

Swales and Rain Gardens



GREEN
from the Ground Up
Seminars for land-savvy developers



[nev-ū-non]
Nevue Ngan Associates



Swales and Rain Gardens: Overview

Kevin Robert Perry

Nevue Ngan Associates



GREEN from the Ground Up

Which city has the most annual rainfall ?

A. Chicago, IL

36 inches



B. Philadelphia, PA

42 inches



C. Malmo, Sweden

29 inches



D. Portland, OR

37 inches



Integrating Rain with Urban Design



GREEN from the Ground Up

The “Toolbox” for Landscape Strategies



Vegetated Swales



Stormwater Planters



Stormwater Curb Extensions



Rain Gardens

Sustainable Stormwater Guiding Principles

1. Manage stormwater runoff both at the source and at the surface.



2. Use plants and soil to slow, filter, cleanse, and infiltrate runoff.



3. Design facilities that are simple, low-cost, and aesthetically enhance the community.



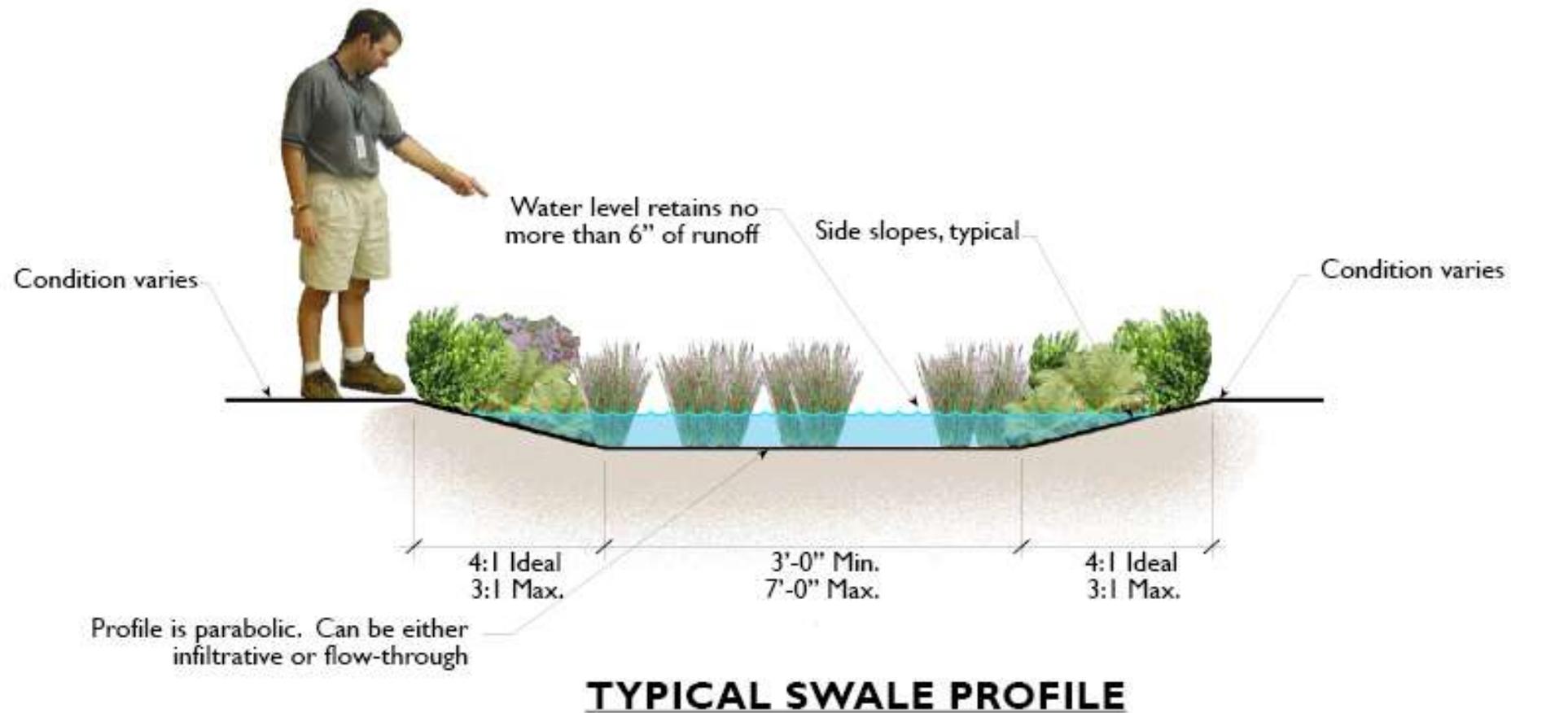
Vegetated Swales

Vegetated swales are shallow landscaped areas designed to capture, convey, and potentially infiltrate stormwater runoff as it moves downstream.



GREEN from the Ground Up

Vegetated Swales



GREEN from the Ground Up

Vegetated Swales



Good Places for Vegetated Swales:

- New residential and commercial streets
- Arterial streets and boulevards
- Within street medians on new streets
- Within the interior and along the edges of parking lots
- Within building perimeter landscaping

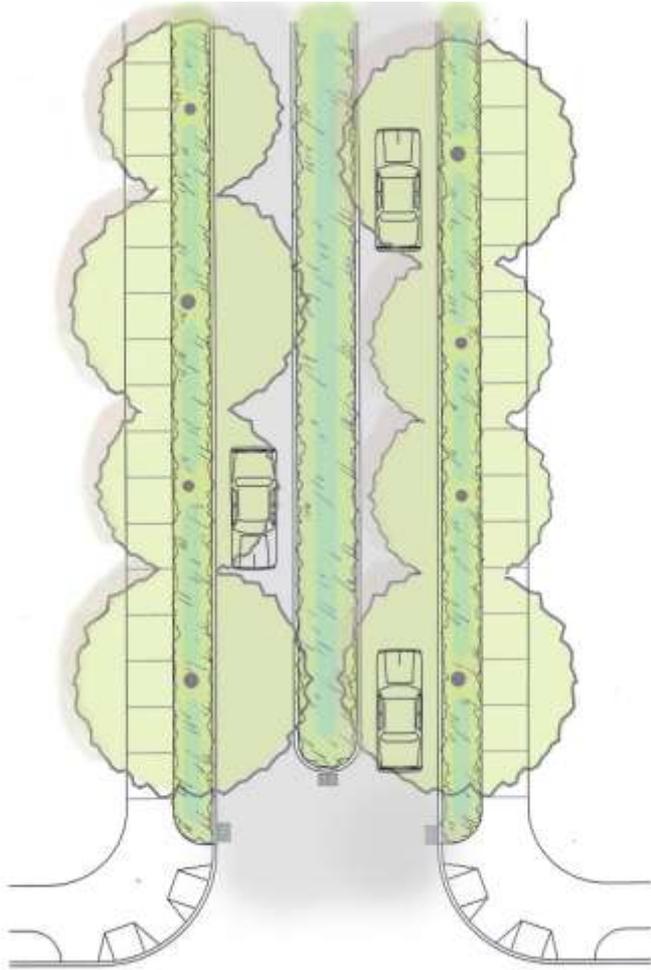
Why Choose Vegetated Swales:

- Widely-accepted stormwater strategy
- Simple to construct
- Relatively low-cost to implement

Potential Constraints:

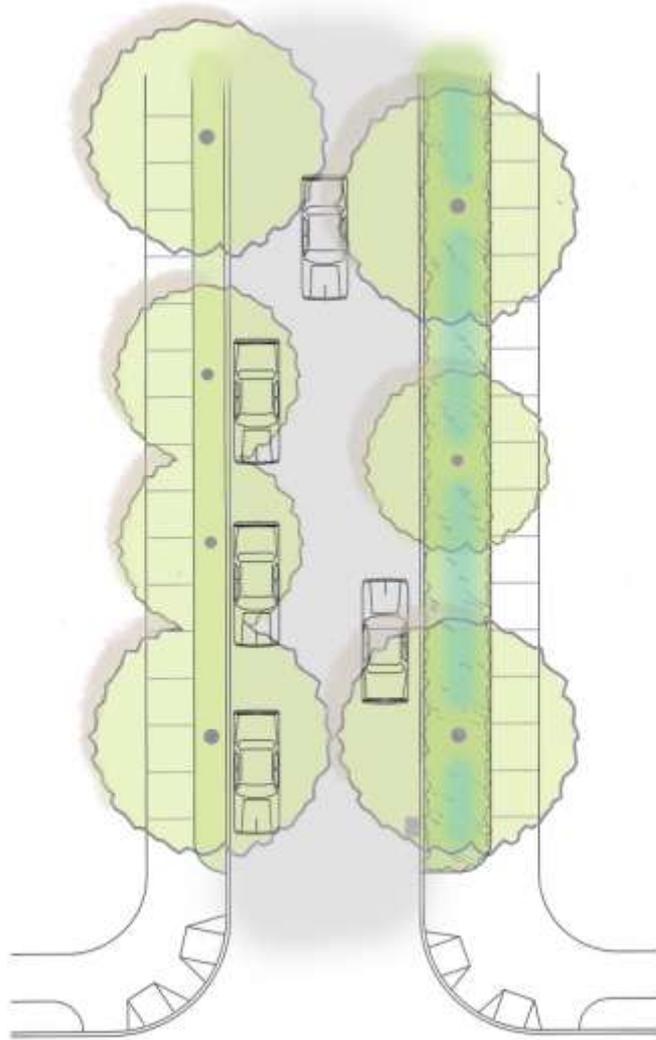
- Need long, continuous spaces which can be difficult to find in retrofit conditions
- Difficult to incorporate other streetscape elements within swales (lighting, signage, etc.)
- More difficult to provide good pedestrian circulation through swales
- Often designed to be “too deep” and, as a result, are not aesthetically pleasing

