GREENER STORMWATER SOLUTIONS
An Overview of the MSD Stormwater Guide for Best Management Practice Design

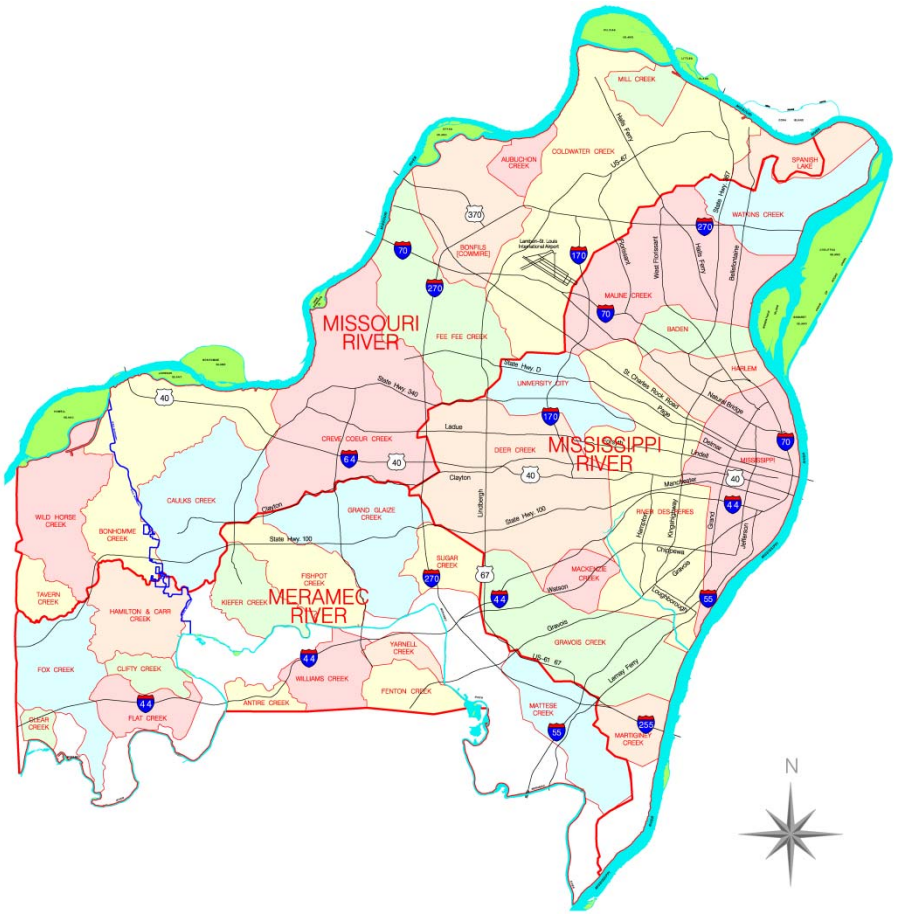
March 10 & 11, 2010 - John Grimm, P.E.

Presentation Outline

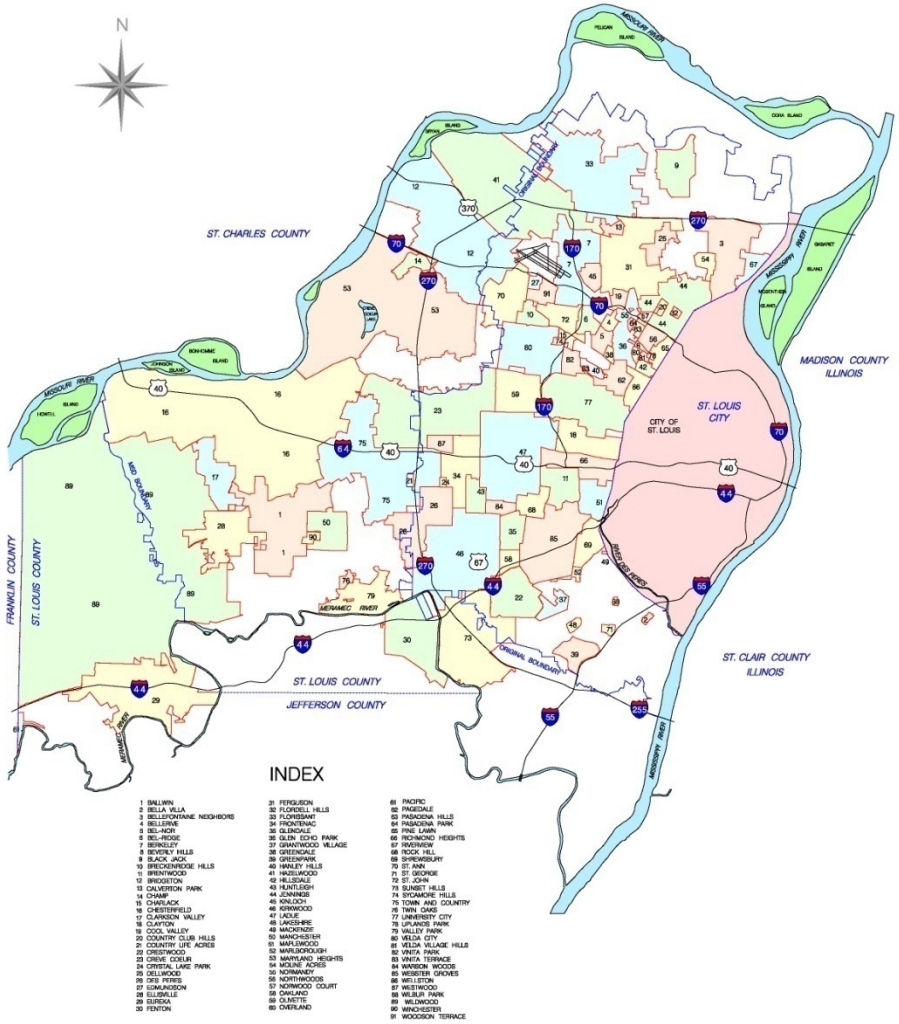
- Part 1 – Old Items
  - EPA Phase II Stormwater Permit Review
  - MSD Design Requirements
  - Best Management Practice (BMP) Options
- Part 2 – New Items
  - Environmental Site Design
  - BMP Landscape Guide
  - A Few Updates to the Guide
  - Some Recent Examples

St. Louis Area

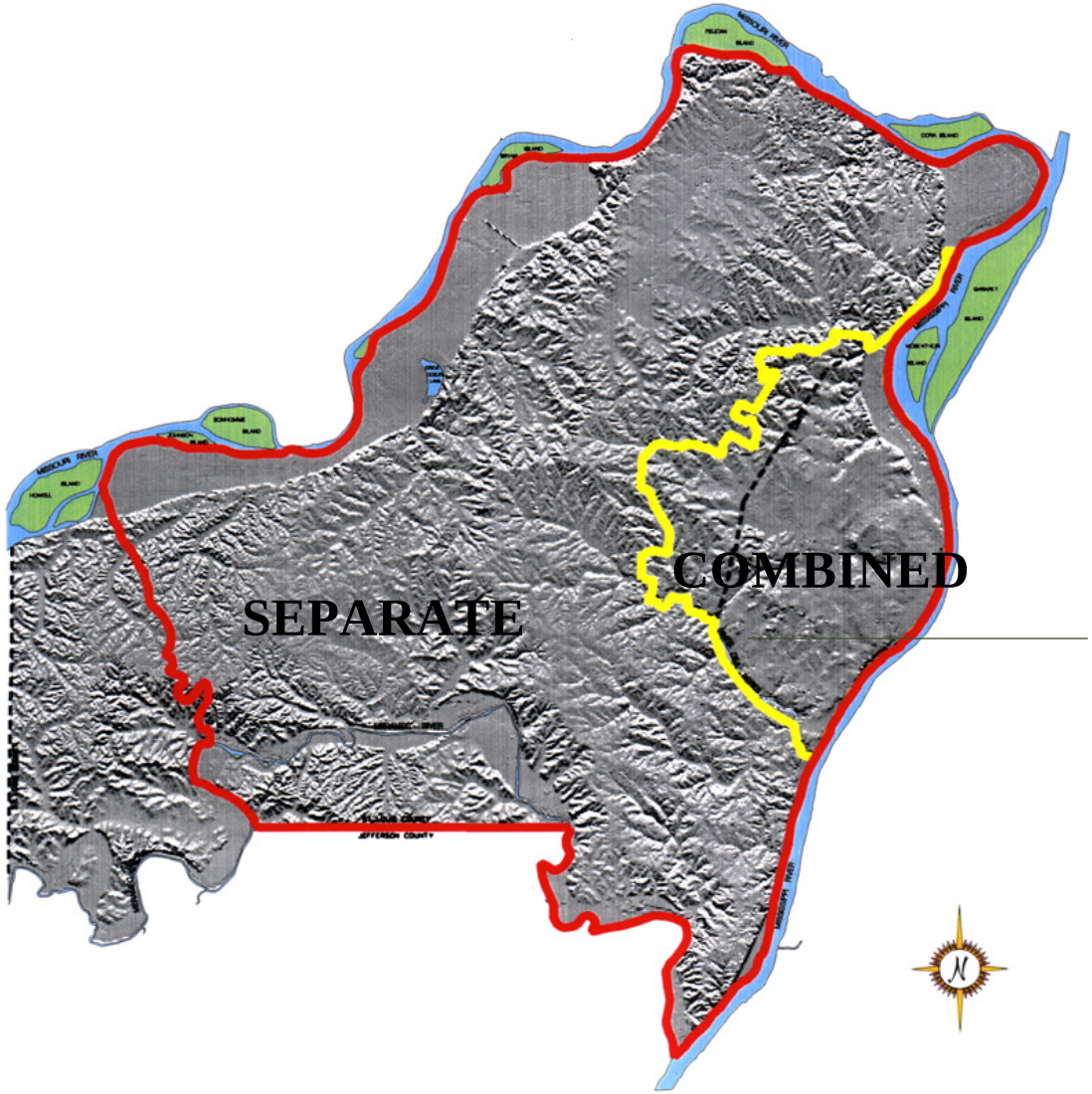
Watersheds



Cities

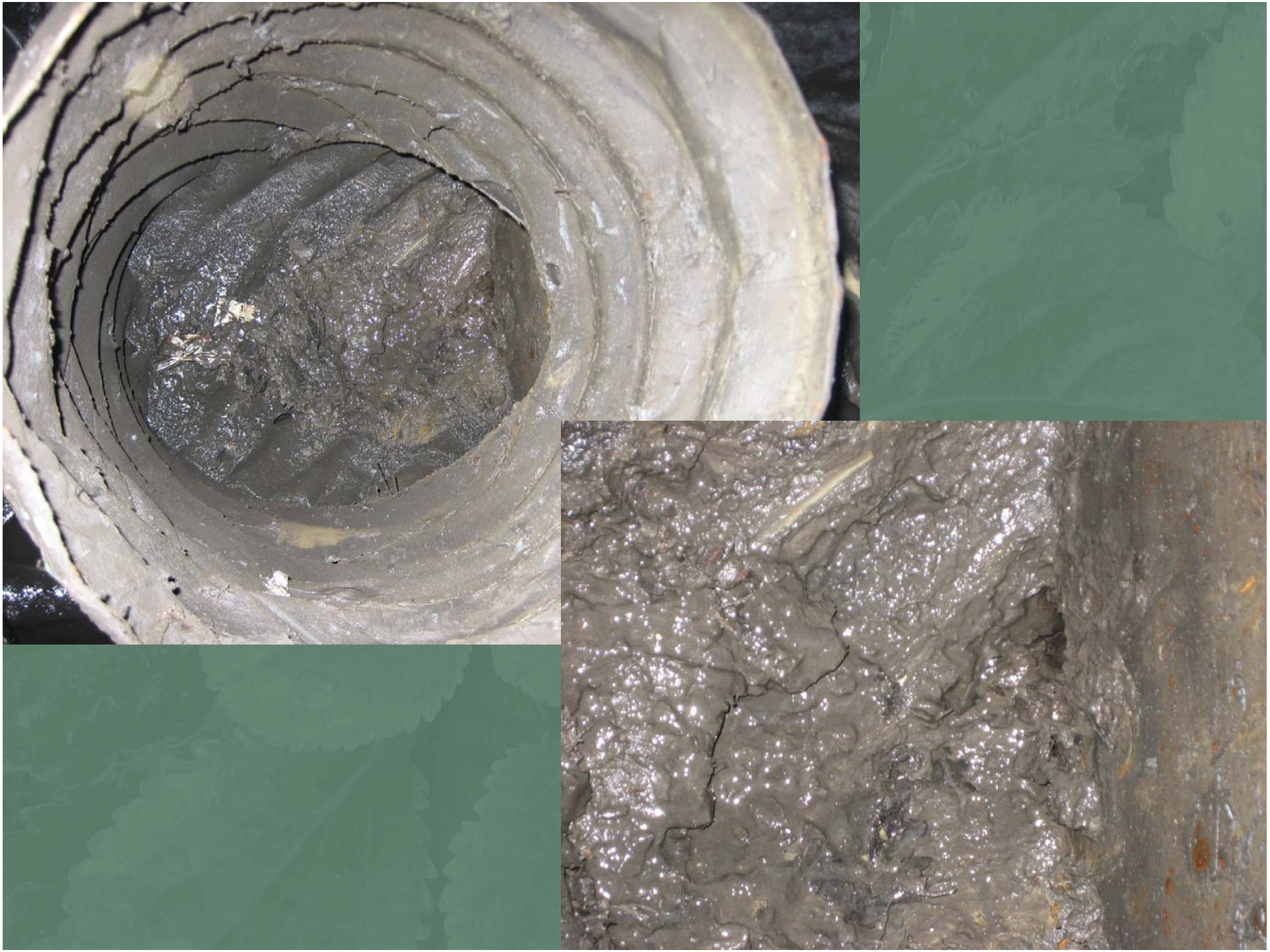


MSD's COMBINED & SEPARATE SEWER AREAS



Chronic Pollutant Loads into Urban Watersheds


CAUTIO



EPA Phase II Stormwater Regulations in St. Louis

- MSD Approved as Plan Area Coordinating Authority
- Cooperation Achieved Between 61 Copermittees

