

Bioretention as Green Infrastructure

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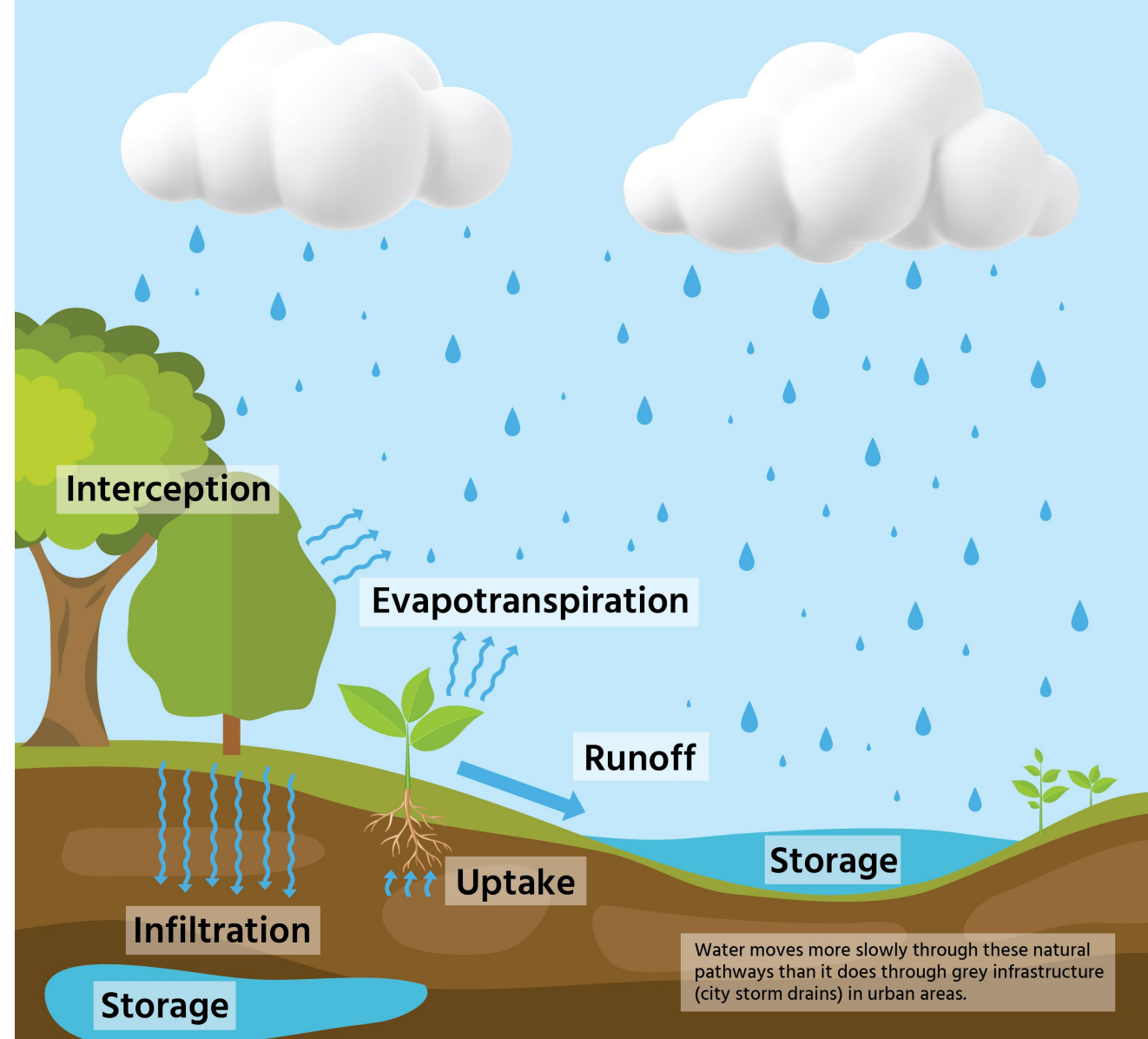


Green Infrastructure

Mimics natural ecosystems to manage stormwater

- Both volume & flow rate
- Less adverse impact on receiving waters
- Secondary benefits (ecological services)

