A LIDA swale's slope end to end is at least 0.5% and no more than 6%. For sites with steeper slopes, check dams may be incorporated into the design. Side slopes from the bottom to the top of the swale must be 3:1 or less. The minimum bottom width is 2 feet, and the minimum depth is 1 foot.

Piping for LIDA Swales
If needed, stormwater may be directed from impervious surfaces to LIDA swales by piping per plumbing code requirements, or may flow directly into the LIDA swale via curb openings. A LIDA swale has no underdrain. An overflow drain allows no more 6 inches of water depth to collect in the LIDA swale. On private property, the overflow drain and piping must meet plumbing code requirements and direct excess stormwater to an approved disposal point. Check with the local jurisdiction or use Clean Water Services Design and Construction Standards for additional information on piping material for use in the public right-of-way.

Setbacks

- Check with the local building department to confirm site-specific requirements.

Peoples Food Cooperative, SE Portland

Ecotrust building, Portland

New Seasons, SE Division St, Portland

Design Factors (continued)

Soil Amendment/Mulch
Amended soils with appropriate compost serve numerous benefits: infiltration; detention, retention; better plant establishment and growth; reduced summer irrigation needs; reduced fertilizer need; increased physical/chemical/microbial pollution reduction; and reduced erosion potential. Primary treatment will occur in the top 18 inches of the LIDA Swale. Amended soil in the treatment area is composed of imported soil, mix of one part organic compost, one part gravelly sand, and one part top soil. Compost is weed-free, decomposed, non-woody plant material; animal waste is not allowed. Reduce water velocities and potential erosion by providing energy dissipaters such as river rock at entrances to the swale. Check with the District or local jurisdiction for Seal of Testing Approval Program (STA) Compost provider.

To avoid erosion, use approved erosion control BMPs.

Vegetation
The entire facility area including side slopes and treatment areas are planted with vegetation appropriate for the soil conditions. Planting conditions vary from wet to relatively dry within the LIDA swale. The flat bottom will be inundated frequently and should be planted with species such as rushes, sedges, perennials, ferns, and shrubs well-suited to wet-to-moist soil conditions. The side slope moisture gradient varies from wet at the bottom to relatively dry near the top where inundation rarely occurs. The moisture gradient will vary depending upon the designed water depth, the swale depth, and side slope steepness. The transition zone from the bottom of the LIDA swale to the designed high water line or top of freeboard should be planted with sedges, rushes, perennials, ferns, and shrubs that can tolerate occasional standing water and wet-to-moist planting conditions. The areas above the designed high water line and immediately adjacent to the LIDA swale will not be regularly inundated and should be planted with self-sustaining, low maintenance grasses, perennials, and shrubs suitable for the local climate and site.

Native plants are encouraged, but appropriate, non-invasive ornamentals are acceptable for aesthetic and functional value. All vegetation should be densely and evenly planted to ensure proper hydrological function of the LIDA swale.

Quantities:

Bottom of LIDA swale (wet-to-moist zone, per 100 sf)
- 115 herbaceous plants, 1' on center spacing, ½-gal container size; or
- 100 herbaceous plants, 1' on center, and 4 shrubs, 1-gal container size, 2' on center

Side slopes and top of LIDA swale (wet-to-moist transition zone and dry zone)
- 1 tree per 300 sq. ft, minimum 2-gal container size by 2 ft-tall and
- 10 shrubs (1-gal) and 70 groundcovers (½-gal) per 100 sf

Trees are allowed in LIDA swales, and may be required. Trees should be selected by adaptability to wet-to-moist conditions and size at maturity. An area twice the width of the tree rootball and the depth of the rootball plus 12" (or total depth of 30", whichever is greater) should be backfilled with amended soil for optimal growth, with no sub-surface rock layer. Place trees along the side slopes rather than the bottom of the LIDA swale.

Tualatin Hills Park at Portland Community College

NE Siskiyou Street, Portland

155th & Hart, Beaverton

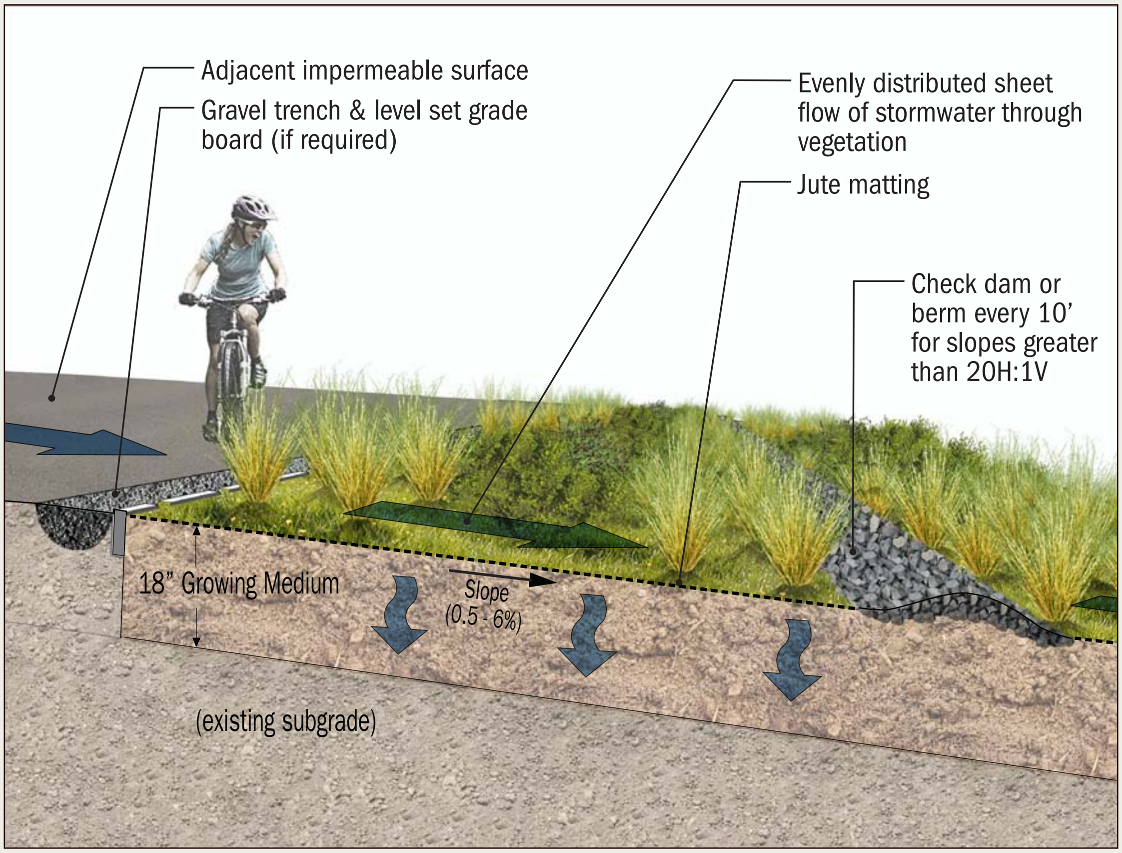
Maintenance

- Water efficient irrigation should be applied for the first two years after construction of the facility, particularly during the dry summer months, while plantings become established. Irrigation after two years is at the discretion of the owner.
- If public, the permittee is responsible for the maintenance of the LIDA swale for a minimum of two years following construction and acceptance of the facility. All publicly maintained facilities not located in the public right-of-way must have a public easement. If private, the property owner is responsible for ongoing maintenance per a recorded maintenance agreement (see Appendix for example maintenance agreement).
- Inspect the facility at least twice annually, in spring and fall.
- Evaluate landscaping and replant as necessary to ensure a minimum of 80% survival rate of the required vegetation and 90% facility coverage. Remove non-native, invasive plant species when found in the facility.
- Remove garbage, landscaping debris and other material that may impede water flow and clog the system.
- Check inlet pipes and outlet structure for damage or missing pieces. Inlet pipes and outlet structures should be free of obstructions and heavy vegetation.
- Design swales so that they do not require mowing.
- See Appendix for detailed maintenance checklist.

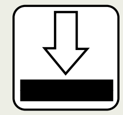
References

- Clean Water Services Design and Construction Standards

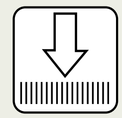
Vegetated Filter Strip



parking areas & impermeable landscape



impermeable soils



permeable soils

Description

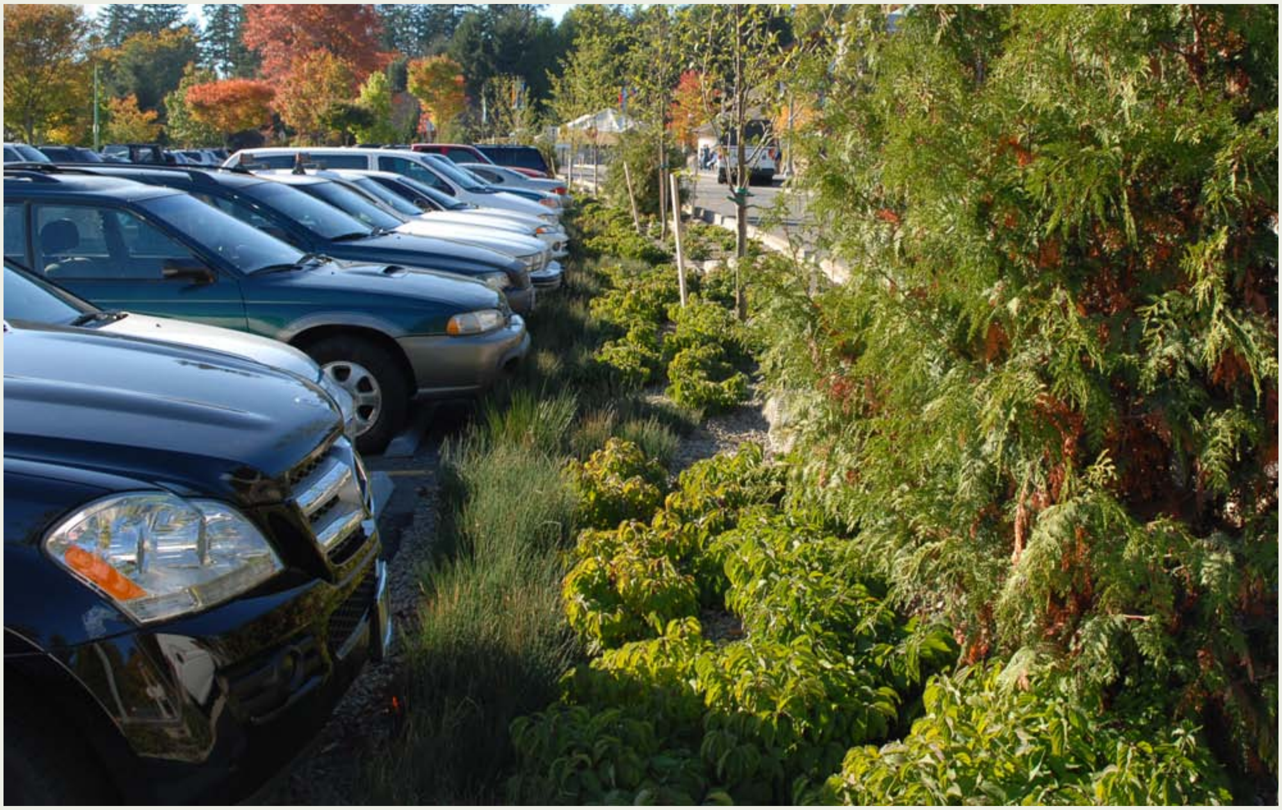
Vegetated filter strips are gently sloped areas designed to receive sheet flows from adjacent impervious surfaces. Filter strips are vegetated with grasses and groundcovers that filter and reduce the velocity of stormwater. Peak stormwater flows are attenuated as stormwater travels across the filter strip and infiltrates or is stored temporarily in the soils below.

For residential driveways, center filter strips typically are 3 feet wide between two 3-foot wide paved sections. The strip treats and infiltrates stormwater only from the impervious area of the drive aisles which slope toward the center filter strip. The driveway center filter strip must be maintained to the design requirements for vegetated filter strips.

Application & Limitations

Vegetated filter strips should be integrated into the overall site design and may help fulfill a site's landscaping area requirement. Vegetated filter strips can be used to manage stormwater runoff from a variety of impervious surfaces such as walkways and driveways on private property and within the public right-of-way. Check with the local jurisdiction if proposing to use a vegetated filter strip in the public right-of-way.

Oregon Zoo parking lot, Portland



Oregon Zoo parking lot

Design Factors

Sizing
Vegetated filter strips are appropriate for all soil types and have 18" depth of growing medium. The size of the filter strip will depend upon the infiltration rate of existing soils. A sizing factor of 0.06 assumes that the site has an infiltration rate less than 2 in/hr.

For example, a facility managing 1,500 square feet of total impervious area would require a 90 sq ft filter strip (1,500 x 0.06).

Size may be decreased if:
- Demonstrated infiltration rate is greater than 2 in/hr using ASTM D3395-09 method; or
- Amended soil depth is increased

Geometry/Slopes
The minimum width of a vegetated filter strip is 5 feet measured in the direction of stormwater flow. The slope is between 0.5 and 6%, and the slope of the impervious area draining to the strip is less than 6%.
Check dams may be required to maintain shallow slopes if the existing site slopes exceed 5%. Typically, check dams are 3 to 5 inches high and are placed every 10 feet where slopes exceed 5%.
If a level spreader such as a grade board or sand/gravel trench is required to disperse runoff evenly across the filter strip, the top must be horizontal and at an appropriate height to direct sheet flow to the soil without scour. Grade boards may be any material that withstands weather and solar degradation but should not be old railroad ties, used utility poles, or other pollutant source.

Piping for Vegetated Filter Strips
Non-infiltrated flows/overflows from the vegetated filter strip are collected and conveyed to an approved system or outlet structure.

Setbacks
Check with local building department to confirm site-specific requirements.

Arata Creek School, Troutdale

Design Factors (continued)

Soil Amendment/Mulch
Amended soils with appropriate compost serve numerous benefits: infiltration; detention; retention; better plant establishment and growth; reduced summer irrigation needs; reduced fertilizer need; increased physical/chemical/microbial pollution reduction; and reduced erosion potential. Primary treatment will occur in the top 18 inches of the vegetated filter strip. Amended soil in the treatment area is composed of equal parts of organic compost, gravelly sand and topsoil. Compost is weed-free, decomposed, non-woody plant material; animal waste is not allowed. Check with the local jurisdiction or Clean Water Services for Seal of Testing Approval Program (STA) Compost provider.

To avoid erosion, use approved erosion control BMP.

Vegetation
Herbs, shrubs and grasses can provide the vegetation needed to remove sediment and pollutants. The vegetated filter strip is planted or seeded with a mix of grasses, wildflowers, and groundcovers well-suited to moist-to-dry soil conditions. All vegetation should be self-sustaining and drought tolerant. Native plants are encouraged but adapted, non-invasive ornamentals are acceptable for added aesthetic and functional value.

Trees are not required for vegetated filter strips, but are encouraged where applicable. Tree species should be selected by their adaptability to moist-to-dry conditions and full size at maturity.

The filter strip conveys evenly-distributed sheet flows of water through vegetation for treatment. Because unplanted areas may decrease stormwater treatment, the entire filter strip must have 100% vegetation coverage to ensure proper hydrologic function.

If check dams are required, plants suited to wet-to-moist planting conditions may be supplemented on the upslope side of the check dam where occasional inundation and pooling of water may occur.

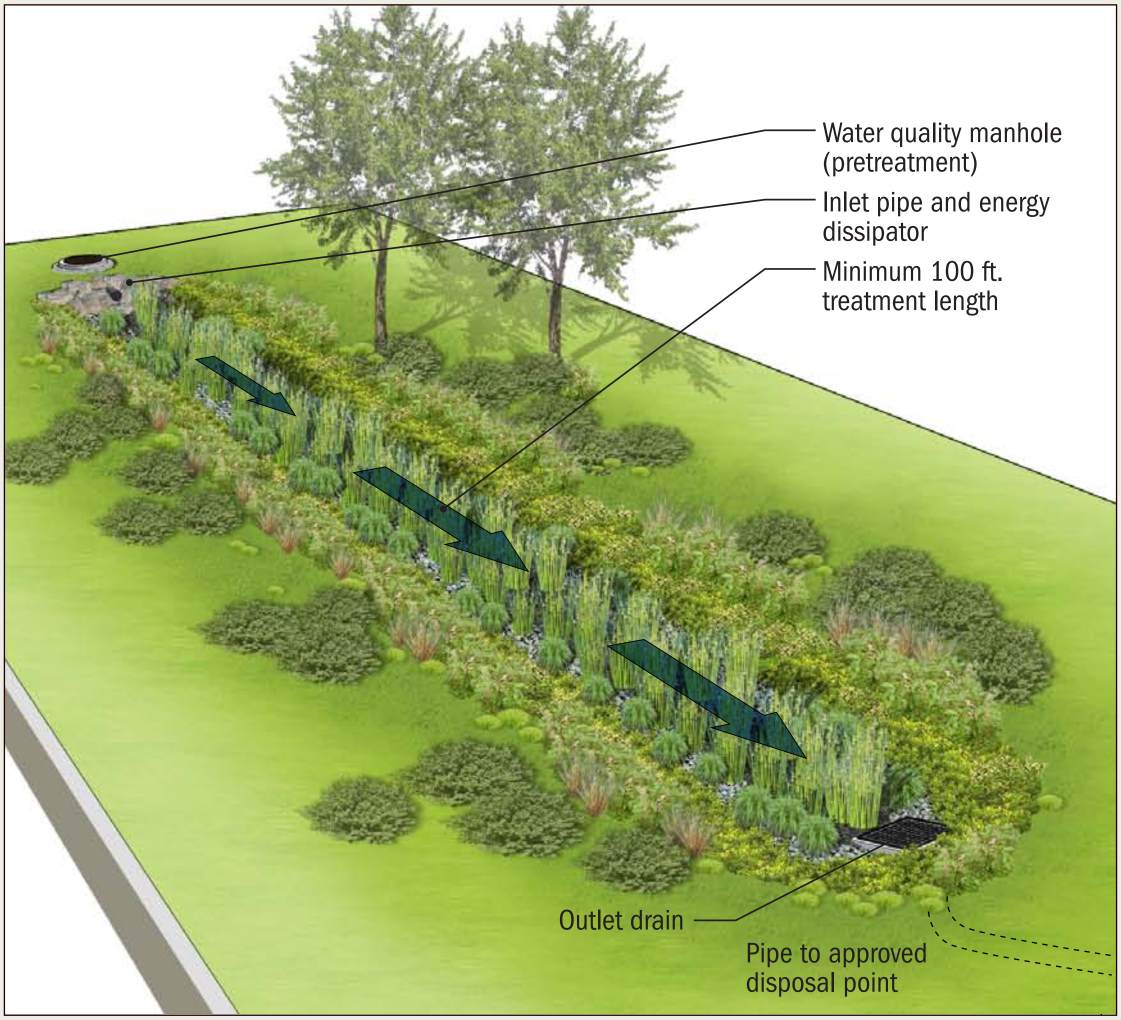
Maintenance

- Water-efficient irrigation should be applied for the first two years after construction of the facility, particularly during the dry summer months, while plantings become established. Irrigation after two years is at the discretion of the owner.
- If public, the permittee is responsible for the maintenance of the vegetated filter strip for a minimum of two years following construction and acceptance of the facility. All publicly maintained facilities not located in the public right-of-way must have a public easement. If private, the property owner is responsible for ongoing maintenance per a recorded maintenance agreement (see Appendix for example maintenance agreement).
- The facility should be inspected monthly during the rainy season (November - April).
- Evaluate landscaping and replant as necessary to ensure 100% facility coverage. Remove non-native, invasive plant species when found in the facility.
- Remove garbage, landscaping debris and other material that may impede uniform sheet water flow.
- See Appendix for a detailed maintenance checklist.

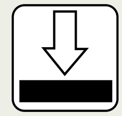
References

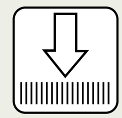
- Clean Water Services Design and Construction Standards
- Stormwater Management Manual; City of Portland Bureau of Environmental Services, 2008.

Vegetated Swale




parking areas & impermeable landscape


impermeable soils


permeable soils

Description

A vegetated swale is a gently sloping landscaped depression that collects and conveys stormwater runoff, and is narrow and at least 100 feet in length. The densely planted swale filters stormwater as it flows the length of the swale and allows infiltration of water into the ground. The vegetated swale may discharge to a storm sewer or other approved discharge point where soils do not drain well.

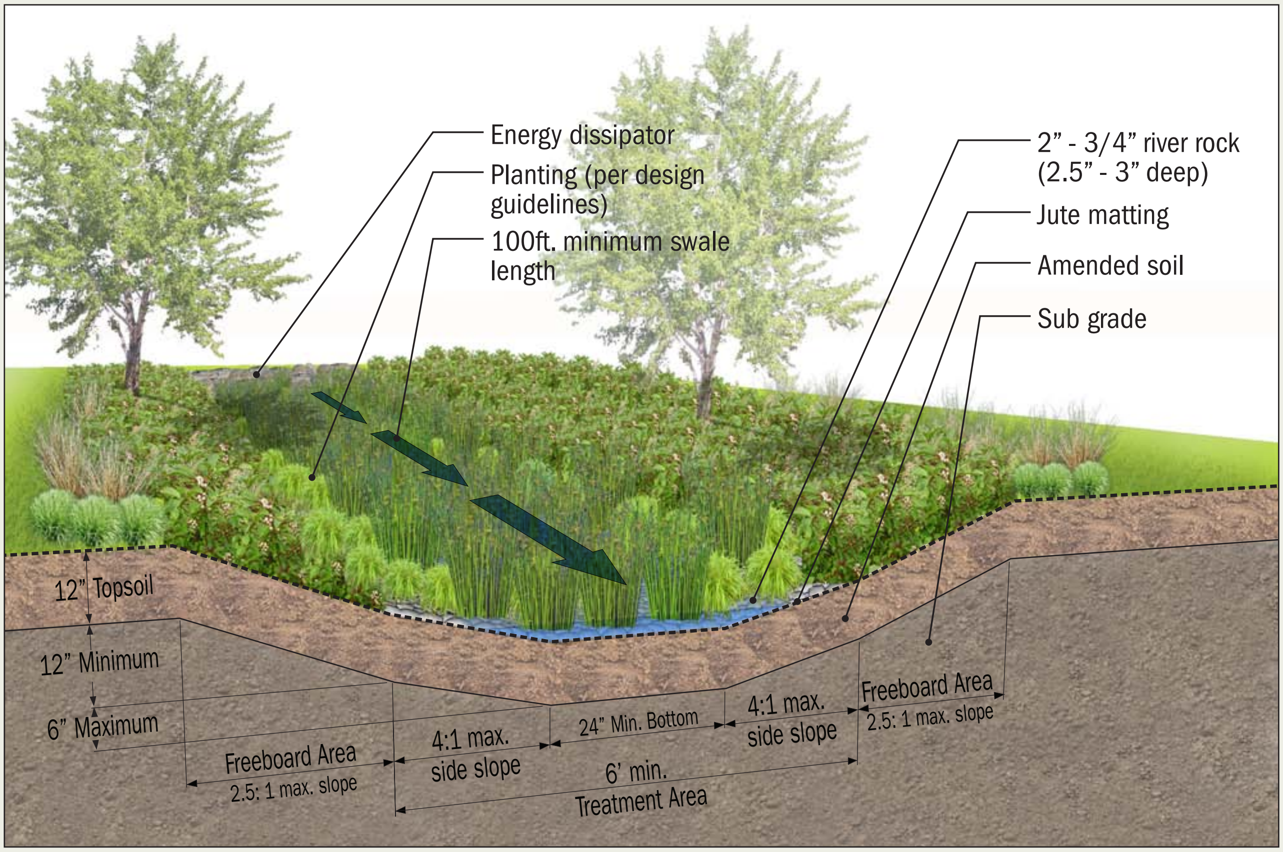
Vegetated swales have a required minimum length, width and stormwater residence time. See Clean Water Services Design and Construction Standards Details 700 and 710.