Vegetated Swales – Residential Streets

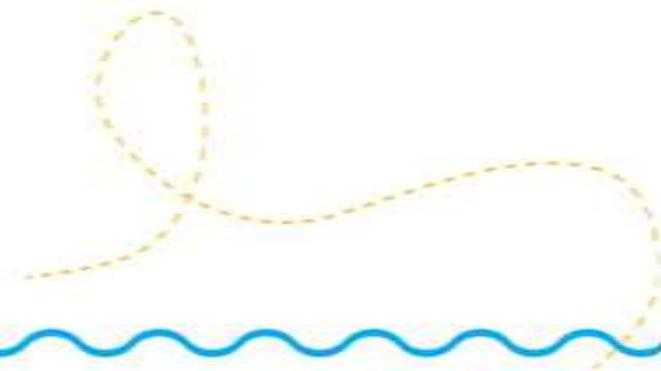


Center Median Swales

Vegetated Swales – Residential Streets

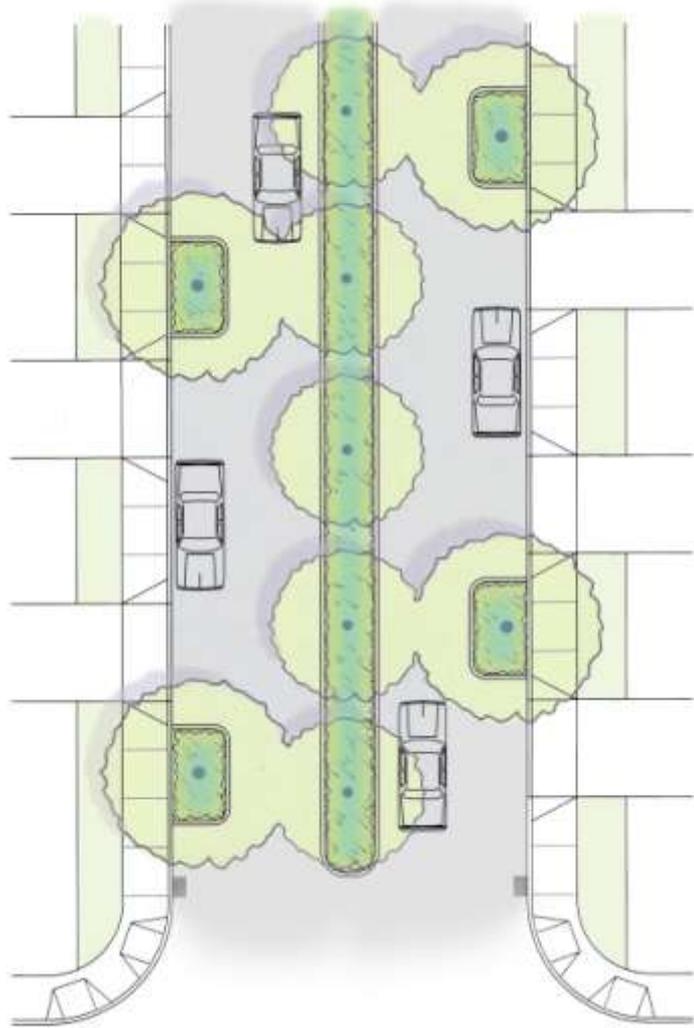


Side Swales



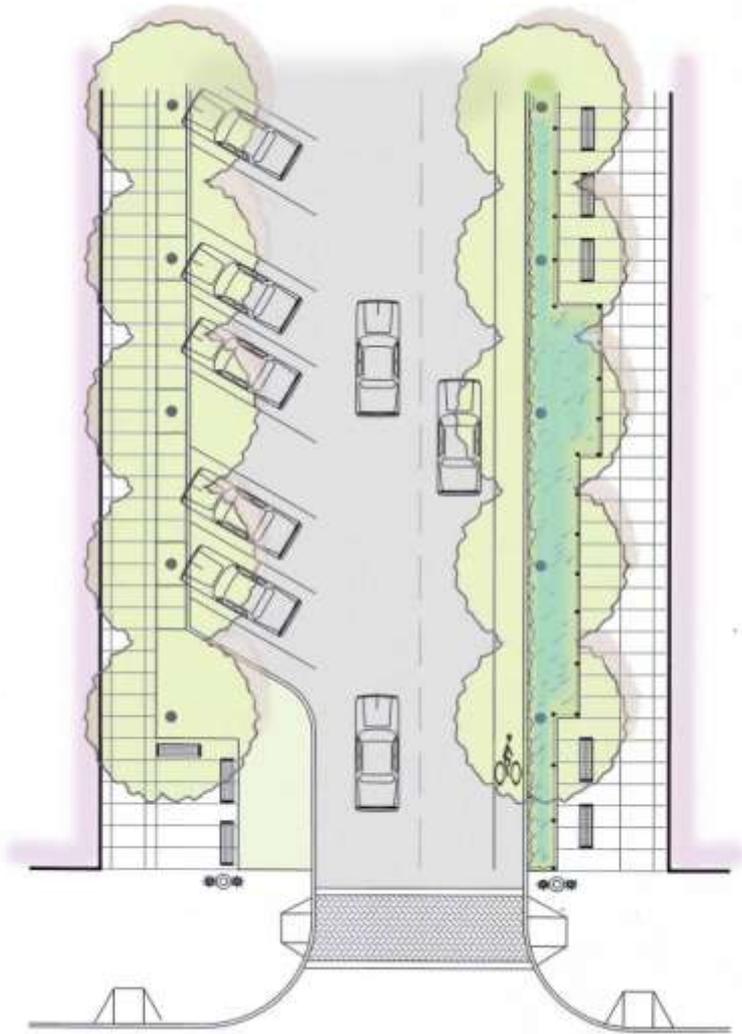
GREEN from the Ground Up

Vegetated Swales – Residential Streets



Center Median Swale with Curb Extensions

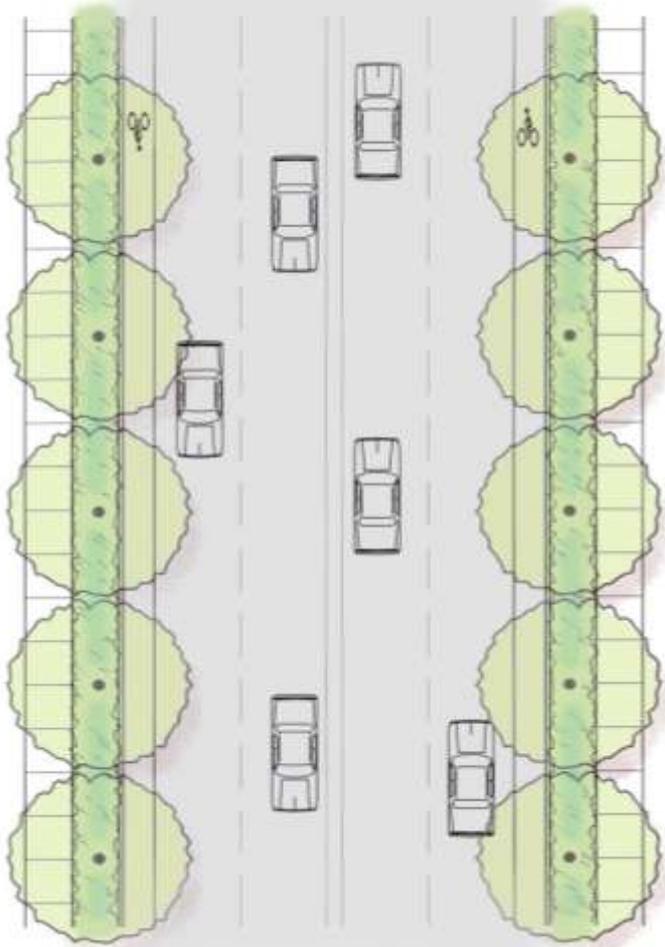
Vegetated Swales – Commercial Streets



“Curbless” Side Swales

GREEN from the Ground Up

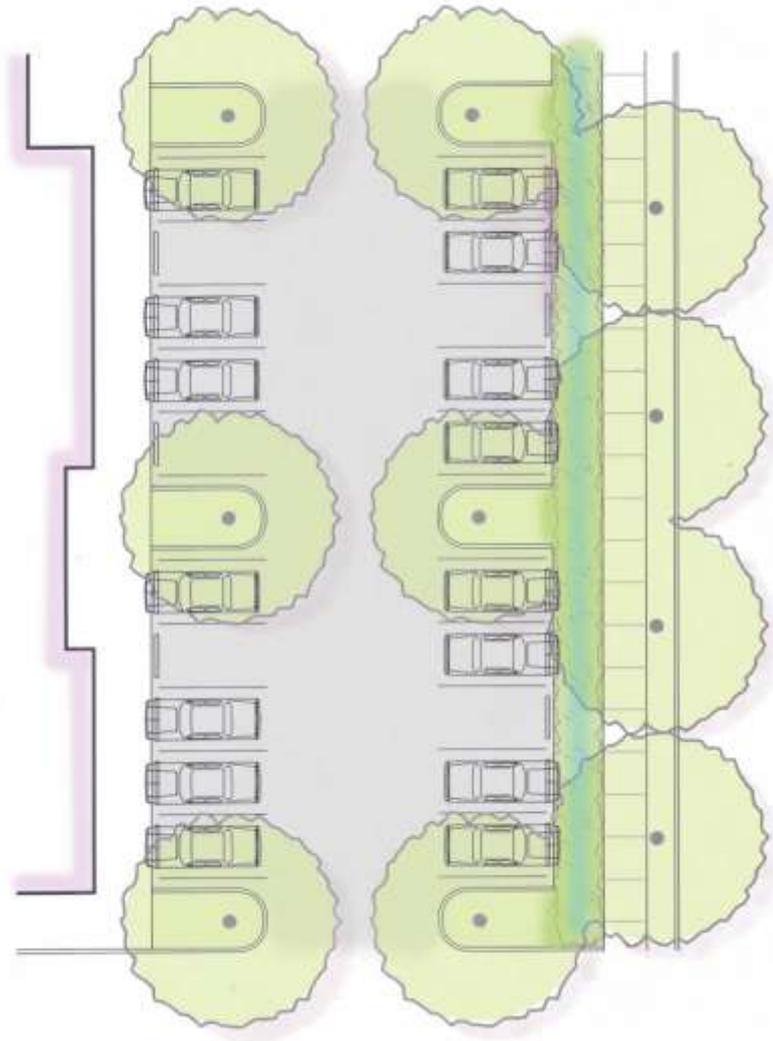
Vegetated Swales – Arterial Streets



Side Swales

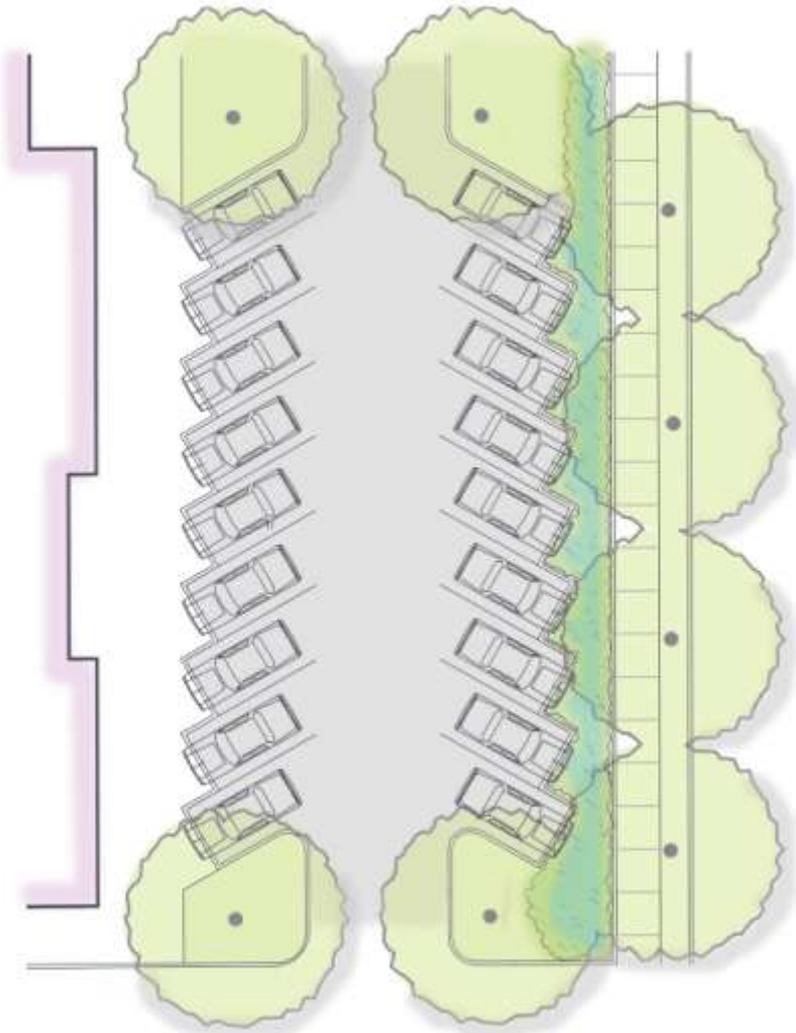
GREEN from the Ground Up

Vegetated Swales – Parking Lots



Side Swales – Head-in Parking

Vegetated Swales – Parking Lots



Side Swales – Angled Parking

GREEN from the Ground Up

Vegetated Swales – Buildings



GREEN from the Ground Up

Vegetated Swales – Buildings



GREEN from the Ground Up

Vegetated Swales – Buildings



GREEN from the Ground Up

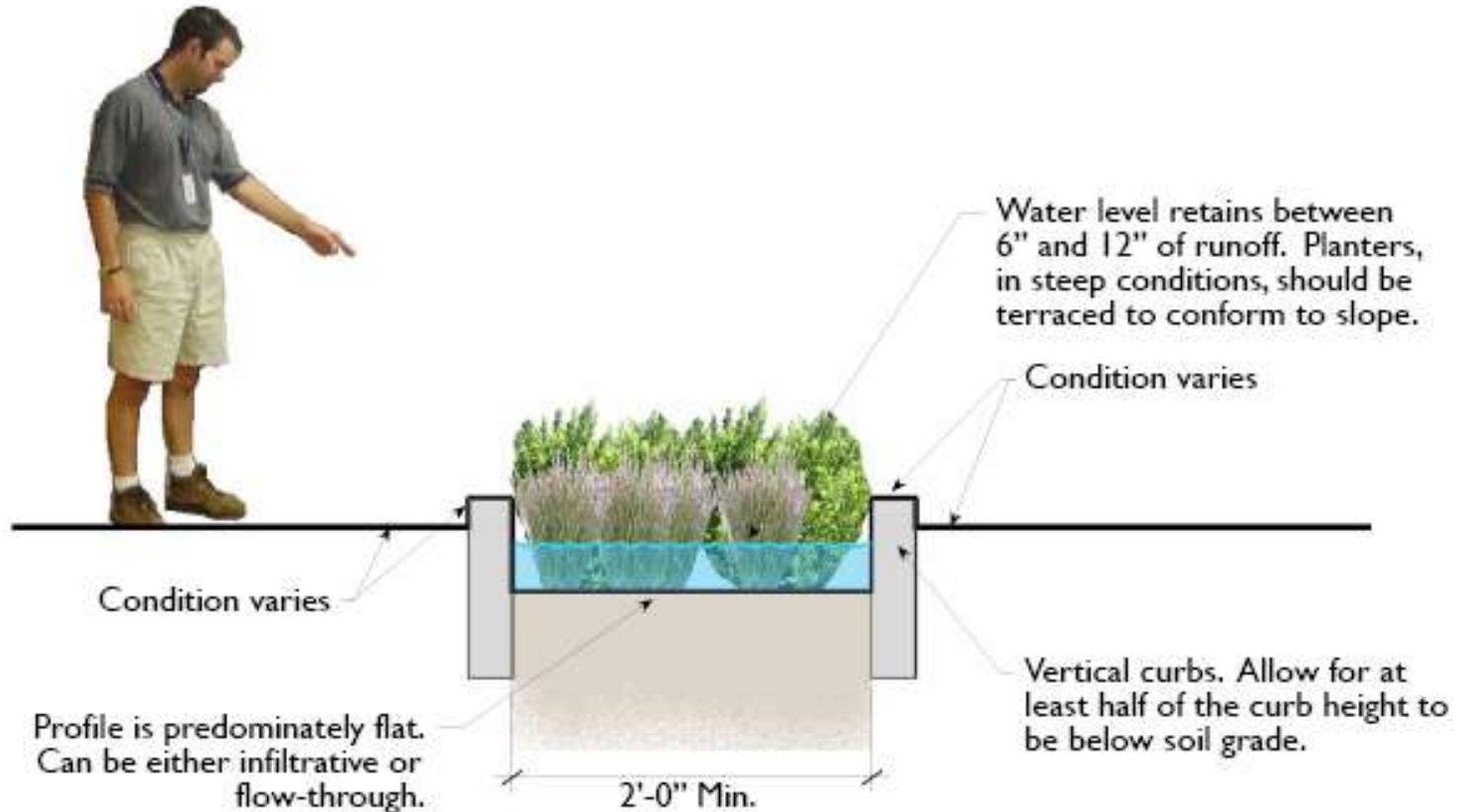
Stormwater Planters

Infiltration and flow-through planters are contained landscape areas designed to capture and retain stormwater runoff.



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Stormwater Planters



TYPICAL PLANTER PROFILE

GREEN from the Ground Up

Stormwater Planters



Good Places for Stormwater Planters:

- Commercial streets and parking lots where space is often constricted
- Adjacent to buildings where space is tight
- Areas of steep topography

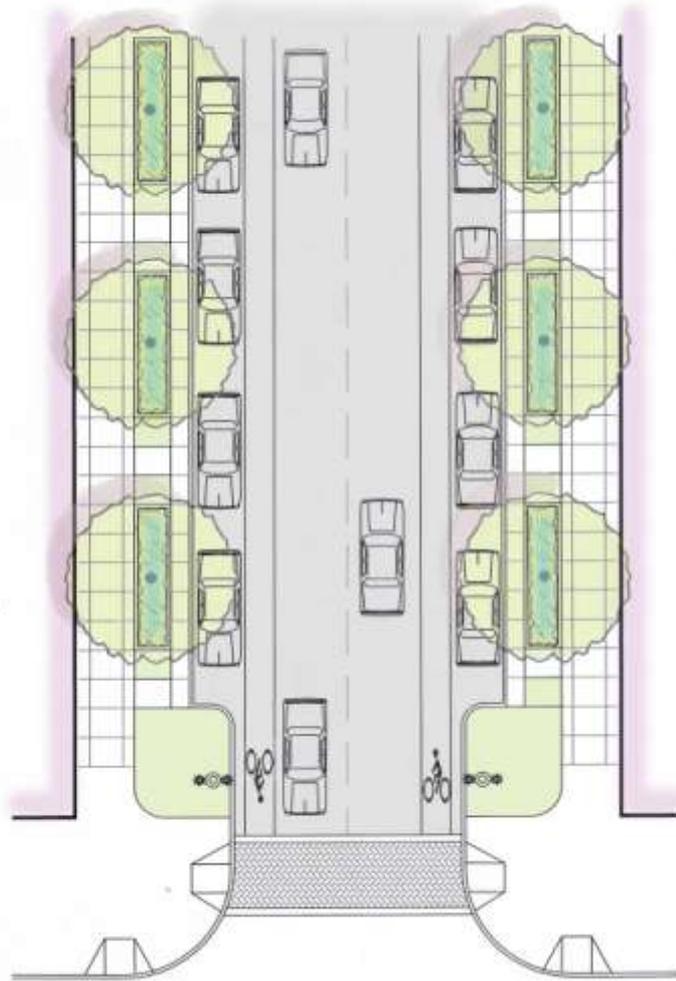
Why Choose Stormwater Planters:

- Are best landscape solution for ultraurban conditions
- Can be used with or without on-street parking depending on available space
- Can fit between other streetscape elements (trees, utilities, signage, etc.) and are highly versatile in shape and size
- Can provide both volume and flow stormwater benefits

Potential Constraints:

- Are generally more expensive than swales due to increased hardscape infrastructure
- Are only contextually appropriate in high density urban settings

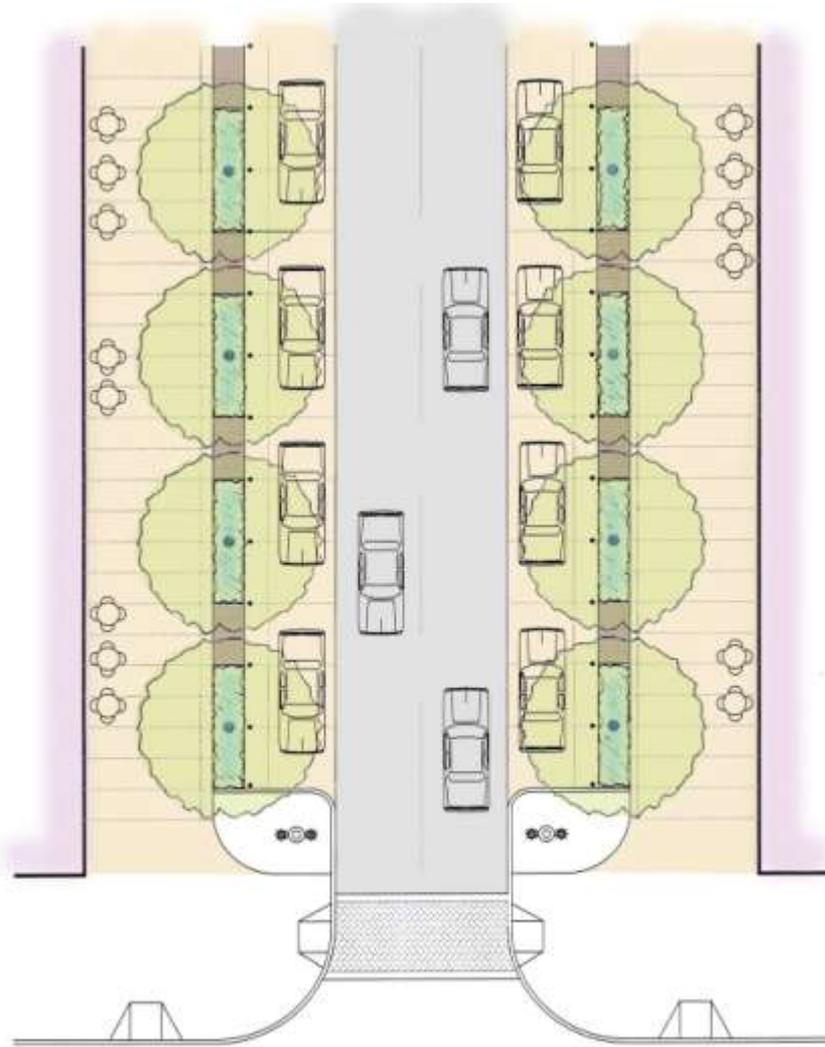
Stormwater Planters – Commercial Streets



Street Planters – With Parking

GREEN from the Ground Up

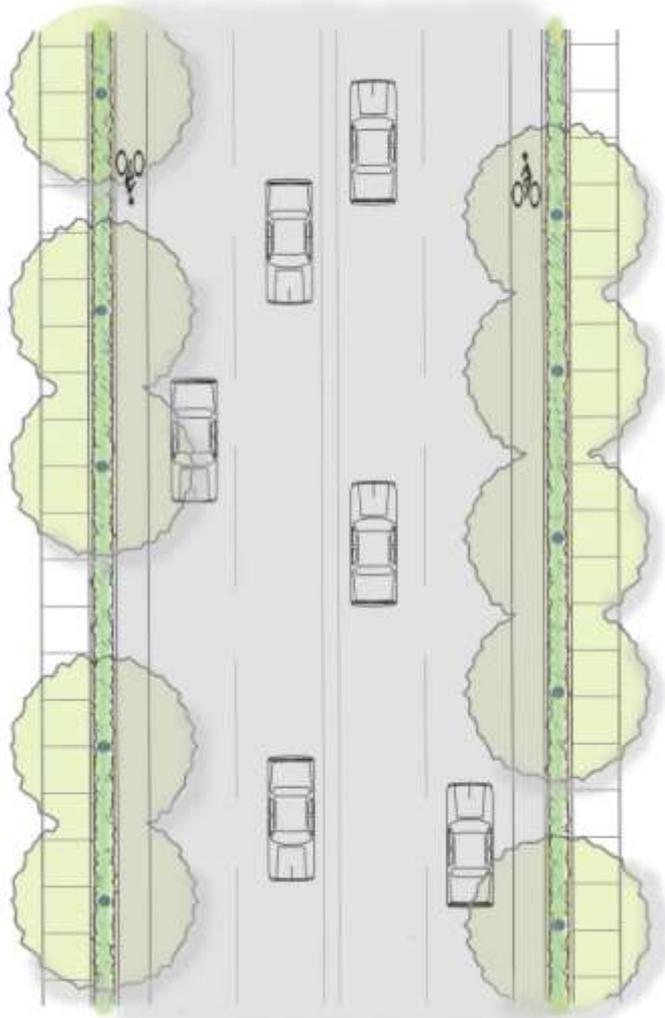
Stormwater Planters – Commercial Streets



Street Planters – With Bridges

GREEN from the Ground Up

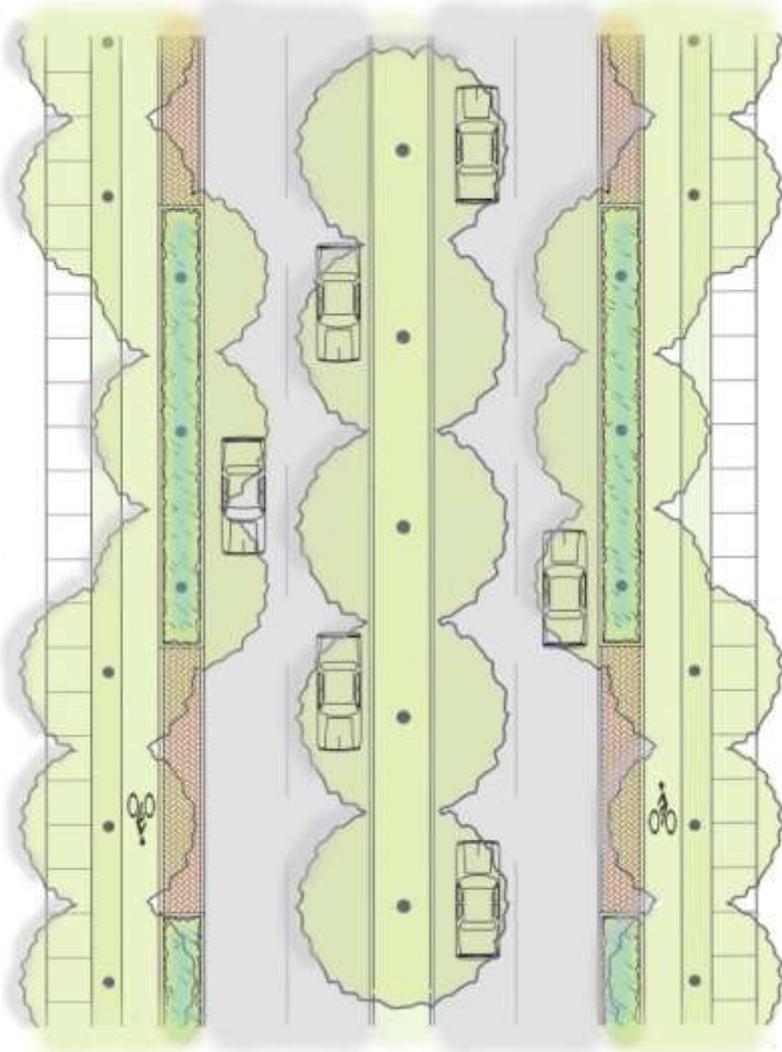
Stormwater Planters – Arterial Streets



Street Planters – “Green Gutter”