Both engineered and natural assets





Green Roofs



Rainwater Harvesting



Permeable Pavements



Planter Boxes



Downspout Disconnection



Bioswales and Grassed Swales



Living Shorelines



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Constructed Wetlands



Green Streets and Alleys



Green Parking

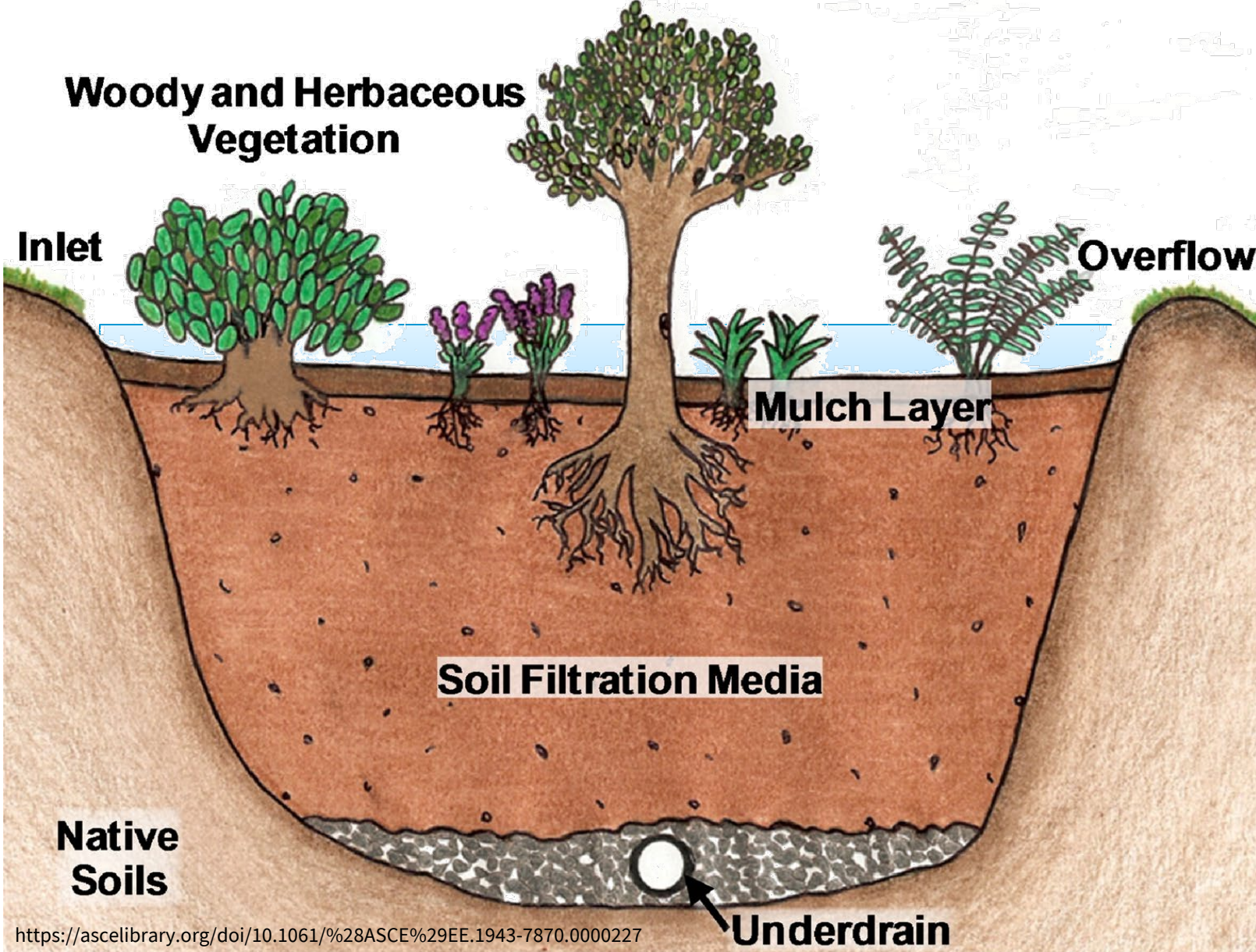


Land Conservation

- Blue Roofs
- Green Walls
- Gardens
- Rain Barrels



Bioretention





2.9 Bioretention



Description

Bioretention is a shallow depression over an excavation that is backfilled with an engineered media (soil) and vegetated. It is among the most effective and versatile stormwater management practices. The gradual percolation of ponded runoff through a vegetated media supplies many different runoff treatment mechanisms including sedimentation, filtration, sorption, biodegradation, nutrient assimilation, transformation, and thermal mitigation. An anaerobic zone or potential sorptive amendments added to the media may enhance the removal of nutrients. Once through the media, captured stormwater can infiltrate into the surrounding subsoil which reduces the volume of runoff, attenuates discharge rates, and recharges groundwater. Where soil infiltration rates are low, an underdrain below the media can be installed to discharge excess runoff to a storm sewer or a downstream channel. This chapter applies bioretention on a small-scale at the individual development level.

Credits

Table 2.9.1 Credits for Bioretention Meeting the Criteria in this Chapter

Objective	Credit	
Runoff Reduction Volume (RRv)	Practices that infiltrate the Water Quality Volume (WQv)	100% of the WQv.
	Practices with an underdrain above a 15-inch internal water storage	75% of the WQv in HSG B soil. 50% of the WQv in HSG C soil. 25% of the WQv in HSG D soil.
	Lined practices	None.

