

Low Impact Development Operations and Maintenance Training

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HERRERA

WASHINGTON STORMWATER CENTER
ASSISTANCE · RESEARCH · TRAINING

DEPARTMENT OF ECOLOGY
State of Washington

Project Funding

Environmental Protection Agency

This project has been funded wholly or in part by the United States Environmental Protection Agency under Puget Sound Ecosystem Restoration and Protection Cooperative Agreement grant PC-00J20101 With Washington State Department of Ecology. The contents of this document do not necessarily reflect the views and policies of the Environmental Protection Agency, nor does mention of trade names or commercial products constitute endorsement or recommendation for use.

Washington State Department of Ecology

Funding for the project provided by Washington State Department of Ecology

AGENDA

Time	Topic	Length
9:00 – 9:30	Introduction	30 minutes
9:30 – 10:30	Bioretention	1 hour
10:30 – 10:45	Break	15 minutes
10:45 – 11:30	Permeable Pavement	45 minutes
11:30 – 11:45	Vegetated Roofs	15 minutes
11:45 – 12:15	Administrative Tools & Guidance	30 minutes
12:15 – 12:30	Q&A	15 minutes
12:30 – 1:30	Lunch (on your own)	1 hour
1:30 – 4:00	Site Visits	2.5 hours

OUTLINE

- Introduction
  - Intro to LID
  - NPDES Permit LID O&M Requirements
  - LID O&M Guidance Overview
- Bioretention
- Permeable Pavement
- Vegetated Roofs
- Administrative Tools & Guidance
- Lunch Break and Site Visits

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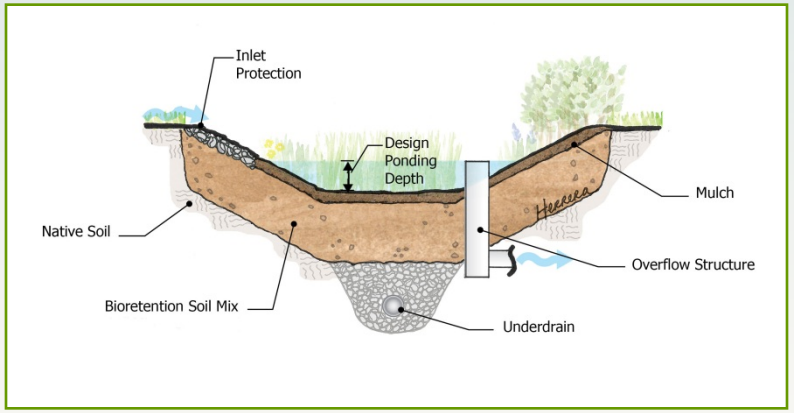
INTRO TO LID

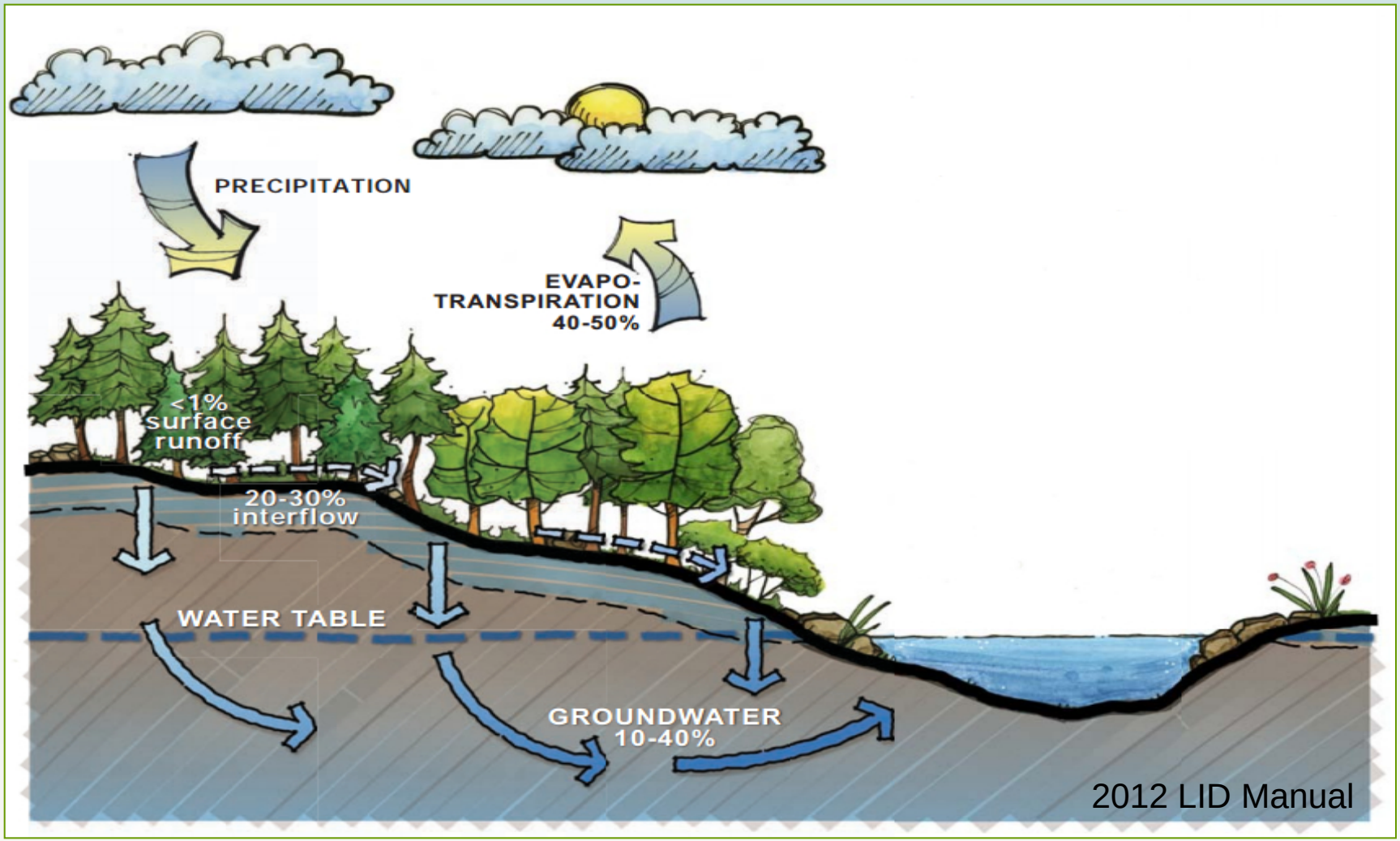
LID is a stormwater management strategy that integrates:

- Site design & planning techniques emphasizing conservation and

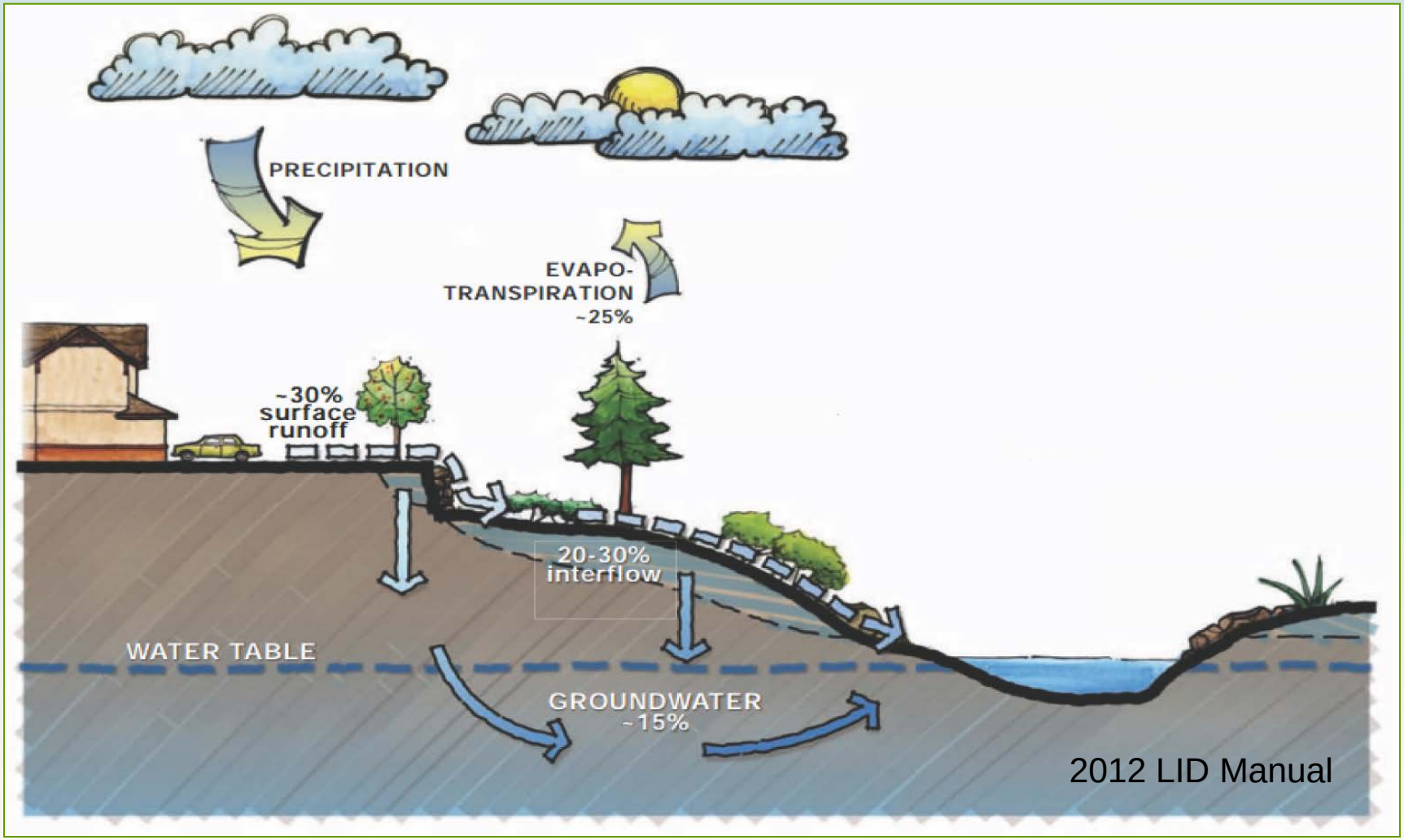
- Use of small-scale engineered controls to closely mimic pre-development hydrologic processes.



PREDEVELOPED FOREST



DEVELOPED CONDITION



SITE DESIGN AND PLANNING TECHNIQUES

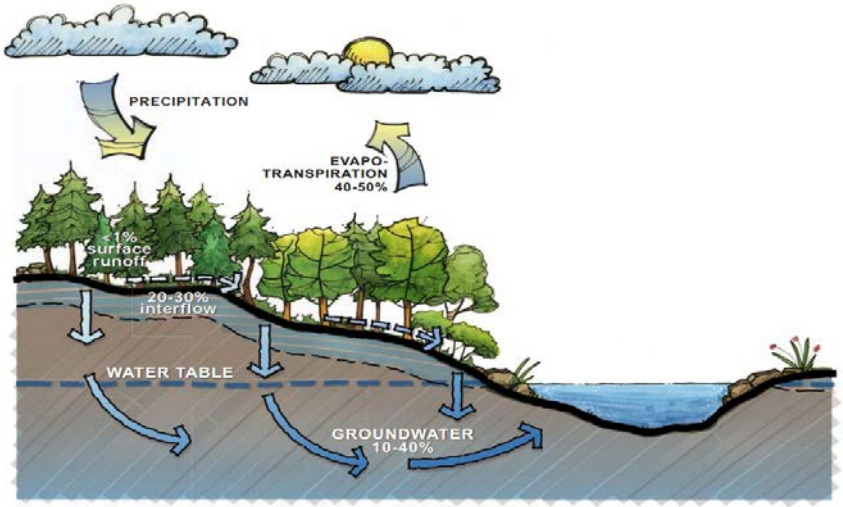
Traditional

LID

- Minimize disturbance
- Reduce impervious surface
- Protect and restore native soils and vegetation
- Manage stormwater close to origin

SMALL-SCALE ENGINEERING CONTROLS
(LID BMPS)

- Infiltration
- Filtration
- Storage
- Evaporation
- Transpiration



Replace Predeveloped Hydrologic Functions

LID BMPS = GREEN STORMWATER INFRASTRUCTURE (GSI)
= INTEGRATED MANAGEMENT PRACTICES (IMPS)
= ON-SITE STORMWATER MANAGEMENT BMPS

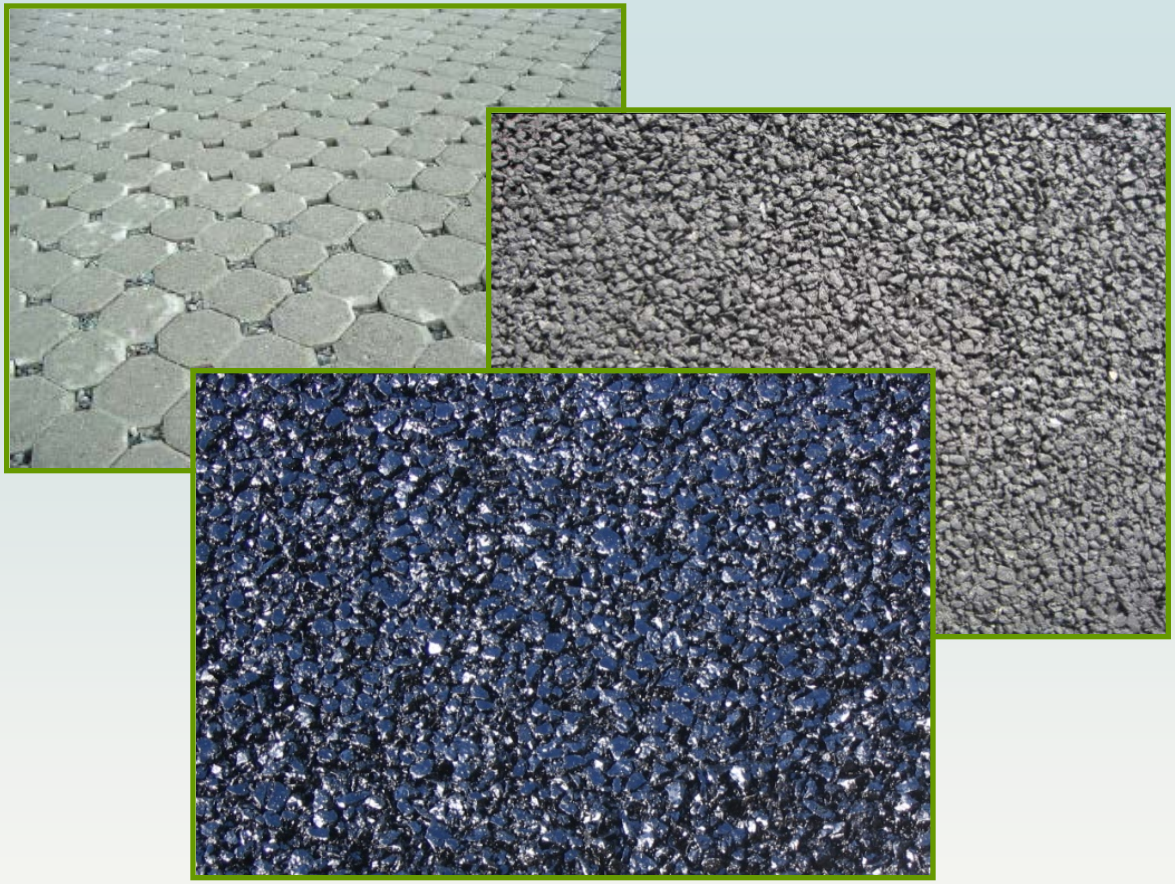
LID BMPs

Bioretention (Rain Gardens)