GREEN from the Ground Up

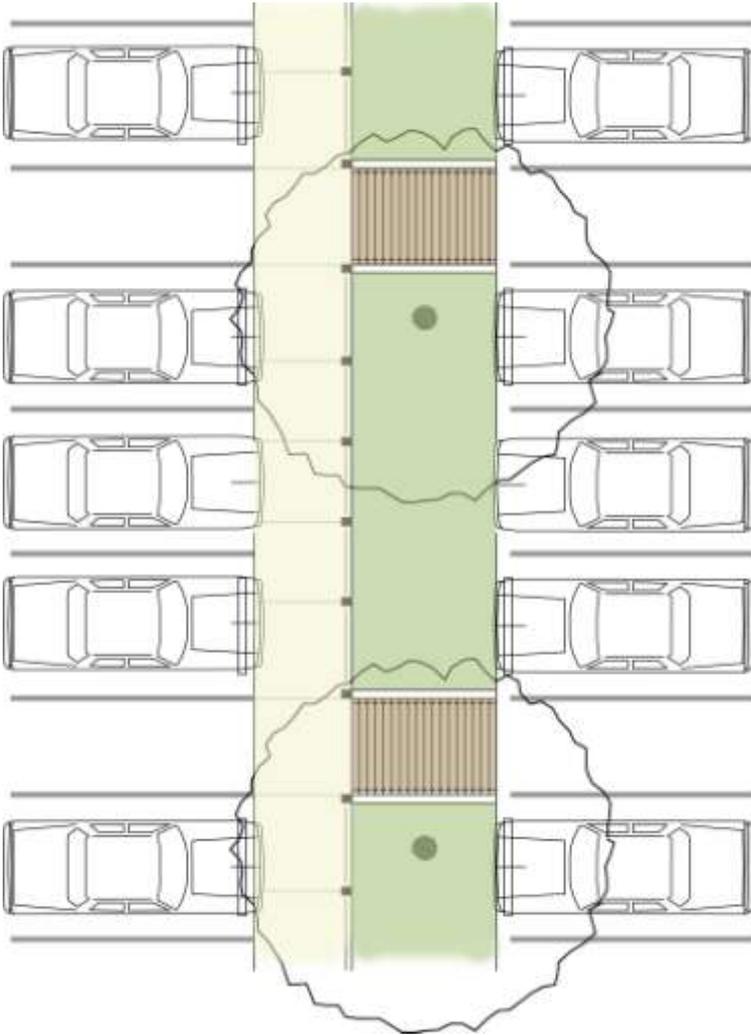
Stormwater Planters – Arterial Streets



Street Planters – With Bike Lane

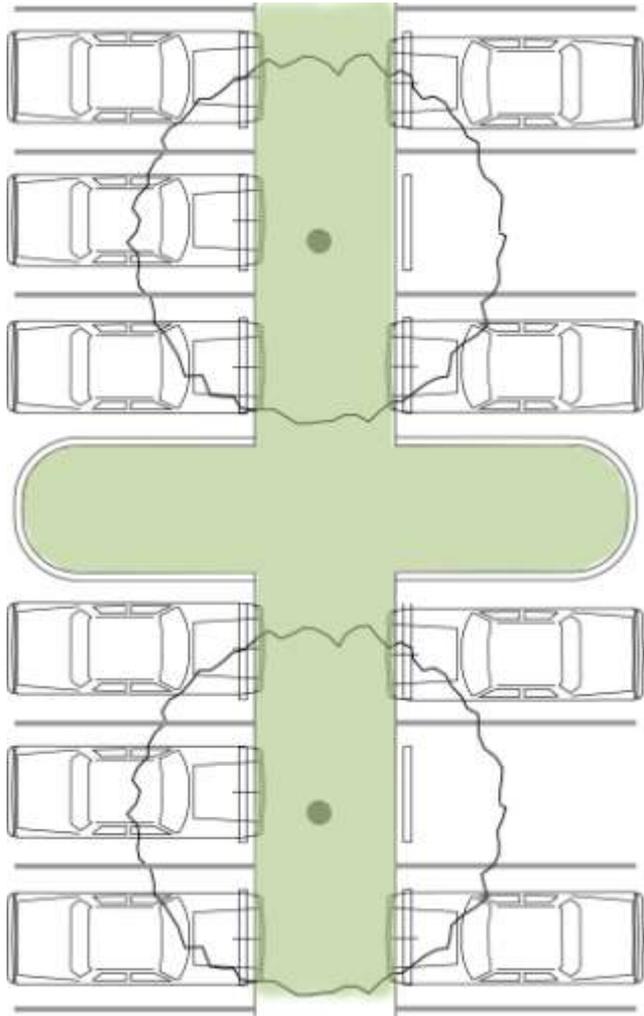
GREEN from the Ground Up

Stormwater Planters – Parking Lots



Center Median

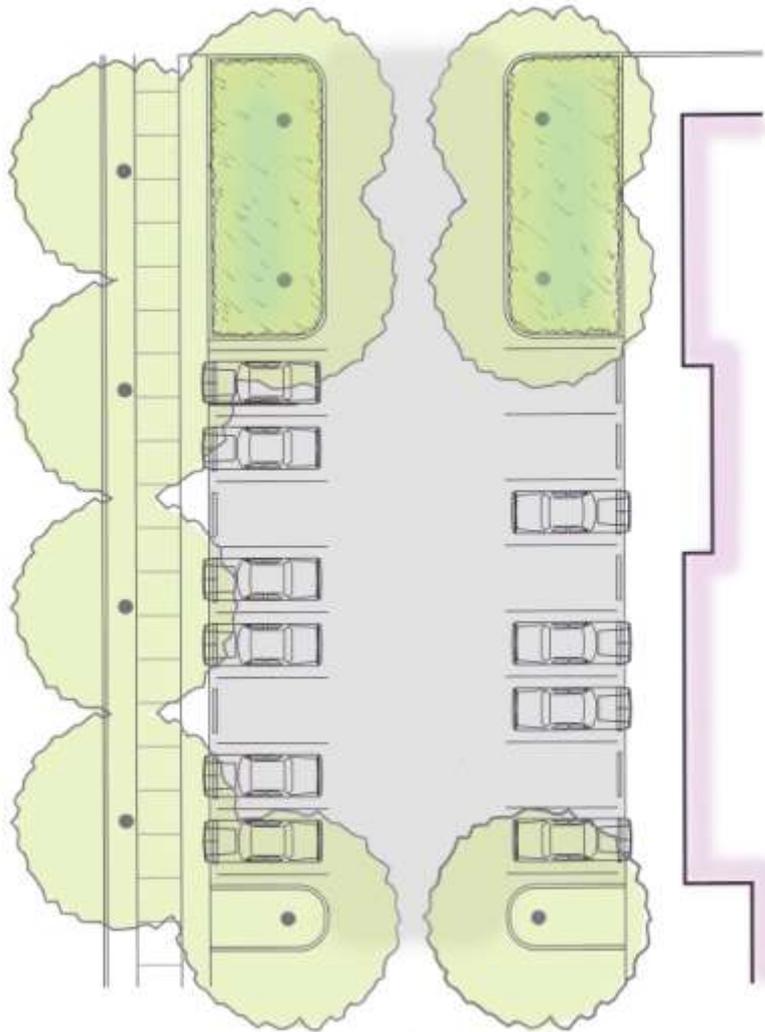
Stormwater Planters – Parking Lots



Center Median

GREEN from the Ground Up

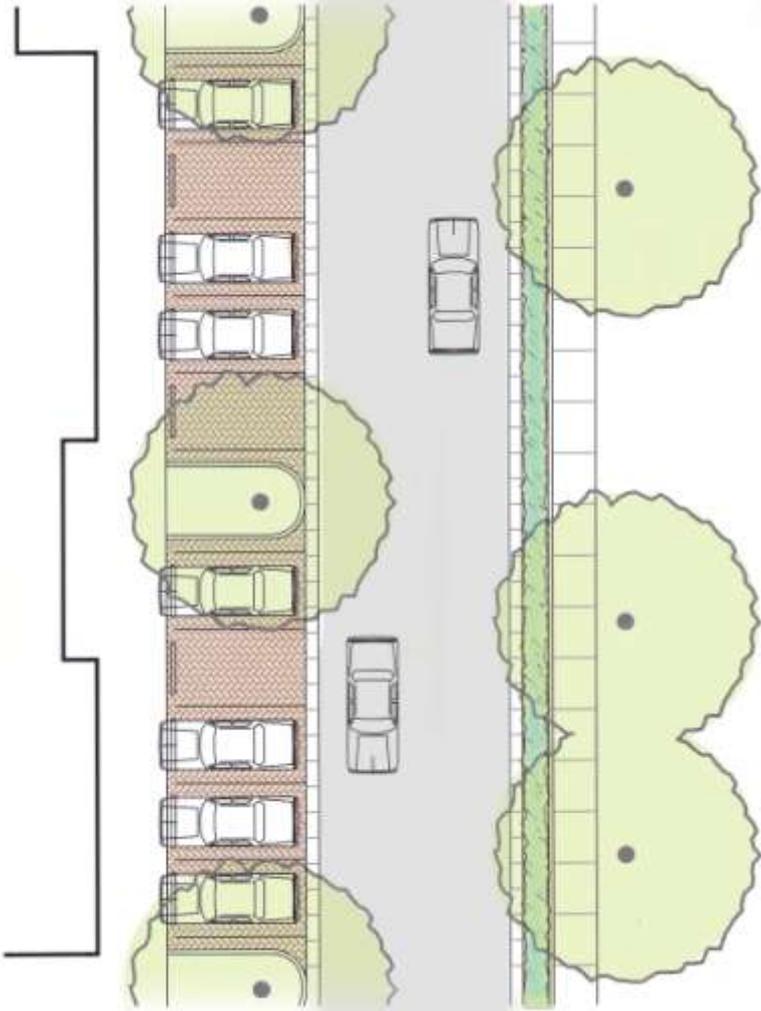
Stormwater Planters – Parking Lots



Planter Island

GREEN from the Ground Up

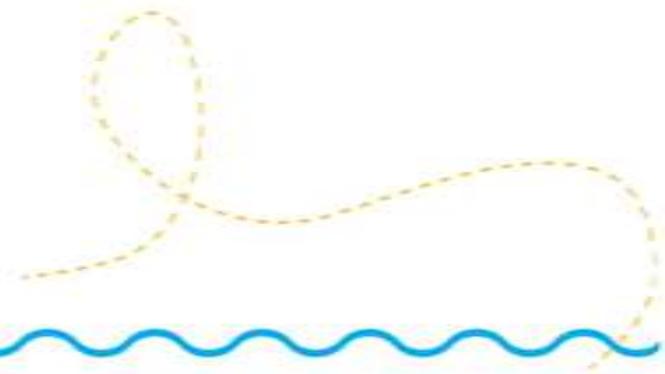
Stormwater Planters – Parking Lots



Narrow Green Gutter

GREEN from the Ground Up

Stormwater Planters – Buildings



GREEN from the Ground Up

Stormwater Planters – Buildings



GREEN from the Ground Up

Stormwater Planters – Buildings



GREEN from the Ground Up

Stormwater Planters – Buildings



GREEN from the Ground Up

Stormwater Planters – Buildings



GREEN from the Ground Up

Stormwater Planters – Buildings



GREEN from the Ground Up

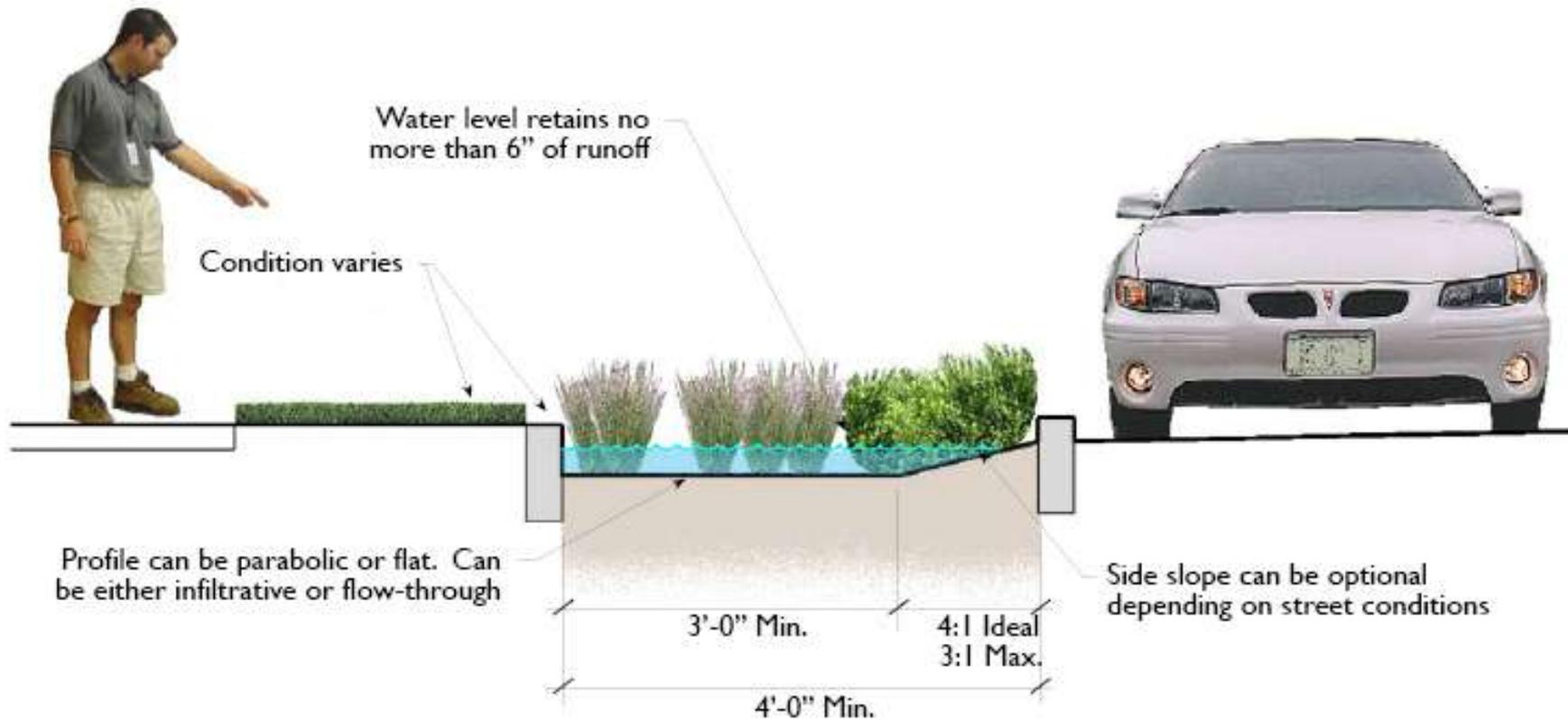
Stormwater Curb Extensions

Stormwater curb extensions are landscape areas within the parking zone of a street that capture stormwater and allow it to interact with plants and soil.



GREEN from the Ground Up

Stormwater Curb Extensions



TYPICAL CURB EXTENSION PROFILE

GREEN from the Ground Up

Stormwater Curb Extensions



Good Places for Curb Extensions:

- Parking zones along commercial streets
- Low-density residential settings where on-street parking is under-used

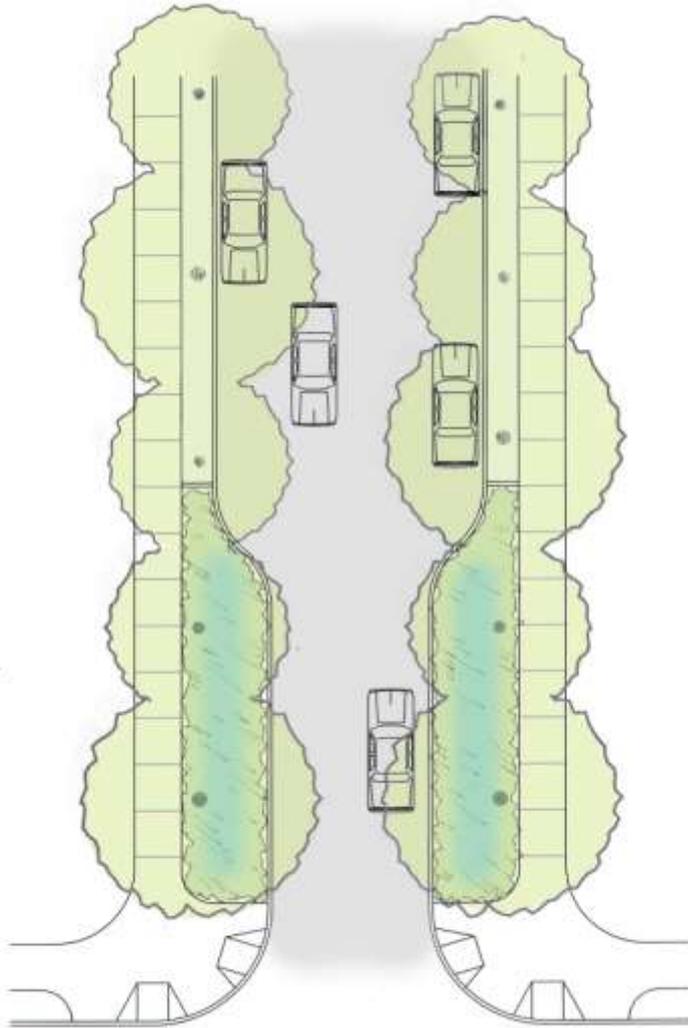
Why Choose Curb Extensions:

- Can significantly “green” a street with minimal investment
- Can be inexpensive to build depending on the local land use context
- Can be flexible in both shape and size to conform to site conditions
- Can narrow portions of a street and provide traffic calming benefits

Potential Constraints:

- Generally requires the removal of on-street parking
- Can sometimes conflict with bike travel if adequate space is not allowed between edge of curb extension and a street’s travel lane