Rainwater & Land Development

Chapter 2.9 - Bioretention

- Released March 2023
- Applies to small-scale bioretention at the individual development scale

Key Thoughts

1. While frequently promoted, bioretention is not the answer for all sites
cons: maintenance, costs, risk, design complexity(?)
pros: multifunctional space
2. Originally an LID concept that is most effective when:
 - many small (decentralized) practices are used
 - integrated into the development layout (in advance)
3. Construction plans need to include fine details

Soil Based Designs

Field Saturated Conductivity (Kfs) *	Design
≥ 0.50 inches per hour	WQv infiltration (true bioretention)
< 0.50 inches per hour	Partial WQV infiltration w/ IWS & underdrain (adapted bioretention)
Any infiltration will be detrimental	liner w/orifice (Biofiltration)

* at elevation of subsurface infiltration bed

Infiltration Volume (RRv)

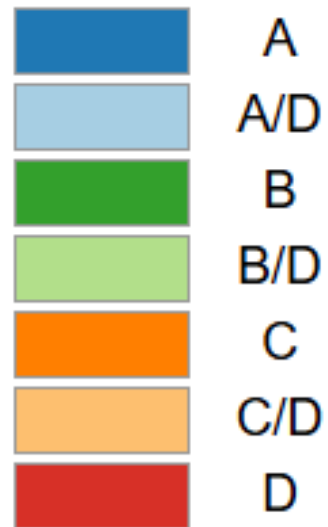
Design	HSG	RRv (% of WQv infiltrated)
$Kfs \geq 0.50$ in/hr	A	100%
$Kfs \leq 0.50$ in/hr	B	75%
	C	50%*
	D	25%*
Lined		0%