- Infiltration
- Filtration
- Storage
- Evaporation
- Transpiration

Permeable Pavement

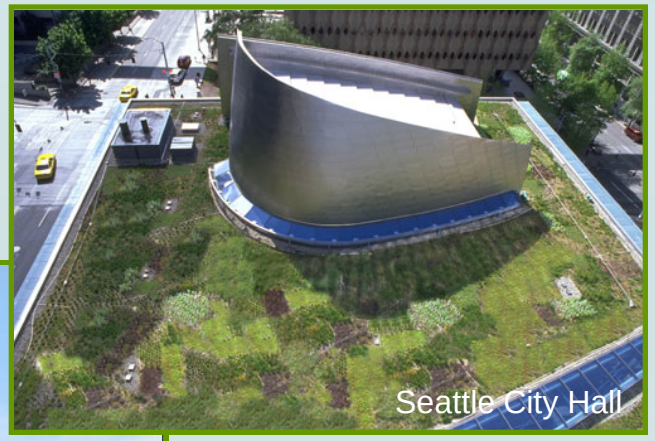
- Infiltration
- Filtration
- Storage
- Evaporation
- Transpiration

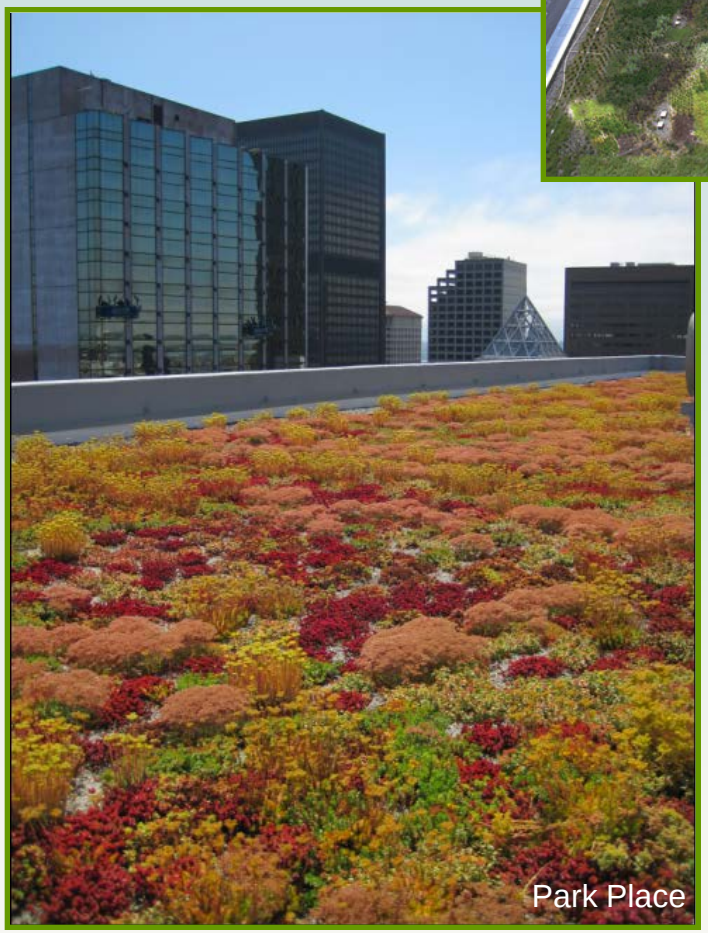


LID BMPs

Vegetated Roofs

- Infiltration
- Filtration
- Storage
- Evaporation
- Transpiration

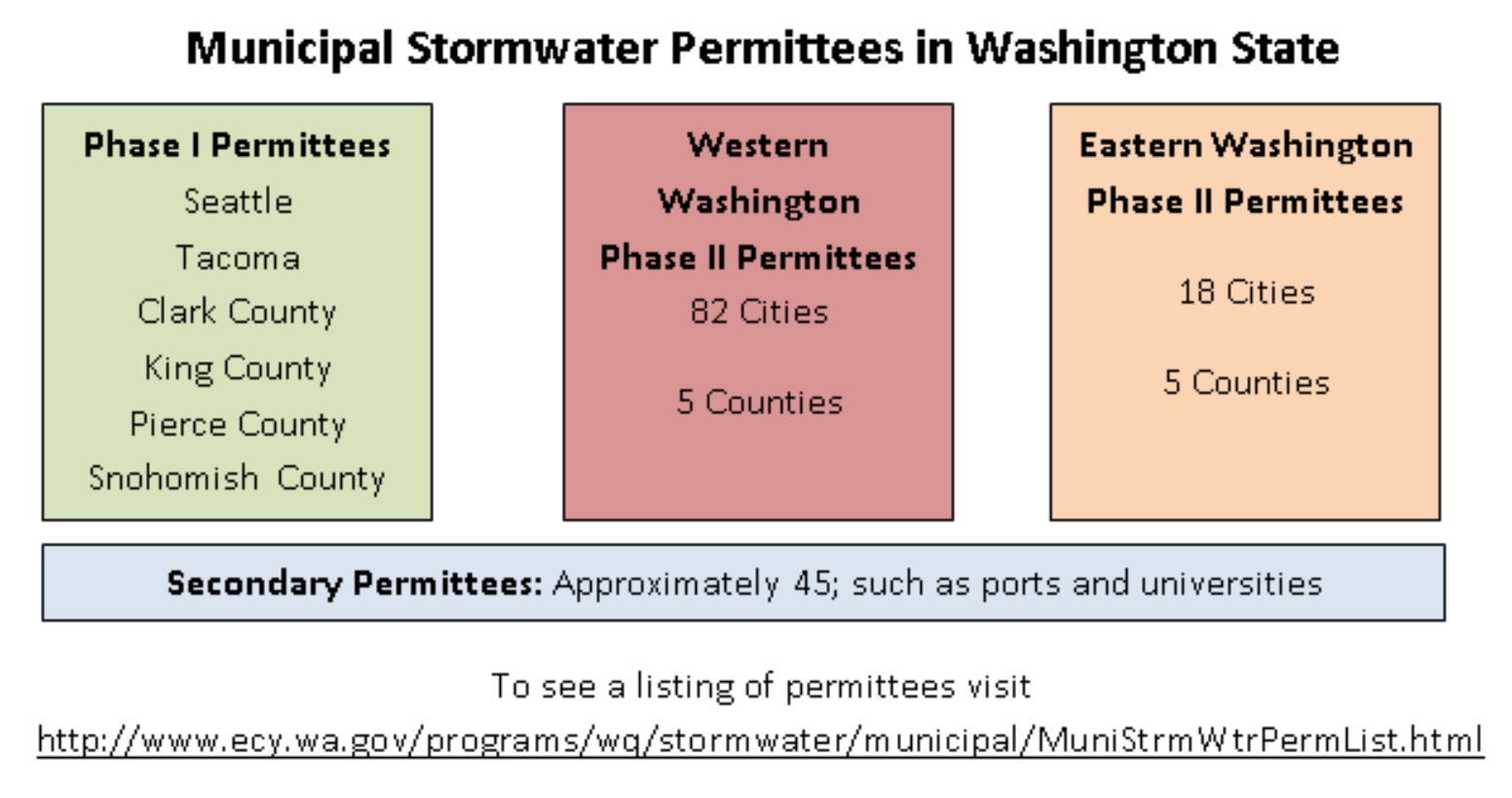

Seattle City Hall


Park Place

NPDES Permit LID O&M Requirements

Western WA NPDES Permit

- National Pollutant Discharge Elimination System (NPDES) Municipal Stormwater Permits



NPDES Permit LID O&M Requirements

Requirements Vary By Permittee

- LID O&M requirements
  - Requirements for Phase IIs are somewhat less extensive
  - Requirements for secondary Permittees vary
- Timelines for updating maintenance standards
  - Phase I
    - by June 30, 2015
    - Per Section S5.C.9.a of the Phase I Permit
  - Phase II
    - Most Phase IIs by December 31, 2016
    - Lewis and Cowlitz Counties by June 30, 2017
    - City of Aberdeen by June 30, 2018
    - Per Section S5.C.5.a of the Phase II Permit

NPDES Permit LID O&M Requirements

Requirements Vary By BMP Classification

- On-site Stormwater Management BMPs
- SW Treatment and Flow Control BMPs/Facilities

NPDES Permit LID O&M Requirements

Minimum Requirements (MRs)

- MR #2- Construction Stormwater Pollution Prevention Plan (SWPPP)
  - Protect LID BMPs from sediment and compaction
- MR #5- On-site Stormwater Management
  - Infiltrate, disperse, and retain runoff on-site to the extent feasible
- MR #6- Runoff Treatment
  - Water quality treatment for pollution-generating areas
- MR #7- Flow Control
  - Control of flow peaks and flow durations

NPDES Permit LID O&M Requirements

On-site Stormwater Management BMPs

- Used to help meet MR #5
- May be used to help meet MR #6 and/or MR #7
- "On-site Stormwater Management BMPs"= LID BMPs
- Includes the following LID BMPs:
  - Rain Gardens (BMP T5.14A)
  - Bioretention (BMP T5.14B)
  - Permeable Pavement (BMP T5.15)
  - Vegetated Roofs (BMP T5.17)
  - Downspout Dispersion (BMP T5.10A)
  - Downspout Full Infiltration (BMP T5.10B)
  - Concentrated Flow Dispersion (BMP T5.11)
  - Sheet Flow Dispersion (BMP T5.12)
  - Compost-amended soils (BMP T5.13)

NPDES Permit LID O&M Requirements

Treatment and Flow Control BMPs/Facilities

- Subset of On-site Stormwater Management BMPs
- Used to meet MR #6 and/or MR #7
- May also be used to meet MR #5
- Includes the following BMPs:
  - Bioretention (BMP T5.14B)
  - Permeable pavement (BMP T5.15)
  - Vegetated roofs (BMP T5.17)
  - Detention facilities
  - Treatment BMPs/facilities

NPDES Permit LID O&M Requirements

Requirements: O&M Standards

Requirement	LID BMP Type	
	On-site SW Management BMPs	SW Treatment & Flow Control BMPs/Facilities (MR #6 and/or MR #7)
Implement maintenance standards	X	X
Adopt or update ordinance or other enforceable documents		X
Implement practices, policies, & procedures to reduce SW impacts associated with runoff		X

NPDES Permit LID O&M Requirements

Requirements: Plan Review

Requirement	LID BMP Type	
	On-site SW Management BMPs	SW Treatment & Flow Control BMPs/Facilities (MR #6 and/or MR #7)
Verify maintenance plan completed & O&M responsibility assigned		X
Verify submission of maintenance instructions	X	X

NPDES Permit LID O&M Requirements

Requirements: Plan Review (Cont.)

Requirement	LID BMP Type	
	On-site SW Management BMPs	SW Treatment & Flow Control BMPs/Facilities (MR #6 and/or MR #7)
Verify that O&M manual is complete		X
Review and approve declaration of covenant (including design details, figures and maintenance instructions) and grant of easement	X	X

NPDES Permit LID O&M Requirements

Requirements: Inspections

Requirement	LID BMP Type	
	On-site SW Management BMPs	SW Treatment & Flow Control BMPs/Facilities (MR #6 and/or MR #7)
Legal authority to inspect private stormwater facilities and enforce maintenance standards	X	X
Conduct post-construction inspections to ensure proper installation	X	X

NPDES Permit LID O&M Requirements

Requirements: Inspections (Cont.)

Requirement	LID BMP Type	
	On-site SW Management BMPs	SW Treatment & Flow Control BMPs/Facilities (MR #6 and/or MR #7)
Conduct inspections during construction in new residential developments*		X
Conduct ongoing annual inspections		X
Perform spot checks for potentially damaged BMPs owned/operated by Permittee after major storm events		X

*every 6 months until 90% of the lots are constructed or when construction is stopped and the site is fully stabilized

NPDES Permit LID O&M Requirements

Requirements: Enforcement

Requirement	LID BMP Type	
	On-site SW Management BMPs	SW Treatment & Flow Control BMPs/Facilities (MR #6 and/or MR #7)
Enforce compliance with maintenance standards as needed based on inspection		X

NPDES Permit LID O&M Requirements

Requirements: Training

Requirement	LID BMP Type	
	On-site SW Management BMPs	SW Treatment & Flow Control BMPs/Facilities (MR #6 and/or MR #7)
Train staff involved in plan review, permitting, construction site inspections, & enforcement	X	X
Implement an ongoing training program for employees who have primary O&M job functions that may impact SW quality	X	X

NPDES Permit LID O&M Requirements

Requirements: Record Keeping

Requirement	LID BMP Type	
	On-site SW Management BMPs	SW Treatment & Flow Control BMPs/Facilities (MR #6 and/or MR #7)
Keep records of inspections and enforcement actions (e.g., inspection reports, notices of violations)	X	X

NPDES Permit LID O&M Requirements

Requirements: Mapping

Requirement	LID BMP Type	
	On-site SW Management BMPs	SW Treatment & Flow Control BMPs/Facilities (MR #6 and/or MR #7)
Scale drawing of the lot(s) and public ROW that show BMP locations	X	X
Map BMPs owned/operated by Permittee		X
Map connections between BMPs and tributary conveyances*		X

*Phase I Only

LID O&M Guidance Overview

Objective

- Support permittees in implementing LID maintenance programs
- Provide specific O&M guidance so Permittees can create maintenance standards that preserve facility function

Note: Jurisdictions may want to tailor the tables to address varying levels-of-service

LID O&M Guidance Overview

Development

- Two advisory committees
  - LID Maintenance Advisory Committee
  - LID Maintenance Administrative Issues Advisory Committee
- Best available information
  - Advisory committee input
  - Literature review
  - Targeted surveys sent to jurisdictions, contractors/ landscapers, and vendors
- Guidance will evolve over time

LID O&M Guidance Overview

Overview

- Summary of NPDES Permit Requirements
- Maintaining LID BMPs
  - Bioretention facilities
  - Rain gardens
  - Permeable pavement
  - Vegetated roofs
  - Downspout infiltration systems
  - Downspout, sheet flow, and conc. dispersion systems
  - Compost amended soils
- Programmatic & Administrative Guidance

LID O&M Guidance Overview

Maintaining LID BMPs

- BMP description
  - How water moves through facility
- Key maintenance considerations to ensure facility function
  - Function by BMP component
  - Key maintenance by BMP component
- Key operations to preserve facility function

LID O&M Guidance Overview

Maintaining LID BMPs (Cont.)