Application & Limitations

Vegetated swales may help fulfill a site's landscaping area requirement. Vegetated swales are approved to treat stormwater from all types of impervious surfaces including private property and the public right-of-way, rooftops, parking lots, and streets.

Westhaven Subdivision, Washington County, Oregon

Vegetated Swale



Design Factors

Sizing
A vegetated swale must be at least 100 feet in length and detain stormwater for at least nine minutes for treatment as specified in Clean Water Services Design and Construction Standards.

Geometry/Slopes
A vegetated swale's slope end to end is at least 0.5% and the maximum velocity for a 25 year storm flow is 2 feet per second. Side slopes within the treatment area are 25% (4 horizontal: 1 vertical) or less; side slopes of the freeboard area above the treatment zone are 40% (2.5 horizontal: 1 vertical) or less. While the bottom of the swale is at least 2 feet wide, the treatment area is at least 6 feet wide and no more than ½ foot in depth. The freeboard area has at least one foot of vertical height. All swales have an energy dissipater such as boulders at the entrance to reduce velocities and spread the flow across the treatment area. The minimum length of the energy dissipater is 4 feet. See Clean Water Services Design and Construction Standards Detail 700.

Piping for Vegetated Swales
Flows coming into the vegetated swale facility are pretreated by a water quality manhole in accordance with the Design and Construction Standards. Other pretreatment may include an approved proprietary treatment device, filter strip, trapped catch basin, or other method approved by the District or City. An approved outlet structure must be provided for all flows. If location would make access for maintenance difficult, the swale may be a flow-through facility with unsumped structures.

Arbor Oaks Subdivision, Washington County, Oregon

Tanasbourne Office Building, Washington County

Aloha Huber Park Elementary School , Washington County

Design Factors (continued)

Setbacks
Check with the local building department to confirm site-specific requirements.

Soil Amendment/Mulch
The treatment area has ¾" to 2-inch river run rock placed 2.5 to 3 inches deep on high density jute or coconut matting over 12 inches of native topsoil. The river rock, topsoil and high density jute or coconut matting extends to the top of the treatment area, topsoil and low density jute matting extends to the edge of the water quality tract or easement area.

Vegetation
The entire facility including freeboard and treatment areas is vegetated according to the Standards with vegetation appropriate for the soil conditions. Planting conditions vary from wet to relatively dry within the swale. The flat bottom will be inundated frequently and should be planted with species such as rushes, sedges, perennials, and ferns, as well as shrubs that are well-suited to wet-to-moist soil conditions. The side slope moisture gradient varies from wet at the bottom to relatively dry near the top where inundation rarely occurs. The moisture gradient will vary depending upon the designed water depth, swale depth, and side slope steepness. The transition zone from the bottom of the swale to the designed high water line or top of freeboard should be planted with sedges, rushes, perennials, and ferns, as well as shrubs that can tolerate occasional standing water, and wet-to-moist planting conditions. The areas above the designed high water line and immediately adjacent to the vegetated swale will not be regularly inundated and should be planted with self-sustaining, low maintenance grasses, perennials, and shrubs suitable for the local climate and site.

Plant Spacing
A) Vegetated swales in tracts or easements less than 30 feet wide are planted as follows to achieve the specified per acre densities:
i. Treatment area = 6 plugs per square foot (min. 1-inch diameter by 6-inch tall)
ii. Total number of shrubs per acre = area in square feet x 0.05
iii. Groundcover = plant and seed to achieve 100% coverage

B) Vegetated swales in tracts or easements 30 feet wide or more are planted as follows to achieve the specified per acre densities:
i. Treatment area = 6 plugs per square foot (min. 1-inch diameter by 6-inch tall)
ii. Total number of trees per acre = area in square feet x 0.01
iii. Total number of shrubs per acre = area in square feet x 0.05
iv. Groundcover = plant and seed to achieve 100% coverage

Broadview, Seattle

PCC Rock Creek Campus, Beaverton

Sandy Boulevard, Portland

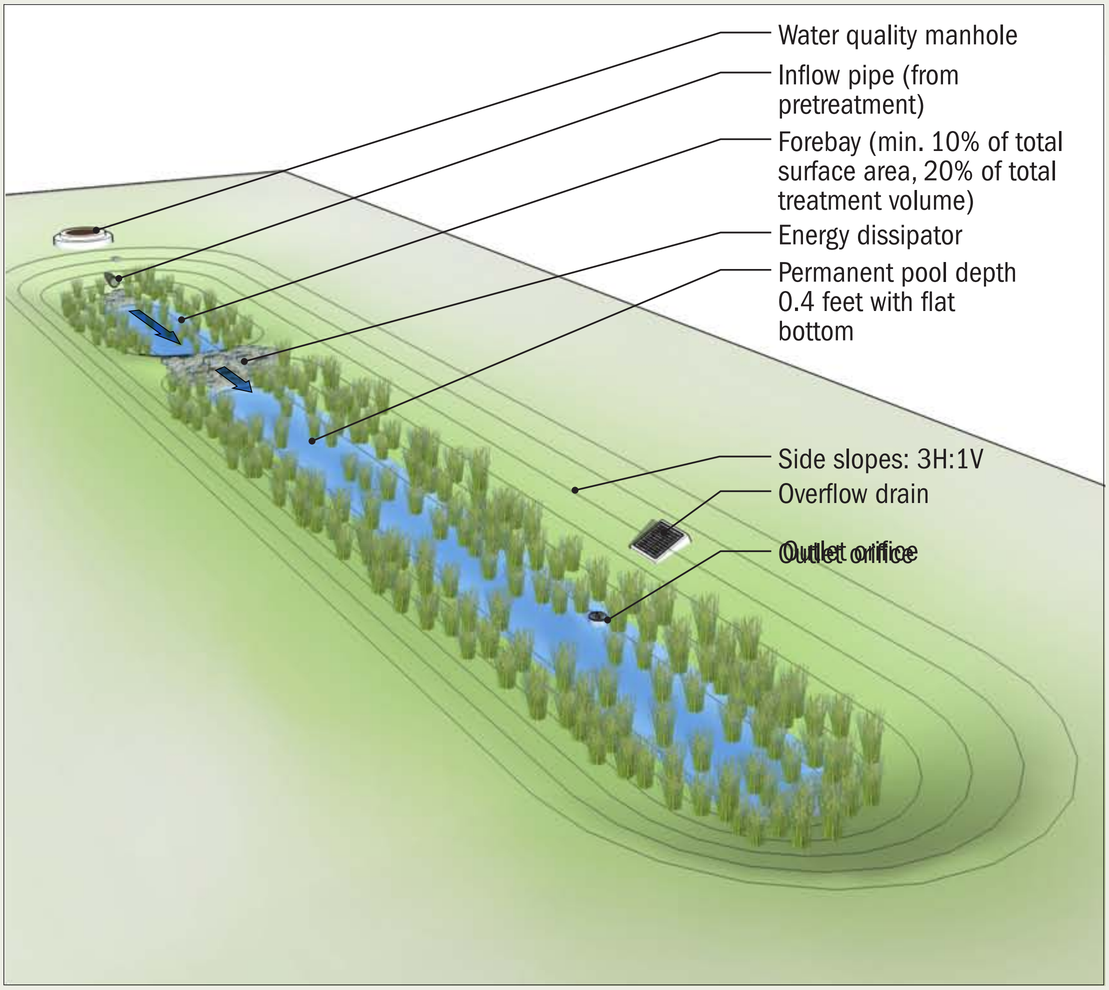
Maintenance

- Provide maintenance access as required by Clean Water Services Design and Construction Standards
- Water efficient irrigation should be applied for the first two years after construction of the facility, particularly during the dry summer months, while plantings become established. Irrigation of plantings after these two years is at the discretion of the owner.
- If public, the permittee is responsible for the maintenance of the vegetated swale for a minimum of two years following construction and acceptance of the facility. All publicly maintained facilities must have a public easement. If private, the property owner is responsible for ongoing maintenance per a recorded maintenance agreement (see Appendix for example maintenance agreement).
- The facility should be inspected in spring and fall, at a minimum.
- Evaluate and replant landscaping to achieve a survival rate of 80% or better with 90% facility coverage. Remove invasive, non-native plants to ensure they occupy no more than 20% of the site.
- Remove all trash and debris that might impede water flow and clog the system.
- Check inlet pipes and outlet structure for damage or missing pieces; remove obstructions and heavy vegetation.
- Make sure stormwater is traveling the length of the treatment area. If stormwater is “short circuiting” the treatment area, repair the swale to achieve full treatment.
- See Appendix for detailed maintenance checklist.

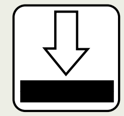
References

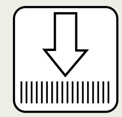
- Clean Water Services Design and Construction Standards
- Gardening with Native Plants poster; Clean Water Services

Extended Dry Basin




parking areas & impermeable landscape


impermeable soils


permeable soils

Description

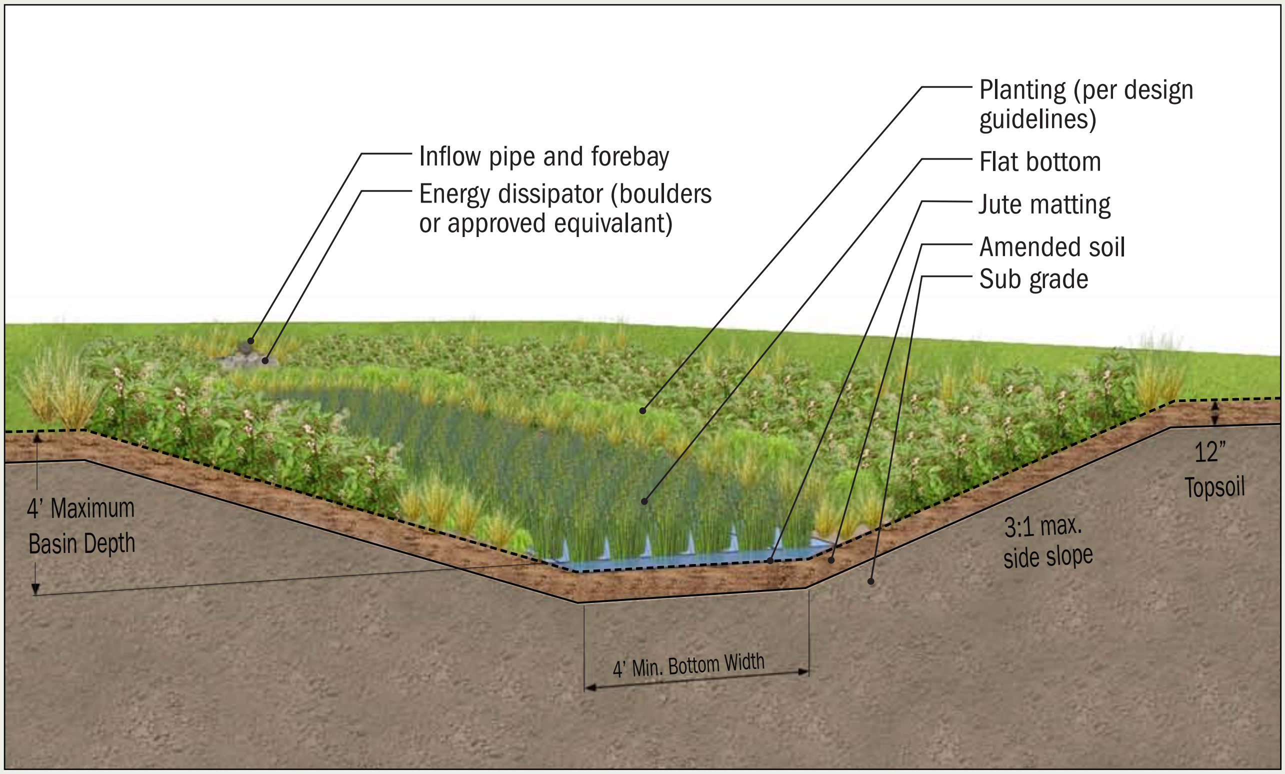
An extended dry basin is a shallow landscaped depression with a flat bottom that collects and holds stormwater runoff, allowing pollutants to settle and filter out as the water infiltrates into the ground or is discharged to an approved location. An extended dry basin has two or more cells (the first cell is the forebay). An inflow pipe conveys stormwater into the basin where it is temporarily stored. Extended dry basins may infiltrate stormwater where soils have high infiltration rates, or may overflow to an approved discharge point.

Application & Limitations

Extended dry basins may help fulfill a site's landscaping area requirement. This type of swale is approved to treat stormwater from all types of impervious surfaces, including private property and the public right-of-way, rooftops, parking lots, and streets.

Home Depot, Glenn Widing Drive, North Portland

Extended Dry Basin



Design Factors

Sizing

Sizing of the detention basin is determined by the volume of runoff and the detention period required for treatment. At a minimum, the detention basin must accommodate the water quality design storm and be sized for a 48 hour drawdown time.

The minimum water quality detention volume is equal to (1) x the water quality volume (WQV). The outlet orifice size is determined by the following equation:
D = 24 * [(Q/ (C[2gH]0.5) / pi] 0.5
Where:
D (in) = diameter of orifice
Q(cfs) = WQV(cf) /(48*60*60)
C = 0.62
H(ft) = 2/3 x temporary detention height to centerline of orifice.

Geometry/Slopes

An extended dry basin has two or more cells. The first cell, the forebay, is at least 10% of the entire surface area and constitutes 20% of the treatment volume. The minimum width of the bottom of the extended dry basin is 4 feet, and the permanent pool depth is 0.4 feet and covers the entire bottom of the basin. The maximum depth of the water quality pool, not including the permanent pool, is 4 feet unless otherwise limited by the jurisdiction.

The maximum side slopes of the basin treatment area are 3H: 1V (33.33%); the minimum freeboard is 1 foot above the 25-year design water surface elevation.

Piping for Extended Dry Basins

Incoming flows are pretreated using a water quality manhole in accordance with the District Standards. Other pretreatment may include proprietary devices, filter strip, trapped catch basin, or methods approved by the District or City. An approved outlet structure is provided for all flows.

Setbacks

Check with the local building department to confirm site-specific requirements.

Soil Amendment/Mulch

If required, place ¾" to 2-inch river run rock 2.5 to 3 inches deep where sustained flow is anticipated. River rock (if required), topsoil, and high density jute or coconut matting extend to the top of the treatment area. Topsoil and low density jute matting extend to the edge of the water quality tract or easement area.

Extended Dry Basin

Washington County

Vegetation

The entire facility area (side slopes and treatment areas) is planted with vegetation appropriate for the varying planting conditions within the extended dry basin. Planting conditions vary from saturated soil to relatively dry, and several planting zones should be considered. The flat bottom of the extended dry basin to the top of the 0.4 foot permanent pool is a saturated zone and will be constantly inundated with water. The saturated zone should be planted with rushes, sedges, and other wetland species (oxygenators) that are well-suited to water-saturated, oxygen-deprived (anaerobic) planting conditions.

The side slopes above the permanent pool depth will vary from wet at the bottom to relatively dry near the top where inundation rarely occurs. This moisture gradient will vary depending upon the designed maximum water depth, basin depth, and side slope steepness. This wet-to-moist transition zone from the top of the permanent pool to the designed high water line or top of freeboard should be planted with sedges, rushes, perennials, ferns and shrubs that can tolerate occasional standing water and wet-to-moist planting conditions. The areas above the designed high water line and immediately adjacent to the extended dry basin will not be regularly inundated. The dry zone should be planted with self-sustaining, low maintenance grasses, perennials, and shrubs suitable for the local climate and site.

The use of native plants is encouraged, but appropriate, adapted non-invasive ornamentals are acceptable for added aesthetic and functional value. All vegetation should be densely and evenly planted to ensure proper hydrological function of the extended dry basin.

Plant Spacing

A) Extended Dry Basins in tracts or easements *less than* 30 feet wide are planted as follows to achieve the specified per acre densities:
i. Treatment area = 6 plugs per square foot (min. 1-inch diameter by 6-inch tall)
ii. Total number of shrubs per acre = area in square feet x 0.05
iii. Groundcover = plant and seed to achieve 100% coverage

B) Extended Dry Basins in tracts or easements 30 feet wide or more are planted as followings to achieve the specified per acre densities:
i. Treatment area = 6 plugs per square foot (min. 1-inch diameter by 6-inch tall)
ii. Total number of trees per acre = area in square feet x 0.01
iii. Total number of shrubs per acre = area in square feet x 0.05
iv. Groundcover = plant and seed to achieve 100% coverage

Home Depot, Glenn Widing Drive, North Portland

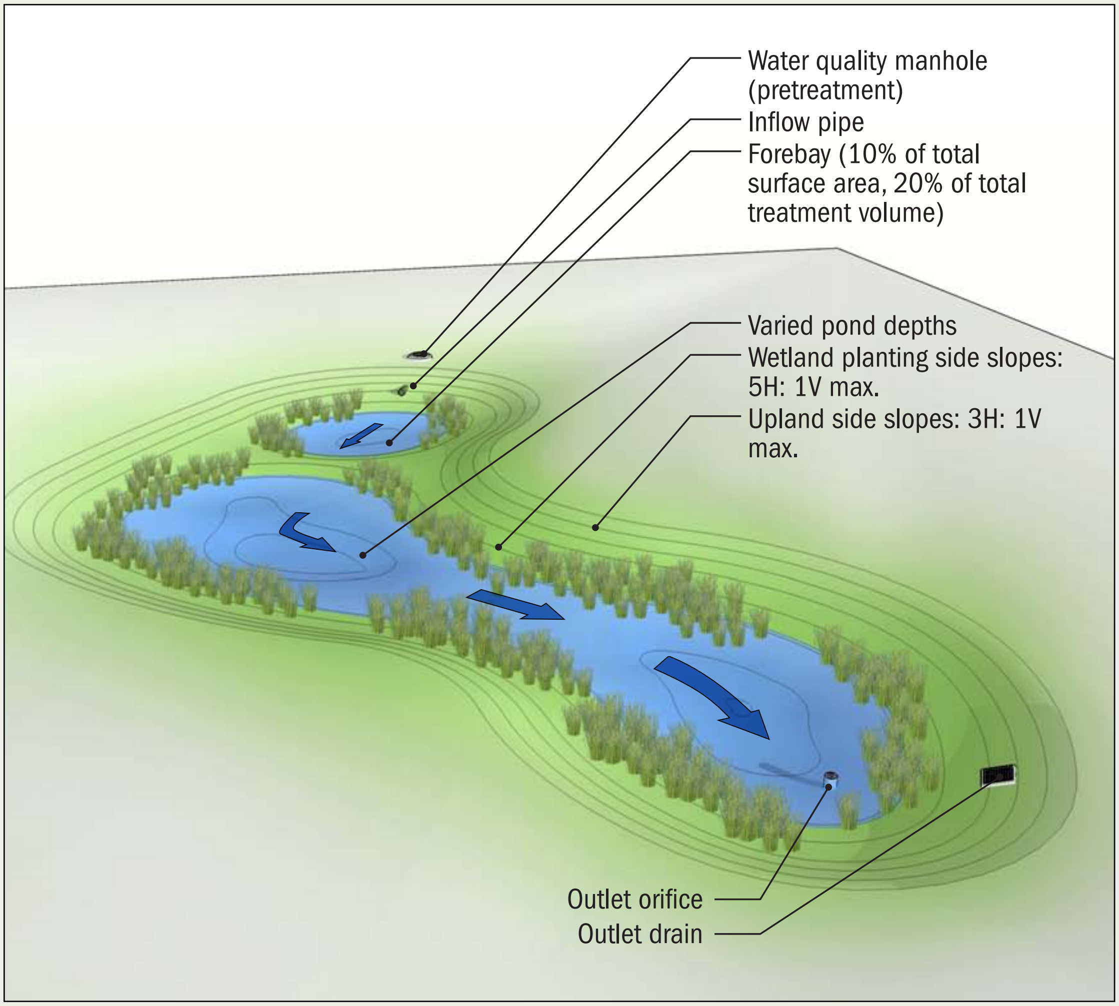
Washington County

Maintenance

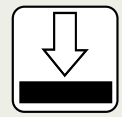
- Water efficient irrigation should be applied for the first two years after construction of the facility, particularly during the dry summer months, while plantings become established. Irrigation of plantings after these two years is at the discretion of the owner.
- If public, the permittee is responsible for the maintenance of the extended dry basin for a minimum of two years following construction and acceptance of the facility. All publicly maintained facilities must have a public easement. If private, the property owner is responsible for ongoing maintenance per a recorded maintenance agreement (see Appendix for example maintenance agreement).
- Remove all trash, debris and sediment regularly to keep outlet structures and trash racks operable during storm events. Proper maintenance also eliminates mosquito breeding habitats. Comply with debris and trash disposal regulations.
- Maintain adequate groundcover and shrubs in the basin, but not overgrown to the extent that storage capacity is inhibited.
- Inspect annually at a minimum by qualified personnel during wet weather to verify detention times are met. Look for and repair clogging, rapid release, subsidence, erosion, cracking, unwanted plant growth, accumulation of sediment in the forebay or around outlets, etc. Based on the inspections, determine an appropriate maintenance and repair schedule.
- See Appendix for detailed maintenance checklist.