* with proper construction

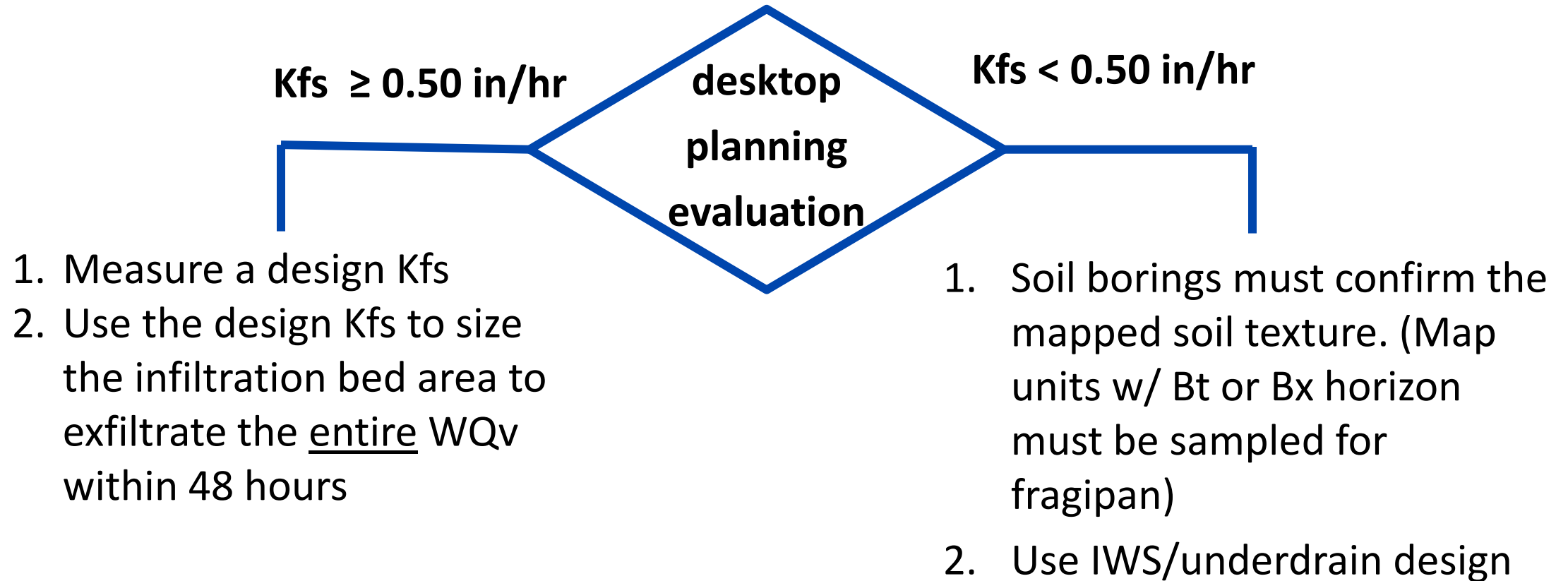
Geauga County Soils

Hydrologic Group

Group



Soil Based Designs



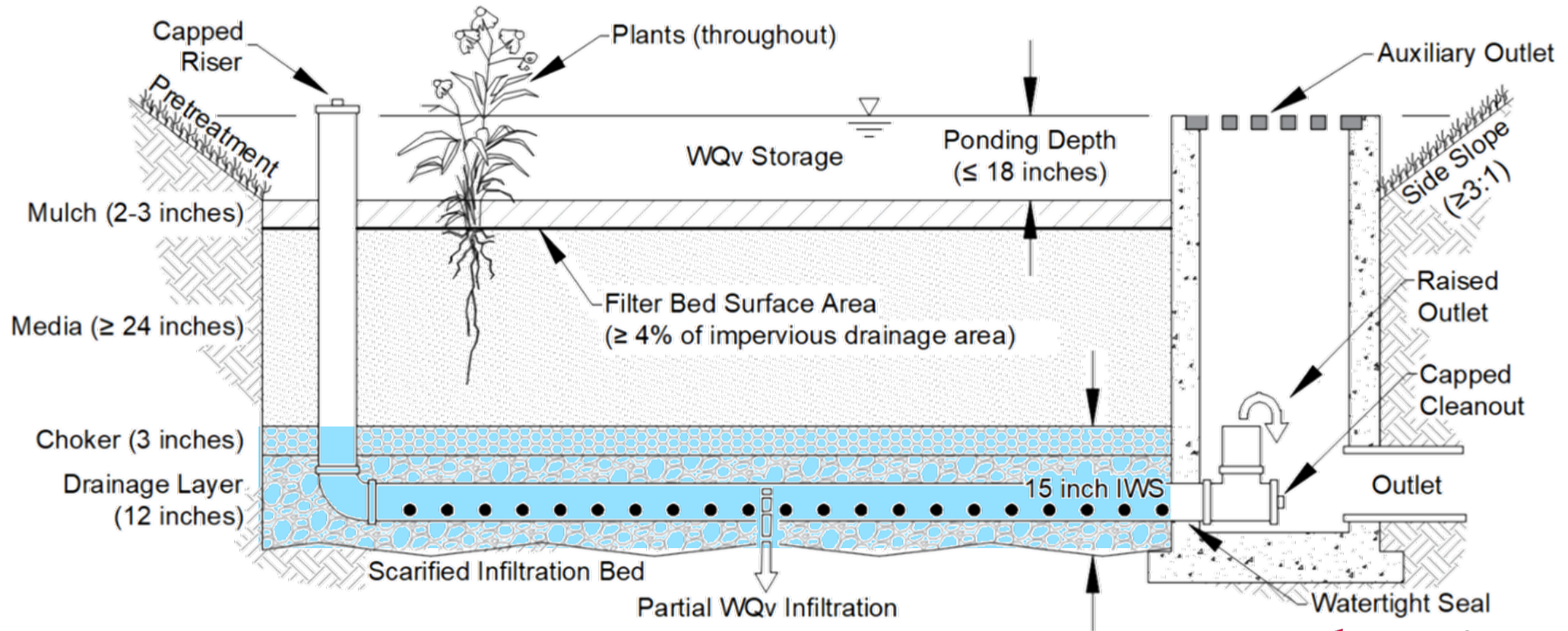
Infiltration Tests

- $K_{fs} \geq 0.50$ in/hr
- See *Rainwater & Land Development* Chapter 2.17 (provisional, to be updated)
- In-situ soil (field based) not lab (core)