- Maintenance standards and procedures

Table 3 (continued). Maintenance Standards and Procedures for Bioretention Facilities.

Component	Recommended Frequency [a]		Condition when Maintenance is Needed (Standards)	Action Needed (Procedures)
	Inspection	Routine Maintenance		
Inlets/Outlets/Pipes				
Splash block inlet	A		Water is not being directed properly to the facility and away from the inlet structure	Reconfigure/ repair blocks to direct water to facility and away from structure
Curb cut inlet/outlet		Weekly during fall leaf drop	Accumulated leaves at curb cuts	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
Pipe inlet/outlet	A		Pipe is damaged	Repair/ replace
	W		Pipe is clogged	Remove roots or debris
	A, S		Sediment, debris, or trash reducing capacity of inlet/outlet	• Clear the blockage • Identify the source of the blockage and take actions to prevent future blockages
		Weekly during fall leaf drop	Accumulated leaves at inlets/outlets	Clear leaves (particularly important for key inlets and low points along long, linear facilities)
		A	Maintain access for inspections	• Clear vegetation within 1 foot of inlets and outlets, maintain access pathways • Transplant vegetation when possible
Erosion control at inlet	A		Concentrated flows are contacting soil and causing erosion	Maintain a cover of round rock or cobbles or other erosion protection measure (e.g., matting) to protect the ground where concentrated water enters the facility (e.g., a pipe, curb cut or swale)
Trash rack	S		Trash or other debris present on trash rack.	Remove/ dispose
	A		Bar screen damaged or missing	Repair/ replace

LID O&M Guidance Overview

Maintaining LID BMPs (Cont.)

- Equipment and material list

Table 13. Vegetated Roof Equipment and Materials List.

General gardening and landscaping equipment	*Gardening and landscaping materials*
☐ Gloves	☐ Plants/seeds
☐ Weeding tool	☐ Growing media
☐ Soil knife	☐ Fertilizer (encapsulated, slow release)
☐ Hand tamper	*Erosion control material**
☐ Hoe	☐ Mulch (intensive roofs)
☐ Rake	☐ Erosion control matting
☐ Push broom	*Equipment and materials for subsurface or drip irrigation system repairs*
☐ Buckets	☐ Soaker hose
☐ Garbage bags (for disposal of noxious weeds)	☐ Hose/shower-type wand
Additional equipment for intensive roofs:	☐ Sprinklers
☐ Pruners	☐ Tree watering bags
☐ Loppers	☐ Buckets
☐ Manual edger	☐ Water source, if necessary
☐ Line trimmer (also known as a string trimmer, weed eater, or weed whacker)	*Safety equipment*
☐ Wheelbarrow	☐ Fall protection as applicable
☐ Shovel	
☐ Stakes and guys	

*Items not required for routine maintenance

LID O&M Guidance Overview

Maintaining LID BMPs (Cont.)

- Skills and staffing
  - List of general skills required
  - List of additional specialized skills
  - Staffing survey estimates (e.g., crew hours per facility, per linear foot, or per square foot)

Skills Needed for Maintenance of Bioretention Facilities

- Landscaping skills (e.g., general plant care)
- Plant identification skills (weeds vs. planted species, invasive vs. common weeds, how to dispose of invasive weeds, timing of weed seed dispersal)
- Erosion control knowledge
- General drainage system maintenance skills (e.g., inlet/pipe/underdrain cleaning experience)

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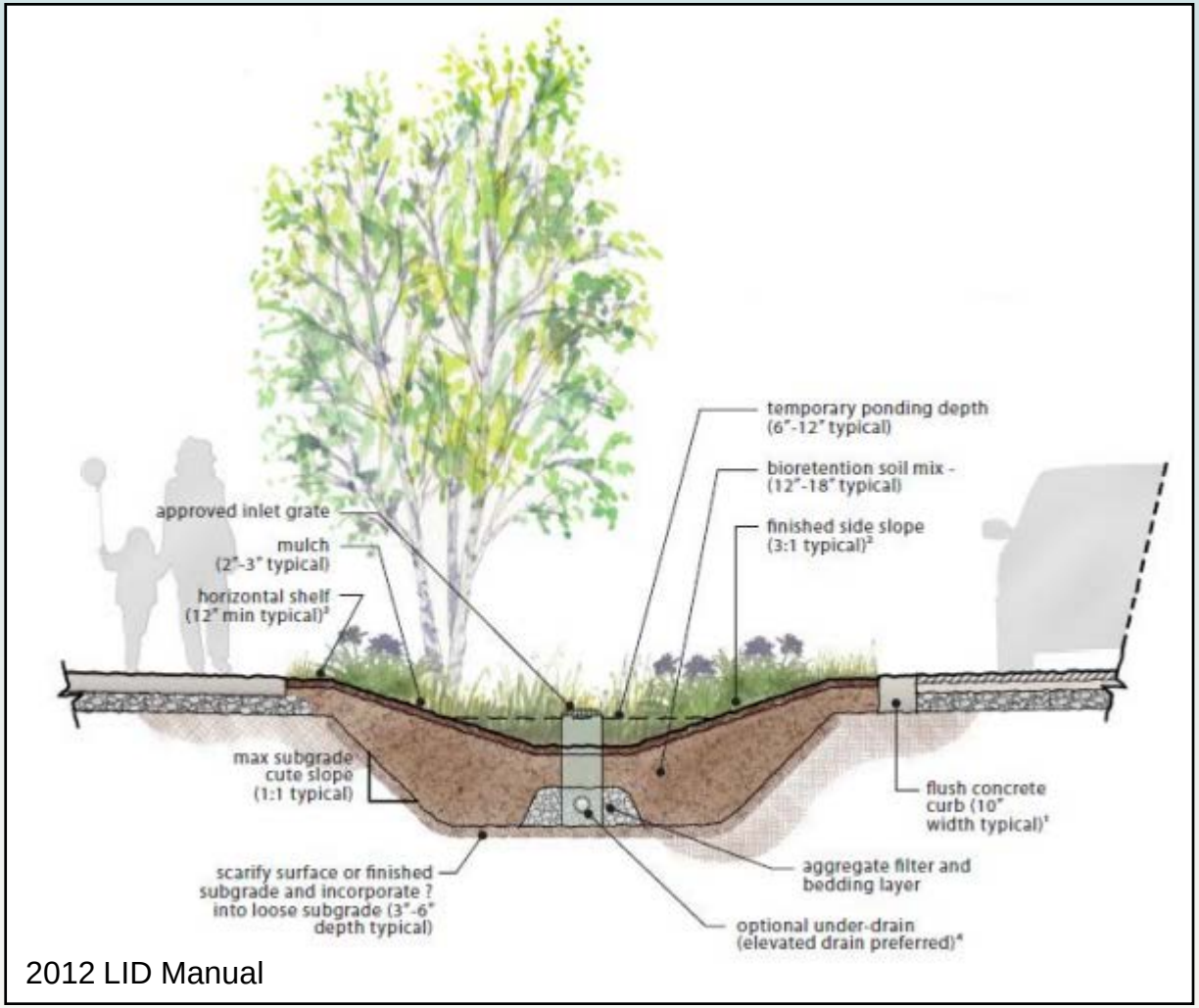
ANATOMY OF A FACILITY



2012 LID Manual

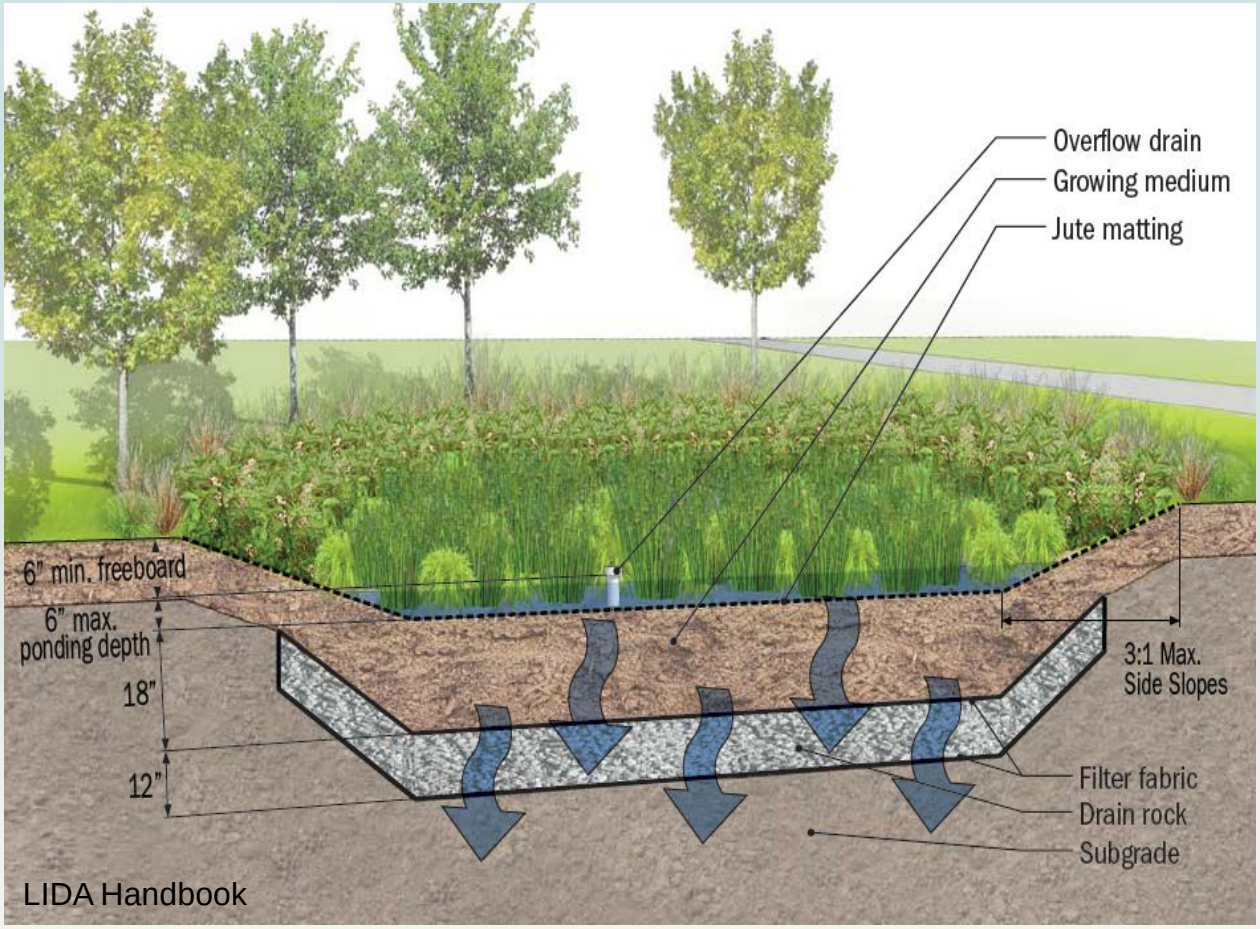
- Inlet
- Ponding area
- Vegetation
- Mulch*
- Bioretention soil
- Drain rock*
- Overflow
- Underdrain*
- Liner*

*Optional

BIORETENTION VS. RAIN GARDEN

- "Bioretention facility"
  - Facility sized for specific treatment and flow control objectives
  - Includes designed soil mixes and perhaps under-drains and control structures
- "Rain garden"
  - Less restrictive design criteria for soil mix and usually without under-drains /other control structures
- Rain gardens have similar, but somewhat less extensive, maintenance requirements

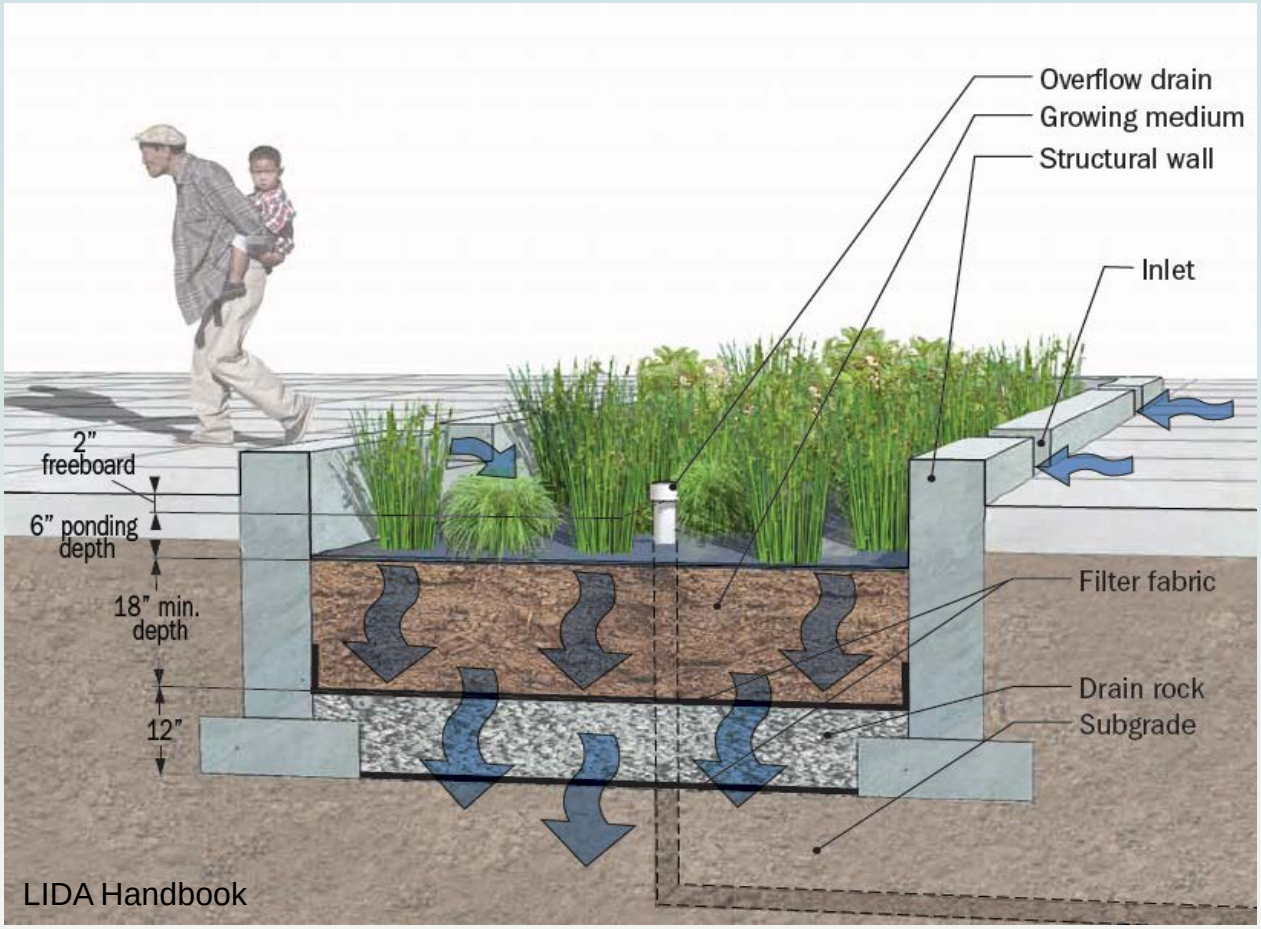
HOW THE FACILITY WORKS



Bioretention Cell

- Water enters facility
- Ponds
- Infiltrates through bioretention soil/ gravel bed
- Infiltrates into underlying soil
- Ponded water exceeding max. depth overflows