References

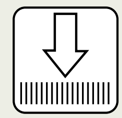
- Clean Water Services Design and Construction Standards
- Gardening with Native Plants poster; Clean Water Services



parking areas & impermeable landscape



impermeable soils



permeable soils

Description

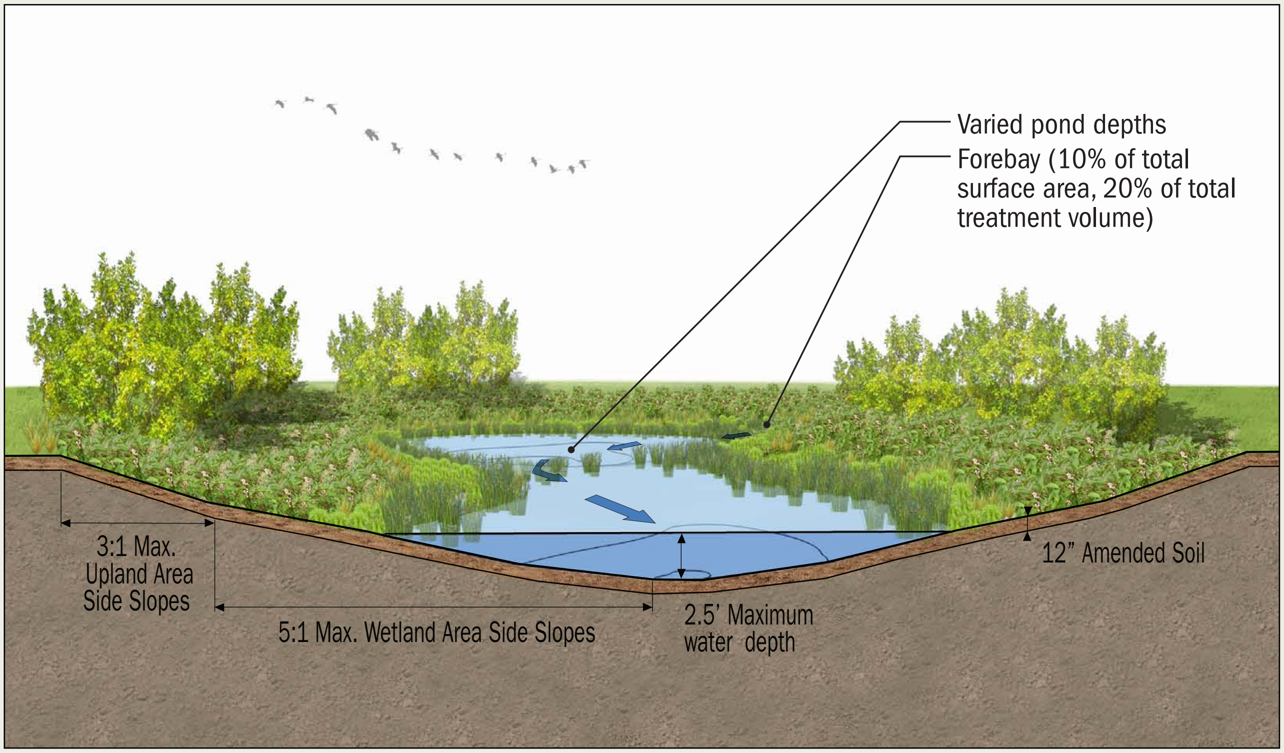
A constructed water quality wetland is a shallow landscaped depression that collects and holds stormwater runoff and allows pollutants to settle and filter out during storm events. Constructed wetlands have a permanent pool of water and also an extended detention area above that fills during storm events and releases water slowly over a number of hours. The permanent pool is sized to reduce pollution by settling and biological processes. The extended detention area is sized to meet flow control requirements.

Application & Limitations

Constructed water quality wetlands may help fulfill a site's landscaping area requirement. Constructed wetlands are approved to treat stormwater from all types of impervious surfaces, including private property and the public right-of way, runoff from rooftops, parking lots, and streets.

Ronler Acres, Hillsboro

Constructed Water Quality Wetland



Design Factors

Sizing

Sizing of the constructed water quality wetland is determined by the volume of runoff and the required detention time for treatment. At a minimum, the detention basin must accommodate the water quality design storm and be sized for a 48 hour drawdown time. The minimum water quality detention volume is equal to (1)x the water quality volume (WQV). The outlet orifice size is determined by the following equation:

D = 24 * [(Q/ (C[2gH]0.5) / Pi] 0.5

Where:

D (in) = diameter of orifice
Q(cfs) = WQV(cf) /(48*60*60)
C = 0.62
H(ft) = 2/3 x temporary detention height to centerline of orifice.

Geometry/Slopes

Constructed water quality wetlands have two or more cells. The first cell, known as the forebay, is at least 10% of the entire surface area and constitutes 20% of the treatment volume. If space is limited, one cell with a forebay at the inlet will settle sediments and distribute flow across the wet pond.

Unlike the flat bottom of an extended dry basin, in a constructed wetland the pool depth varies throughout the pond. Not including the permanent pool, the maximum depth of the water quality pool is 2.5-feet unless otherwise approved by the jurisdiction.

Side slopes for wetland planting areas should not exceed 5H: 1V (20%) and side slopes for non-wetland planting areas should not exceed 3H: 1V (33.33%). The minimum freeboard height is 1 foot from the 25-year design water surface elevation. A perimeter 10 to 20 feet wide provides inundation during storm events.

Piping for Constructed Water Quality Wetlands

Incoming flows to the water quality wetland facility are pretreated by a water quality manhole or other approved pretreatment method in accordance with District Standards. Other pretreatment methods may include proprietary devices, filter strip, trapped catch basin, or other methods as approved by the District or City. An approved outlet structure is provided for all flows.

Setbacks

Check with the local building department to confirm site-specific requirements.

Oleson Woods Apartments, Tigard

Design Factors (continued)

Soil Amendment/Mulch
A minimum of 12” of topsoil should be applied to all treatment areas.

Vegetation
The entire facility area (permanent pool, side slopes and perimeter zone) are planted with vegetation appropriate for the varying planting conditions within the constructed wetland. Planting conditions within the wetland vary from saturated soil to relatively dry, and several planting zones should be considered. The zone between the bottom of the constructed wetland and the top of the permanent pool will be constantly inundated with water and have saturated soils. This wet zone should be planted with rushes, sedges, and other wetland species that are well-suited to water-saturated, oxygen-deprived (anaerobic) planting conditions. The variable depth of the bottom of the wetland will create a series of micro planting conditions. Within this wet zone, areas of open water may be too deep to support significant vegetation.

The side slopes above the permanent pool depth to the outer edges of the perimeter zone will have a moisture gradient that varies from wet near the bottom to relatively dry near the edge of the perimeter area where inundation rarely occurs. This moisture gradient will vary depending upon the maximum designed water depth, constructed wetland depth, and side slope steepness. This moist-to-wet transition zone from the top of the permanent pool to the designed high water line or top of freeboard should be planted with sedges, rushes, perennials, ferns and shrubs that can tolerate occasional standing water and wet-to-moist planting conditions. Areas above the designed high water line and immediately adjacent to the water quality wetland is a dry zone and will not be regularly inundated. The dry zone should be planted with self-sustaining, low maintenance grasses, perennials, and shrubs suitable for the local climate. The planting design should minimize solar exposure of open water areas to reduce heat gain in the water. Lower water temperatures help to maintain healthy oxygen levels and minimize algae blooms. Trees or other appropriate vegetation should be planted at the perimeter of the pond to maximize shading. The use of native plants is encouraged, but adapted, non-invasive ornamentals are acceptable for added aesthetic and functional value.

Synopsys, Hillsboro

Ronler Acres, Hillsboro

Vegetation (continued)
All vegetation should be densely and evenly planted to ensure proper hydrological function of the water quality wetland.

Plant Spacing

Constructed Water Quality Wetlands in tracts or easements are to be planted as follows to achieve the specified per acre densities:
i. Treatment area = 6 plugs per square foot (min. 1-inch diameter by 6-inch tall)
ii. Total number of trees per acre = area in square feet x 0.01
iii. Total number of shrubs per acre = area in square feet x 0.05
iv. Groundcover = plant and seed to achieve 100% areal coverage

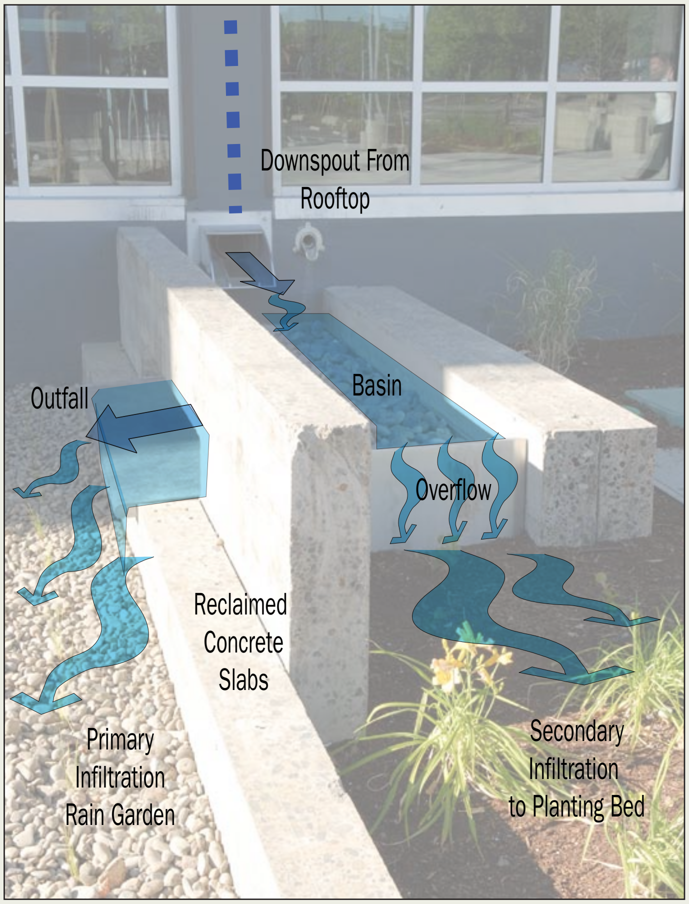
Maintenance

- Water efficient irrigation should be applied for the first two years after construction of the facility, particularly during the dry summer months, while plantings become established. Irrigation of plantings after these two years is at the discretion of the owner.
- If public, the permittee is responsible for the maintenance of the constructed water quality wetland for a minimum of two years following construction and acceptance of the facility. All publicly maintained facilities must have a public easement. If private, the property owner is responsible for ongoing maintenance per a recorded maintenance agreement (see Appendix for an example of maintenance agreement).
- Conduct inspections by qualified personnel at least once a year; evaluate the effectiveness of the regular maintenance schedule and determine the timing of corrective maintenance procedures.
- Remove debris and trash regularly to reduce the chance of outlet structures, trash racks and other components becoming clogged and inoperable during storm events. Dispose of debris and trash in compliance with local, state and federal waste regulations. Use only suitable disposal/recycling sites.
- Investigate any evidence of clogging or rapid release in the wetland. Correct any subsidence, erosion, cracking, unwanted vegetation growth, over-accumulation of sediment around forebays, etc.
- Place inlet structure at the appropriate level to function; not low enough to get buried or "silt in", nor so high that it causes erosion during storm events.
- Replant any bare patches as necessary to achieve adequate coverage.
- See Appendix for detailed maintenance checklist.

References

- Clean Water Services Design and Construction Standards
- Gardening with Native Plants poster; Clean Water Services

Conveyance and Stormwater Art



RiverEast Center, Portland. Stormwater from the rooftop is conveyed by a downspout into a sculptural basin made with reclaimed concrete from the retrofit of the building. The basin detains and slows runoff before it flows into a series of adjacent rain gardens, grated runnels and swales.

buildings

parking areas & impermeable landscape

impermeable soils

permeable soils

Description

Stormwater conveyance is the flow, movement or transfer of stormwater from one location to another. Stormwater conveyance techniques deliberately transport water from where it falls to where it will be treated. All Low Impact Development Approaches (LIDA) convey stormwater, and the movement and slowing of water through these facilities improves water quality and attenuates peak stormwater flows.

There are design standards for each type of LIDA, but there is flexibility to allow creativity and site-specific adaptation for how stormwater enters and passes through these facilities to meet required performance criteria.

Application & Limitations

There are two general methods of stormwater conveyance, underground and above ground.

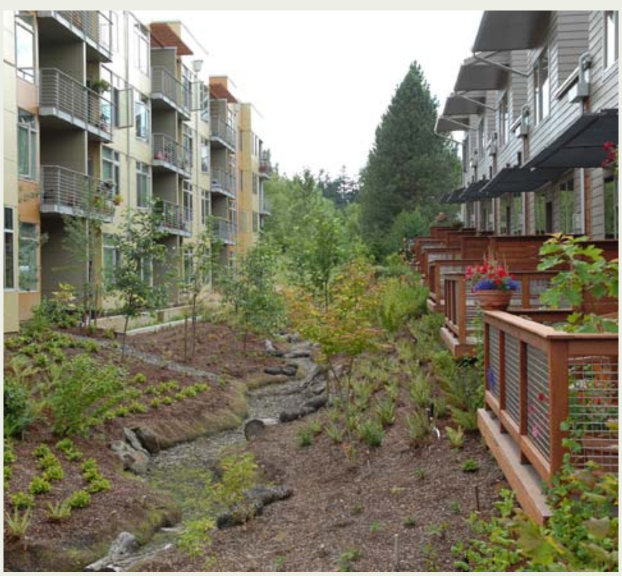
1. Underground conveyance channels stormwater in pipes below-ground and typically requires a plumbing permit. (See Design and Construction Standards for additional details and requirements.)
2. Above ground conveyance moves water on the surface of the ground. In applicable locations, such as LIDA facilities, the benefits of above ground conveyance may include:

- Lower construction costs due to less excavation and underground piping
- Less site disturbance
- Improved oxygenation and cleansing of water
- More opportunities for artistic and creative design
- Enhanced public awareness of urban stormwater

Conveyance and Stormwater Art

New Seasons, 20th and Division, Portland. A whimsical steel sculpture conveys stormwater from a grocery store rooftop into an infiltration planter.

Estacada Library. Stormwater is conveyed from the rooftop to an infiltration basin. As the basin fills with water, it overflows into a connected series of swales and additional infiltration basins that convey stormwater around the library.



Headwaters at Tryon Creek, SW Portland. Headwaters is a residential development where senior housing, town homes, and an apartment building were designed to be integrated with the daylighting (removal from an underground piping system) of a tributary of Tryon Creek.

North Main Village, Milwaukie. Stormwater is the featured design element for this residential courtyard. Water from rooftops is conveyed by steel scuppers into decorative planters to meandering runnels and water quality swales.

"Downspout 101", Seattle (artist Buster Simpson). The branching downspout is part of a public art project called "Growing Vine Street" that uses visual and provocative conveyance techniques to raise awareness of the stormwater flowing through the neighborhood.

PSU Stephen Epler Hall. Stormwater from the impermeable plaza area is directed to bands of granite stone that are strategically placed at low drainage points to convey stormwater to a series of flow-through planters.

Team Estrogen Warehouse, Washington County. Stormwater from the warehouse roof is conveyed by a scupper into a concrete splash basin. The velocity of the water is slowed before the water flows into a vegetated swale.

Block 11, Washougal, WA. Stormwater from surrounding rooftops is directed into the plaza's vertical sculpture before entering flow-through planters.

Conveyance and Stormwater Art

Glencoe Elementary School Rain Garden, Portland. Stormwater from neighboring streets is conveyed into an infitration rain garden filled with native plants and rock berms that slow the flow of water. The rain garden is also a visual amenity and educational component for the elementary school (photo courtesy of 2008 Portland Stormwater Manual).

Headwaters at Tryon Creek, SW Portland. The rounded and stepped design of these infiltration planters are molded to the specific conditions of the site. The concrete walls are a creative interpretation of check dams that are used to convey water across flat surfaces over steep topography.

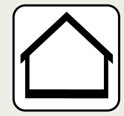
New Seasons, Beaverton. Two decorative scuppers collect and convey roof stormwater into an infiltration basin.

10th @ Hoyt, Portland. The design of this urban courtyard is inspired by Persian gardens. Downspouts convey stormwater from the surrounding rooftops into a series of channels and colorful fountains.

Local 49, Portland. Stormwater is conveyed from the rooftop by a decorative stainless steel metal scupper into the courtyard. Water flows from the scupper into a concrete runnel, detention basin and planters.

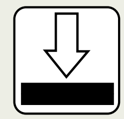
Planting Design and Habitat

Tanner Springs Park, Portland. Stormwater from surrounding impermeable surfaces is conveyed and recirculated through a constructed wetland and filter strip to be cleansed and aerated. The filter strip and wetland edge is planted with a variety of native plants based on their suitability to the different planting conditions.

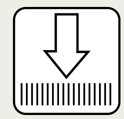


buildings

parking areas & impermeable landscape



impermeable soils



permeable soils

Description

A habitat is a space that provides food, water and shelter for the survival and reproduction of an organism. Low Impact Development Approaches (LIDA) facilities mimic the natural habitats, processes and hydrology of a particular site. The environmental benefits of LIDA facilities include:

- Less disturbance to sites than conventional stormwater management methods
- Reduced and delayed peak stormwater flows
- Reduced discharge of pollutants
- Increased planted space and habitat
- Creation of a multifunctional landscape that enhances visual and functional amenities

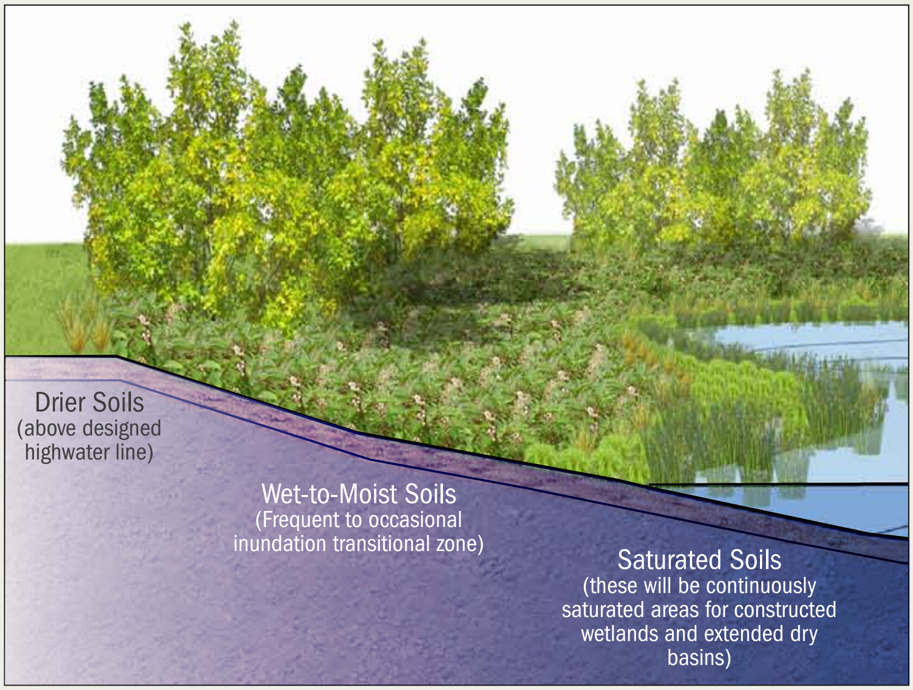
All of these on-site benefits generate a variety of off-site benefits that preserve and enhance riparian and wetland habitats “downstream” from the facility by reducing the negative environmental affects associated with urban development.

Application & Limitations

Nearly all LIDA facilities have the potential to create and improve habitat on and near the site. Water is one of the most important factors in the creation of habitat, and because most LIDA facilities receive large amounts of stormwater they offer a great opportunity to create habitat. Planting vegetation is one of the most practical ways to create habitat within a LIDA facility.

Each LIDA facility has planting design guidelines such as required plant spacing and plant types, but there is flexibility to maximize habitat for a variety of organisms such as invertebrates, amphibians, small mammals and birds.

Planting Design and Habitat



Planting conditions and habitats are varied for LIDA facilities with side slopes, such as vegetated swales, LIDA swales, extended dry basins and water quality wetlands.

Design Factors

<u>Relationship of Form and Hydrology</u>
Careful consideration of the planting conditions within a LIDA facility will help to ensure the success of a planting design.

Planting conditions for sloped, basin-like stormwater facilities such as swales, extended dry basins, constructed water quality wetlands, and infiltration basins have a variety of moisture levels. Soil conditions at and near the bottom of the facility are wet due to frequent or constant inundation, and side slopes vary from wet at the bottom to relatively dry near the top. The moisture gradient varies with the designed maximum water depth, the time it takes for a facility to drain after a storm event, and the steepness of the side slopes. The zone from the bottom of the facility to the designed high water line or top of freeboard should be planted with plants that tolerate occasional standing water and wet-to-moist conditions. Above the designed high water line vegetation is not affected by stormwater entering the facility and should be planted with species well-suited to the local climate and context.

Planting conditions are more uniform for flow-through and infiltration planters because of the relatively flat surface.

Planting conditions for LIDA facilities without sloped edges (such as concrete flow-through planters and infiltration planters) are largely uniform.

Beaumont Village, Portland

Oregon Convention Center Rain Garden, Portland

Mt. Tabor Middle School, Southeast Portland

Design Factors (continued)

Climate and Microclimate
All stormwater facility vegetation should be well-adapted to both the northwest regional climate and the facility's microclimate. Although regional climate dictates average seasonal temperatures, amount of rainfall and available daylight, site-specific microclimates can vary considerably and should be factored into the planting design, particularly in an urbanized environment. For example, sword fern is a plant native to woodlands of the Pacific Northwest that likely would not survive if placed in a south facing flow-through planter with direct sun exposure most of the day and heat radiating off the building. But, sword fern placed in a flow-through planter on the north side of the building likely would thrive.

Native and Adapted Plants
The use of native plants is strongly recommended. They are well-adapted to the local climate and offer more habitat value for native organisms. Non-native or adapted plants may be used in stormwater facilities for added color and habitat value as long as they are noninvasive and appropriate for the facility. Local nurseries offer a wealth of information about native and adapted plants.

Habitat Diversity and Layering of Plants
Natural environments in the Pacific Northwest are characterized by diverse, layered plant habitats. A forest typically has three broad habitats vertically arranged one on top of the other; low-growing groundcovers, topped by shrubs, topped by arborescent shrubs (shrubs that look like small trees) and trees. These layers vary in composition and form from one habitat type to another, such as the different northwest habitats of forest, wetland, and riparian. Different organisms occupy different niches within these habitats, creating greater biodiversity. A range of habitats can be created in LIDA facilities by selecting a variety of complementary vegetation to plant together, such as groundcovers, perennials, shrubs, and trees. The structural variety of a diversified planting design can also be very pleasing to the eye.