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DEPARTMENT OF NATURAL RESOURCES

MISSOURI CLEAN WATER COMMISSION

MISSOURI STATE OPERATING PERMIT
WATER POLLUTION CONTROL PROGRAM

General Operating Permit

In compliance with the Missouri Clean Water Law, (chapter 644 R.S. Mo. as amended, hereinafter, the Law), and the Federal Water Pollution Control Act (Public Law 92-500, 92nd Congress) as amended,

Permit No.:	MO-R040005
Owner:	Metropolitan St. Louis Sewer Dist.
Address:	10 East Grand Avenue St. Louis, MO 63147
Continuing Authority:	Same
Facility Name:	MSD Small MS4
Facility Address:	10 East Grand Avenue, St. Louis, MO 63147
Legal Description:	See Page 2
Latitude Longitude	See Page 2
Receiving Stream	See Page 2
First Classified Stream- **ID#**:	See Page 2
USGS # and Sub Watershed #	See Page 2

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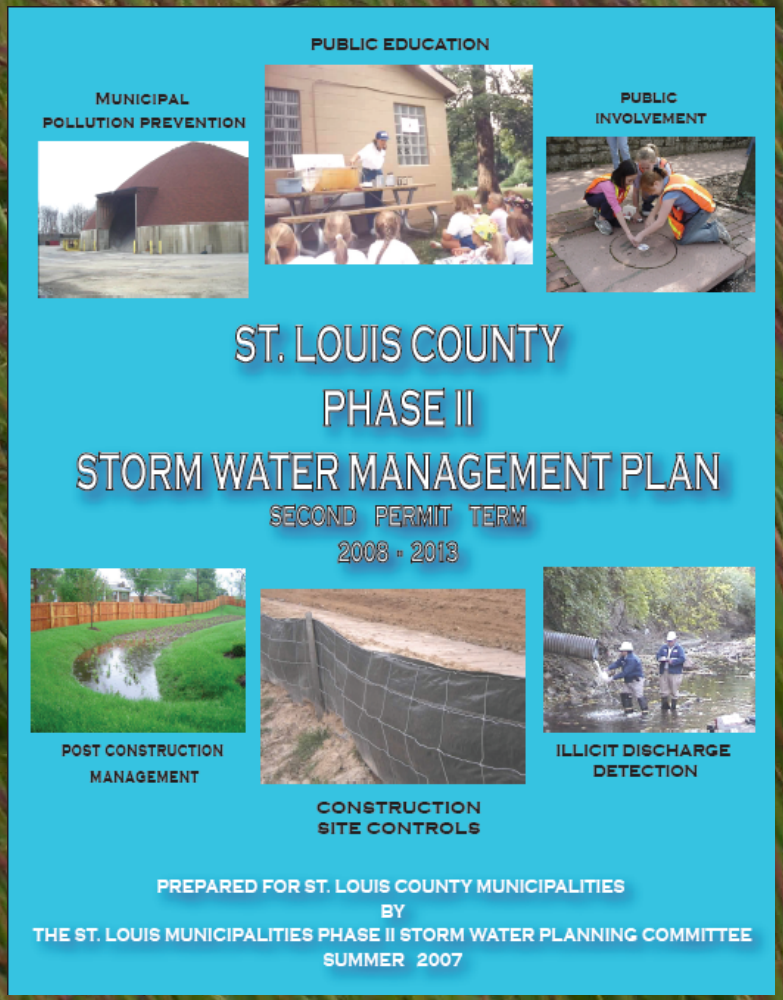
Storm Water Management Plan

- 5-Year Plan
- 6 Minimum Control Measures
- General Permit
- Annual Reporting



Joint Responsibility for 6 MCMs

Minimum Control Measure	Primary Responsible Entity		
	MSD	County	Cities
1. Public education and outreach on storm water impacts	X		
2. Public involvement/participation	X		
3. Illicit discharge detection and elimination	X		
4. Construction site storm water runoff control	X	X	X
5. Post-construction storm water management in new development and redevelopment	X	X	
6. Pollution prevention/good housekeeping for municipal operations	X	X	X

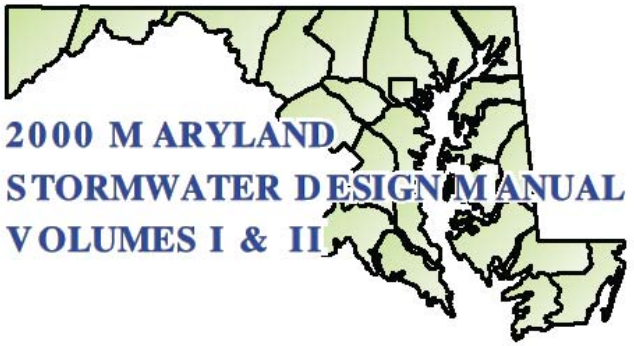
THE METROPOLITAN ST. LOUIS SEWER DISTRICT

MSD

RULES AND REGULATIONS AND ENGINEERING DESIGN REQUIREMENTS FOR SANITARY SEWER AND STORMWATER DRAINAGE FACILITIES

FEBRUARY 2006

2000 MARYLAND STORMWATER DESIGN MANUAL VOLUMES I & II



PREPARED BY:

CENTER FOR WATERSHED PROTECTION

ELLICOTT CITY, MARYLAND

AND THE

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WATER MANAGEMENT ADMINISTRATION
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(410) 631-3543 1-800-633-6101 http://www.mde.state.md.us

New Design Methods…..
Let's Change "Business as Usual"…
We Have to

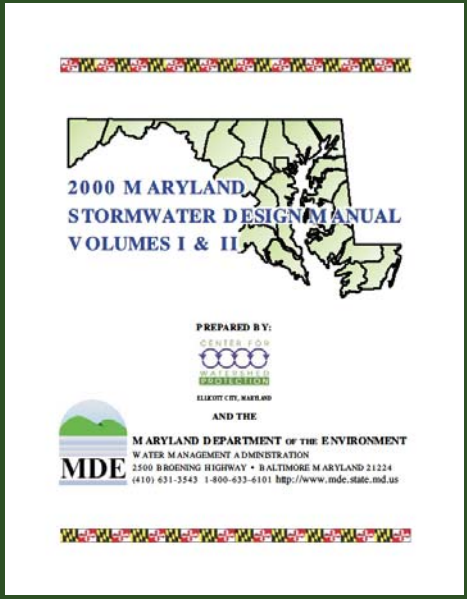
- Begin stormwater management early in the site development process
- New LID site design methods and required Storm Water Phase II Regulations mesh with USGBC LEED Certification
- Less sewers, less curbs, less hard surfaces, less runoff
- More green space, more swales, more natural features, more native vegetation

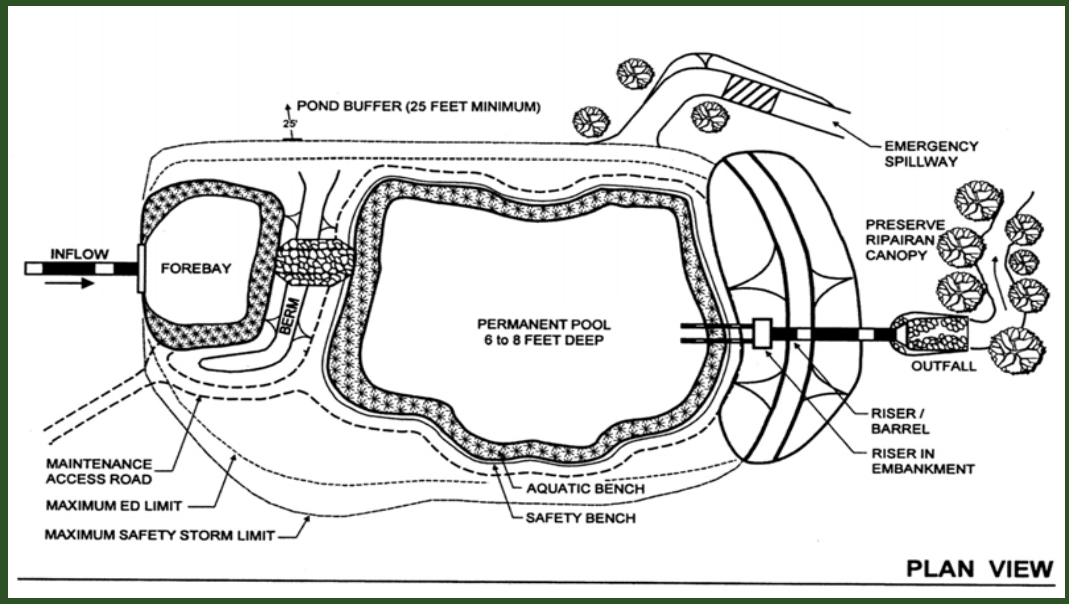
MSD Revised Rules and Regulations Storm Water Criteria

- Flood Volume (Qp) Requirements similar to 1997 MSD Regs
  - Maintain peak flow for 2 yr (3.1”) & 100 yr (7.2”) storm
- New Channel Protection Volume (CPv)
  - Extended detention of 1 yr (2.5”) storm
- New Water Quality Volume (WQv)
  - Treatment using BMPs for 90% of annual storm events (1.14”)

Design Standards Selected - CPv and WQv

- Maryland Stormwater Design Manual
  - Volume 1 – Stormwater Management Criteria
  - Volume 2 – Stormwater Design Appendices
  - www.mde.state.md.us



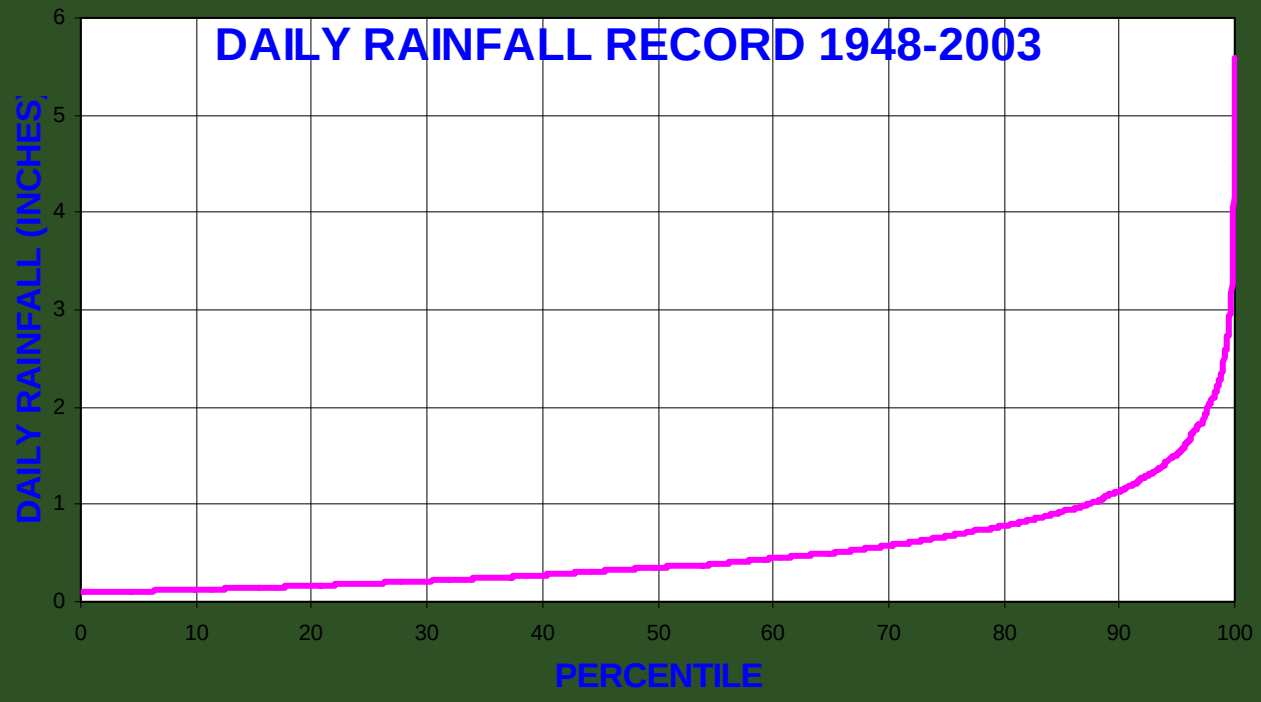


Water Quality Volume - WQv

- Storage Needed to Capture and Treat the Runoff from 90% of the Recorded Daily Rainfall Events (1.14”)
- Be Capable of Removing 80% of the Total Suspended Solids (TSS)
- Have an Acceptable Field Longevity
- Presumed Compliance – BMPs Must Meet the Maryland Manual