HOW THE FACILITY WORKS



Bioretention Planter

- Water enters facility
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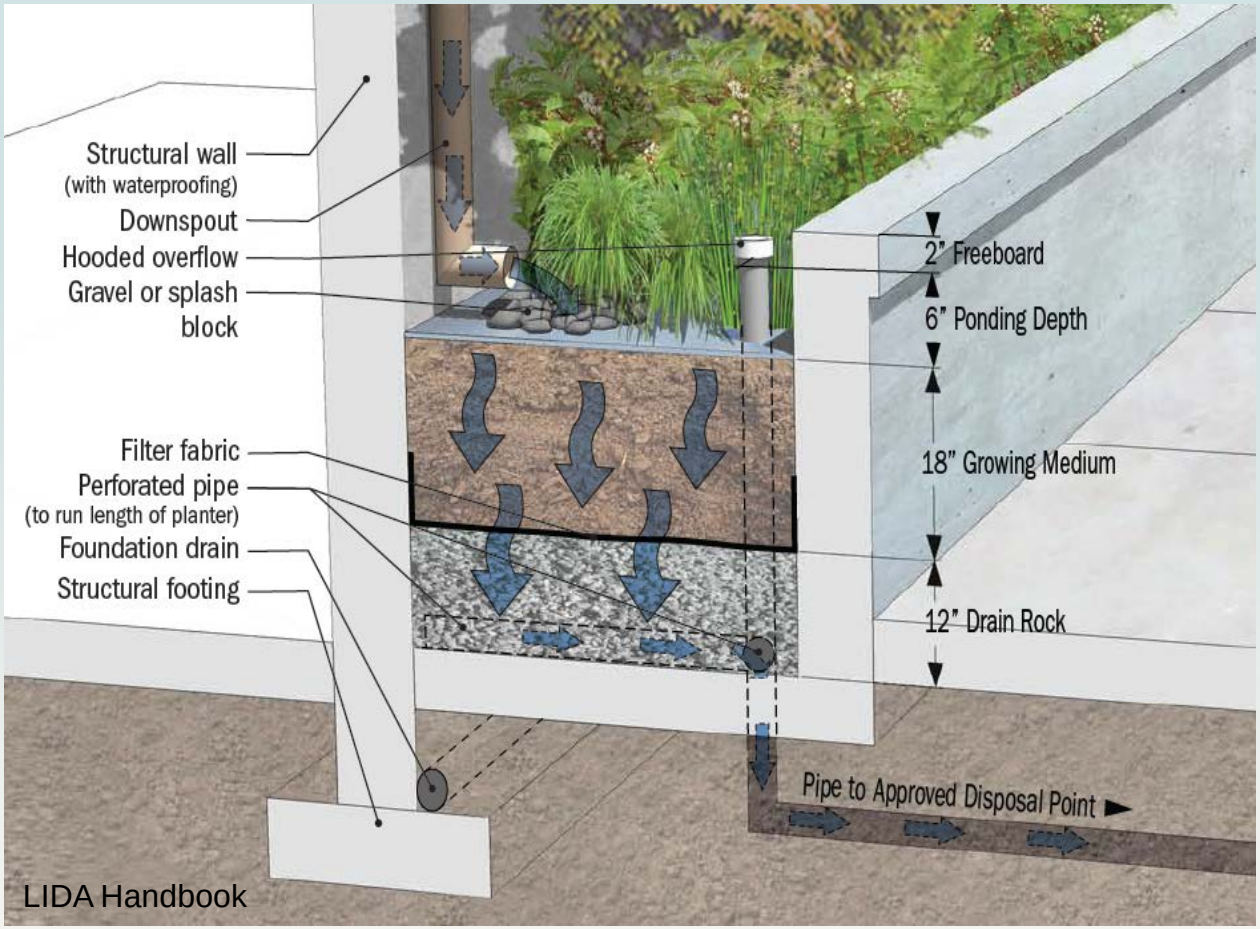
HOW THE FACILITY WORKS



Bioretention Planter

- Water enters facility
- Ponds
- Infiltrates through bioretention soil/ gravel bed
- ~~Infiltrates into underlying soil~~
- Ponded water exceeding max. depth overflows
- Underdrain collects water in gravel layer and routes to overflow

MAINTENANCE STANDARDS & PROCEDURES BY COMPONENT

- Inlets
- Ponding area
- Check dams/weirs
- Bioretention soil
- Outlets
- Underdrains
- Vegetation
- Weeds
- Watering
- Mulch

INLET MAINTENANCE CONSIDERATIONS

- Stormwater must freely enter facility (no obstructions)
- Water entering facility should not cause erosion

INLET TYPES

Sheet flow from sidewalk and roadway

Sheet flow from parking lot

INLET TYPES

Curb cut

Curb cut with grate

Bioretention

Inlet Types

Trench drain from upslope BMP

Trench drain from roadway

INLET TYPES

Piped inlet from roadway/parking lot

Piped inlet from upslope BMP

INLET MAINTENANCE

- Maintain erosion control at concentrated flow inlets (e.g., rock pad)
- Ensure pipe is not damaged or clogged

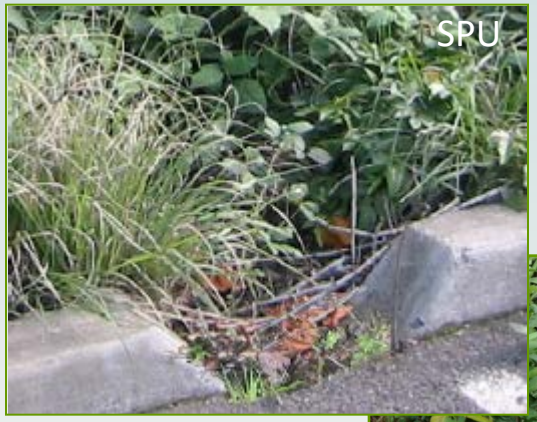
Curb cut

Trench drain

Piped flow

INLET MAINTENANCE

- Remove accumulated sediment, debris, leaves
- Clear/move vegetation inhibiting flow into facility



Curb cuts

Catch basin inlets

PONDING AREA MAINTENANCE CONSIDERATIONS

- Ponding area provides temporary surface storage before infiltration
- Must infiltrate within 48 hour “drawdown” time after the end of a storm
  - Restores hydraulic capacity of system
  - Prevent mosquito breeding conditions

PONDING AREA TYPES

Earthen depression

Rockery walls

PONDING AREA TYPES

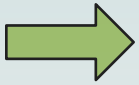
In ground concrete planter

Aboveground metal planter

PONDING AREA MAINTENANCE

- Ponding reservoir integrity
  - Concrete or metal planter: ensure integrity (e.g., cracks, leaks)
  - Rockery: ensure rockery sidewalls are secure
  - Earthen side slopes/berms:
    - Erosion: stabilize and address cause of erosion, if feasible
    - Settlement: restore to design height
    - Leaks/seeps on face of berm: repair/compact

PONDING AREA MAINTENANCE

- Accumulation of material in ponding area
  - Remove trash and debris
  - Remove leaves if impacting facility function
  - Accumulated sediment to extent that infiltration rate is reduced (see "excessive ponded water") or storage capacity reduced 
    - Remove excess sediment
    - Replace any vegetation damaged or destroyed by sediment accumulation and removal
    - Identify and control the sediment source, if feasible

PONDING AREA MAINTENANCE

- Excessive ponded water
  - Overflows during small storms or
  - Does not fully infiltrate within 48 hours of end of storm

⇨ Determine cause

1. Leaves/debris in bottom impeding infiltration?
2. Underdrain, if present, is clogged?
3. Water inputs (e.g., groundwater, illicit connections)
4. Verify sized for contributing area (and area has not increased)

If Steps 1-4 do not solve problem: bioretention soil is likely clogged

⇨ Remove/replace bioretention soil

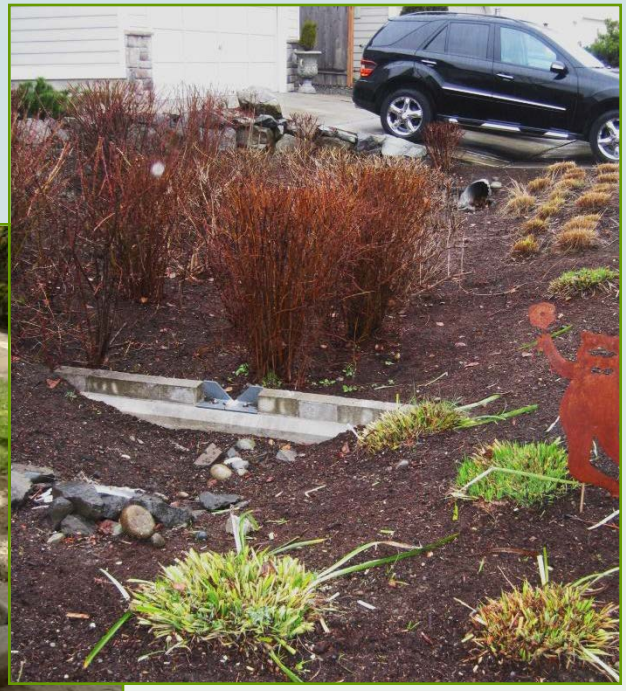
CHECK DAMS/WEIRS MAINTENANCE CONSIDERATIONS

- Provides ponding on sloped facilities
- Provides detention/some water quality (settling)

CHECK DAMS/WEIR TYPES

Concrete

Portland (2012 LID Manual)



Meadow on the Hylebos

110th Street Cascade, Seattle, WA

CHECK DAMS/WEIR TYPES

Log/Wooden

Gravel

Earthen

CHECK DAMS/WEIRS MAINTENANCE

- Remove accumulated sediment, debris, leaves blocking/or with potential to block flow
- Repair any erosion/undercutting and take preventative measures

BIORETENTION SOIL MAINTENANCE CONSIDERATIONS

- Infiltration through soil mix provides water quality treatment
- Stormwater must infiltrate freely into bioretention soil
- Infiltration rate may be reduced by compaction or clogging with fine sediment

LIDsigns.com

BIORETENTION SOIL MAINTENANCE

- Remove and replace if clogged (see “excessive ponded water”)
- Minimize loading in cell to protect bioretention soil from compaction during maintenance
  - Never drive equipment or apply heavy loads in facility footprint
  - Minimize any loading to cell during wet conditions
  - Consider measures to distribute loading if heavy foot traffic is required or equipment must be placed in facility (e.g., boards to distribute loads)

OUTLET MAINTENANCE CONSIDERATIONS

- Stormwater must freely exit facility once capacity exceeded (above maximum ponding depth)
- Overflows must be conveyed to safe discharge point (e.g., storm drain system)

OUTLET TYPES

Vertical Stand Pipe with Beehive Grate

Exit Curb Cut Trench Drain

OUTLET MAINTENANCE

- Remove accumulated sediment, debris, leaves at outlet/grate/trash rack
- Clear/move vegetation within 1 foot of outlet to maintain access
- Clear pipes of accumulated material

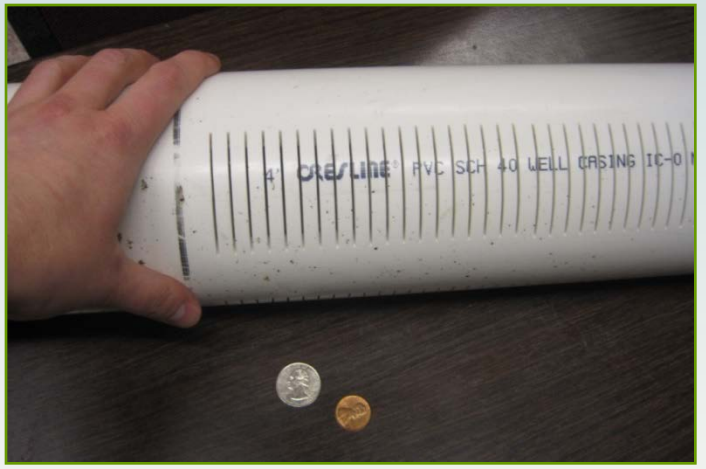
UNDERDRAIN MAINTENANCE CONSIDERATIONS

- Underdrains are sometimes included to collect treated water under the bioretention soil (e.g., where infiltration to native soil is not feasible)
- Perforated or slotted pipe wrapped in an aggregate blanket (or filter fabric)
- May have flow restrictor (e.g., orifice) to detain flow
- Underdrain/orifices must be kept clear

UNDERDRAIN MAINTENANCE

- Prolonged surface ponding

  - Jet clean or rotary cut debris/roots from underdrain
  - If equipped with flow restrictor (orifice), clean regularly



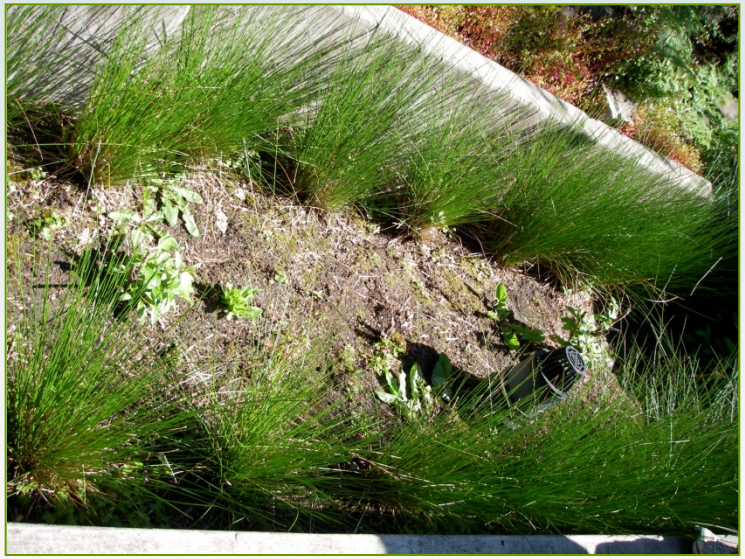
VEGETATION MAINTENANCE CONSIDERATIONS

- Grasses, shrubs and trees:
  - Intercepts rain before it hits the soil and facilitates evaporation
  - Uptakes water from the soil and transpires it to the atmosphere
- Improve soil structure and increases infiltration capacity
- Promotes water quality treatment