Irrigation
Water efficient irrigation should be applied for at least the first two years after construction of the facility, particularly during the dry summer months, while plantings become established.

Planting Design and Habitat

Oleson Woods Apartments, Tigard

Rock Creek Greenway

Maintenance

- Check regularly for weeds. Remove weeds or invasive plants such as blackberries and ivy, and implement a weed control program as needed.
- Check mulch regularly to maintain uniform coverage. Most LIDA facilities specify a mulch cover such as river rock to prevent erosion and moisture loss during dry periods.
- Replant bare patches as necessary to comply with the facility's coverage requirements and maintenance plan.

References

- Clean Water Services Design and Construction Standards
- Gardening with Native Plants poster; Clean Water Services

Ronler Acres, Hillsboro

Appendices: Glossary

Appendices: Glossary

The vocabulary of low impact development is evolving, and many terms are used interchangeably and to describe the same or similar things. This glossary is a compilation of commonly used terms and their sources. Several definitions for some terms are listed here to demonstrate various usages and sources, as there is no absolute authoritative definition for many of them. Please see the Additional Resources and Informational Web Sites pages for more definitions.

General Terms

Best Management Practices (BMPs) are techniques used to control stormwater runoff, sediment control, and soil stabilization, as well as management decisions to prevent or reduce nonpoint source pollution. The EPA defines a BMP as a "technique, measure or structural control that is used for a given set of conditions to manage the quantity and improve the quality of stormwater runoff in the most cost-effective manner."

Low impact development: a stormwater management and land development strategy applied at the parcel and subdivision scale that emphasizes conservation and use of on-site natural features integrated with engineered, small-scale hydrologic controls to more closely mimic predevelopment hydrologic functions. (Low Impact Development – Technical Guidance Manual for Puget Sound)

Low impact design: an approach for site development that protects and incorporates natural site features into erosion and sediment control and stormwater management plans. (Low Impact Design Manual for the Auckland Region 2000)

Low impact development aims to mimic natural hydrology and processes by using small-scale, decentralized practices that infiltrate, evaporate, and transpire rainwater. Specifically, LID aims to:

- Minimize impervious surfaces;
- Disconnect hydrologic elements (roofs, downspouts, parking areas);
- Maintain/increase flow paths and times; and
- Utilize decentralized treatment practices. (NAHB Research Center Toolbase Services)

Green development practices: stormwater management techniques that utilize the processes of retention, infiltration, and evapotranspiration to treat runoff and reduce the volume of stormwater. (Gresham Development Code)

Specific Terms

Bioretention: Vegetated depressions that collect runoff and facilitate its infiltration into the ground. (Department of Defense Guidebook)

Bioretention areas: Storm water directed to these shallow topographic depressions in the landscape is filtered, stored, and infiltrated into the ground using specialized vegetation and engineered soils. (NAHB Research Center Toolbase Services)

Cisterns and rain barrels: harvest and store rainwater from roofs which provides "soft" chemical-free water for garden or lawn irrigation, reduces water bills and conserves municipal water supplies. (Connect the Drops)

Dry wells: Gravel- or stone-filled pits that are located to catch water from roof downspouts or paved areas. (DOD Guidebook)

Eco-roof and roof gardens: Eco-roofs or roof gardens are vegetated rooftops that use the plant-soil complex to store, detain, and filter rainfall. They are used to reduce runoff volume and slow runoff rates. An eco-roof is a lightweight vegetated roof system made of a synthetic waterproof membrane, a drainage layer, a maximum 6-inch layer of soil, and a cover of plants. A roof garden is a heavyweight vegetated roof system consisting of a waterproof membrane, drainage layer, and a thick layer of soil (typically 12 inches or more), vegetation, and hardscaping to allow access to the garden (e.g., planters, stepping stones, benches). Building Official approval is required for installation of eco-roofs and roof gardens. (D & C Standards)

Filter strips: Bands of dense vegetation planted immediately downstream of a runoff source designed to filter runoff before entering a receiving structure or water body. (DOD Guidebook)

Flow-through planters: structural landscaped reservoirs placed on impervious surfaces used to collect, filter, and temporarily store stormwater runoff, allowing pollutants to settle and filter out as the water percolates through the planter soil until flowing through to an approved conveyance. (D & C Standards)

Grassed swales: Water moving through these systems is slowed, filtered, and percolated into the ground. These systems can act as low cost alternatives to curbs, gutters, and pipes. (NAHB Research Center Toolbase Services)

Grassed swales: Shallow channels lined with grass and used to convey and store runoff. (DOD Guidebook)

Green roofs: eco-roofs are covered with lightweight soils and plants. Used for decades in Europe, they mitigate the urban heat island effect, insulate the roof and extend its life and reduce energy costs. (Connect the Drops)

Green streets: replace conventional catch basins, pipes, curbs and detention facilities with vegetated swales, bioretention cells and/or pervious pavement. (Connect the Drops)

Infiltration planter: structural landscaped reservoirs used to collect, filter, and infiltrate stormwater runoff, allowing pollutants to settle and filter out as the water percolates through the planter soil and infiltrates into the ground. (D & C Standards)

Infiltration trenches: Trenches filled with with porous media such as bioretention material, sand or aggregate that collect runoff and exfiltrate it into the ground. (DOD Guidebook)

Inlet pollution removal devices: small stormwater treatment systems that are installed below grade at the edge of paved areas and trap or filter pollutants in runoff before it enters the storm drain. (DOD Guidebook)

Permeable pavement: Asphalt or concrete rendered porous by the aggregate structure. (DOD Guidebook)

Permeable pavements: surfaces that allow water to pass through voids in the paving material and/or between paving units while providing a stable, load-bearing surface. An important component to permeable pavements is the reservoir base course, which provides stability for load-bearing surfaces and underground storage for runoff. (Seattle Green Parking)

Permeable pavers: Manufactured paving stones containing spaces where water can penetrate into the porous media placed underneath. (DOD Guidebook)

Pervious paving: Pervious pavement and pavers are water permeable ground covers which infiltrate precipitation, reduce stormwater runoff flow rate, volume, and temperature, and filter some pollutants. Pervious pavement resembles its solid pavement counterpart, but has more void spaces that allow water to pass through the pavement into a reservoir base of crushed aggregate, then infiltrate into the ground. Pervious pavers are typically made of pre-cast concrete, brick, stone, or cobbles. (D & C Standards)

Pervious, permeable or porous pavements: allow water to soak through the paved surface into the ground. Examples are porous concrete and asphalt, grasscrete, gravel with plastic grid systems and interlocking paving bricks. (Connect the Drops)

Porous pavement: permeable pavement surface with an underlying stone layer that temporarily stores water that percolates through the surface before infiltrating into the subsoil or being collected in underlying drain pipes and being discharged off-site. There are many types of porous pavements including plastic rings planted with grass, stone or concrete pavers with pore spaces backfilled with gravel or sand, porous asphalt mixes, and porous concrete mixes. Porous pavement should be designed to accept water from precipitation and potentially sheet flow from adjacent impervious surfaces, but not concentrated discharges of stormwater runoff. The pavement surface shall be inspected for proper infiltration performance and structural stability within 48 hours after each major storm event. (Green Development Practices, Gresham)

Rain barrels and cisterns: Containers of various sizes that store the runoff delivered through building downspouts. Rain barrels are generally smaller structures, located above ground. Cisterns are larger, are often buried underground, and may be connected to the building's plumbing or irrigation system. (DOD Guidebook)

Rain gardens: also known as swales or bioswales, are planted open depressions in the landscape designed to accept stormwater runoff from adjacent impervious surfaces. Rain gardens trap pollutants in stormwater by filtering it through topsoil as the water infiltrates into native soils or underlying drain pipes. Rain gardens reduce the volume of stormwater that is discharged off-site and into natural streams. Rain gardens should drain within 24 hours of a storm event. (Green Development Practices, Gresham)

Rain gardens: or bioretention cells are vegetated areas that collect runoff so it can slowly infiltrate into the ground. Some have special soil mixtures that maximize infiltration and pollutant removal but avoid extended ponding. (Connect the Drops)

Reduced pervious footprint: narrow streets, multi-level structures reduce the impervious area that causes stormwater runoff. (Connect the Drops)

Sand filters: structural landscaped reservoirs used to collect and filter stormwater runoff allowing pollutants to settle and filter out as the water percolates through the sand bed. The treated filtrate can then be discharged through an underdrain system or infiltrated directly into native soils, if appropriate. (D & C Standards)

Smart site design: conserves trees and habitat, minimizes disturbance and soil compaction, and integrates on-site stormwater management into the other considerations for site development. (Connect the Drops)

Soil amendments: Minerals and organic material added to soil to increase its capacity for absorbing moisture and sustaining vegetation. (DOD Guidebook)

Stormwater planters: designed to accept stormwater runoff from adjacent impervious surfaces. They remove pollutants by filtering runoff through layers of topsoil and then either infiltrating it into native soils (infiltration stormwater planter) or perforated underdrain pipes to be discharged off-site (filtration stormwater planter). Water should drain through the planter within 24 hours after a storm event. (Green Development Practices, Gresham)

Street swales: gently sloping depressions planted with dense vegetation or grasses designed to receive, filter, and infiltrate the runoff as it conveys the stormwater along its length. Water quality improvement is achieved by the settling out of particulates in the water column and by the biological and chemical action of the water. Swales can include check dams to help slow and detain the flow. (D & C Standards)

Tree box filters: in-ground containers with high rate pollutant filtering and runoff storage used along curb and gutter systems to intercept, slow, and treat roadway runoff in urban areas. (D & C Standards)

Tree box filters: Curbside containers placed below grade, covered with a grate, filled with filter media and planted with a tree in the center. (DOD Guidebook)

Vegetated buffers: Natural or man-made vegetated areas adjacent to a water body, providing erosion control, filtering capability, and habitat. (DOD Guidebook)

Vegetated filter strips: or vegetated filters, are gently sloping areas used to filter, slow, and provide pre-treatment to stormwater flows. (D & C Standards)

Vegetated infiltration basins: shallow landscaped depressions used to collect and hold stormwater runoff, allowing pollutants to settle and filter out as the water infiltrates into the ground. (D & C Standards)

Vegetated roofs: Impermeable roof membranes overlaid with a lightweight planting mix with a high infiltration rate and vegetated with plants tolerant of heat, drought, and periodic inundation. (DOD Guidebook)

Vegetated swales: broad, shallow channels that reduce stormwater volume and velocity and filter pollutants from the water. (Connect the Drops)

More about Swales: excerpts from an APWA webinar

Swale: Flat bottom depression

Ditch: Deep-cut steep side slopes

Conveyance Swale: Purpose to move water (temp vs permanent)

Bioswale: Engineered vegetated swale, cleans water

Bioretention Swale: Vegetated, infiltrates and cleans water

Natural Drainage Swales: Engineered system with amended subsurface soil layer

Raingarden: Organic shaped depression with amended soils and plants to soak up and retain water. Typically has overflow.

Stormwater planter: More structural to complement building; functions as retention to reduce stormwater discharge; planted

Furrow: Small conveyance swale

Dispersal or Infiltration Trench: Underground washed rock or gravel to spread out flows

Structural Water Quality BMPs

Infiltrating BMPs: Basins, Trenches, Swales, Pavement

Filtering BMPss: Basins, Trenches, Swales, Sand filters, Proprietary Systems

Retention BMPs: Ponds, Wetlands

Appendices: Additional Resources

Clean Water Services

Clean Water Services Design and Construction Standards
cleanwaterservices.org/PermitCenter/DesignAndConstruction/default.aspx

Amended Soils

US Composting Council STA Compost Technical Data Sheet
www.compostingcouncil.org/programs/sta/
US Composting Council STA Compost Providers
www.compostingcouncil.org/programs/sta/participants.phb

Building Codes

Washington County Building Services
co.washington.or.us/deptmts/lut/land_dev/bld_serv.htm

Design Manuals from the Pacific Northwest

Habitat Friendly Development Practices Guidance Manual; Beaverton, 2006
beavertonoregon.gov/departments/CDD/Planning/habitat/docs/Final_Guidance_2_16_06.pdf

Stormwater Management Manual, Portland BES, 2008
portlandonline.com/bes/index.cfm?c=47952

Green Development Practices for Stormwater Management. An Implementation Guide for Development Projects in the Pleasant Valley and Springwater Plan Districts; City of Gresham, 2007
ci.gresham.or.us/doclibrary/docs/greenDevelopmentPractices.pdf

Low Impact Development Technical Guidance Manual for Puget Sound, 2005 pierce.
wsu.edu/Water_Quality/LID/LID_manual2005.pdf

City of Seattle, "Stormwater Treatment Technical Requirements Manual"
web1.seattle.gov/dpd/dirrulesviewer/Rule.aspx?id=27-2000

King County Surface Water Management Design Manual
kingcounty.gov/environment/waterandland/stormwater/documents/surface-water-design-manual.aspx

Green Roofs

City of Portland Ecoroof Website
portlandonline.com/bes/index.cfm?c=44422&

Greenroof Projects Database
greenroofs.com

Green Streets

Green Street Standards. City of Gresham. July 2007
ci.gresham.or.us/doclibrary/docs/greenStreetStandards.pdf

Native Plants

Clean Water Services Native Plant Finder
cleanwaterservices.org/EducationAndOutreach/NativePlantFinder/default.aspx

Portland Plant List, 2004
portlandonline.com/shared/cfm/image.cfm?id=58951

Plant Native
plantnative.org/nd_or.htm

Plumbing Code

2008 Oregon Specialty Plumbing Code
cbs.state.or.us/external/bcd/programs/plumbing/2008opsc.html

Porous Pavement

Pervious Pavement
perviouspavement.org

Oregon Department of Transportation Standard Specifications
oregon.gov/ODOT/HWY/SPECS/docs/08book/08_00700.pdf

Interlocking Concrete Pavement Institute Specifications
icpi.org/design/tech_specs.cfm

National Asphalt Pavement Association Information Series 131 "Porous Asphalt Pavements for Stormwater Management"
hotmix.org

Rain Gardens

Rain Gardens of West Michigan raingardens.org/Index.php

Rain Garden Network raingardennetwork.com/

Virginia Dept. of Forestry dof.virginia.gov/rfb/rain-gardens.shtml

Kansas City 10,000 Rain Gardens rainkc.com/

University of Rhode Island uri.edu/ce/healthylandscapes/raingarden.htm

Brooklyn Botanic Garden bbg.org/gar2/topics/design/2004sp_raingardens.html

Soil Infiltration Rates

Natural Resources Conservation Service
soildatamart.nrcs.usda.gov/State.aspx

Wetland Maps
National Wetlands Inventory
fws.gov/wetlands

More informational web sites

Low Impact Development Handbook; County of San Diego, 2007
sdcounty.ca.gov/dplu/docs/LID-Handbook.pdf
sdcounty.ca.gov/dplu/docs/LID-Appendices.pdf

Maryland Stormwater Manual
mde.maryland.gov/Programs/WaterPrograms/SedimentandStormwater/stormwater_design/index.asp

Low Impact Development; Department of Defense, 2004
wbdg.org/ccb/DOD/UFC/ufc_3_210_10.pdf

Low Impact Development Urban Design Tools
lid-stormwater.net

Low Impact Development Center
lowimpactdevelopment.org

Prince George's County, Maryland
goprincegeorgescounty.com

NAHB Research Center Toolbase Services
toolbase.org

U.S. Environmental Protection Agency
epa.gov/nps/lid

Federal Highway Administration UltraUrban BMP Manual
fhwa.dot.gov/environment/ultraurb

International Stormwater BMP Database
bmpdatabase.org

Puget Sound Partnership
psp.wa.gov/stormwater.php

Metro Nature Friendly Development
oregonmetro.gov

Stormwater Managers Resource Center
stormwatercenter.net

Free publications from Clean Water Services

Slow the Flow! Field Operations Facility booklet

Gardening with Native Plants poster

Rain Garden poster

Invasive Plants flyer

Connect the Drops booklet

Appendices: Maintenance

After Recording Return to:
Clean Water Services
2550 SW Hillsboro Hwy.
Hillsboro, OR 97123

PRIVATE STORMWATER FACILITIES AGREEMENT

This Agreement is made and entered into this _______ day of ________________ 20___, by and between Clean Water Services (District) and ________________________ (Owner).

RECITALS

A. Owner has developed or will develop (select all applicable private stormwater facilities):

☐ Private Stormwater Detention or Retention Facilities
☐ Private Water Quality Treatment Facilities
☐ Low Impact Development Facilities

B. The Facilities enable development of property while mitigating the impacts of additional surface water and pollutants associated with stormwater runoff prior to discharge from the property to the public stormwater system. The consideration for this Agreement is connection to the public stormwater system.

C. The property benefited by the Facilities and subject to the obligation of this Agreement is described below or in Exhibit A (Property) attached hereto and incorporated by reference.

D. The Facilities are designed by a registered professional engineer to accommodate the anticipated volume of runoff and to detain and treat runoff in accordance with District's Design and Construction Standards.

E. Failure to inspect and maintain the Facilities can result in an unacceptable impact to the public stormwater system.

NOW, THEREFORE, it is agreed by and between the parties as follows:

1. OWNER INSPECTIONS District shall provide Owner an Operations and Maintenance Plan (O&M Plan) for each Facility. Owner agrees to operate, inspect and maintain each Facility in accordance with the O&M Plan. Owner shall maintain a log of inspection activities. The log shall be available to District upon request or during District inspections.

2. DEFICIENCIES All aspects in which the Facilities fail to satisfy the O&M Plan shall be noted as "Deficiencies".

3. OWNER CORRECTIONS All Deficiencies shall be corrected at Owner's expense within thirty (30) days after completion of the inspection. If more than 30 days is reasonably needed to correct a Deficiency, Owner shall have a reasonable period to correct the Deficiency so long as the correction is commenced within the 30-day period and is diligently prosecuted to completion.

4. DISTRICT INSPECTIONS Owner grants District the right to inspect the Facilities. District will endeavor to give ten (10) days prior written notice to Owner, except that no notice shall be required in case of an emergency. District shall determine whether Deficiencies need to be corrected. Owner (at the address provided at the end of this Agreement, or such other address as Owner may designate in writing to District) will be notified in writing through the US Mail of the Deficiencies and shall make corrections within 30 days of the date of the notice.

5. DISTRICT CORRECTIONS If correction of all Owner or District identified Deficiencies is not completed within thirty (30) days after Owner's inspection or District notice, District shall have the right to have any Deficiencies corrected. District (i) shall have access to the Facilities for the purpose of correcting such Deficiencies and (ii) shall bill Owner for all costs reasonably incurred by District for work performed to correct the Deficiencies (District Correction Costs) following Owner's failure to correct any Deficiencies in the Facilities. Owner shall pay District the District Correction Costs within thirty (30) days of the date of the invoice. Owner understands and agrees that upon non-payment, District Correction Costs shall be secured by a lien on the Property for the District Correction Cost amount plus interest and penalties.

6. EMERGENCY MEASURES If at any time District reasonably determines that the Facilities create any imminent threat to public health, safety or welfare, District may immediately and without prior notice to Owner take measures reasonably designed to remedy the threat. District shall provide notice of the threat and the measures taken to Owner as soon as reasonably practicable, and charge Owner for the cost of these corrective measures.

7. FORCE AND EFFECT This Agreement has the same force and effect as any deed covenant running with the land and shall benefit and bind all owners of the Property present and future, and their heirs, successors and assigns.

8. AMENDMENTS The terms of this Agreement may be amended only by mutual agreement of the parties. Any amendments shall be in writing, shall refer specifically to this Agreement, and shall be valid only when executed by the owners of the Property, District and recorded in the Official Records of the county where the Property is located.

9. PREVAILING PARTY In any action brought by either party to enforce the terms of this Agreement, the prevailing party shall be entitled to recover all costs, including reasonable attorney's fees as may be determined by the court having jurisdiction, including any appeal.

10. SEVERABILITY The invalidity of any section, clause, sentence, or provision of this Agreement shall not affect the validity of any other part of this Agreement, which can be given effect without such invalid part or parts.

IN WITNESS WHEREOF, Owner and District have signed this Agreement.

CLEAN WATER SERVICES

By: ________________________
General Manager or Designee

OWNER

By: ________________________

Title: ______________________

Address: ____________________________

____

NOTARIZE DOCUMENT BELOW

[Use this notary block if Owner is an individual.]

STATE OF ________________)
)
County of _________________)

This instrument was acknowledged before me this _______day of __________________________, 20___,
by ____
____.

____
Notary Public

[Use this notary block if Owner is an entity.]

STATE OF ________________)
)
County of _________________)

This instrument was acknowledged before me on
____________________________________(date)
by__________________________________(name of person)
as _____________________________ (title) of
_________________________________(name of entity).

____
Notary Public

Porous Pavement Checklist

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Annually Required	Structural components	Water infiltrates unevenly across surface or ponds in low areas	Clogged surface	Water infiltrates evenly across surface; recommend vacuum sweep at least twice per year and power wash annually or as needed; do not use surfactants
	Annually Required	Structural components	Cracked or moving edge constraints; cracked or settled pavement	Cracked or moving edge constraints, or cracked or settled pavement that affects overall performance	Repair all cracks, settlement or other defects that affect performance per manufacturers' specifications
	Annually during the Fall Required	Vegetation	Leaf litter deposition on surface	Leaf litter that could affect stormwater infiltration through pavement	Sweep leaf litter and sediment to prevent surface clogging and ponding
	Annually during the growing season Required	Vegetation	Weeds	Weeds that cover 10% of the surface area	Remove weeds by hand, or use an herbicide approved for use around sensitive areas; Refer to Clean Water Services integrated pest management guidance documents.
	Annually Required	Filter medium between pavers	Aggregate loss in pavers from settling and power washing	Settling of pavers or lack of aggregate around pavers	Reset pavers and replace pore space with aggregate from original design

Green Roof Checklist

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Summer Annually Required	Green Roof structural components	Standing water, super saturated soil	Clogged drain or compacted soil	Clear drains; remove organics and other debris from drain; loosen compacted soil and amend
	Summer Annually Required	Structural components	Leaks in roof	Tears or perforation of membrane	Contact manufacturer for repair or replacement
	Fall and Spring Annually Required	Vegetation	Dead or stressed vegetation	Vegetation should cover 90% of facility	Replant per original planting plan; irrigate as needed
	Fall and Summer Annually Required	Vegetation	Dry grass or plants	Viable plant life	Prune grass and plantings; remove clippings
	All seasons weed as necessary Annually Required	Vegetation	Weeds	Weeds on more than 20% of the site	Remove weeds by hand; do not use pesticides
	Annually Required	Growing medium	Exposed soil	Vegetation should cover 90% of facility	Cover with plants and mulch as needed
	Annually Required	Growing medium	Erosion	Rill or gully formation	Fill eroded areas with approved soil and lightly compact and replant
	Monthly during growing season Annually Required	General	Vegetation	Specified or approved grass grows so tall that it competes with shrubs or becomes a fire danger.	String trim grass to 4" to 6" and remove clippings; (Note: except emergent wetland grasses in the treatment area of low maintenance facilities)
	If replanting in the Summer, irrigation will be necessary.				