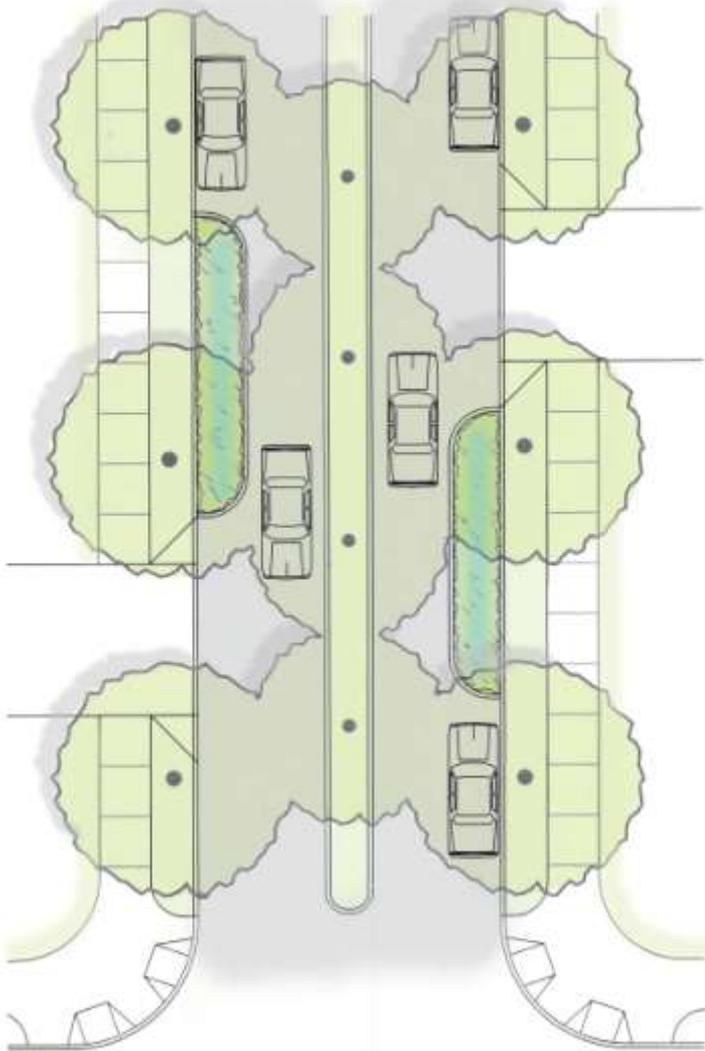
Curb Extensions – Residential Streets



At Intersections

GREEN from the Ground Up

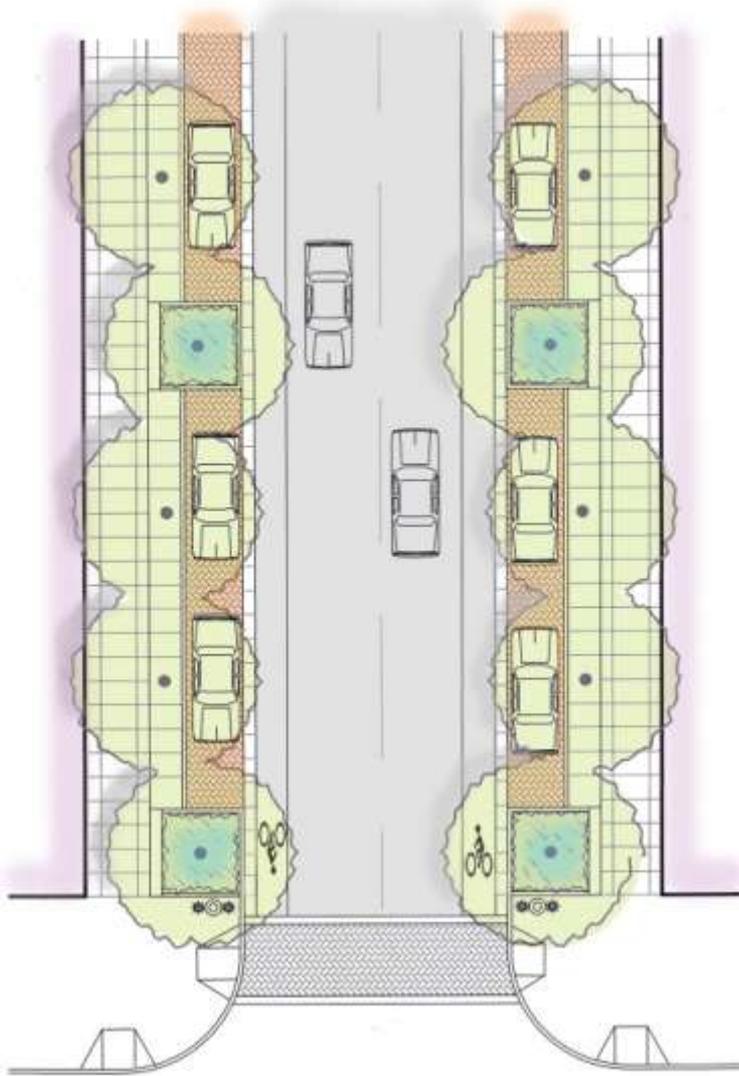
Curb Extensions – Residential Streets



Mid-Block With Landscape Median

GREEN from the Ground Up

Curb Extensions – Commercial Streets



Mid-Block With Pervious Paving

GREEN from the Ground Up

Curb Extensions – Commercial Streets



Angled Parking

GREEN from the Ground Up

Curb Extensions – Arterial Streets



Mid-Block

GREEN from the Ground Up

Curb Extensions – Arterial Streets



Large Curb Extensions

GREEN from the Ground Up

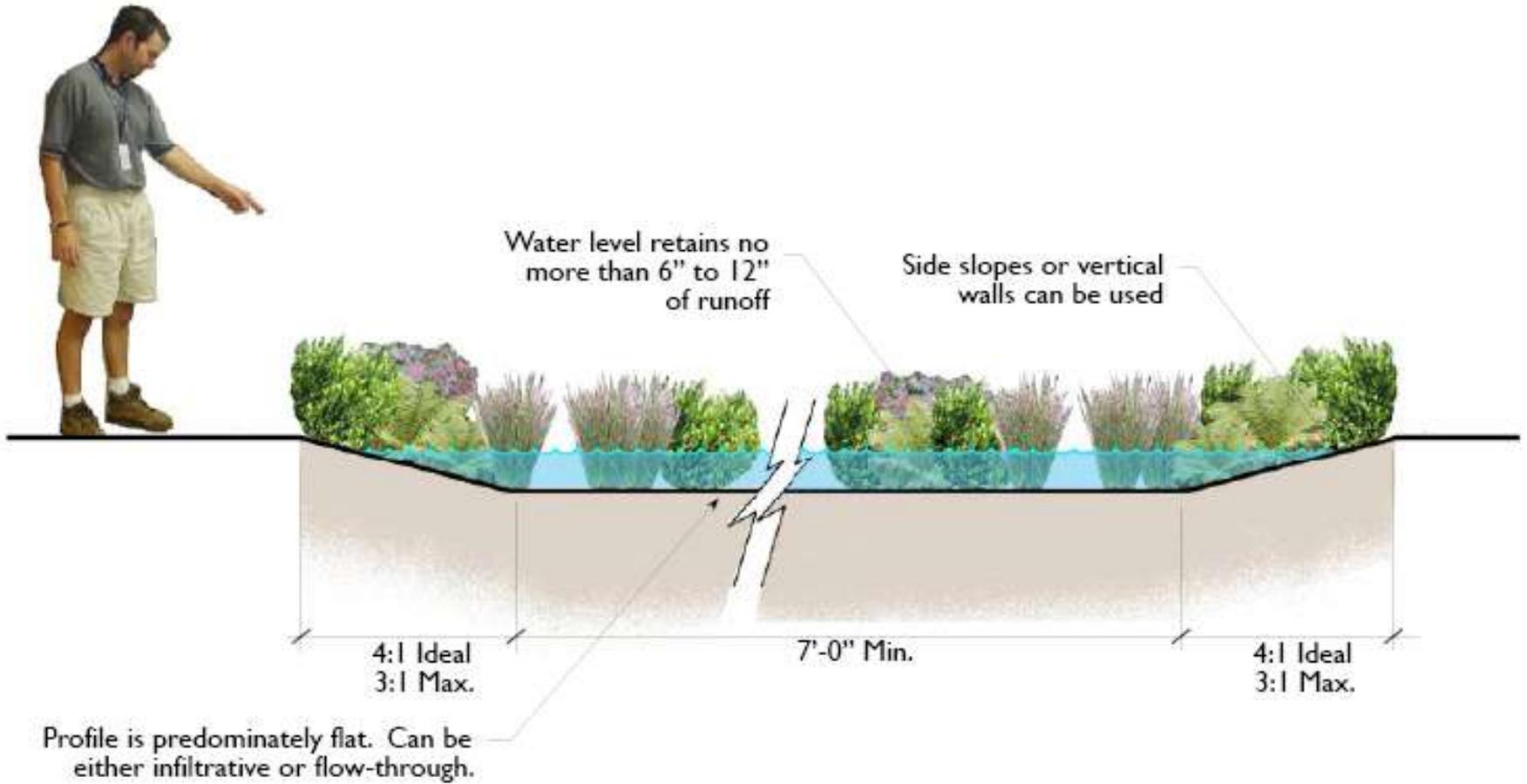
Rain Gardens

Rain gardens are shallow landscape areas that can collect, slow, filter and absorb large volumes of water, delaying discharge into the watershed system.



GREEN from the Ground Up

Rain Gardens



TYPICAL RAIN GARDEN PROFILE

GREEN from the Ground Up

Rain Gardens



Good Places for Rain Gardens

- Underutilized space adjacent to parking lots and streets
- Single family residential lots
- Left over spaces created by angled street intersections
- Large landscaped areas next to buildings

Why Choose Rain Gardens:

- Can often significantly “green” a space that would otherwise be leftover asphalt area
- Can often be simple opportunities to disconnect roof downspouts next to homes
- Can provide the greatest stormwater flow and volume benefit if large in size
- Offer versatility in shape

Potential Constraints:

- More maintenance may be required if large in size
- May not be able to manage all of a site’s runoff if a rain garden is small in size

Rain Gardens – Residential Streets



GREEN from the Ground Up

Rain Gardens – Residential Lots



GREEN from the Ground Up

Rain Gardens – Residential Lots



GREEN from the Ground Up

Rain Gardens – Residential Lots



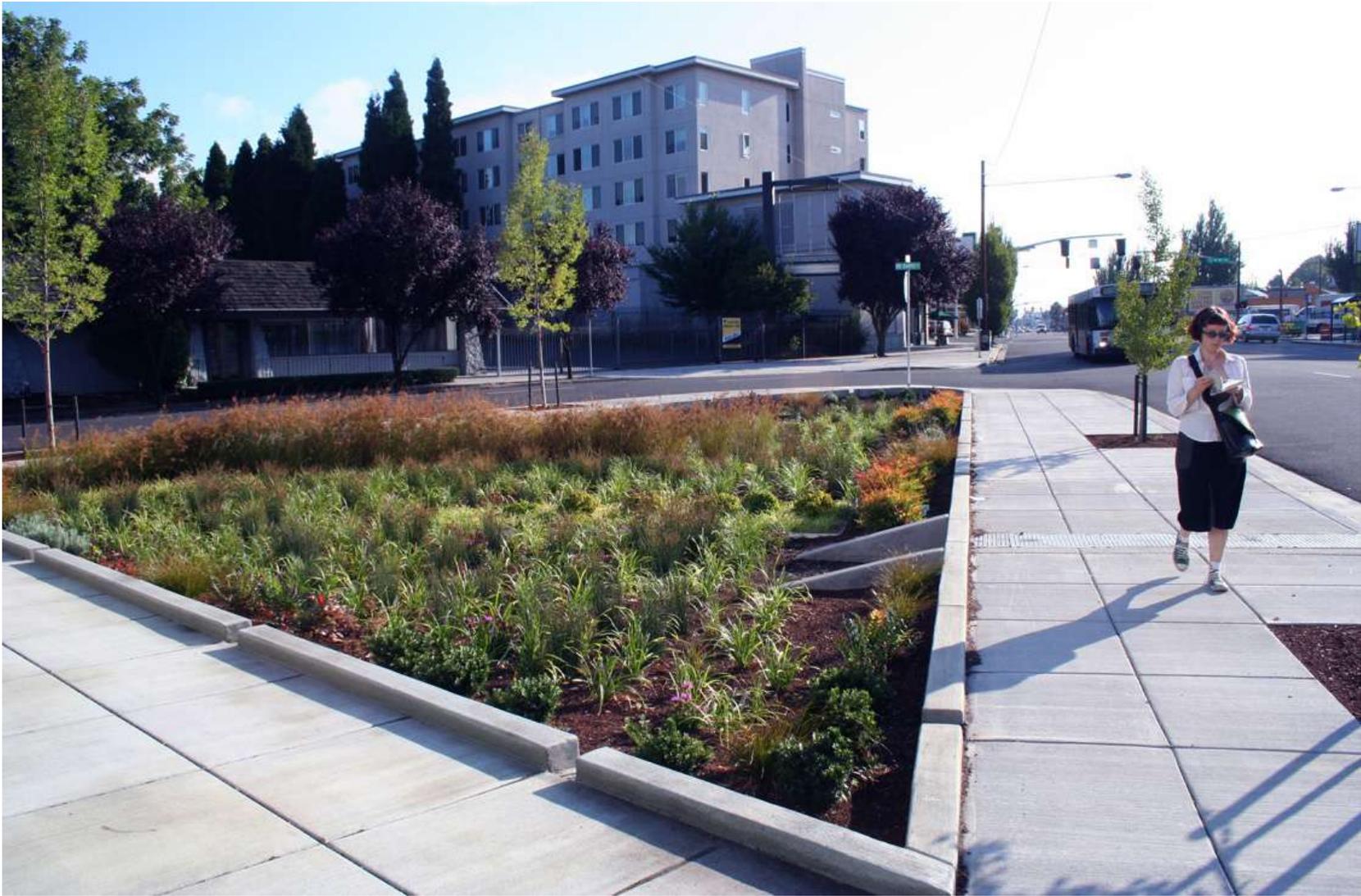
GREEN from the Ground Up

Rain Gardens – Residential Lots



GREEN from the Ground Up

Rain Gardens – Commercial Streets



GREEN from the Ground Up

Rain Gardens – Commercial Streets



GREEN from the Ground Up

Rain Gardens – Commercial Streets



GREEN from the Ground Up

Rain Gardens – Parking Lots



GREEN from the Ground Up

Rain Gardens – Parking Lots



GREEN from the Ground Up

Rain Gardens – Parking Lots



GREEN from the Ground Up

Rain Gardens – Parking Lots



GREEN from the Ground Up

Rain Gardens – Buildings



GREEN from the Ground Up

Rain Gardens – Buildings



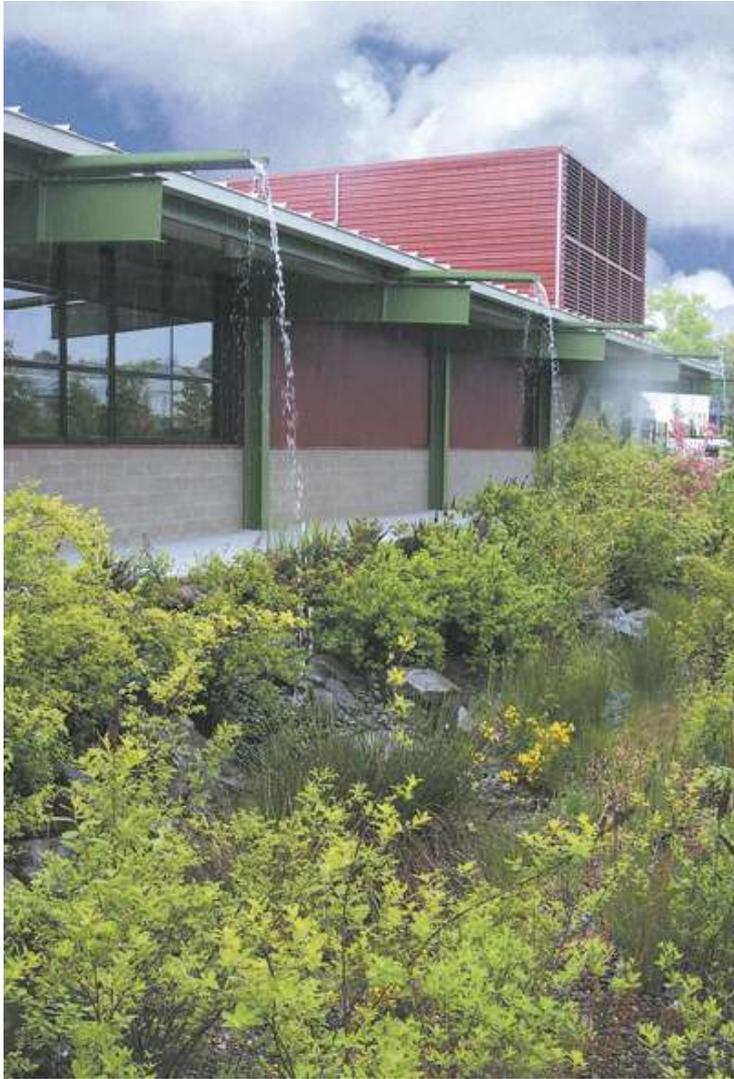
GREEN from the Ground Up

Rain Gardens – Buildings



GREEN from the Ground Up

Stormwater Conveyance from Buildings



GREEN from the Ground Up

In still conditions, how fast do rain drops fall?

A. 7-18 miles per hour

B. 5-7 miles per hour

C. 18-30 miles per hour



The Civil Engineer's Perspective

Paul Dedyo, PE, LEED AP

KKPFF Consulting Engineers



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Seminars for land-savvy developers



Overview of Presentation



- Applicability
- Sizing & Design
- Regulatory Permitting (UICs)
- Construction

Common Considerations

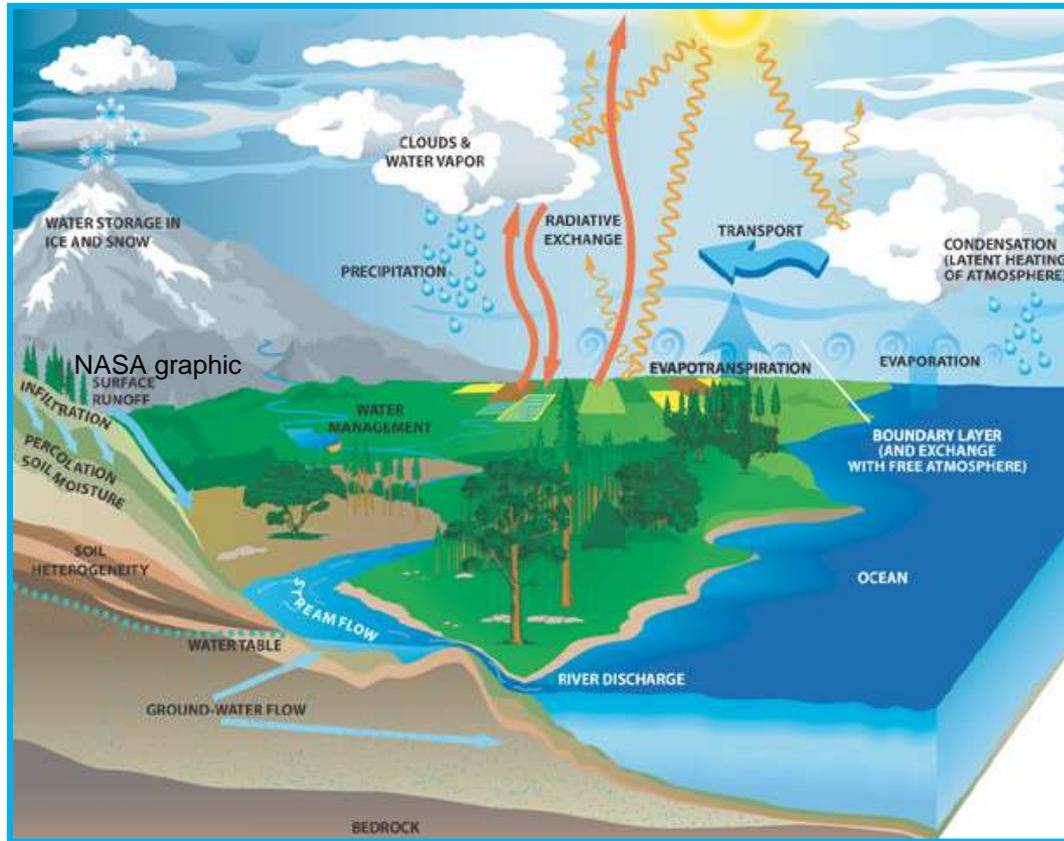
- Topography
- Overflow Path
- Geotechnical Evaluation
 - Native Infiltration Rates
 - Groundwater or Impermeable Strata
- Slopes
- Structures with Habitable Space
- Code Setback Requirements
- Existing Vegetation

Overview of Presentation



- Applicability
- Sizing & Design
- Regulatory Permitting (UICs)
- Construction

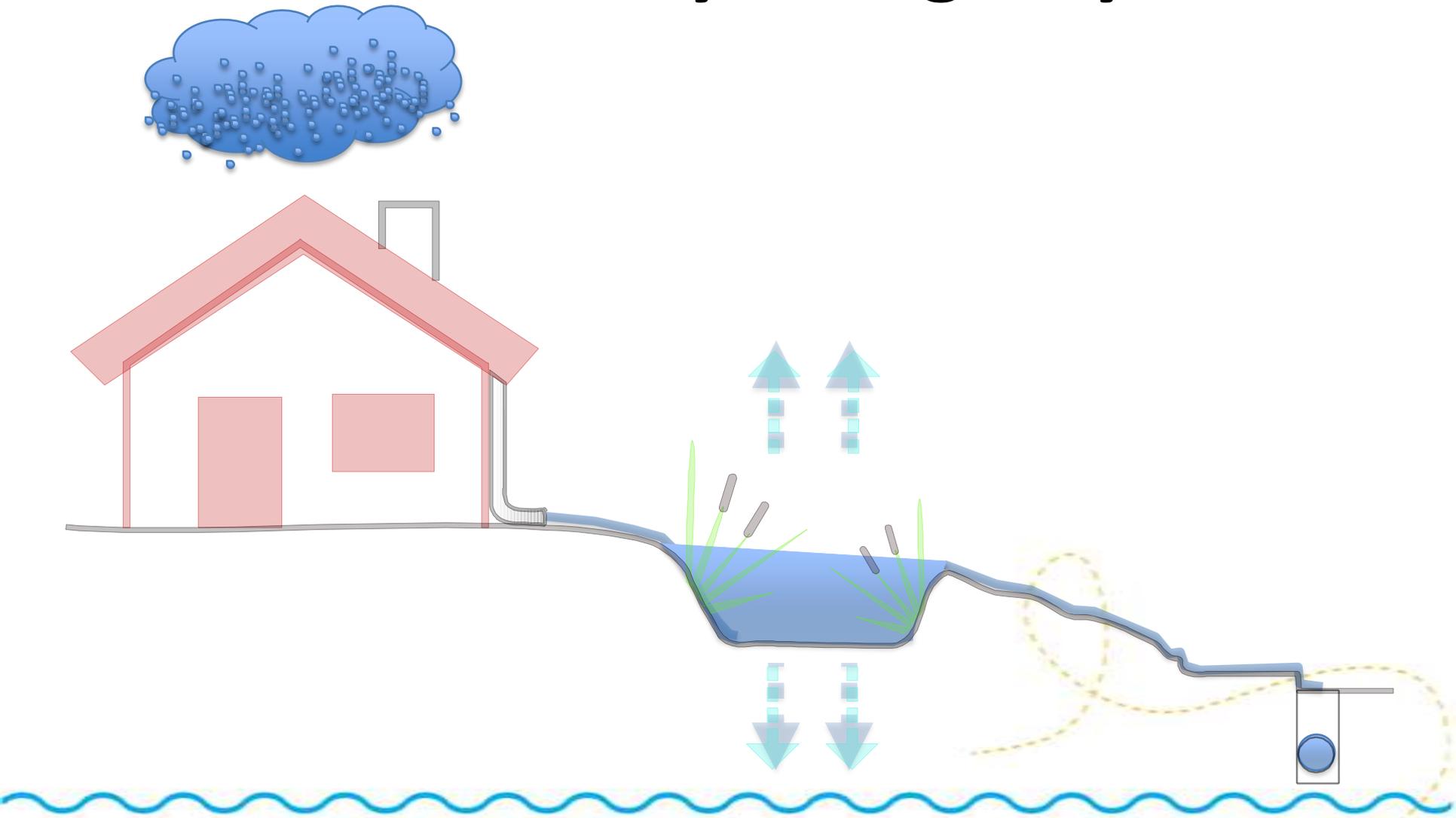
What is it? The Hydrologic Cycle



NASA graphic

GREEN from the Ground Up

Mimic the Hydrologic Cycle

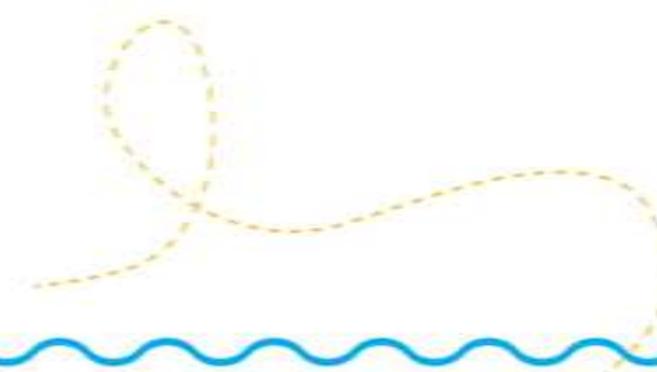


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Goals



- Local Regulatory Jurisdiction
- Mitigation
- Mimic the Hydrologic Cycle



Critical Criteria for Sizing

- Storm Catchment Area and Event



Credit: Flickr

- Native Soil Infiltration Rate
- Importing Growing Medium Infiltration Rate
- Facility Type and Size