Proper Adoption of BMPs Based on Local Conditions

Water Quality Protection Volume



MSD Allows Many BMP Options

- Ponds
- Wetlands
- Infiltration Practices
- Filtering Practices
- Open Channel Practices

Supplement these with Storm Water Credits

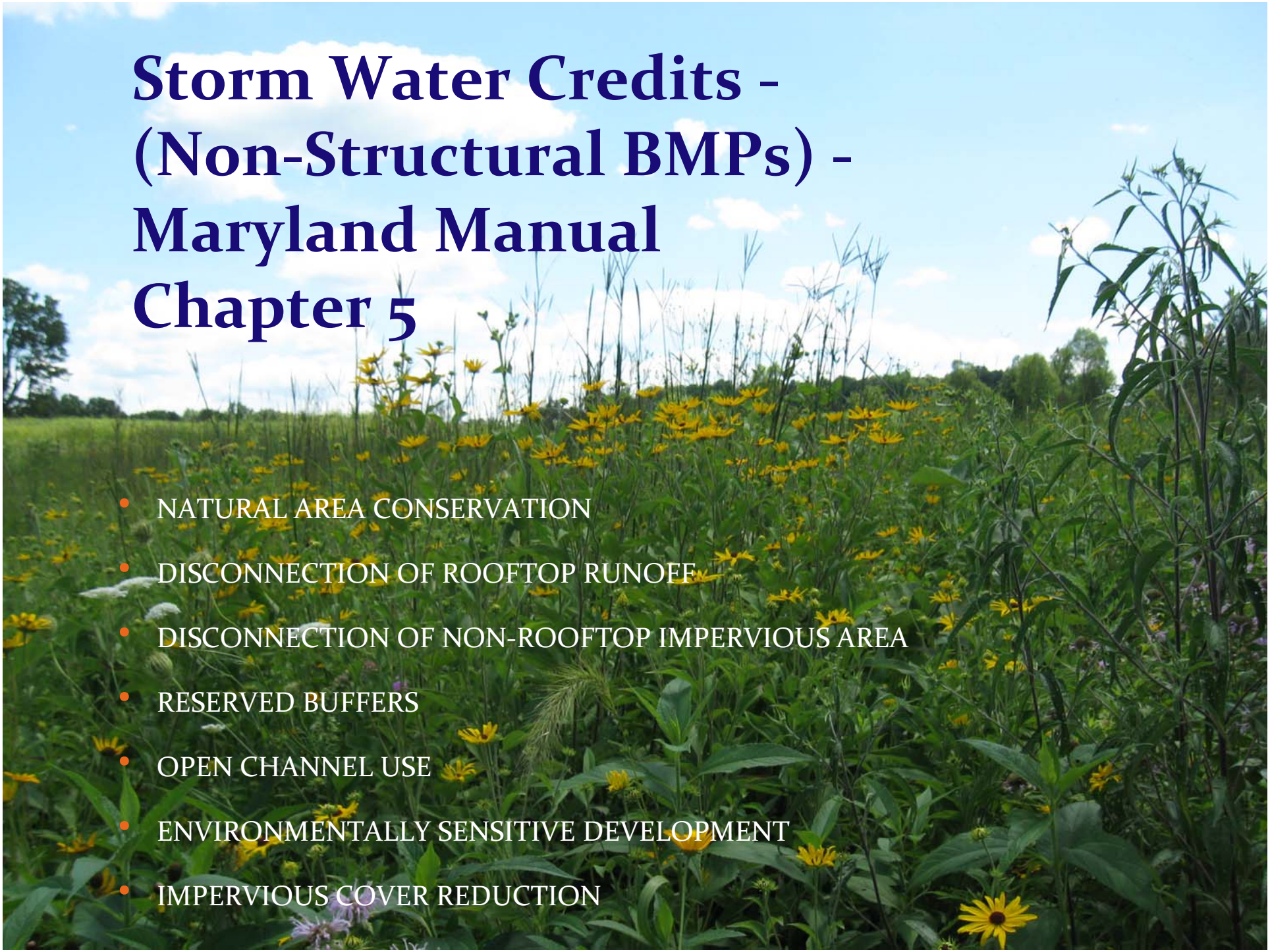
BMPs TO TREAT THE ENTIRE DISTURBED AREA

BMP TABLE							
Area	Acres	Description	BMP	Stormwater Credit	WQv Reduction Type (1of 3 Types**)	WQv Required (Cu. Ft.)	WQv Provided (Cu. Ft.)
A	3	North	Rain Garden	-	-	2000	2100
B	4	Southwest	Sand Filter	-	-	2300	2450
C	1.5	East	Rain Garden	-	-	1900	2100
D	2	East Buffer	-	Sheet Flow to Buffers	Reduced Site Area	-	-
E	0.4	4 Houses	-	Disconnect Downspouts	Reduced Rv	-	-
	Total 10.9*						

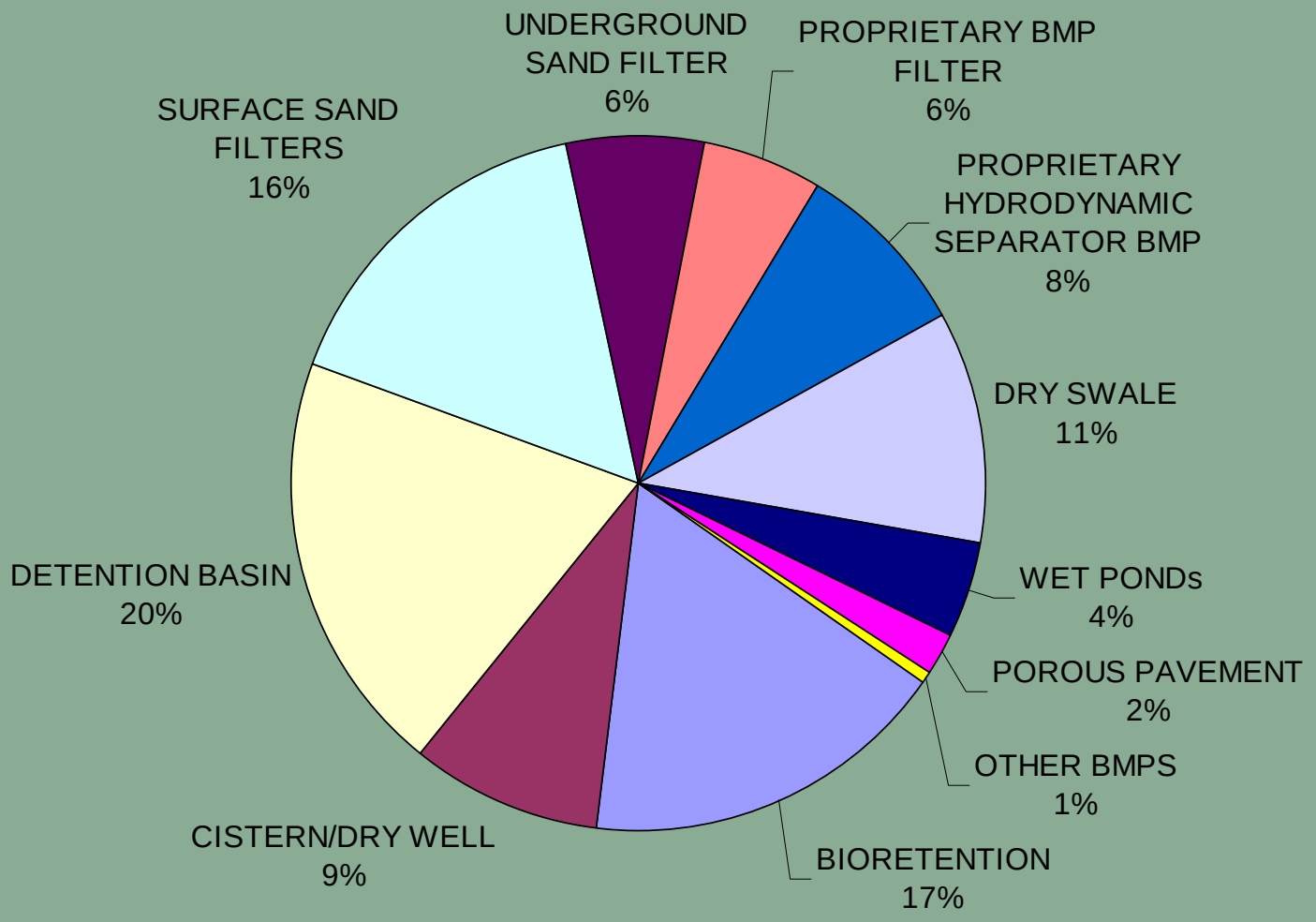
*Total Acres here to equal Total Disturbed Area

**WQv Reductions are either Reduced Site Area, Reduced Rv, or Met by Credits. See Maryland Manual Chapter 5.

Storm Water Credits - (Non-Structural BMPs) - Maryland Manual Chapter 5



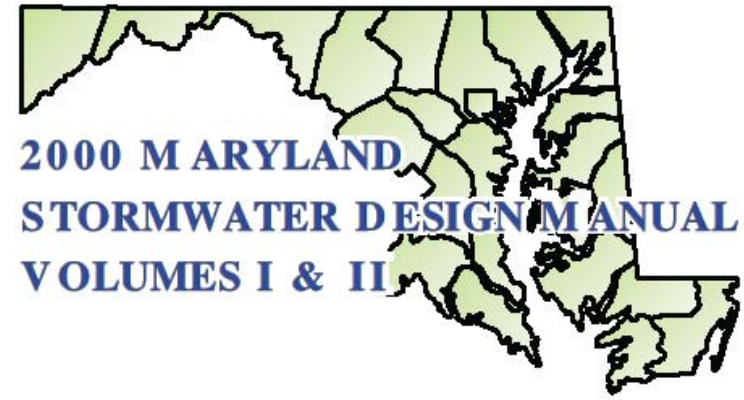
- NATURAL AREA CONSERVATION
- DISCONNECTION OF ROOFTOP RUNOFF
- DISCONNECTION OF NON-ROOFTOP IMPERVIOUS AREA
- RESERVED BUFFERS
- OPEN CHANNEL USE
- ENVIRONMENTALLY SENSITIVE DEVELOPMENT
- IMPERVIOUS COVER REDUCTION



MSD Post-Construction BMPs Since October 2006

Permitted for Construction and "In Process" = 865 BMPs

Construction Approved = 196 BMPs



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Chapter
5.0

Environmental Site Design

Environmental Site Design

- Use Non-Structural Storm Water Credits - Disconnected Areas, Sheet Flow to Buffers, Conservation Areas, Native Prairie Areas
- Explore Alternative Surfaces – Green Roofs, Permeable Pavements
- Minimize Disturbance
- Stream Bank Buffer Areas including Non-Disturbed Vegetated Areas and Newly Created Buffer Areas
- Use Micro Scale Practices – Raingardens, Microdetention, Native Vegetated Swales, Rainwater Harvesting, Infiltration
- Remember that Storm Water Credits Help to Reduce BMP Size and BMP Maintenance
- Promote Redevelopment and Re-use

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Director of Staff, Clean Water Commission

Everyone starts with the General Permit and then it is tweaked for local conditions and control

4.2.5 **Post-Construction Storm Water Management in New Development and Redevelopment**

4.2.5.1 *Permit requirement.* The permittee shall develop, implement, and enforce a program to address the quality of long-term storm water runoff from new development and redevelopment projects that disturb greater than or equal to one acre, including projects less than one acre that are part of a larger common plan of development or sale, that discharge into the permittee's regulated small MS4. The permittee's program shall ensure that controls are in place that have been designed and implemented to prevent or minimize water quality impacts by reasonably mimicking pre-construction runoff conditions on all affected new development projects and by effectively utilizing water quality strategies and technologies on all affected redevelopment projects, to the maximum extent practicable. The permittee shall assess site characteristics at the beginning of the construction design phase to ensure adequate planning for storm water program compliance. The purpose for this approach is to arrive at designs and practices that provide for most effective water quality treatment through infiltration, flow rates and similar site-design opportunities. As part of the SWMP document, the post-construction runoff control program shall include the following information, at a minimum:

4.2.5.1.1 A strategy to minimize water quality impacts, by reasonably mimicking pre-construction runoff conditions in affected new development and incorporating water quality protection in affected redevelopment projects to the maximum extent practicable, and include a combination of structural and/or non-structural BMPs appropriate for the permittee's community;

4.2.5.1.2 An ordinance or other regulatory mechanism to address post-construction runoff from new development and redevelopment projects to the extent allowable under State, or local law. If the permittee needs to develop a mechanism, the permittee shall describe the plan and a schedule for implementation. If the permittee's ordinance or regulatory mechanism is already developed, the permittee shall include a copy of the relevant sections with the SWMP document;

4.2.5.1.3 A plan to ensure adequate long-term operation and maintenance of selected BMPs, including types of agreements between the permittee and other parties such as the post-development landowners or regional authorities;

4.2.5.1.4 Specific priority areas for this program; and

4.2.5.1.5 Any non-structural BMPs in the permittee's program, including, as appropriate:

4.2.5.1.5.1 Policies and ordinances that provide requirements and standards to direct growth to identified areas, protect sensitive areas such as wetlands and riparian areas, maintain and/or increase open space (including a dedicated funding source for open space acquisition), provide buffers along sensitive water bodies, minimize impervious surfaces, and minimize disturbance of soils and vegetation;

4.2.5.1.5.2 Policies or ordinances that encourage infill development in higher density urban areas, and areas with existing storm sewer infrastructure, and redevelopment of Brownfield sites or grayfields which may include abandoned malls or similar properties;

4.2.5.1.5.3 Education programs for developers and the public about project designs that minimize water quality impacts; and

4.2.5.1.5.4 Other measures such as minimization of the percentage of impervious area after development, use of measures to minimize directly connected impervious areas, site designs that provide for integration of a variety of infiltration practices and source control measures often thought of as good housekeeping, preventive maintenance and spill prevention.