Infiltration Planter—Rain Garden Checklist

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Monthly Annually Required	General	Invasive Vegetation as outlined in Ch.4 D&C Standards	No invasive vegetation is planted or permitted to remain, including but not limited to: Himalayan Blackberry; Reed Canary Grass; Teasel; English Ivy; Nightshade; Clematis; Cattail; Thistle; Scotch Broom	No invasive vegetation; Remove excessive weeds. Attempt to control even if complete eradication is not feasible. Refer to Clean Water Services integrated pest management guidance documents.
	Monthly from November through April Annually Required	General	Vegetation	Vegetation blocking more than 10% of the inlet pipe opening	No vegetation blocking inlet pipe opening
	Monthly and after any major storm (1-inch in 24 hours) Annually Required	General	Trash and Debris	Visual evidence of trash, debris or dumping	Trash and debris removed from facility
	Monthly from November through April and after any major storm (use 1-inch in 24 hours as a guideline) Annually Required	General	Contaminants and Pollution	Evidence of oil, gasoline, contaminants or other pollutants	No contaminants or pollutants present; coordinate removal/ cleanup with local jurisdiction
	Monthly from November through April and after any major storm (1-inch in 24 hours) Annually Required	General	Erosion	Eroded damage more than 2 inches deep if cause of damage is still present or there is potential for continued erosion	Area stabilized using appropriate erosion control measures
	Monthly and after any major storm (1-inch in 24 hours) Annually Required	General	Obstructed Inlet/ Outlet	Inlet/outlet areas clogged with sediment, vegetation or debris	Unobstructed inlet/outlet; material and blockages removed

Infiltration Planter—Rain Garden Checklist (continued)

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Monthly Annually Required	General	Rodents	Evidence of rodents or water piping through facility via rodent holes	No rodents; facility repaired. Refer to Clean Water Services integrated pest management guidance documents.
	Annually Required	General	Insects	Insects such as wasps and hornets interfere with maintenance activities	Harmful insects removed
	Monthly from November through April Annually Required	Storage Area	Sediment or standing water	Water ponding after rainfall ceases and infiltration time has passed, or testing indicates facility is working at 90% or less of design capability; sediment depth exceeds 2 inches	No standing water 24 hours after major storm (1-inch in 24 hours); sediment is removed and facility works according to design
	Monthly from November through April and after any major storm (1-inch in 24 hours) Annually Required	Rock Filters	Sediment and Debris	By visual inspection, little or no water flows through filter during heavy rain storms	Gravel in rock filter is replaced
	Monthly during growing season Annually Required	General	Vegetation	Specified or approved grass grows so tall that it competes with shrubs or becomes a fire danger.	String trim grass to 4" to 6" and remove clippings; take care not to girdle the bark of trees and shrubs. (Note: except emergent wetland grasses in the treatment area of low maintenance facilities)

Flow-Through Planter Checklist

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Monthly from November through April Annually Required	General	Sediment Accumulation in Treatment Area	Sediment depth exceeds 3 inches	Sediment removed from vegetated treatment area; planter is level from side to side and drains freely toward outlet; no standing water within 24 hours after any major storm (1-inch in 24 hours)
	Monthly from November through April Annually Required	General	Erosion Scouring	Eroded or scoured planter bottom due to flow channelization, or higher flows	Repair ruts or bare areas by filling with topsoil during dry season; regrade and replant large bare areas
	Monthly from November through April and after any major storm (1-inch in 24 hours) Annually Required	General	Standing Water	Standing water in the planter between storms that does not drain freely	Remove sediment or trash blockages; improve end to end grade so there is no standing water 24 hours after any major storm (1-inch in 24 hours)
	Monthly from November through April Annually Required	General	Flow Not Distributed Evenly	Flows unevenly distributed through planter width due to uneven or clogged flow spreader	Level the spreader and clean so that flows spread evenly over entire planter width
	Annually Required	General	Settlement / Misalignment	Failure of planter has created a safety, function, or design problem	Planter replaced or repaired to design standards
	Monthly from November through April Annually Required	General	Constant Baseflow	Small, continual flow of water through the planter even after weeks without rain; planter bottom has an eroded, muddy channel	Add a low-flow pea gravel drain the length of the planter or bypass the baseflow around the planter
	Monthly from November through April Annually Required	General	Vegetation	Vegetation blocking more than 10% of the inlet pipe opening	No vegetation blocking inlet pipe opening

Flow-Through Planter Checklist (continued)

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Monthly Annually Required	General	Poor Vegetation Coverage	Grass or other vegetation is sparse, or bare in more than 10% of the planter bottom	Determine cause of poor growth and correct the condition; replant with plugs or containerized plants as needed to meet current density standards during next appropriate planting season.
	Monthly Annually Required	General	Invasive Vegetation as outlined in Ch.4 D&C Standards	No invasive vegetation is planted or permitted to remain, including but not limited to the following: Himalayan Blackberry; Reed Canary Grass; Teasel English Ivy; Nightshade; Clematis; Cattail Thistle; Scotch Broom	No invasive vegetation; remove excessive weeds. Attempt to control even if complete eradication is not feasible. Refer to Clean Water Services integrated pest management guidance documents.
	Monthly Annually Required	General	Rodents	Evidence of rodents or water piping through facility via rodent holes	No rodents; facility repaired. Refer to Clean Water Services integrated pest management guidance documents.
	Annually Required	General	Insects	Insects such as wasps and hornets interfere with maintenance activities	Harmful insects removed
	Monthly and after any major storm (1-inch in 24 hours) Annually Required	General	Trash and Debris	Visual evidence of trash, debris or dumping	Trash and debris removed from facility
	Monthly from November through April Annually Required	General	Contamination and Pollution	Any evidence of oil, gasoline, contaminants, or other pollutants	No contaminants or pollutants present; coordinate removal/cleanup with local water quality response agency
	Monthly and after any major storm (1-inch in 24 hours) Annually Required	General	Obstructed Inlet/Outlet	Inlet/outlet areas clogged with sediment, vegetation or debris	Remove material to clear inlet and outlet area
	Monthly during growing season Annually Required	General	Excessive Shading	Vegetation growth is poor because sunlight does not reach planter	Trim over-hanging limbs, if possible; remove brushy vegetation as needed
	Monthly during growing season Annually Required	General	Vegetation	Specified or approved grass grows so tall that it competes with shrubs or becomes a fire danger.	String trim grass to 4" to 6" and remove clippings; take care not to girdle the bark of trees and shrubs. (Note: except emergent wetland grasses in the treatment area of low maintenance facilities)

LIDA Swale Checklist

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Monthly from November through April and after any major storm (1-inch in 24 hours) Annually Required	General	Sediment Accumulation in Treatment Area	Sediment depth exceeds 3 inches	Remove sediment deposits on grass treatment area of the bio-swale; swale is level from side to side and drains freely toward outlet; no standing water after inflow has ceased
	Monthly from November through April and after any major storm 1-inch in 24 hours) Annually Required	General	Standing Water	Standing water in the planter between storms that does not drain freely	Remove sediment or trash blockages; improve grade from end to end of planter; no standing water 24 hours after any major storm (1 inch in 24 hours)
	Monthly from November through April Annually Required	General	Flow Not Distributed Evenly	Flows unevenly distributed through swale due to uneven or clogged flow spreader	Level the spreader and clean so that flows spread evenly over entire swale width
	Monthly from November through April Annually Required	General	Constant Baseflow	Small, continual flow of water through the swale even after weeks without rain; swale bottom has an eroded, muddy channel	Add a low-flow pea gravel drain the length of the swale or bypass the baseflow around the swale
	Monthly Annually Required	General	Poor Vegetation Coverage	Grass or other vegetation is sparse, bare or eroded in more than 10% of the swale bottom	Determine cause of poor growth and correct the condition; re-plant with plugs or containerized plants as needed to meet current density standards during next appropriate planting season
	Monthly Annually Required	General	Invasive Vegetation as outlined in Ch.4 D&C standards	No invasive vegetation is planted or permitted to remain, including but not limited to the following: Himalayan Blackberry; Reed Canary Grass; Teasel; English Ivy; Nightshade; Clematis; Cattail Thistle; Scotch Broom	No invasive vegetation; remove excessive weeds. Attempt to control even if complete eradication is not feasible. Refer to Clean Water Services integrated pest management guidance documents

LIDA Swale Checklist (continued)

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Monthly from November through April Annually Required	General	Excessive Shading	Vegetation growth is poor because sunlight does not reach swale	Trim over-hanging limbs, if possible; remove brushy vegetation as needed
	Monthly and after any major storm (1-inch in 24 hours) Annually Required	General	Obstructed Inlet/ Outlet	Inlet/outlet areas clogged with sediment, vegetation or debris	Remove material to clear inlet and outlet area
	Monthly from November through April Annually Required	General	Erosion Scouring	Eroded or scoured planter bottom due to flow channelization, or higher flows	Repair ruts or bare areas by filling with topsoil during dry season; regrade and replant large bare areas
	Monthly and after any major storm (1-inch in 24 hours) Annually Required	General	Trash and Debris	Visual evidence of trash, debris or dumping	Trash and debris removed from facility
	Monthly from November through April Annually Required	General	Vegetation	Vegetation blocking more than 10% of the inlet pipe opening	No vegetation blocking inlet pipe opening
	Monthly from November through April Annually Required	General	Contamination and Pollution	Any evidence of oil, gasoline, contaminants, or other pollutants	No contaminants or pollutants present; coordinate removal/ cleanup with local water quality response agency
	Monthly from November through April Annually Required	General	Rodents	Evidence of rodents or water piping through facility via rodent holes	No rodents; facility repaired. Refer to Clean Water Services integrated pest management guidance documents
	Annually Required	General	Insects	Insects such as wasps and hornets interfere with maintenance activities	Harmful insects removed
	Monthly Annually Required	General	Vegetation	Specified or approved grass grows so tall that it competes with shrubs or becomes a fire danger.	String trim grass to 4" to 6" and remove clippings; take care not to girdle the bark of trees and shrubs. (Note: except emergent wetland grasses in the treatment area of low maintenance facilities)

Vegetated Filter Strip Checklist

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Monthly from November through April Annually Required	General	Flow not distributed evenly	Flows unevenly distributed through filter strip due to uneven or clogged flow spreader	Level the spreader and clean so that flows spread evenly over entire filter strip width
	Monthly Annually Required	General	Invasive Vegetation as outlined in Ch.4 D&C standards	No invasive vegetation is planted or permitted to remain, including but not limited to the following: Himalayan Blackberry; Reed Canary Grass; Teasel; English Ivy; Nightshade; Clematis; Cattail; Thistle; Scotch Broom	No invasive vegetation; remove excessive weeds. Attempt to control even if complete eradication is not feasible. Refer to Clean Water Services integrated pest management guidance documents.
	Monthly from November through April Annually Required	General	Vegetation	Grass more than 10 inches tall; weeds and other vegetation taking take over	Mow grass to a height of 3 to 4 inches; control nuisance vegetation such that flow is not impeded
	Monthly from November through April Annually Required	General	Erosion	Eroded or scoured filter bottom due to flow channelization, or higher flows	Repair ruts or bare areas by filling with topsoil during dry season; regrade and replant large bare areas
	Monthly from November through April Annually Required	General	Scouring Sediment Accumulation	Sediment depth exceeds 2 inches	Remove sediment deposits; re-level so slope is even and flows pass evenly through strip
	Monthly and after any major storm (use 1-inch in 24 hours as a guideline) Annually Required	General	Trash and Debris	Visual evidence of trash, debris or dumping	Trash and debris removed from facility
	Monthly Annually Required	General	Rodents	Evidence of rodents or water piping through facility via rodent holes	No rodents; facility repaired. Refer to Clean Water Services integrated pest management guidance documents.
	Annually Required	General	Insects	Insects such as wasps and hornets interfere with maintenance activities	Harmful insects removed
	Monthly during growing season Annually Required	General	Vegetation	Specified or approved grass grows so tall that it competes with shrubs or becomes a fire danger	String trim grass to 4" to 6" and remove clippings; take care not to girdle the bark of trees and shrubs

Vegetated Swale Checklist

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Monthly and after any major storm (1-inch in 24 hours) Annually Required	General	Obstructed Inlet/ Outlet	Inlet/outlet areas clogged with sediment, vegetation or debris	Unobstructed inlet/outlet; material and blockages removed
	Monthly from November through April Annually Required	General	Flow not distributed evenly	Flows unevenly distributed through swale due to uneven or clogged flow spreader	Level the spreader and clean so that flows spread evenly over entire swale width
	Annually Required	General	Structure Damage to Frame or Top Slab	Frame not sitting flush on top slab (more than 3/4 inch between frame and top slab); frame not securely attached	Frame is firmly attached and sits flush on the riser rings or top slab
	Annually Required	General	Fractures or Cracks in Basin Walls or Bottom	Maintenance person determines the structure is unsound	Basin replaced or repaired to design standards
	Annually Required	General	Fractures or Cracks in Basin Walls or Bottom	Grout fillet is separated or cracked wider than 1/2 inch and longer than 1 foot at the joint of any inlet/outlet pipe, or evidence of soil entering through cracks	Pipe is regrouted and secure at basin wall
	Annually Required	General	Settlement / Misalignment	Failure of basin has created a safety, function, or design problem	Basin replaced or repaired to design standards
	Monthly from November through April Annually Required	General	Constant Baseflow	Small, continual flow of water through the swale even after weeks without rain; swale bottom has an eroded, muddy channel	Add a low-flow pea gravel drain the length of the swale or bypass the baseflow around the swale
	Monthly from November through April Annually Required	General	Sediment Accumulation in Treatment Area	Sediment depth exceeds 3 inches	Remove sediment deposits on grass treatment area of the bio-swale; swale is level from side to side and drains freely toward outlet; no standing water once inflow has ceased

Vegetated Swale Checklist (continued)

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Monthly from November through April Annually Required	General	Erosion Scouring	Eroded or scoured planter bottom due to flow chan-nelization, or higher flows	Repair ruts or bare areas by filling with topsoil during dry sea-son; regrade and replant large bare areas
	Monthly Annually Required	General	Poor Vegetation Coverage	Grass or other vegetation is sparse or bare in more than 10% of the swale bottom	Determine cause of poor growth and correct the condition; replant with plugs or containerized plants as needed to meet current density standards during next appropriate planting season.
	Monthly Annually Required	General	Invasive Vegetation as outlined in Ch.4 D&C standards	Nuisance weeds or other invasive vegetation is taking over	No invasive vegetation; remove excessive weeds. Attempt to control even if complete eradication is not feasible. Refer to Clean Water Services integrated pest management guidance documents.
	Monthly Annually Required	General	Vegetation	Vegetation blocking more than 10% of the basin opening	No vegetation blocking opening to basin
	Monthly from November through April Annually Required	General	Vegetation	Vegetation growing in inlet/outlet pipe joints that is more than 6 inches tall and less than 6 inches apart	No vegetation or root growth present
	Monthly from November through April Annually Required	General	Vegetation	Vegetation blocking more than 10% of the inlet pipe opening	No vegetation blocking inlet pipe opening
	Monthly from November through April Annually Required	General	Excessive Shading	Vegetation growth is poor because sunlight does not reach swale	Trim over-hanging limbs, if possible; remove brushy vegetation as needed

Vegetated Swale Checklist (continued)

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Monthly and after any major storm (1-inch in 24 hours) Annually Required	General	Trash and Debris	Visual evidence of trash, debris or dumping	Trash and debris removed from facility
	Monthly from November through April Annually Required	General	Standing Water	Standing water in the swale between storms that does not drain freely	Remove sediment or trash blockages; improve grade from end to end of swale; no standing water 24 hours after any major storm (1-inch in 24 hours)
	Monthly from November through April Annually Required	General	Rodents	Evidence of rodents or water piping through facility via rodent holes	No rodents; facility repaired. Refer to Clean Water Services integrated pest management guidance documents.
	Annually Required	General	Insects	Insects such as wasps and hornets interfere with maintenance activities	Harmful insects removed
	Monthly from November through April Annually Required	General	Contamination and Pollution	Any evidence of oil, gasoline, contaminants, or other pollutants	No contaminants or pollutants present; coordinate removal/ cleanup with local water quality response agency
	Monthly from November through April and after any major storm (1-inch in 24 hours) Annually Required	Grates	Trash and Debris	Visual evidence of trash, debris or dumping	Trash and debris removed from grate
	Annually Required	Grates	Damaged or Missing	Grate missing or broken grate members	Grate is in place and meets design standards
	Annually Required	Outlet Structure	Grate Not in Place	Grate is missing or only partially in place	Any open structure needs maintenance; replace grate if missing
	Monthly during growing season Annually Required	General	Vegetation	Specified or approved grass grows so tall that it competes with shrubs or becomes a fire danger. (Note: except emergent wetland grasses in the treatment area of low maintenance facilities)	String trim grass to 4" to 6" and remove clippings; take care not to girdle the bark of trees and shrubs

Extended Dry Basin Checklist

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Monthly and after any major storm (1-inch in 24 hours) Annually Required	General	Trash and Debris	Visual evidence of trash, debris or dumping	Trash and debris removed from facility
	Monthly Annually Required	General	Invasive Vegetation as outlined in Ch.4 D&C Standards	No invasive vegetation is planted or permitted to remain, including but not limited to: Himalayan Blackberry; Reed Canary Grass; Teasel; English Ivy; Nightshade; Clematis; Cattail; Thistle; Scotch Broom	No invasive vegetation; remove excessive weeds. Attempt to control even if complete eradication is not feasible; Refer to Clean Water Services integrated pest management guidance documents.
	Monthly from November through April Annually Required	General	Vegetation	Vegetation blocking more than 10% of inlet pipe opening	No vegetation blocking inlet pipe opening
	Monthly from November through April and after any major storm (1-inch in 24 hours) Annually Required	General	Contaminants and Pollution	Evidence of oil, gasoline, contaminants or pollutants	No contaminants or pollutants present; coordinate removal/ cleanup with local jurisdiction
	Monthly Annually Required	General	Rodents	Evidence of rodents or water piping through facility via rodent holes	No rodents; facility repaired. Refer to Clean Water Services integrated pest management guidance documents.
	Annually Required	General	Insects	Insects such as wasps and hornets interfere with maintenance activities	Harmful insects removed
	Annually Required		Tree Growth and Hazard Trees	Tree growth interferes with access for maintenance (slope mowing, silt removal, vactoring, or equipment movements). Do not remove trees that are not interfering with access or maintenance.	Trees do not hinder maintenance activities; recycle harvested trees into mulch or beneficial uses (e.g., alders for firewood)
	Annually Required	General	Hazard Trees	Dead, dying or diseased trees	Hazard trees removed; certified Arborist to determine health of tree or removal requirements

Extended Dry Basin Checklist (continued)

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Monthly and after any major storm (1-inch in 24 hours) Annually Required	General	Obstructed Inlet/ Outlet	Inlet/outlet areas clogged with sediment, vegetation or debris	Unobstructed inlet/outlet; material and blockages removed
	Annually Required	Pond Berms (Dikes)	Erosion	Discernable water flow through pond berm or ongoing and potential erosion; recommend inspection by licensed civil engineer to evaluate condition and recommend repair	Piping eliminated; erosion potential resolved
	Annually Required	Pond Berms (Dikes)	Settlements	Any part of berm has settled 4 inches lower than the design elevation; measure settlement to determine amount. Settling may indicate more severe problems with the berm or outlet works. A licensed civil engineer should be consulted to determine the source of the settlement.	Dike is reconstructed to the design elevation
	Monthly from November through April and after any major storm (1-inch in 24 hours) Annually Required	Compacted Berm Embankment	Erosion	Erosion observed on a compacted berm embankment; a licensed civil engineer should be consulted to resolve the source of erosion.	Erosion resolved
	Annually Required	Emergency Overflow/ Spillway	Blockage of Overflow/ Spillway	Tree growth on emergency spillways creates blockages and may cause the berm to fail due to uncontrolled overtopping. A licensed civil engineer should be consulted for proper berm/spillway restoration.	Trees removed Small root system (base less than 4 inches) may be left in place; otherwise, roots are removed and the berm is restored
	Annually Required	Emergency Overflow/ Spillway	Exposed Soil or Erosion	Native soil is exposed at the spillway, or there is only one layer of rock in areas 5 sf or larger; rip-rap on inside slopes need not be replaced	Rocks and pad depth are restored to design standards
	After any major storm (use 1-inch in 24 hours as a guideline) Annually Required	Overflow Structure and Orifice Plate	Excessive Standing Water or Water Is Not Detained For Required Time	If water is not detained check to see if the orifice plate is installed; if water does not drain in required time, check to see if overflow structure is plugged	Orifice plate is cleared for proper drainage or re-installed to ensure required detention; overflow structure is unobstructed

Extended Dry Basin Checklist (continued)

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Monthly from November through April Annually Required	Pond Bottom	Sediment Accumulation in Pond Bottom	Sediment accumulation in pond bottom exceeds 6 inches or affects facility inlet/ outlet or plant growth in treatment area	Sediment removed to designed pond shape and depth; reseeded as necessary to control erosion; replanted to achieve treatment; stormwater is evenly distributed within treatment area
	Monthly from November through April Annually Required	Liner (If Applicable)	Exposed or Damaged	Liner is visible; more than three 1/4-inch holes in liner	Liner repaired or replaced and fully covered
	Monthly from November through April and after any major storm (1-inch in 24 hours) Annually Required	Side Slopes of Pond	Erosion	Eroded damage more than 2 inches deep if cause of damage is still present or there is potential for continued erosion	Slopes stabilized using appropriate erosion control measures (rock reinforcement, planting of grass, compaction)
	Monthly during growing season Annually Required	General	Vegetation	Specified or approved grass grows so tall that it competes with shrubs or becomes a fire danger.	String trim grass to 4" to 6" and remove clippings; take care not to girdle the bark of trees and shrubs. (Note: except emergent wetland grasses in the treatment area of low maintenance facilities)