Sizing for Site Conditions

- Sizing Ratio
- Multiple Smaller Facilities or Combined
- Plumbing/Conveyance
- Maximum Catchment Area

Infiltration Testing



Credit: Earth Engineers



Credit: Flickr

- Type of Tests
- Number of Tests
- Depth of Tests

Falling Head



Credit: University of Sydney

Double Ring Infiltrometer

Growing Medium

Three-part Mix

- Loamy Sand
- Compost
- Sand



Testing of Growing Medium

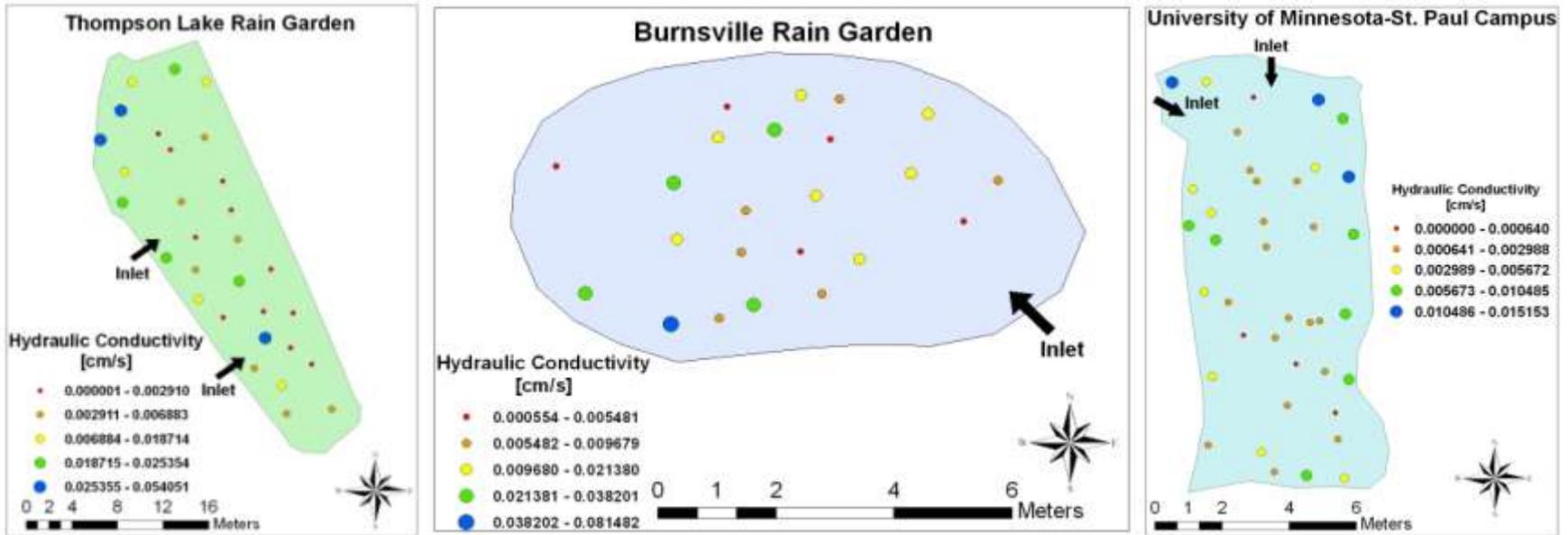
Developing the best blend ratio



Falling Head Perco-Meter

- Laboratory ASTM Testing
- Informal Falling Head Testing
- Mock-up Garden Testing

Variable Performance



Credit: University of Minnesota

GREEN from the Ground Up

Facility Type and Size

- Available Space
- Topography



Credit: Flickr



Credit: Virginia Department of Forestry



Credit: Vivian Felton, NRCS



Credit: Rain Gardens of West Michigan

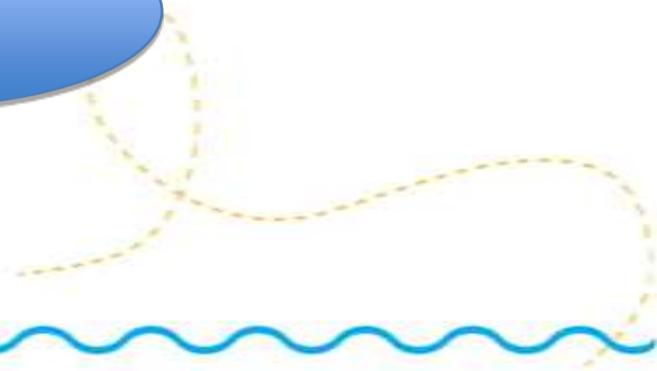
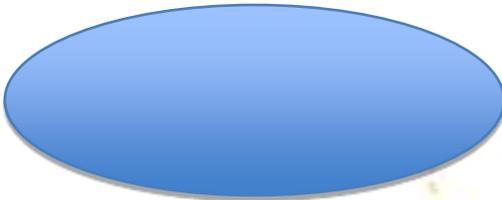
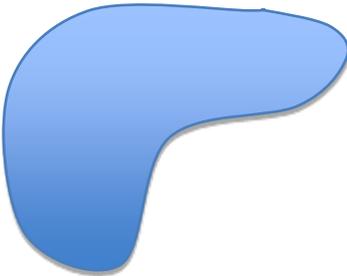
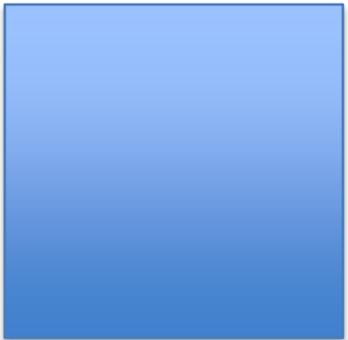
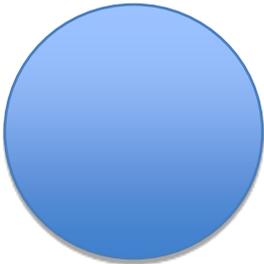


Credit: Maplewood MN Rain Gardens



Credit: Flickr

Geometry



Overflow Scenarios



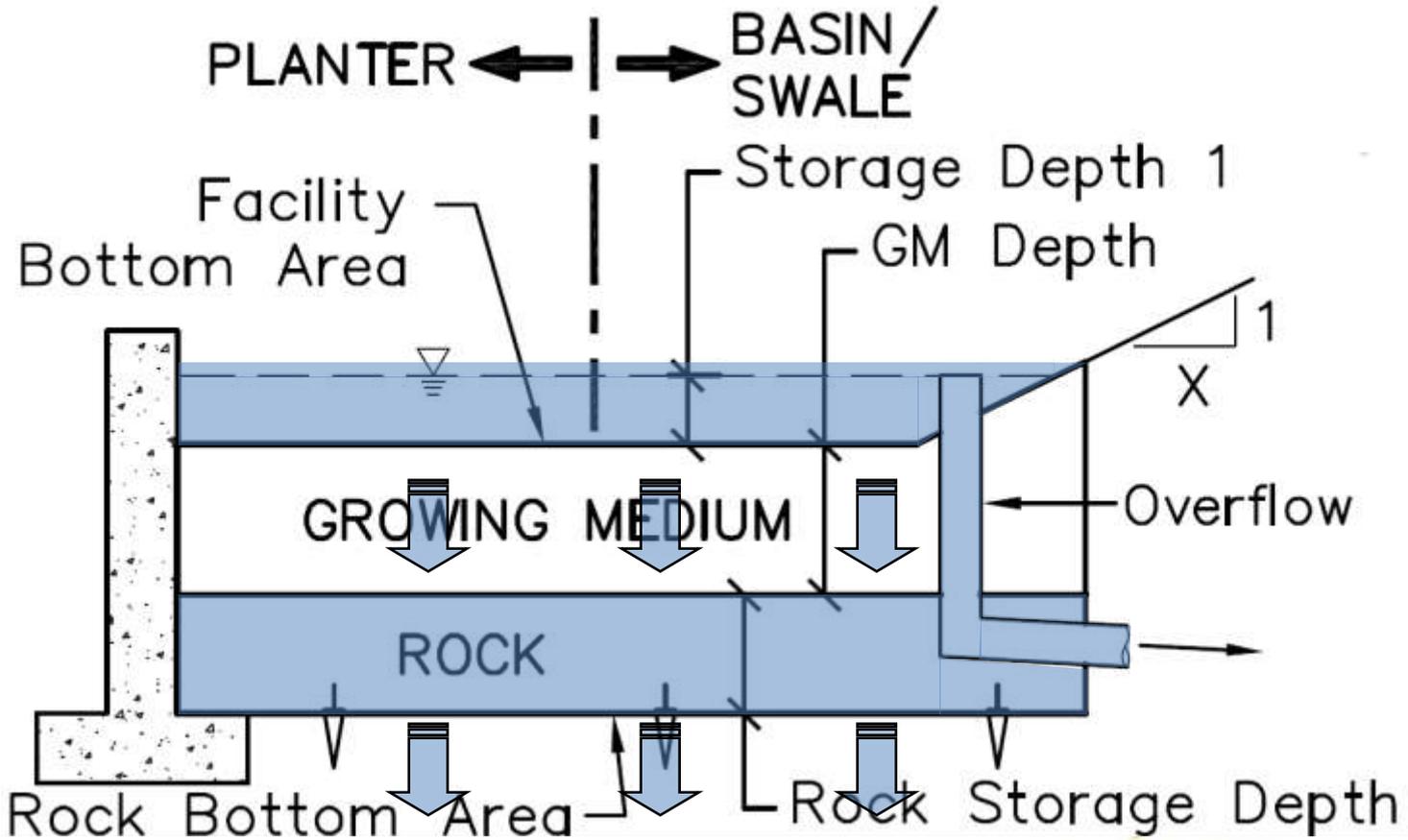
Credit: Flickr

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Facility Function

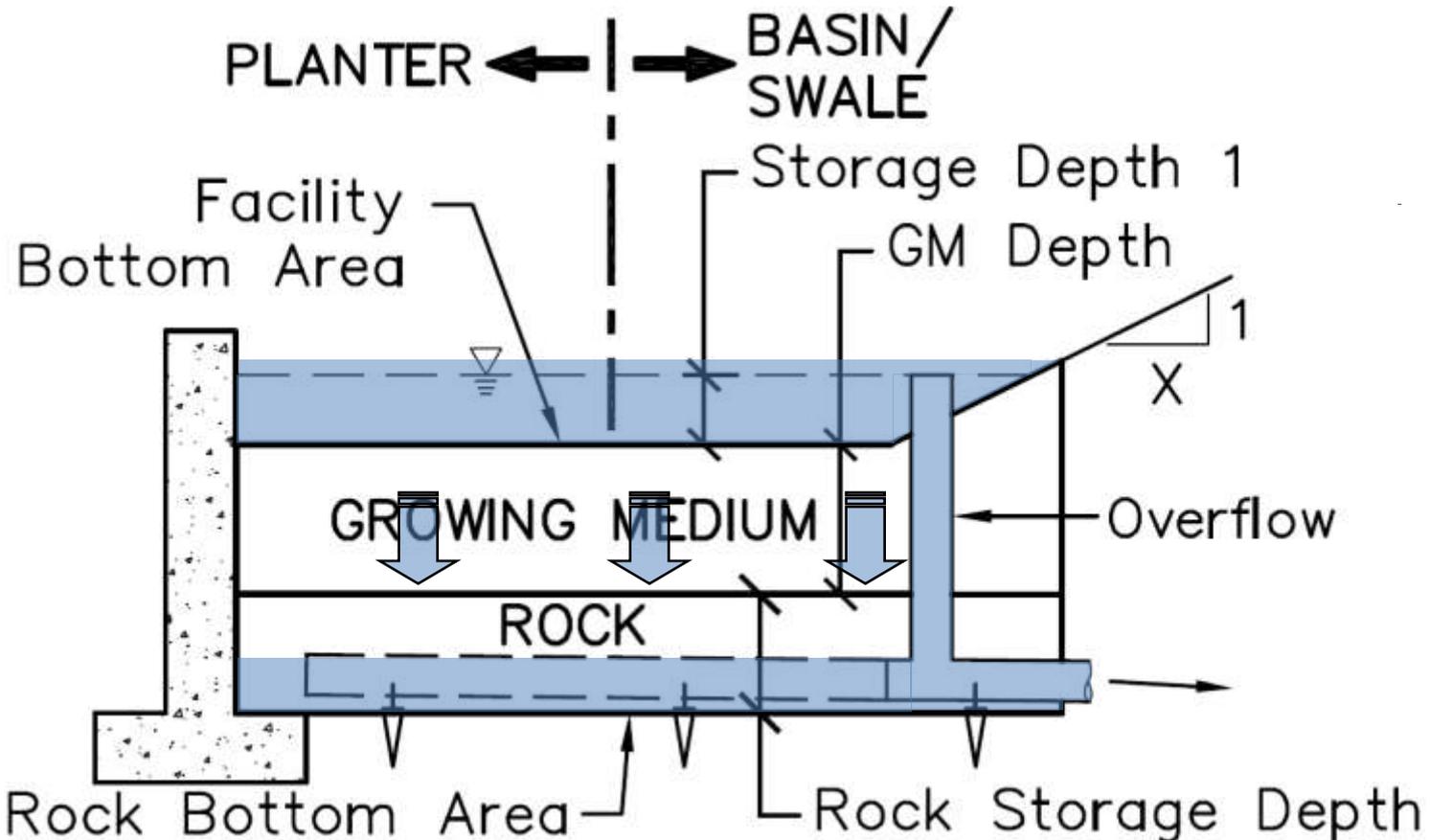
- Surface Infiltration Facility
 - With or Without Gravel Storage Bed
 - No Underdrain Pipe
 - Controlled Overflow
- Flow Through Facility
 - With Underdrain Pipe in Gravel
 - Assumed Little to No Infiltration
 - Controlled Overflow

Infiltration Facility



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Flow Through Facility



GREEN from the Ground Up

Overview of Presentation

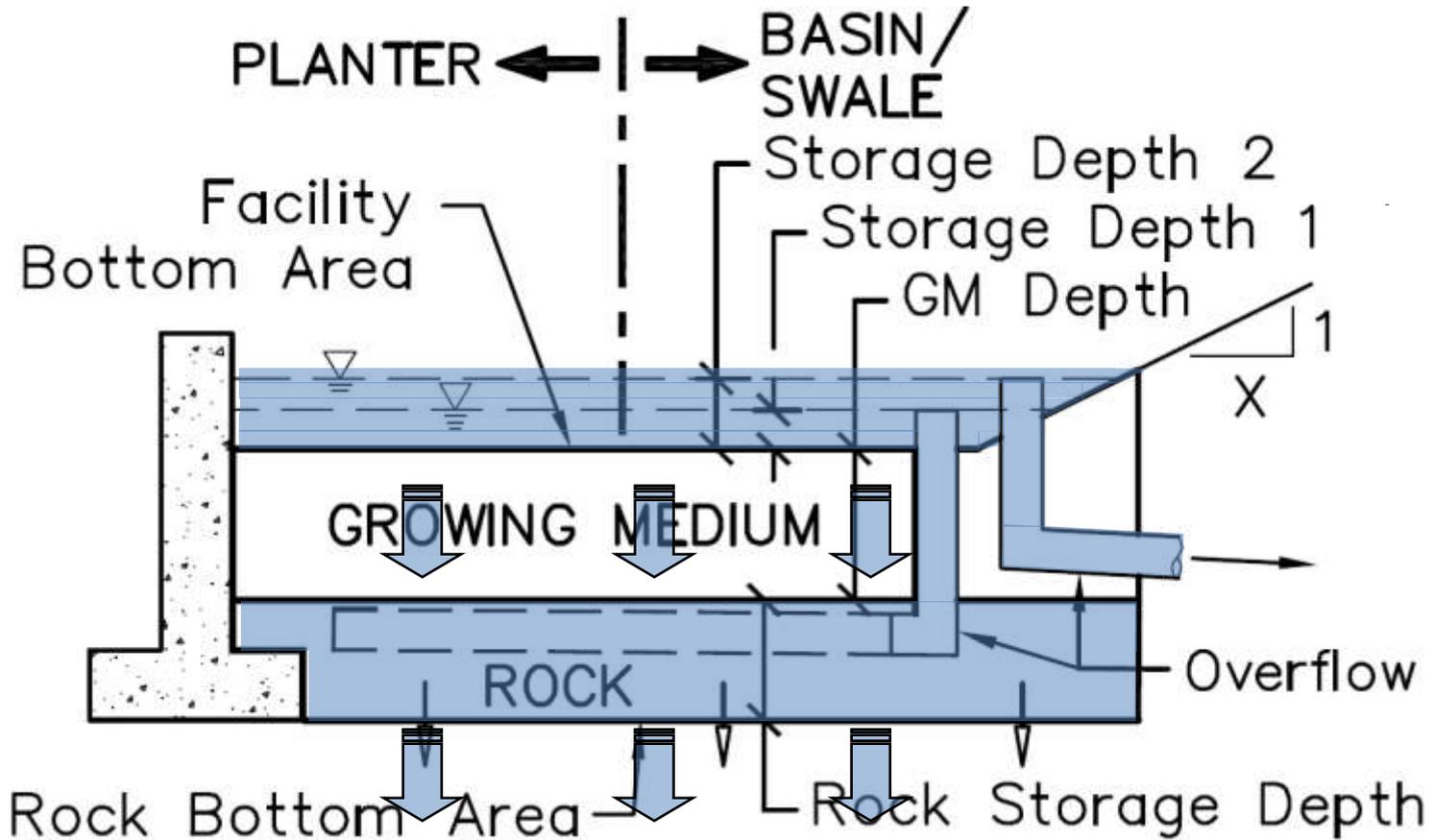


- Applicability
- Sizing & Design
- Regulatory Permitting (UICs)
- Construction

Facility Function

- Surface Infiltration Facility - UIC
 - Direct Connection to Underdrain Pipe in Gravel
 - Controlled Overflow