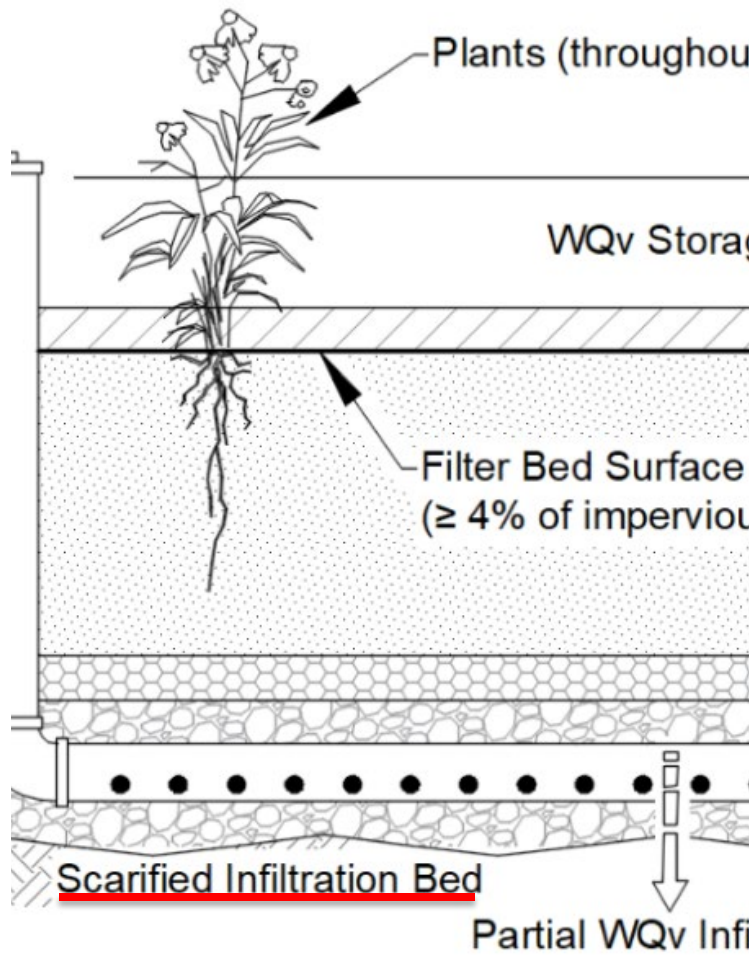


Internal Water Storage Design

b) Bioretention with an Underdrain and Raised Outlet to Create Internal Water Storage (IWS) for Partial Infiltration of the WQv in Poorly to Moderately Drained Soil



Infiltration Bed as a Structural Component



Infiltration Bed as a Structural Component

- To preserve the design soil infiltration rate and the RRv credit, require:
 1. excavation take place only in dry soil conditions,
 2. excavation take place from the perimeter or use protective mats if equipment must be operated within the bioretention excavation to minimize soil compaction,
 3. the builder rakes the soil surface a few inches deep with the teeth of the excavator bucket during the final excavation pass or a similar method; and
 4. any unavoidable soil smearing or surficial compaction be remediated by tilling, scarifying, and/or fracturing the soil surface once it has dried.
- If efforts to prevent compaction and smearing cannot be included in the plans, conduct infiltration tests after excavation to confirm the design Kfs

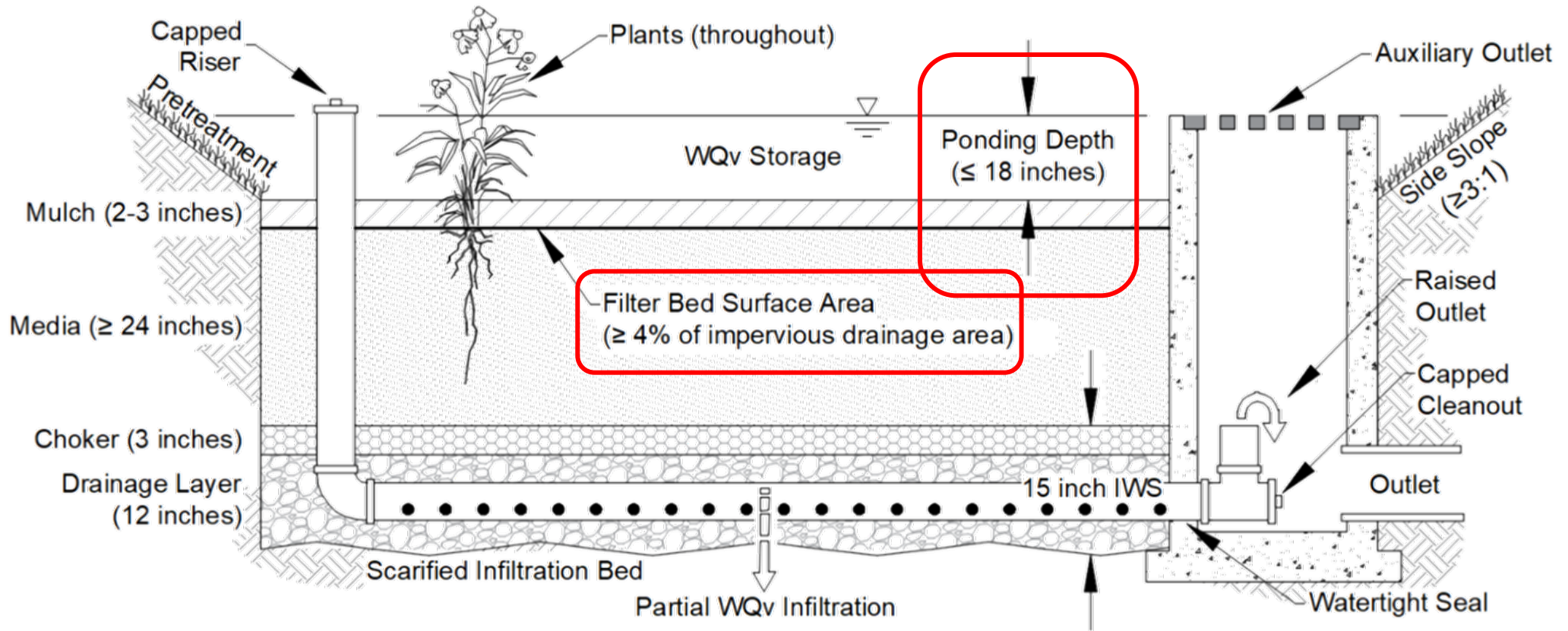
Designing Bioretention in Accordance with the Rainwater and Land Development Manual