4.2.5.1.6 Any structural BMPs in the permittee's program, including, as appropriate:

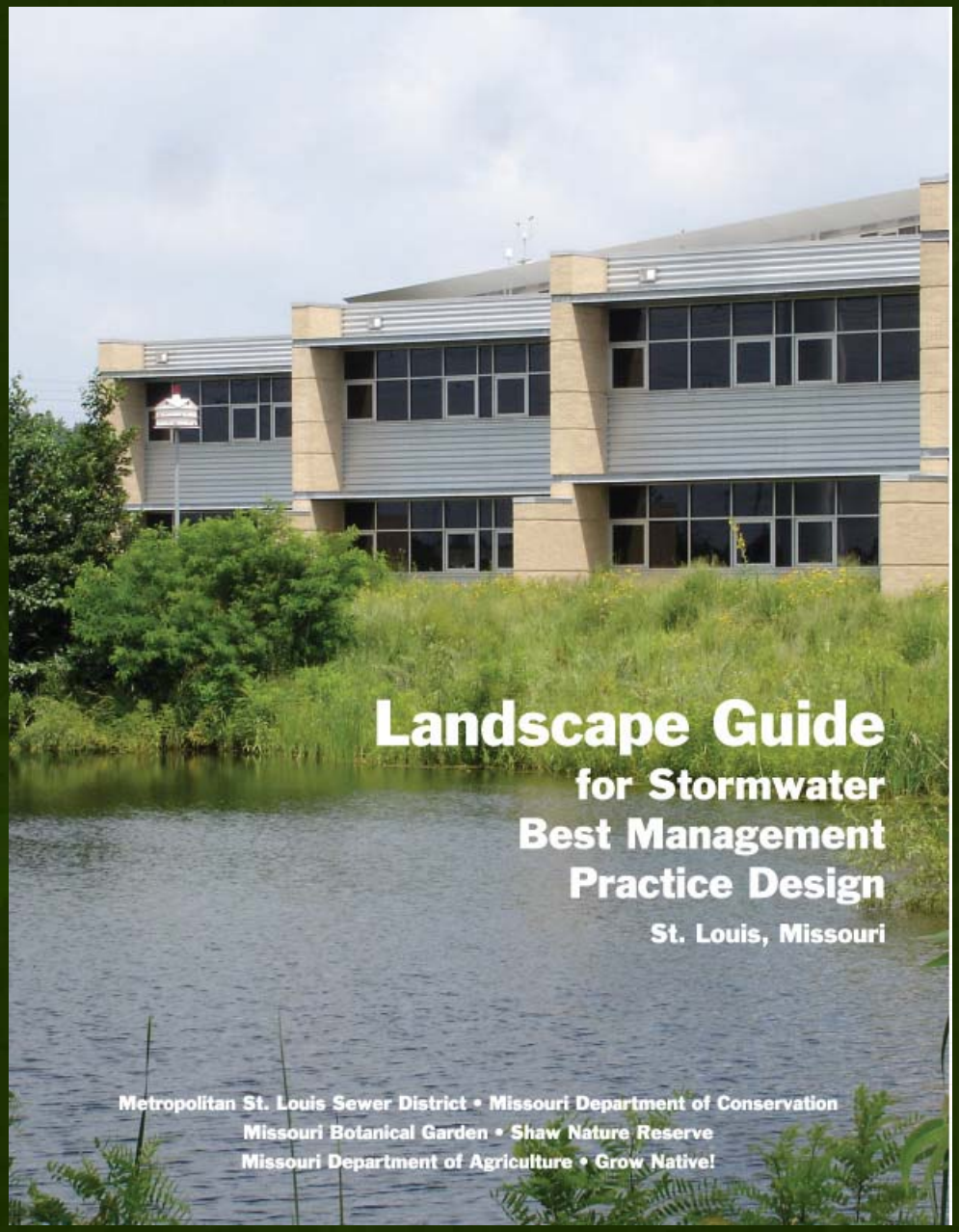
4.2.5.1.6.1 Practices that provide infiltration, evapotranspiration or re-use such as grassed swales, bioretention cells, cisterns and green roofs; and

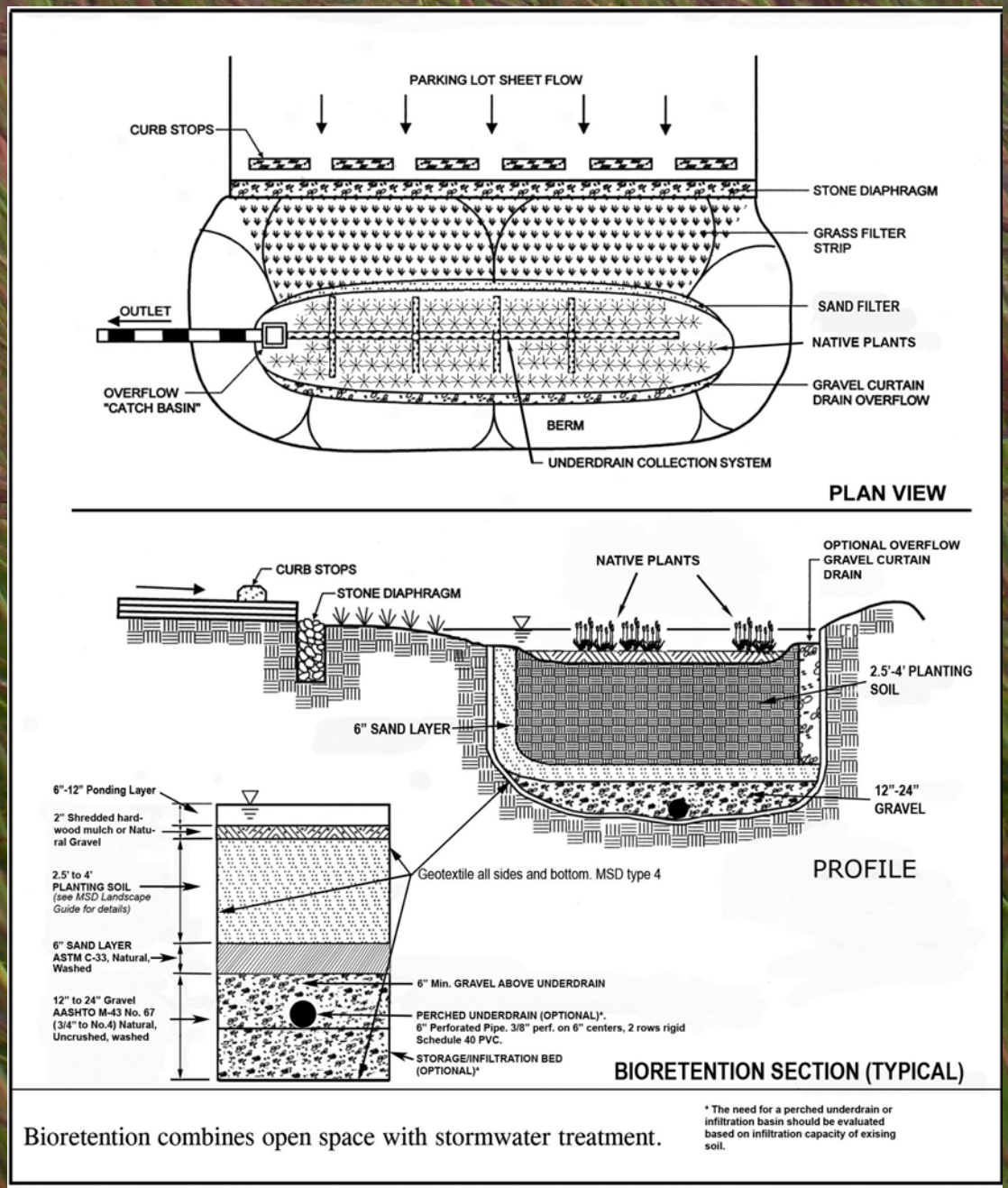
4.2.5.1.6.2 Redevelopment practices such as planter boxes, street retrofits, parking-lot infiltration and green roofs.

4.2.5.1.7 How the permittee will evaluate the success of this minimum measure.

What will Future Criteria Be?

- BMPs were required (2003-2008 permit)
- Mimic Predevelopment Hydrology Wording Added (2008-2013 permit)…to be Continued in the Future
- Future Runoff Volume Reduction Requirements in Separate and Combined Areas of MSD…?
- Future Watershed Based TMDL Requirements…?
- Future Low Impact Development (LID) / Environmental Site Design Requirements…?
- More municipalities with permits requiring BMPs


Landscape Guide
for Stormwater
Best Management
Practice Design
St. Louis, Missouri
Metropolitan St. Louis Sewer District • Missouri Department of Conservation
Missouri Botanical Garden • Shaw Nature Reserve
Missouri Department of Agriculture • Grow Native!



Bioretention combines open space with stormwater treatment.

* The need for a perched underdrain or infiltration basin should be evaluated based on infiltration capacity of exising soil.

WHY RAINGARDENS?

POLLUTANT AND VOLUME REMOVAL CAPABILITIES

BMP Type	Annual Volume Reduction[a]	Pollutant Removal Rate[b]				
		TSS	Metals (Cu, Zn, Pb)	TKN (Nitrogen)	Total-P	Bacteria
Bioretention	40%	90%	93-98%	68-80%	70-83%	90%
Sand Filter	0%	70%	45%	46%	33%	76%

a: Volume Based Hydrology. Reese, A.J. Stormwater Magazine. September 2009.

b: USEPA Fact Sheets EPA 832-F-99-007 (Sand Filters) and EPA 832-F-99-012 (Bioretention).