Constructed Water Quality Wetland Checklist

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Monthly and after any major storm (1-inch in 24 hours) Annually Required	General	Trash and Debris	Visual evidence of trash, debris or dumping	Trash and debris removed from facility
	Monthly and after any major storm (1-inch in 24 hours) Annually Required	General	Obstructed Inlet	Inlet/outlet areas clogged with sediment, vegetation or debris	Unobstructed inlet/outlet; material and blockages removed
	Annually Required	General	Erosion	Erosion of pond side slopes; scouring of the pond bottom more than 6 inches, or continued erosion is prevalent	Slopes and pond bottom repaired and stabilized using proper erosion control measures
	Monthly Annually Required	General	Invasive Vegetation as outlined in Ch.4 D&C standards	No invasive vegetation is planted or permitted to remain, including but not limited to: Himalayan Blackberry; Reed Canary Grass; Teasel; English Ivy; Nightshade; Clematis; Cattail; Thistle; Scotch Broom	No invasive vegetation; remove excessive weeds. Attempt to control even if complete eradication is not feasible. Refer to Clean Water Services integrated pest management guidance documents.
	Monthly from November through April Annually Required	General	Vegetation	Vegetation blocking more than 10% of the inlet pipe opening	No vegetation blocking inlet pipe opening
	Monthly Annually Required	General	Rodents	Evidence of rodents or water piping through facility via rodent holes	No rodents; facility repaired. Refer to Clean Water Services integrated pest management guidance documents.
	Annually Required	General	Insects	Insects such as wasps and hornets interfere with maintenance activities	Harmful insects removed
	Monthly from November through April Annually Required	Inlet/Outlet Pipe	Inlet/Outlet Pipe Blocked	Inlet/outlet pipe clogged with sediment or debris	Inlet and outlet piping cleared

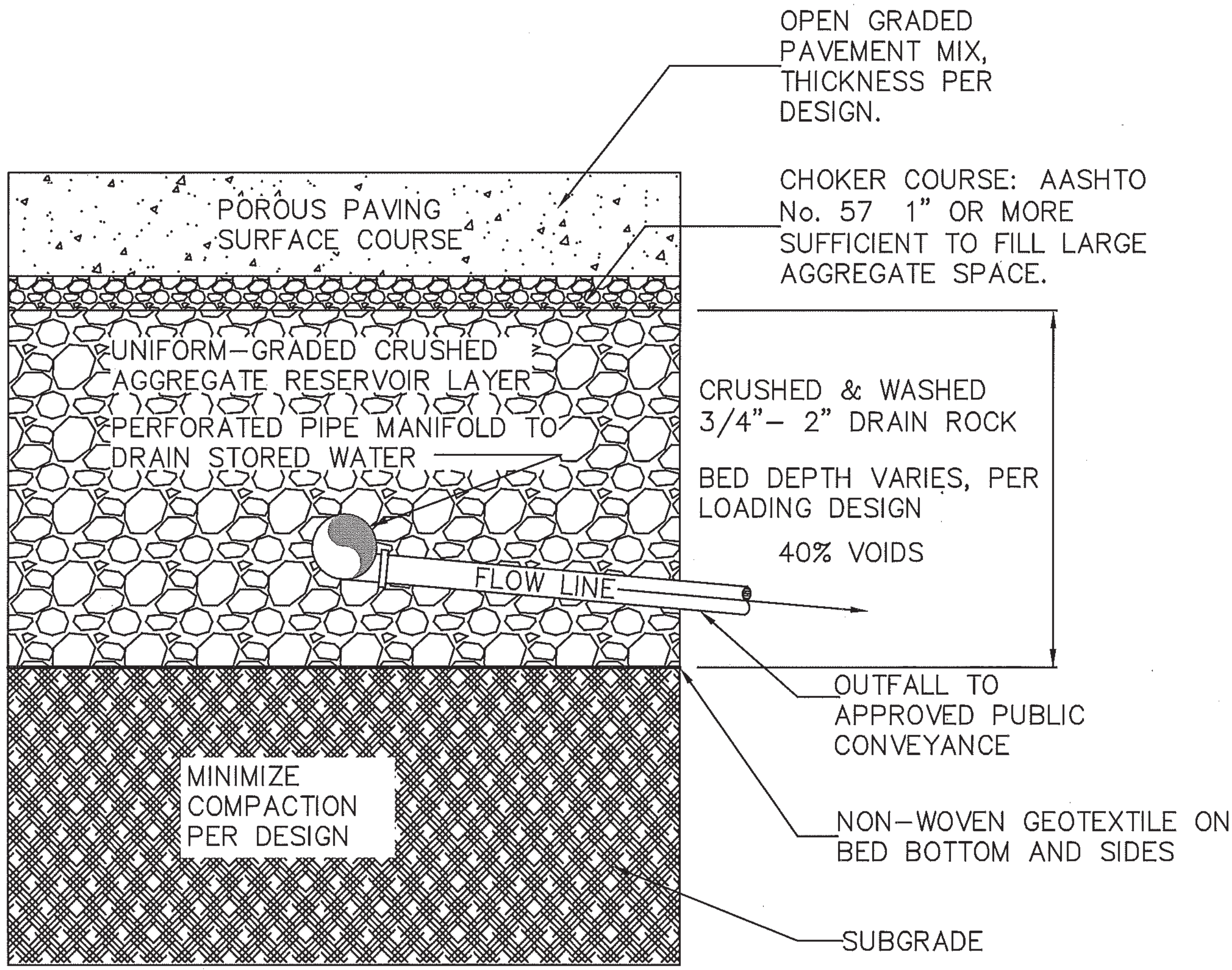
Constructed Water Quality Wetland Checklist (continued)

Annual inspections are required. This checklist describes inspection activities, and notes additional recommended inspections. Contact the design engineer, Clean Water Services or City representative for more information.

CHECK ✓	Recommended, in addition to required annual inspection	System Feature	Problem	Conditions to Check for	Preferred Conditions and Maintenance Practices
	Annually Required	Emergency Over-flow/ Spillway	Exposed Soil or Erosion	Native soil is exposed at the spillway, or only one layer of rock in areas 5 sf or larger; rip-rap on inside slopes need not be replaced	Rocks and pad depth are restored to design standards
	Monthly from November through April Annually Required	Pond	Oil Sheen on Water	Prevalent and visible oil sheen	Oil removed using oil-absorbent pads or vactor truck; source of oil located and corrected. If low levels of oil persist, plant wetland plants that can uptake small concentrations of oil such as Juncus effusus (soft rush)
	Monthly from November through April Annually Required	Pond Bottom Dike/Berm Internal Berm	Sediment Accumu-lation in Pond Bottom	Sediment depth in wetland bottom exceeds 6 inches or affects inlet/outlet functions or plant growth in treatment area	Sediment removed to designed wetland shape and depth; reseed if necessary to control erosion, or replant to achieve treatment
	Annually Required	Dike/Berm	Settlement of Pond Dike/Berm	Any part has settled 4 inches or lower than the design elevation; inspector determines dike/berm is unsound	Dike/berm is repaired to specifications
	Annually Required	Internal Berm	Erosion	Berm dividing cells should be level so water flows evenly over entire length of berm	Berm surface is leveled
	Monthly during growing season Annually Required	General	Vegetation	Specified or approved grass grows so tall that it com-petes with shrubs or becomes a fire danger	String trim grass to 4" to 6" and remove clippings; take care not to girdle the bark of trees and shrubs. (Note: except emergent wetland grasses in the treatment area of low maintenance facilities)

Appendices: Detail Drawings

(Additional detail drawings are available in Clean Water Services Design and Construction Standards
cleanwaterservices.org/PermitCenter/DesignAndConstruction/default.aspx**)**



NOTES:

1. PRIVATE WATER QUANTITY CONTROL SYSTEM, NOT FOR PUBLIC RIGHT OF WAY
2. PAVEMENT SURFACE WITH SIGNIFICANT PERMEABILITY (> 8" PER HR)
3. UNIFORM–GRADED DRAIN ROCK BED WITH MINIMUM 40% VOID SPACE
4. PROVIDE PERFORATED PIPE MANIFOLD IN RESERVOIR LAYER FOR CONVEYANCE, IF NATIVE SOIL INFILTRATION RATES LESS THAN 2"/HOUR. SEE PERFORATED PIPE DETAIL.
5. NOT RECOMMENDED FOR TRAFFIC SURFACES WITH SLOPE > 5%.
6. DO NOT PLACE DRAIN ROCK BED ON COMPACTED FILL.
7. SUBGRADE SLOPED TO MANIFOLD FOR DRAINAGE.
8. HIGHEST SEASONAL WATER TABLE MUST BE AT LEAST 10' BELOW RESERVOIR LAYER. STRUCTURE MUST BE 100' AWAY FROM DRINKING WATER WELL. MINIMUM OF 100' AWAY UP SLOPE & 10' AWAY DOWN SLOPE FROM STRUCTURE FOUNDATIONS.
9. SIGNAGE IDENTIFYING POROUS PAVEMENT REQUIRED.
10. WATER QUALITY TREATMENT REQUIRED FOR FLOWS FROM OTHER IMPERVIOUS AREAS THAT DRAIN TO POROUS PAVEMENT.
11. NON–WOVEN GEOTEXTILE CONFORMING TO ODOT TYPE II VARIATION OR APPROVED EQUAL.

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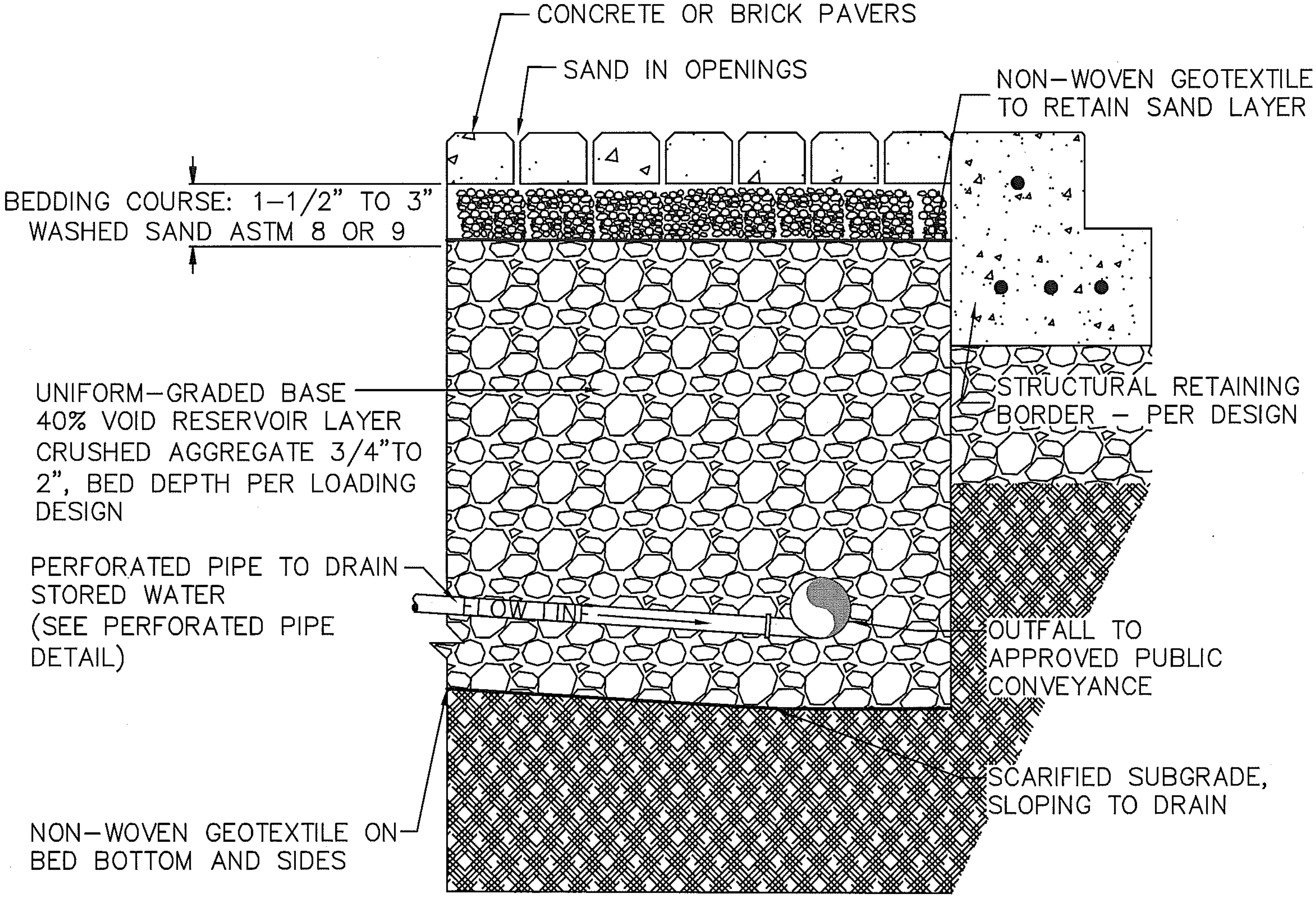

NOTES:

1. PRIVATE WATER QUANTITY CONTROL SYSTEM, NOT FOR PUBLIC RIGHT OF WAY.
2. PROVIDE DRAINAGE MANIFOLD IF MINIMUM INFILTRATION OF 2"/HOUR IS NOT AVAILABLE.
3. HIGHEST SEASONAL WATER TABLE MUST BE AT LEAST 10' BELOW RESERVOIR LAYER. STRUCTURE MUST BE 100' AWAY FROM DRINKING WATER WELL. MINIMUM OF 100' AWAY UP SLOPE & 10' AWAY DOWN SLOPE FROM STRUCTURE FOUNDATIONS.
4. PAVERS TO BE HELD IN PLACE BY STRUCTURAL RETAINING BORDER AT THE OUTER EDGES OF THE AREA TO BE PAVED.
5. 2 3/8" THICK PAVERS MAY BE USED IN PEDESTRIAN APPLICATIONS.
6. WATER QUALITY TREATMENT REQUIRED FOR FLOWS FROM OTHER IMPERVIOUS AREAS THAT DRAIN TO POROUS PAVERS.
7. SUBGRADE TO BE SLOPED TO MANIFOLD FOR DRAINAGE.
8. NON-WOVEN GEOTEXTILE CONFORMING TO ODOT TYPE II VARIATION OR APPROVED EQUAL.

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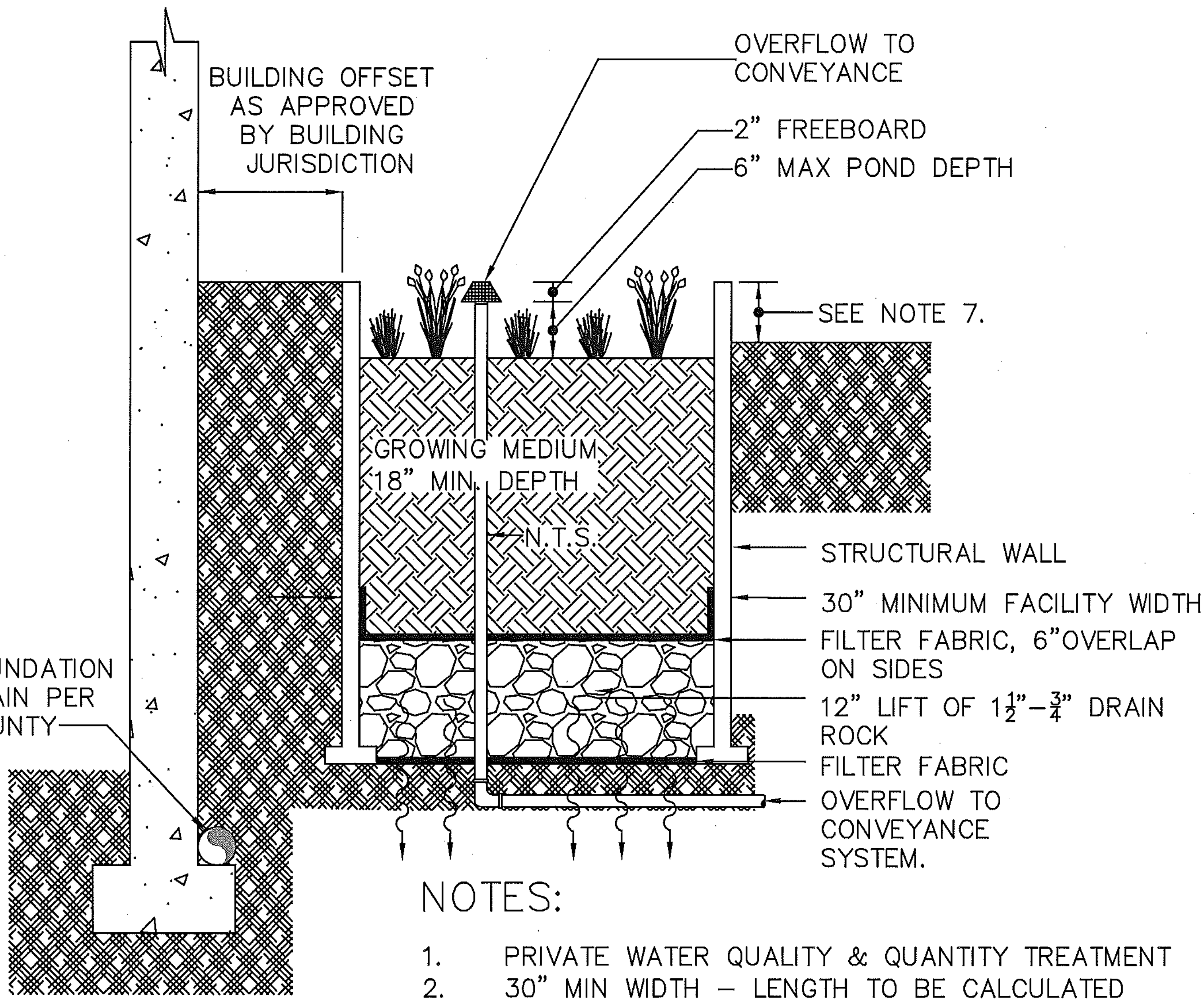

LOT# ______

BOX SIZE (SF.) _____

OF PLANTS ------

TYPE OF PLANTS ---

____

SIZE OF PLANTS ---

(MIN. 1" X 6" PLUGS)

NOTES:

1. PRIVATE WATER QUALITY & QUANTITY TREATMENT
2. 30" MIN WIDTH – LENGTH TO BE CALCULATED BASED ON FLOWS
3. VEGETATION: SMALL SHRUBS, TREATMENT PLANTINGS; RUSH GRASSES, SEE _____ IN LIDA HAND BOOK.
4. TREES OR DEEP ROOTED VEGETATION OVER PIPING ARE NOT RECOMMENDED.
5. SIZING BY NATIVE SOIL INFILTRATION RATE REQUIRES CALCULATIONS BASED ON PERCOLATION TEST RESULTS.
6. STORM FLOW INLETS THROUGH WALL CUT OUTS, AND/OR DOWN SPOUTS. BOTH TO MAINTAIN MAXIMUM LINEAR DISTANCE FROM THE OVERFLOW PIPE.
7. PLANTER HEIGHT ABOVE GROUND AND DEPTH BELOW GROUND PER OTHERS. 2" MINIMUM ABOVE OVERFLOW OR BY DESIGN.
8. OVERFLOW PIPE TO BE MINIMUM OF THE APPLICABLE PLUMBING CODE, OR CONVEY THE 25 YEAR STORM.
9. GEOTECHNICAL ENGINEERING REVIEW OF FACILITY PROXIMITY TO BUILDING & DEPTH BELOW BUILDING FOOTING REQUIRED.

LIDA HANDBOOK
STANDARD DETAILS

STRUCTURAL INFILTRATION PLANTER W/ BLDG. OFFSET

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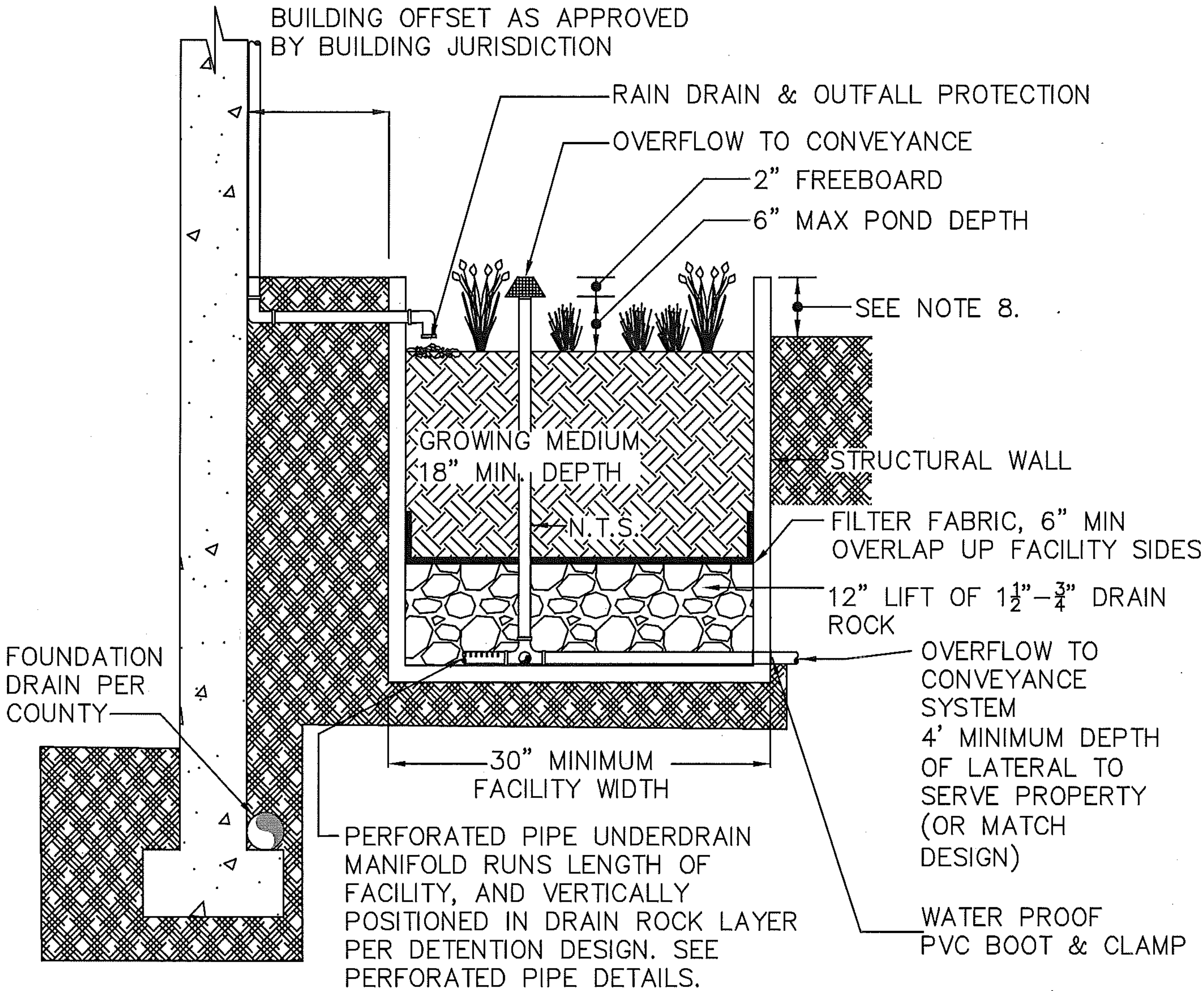
DRAWING NUMBER 793



NOTES:

1. PRIVATE WATER QUALITY TREATMENT
2. 30" MIN WIDTH – FACILITY LENGTH TO BE CALCULATED BASED ON INCOMING FLOWS.
3. VEGETATION: SMALL SHRUBS, TREATMENT PLANTINGS; RUSH GRASSES, SEE _____ IN LIDA HANDBOOK.
4. NO TREES OR DEEP ROOTED VEGETATION OVER PIPING.
5. RAIN DRAINS AND OVERFLOW TO MAINTAIN MAXIMUM LINEAR SEPARATION.
6. NO BARK DUST TO BE USED WITHIN FACILITY.
7. OUTFALL PROTECTION SIZED PER FLOW CALCULATIONS.
8. PLANTER HEIGHT ABOVE GROUND AND DEPTH BELOW GROUND PER OTHERS. 2" MINIMUM ABOVE OVERFLOW OR BY DESIGN.
9. BUILDING JURISDICTION APPROVAL REQUIRED WHEN DEPTH OF FACILITY IS BELOW BUILDING FOOTING.