VEGETATION

GENERAL

- Determine cause of poor vegetation growth and establishment and replant as necessary to obtain 75% or greater survival rate.
- Remove and dispose of diseased plants or plant parts
- Replace dead vegetation within 30 days of reported dead and dying plants (as practical depending on weather and planting season)



Bare ground

Compaction and bare ground

VEGETATION

EMERGENT VEGETATION AND GRASSES

Hand rake with small rake or fingers to remove dead foliage in spring or earlier only if foliage is blocking water flow

- **Emergent vegetation:** Sedges and rushes do not like pruning
- **Perennial ornamental grasses:** Leave dry foliage for winter interest
- **Evergreen ornamental grasses:** Clean, rake, and comb grasses when they become too tall. Cut back to ground or thin every 2 to 3 years as needed

VEGETATION

WEEDS

- Remove weeds manually, with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate
- Follow IPM protocols for weed management
- By law, Class A & B noxious weeds must be removed, bagged and disposed as garbage immediately
- Reasonable attempts must be made to remove and dispose of Class C noxious weeds

VEGETATION

EXCESSIVE VEGETATION

- Edge or trim groundcovers that grow beyond the facility edge onto sidewalks, paths, or street edges when the create pedestrian safety hazards or clog adjacent permeable pavement surfaces
- Prune, trim, or if necessary, replace plants when vegetation density inhibits stormwater flow beyond design ponding or becomes a hazard for pedestrian and vehicular circulation and safety

WATERING

SUMMER WATERING FIRST YEAR

Once every 1 – 2 weeks or as needed during prolonged dry periods

- Trees: 10 – 15 gallons
- Shrubs: 3 – 5 gallons
- Groundcovers: 2 gallons/ square foot

SUMMER WATERING SECOND AND THIRD YEAR

Once every 2 – 4 weeks or as needed during prolonged dry periods

- Same watering quantities as year one watering

WATERING

AFTER 3 -YEAR ESTABLISHMENT PERIOD

- Trees may take up to 5 years to become fully established
- Identify trigger mechanisms for drought-stress of different species and water immediately after initial signs of stress appear
  - e.g., Leaf wilt, senescence, etc.
- Water during drought conditions

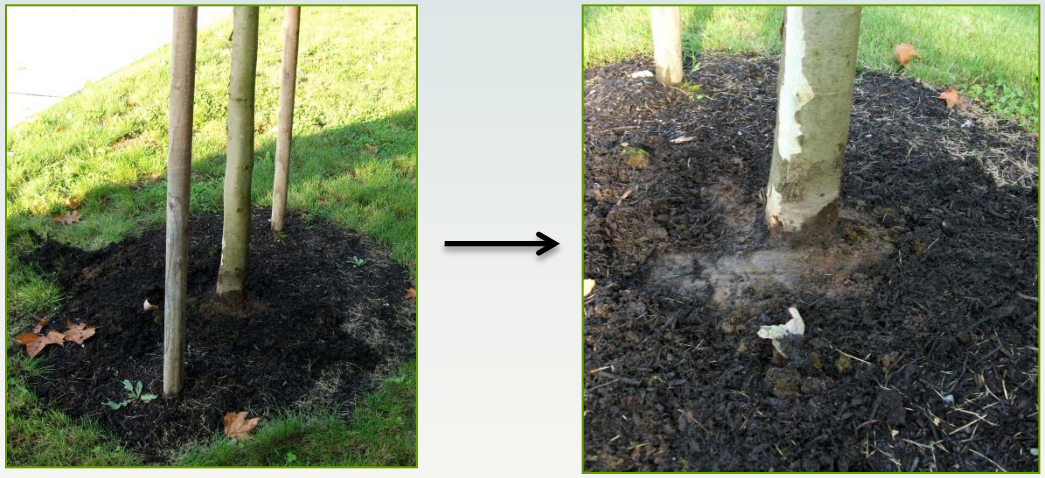
MULCH MAINTENANCE CONSIDERATIONS

- Layer of mulch covers bioretention soil to:
  - Reduces weed establishment
  - Regulates soil temperatures and moisture
  - Adds organic matter to the soil

MULCH

- Supplement mulch with hand tools to a depth of 2 to 3 inches
- Replenish mulch per O&M guidance: Often coarse compost used in facility bottom and arborist wood chips on side slopes above typical water levels

No mulch and undefined edge



Hand apply mulch to avoid covering base of trees and shrubs

EQUIPMENT/ MATERIALS LIST

Table 4. Bioretention Equipment and Materials List.

Landscaping equipment

- ☐ Gloves
- ☐ Weeding tool
- ☐ Soil knife
- ☐ Pruners
- ☐ Loppers
- ☐ Stakes and guys
- ☐ Manual edger
- ☐ Line trimmer (also known as a string trimmer, weed eater, or weed whacker)
- ☐ Rototiller
- ☐ Hoe
- ☐ Rake
- ☐ Wheelbarrow
- ☐ Shovel
- ☐ Push broom
- ☐ Hand tamper
- ☐ Blade sharpeners
- ☐ Tarp/ Buckets (to remove leaf litter/debris)
- ☐ Garbage bags (for disposal of trash/noxious weeds)
- ☐ Bark and mulch blower
- ☐ Boards to stand on during maintenance to prevent soil compaction (if maintenance is necessary during periods when Bioretention media is wet)

Watering equipment

- ☐ Soaker hose
- ☐ Hose/shower-type wand
- ☐ Sprinklers
- ☐ Tree watering bags
- ☐ Buckets
- ☐ Keys for irrigation boxes
- ☐ Water source (e.g., watering truck), if necessary

*Landscaping materials**

- ☐ Plants
- ☐ Stakes and ties

*Erosion control material**

- ☐ Rock or cobbles for rock pad
- ☐ Erosion control matting

Mulch

- ☐ Arborist wood chip mulch
- ☐ Coarse compost mulch
- ☐ Rock mulch

Pipe/structure inspection and maintenance equipment

- ☐ Hand tools
- ☐ Wrench or manhole lifter (for opening manhole lids, grates, etc.)
- ☐ Flashlight
- ☐ Mirror (for viewing pipes without entering structure)
- ☐ Garden hose
- ☐ Plumbing snake
- ☐ Measuring tape or ruler

*Specialized equipment**

- ☐ Mini excavator
- ☐ Vactor truck
- ☐ Manual seed broadcaster
- ☐ Soil monitoring equipment (T handle core sampler, soil auger, soil nutrient test kit)
- ☐ Flame weeder or hot water weeder
- ☐ Water jet or root saw (Vactor truck tools) for clearing roots from underdrains
- ☐ Equipment for infiltration testing

*Bioretention Soil**

- ☐ Bioretention soil per design specifications

* Items not required for routine maintenance

SKILLS

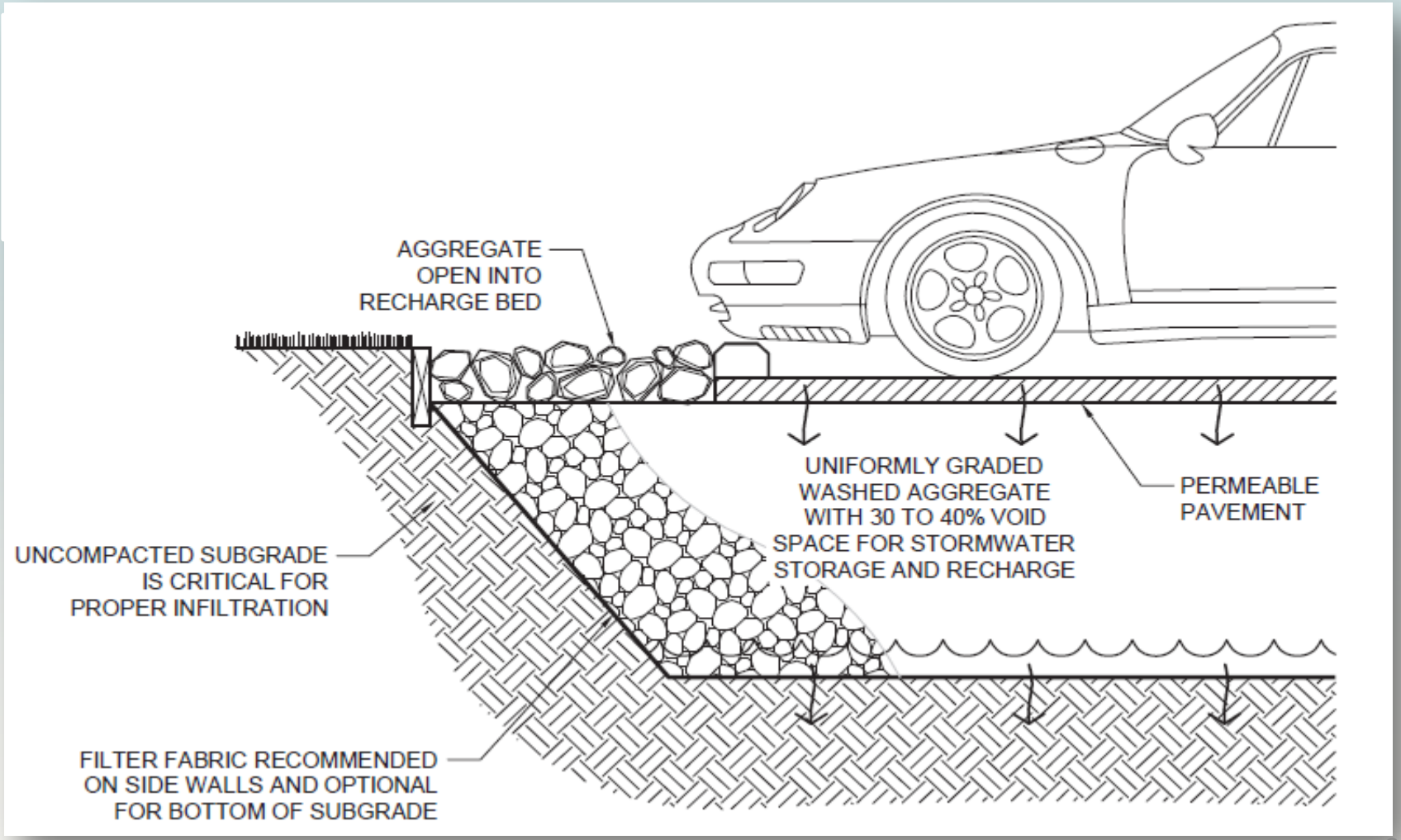
- Landscaping skills (e.g., general plant care)
- Plant identification skills (weeds vs. planted species, invasive vs. common weeds, how to dispose of invasive weeds, timing of weed seed dispersal)
- Erosion control knowledge
- General drainage system maintenance skills (e.g., inlet/pipe/underdrain cleaning experience)
- Additional specialized skills for corrective maintenance

BREAK

OUTLINE

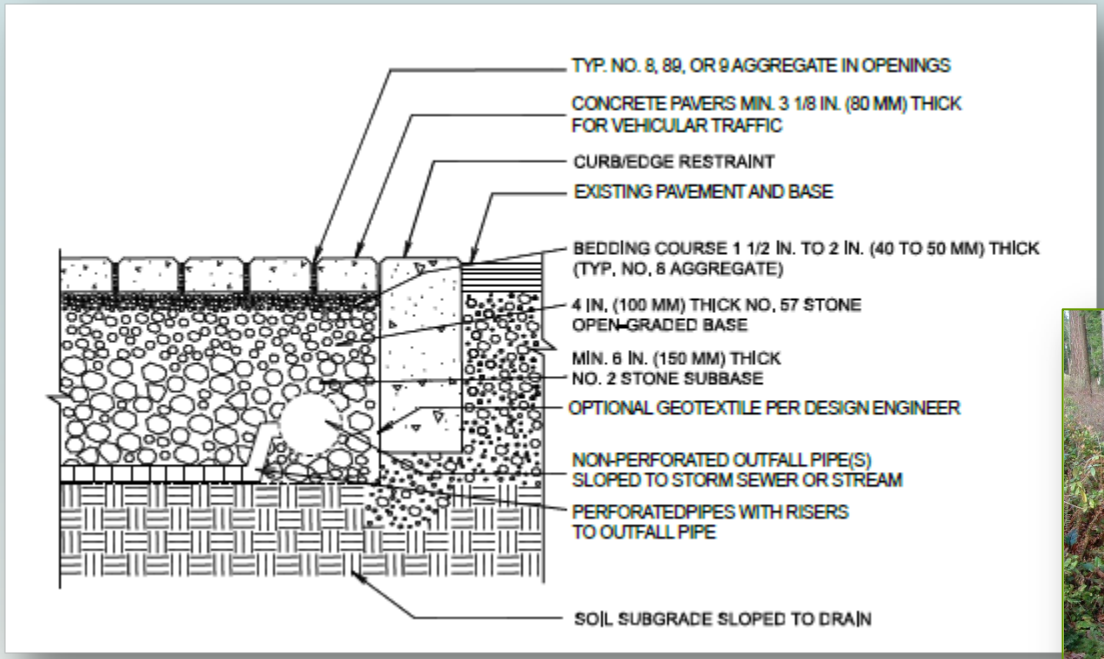
- Introduction
  - Intro to LID
  - NPDES Permit LID O&M Requirements
  - LID O&M Guidance Overview
- Bioretention
- Permeable Pavement
- Vegetated Roofs
- Administrative Tools & Guidance
- Lunch Break and Site Visits