SIZING



WQv Geometry

b) Bioretention with an Underdrain and Raised Outlet to Create Internal Water Storage (IWS) for Partial Infiltration of the WQv in Poorly to Moderately Drained Soil



Filter Bed Surface Area & Ponding Volume



Filter Bed Surface Area & Ponding Volume



Credit: Wisconsin DNR

Designing Bioretention in Accordance with the Rainwater and Land Development Manual

MEDIA MIX



Table 2.9.2 Bioretention Media Specifications

USDA Soil Texture Classification	Loamy sand.
Clay Content	The mineral fraction of the media shall be no greater than 10 percent clay per USDA classification (< 0.002 mm) by weight.
Sand Content	The mineral fraction of the media shall be no less than 80 percent and no more than 90 percent medium to coarse sand per USDA classification (0.25 to 1.0 mm) by weight.
Organic Matter Content	1.5 to 5 percent by dry weight as determined by percent loss on ignition (ASTM-D2974).
pH	5.5 to 8.0
Phosphorus	Not to exceed 40 mg/kg as determined by the Mehlich-3 test.
Soluble Salts	500 ppm maximum (soil/water 1:2).

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PRETREATMENT



Pretreatment



Functions:

1. Remove sediment
2. Collect trash
3. Grade drop

← Sheet flow through grass filter

Pretreatment



↑ Drop inlet

Forebay w/ spreader weir →



↑ Proprietary



Pretreatment



Rock Pad

Curb Cuts

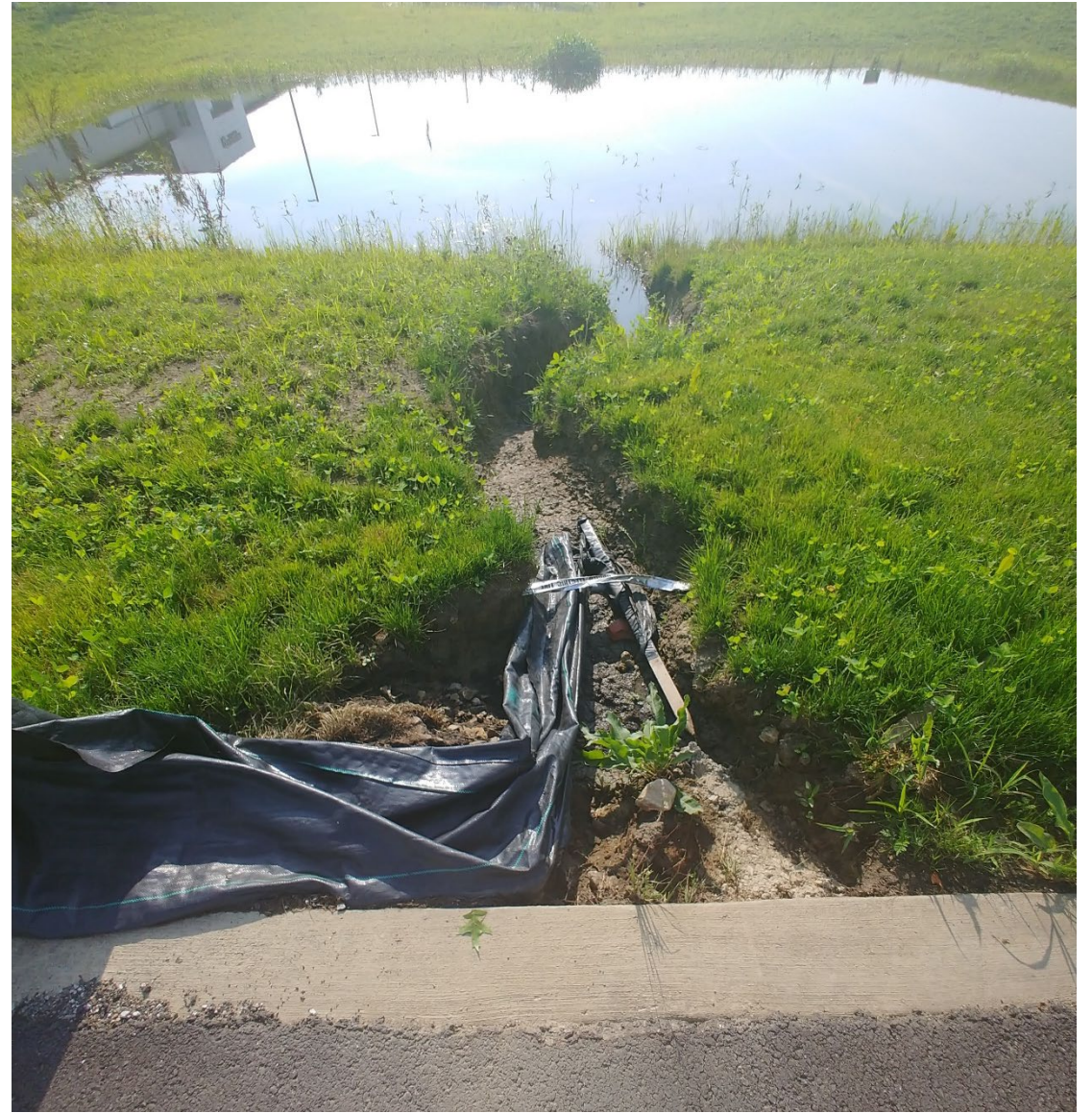


Geauga SWCD Green Infrastructure Workshop
March 12, 2025





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OTHER COMPONENTS



Vegetation (the “bio” in bioretention)