LOT# ______

BOX SIZE (SF.) ____

OF PLANTS ----

TYPE OF PLANTS --

____

SIZE OF PLANTS ---

(MIN. 1" X 6" PLUGS)

LIDA HANDBOOK
STANDARD DETAILS

FLOW-THROUGH PLANTER W/ BLDG. OFFSET

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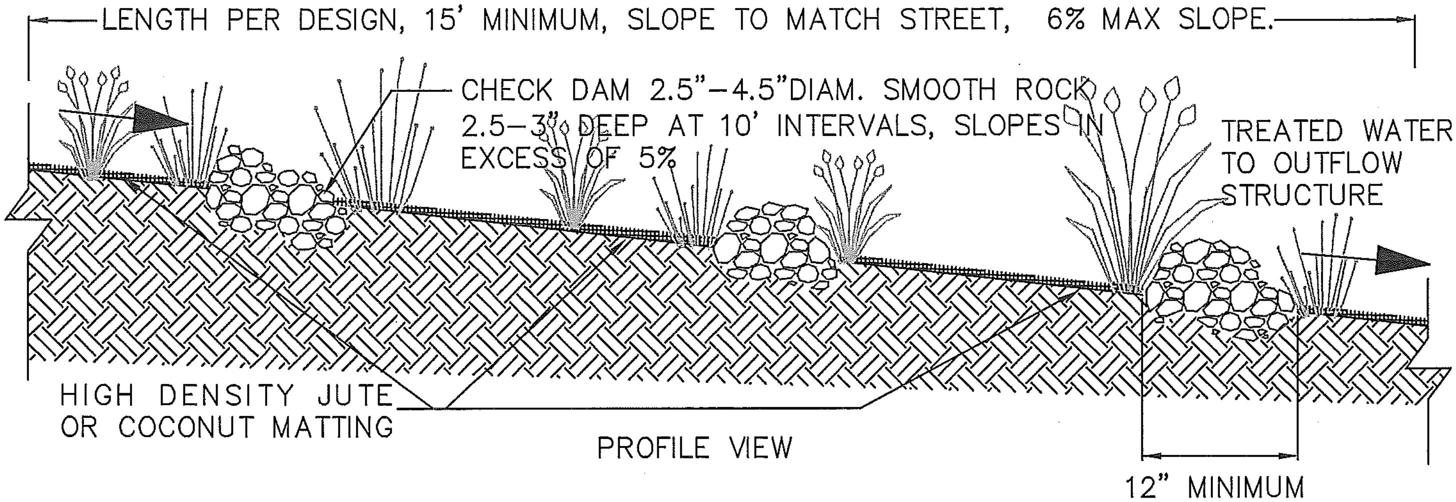
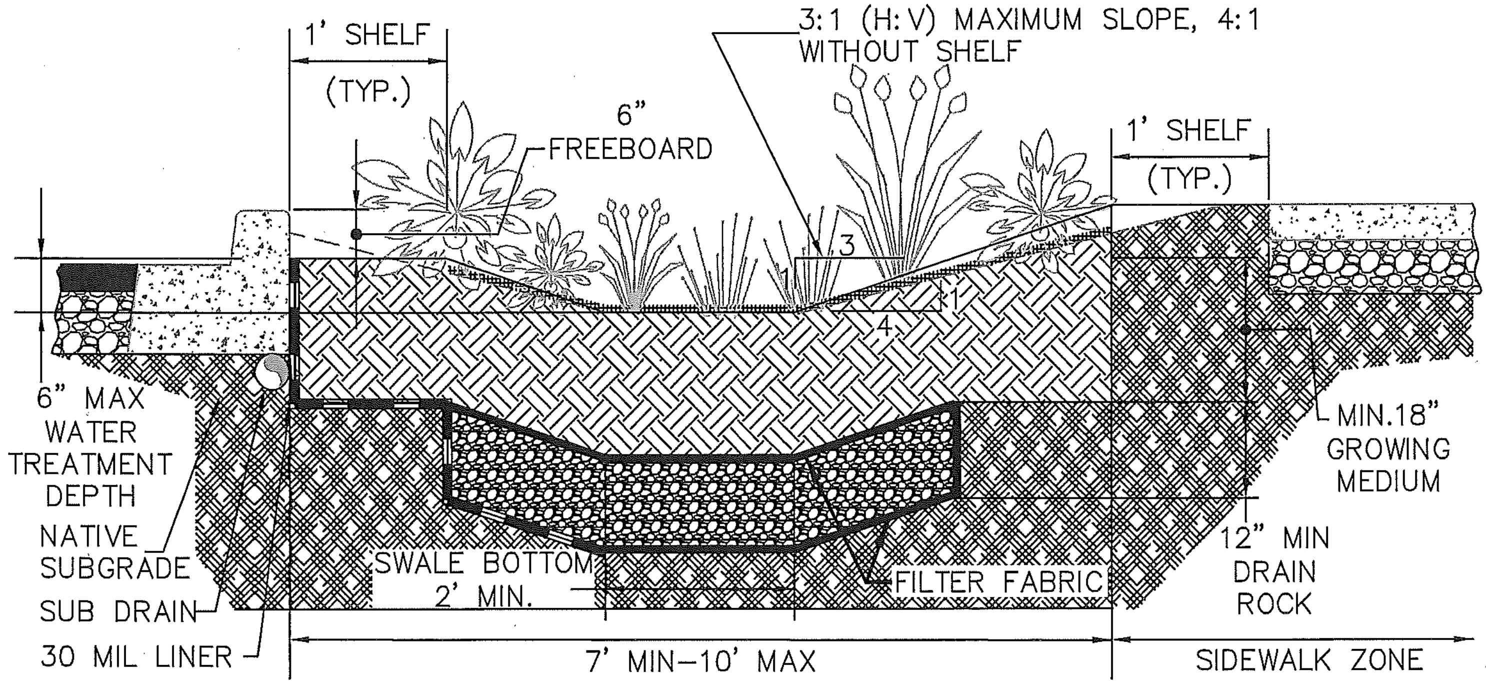


PROFILE VIEW



CROSS-SECTIONAL VIEW WITH ON STREET PARKING

NOTES:

1. PUBLIC WATER QUALITY SYSTEM. 1' SHELVES AND REINFORCED THICKENED SIDEWALK FREEBOARD EDGE MAY BE REQUIRED BY COUNTY.
2. INFLOW STRUCTURE PER LOCAL JURISDICTION.
   a. INFLOW STRUCTURE – CURB CUTOUT, SEE CURB CUT-OUT DETAIL.
   b. INFLOW STRUCTURE – CURB INLET, SEE MODIFIED CG-30 DETAIL.
4. OVERFLOW PIPING TO ALLOW NO MORE THAN 6" PONDING, WITH A MINIMUM OF 2" FREEBOARD, AND BE SIZED TO JURISDICTIONAL PLUMBING CODE, OR TO CONVEY THE 25 YEAR STORM.
5. FLOW DISSIPATERS SHALL BE PLACED AS SPECIFIED ABOVE OR PER DESIGN.
6. VEGETATION TO BE USED IN THE SWALE BOTTOM CONFORMS TO PLANTINGS APPROVED FOR THE WET MOISTURE REGIME. VEGETATION TO BE USED ALONG THE SWALE SIDE CONFORMS TO PLANTINGS APPROVED FOR THE MOIST MOISTURE REGIMES.
7. 30 MIL IMPERMEABLE LINER, OR APPROVED EQUIVALENT PER JURISDICTIONAL ROAD AUTHORITY. SUBDRAIN CONNECTS WITH STORM SEWER SYSTEM. DRAIN ROCK LAYER NOT RECOMMENDED FOR LONGITUDINAL SLOPES OF GREATER THAN 2%.

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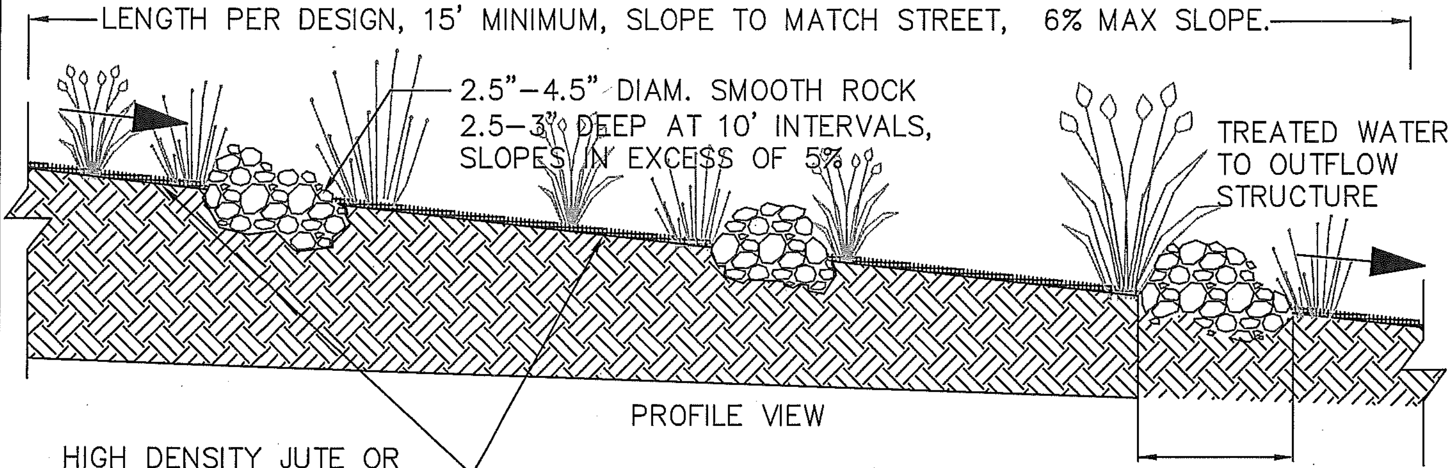
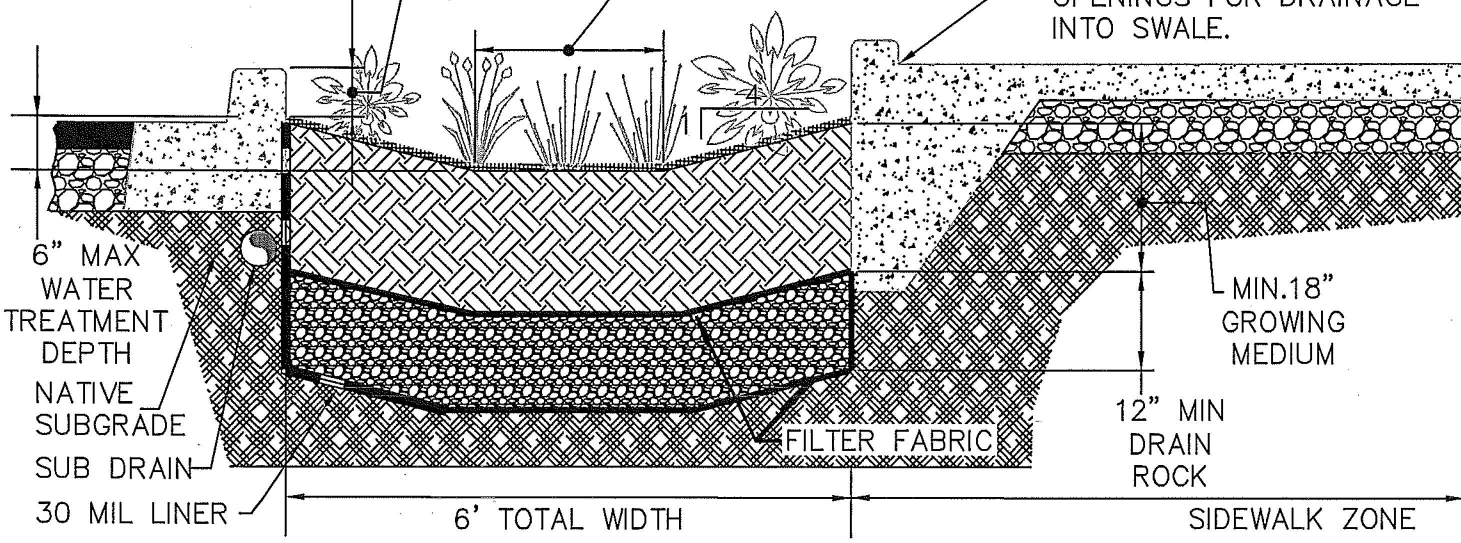


PROFILE VIEW



CROSS-SECTIONAL VIEW WITH ON STREET PARKING

NOTES:

1. PUBLIC WATER QUALITY SYSTEM. 6' TOTAL WIDTH, 2' FLAT BOTTOM WITH 4H:1V SIDE SLOPES. REINFORCED THICKENED SIDEWALK FREEBOARD EDGE REQUIRED BY COUNTY.
2. INFLOW STRUCTURE PER LOCAL JURISDICTION.
   a. INFLOW STRUCTURE – ODOT MODIFIED CURB OPENING OPTION 1, DETAIL NO. DET1750.
   b. INFLOW STRUCTURE – CURB INLET, SEE MODIFIED CG-30 DETAIL.
4. OVERFLOW PIPING TO ALLOW NO MORE THAN 6" PONDING, WITH A MINIMUM OF 2" FREEBOARD, AND BE SIZED TO JURISDICTIONAL PLUMBING CODE, OR TO CONVEY THE 25 YEAR STORM.
5. FLOW DISSIPATERS SHALL BE PLACED AS SPECIFIED ABOVE OR PER DESIGN.
6. VEGETATION TO BE USED IN THE SWALE BOTTOM CONFORMS TO PLANTINGS APPROVED FOR THE WET MOISTURE REGIME. VEGETATION TO BE USED ALONG THE SWALE SIDE CONFORMS TO PLANTINGS APPROVED FOR THE MOIST MOISTURE REGIMES.
7. 30 MIL IMPERMEABLE LINER, OR APPROVED EQUIVALENT PER JURISDICTIONAL ROAD AUTHORITY. SUBDRAIN CONNECTS WITH STORM SEWER SYSTEM. DRAIN ROCK LAYER NOT RECOMMENDED FOR LONGITUDINAL SLOPES OF GREATER THAN 2%.

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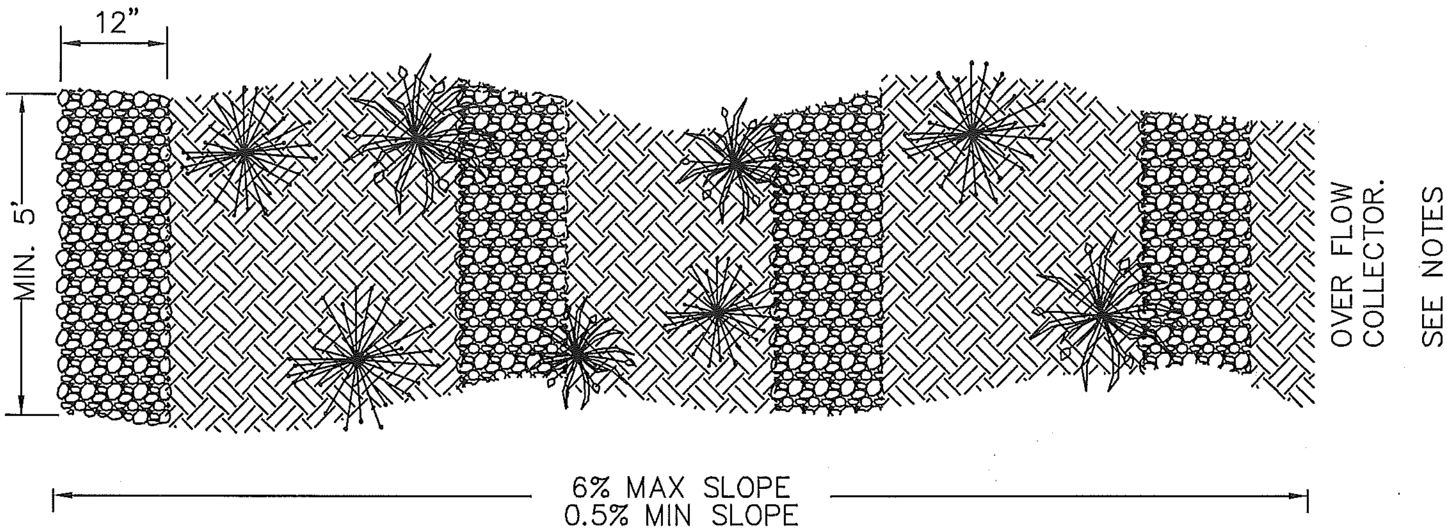
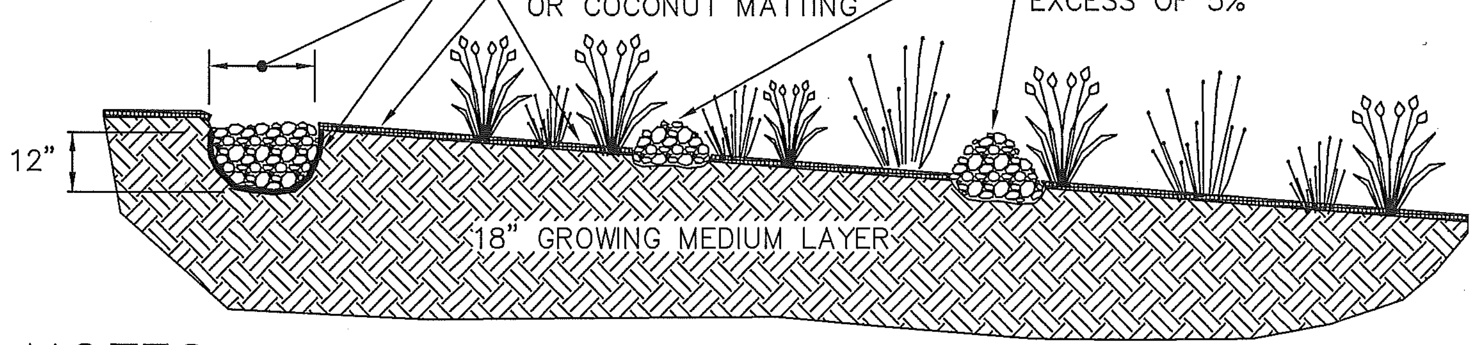
PLAN



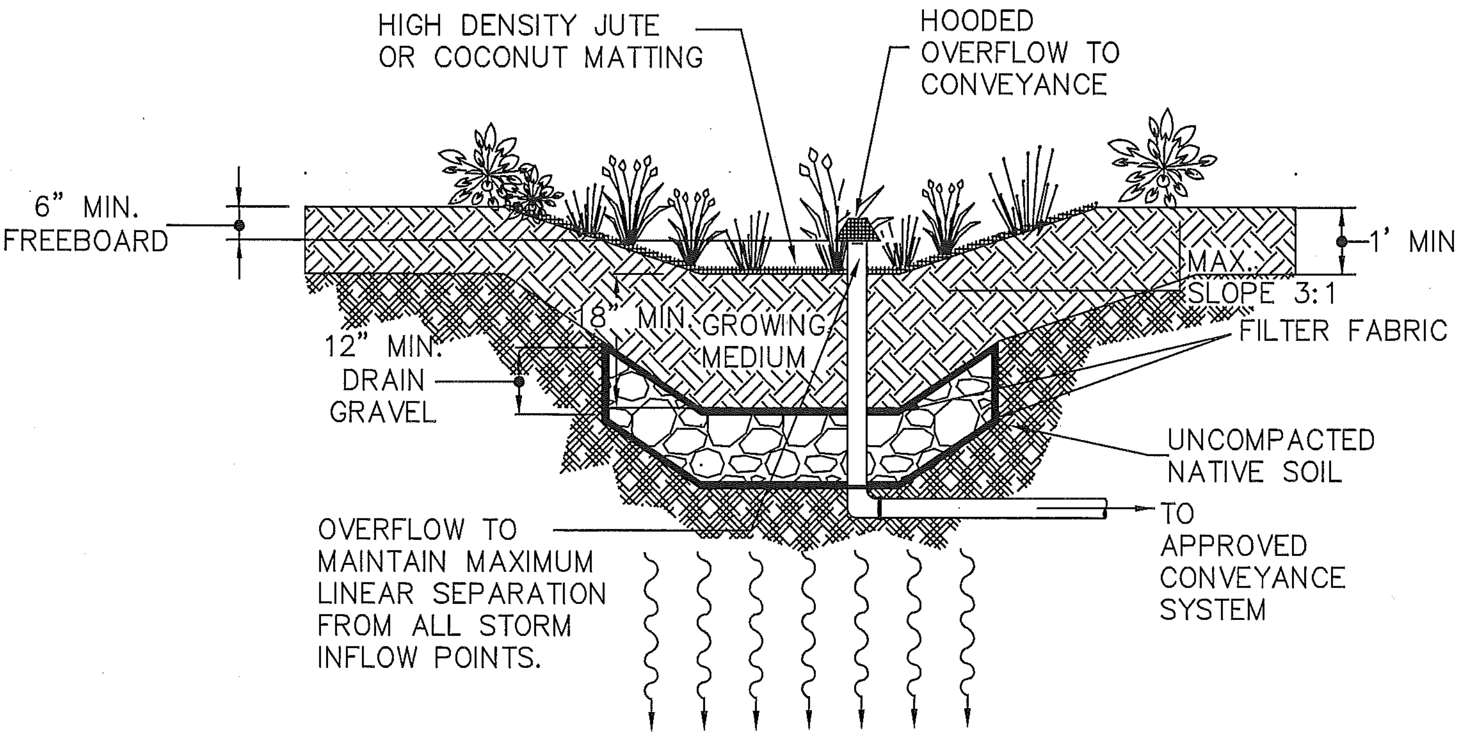
PROFILE



NOTES:

1. COLLECTION AND CONVEYANCE OF OVERFLOW FROM FILTER STRIP SHALL BE SPECIFIED ON PLANS TO APPROVED PUBLIC CONVEYANCE SYSTEM.
2. GROWING MEDIUM SHALL BE USED TO AMEND THE TOP 18" OF THE FILTER STRIP.
3. FACILITY SHALL BE A MINIMUM OF 5' WIDE.
4. ENTIRE FILTER STRIP MUST HAVE 100% COVERAGE BY APPROVED, NATIVE GRASSES, WILDFLOWER BLENDS, GROUND COVERS, OR ANY COMBINATION THEREOF.
5. A GRADE BOARD, SPREADER, OR SAND/GRAVEL TRENCH MAY BE REQUIRED TO DISPERSE THE RUNOFF EVENLY ACROSS THE FILTER STRIP TO PREVENT POINT OF DISCHARGE/CHANNELIZATION. THE TOP OF THE LEVEL SPREADER MUST BE HORIZONTAL AND AT AN APPROPRIATE HEIGHT TO PROVIDE SHEETFLOW DIRECTLY TO THE SOIL WITHOUT SCOUR. LEVEL SPREADERS SHALL NOT HOLD A PERMANENT VOLUME OF RUNOFF. SPREADERS MAY BE CONCRETE PER CWS DETAIL #750. TRENCHES USED AS LEVEL SPREADERS CAN BE FILLED WITH WASHED CRUSHED ROCK, PEA GRAVEL OR SAND.
6. CHECK DAMS SHALL BE PLACED ACCORDING TO FACILITY DESIGN OTHERWISE:
   A. EQUAL TO THE WIDTH OF THE FILTER

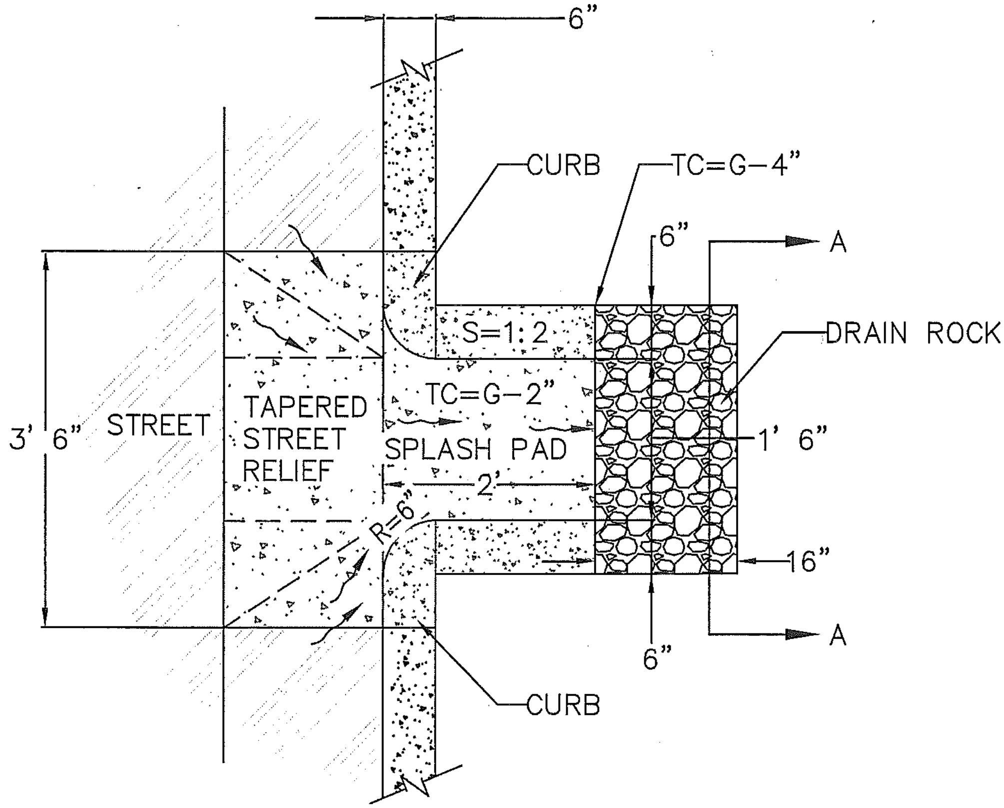
LIDA HANDBOOK	VEGETATED FILTER STRIP	Clean Water Services — Our commitment is clear. 2550 SW Hillsboro Hwy, Hillsboro, OR 97123, (503) 681-3600, www.cleanwaterservices.org	DRAWING NUMBER 796



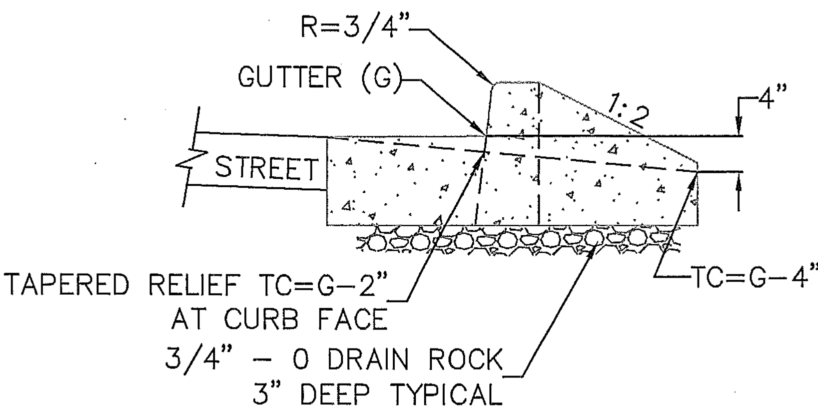
NOTES:

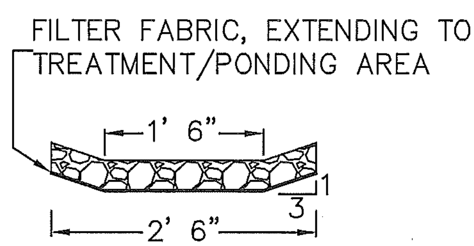
1. PUBLIC WATER QUALITY AND/OR QUANTITY SYSTEM
2. PROVIDE OVERFLOW CONVEYANCE SYSTEM, OVERFLOW CONVEYANCE HEIGHT TO ALLOW 6" MAXIMUM PONDING, PIPING TO A MINIMUM OF THE PLUMBING CODE OR CONVEY THE 25 YEAR STORM.
3. IF USING THE NATIVE SOIL INFILTRATION FOR SIZING, THE RATE SHALL BE DETERMINED BY ASTM STANDARD TESTING METHODS.
4. FLOW DISSIPATORS SHOULD BE USED IF ENTRY SLOPE TO THE BASIN IS GREATER THAN 3:1. FLOW DISSIPATORS SHALL BE CONSTRUCTED OUT OF ROCK OR GRAVEL PER DESIGN FLOW VELOCITY AT ENTRY OF THE FACILITY.
5. SEPARATION BETWEEN DRAIN GRAVEL AND GROWING MEDIUM SHALL BE APPROVED FILTER FABRIC.
6. TREATMENT AREA SHALL HAVE HIGH DENSITY JUTE OR COCONUT MATTING OVER 18" MINIMUM OF GROWING MEDIUM OR BASE STABILIZATION METHOD AS APPROVED BY THE DISTRICT.
7. VEGETATION TO BE USED IN WET AREAS OF THE BASIN IS PER APPENDIX "A" OF R&O 07-20 FOR THE WET MOISTURE CONDITIONS.
8. VEGETATION TO BE USED IN OTHER AREAS OF BASIN CONFORMS TO _____ OF THIS HANDBOOK AS APPROVED BY DISTRICT.

LIDA HANDBOOK	NON-STRUCTURAL INFILTRATION PLANTER	Clean Water Services Our commitment is clear. 2550 SW Hillsboro Hwy Hillsboro, OR 97123 (503) 681-3600 www.cleanwaterservices.org	DRAWING NUMBER 797



CURB CUT-OUT





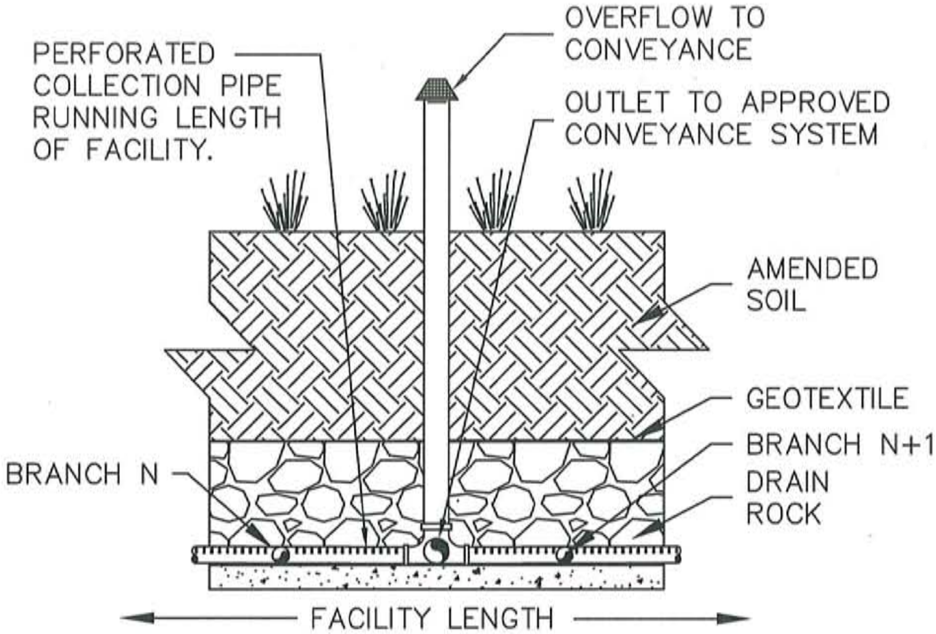
SECTION A-A

NOTES:

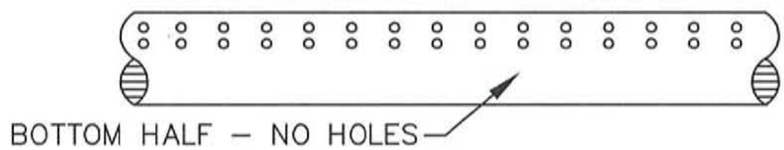
1. INFLOW STRUCTURE PER LOCAL JURISDICTION. CURB CUT OUTS NOT ALLOWED ON WASHINGTON COUNTY ROADS – USE MODIFIED CG-30 SEE DETAIL, FOR INLET STRUCTURE, OR ODOT DETAIL DET 1750 FOR APPROPRIATELY SIZED CURB CUT.
2. INFLOW STRUCTURE – CURB CUTOUT SHALL HAVE MINIMUM 2" DROP AT THE FLOW LINE LEADING TO THE SPLASH PAD, SEE DETAIL.
3. FLOW RETARDING DRAIN ROCK MINIMUM SIZE 2" – $\frac{3}{4}$ MINUS OR SIZED BY DESIGN INFLOW TO BE PLACED 2.5" TO 3" DEEP BEHIND SPLASH PAD.
4. CURB PROFILE PER LOCAL JURISDICTION.

LIDA HANDBOOK	**CURB CUT OUT NON WASHINGTON COUNTY ROADS**	Clean Water Services Our commitment is clear. 2550 SW Hillsboro Hwy Hillsboro, OR 97123 (503) 681-3600 www.cleanwaterservices.org	**DRAWING NUMBER 401**

PERFORATED PIPE MANIFOLD PROFILE

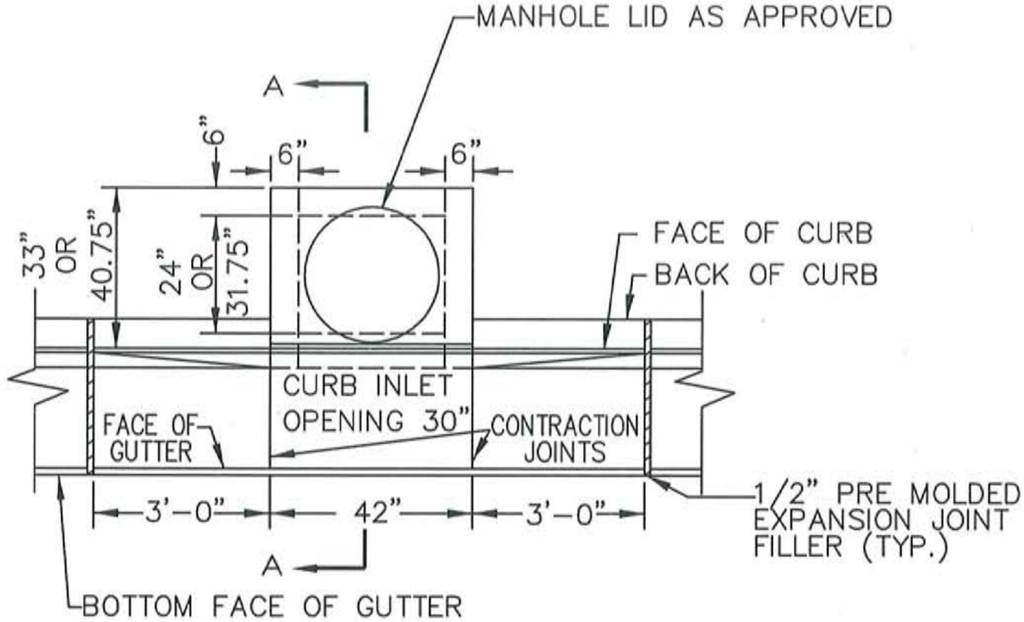


PERFORATED PIPE DETAIL

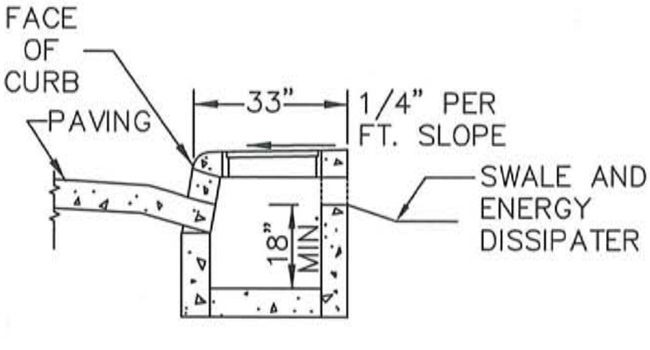


NOTES:

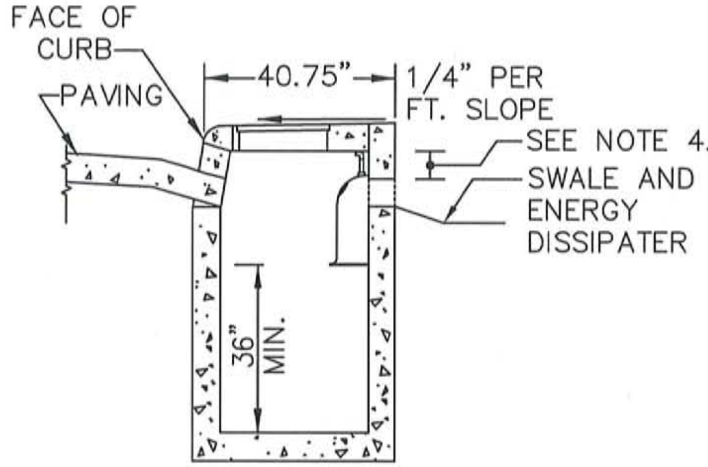
1. BRANCH SPACING AND NUMBER OF BRANCHES TO BE CALCULATED BASED ON STORM FLOWS FROM IMPERVIOUS AREA BEING TREATED.
2. WRAP PERFORATED PIPE WITH GEOTEXTILE TO PREVENT INFILTRATION OF FINES.
3. NO TREES OR DEEP ROOTED VEGETATION OVER PIPING.
4. GRADE SUBGRADE TO PROVIDE MANIFOLD WITH POSITIVE DRAINAGE.
5. CONVEYANCE SIZED AT MINIMUM FOR 25 YEAR EVENT STORM FLOWS.
6. DETENTION (IF REQUIRED) VOLUME BASED ON DEPTH OF DRAIN ROCK RESERVOIR LAYER AND POSITION OF MANIFOLD WITHIN THE DRAIN ROCK LAYER.
7. FITTINGS TO BE SAME MATERIAL AS PERFORATED PIPE.
8. PIPE SECTIONS EXPOSED TO SUNLIGHT SHALL BE OF MATERIAL NOT SUBJECT TO DEGRADATION FROM THE EFFECTS OF SUNLIGHT.



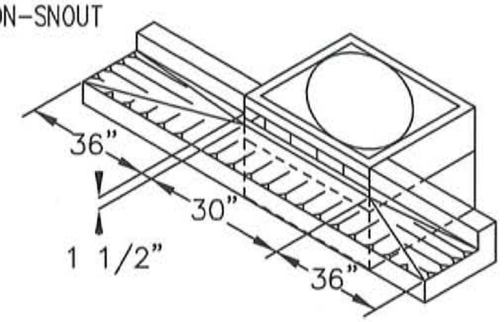
PLAN VIEW



SECTION A-A NON-SNOUT



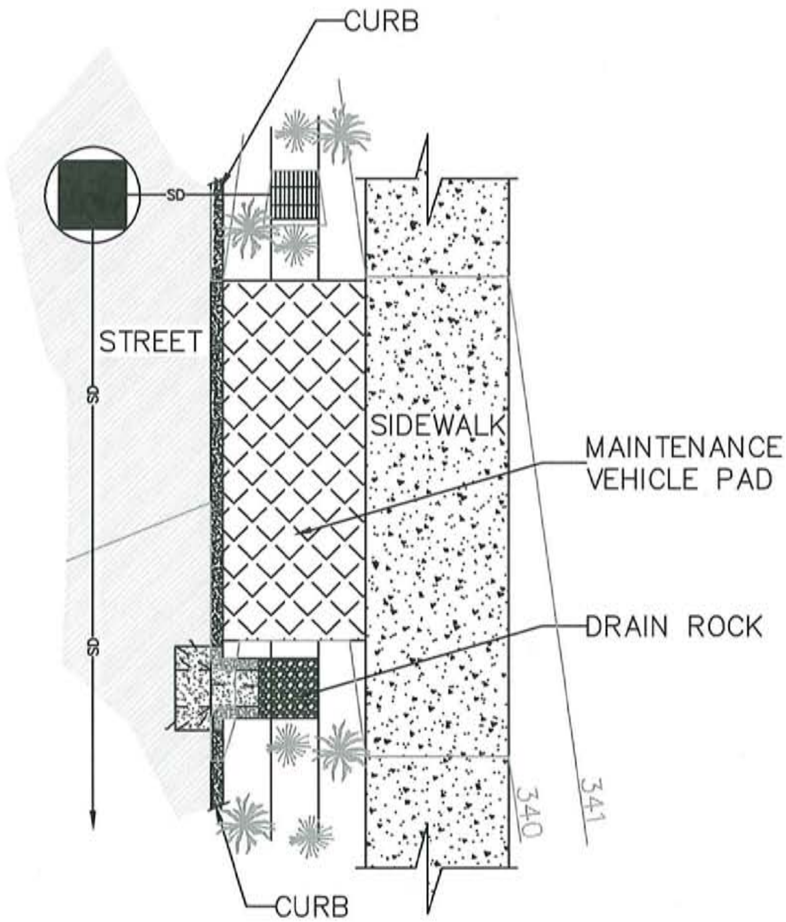
SECTION A-A SNOUT



PERSPECTIVE VIEW SHOWING DEPRESSED GUTTER AT CURB INLET

NOTES:

1. ALL FABRICATED METAL PARTS SHALL BE NEW STRUCTURAL, ASTM A-36 STEEL, AND BE HOT-DIPPED GALVANIZED AFTER FABRICATION.
2. INSTALL STRUCTURE ON MINIMUM OF 8" OF ¾" TO 0" COMPACTED BASE MATERIAL.
3. INSTALL ENERGY DISSIPATER AT OUTFALL OF STRUCTURE.
4. SNOUTED CG-30 TO BE USED ON ARTERIALS AND COLLECTORS. UN-SNOUTED STRUCTURE ONLY ON LOCAL AND NEIGHBORHOOD STREETS. POSITION OF SNOUT WITHIN STRUCTURE MAY VARY DEPENDING ON WATER QUALITY FACILITY GEOMETRY. ADJUST VAULT SIZING ACCORDINGLY TO INSURE SNOUT NOT DIRECTLY UNDER ACCESS MANHOLE LID.
5. SEE CWS STANDARD DETAILS 250 AND 260 FOR SNOUT INFORMATION.



NOTES:

1. PUBLICLY MAINTAINED LIDA FACILITIES SHALL BE PROVIDED WITH MAINTENANCE ACCESS PER R&O 07–20 CHAPTER 4.02.4.
2. PROVIDE ACCESS FOR ROADSIDE SWALE AS ILLUSTRATED, OR PER LOCAL JURISDICTION. DESIGN FOR TRAFFIC VOLUME AND/OR SIGHT DISTANCE MAY BE REQUIRED. MINIMUM 20' LONG, 7' WIDE PERVIOUS OR IMPERVIOUS PAVEMENT CAPABLE OF SUPPORTING A TYPICAL MAINTENANCE VEHICLE SHALL BE LOCATED WITHIN 10' OF ANY SUMPED STRUCTURES .
3. IF PERVIOUS PAVERS ARE USED, A STRUCTURAL BORDER SHALL BE DESIGNED TO PREVENT SHIFTING OF THE PAVERS.