Underground Injection Control



GREEN from the Ground Up

Oregon DEQ UIC Registration

REGISTRANT		UNDERGROUND INJECTION CONTROL REGISTRATION Stormwater Drainage Systems		REG. DATE NAME	
Record # _____ Assmt Record # _____		(Submit two copies. See following pages for detailed instructions.) Review form with your permit or Oregon Department of Environmental Quality Attn: Business Office 811 SW Sixth Avenue Portland OR 97204		Registration # _____	
A. FACILITY NAME, LOCATION & CONTACT					
1. Facility's Legal Name		2. Operation Name			
3. Facility Physical Address City, State, Zip Code		4. Facility Mailing Address City, State, Zip Code			
5. Latitude (decimal)		Longitude (decimal)			
8. Consultant Contact Name Consultant Telephone # Fax #		7. Responsible Official/Owner Name Address City, State, Zip Code			
B. FACILITY DESCRIPTION (ATTACH DOCUMENTS AS NEEDED)					
1. SIC code _____ or NAICS code _____		Secondary SIC/NAICS code _____			
2. Briefly describe the nature of business at this facility:					
3. Briefly describe the types of materials, products, and wastes handled at the facility:					
4. <input type="checkbox"/> Existing soil groundwater contamination (brownfield) plan. Nearest cleanup site within 1/2 mile _____ (attach map)					
5. Provide the number of projected trips per day from the traffic report for the site: _____					
6. Land use zoning of facility: <input type="checkbox"/> Industrial <input type="checkbox"/> Commercial <input type="checkbox"/> Residential <input type="checkbox"/> Other _____					
7. Drinking water source: <input type="checkbox"/> Public water <input type="checkbox"/> Private Well					
8. Process water source: Monthly average usage (gal./day) _____ <input type="checkbox"/> Public water <input type="checkbox"/> Private Well <input type="checkbox"/> Recycled or Reclaimed					
9. Indicate if present and submit a copy of:					
<input type="checkbox"/> UIC spill prevention response plan		<input type="checkbox"/> Employee training on spill plan		<input type="checkbox"/> Pr(s)g(s) or block(s) for UIC system	
<input type="checkbox"/> Spill clean up supplies		<input type="checkbox"/> Containment structures		<input type="checkbox"/> Retrofit sampling data	
<input type="checkbox"/> Maintenance program and schedule for UIC system(s)		<input type="checkbox"/> Fine Marshall survey/SUDS sheets (subtable)		<input type="checkbox"/> Free Marshal survey/SUDS sheets (subtable)	
<input type="checkbox"/> UIC storm water plan attached		<input type="checkbox"/> Monitoring plan attached			
10. Does an adequate confinement barrier or filtration condition exist at the site to protect groundwater? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Do not know If "YES," attach relevant DHS/UGS documentation.					
11. Is construction to or construction of a surface discharging storm sewer feasible? <input type="checkbox"/> Yes <input type="checkbox"/> No If "NO," provide relevant documentation as to why a viable or other green options cannot be used.					
12. None of the location is a sensitive site: <input type="checkbox"/> Steep slope or hazard area <input type="checkbox"/> Groundwater Management Area					
<input type="checkbox"/> Flood Plain <input type="checkbox"/> Other _____					
13. Signs and attach a UIC non-exposure certificate. <input type="checkbox"/> Attached (Not required if land use is residential)					
14. List any other DEQ or public agency permits applied for or issued to this facility:					
15. Will these UICs be tested once in a non-regulatory once developed? <input type="checkbox"/> Yes <input type="checkbox"/> No <input type="checkbox"/> Do not know.					
C. UNDERGROUND INJECTION CONTROL INFORMATION - Go to next page of this form.					
To expedite the registration of your facility, please fill out this form in its entirety.					
D. SIGNATURE OF LEGALLY AUTHORIZED REPRESENTATIVE					
I hereby certify that the information contained in this registration is true and correct to the best of my knowledge and belief.					
Name of Legally Authorized Representative (Type or Print)		Title			
Signature of Legally Authorized Representative		Date			

UIC REGISTRATION FOR STORM WATER DRAINAGE SYSTEMS	
Oregon Department of Environmental Quality (Submit two copies of this form to DEQ. See following pages for detailed instructions.)	
LEGAL NAME: _____	
C. UNDERGROUND INJECTION CONTROL INFORMATION	
Attach a facility map that clearly identifies the location of each UIC system by name or number. Provide the information requested below for each UIC storm water drainage system. Attach additional copies of this sheet if necessary.	
UIC SYSTEM # or NAME: _____	
INSTALLATION YEAR: _____	
1. Latitude (decimal) _____ Longitude (decimal) _____	2. Type: <input type="checkbox"/> Dry well/wing <input type="checkbox"/> Drill hole <input type="checkbox"/> Deadfield <input type="checkbox"/> Infiltration trench <input type="checkbox"/> Other discharge
3. Drainage Area: <input type="checkbox"/> Roof drains only <input type="checkbox"/> Parking area only <input type="checkbox"/> Other, specify: _____	4. Distance to nearest Domestic/public water well _____ Wellhead _____ Surface water(s) _____ Depth to water high water table: _____ feet If not available, average depth to groundwater: _____ feet Attach well log(s) for the nearest water well. <input type="checkbox"/> Attached
5. Status: (see instructions for status definition) <input type="checkbox"/> Planning stage <input type="checkbox"/> Under construction <input type="checkbox"/> Active <input type="checkbox"/> Not in use or Temporarily Abandoned <input type="checkbox"/> Permanently Abandoned/Decommissioned (date & method) (Submit 30-Day Pre-Closure Form UIC 1000-CLO.)	6. Characteristics: Depth _____ ft Diameter _____ ft Design drainage rate _____ Size of impervious area drained _____ Type of treatment prior to discharge: _____
7. <input type="checkbox"/> Located in a delineated source water area	
UIC SYSTEM # or NAME: _____	
INSTALLATION YEAR: _____	
1. Latitude (decimal) _____ Longitude (decimal) _____	2. Type: <input type="checkbox"/> Dry well/wing <input type="checkbox"/> Drill hole <input type="checkbox"/> Deadfield <input type="checkbox"/> Infiltration trench <input type="checkbox"/> Other discharge
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1. Latitude (decimal) _____ Longitude (decimal) _____	2. Type: <input type="checkbox"/> Dry well/wing <input type="checkbox"/> Drill hole <input type="checkbox"/> Deadfield <input type="checkbox"/> Infiltration trench <input type="checkbox"/> Other discharge
3. Drainage Area: <input type="checkbox"/> Roof drains only <input type="checkbox"/> Parking area only <input type="checkbox"/> Other, specify: _____	4. Distance to nearest Domestic/public water well _____ Wellhead _____ Surface water(s) _____ Depth to water high water table: _____ feet If not available, average depth to groundwater: _____ feet Attach well log(s) for the nearest water well. <input type="checkbox"/> Attached
5. Status: (see instructions for status definition) <input type="checkbox"/> Planning stage <input type="checkbox"/> Under construction <input type="checkbox"/> Active <input type="checkbox"/> Not in use or Temporarily Abandoned <input type="checkbox"/> Permanently Abandoned/Decommissioned (date & method) (Submit 30-Day Pre-Closure Form UIC 1000-CLO.)	6. Characteristics: Depth _____ ft Diameter _____ ft Design drainage rate _____ Size of impervious area drained _____ Type of treatment prior to discharge: _____
7. <input type="checkbox"/> Located in a delineated source water area	

Overview of Presentation



- Applicability
- Sizing & Design
- Regulatory Permitting (UICs)
- Construction

Construction Phasing

- Pre-Con with Engineer & Jurisdiction
- Many variables vulnerable during construction
- Details and Horizontal Control

Green Streets - Sumner

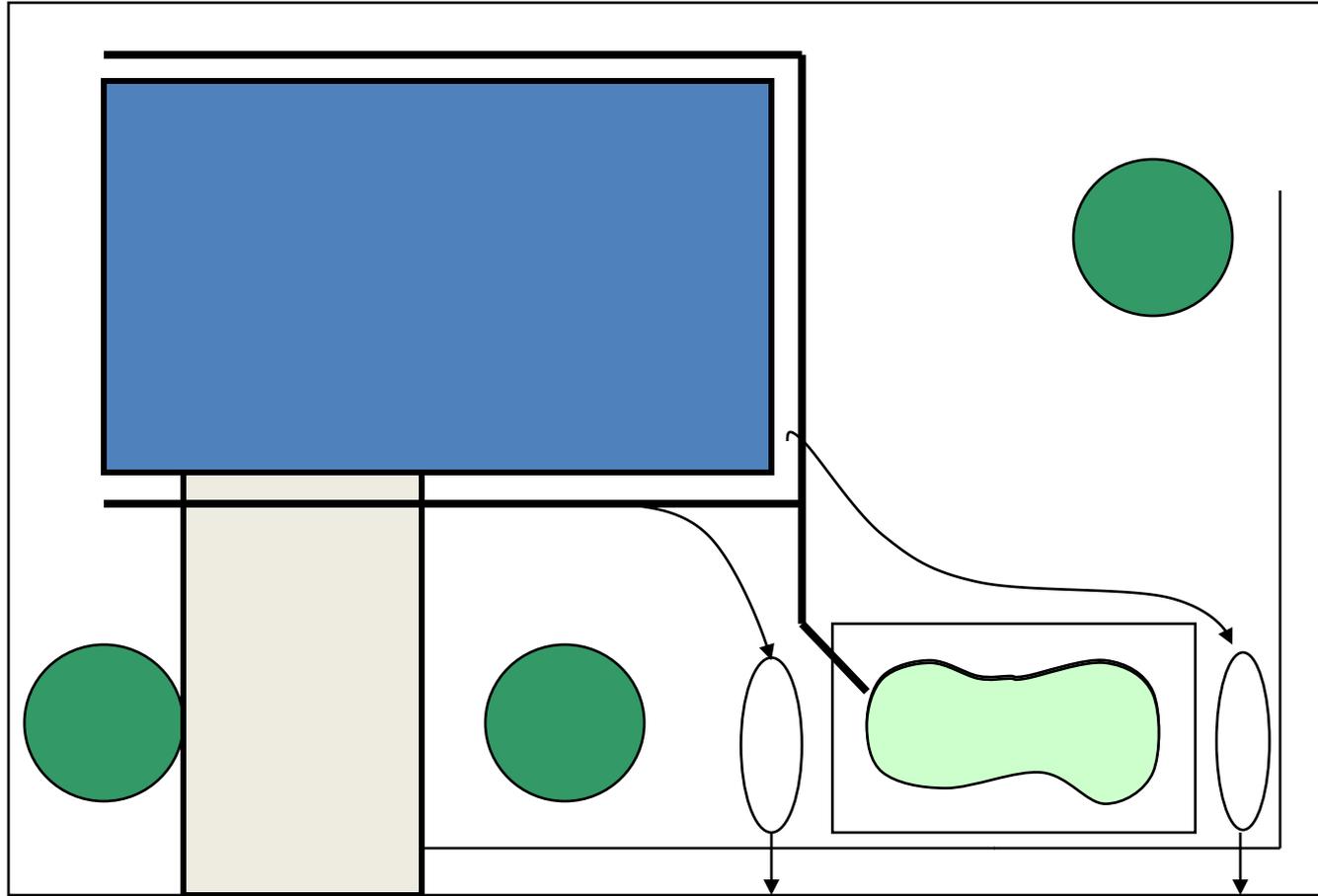


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Construction Phasing

- Pre-Con with Engineer & Jurisdiction
- Many variables vulnerable during construction
- Details and Horizontal Control
- Installation Sequencing & Erosion Control

Construction Sequence



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Facility Construction

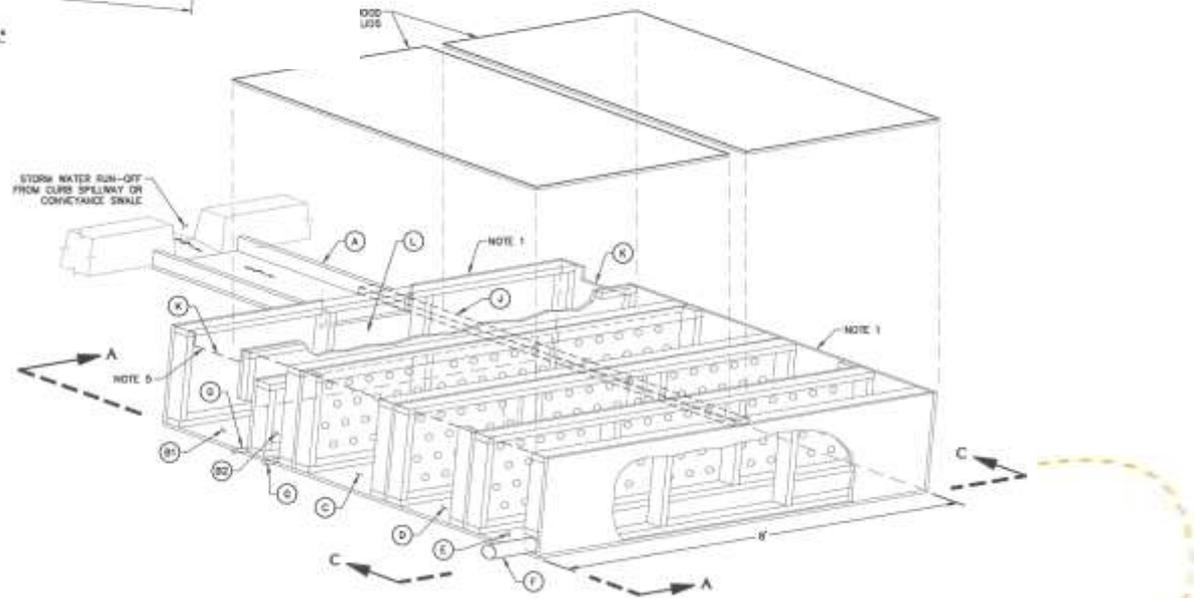
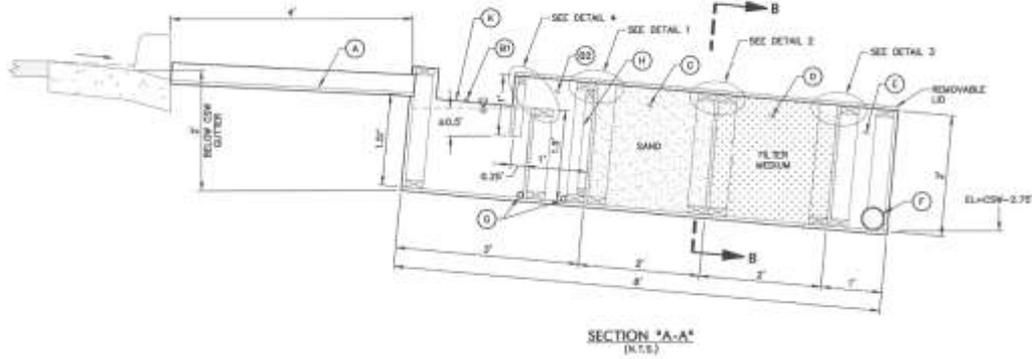
- Outline area of facility
- Remove existing sod or vegetation
- Strip surface soils to expose suitable subgrade
- Build berm if needed on prepared subgrade
- Set gravel and/or growing medium per plan
- Final grading
- Plantings and finish materials
- Establishment period
- Route drainage to facility

In-Line Erosion Control



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Erosion Control – Dual Filter



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Construction Phasing

- Pre-Con with Engineer & Jurisdiction
- Many variables vulnerable during construction
- Details and Horizontal Control
- Construction Sequencing & Erosion Control
- Submittals & Testing
- Anticipate Weather Conditions
- Placement and Compaction
- As-Built Verification
- Maintenance

Construction – Gravel Bed with Underdrain



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Construction – Initial Landscaping & Jute



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Construction – Growing Medium and Rock Channel Bed



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Construction – Growing Medium Replaced



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Construction – Restored Facility



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Summary



- Learn about site conditions and suitability
- Establish goals for facility
- Select facility type
- Facility should be designed by an experienced and knowledgeable Engineer with Detailed Grading Plan
- Pre-Con & Construction Sequence
- Submittals & Horizontal Control
- Erosion Control
- As-Built Verification

Questions?

Paul M. Dedyo, PE, LEED AP

KPFF Consulting Engineers

paul.dedyo@kpffcivilpdx.com



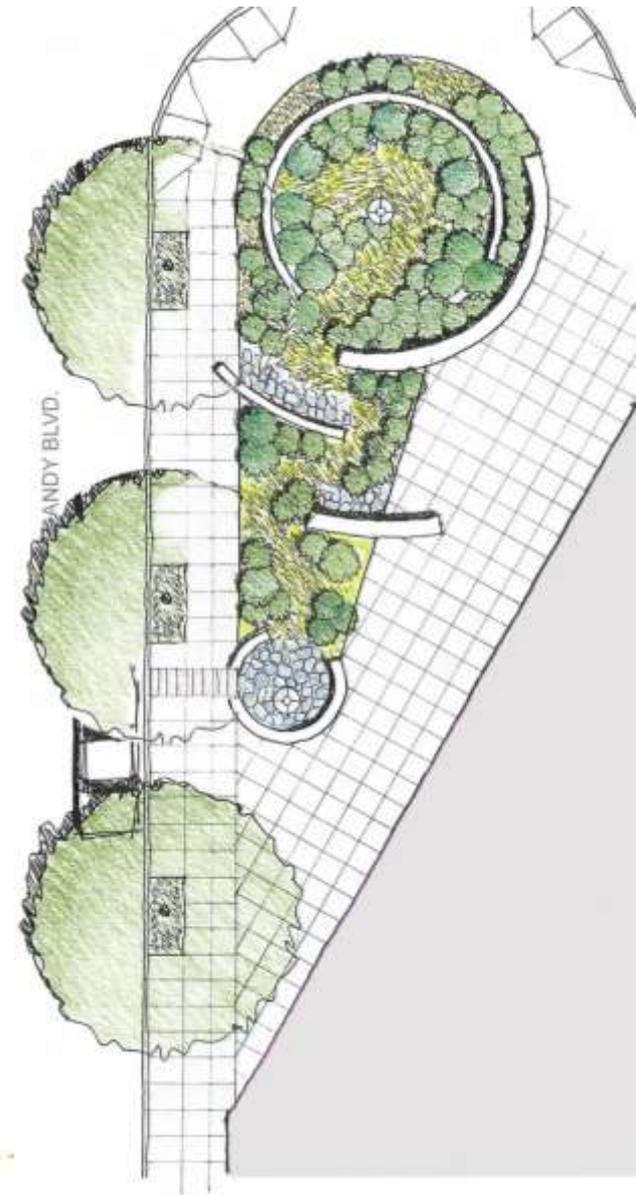
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Lessons Learned

Design, Construction, and Practical Theory

Design Lessons Learned

- Create design solutions that “fit” within the surrounding neighborhood context.
- Get a detailed topographic survey. Working with water is working with minutia.
- Planting solutions vary from site to site and with types of stormwater facilities.
- Plant in high densities (They don’t call it a “green infrastructure” for nothing!).
- Do I really need that? Keep the design as simple and cost effective as possible.
- Design for people, not just stormwater
- Don’t forget pedestrian circulation



Creating Design Solutions That “Fit”



Is this appropriate in a residential setting?

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Creating Design Solutions That “Fit”



What else could have been done here that is more simple, natural, and in context?