Vegetation

CONSTRUCTION SEQUENCE FOR RAIN GARDEN BASIN:

1. COMPLETE SITE GRADING. PROVIDE PROTECTION SO STORMWATER RUNOFF IS PROHIBITED FROM ENTERING THE BIORETENTION BASIN DURING CONSTRUCTION.
2. SUBGRADE PREPARATION
 - a. EXISTING SUBGRADE IN BIORETENTION BASIN SHOULD NOT BE COMPACTED OR SUBJECT TO EXCESSIVE CONSTRUCTION EQUIPMENT TRAFFIC.
 - b. INITIAL EXCAVATION CAN BE PERFORMED DURING ROUGH SITE GRADING, BUT SHOULD NOT BE CARRIED TO WITHIN ONE FOOT OF THE FINAL BOTTOM ELEVATION. FINAL EXCAVATION SHOULD NOT TAKE PLACE UNTIL ALL DISTURBED AREAS IN THE DRAINAGE AREA HAVE BEEN STABILIZED.
 - c. WHERE EROSION OF SUBGRADE HAS CAUSED ACCUMULATION OF FINE MATERIALS AND/OR SURFACE PONDING IN THE GRADED BOTTOM, THIS MATERIAL SHOULD BE REMOVED WITH LIGHT EQUIPMENT AND THE UNDERLYING SOILS SCARIFIED TO A MINIMUM DEPTH OF SIX INCHES WITH A YORK RAKE OR EQUIVALENT BY LIGHT TRACTOR.
 - d. BRING SUBGRADE OF BIORETENTION AREA TO LINE, GRADE, AND ELEVATIONS INDICATED. FILL AND LIGHTLY REGRADE ANY AREAS DAMAGED BY EROSION, PONDING, OR TRAFFIC COMPACTION. ALL BIORETENTION AREAS SHOULD BE LEVEL GRADE ON THE BOTTOM.
3. STABILIZE THE GRADING EXCEPT WITHIN THE BIORETENTION BASIN. THE BIORETENTION BASIN MAY BE USED AS A TEMPORARY SEDIMENT TRAP PROVIDED THE PROPOSED FINISH ELEVATION OF THE BED IS AT LEAST 12 INCHES LOWER THAN THE BOTTOM ELEVATION OF THE SEDIMENT TRAP (IF USED AS SUCH, ALL ACCUMULATED MATERIAL AND AT LEAST 12 INCHES OF SOIL SHOULD BE REMOVED).
4. EXCAVATE THE BIORETENTION BASIN TO PROPOSED INVERT DEPTH AND SCARIFY THE EXISTING SOIL SURFACES. DO NOT COMPACT SOILS.
5. BACKFILL THE BIORETENTION BASIN WITH THE SOIL MIXTURE AS SHOWN ON THE DESIGN PLANS AND SPECIFICATIONS. OVERFILLING IS RECOMMENDED TO ACCOUNT FOR SETTLING. LIGHT HAND TAMPING IS ACCEPTABLE IF NECESSARY.
6. COMPLETE FINAL GRADING TO ACHIEVE PROPOSED DESIGN ELEVATIONS. LEAVING SPACE FOR UPPER MULCH AS SPECIFIED ON PLANS.