Use NATIVE Plants

- Deep Root Systems
- Rainfall Infiltration Benefits
- Rainfall Interception Benefits
- Better Nutrient Removal
- Minimal Irrigation - Conserves Water
- Minimal or No Fertilizing, also help to Uptake Excess Fertilizer from Upstream Drainage Areas
- Less Maintenance
- Better Survivability
- Enhance Biodiversity (Mosquito Control) and Promote a Conservation Culture
- Control Erosion
- Very Wet or Very Dry Conditions

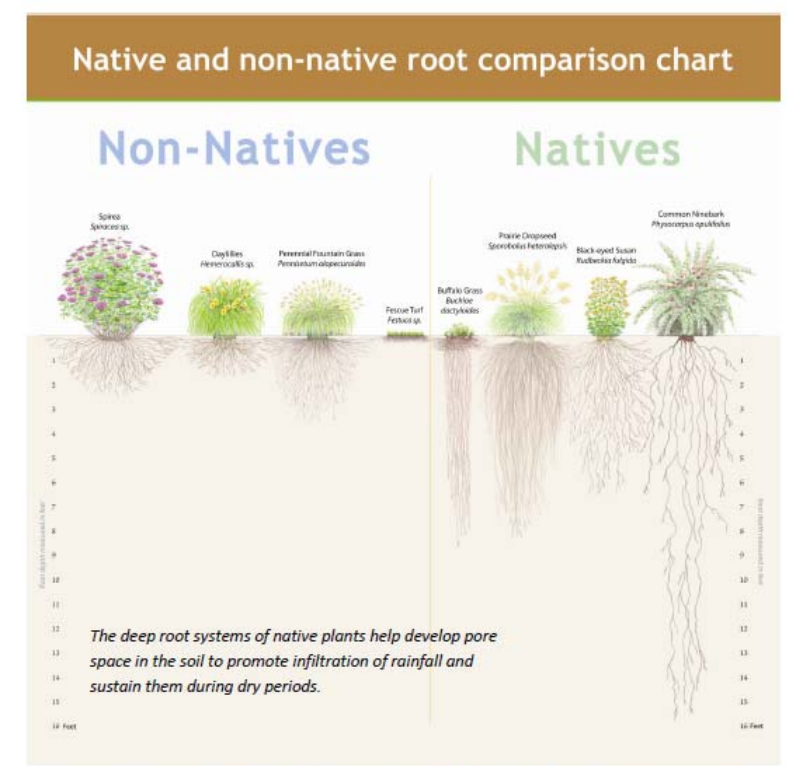


Figure 2: Native versus Non-Native Root Systems. Source: Mid America Regional Council of Governments

PLANT LISTS FOR RAIN GARDENS

Name		Submerged	Pond Edge & Perma	Over gravel	Over sand	Lower slopes	Upper slopes	Plant of Merit	Height	Spacing	Color	Bloom Time												Sun	Pt Sun	Pt Shade	Shade	Dry	Medium	Wet	Birds	Butterflies	Fall color	Winter interest	Flood frequency tol	Flood height toleran	Flood duration toler	Salt tolerance	Aggressiveness
Latin	**Common**											*J*	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*																
Bioretention and Organic Filter																																						
Grasses/Sedges																																						
Andropogon gerardii	Big bluestem				x	x	x		4-6'	2'	plum	x	x							x	x	x	x	x				x	x		x		x	x	M	12	2		M
Bouteloua curtipendula	Sideoats grama			x	x		x		1-2'	1'	tan							x	x	x	x	x		x	x			x	x		x			x	L				L
Carex praegracilis*	Tollway sedge		x	x		x	x		1-2'	1.5'	tan				x	x	x							x	x			x	x	x	x				H	12	2	H	H
Carex grayii	Bur sedge		x	x		x			1-2'	1.5'	tan				x	x	x							x	x	x	x		x	x	x				H	24	3		L
Carex vulpinoidea	Fox sedge		x	x		x			2-3'	1.5'	tan					x	x	x						x	x	x			x	x					H	24		L	L
Chasmanthium latifolium	River oats			x	x	x	x		2-5'	1.5'	green						x	x	x	x	x	x			x	x	x	x	x		x		x	x	M	12	1		H
Schizachyrium scoparium	Little bluestem				x		x		2-4'	1.5'	bronze	x	x						x	x	x	x	x	x					x	x		x		x	x	L			M	L
Sporobolus heterolepis	Prairie dropseed			x		x	x	x	2-3'	1.5'	tan								x	x	x	x	x	x					x	x		x			x	L				L
Forbs																																						
Amsonia illustris	Shining bluestar		x	x	x	x			2-3'	3'	lt. blue				x	x								x	x	x			x	x		x	x		H	36	5		L
Aster novae-angliae	New England aster		x	x		x			3-6'	2'	violet								x	x				x	x				x	x		x	x		M	24	3	L	H
Coreopsis lanceolata	Lanceleaf coreopsis			x	x		x		1-2'	1.5'	yellow					x	x							x	x			x	x			x			L				M
Chelone obliqua	Rose turtlehead		x	x		x		x	3-4'	2'	se/purple								x	x	x			x	x	x	x		x	x					M	12	1		M
Echinacea pallida	Pale purple coneflower						x		2-3'	1.5'	violet						x	x						x	x			x	x		x				L				L
Eryngium yuccifolium	Rattlesnake master								4-5'	1.5'	green						x	x	x	x				x				x	x			x			M	12	2	M	L
Pycnanthemum tenuifolium	Slender Mountain Mint			x	x				2-3'	1.5'	white							x	x	x				x	x			x	x			x			L				H
Ratibida pinnata	Yellow/Grey coneflower						x		3-5'	1.5'	yellow						x	x	x					x				x	x		x	x			M	12	1	M	H
Rudbeckia hirta	Black-eyed Susan								2-3'	1.5'	yellow						x	x	x	x				x				x	x			x			M				M
Eupatorium coelestinum	Mist flower; wild ageratum		x	x	x	x			1-2'	1.5'	avender							x	x	x	x			x	x				x	x		x			H	12	3		M
Solidago rugosa	Rough-leaved goldenrod			x		x	x		2-3'	1.5'	yellow								x	x				x	x	x	x	x	x			x		x	L			M	H
Verbesina helianthoides	Yellow wingstem								2-3'	1.5'	yellow						x							x	x	x		x	x		x	x			L				M
Zizia aurea	Golden alexander						x		1.5-3'	1.5'	yellow				x	x								x	x	x		x	x			x			L			M	H
Trees/Shrubs																																						
Carpinus caroliniana	Musclewood			x		x	x		15-20'	20'	yellow	x	x	x							x	x	x	x	x	x		x	x				x	x	M	6	1		L
Cercis canadensis	Redbud			x	x	x	x		10-20'	15'	pink			x	x									x	x	x		x	x						L			L	M
Hamamelus virginiana	Eastern witchazel		x	x		x	x		10-15'	15'	yellow										x	x	x		x	x	x	x	x				x	x	L			L	L
Quercus alba	White oak			x		x	x		40-60'	30'	green				x	x					x	x		x	x	x	x	x	x		x	x	x	x	L			H	L
Requirements																																						
Local Ecotype Rule: Plants of Missouri or Southern Illinois ecotype are required.																																						
Must use a minimum of 5 grass/sedge species and 8 forb species for each BMP.																																						
Each species must consist of between 5% - 15% of the total plant count for each BMP.																																						
Biodegradable erosion blanket must be used on slopes greater than 10%.																																						
Erosion blankets must be coarse to allow varying leaf sizes (examples include Geojute, Curlex #1 and NorthAmerican Green S75 single net straw blanket, or equivelant)																																						
*Experimental for practice and/or limited availability in commercial trade																																						

<u>TOUGH</u> Missouri Native Plants Eager to Head out to MSD-Required BMPs!!!

What's New???

New Formal Bioretention Plant List

Latin Name	Common Name	Submerged & Emergent (water depth in feet)	Pond Edge & Permanent Water	Over sand	Lower slopes & bioretention base	Upper slopes	Height (feet)	Spacing (feet)	Seasonal Interest - Color and Months	J	F	M	A	M	J	J	A	S	O	N	D	Sun	Pt Sun	Pt Shade	Shade	Dry	Medium	Wet	Birds	Butterflies	Fall Color	Winter Interest	Flood frequency tolerance	Flood height tolerance	Flood duration tolerance	Flood duration tolerance (days)	Salt tolerance	Aggressiveness	Silt tolerance
Grasses/Sedges																																									
Carex annectans	Yellow fruited sedge		x		x		2-3	1.5	tan				x	x	x							x	x	x			x	x	x			x	H	12	3			L		L	
Carex albicans	Oak sedge				x	x	10"	1	evergree	x			x	x					x	x	x	x	x	x						x	M	12	1			L			
Carex eburnea	Bristle-leaf sedge					x			evergree	x			x	x					x	x	x									x	L					L			
Carex grayii	Bur sedge		x		x		1-2	1.5	evergree	x				x	x	x			x	x	x		x	x	x			x	x	x				M	12	2			L		M	
Carex muskingumensis	Palm sedge		x	x	x		2-3	1.5	lt. yellow	x				x	x	x			x	x	x	x	x	x				x	x	x			x	H	24	3			M		M	
Juncus effusus	Soft rush	0-1	x				2-3	1.5	vergreen										x	x	x	x	x	x				x	x	x			x	H	24	4	L		M		M	
Schizachyrium scoparium	Little bluestem			x		x	2-3	1.5	bronze	x	x							x	x	x	x	x				x	x		x		x	x	L	12	1	M		L		L	
Sporobolus heterolepis	Prairie dropseed				x	x	2-3	1.5	yellow									x	x	x	x	x				x	x		x			x	L					L			
Forbs																																										
Amsonia illustris**	Shining bluestar		x	x	x		2-3	2.5	lt. blue					x	x							x	x	x		x	x	x		x	x		H	36	5			L		L	H
Aster oblongifolius	Aromatic aster					x	2	1.5	av. Blue									x	x			x	x			x	x		x		x		L					M		L	
Asclepias tuberosa	Butterfly milkweed			x		x	1-2	1.5	orange						x	x	x					x	x			x	x						L				V		M			
Baptisia sphaerocarpa	Yellow wild indigo					x	2	2	yellow					x	x							x	x			x	x				x		L						L			
Chelone obliqua	Rose turtlehead		x		x		3-4	2	se/purple								x	x	x			x	x	x	x		x	x					M	12	1			M			
Coreopsis palmata	Finger coreopsis			x		x	2	1	yellow					x	x							x	x			x	x		x				L						L			
Echinacea purpurea	Purple coneflower					x	2-3	1.5	lt. purple							x	x	x						x	x	x	x	x		x	x		L						L			
Heuchera americana	American alumroot					x	1	1.5	cream					x	x							x	x			x	x		x				L						L			
Heuchera parviflora	Late-flowering alumroot					x	1	1.5	white									x	x					x	x	x	x		x				L						L			
Heuchera richardsonii	Prairie alumroot				x	x	1	1.5	cream					x	x							x	x	x	x	x	x	x		x			M	12	1				L			
Heuchera villosa	Maple-leaf alumroot					x	1	1.5	white									x	x					x	x	x	x		x				L						L			
Hibiscus lasiocarpos**	Rose mallow		x	x	x		3-7	2.5	white/pink							x	x	x	x			x	x	x		x	x		x	x		H	36	5			M		M	M
Iris cristata	Dwarf crested iris					x	1	1	Violet				x	x										x	x	x	x		x				L						L			
Iris fulva	Copper iris		x	x	x		2-3	1.5	copper					x	x							x	x					x	x	x			M	12	1			M			
Liatris spicata	Dense blazingstar			x	x	x	2-3	1.5	lavender						x	x						x	x					x	x	x	x	x	M	12	1			L			
Lobelia cardinalis*	Cardinal flower		x	x	x		2-3	1.5	red							x	x	x				x	x	x		x	x	x				H	18	5	L		M		U	
Lobelia siphilitica	Blue lobelia		x		x	x	1-2	1.5	blue								x	x				x	x			x	x	x		x		H	24	3			L		H	
Parthenium hispidim	American feverfew					x	1-2	1.5	white				x	x	x							x	x			x	x			x			L						M			
Pycnanthemum tenuifolium	Slender mountain mint			x	x	x	2	1.5	white						x	x	x					x	x			x	x			x			L						L			
Rudbeckia fulgida	Orange coneflower		x	x	x		2	1.5	yellow							x	x					x	x				x	x	x	x	x	H	24	3			M			
Sedum ternatum	Woodland stonecrop					x	6"	1	white/evrg	x				x	x					x	x	x									x	L						L			
Solidago flexicaulis	Zig-zag goldenrod				x	x	2	1.5	yellow									x	x				x	x	x	x	x			x			L						L			
Spigelia marylandica	Indian pink				x	x	1-2	1.5	red/yel						x	x	x							x	x	x	x		x				L						L			
Trees/Shrubs																																										
Aesculus pavia	Red buckeye		x		x		10-20	15	red				x	x								x	x	x			x	x	x				H	24	2			L		M	
Aronia melanocarpa**	Black chokeberry				x	x	5-7	5	white					x	x				x	x			x	x	x	x	x	x	x		x	x	M	12	2			L			
Betula nigra*	River birch		x		x	x	30-40	15-20	cream				x	x								x	x	x		x	x	x				H	36	5			H		H	
Calicarpa americana	Beautyberry					x	3-5	4-6	pink/pur						x	x			x	x	x		x	x	x		x	x			x		L					L			
Carpinus caroliniana	Musclewood				x	x	15-20	20	yellow	x	x	x							x	x	x	x	x	x			x	x			x	x	M	6	1			L			
Cercis canadensis	Redbud			x	x	x	10-20	15	pink				x	x								x	x	x			x	x					L			L		M		L	
Chionanthus virginicus	Fringetree					x	10-15	10	white					x	x				x	x		x	x			x		x				L						L			
Comus alternifolia	Pagoda dogwood					x	10-15	10	white					x	x				x	x		x	x	x	x	x	x		x		x	x	L					L			
Comus florida	Flowering dogwood					x	10-15	10	white				x	x	x				x	x			x	x	x	x	x		x		x	x	L					L			
Crataegis viridis	Green hawthorne		x		x	x	15-20	15	white					x	x				x	x		x	x		x	x	x	x			x	x	M	12	1			L		M	
Diospyos virginiana	Persimmon			x	x	x	30-40	20	orange					x	x				x	x	x	x	x		x	x		x			x	x	M	12	1			M		M	
Dirca palustrus	Leatherwood					x	5-7	5	lt. yel				x	x									x		x	x	x				x	x	L					L			
Hamamelus virginiana	Eastern witchazel		x		x	x	10-15	15	yellow										x	x	x		x		x	x	x	x			x	x	L			L		L			
Hydrangea arborescens	Wild Hydrangea				x	x	5-7	5	white						x	x	x	x	x	x		x	x	x	x	x	x		x	x	x	x	L				L		L	L	
Ilex verticillata	Winterberry holly		x	x	x		5-10	10	red					x	x				x	x	x	x	x	x		x	x	x			x	x	H	12	3			L		M	
Neviusia alabamense** ***	Alabama snowreath				x	x	8-10	7	white					x	x							x	x			x	x					x	M						M			
Nyssa sylvatica	Black gum			x	x		40-50	25	white					x	x				x	x		x	x		x	x		x		x	x	L			H		L			
Quercus bicolor	Swamp white oak		x		x	x	40-50	25	white					x	x							x	x	x	x	x	x		x			x	H	24	3			H			
Quercus muehlenbergii	Chinquapin oak				x	x	40-50	35	white					x	x							x	x	x	x	x						x	L			H		L		L	
Quercus phellos	Willow oak		x		x	x	40-50	25	white					x	x							x	x			x	x	x	x			x	M	24	3			L			
Quercus shumardi	Shumard oak						40-50	25	white					x	x							x	x			x		x				x	L					L			
Ribes odoratum	Golden current					x	5-7	5	yellow					x	x	x						x	x			x		x					L					L			
Taxodium disticum	Bald cypress	x	x	x	x		40-60	20	orange										x	x		x	x				x	x			x	x	H	36	7			L		H	
Tilia americana	American linden		x		x	x	50-60	30	cream					x	x							x	x	x	x		x	x	x	x		x	H	36	7			M		H	

Requirements

Local Ecotype Rule: Plants of Missouri or Southern Illinois ecotype are required.