HOW THE FACILITY WORKS

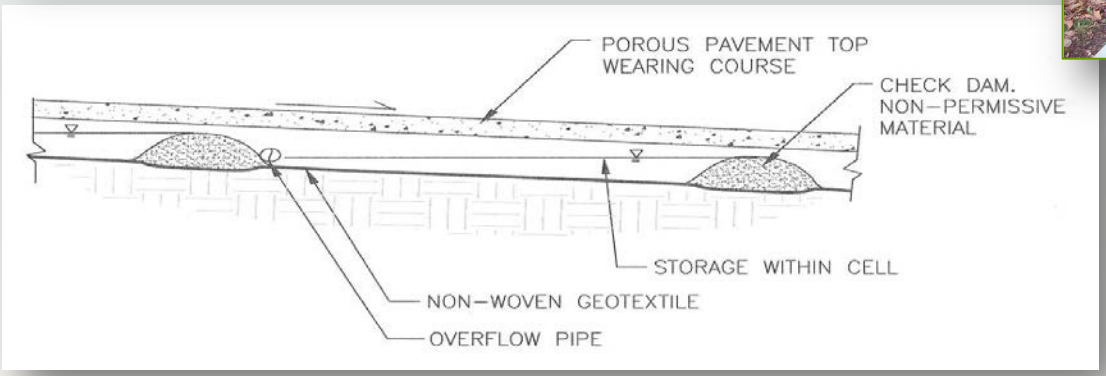


PERMEABLE PAVEMENT

HOW THE FACILITY WORKS



- Inlets
- Outlets
- Slopes



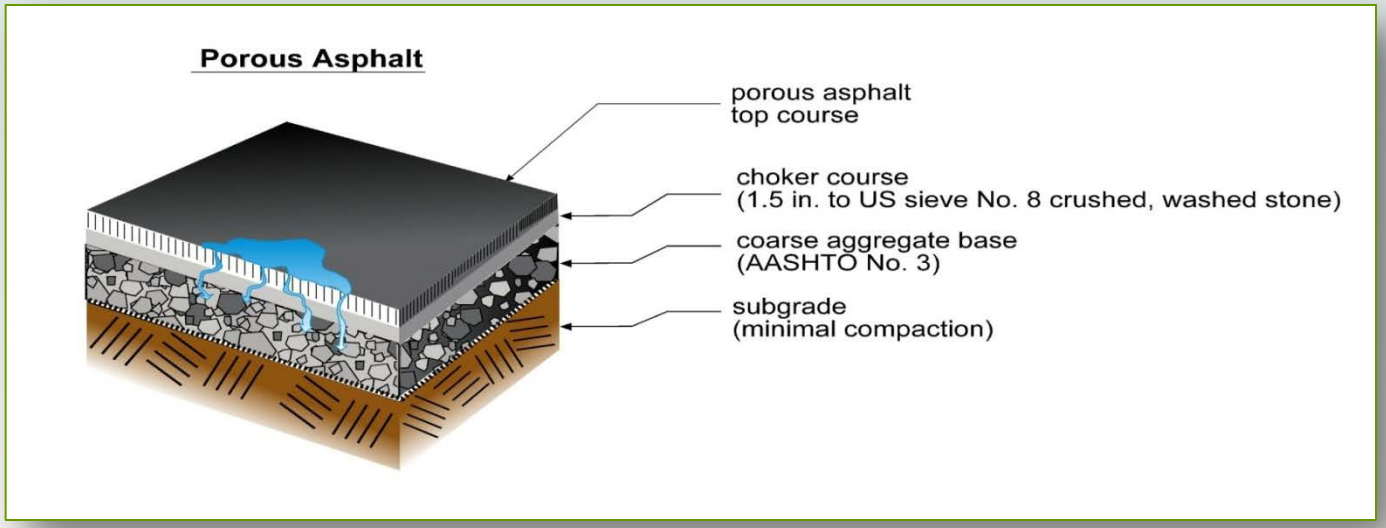
WEARING COURSE TYPES

- Concrete and asphalt
- Permeable Interlocking Concrete Pavers (PICP) and Aggregate (AGG) Pavers
- Grid with gravel
- Grid with grass

Permeable Pavement

Anatomy of a Facility (Porous Asphalt)

- Flexible
- Similar to conventional asphalt, but fines < No. 30 sieve reduced
- Typically used for parking and light traffic loads; however, has been used for medium and heavy applications.
- ~16 percent voids typical (2-3 percent for conventional)



Permeable Pavement

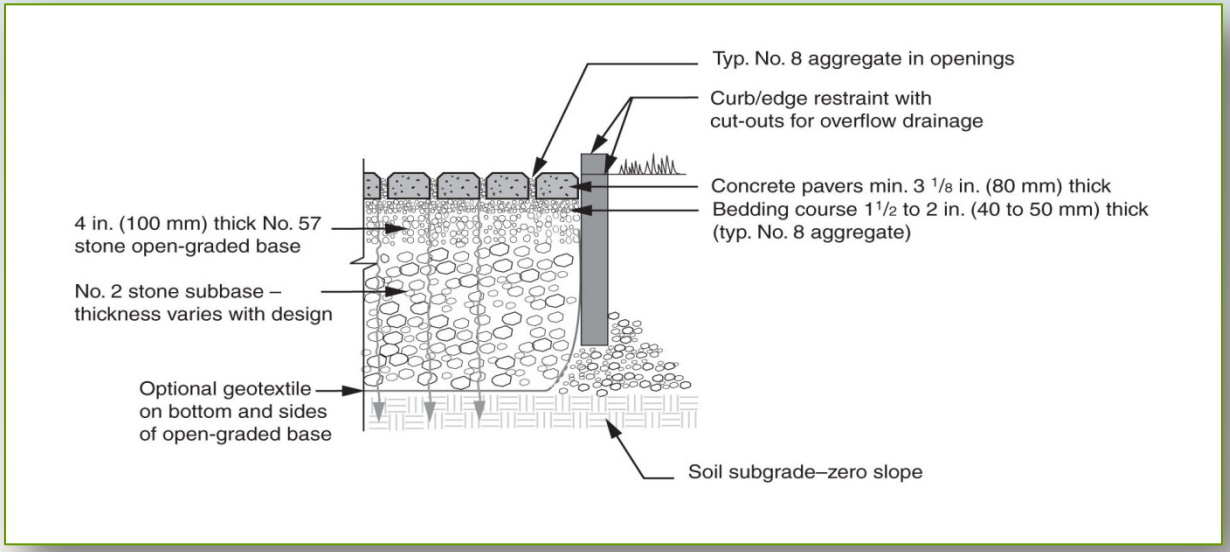
Anatomy of a Facility (Pervious Concrete)

- Rigid
- 1/4 to 5/8 round or crushed aggregate typical, portland cement, and admixtures (optional) to increase workability and strength
- 15 to 20 percent voids typical

Permeable Pavement

Anatomy of a Facility (Pavers)

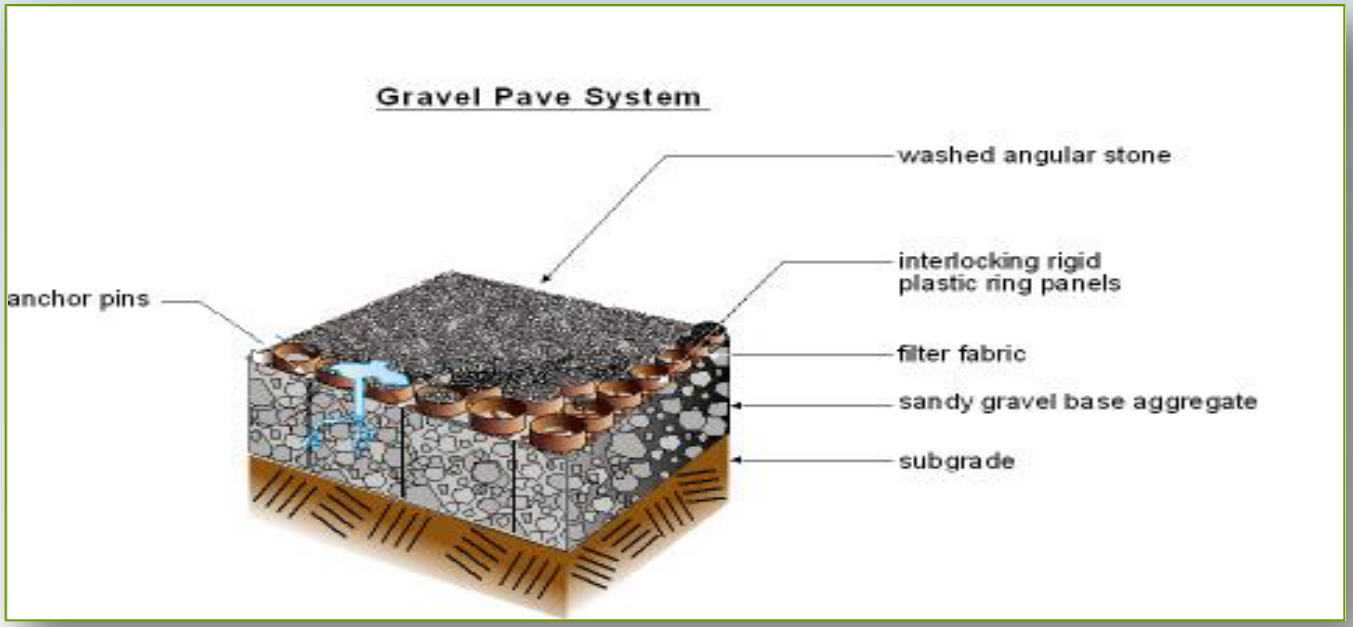
- Flexible
- Capable of high vehicle loads. Used for lower speeds.
- High-density concrete that interlock and transfer vertical loads to surrounding pavers
- 12 percent voids typical



PERMEABLE PAVEMENT

ANATOMY OF A FACILITY (PLASTIC GRIDS)

- Flexible
- Plastic grid filled with gravel or soil and planted with grass
- Capable of high vehicle loads. Used for lower speeds.
- Highest percent voids



Permeable Pavement

Key Maintenance Considerations to Preserve Function

- Protect subgrade, aggregate base and wearing course from construction sediment
- Stabilize adjacent landscape areas
- Protect surface from material stockpiles
- Modify snow management procedures
  - Skids and rollers
  - Sand minimally and remove ASAP
  - Avoid stockpiling snow on permeable pavement

Permeable Pavement

Maintenance Standards & Procedures by Component

- Pavement surface
- Adjacent hard surfaces and landscape areas
- Drains

PAVEMENT SURFACE (ASPHALT AND CONCRETE)

Routine maintenance (cleaning surface debris)

- Large areas: vacuum sweep (regenerative air or high efficiency vacuum)
- Small areas: walk behind vacuums, shop vacs, hand held pressure washer or power washer with rotating brushes (pressure systems: test small area first)
- Frequency: 1-2 times annually or as determined by site conditions
- Consult with equipment manufacturer/rep for optimum operation

PAVEMENT SURFACE (ASPHALT AND CONCRETE)

Corrective maintenance (clogged wearing course)

- Review overall performance of the facility. If water ponds or flows off pavement surface during rain event , corrective maintenance or testing is needed.
- Test the surface infiltration rate using ASTM C1701 (perform 1 test/installation but not < 1 test/2500 sq ft).
- If the results from ASTM C1701 indicate an infiltration rate of 10 inches per hour, then take corrective action.
- For corrective maintenance, use a pressure wash and vacuum system, hand held pressure wash or power wash with rotating brushes or pure vacuum sweeper calibrated to not dislodge wearing course aggregate.

Before

During

After cleaning

PAVEMENT SURFACE (ASPHALT AND CONCRETE)

Moss (inhibits infiltration or presents slip safety hazard)

- Sidewalks: Use a broom to remove moss in the summer when it is dry
- Parking lots and roadways: Pressure wash (hand held pressure washer or power washer with rotating brushes), vacuum sweep with brush, or use a combination of the two

Conventional concrete with moss

PAVEMENT SURFACE (ASPHALT AND CONCRETE)

Major cracks or trip hazards and concrete spalling and raveling

- Fill potholes or small cracks with patching mixes
- Replace in-kind where feasible
- Large cracks and settlement may require cutting and replacing the pavement section. Replacing porous asphalt with conventional asphalt is acceptable if it is a small percentage of the total facility area and does not impact the overall facility function.

PAVEMENT SURFACE (PICP AND AGG PAVERS)

Routine maintenance (cleaning surface debris)

- Large areas: high efficiency regenerative air or vacuum sweepers
- Small areas: walk behind vacuums and shop vacs
- Frequency: 1-2 times annually or as determined by site conditions
- Consult with equipment manufacturer/rep for optimum operation

- Vacuum settings may have to be adjusted to prevent excess uptake of aggregate from paver openings or joints. Vacuum surface openings in dry weather to remove dry, encrusted sediment.

PAVEMENT SURFACE (PICP AND AGG PAVERS)

Corrective maintenance (clogged wearing course)

- Review overall performance of the facility. If water ponds or flows off pavement surface during rain event , corrective maintenance or testing is needed.
- Test the surface infiltration rate using ASTM C1701 (perform 1 test/installation but not < 1 test/2500 sq ft).
- If the results from ASTM C1701 indicate an infiltration rate of 10 inches per hour, then take corrective action.
- For corrective maintenance, use a pure vacuum sweeper or pressure wash and vacuum system calibrated to remove all visible sediment (likely 2-3 cm of aggregate) in the joints or infiltration cells. Replace aggregate in joints or infiltration cells per manufacturer specifications.

PAVEMENT SURFACE (PICP AND AGG PAVERS)

Structural integrity

- Paver block missing or damaged: Remove individual damaged paver blocks by hand and replace or repair per manufacturer's recommendations
- Loss of aggregate material between paver blocks: Refill per manufacturer's recommendations
- Surface settling: May require resetting

PAVEMENT SURFACE (PICP AND AGG PAVERS)

Moss

- Sidewalks: Use a broom to remove moss in the summer when it is dry
- Parking lots and roadways: Vacuum sweep or stiff broom/power brush

PAVEMENT SURFACE (GRID WITH GRAVEL)

Routine maintenance (cleaning surface debris)

- Large areas: vacuum sweep (regenerative air, high efficiency vacuum)
- Small areas: walk behind vacuums, shop vacs, rake, leaf blower
- Frequency: 1-2 times annually or as determined by site conditions
- Consult with equipment manufacturer/rep for optimum operation
- Vacuum settings may have to be adjusted to prevent excess uptake of aggregate from plastic grid. Vacuum surface openings in dry weather to remove dry, encrusted sediment.
- Maintain aggregate 0.25 inches above grid structure

PAVEMENT SURFACE (GRID WITH GRAVEL)

Corrective maintenance (clogged wearing course)

- Observe the pavement system after a rain event (testing infiltration rate using ASTM C1701 likely not applicable)
- Corrective action needed, if ponding on surface or water flows off aggregate surface during rain event
- Use vacuum system calibrated to remove all visible sediment (likely 2-3 cm of aggregate). Replace aggregate per manufacturer specifications (usually 0.25 inches above grid structure).