7. BIORETENTION BASIN INSTALLATION
 - a. UPON COMPLETING SUBGRADE WORK, NOTIFY THE ENGINEER TO INSPECT AT HIS/HER DISCRETION BEFORE PROCEEDING WITH BIORETENTION INSTALLATION.
 - b. FOR THE SUBSURFACE STORAGE/INFILTRATION BED INSTALLATION, SOILS SHOULD BE PLACED ON THE BOTTOM TO THE SPECIFIED DEPTH.
 - c. THE CONTRACTOR SHALL INSTALL UNDERDRAIN AS DETAILED ON THE PLANS AND AS DIRECTED BY THE ENGINEER. THE UNDERDRAIN SHALL BE CONNECTED DOWNSTREAM TO THE SPECIFIED DRAINAGE STRUCTURE. THE UNDERDRAIN SHALL BE CONSTRUCTED WITH A MINIMUM 0.5% SLOPE.
 - d. PLANTING SOIL SHOULD BE PLACED IMMEDIATELY AFTER APPROVAL OF SUBGRADE PREPARATION/BED INSTALLATION. ANY ACCUMULATION OF DEBRIS OR SEDIMENT THAT TAKES PLACE AFTER APPROVAL OF SUBGRADE SHOULD BE REMOVED PRIOR TO INSTALLATION OF PLANTING SOIL AT NO EXTRA COST TO THE OWNER.
 - e. INSTALL APPROVED PLANTING SOIL IN 18-INCH MAXIMUM LIFTS AND LIGHTLY COMPACT (TAMP WITH BACKHOE BUCKET OR BY HAND). KEEP EQUIPMENT MOVEMENT OVER PLANTING SOIL TO A MINIMUM - DO NOT OVER-COMPACT. INSTALL PLANTING SOIL TO GRADES INDICATED ON THE DRAWINGS. LOADS ON THE SOIL SHOULD NOT EXCEED FOUR POUNDS PER SQUARE INCH.
 - f. PRESOAK THE PLANTING SOIL AT LEAST 24 HOURS PRIOR TO PLANTING VEGETATION TO AID IN SETTLEMENT.
 - g. PLANT TREES AND SHRUBS ACCORDING TO SUPPLIER'S RECOMMENDATIONS AND ONLY FROM MID-MARCH THROUGH THE END OF JUNE OR FROM MID-SEPTEMBER THROUGH MID-NOVEMBER.
 - h. INSTALL TWO OR THREE INCHES OF SHREDDED HARDWOOD MULCH (MINIMUM AGE SIX MONTHS) EVENLY AS SHOWN ON PLANS. DO NOT APPLY MULCH IN AREAS WHERE GROUND COVER IS TO BE GRASS OR WHERE COVER WILL BE ESTABLISHED BY SEEDING.
 - i. PROTECT THE BIORETENTION BASIN FROM SEDIMENT AT ALL TIMES DURING CONSTRUCTION. APPROPRIATE MEASURES SHOULD BE USED AT THE TOE OF SLOPE THAT IS ADJACENT TO THE BIORETENTION BASIN TO PREVENT SEDIMENT FROM WASHING INTO THESE AREAS DURING CONSTRUCTION.
 - j. WHEN THE SITE IS FULLY VEGETATED AND THE SOIL MANTLE IS STABILIZED, NOTIFY THE PLAN DESIGNER TO INSPECT THE BIORETENTION BASIN DRAINAGE AREA AT HIS/HER DISCRETION BEFORE THE AREA IS BROUGHT ONLINE AND SEDIMENT CONTROL DEVICES REMOVED.
8. MULCH AND INSTALL EROSION PROTECTION AT SURFACE FLOW ENTRANCES WHERE NECESSARY.

RAIN GARDEN - PLANT LIST

QTY.	CODE	COMMON NAME	BOTANICAL NAME	INSTALL SIZE	CONDITION
SHRUBS					
-	IV	WINTERBERRY HOLLY	ILEX VERTICILLATA	3 GAL.	CONTAINER
-	CO	DOGWOOD	CORNUS SP.	5 GAL.	CONTAINER
-	AP	BOTTLEBRUSH BUCKEYE	AESCULUS PARVIFLORA	5 GAL.	CONTAINER
-	AR	CHOKEBERRY	ARONIA SP.	3 GAL.	CONTAINER
-	IVH	HENRY'S GARNET SWEETSPIRE	ITEA VIRGINICA 'HENRY'S GARNET'	3 GAL.	CONTAINER
-	PO	SUMMER WINE NINEBARK	PHYSOCARPUS OPULIFOLIUS 'SUMMER WINE'	3 GAL.	CONTAINER
ORNAMENTAL GRASSES & PERENNIALS					
-	CA	KARL FOERSTER FEATHER REED GRASS	CALAMAGROSTIS ACUTIFLORA 'KARL FOERSTER'	2 GAL.	CONTAINER
-	PV	HEAVY METAL SWITCH GRASS	PANICUM VIRGATUM 'HEAVY METAL'	2 GAL.	CONTAINER
-	CS	TUSsock SEDGE	CAREX STRICTA	2 GAL.	CONTAINER
-	AT	BUTTERFLY MILKWEED	ASCLEPIAS TUBEROSA	2 GAL.	CONTAINER
-	AS	ASTERS	ASTER SP.	2 GAL.	CONTAINER
-	LC	CARDINAL FLOWER	LOBELIA CARDINALIS	2 GAL.	CONTAINER
-	SSC	SOLAR CASCADE GOLDENROD	SOLIDAGO 'SOLAR CASCADE'	2 GAL.	CONTAINER

NOTE:
RAIN GARDEN LIST IS NOT COMPREHENSIVE. NO QUANTITIES ARE SHOWN - DETAILED PLANTING PLAN AND LIST WILL BE PROVIDED PRIOR TO CONSTRUCTION.



Importance of Mulch



Vegetation

No-Mow Grass



Source: St. Louis MSD

Thankyou & Questions?

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