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Creating Design Solutions That “Fit”

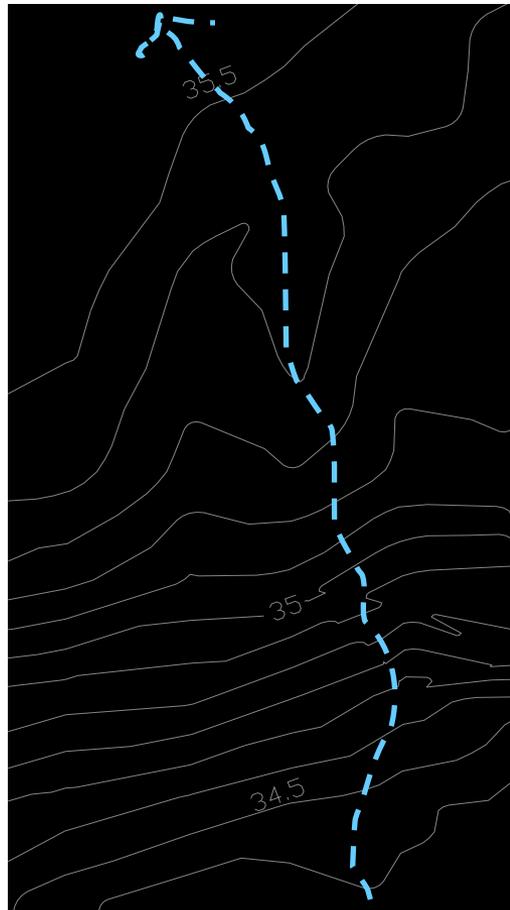


GREEN from the Ground Up

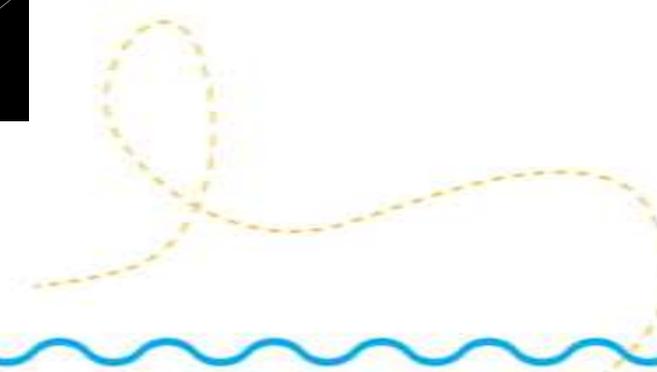
Get A Detailed Topography Survey



Topographic Survey
1/2 foot contour interval



Topographic Survey
1/10 foot contour interval



Varying Planting Solutions



SW 12th Avenue Green Street
(Small Space, Single Species Planting)



Mount Tabor Middle School
(Large Space, Diverse Planting)

Varying Planting Solutions – Formal/Manicured



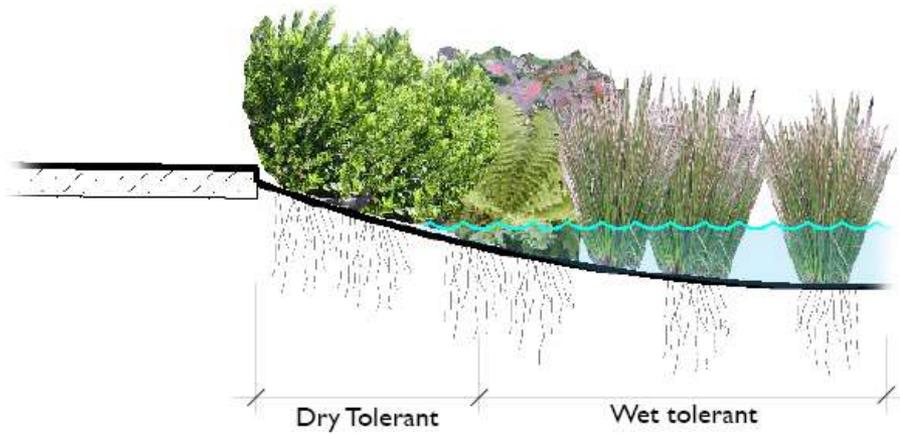
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Varying Planting Solutions – Informal “Natural”

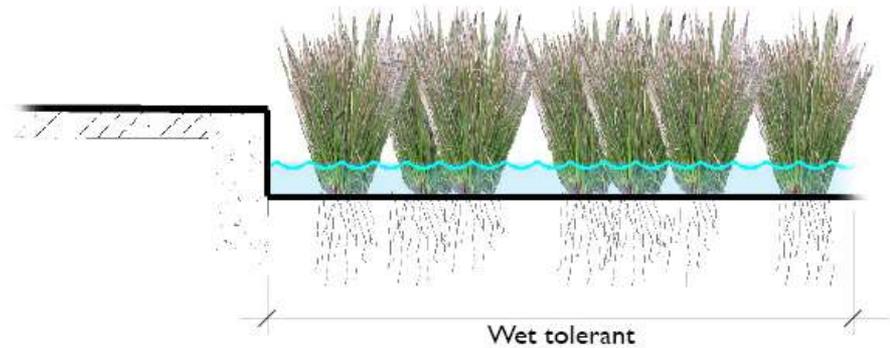


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Varying Planting Solutions



Swales With Side Slopes



Planters Without Side Slopes

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Varying Planting Solutions



GREEN from the Ground Up

Varying Planting Solutions



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Designing for People, Not Just Stormwater



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Designing for People, Not Just Stormwater



GREEN from the Ground Up

Designing for People, Not Just Stormwater



GREEN from the Ground Up

Designing for People, Not Just Stormwater



GREEN from the Ground Up

Designing for People, Not Just Stormwater



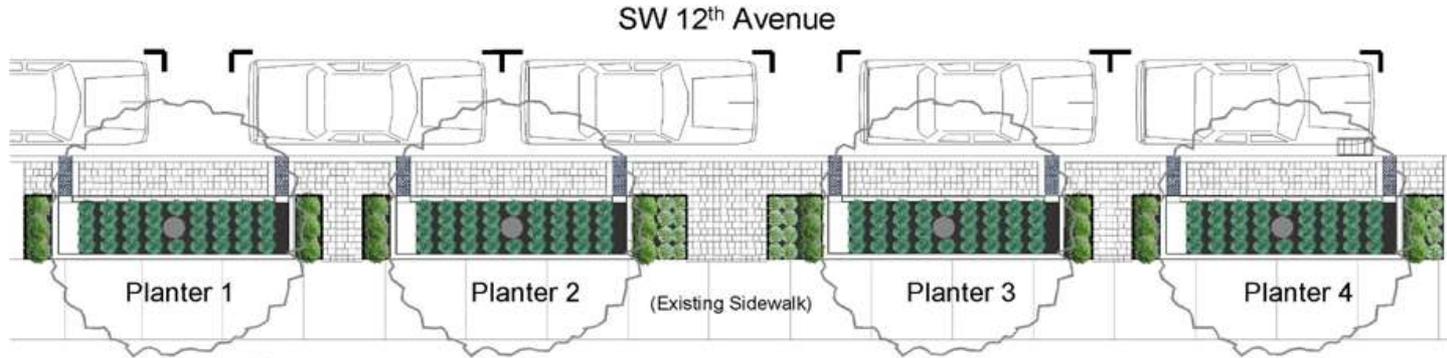
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Pedestrian Circulation With Stormwater



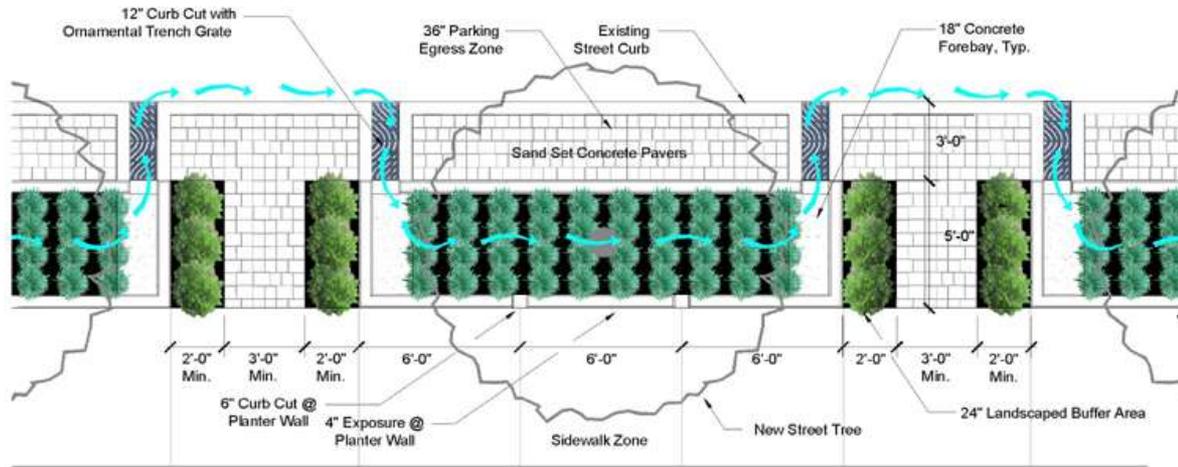
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Pedestrian Circulation With Stormwater



SW 12th Avenue Stormwater Planter ~ Plan View

N.T.S.



SW 12th Avenue Stormwater Planter ~ Enlarged Plan

N.T.S.



Pedestrian Circulation With Stormwater



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Pedestrian Circulation With Stormwater



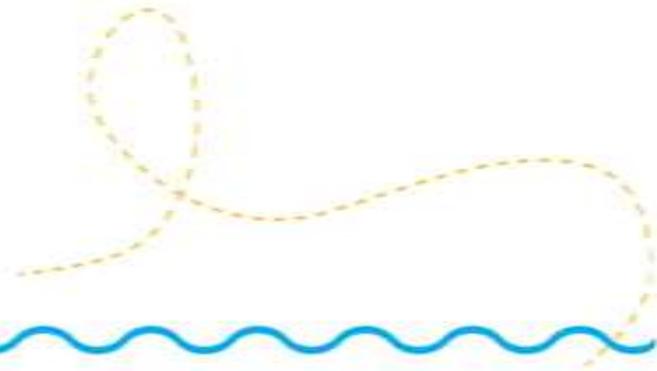
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Pedestrian Circulation With Stormwater



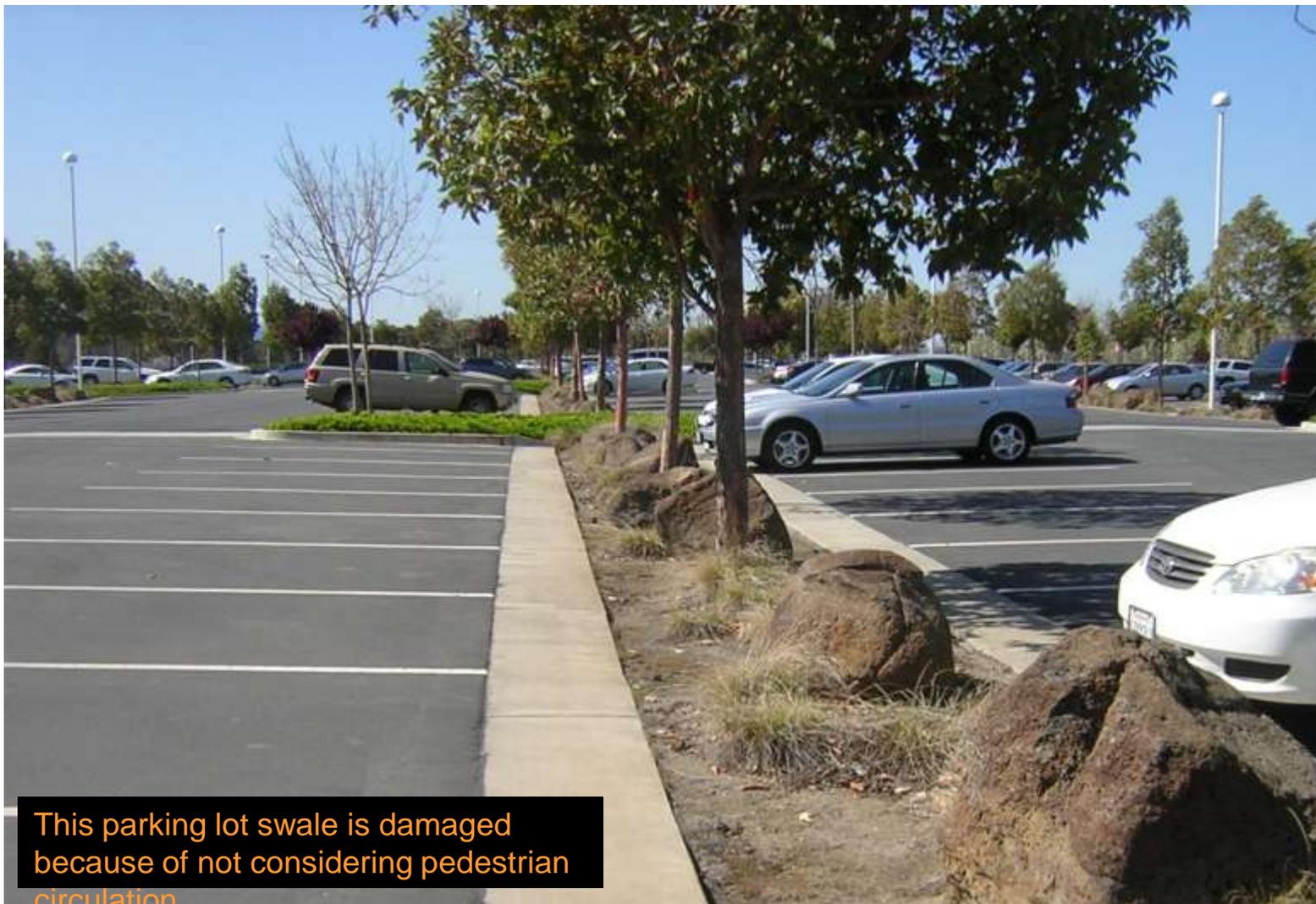
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Pedestrian Circulation With Stormwater



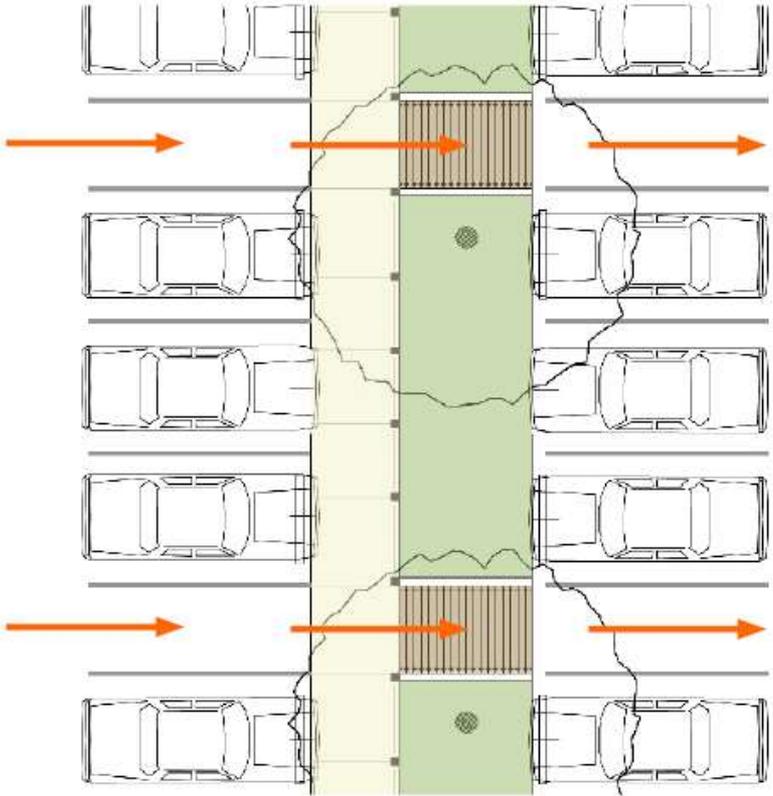
GREEN from the Ground Up

Pedestrian Circulation With Stormwater



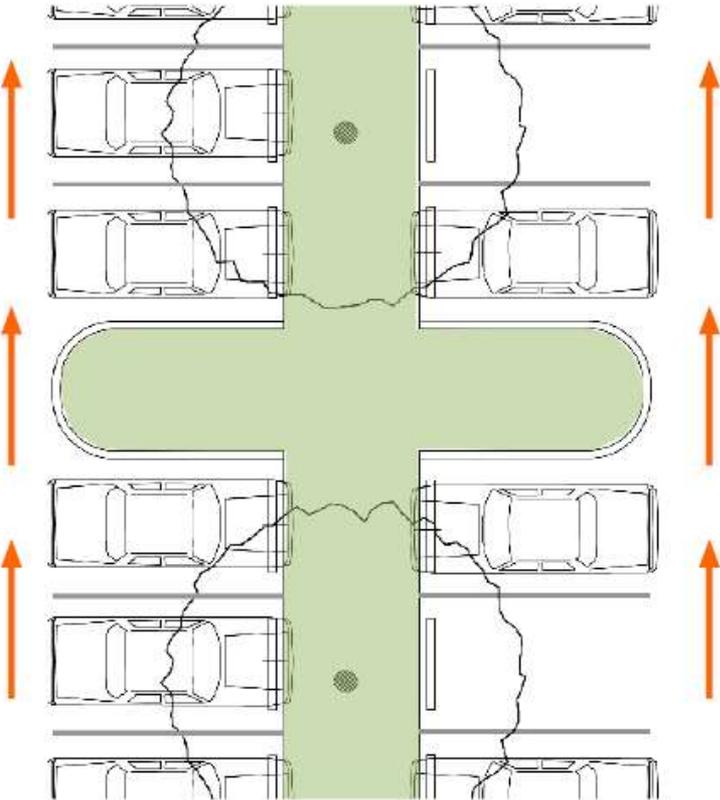
This parking lot swale is damaged because of not considering pedestrian circulation.

Pedestrian Circulation With Stormwater



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Pedestrian Circulation With Stormwater



GREEN from the Ground Up

Construction Lessons Learned

- Soil prep is critical, need to break up compaction, then import amended soil mix.
- Specify amended soil with at least 30% organic material within it.
- Allow for considerable construction administration, contractors are not used to doing this work and need help with understanding the design intent.
- Be prepared for in the field adjustments, especially with retrofit projects.
- Keep the stormwater facility “off-line” until after planting.
- Provide post-construction observation to correct any design issues/mistakes.



Soil Preparation



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Soil Preparation



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Soil Preparation – Breaking Up Compaction



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Soil Preparation – Import Soil in Lifts



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Soil Preparation – Apply Appropriate Mulch



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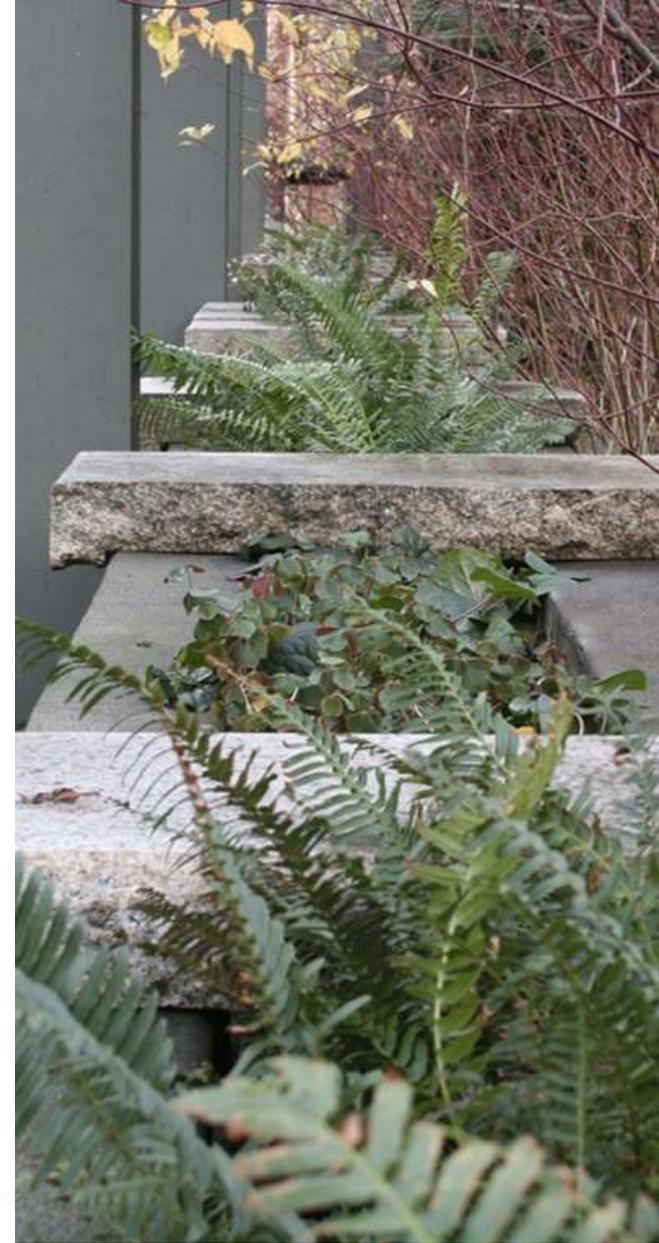
Soil Preparation – Protect Facility



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Things To Think About

- Bad examples can be just as influential as the good ones. Make strong efforts to design good demonstration projects.
- Create design solutions that are cost effective and help reduce future maintenance efforts.
- We must continue to innovate and not settle on first designs. There is always room for improvement.
- There needs to be better collaboration between landscape architects, civil engineers, and architects.