PAVEMENT SURFACE (GRID WITH GRAVEL)

Structural integrity

- Grid damaged: Remove pins (if present), pry up grid segments, and replace grid and gravel. Replace grid segments where three or more adjacent rings are broken or damaged.
- Loss of aggregate material: Refill per manufacturer's recommendations (usually 0.25 inches above grid structure)
- Surface settling: May require resetting

Gravel Pave not installed to manufacturer recommendations

Permeable Pavement

Pavement Surface (Grid with grass)

Routine maintenance (cleaning surface debris)

- Large and small areas: rakes, leaf blowers…consult manufacturer guidelines for cleaning surface debris
- Frequency: 1-2 times annually or as determined by site conditions
- Maintain soil/sand slightly below grid structure

PAVEMENT SURFACE (GRID WITH GRASS)

Corrective maintenance (clogged wearing course)

- Observe the pavement system after a rain event. Testing infiltration rate using ASTM C1701 likely not be applicable.
- Corrective action needed if ponding on surface or water flows off aggregate surface during rain event
- Follow manufacturer's guidelines for repairing surface

PAVEMENT SURFACE (GRID WITH GRASS)

Structural integrity

- Grid damaged: Remove pins (if present), pry up grid segments, and replace grid and grass. Replace grid segments where three or more adjacent rings are broken or damaged.

- Poor grass coverage in paving grid: Restore growing medium, reseed or plant, *aerate*, and/or amend vegetated area as needed. Traffic loading may be inhibiting grass growth; reconsider traffic loading if feasible. Growing media elevation should be maintained slightly below grid structure. Consult manufacturer/sales representative.

- Grass growth: use mulch mower. Top dress with 0.5 inches of compost if nutrient deficient (do not use fertilizer).

- Surface settling: May require resetting

ADJACENT LANDSCAPE AREAS

Runoff depositing sediment, mulch or other material

- Check if surface elevation of planted area is too high, or slopes towards pavement, and can be re-graded (prior to re-grading, protect porous pavement by covering with temporary plastic and secure covering in place)
- Mulch and/or plant all exposed soils that may erode to paving installation surface
- Clean

UNDER- AND ELEVATED-DRAINS

Drainage

- Drain clogged: Jet clean or rotary cut debris/roots from under-drain. Clean flow restrictor/orifice. Identify the source of the blockage and take actions to prevent future blockages.

- Soil exposed or other signs of erosion damage are present at discharge point: Identify source of problem. Repair erosion and stabilize surface.

- Water remains in the storage aggregate longer than anticipated by design after the end of a storm: Determine if problem. Inspect drains. If structural problems possible schedule investigation of subsurface materials or other potential causes of extended ponding.

PERMEABLE PAVEMENT

EQUIPMENT/ MATERIALS LIST

Table 9. Permeable Pavement Equipment and Materials List.

Equipment to address clogging of wearing course, such as:	*Weed / vegetation removal equipment, such as:*
☐ Hand held pressure washer or power washer with rotating brushes (not recommended for open-celled aggregate-filled systems) ☐ Walk-behind vacuum (sidewalks) ☐ Pure vacuum sweeper ☐ ShopVac (small areas) ☐ Combined higher pressure wash and vacuum system	☐ Weeding tools ☐ Weed burner ☐ Edging and trimming equipment to control groundcover and other vegetation from extending onto pavement surface
Equipment to remove sediment, debris, and leaf litter, such as:	*Additional equipment for grass-filled open-celled grid systems*
☐ High efficiency regenerative air or vacuum sweeper (roadways, parking lots) ☐ Push broom (can also be used to spread and clean aggregate in gravel-filled open-celled grid and permeable paver systems) ☐ Brush broom (course bristled broom) to remove moss ☐ Leaf blower	☐ Mower or mulch mower ☐ Topdress grass seed ☐ Compost ☐ Replacement grid segments
*Erosion control equipment (to stabilize adjacent landscaped areas and protect pavement from sediment inputs)**	*Additional equipment for gravel-filled open-celled grid systems*
☐ Erosion control matting ☐ Rocks ☐ Mulch ☐ Plants ☐ Landscaping tools ☐ Tarps (to protect pavement in area of landscaping from clogging, e.g., mulch stockpiles)	☐ Rakes and shovels ☐ Aggregate to replace material after vacuuming or to replenish material in high use areas ☐ Replacement grid segments ☐ Wheelbarrow (for transporting replacement aggregate)
Pipe/structure inspection and maintenance equipment	*Additional equipment for permeable paver systems*
☐ Hand tools ☐ Wrench or manhole opener (for opening manhole lids, grates, etc.) ☐ Flashlight ☐ Mirror (for viewing pipes without entering structure) ☐ Garden hose ☐ Plumbing snake ☐ Measuring tape or ruler	☐ Rakes and shovels ☐ Extra pavers and bedding material ☐ Aggregate to replace materials between pavers after vacuuming ☐ Wheelbarrow (for transporting replacement aggregate)
	Snow removal equipment, such as:
	☐ Plow with skids to prevent damage to permeable pavement ☐ Snow blower

SKILLS

- Sweeper and equipment operation
- Commercial driver's license (CDL)
- Landscaping skills (e.g., general plant care) for grass-filled open-celled grid systems
- Engineer and/or landscape architect for major maintenance

OUTLINE

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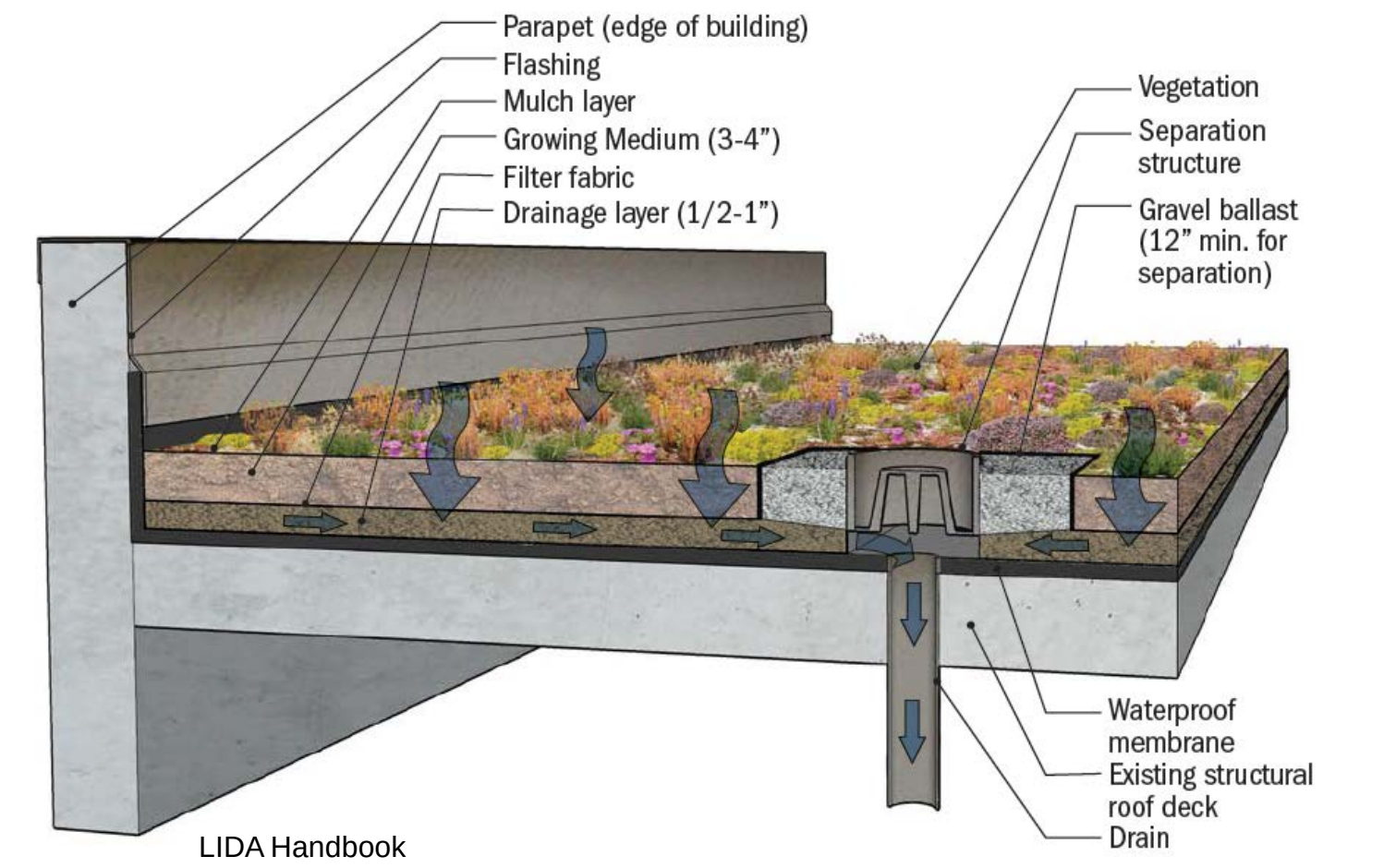
VEGETATED ROOFS

HOW THE FACILITY WORKS



LIDA Handbook

VEGETATED ROOFS MAINTENANCE CONSIDERATIONS

- Stormwater must infiltrate freely through soil
- Stormwater must freely exit facility
- Vegetation should be healthy and cover majority of soil surface

Park Place Green Roof

MAINTENANCE STANDARDS & PROCEDURES BY COMPONENT

- Growth Medium
- Roof Drain
- Flashing, Gravel Stops, or Other System Components
- Vegetation
- Weeds
- Watering

Vegetated Roofs

Growth Medium

- Aerate or replace mediumif failing to infiltrate (careful not to damage waterproof membrane)
- Supplement growth medium to design thickness
- For visible erosion or scour, prevent further damage and repair media
- Repair or replace damaged erosion control material until 90% vegetation cover

Compaction

Wind erosion

Vegetated Roofs

Roof Drain

- Clear blockage and debris to prevent or repair clogging
- Repair/replace damaged inlet pipes

Flashing, Gravel Stops, or Other System Components

- Repair (e.g., recoat) or replace deteriorating elements to eliminate potential pollutant source

VEGETATED ROOFS

VEGETATION

- Plant areas below 90% cover and install erosion control measures, if necessary, until 90% cover is achieved
- Mulch mow sedums to encourage establishment
- Recycle or remove dead vegetation and replace, if necessary

Stressed vegetation

Moss


Vegetation Growing Over Path

Vegetated Roofs

Weeds

- Remove weeds manually, with pincer-type weeding tools, flame weeders, or hot water weeders as appropriate

- Follow IPM protocols for weed management

Weeds

Watering

- Once every 1-2 weeks as needed during prolonged dry periods during establishment periods

- As needed during prolonged dry periods after establishment

EQUIPMENT/ MATERIALS LIST

Table 13. Vegetated Roof Equipment and Materials List.

General gardening and landscaping equipment	*Gardening and landscaping materials*
☐ Gloves	☐ Plants/seeds
☐ Weeding tool	☐ Growing media
☐ Soil knife	☐ Fertilizer (encapsulated, slow release)
☐ Hand tamper	*Erosion control material**
☐ Hoe	☐ Mulch (intensive roofs)
☐ Rake	☐ Erosion control matting
☐ Push broom	*Equipment and materials for subsurface or drip irrigation system repairs*
☐ Buckets	☐ Soaker hose
☐ Garbage bags (for disposal of noxious weeds)	☐ Hose/shower-type wand
Additional equipment for intensive roofs:	☐ Sprinklers
☐ Pruners	☐ Tree watering bags
☐ Loppers	☐ Buckets
☐ Manual edger	☐ Water source, if necessary
☐ Line trimmer (also known as a string trimmer, weed eater, or weed whacker)	*Safety equipment*
☐ Wheelbarrow	☐ Fall protection as applicable
☐ Shovel	
☐ Stakes and guys	

*Items not required for routine maintenance

Vegetated Roofs

Skills

- Landscaping skills
- Plant identification skills
- General drainage system maintenance skills (e.g., subsurface or drip irrigation system repair)
- Roof work safety training
- Engineer and/or landscape architect for major maintenance

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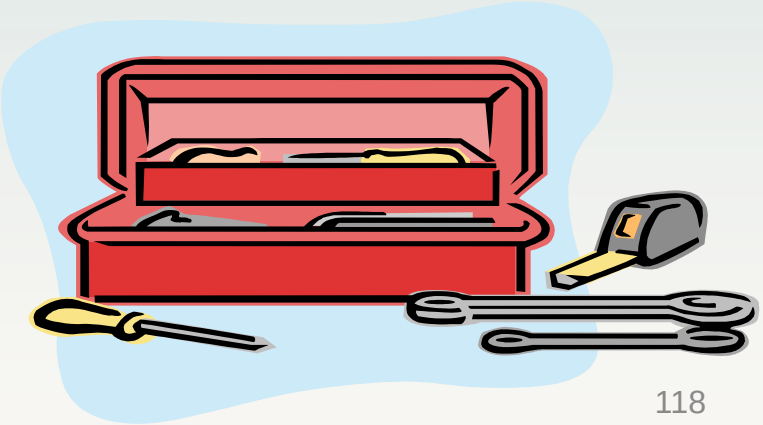
Administrative Tools & Guidance

Tools

- Stormwater code/manual
- Legal agreements
- Project-specific requirements
- Financial surety measures
- Record keeping and tracking
- Inspection programs
- Mapping
- Private property owner education



ADMINISTRATIVE TOOLS & GUIDANCE

STORMWATER CODE/MANUAL

- **Require long-term maintenance** of all permanent stormwater treatment and flow control BMPs/facilities

- Set forth **minimum inspection, operation, and maintenance requirements**

- Define permitting and plan review processes
  - List required **development project submittal elements** (e.g., Stormwater Site Plans, legal agreements, project O&M manual)

- **Identify the party responsible for retention, protection, and maintenance of BMPs**

ADMINISTRATIVE TOOLS & GUIDANCE

STORMWATER CODE/MANUAL (CONT.)

- **Describe how the responsibility for maintenance of BMPs is transferred** when property ownership changes

- Define the inspection process
  - Establish **legal authority of local government to inspect private stormwater facilities**

- Define the enforcement process
  - Establish legal authority of local government to enforce BMP maintenance standards
  - Establish enforcement mechanisms, such as fee triggers and schedule, for unmaintained facilities

Administrative Tools & Guidance

Stormwater Code/Manual (Cont.)

- Set forth requirement for **financial surety measures** (e.g., bonds) for development plats to guarantee maintenance of BMPs after construction

- Establish **limited legal authority to conduct maintenance** when not conducted in a timely manner and bill the property owner for the costs

Administrative Tools & Guidance

TIPS: Incorporating private facilities into City/County program

1. Inspect facilities and require that the property owner hire a qualified contractor to conduct necessary maintenance
2. Require facility owners to contract with a third party inspector and provide an inspection certification letter to the City/County, as well as proof that any required maintenance has been completed
3. Perform maintenance and charge the property owner
4. Assume maintenance responsibilities through a deed or easement

Administrative Tools & Guidance

Legal Agreements

- **Identify and characterize stormwater features** on site (i.e., attach as-built drawing of the lot with the location(s) of BMPs, design details, and maintenance instructions)
- **Require inspection and O&M activities** and direct responsible party to other resources
- **Identify the party responsible for retention, protection, and maintenance of BMPs**
- **Describe how the responsibility for maintenance of BMPs is transferred** when property ownership changes
- Help give the local government **legal access for inspection** of BMPs

ADMINISTRATIVE TOOLS & GUIDANCE

TIPS: WHAT HAPPENS WHEN A PROPERTY IS SOLD?