It is recommended that a minimum of 5 grass/sedge species and 8 forb species be provided for each BMP. Deviation to this is acceptable for aesthetic variation if desired for more formal planting areas.

Refer to Planting, Water, and Mulch Requirements for Stormwater BMP's for plant sizes and irrigation requirements

Biodegradable erosion blanket must be used on slopes greater than 10%.

Erosion blankets must be coarse to allow varying leaf sizes (examples include Geojute, Curlex #1 and NorthAmerican Green S75 single net straw blanket, or equivalent)

This plant list was created for more formal garden areas. Plants selections based on: 3-4 season interest (foliage, flowers, fruits), long-lived (exceptions*), compact habit (exceptions**), readily available from nurseries (exceptions***)

should not be confused with rain gardens promoted for homeowner installation, which are beneficial but do not involve rigorous engineering to meet stormwater standards.

Bioretention areas are generally designed with underdrains. However, where proper infiltration testing indicates an infiltration rate greater than 0.52 inches per hour, consideration may be given to eliminating underdrains or limiting their use. Given this practice would encourage groundwater infiltration, it should be carefully considered and where possible encouraged. In areas where significant infiltration is possible, or it is desired to limit the use of underdrains, the underdrains may be perched as shown in Figure 7.

The characteristics of the soil for the bioretention facility are perhaps as important as the facility location, size and treatment volume. The soil must be permeable enough to allow runoff to filter through the media, while having characteristics that promote and sustain a robust vegetative cover crop. In addition, much of the nutrient pollutant uptake (nitrogen and phosphorus) is accomplished through absorption and microbial activity within the soil profile. Therefore, the soils must balance soil chemistry and physical properties to support biotic communities above and below ground.

The planting soil should be a sandy loam or loamy sand (should contain a minimum of 35 to 60 percent sand, by volume). The clay content for these soils should be less than 10 percent by volume. A permeability of at least 1.0 feet per day (0.5 inches per hour) is required (a conservative value of 0.5 feet per day is used for design). The soil should be free of stones, stumps, roots, or other woody material over 1 inch in diameter. For best results, brush or seeds from noxious weeds, such as Johnson grass, mugwort, nutsedge and Canadian thistle should not be present in the soils. Placement of the planting soil should be in lifts of 12 to 18 inches, loosely compacted (rubber-wheeled heavy equipment and mechanical tamping devices are not recommended for compaction). The specific characteristics are presented in the following table.

Table 1: Planting Soil Characteristics. Source: Maryland Stormwater Manual

Parameter	Value
pH range	5.2 to 8.00
Organic matter	1.5 to 5.0%
Magnesium	35 lbs. per acre, minimum
Phosphorus (P_2O_5)	75 lbs. per acre, minimum
Potassium (K_2O)	85 lbs. per acre, minimum
Soluble salts	≤ 500 ppm

The mulch layer plays an important role in the performance of the bioretention system. It helps maintain soil moisture and avoids surface sealing that reduces permeability. Mulch helps prevent erosion and provides a microenvironment suitable for soil biota at the mulch/soil interface. It also serves as a pretreatment layer, trapping the finer sediments that remain suspended after the primary pretreatment.

The mulch layer should be standard landscape style, single or double shredded hardwood mulch. The mulch layer should be free of other materials, such as weed seeds, soil, roots, etc. The mulch should be applied to a maximum depth of three inches. Grass clippings should not be used as a mulch. Alternatively, pea gravel or other similar natural gravel may be used.

Page 16 Change Infiltration Rate for Planting Soil

PAGE 16, Change in Infiltration Rate for Planting Soil

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Use Soil as Specified on Page 16, and Use 2.0 Feet Per Day for Infiltration Rate Design

Native Seeding a Dry Detention Basin - Requirements are Being Added to the Landscape Guide

http://www.shawnature.org/nativeland/NativeLandscapingManual/ChapterOne.aspx

Native Seeding, Where ???

- Bioretention and Other BMPs are to be Planted (Not Seeded)
- Native Seeding Will be Required for Newly Established Buffer Areas (Native Planting Allowed Also)
- Native Seeding Will be the Preferred Option for Flood Volume (Qp) and/or Channel Protection (CPv) Basins (Native Planting Allowed Also)
- Landscape Guide will have Short Seed Mix (Less Diverse) and a Standard Seed Mix (More Diverse)

Important Seeding Concerns

- Erosion Must be Controlled (Use Erosion Blankets Over Newly Seeded Areas, Use Heavier Blankets in Higher Flow Velocity Areas, Bottoms, Swales)
- Must Maintain Seeded Areas, Keep out Woody Vegetation
- Periodic Controlled Burns and/or Mowing or Brush Hogging
- NO Woody Vegetation on Fill Slopes and Dam Embankments
- Need to Periodically Inspect Dam Embankments for Erosion Problems, Rodents
- Deep Roots Could be a Concern on Dam Embankments

Costs: Turf Sodded Basin

- Sod $5/sq.yd. Plus up to $2.50/sq.yd. for Watering
- Mow Every Two Weeks….Forever

Costs: Native Seeded Basin

- Seeding $1/sq.yd. NO Watering
- Erosion Blanket $2/sq.yd.
- Mow 3 to 4 Times a Year for the First Two Years, then Mow or Burn Once a Year (Late Winter) Thereafter

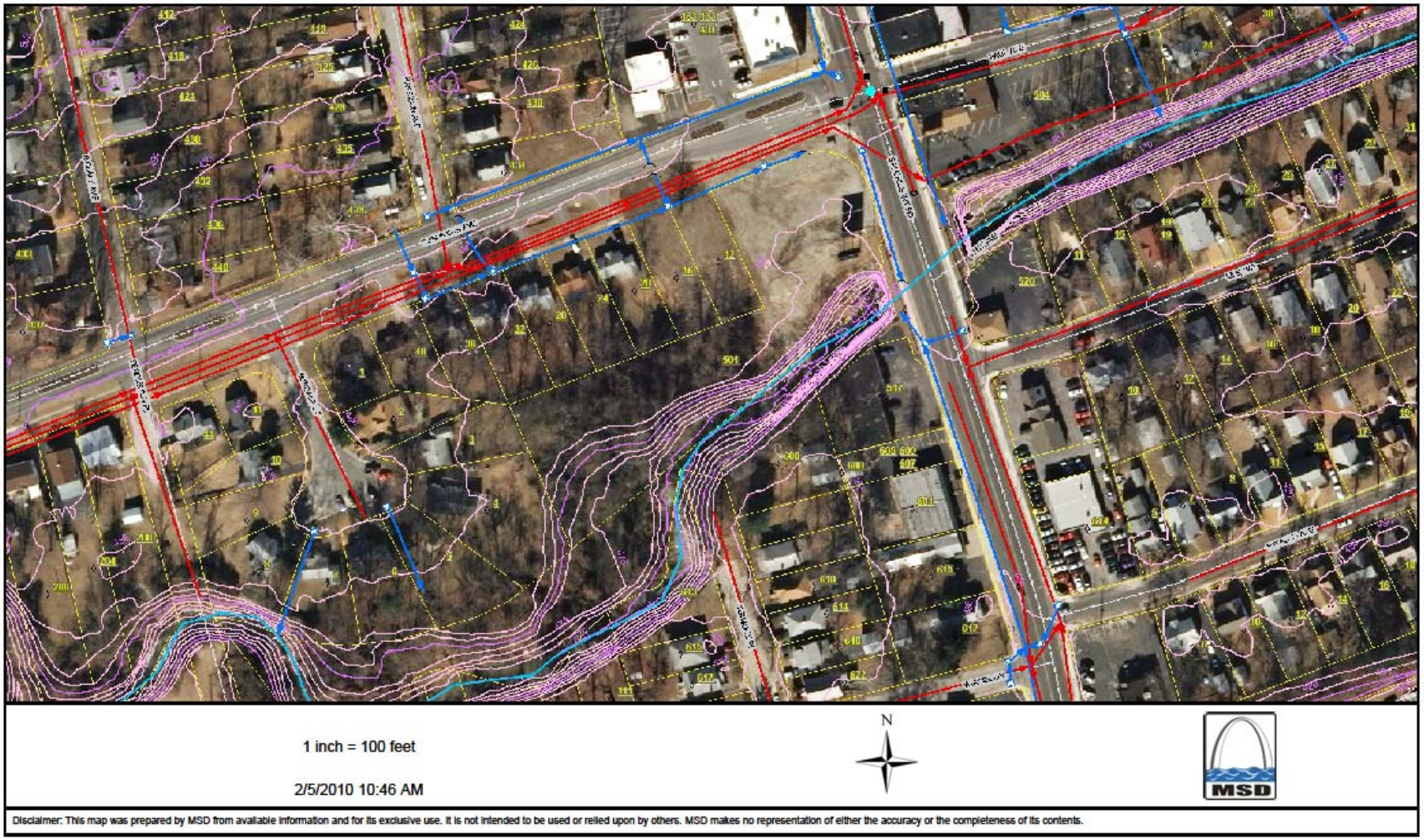
Infiltration

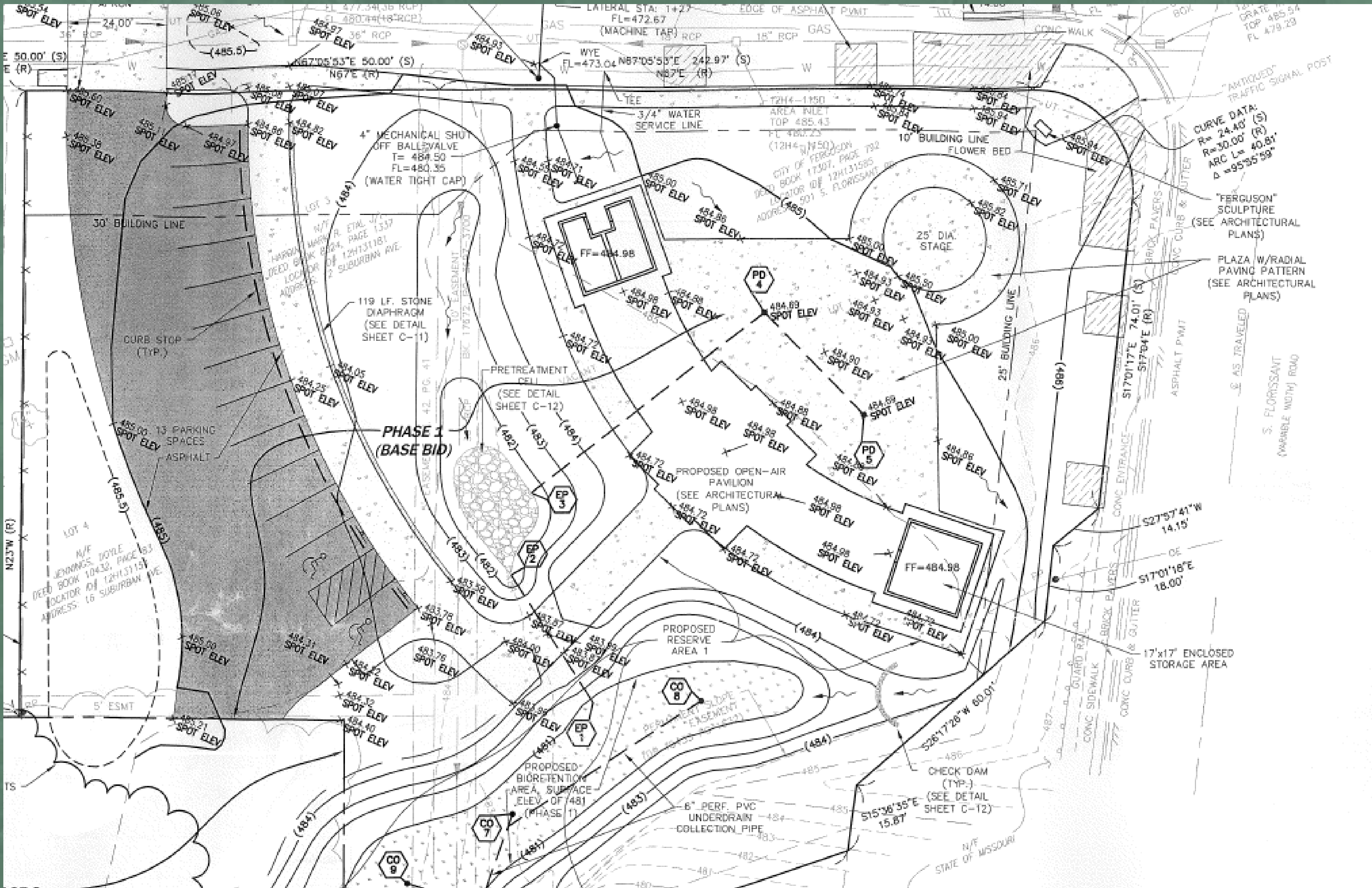
- WQv Storage in Base Rock Voids
- No Crushed Limestone, Use Natural Uncrushed, Washed Gravel
- No Storage up in Pervious Pavement Section
- Make Sure Ponding Does not Come Out at Low End
- Do in “Cut” Areas, not in Compacted “Fill” Areas
- Need Percolation Testing
- Need Monitoring Wells
- Minimize Disturbance and Eliminate Construction Traffic on Infiltration Basin Area Soil
- Push out Sand Layer over Subgrade, then Keep Running Over Sand, use Same Technique for Rock Placement
- Will Downstream Seepage be a Problem? Check Downstream Topography