Presentation Topics



- ❖ Verde
- ❖ Stormwater Facility Maintenance
- ❖ Tenant & Homeowner Education
- ❖ Examples & Costs





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The Mission of Verde, a tax-exempt nonprofit corporation, is to improve the economic health of disadvantaged communities by creating job training, employment, and entrepreneurial opportunities, fostering the connection between economic vitality and environmental protection and restoration.

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Activities



Social Enterprise



Outreach & Education



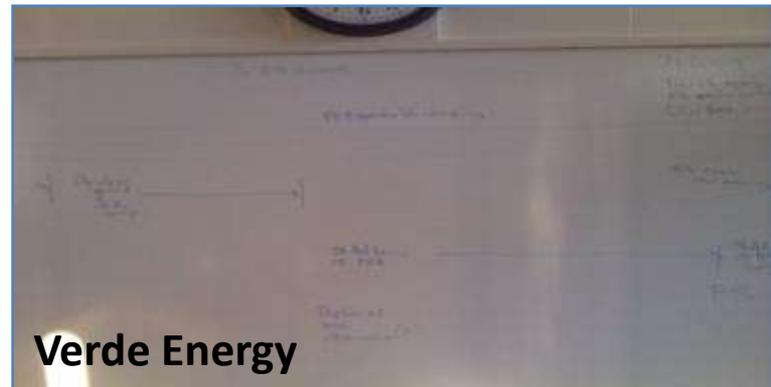
Social Enterprise



Verde Landscape



Verde Nursery



Verde Energy

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Outreach & Education



GREEN from the Ground Up



Friendly Maintenance Fact #1: A Stormwater Facility is Infrastructure

It's a Lot Like:



It's Not Like:



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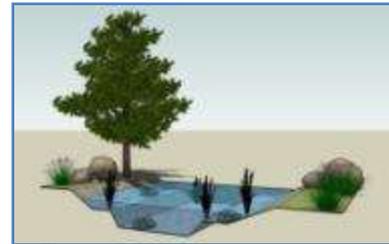
Friendly Facility Maintenance Fact #2: Follow the O&M Plan

Stormwater Management Facilities

Operation
and
Maintenance
for
Private Property
Owners



Access



Structure



Water Flow/Infiltration



Vegetation



Erosion



Pests



Pollution/Debris

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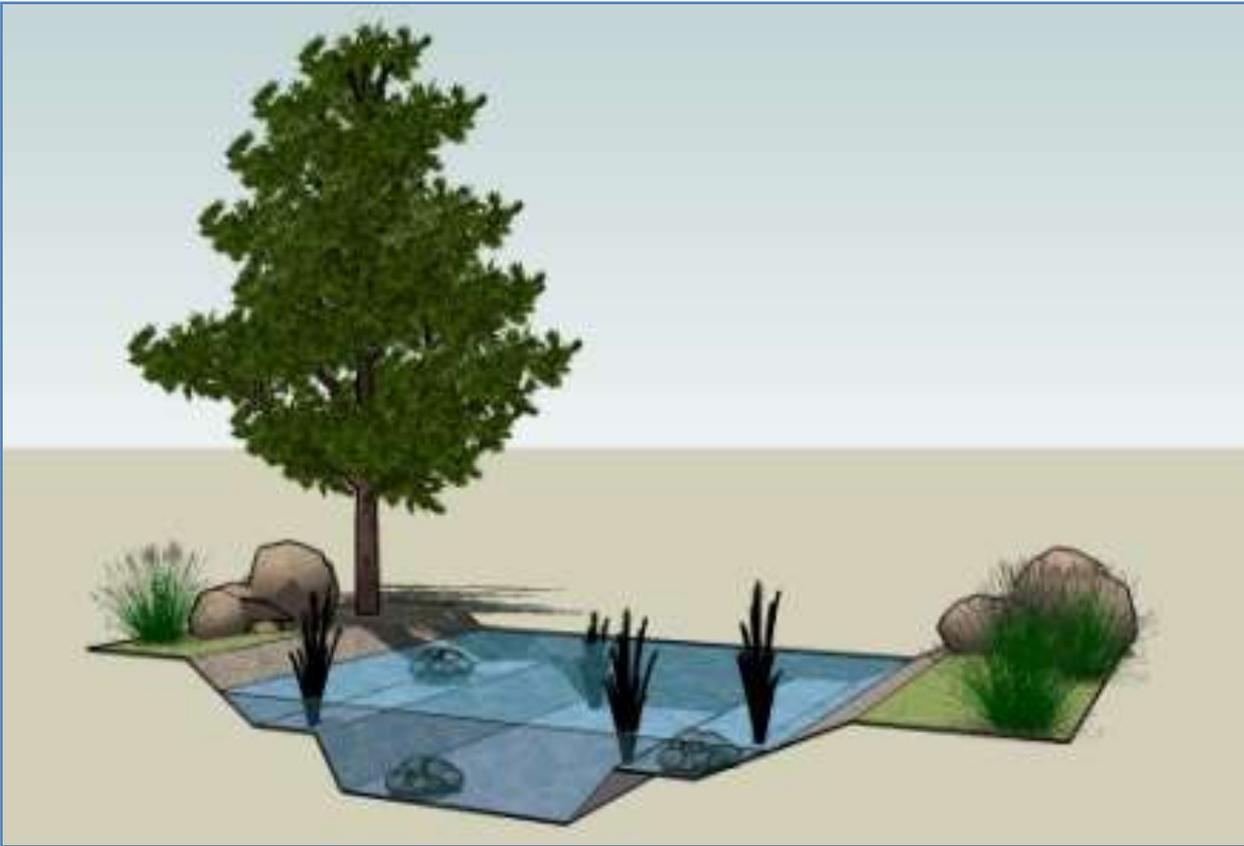
O&M Plan: Access



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O&M Plan: Structure



Missing Part(s)

Broken Part(s)

Not To Design
Standards

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O&M Plan: Water Flow/Infiltration



**Blocked,
Capacity
Diminished**

**Uneven
ponding or
Stagnant-
Standing Water**



O&M Plan: Vegetation



**Strained
Vegetation**

**Insufficient
Plant Cover**

**Remove
Invasives,
Noxious Weeds**

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O&M Plan: Erosion



Scouring

Channelization

Slope Failure

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O&M Plan: Pests



GREEN from the Ground Up



O&M Plan: Pollution



Debris

Off-Color, Odor

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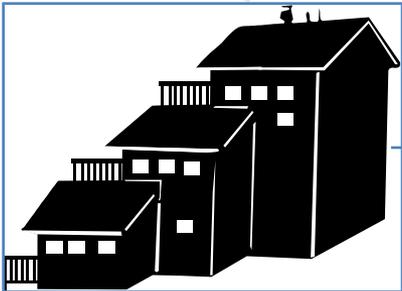
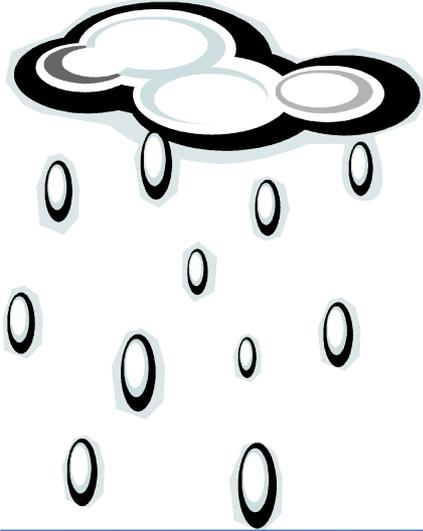
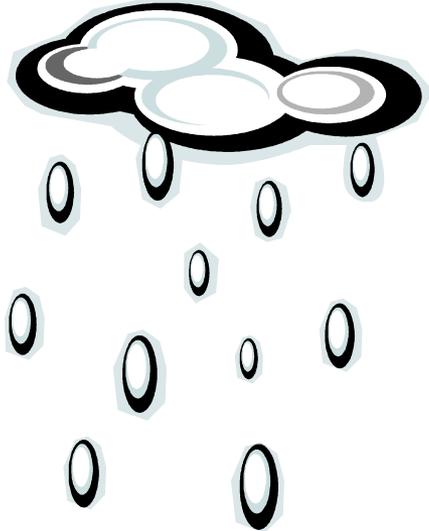
Friendly Facility Maintenance Fact #3: Tenant & Homeowner Education Makes a Big Difference



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Tenant Education: Stormwater

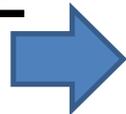


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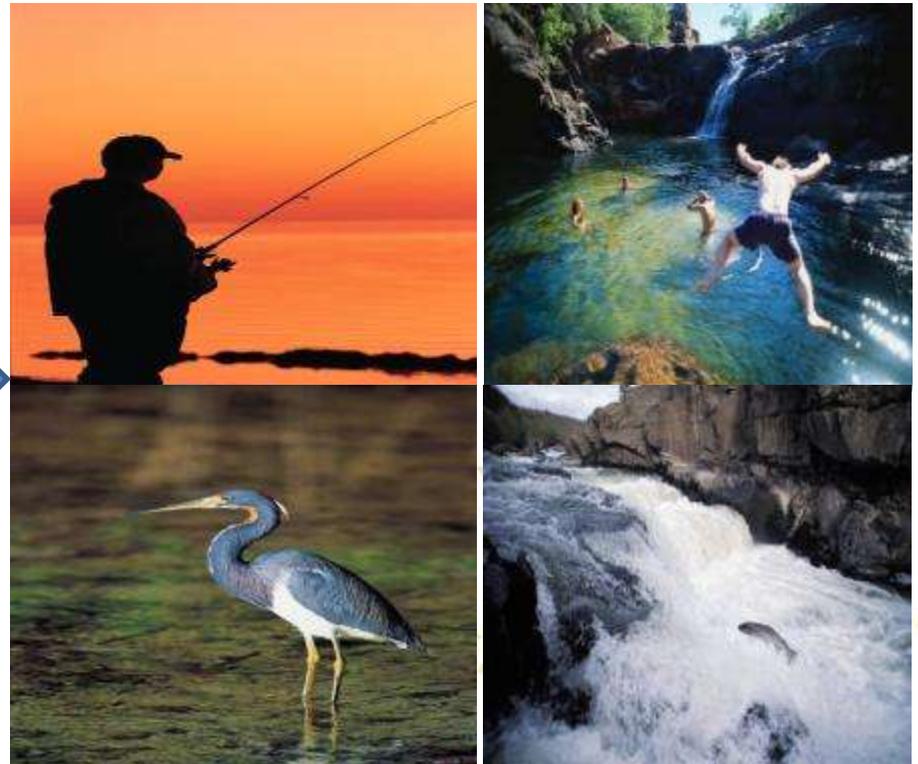


Tenant Education: Stormwater

Stormwater Contains Pollution



Stormwater Takes Pollution To:



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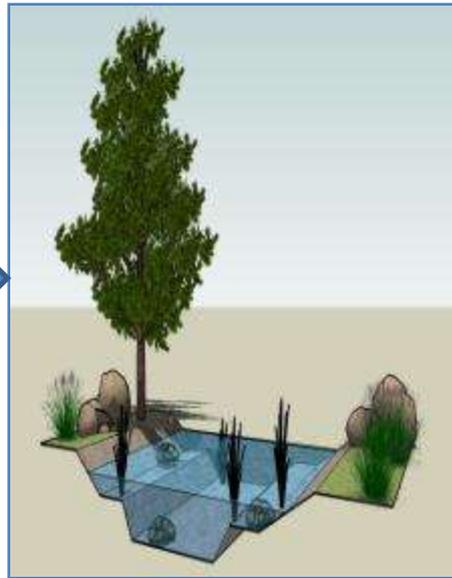


Tenant Education: Facility Function

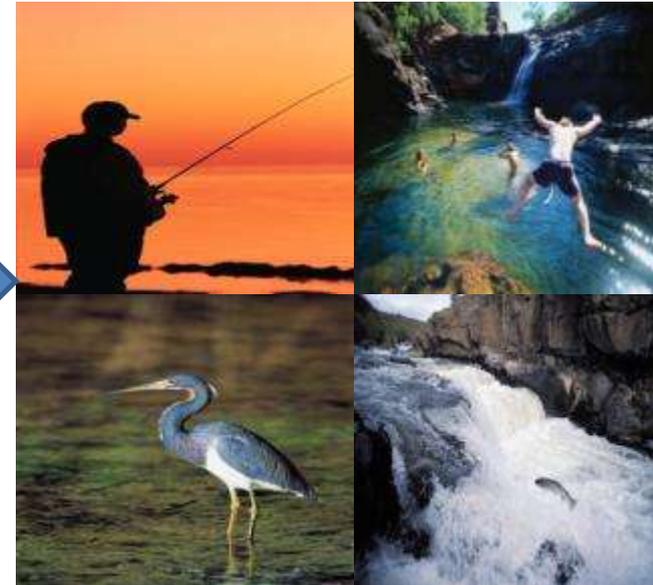
**Stormwater with
Pollution**



**Stormwater
Facility**



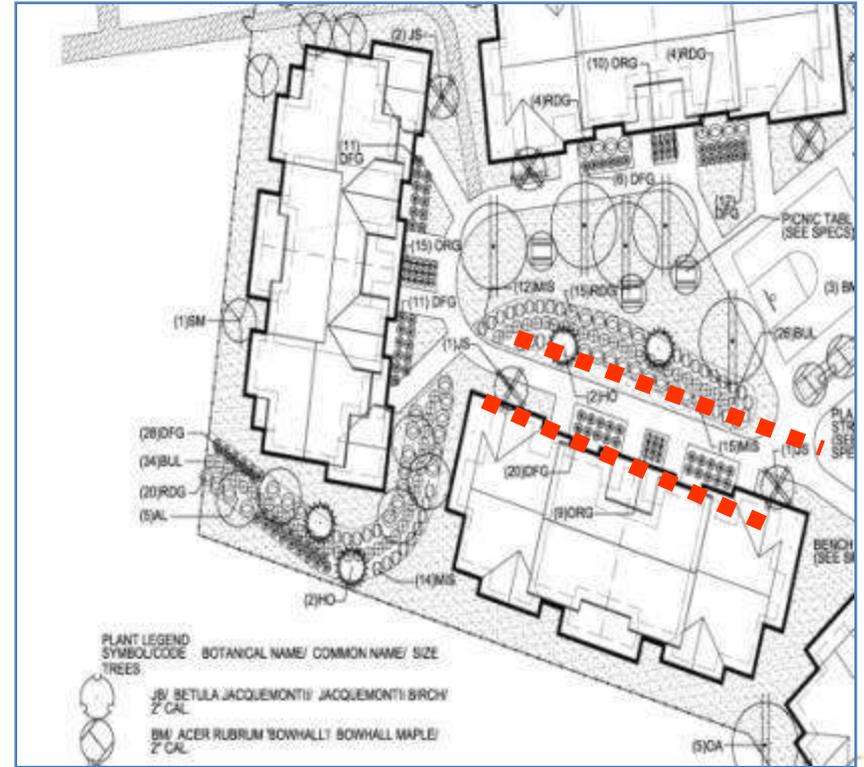
**Stormwater w/o
Pollution**



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Tenant Education: Facility Locations



PLANT LEGEND
SYMBOL/CODE BOTANICAL NAME/ COMMON NAME/ SIZE

TREES

	JB/ BETULA JACQUEMONTI/ JACQUEMONTI BIRCH 2' CAL
	BM/ ACER RUBRUM/ BOWHALL/ BOWHALL MAPLE/ 2' CAL



Tenant Education: Plant Health

Redtwig Dogwood

- **Function:**
Habitat, Erosion Control
- **Warning:** Leaf color changes when plant is not receiving enough water





Tenant Education: Stewardship



No Bicycling



No Running



Rocks



Tree Stakes



Watch for Plant Health



No Trash

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Friendly Facility Maintenance Fact #3: Tenant & Homeowner Education Makes a Big Difference



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Friendly Facility Maintenance Fact #3: Tenant & Homeowner Education Makes a Big Difference



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Example: Deferred Maintenance



GREEN from the Ground Up



Example: Deferred Maintenance



GREEN from the Ground Up



Example: Deferred Maintenance



GREEN from the Ground Up



Example: Deferred Maintenance



GREEN from the Ground Up



Example: Corrective Action



GREEN from the Ground Up



Example: Corrective Action



GREEN from the Ground Up



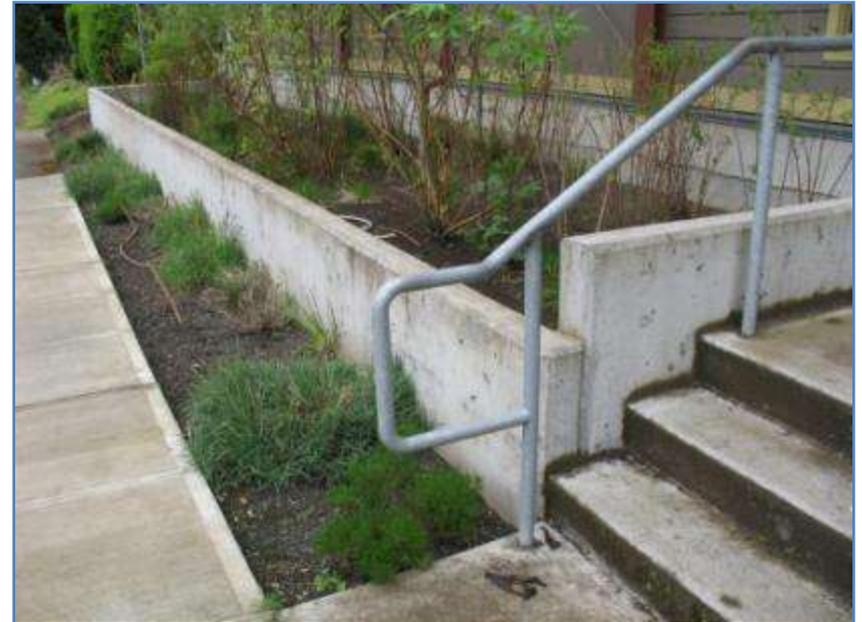
Example: Corrective Action



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Example: Corrective Action



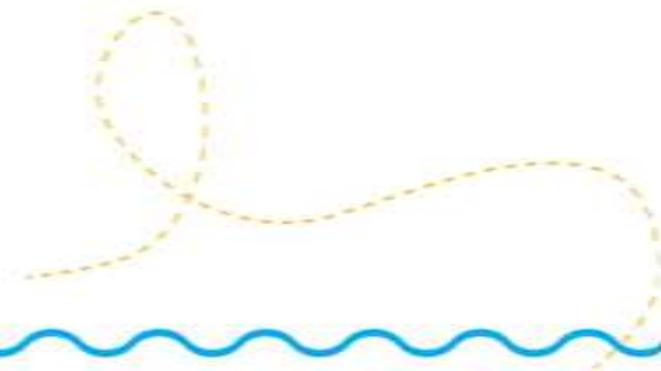
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Thank you partners!

- ◆ Oregon Department of Environmental Quality
- ◆ Home Builders Association of Metro Portland
- ◆ Clackamas River Basin Council
- ◆ Nevue Ngan Associates
- ◆ KPFF Engineering
- ◆ Verde



GREEN
from the Ground Up
Seminars for land-savvy developers



[nev-ū-nan]
Nevue Ngan Associates