- Include language in the covenant that the property owner must inform all future purchasers of the existence and maintenance requirements of the stormwater BMPs on their property
- Require informational handouts at point-of-sale inspections
- Require escrow companies to fax or e-mail the City/County when they perform the “tap and connection” check at time of sale to help the local government track the responsible party
- If a financial surety is in place, require the new owner to obtain one before releasing the existing bond

ADMINISTRATIVE TOOLS & GUIDANCE

TIPS: WORKING WITH HOAS

- HOAs can conduct maintenance or arrange for a qualified third party professional to conduct the maintenance
- Provides a point of contact for outreach and education
- An incentive to encourage ongoing HOA responsibility for stormwater facility maintenance could include a reduced stormwater utility fee
- Some HOAs dissolve over time. The legal agreement can be written to transfer the maintenance responsibility for a shared facility to the individual property owners if an HOA goes defunct.

Administrative Tools & Guidance

Project Specific Requirements

- **Minimum Requirements #1 - #5**: Stormwater Site Plans should include maintenance instructions for On-site Stormwater Management BMPs
- **MR #1 - #9:** maintenance instructions should also be developed for all On-site Stormwater Management BMPs that are not defined as Stormwater Treatment and Flow Control BMPs/ Facilities

- **MR #6 and/or MR #7:** Provide O&M manuals for each Stormwater Treatment and Flow Control BMP/Facility

Administrative Tools & Guidance

Financial Surety Measures

- If authorized by the jurisdiction's code, local governments can require that sureties (bonds or assignment of accounts/ assignment of savings) are obtained by developers
- Allows the government to enforce maintenance requirements (e.g., by pulling the bond) until the plat is fully constructed, or longer
- Generally only valid for two years before they are released (RCW 58.17.130)
- If LID BMPs are on individual lots, they may not all may be in place within 2 years

Administrative Tools & Guidance

Record Keeping and Tracking

- Parcel information
- City/County permit (ROW and/or building permit)
- Relevant sections of the Stormwater Site Plan
- “As-builts” or “record drawings” (individual lots and public ROW)
- Legal agreements (covenants, easements)
- Location information (GPS data, digital maps)
- Project O&M manual (where applicable)
- Maintenance logs (typically included in a Project O&M Manual)
- Inspection forms
- Enforcement documents

Administrative Tools & Guidance

Inspection Programs

- **Immediately post-construction** for all LID BMPs - installed per plan and functioning properly
- **Every 6 months** (until 90% of lots are constructed) for permanent Stormwater Treatment and Flow Control BMPs/Facilities in new residential developments - identify maintenance needs and enforce maintenance standards
- **Ongoing annual** inspections for all Stormwater Treatment and Flow Control BMPs/Facilities (MR #6 and/or MR #7)

ADMINISTRATIVE TOOLS & GUIDANCE

TIPS: INSPECTION PROGRAMS

- **Written notice and securing consent** from the property owner may help to avoid potential conflict and allows a “contact” and opportunity for education

- **Educational door hangers or handouts** can be used to inform property owners of upcoming inspections

- Consider **third party inspection** for BMPs in settings that are difficult for inspector to access or if property owners do not grant access to City/County

Administrative Tools & Guidance

Mapping

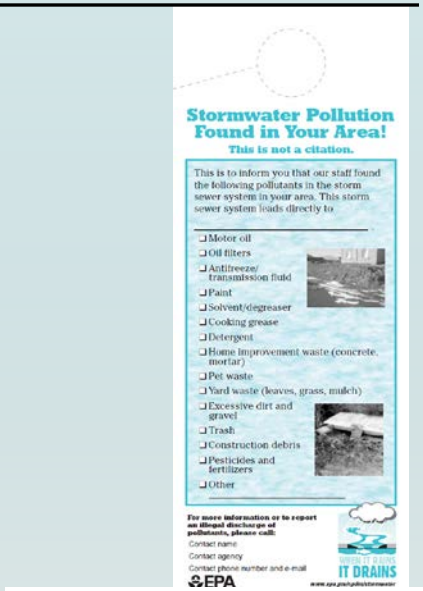
- **Placing single points on stormwater system maps:** reference permanent stormwater control plans (also referred to as “as-builts” or record drawings”) near the center of the dispersed LID BMPs

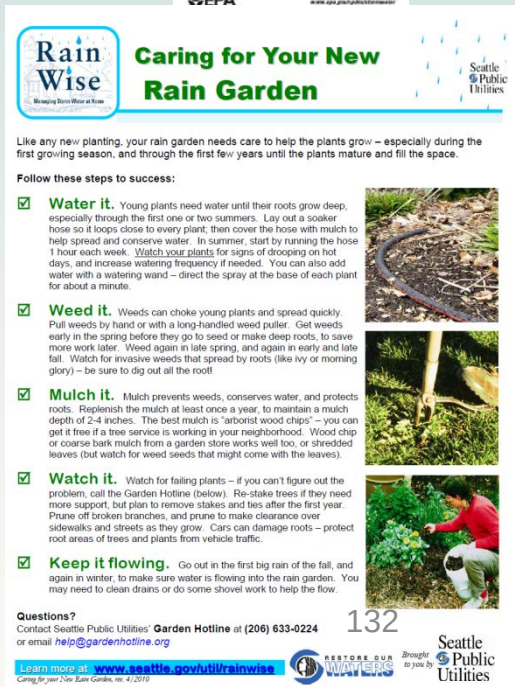
- **Mapping the location of each LID BMP:** may be more time consuming and clutter some stormwater system maps; however, it will provide the location of each known LID BMP and may be easier to track inspections and maintenance

ADMINISTRATIVE TOOLS & GUIDANCE

PUBLIC EDUCATION

- Door hangers or handouts distributed at maintenance inspections
- Booklet on how to maintain LID features (e.g., rain gardens), provided to the homeowner, along with other property documentation, by the developer
- Homeowner education program(s) – encourage realtors to inform potential homebuyers of the presence of LID features, maintenance requirements, and inspection prior to purchase





Administrative Tools & Guidance

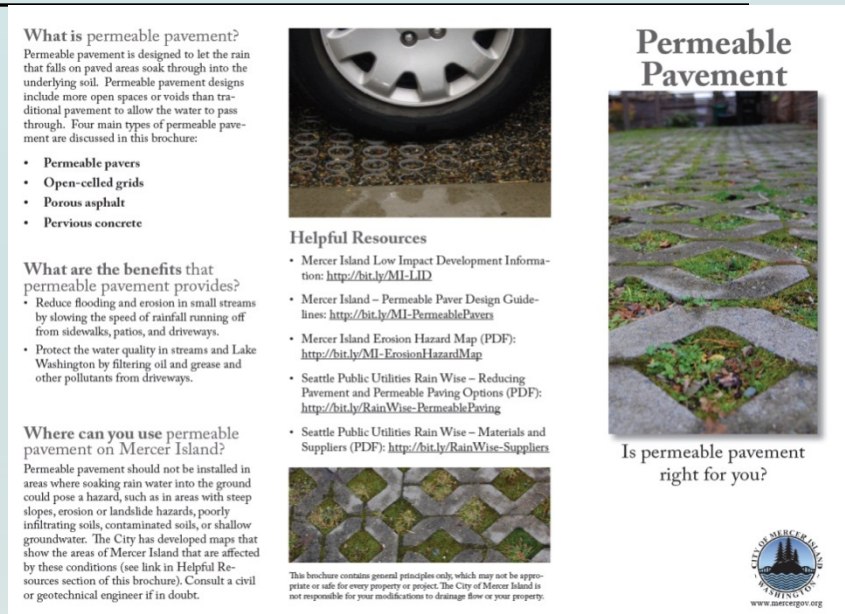
Public Education (Cont.)

- Placard in the house or signage outside of the house
- Program for homeowner education at the permit counter
- Program for HOA education in the classroom and as a site visit
- Classes for homeowners/private property owners/HOAs through universities or groups such as extension programs, Conservation Districts, or Master Gardeners Associations

Administrative Tools & Guidance

Public Education (Cont.)

- Educational handouts/fact sheets distributed via local partnerships and programs
- Utility bill inserts
- Broader community outreach through media, web resources, or activities at community events



What is permeable pavement?

Permeable pavement is designed to let the rain that falls on paved areas soak through into the underlying soil. Permeable pavement designs include more open spaces or voids than traditional pavement to allow the water to pass through. Four main types of permeable pavement are discussed in this brochure:

- **Permeable pavers**
- **Open-celled grids**
- **Porous asphalt**
- **Pervious concrete**

What are the benefits that permeable pavement provides?

- Reduce flooding and erosion in small streams by slowing the speed of rainfall running off from sidewalks, patios, and driveways.
- Protect the water quality in streams and Lake Washington by filtering oil and grease and other pollutants from driveways.

Where can you use permeable pavement on Mercer Island?

Permeable pavement should not be installed in areas where soaking rain water into the ground could pose a hazard, such as in areas with steep slopes, erosion or landslide hazards, poorly infiltrating soils, contaminated soils, or shallow groundwater. The City has developed maps that show the areas of Mercer Island that are affected by these conditions (see link in Helpful Resources section of this brochure). Consult a civil or geotechnical engineer if in doubt.

Helpful Resources

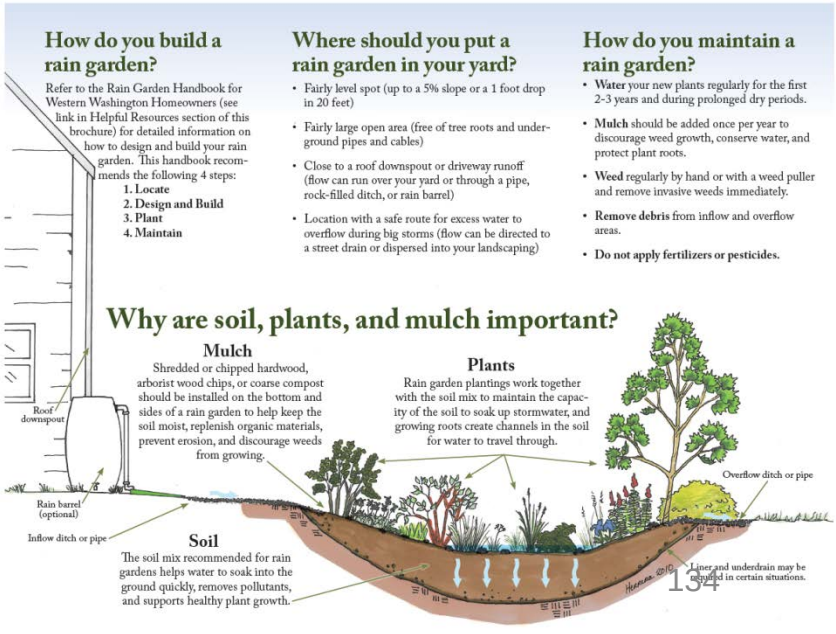
- Mercer Island Low Impact Development Information: http://bit.ly/MI-LID
- Mercer Island – Permeable Paver Design Guidelines: http://bit.ly/MI-PermeablePavers
- Mercer Island Erosion Hazard Map (PDF): http://bit.ly/MI-ErosionHazardMap
- Seattle Public Utilities Rain Wise – Reducing Pavement and Permeable Paving Options (PDF): http://bit.ly/RainWise-PermeablePaving
- Seattle Public Utilities Rain Wise – Materials and Suppliers (PDF): http://bit.ly/RainWise-Suppliers

This brochure contains general principles only, which may not be appropriate or safe for every property or project. The City of Mercer Island is not responsible for your modifications to drainage flow or your property.

Permeable Pavement

Is permeable pavement right for you?

www.mercergov.org



How do you build a rain garden?

Refer to the Rain Garden Handbook for Western Washington Homeowners (see link in Helpful Resources section of this brochure) for detailed information on how to design and build your rain garden. This handbook recommends the following 4 steps:

1. Locate
2. Design and Build
3. Plant
4. Maintain

Where should you put a rain garden in your yard?

- Fairly level spot (up to a 5% slope or a 1 foot drop in 20 feet)
- Fairly large open area (free of tree roots and underground pipes and cables)
- Close to a roof downspout or driveway runoff (flow can run over your yard or through a pipe, rock-filled ditch, or rain barrel)
- Location with a safe route for excess water to overflow during big storms (flow can be directed to a street drain or dispersed into your landscaping)

How do you maintain a rain garden?

- **Water** your new plants regularly for the first 2-3 years and during prolonged dry periods.
- **Mulch** should be added once per year to discourage weed growth, conserve water, and protect plant roots.
- **Weed** regularly by hand or with a weed puller and remove invasive weeds immediately.
- **Remove debris** from inflow and overflow areas.
- **Do not apply fertilizers or pesticides.**

Why are soil, plants, and mulch important?

Mulch
Shredded or chipped hardwood, arborist wood chips, or coarse compost should be installed on the bottom and sides of a rain garden to help keep the soil moist, replenish organic materials, prevent erosion, and discourage weeds from growing.

Plants
Rain garden plantings work together with the soil mix to maintain the capacity of the soil to soak up stormwater, and growing roots create channels in the soil for water to travel through.

Soil
The soil mix recommended for rain gardens helps water to soak into the ground quickly, removes pollutants, and supports healthy plant growth.

Roof downspout
Rain barrel (optional)
Inflow ditch or pipe
Overflow ditch or pipe
Liner and underdrain may be required in certain situations.

Administrative Tools & Guidance

Tips: Large Developments

Large developments pose challenges for LID BMP maintenance programs because:

- Subdivisions may include numerous distributed LID BMPs with a large number of responsible parties
- The developer may not have all BMPs sited and designed at time of plan review
- There is a risk that the plat will be cleared and the project abandoned
- Lots could be sold to multiple builders and construction could occur over a long period of time

ADMINISTRATIVE TOOLS & GUIDANCE

TIPS: LARGE DEVELOPMENTS

Local governments could consider the following:

- Require bonding until full build out and stormwater BMP construction
- Ensure financial surety amount is sufficient
- Require multi-party covenants for BMPs in the ROW (e.g., roadside bioretention) recorded for each lot adjacent to the ROW
- Prohibit or limit wholesale clearing (mass grading) of sites
- Require covenant and easement agreements to be recorded prior to final plat or final short plat are recorded

Q&A

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