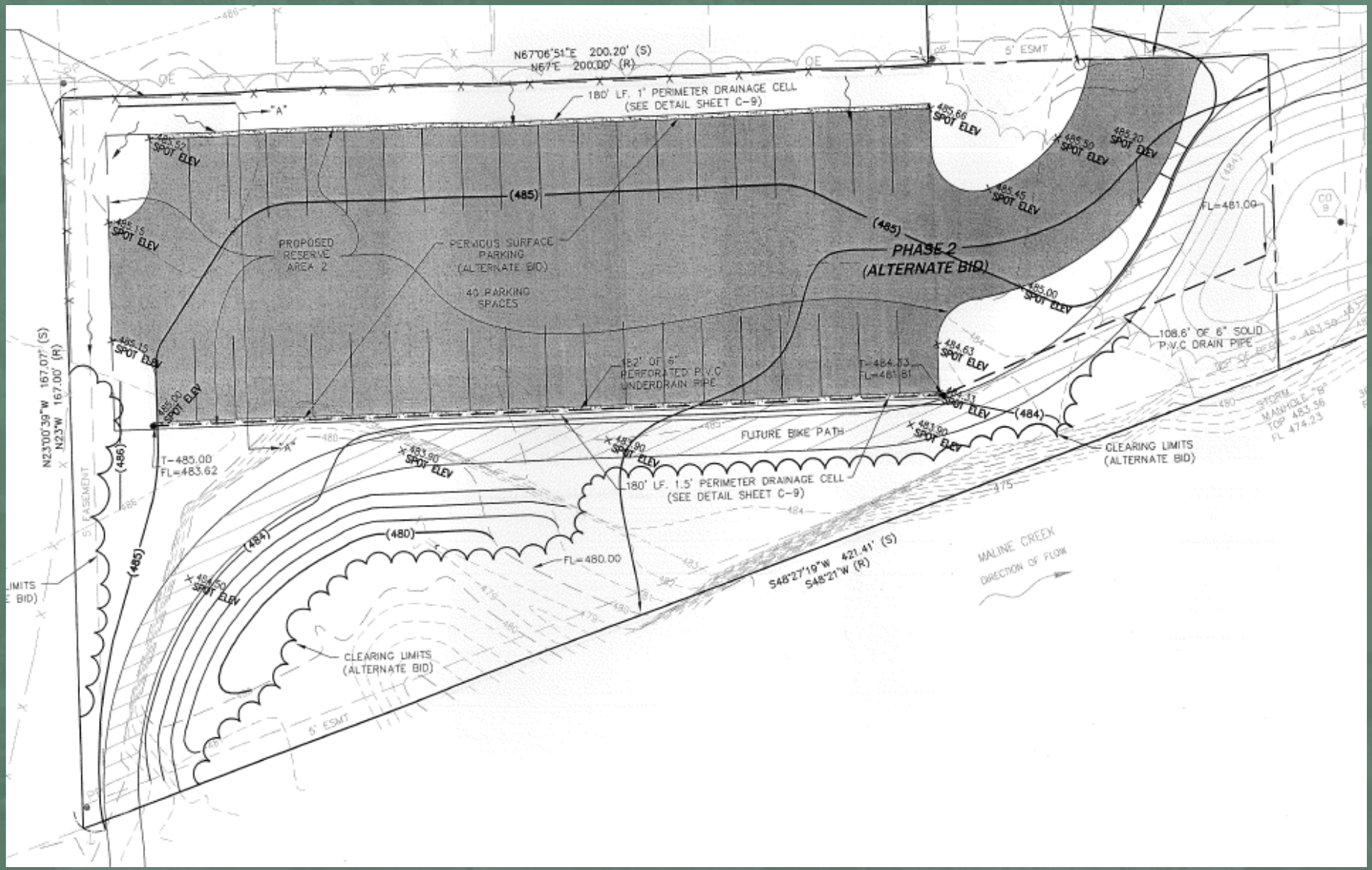
Infiltration Examples and Information

- City of Ferguson Maline Creek Park Pervious Parking Lot
- Bommarito Mazda South
- Percolation Test Requirements
- North St. Louis MSD Harlem Baden Relief – Pervious Parking Lots

City of Ferguson Maline Creek Park Pervious Parking Lot

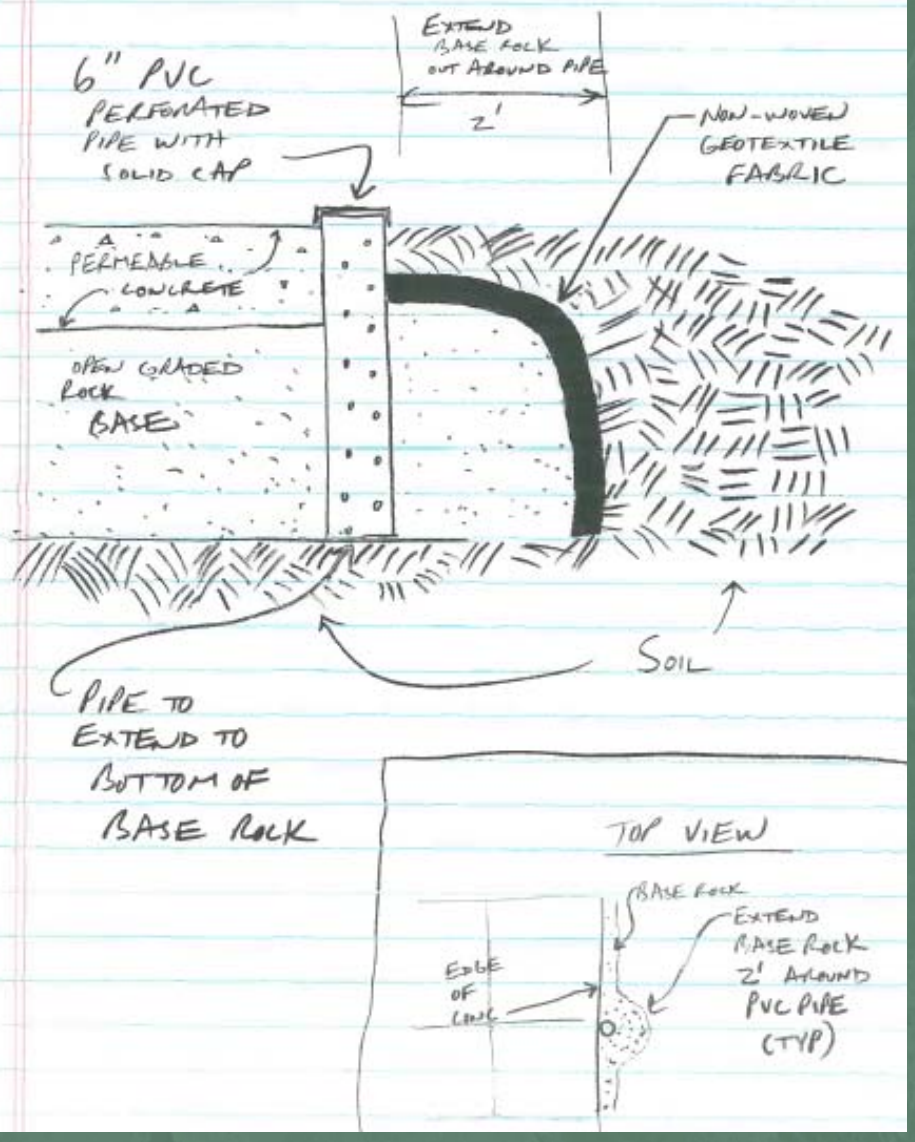



PHASE 1
(BASE BID)
PROPOSED OPEN-AIR
PAVILION
(SEE ARCHITECTURAL
PLANS)
25' DIA.
STAGE
FF=484.98
13 PARKING
SPACES
ASPHALT
CURB STOP
(TYP.)
30' BUILDING LINE
10' BUILDING LINE
25' BUILDING LINE
FLOWER BED
"FERGUSON"
SCULPTURE
(SEE ARCHITECTURAL
PLANS)
PLAZA W/RADIAL
PAVING PATTERN
(SEE ARCHITECTURAL
PLANS)
CURVE DATA:
R= 24.40' (S)
R=30.00' (R)
ARC L= 40.81'
Δ =95°35'59"
PRETREATMENT
CELL
(SEE DETAIL
SHEET C-12)
119 LF. STONE
DIAPHRAGM
(SEE DETAIL
SHEET C-11)
4" MECHANICAL SHUT
OFF BALL VALVE
T= 484.50
FL=480.35
(WATER TIGHT CAP)
3/4" WATER
SERVICE LINE
PROPOSED
RESERVE
AREA 1
PROPOSED
BIORETENTION
AREA, SURFACE
ELEV. OF 481
(PHASE 1)
6" PERF. PVC
UNDERDRAIN
COLLECTION PIPE
CHECK DAM
(TYP.)
(SEE DETAIL
SHEET C-12)
17'x17" ENCLOSED
STORAGE AREA
S. FLORISSANT
(VARIABLE WIDTH) ROAD
ASPHALT PVMT
CONC ENTRANCE
CONC SIDEWALK
N/F
STATE OF MISSOURI
LOT 4
N/F
JENNINGS, DOYLE
DEED BOOK 10432, PAGE 183
ADDRESS: 16 SUBURBAN AVE.
N67°05'53"E 50.00' (S)
N67°05'53"E 242.97' (S)
S17°01'17"E 74.01' (S)
S27°57'41"W
14.15'
S17°01'18"E
18.00'
S26°17'26"W 60.01'
S15°36'35"E
15.87'


N67°06'51"E 200.20' (S)
N67°E 200.00' (R)
180' LF. 1' PERIMETER DRAINAGE CELL
(SEE DETAIL SHEET C-9)
5' ESMT
"A"
PROPOSED RESERVE AREA 2
PERVIOUS SURFACE PARKING (ALTERNATE BID)
40 PARKING SPACES
PHASE 2 (ALTERNATE BID)
182' OF 6" PERFORATED P.V.C UNDERDRAIN PIPE
T=484.33
FL=481.81
108.6' OF 6" SOLID P.V.C DRAIN PIPE
FL=481.00
FUTURE BIKE PATH
CLEARING LIMITS (ALTERNATE BID)
180' LF. 1.5' PERIMETER DRAINAGE CELL
(SEE DETAIL SHEET C-9)
T=485.00
FL=483.62
FL=480.00
N23°00'39"W 167.07' (S)
N23°W 167.00' (R)
S48°27'19"W 421.41' (S)
S48°21'W (R)
MALINE CREEK
DIRECTION OF FLOW
STORM MANHOLE "B"
TOP 483.56
FL 474.23
SPOT ELEV

PERMEABLE PAVEMENT MONITORING WELL

NOT TO SCALE

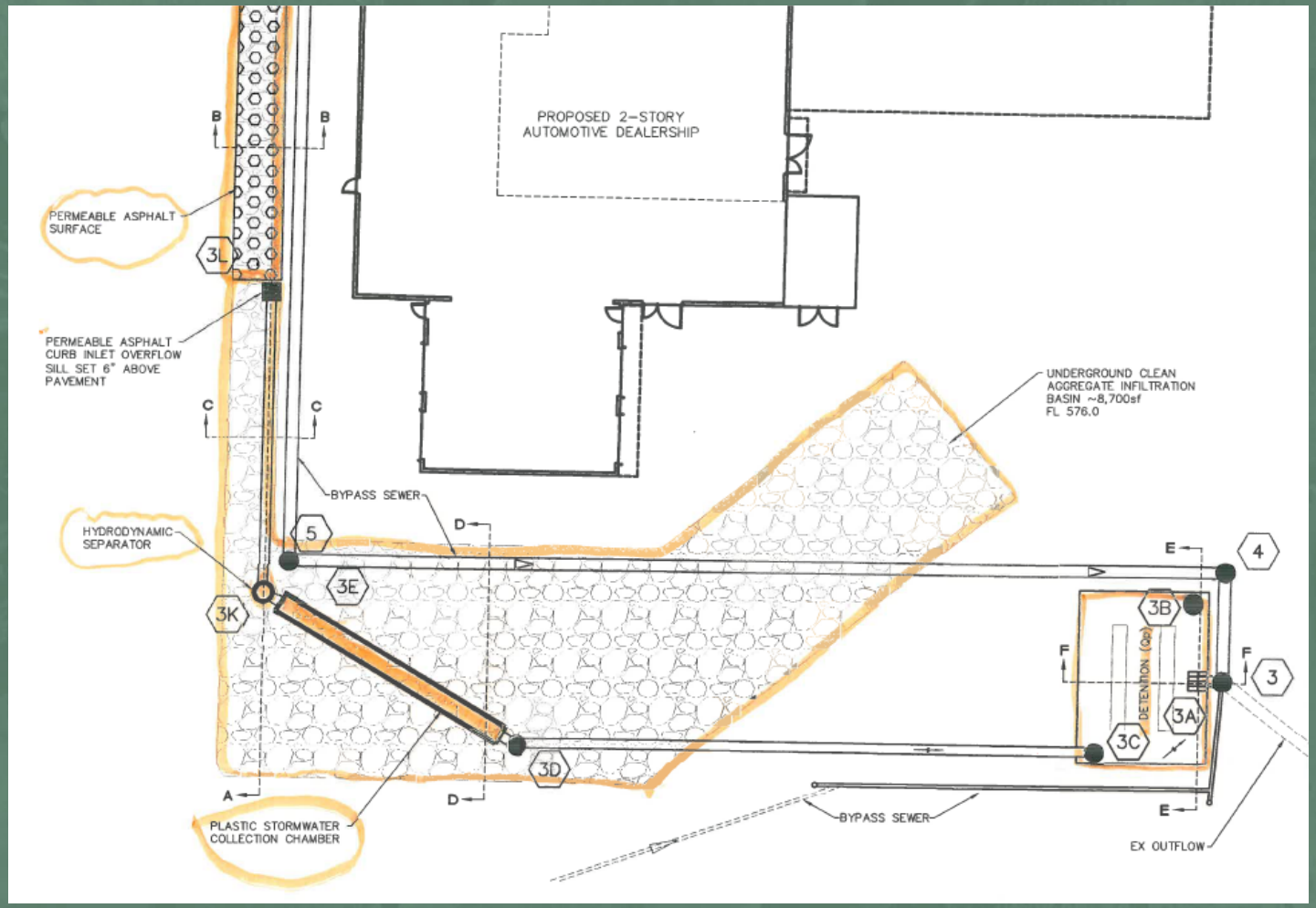


MSD Impervious Area Storm Water Rates (Per 100 Sq. Ft. of Impervious Area)

- 12 cents on 3/1/2008
- 17 cents on 1/1/2009
- 20 cents on 1/1/2010
- 23 cents on 1/1/2011
- 25 cents on 1/1/2012
- 27 cents on 1/1/2013
- 29 cents on 1/1/2014

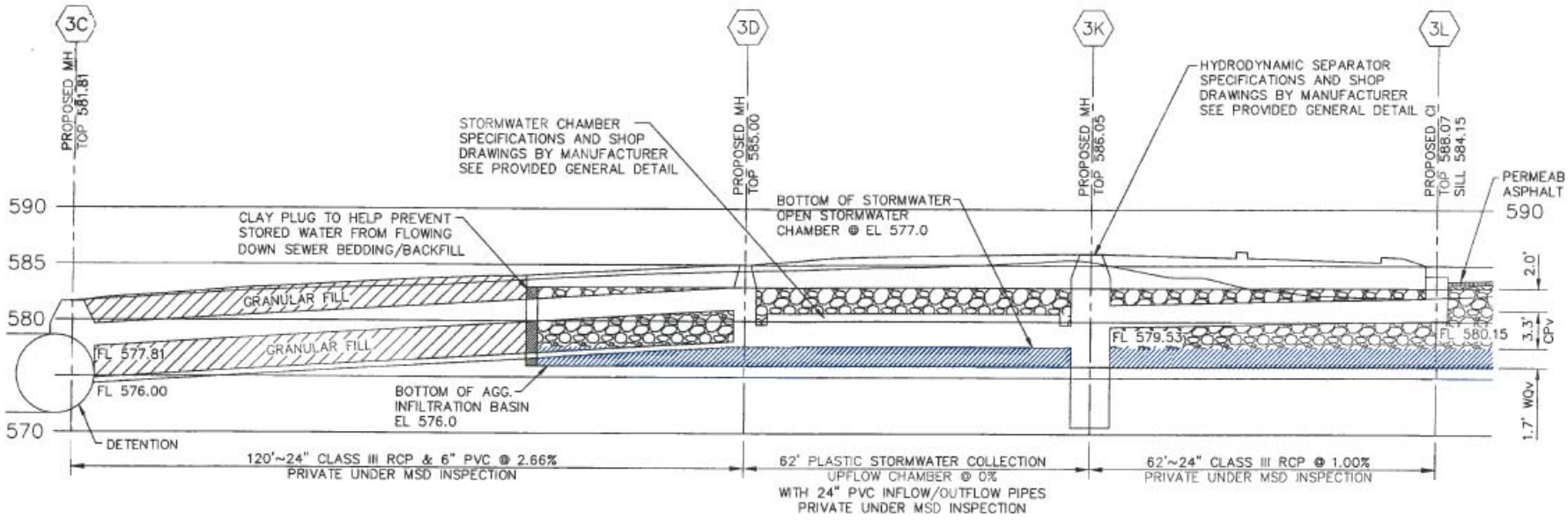
Bommarito Mazda South Lindbergh

Infiltration Basin for WQv and Underground Storage for CPV and Qp



WATER QUALITY EXHIBIT

NTS

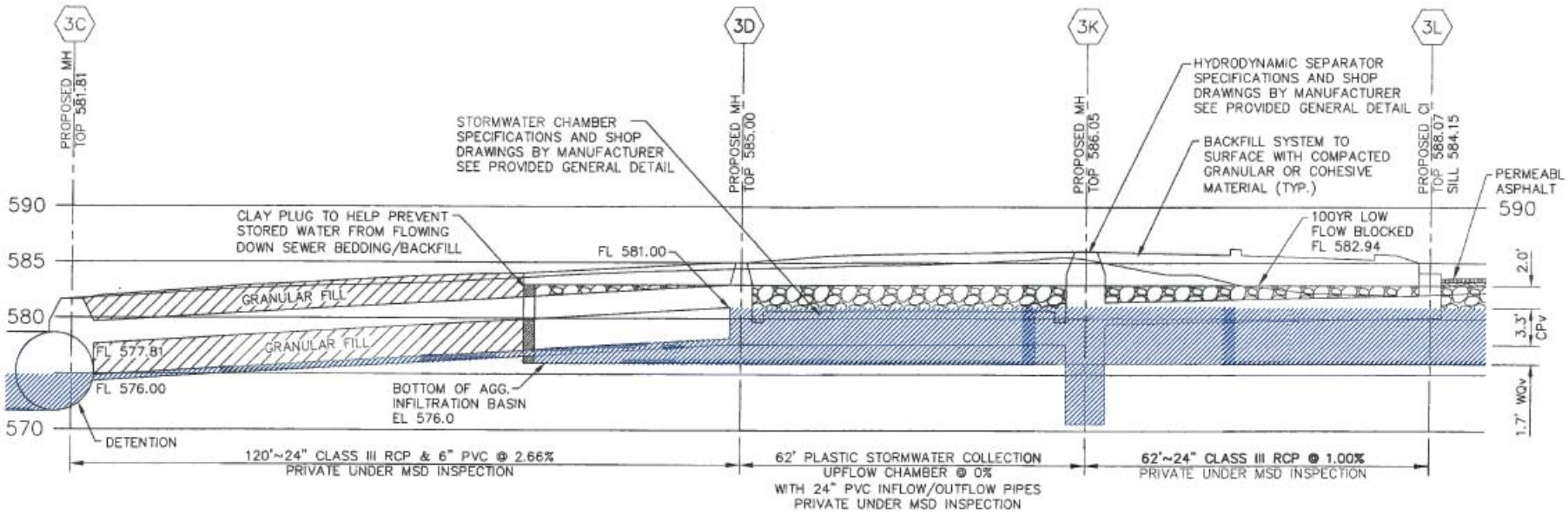


Vance Engineering, Inc.
10779 Page Ave.
St. Louis, MO 63132
P: 314.427.1800
F: 314.427.1801

DATE: 2/4/10

CHANNEL PROTECTION EXHIBIT

NTS



Vance Engineering, Inc.
10779 Page Ave.
St. Louis, MO 63132
P: 314.427.1800
F: 314.427.1801

DATE: 2/4/10

Bommarito Mazda South Lindbergh

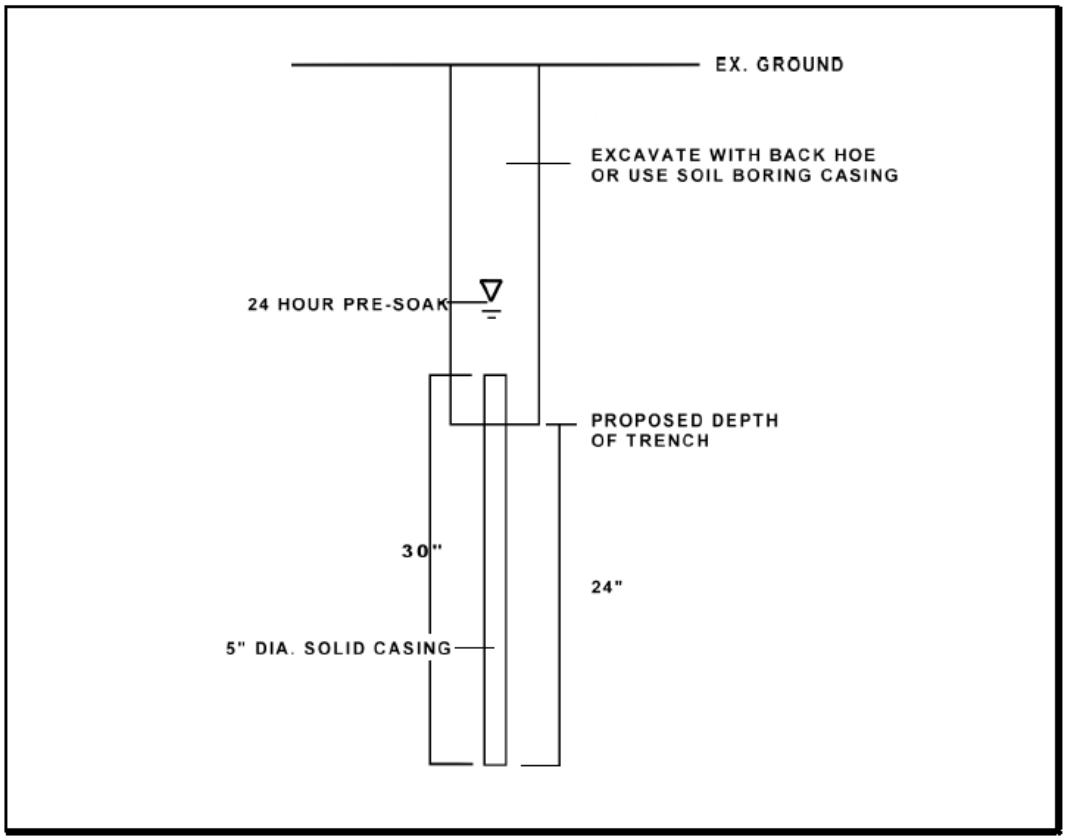
Preliminary Bids for Infiltration Bed & Rock Void Storage Option were 30% to 40% Cheaper than Underground Filter Vault Option with Underground Conduit Storage

Percolation Testing

Appendix
D.1

Testing Requirements for Infiltration, Bioretention and Sand Filter Subsoils

Figure D.1.1 Infiltration Testing Requirements

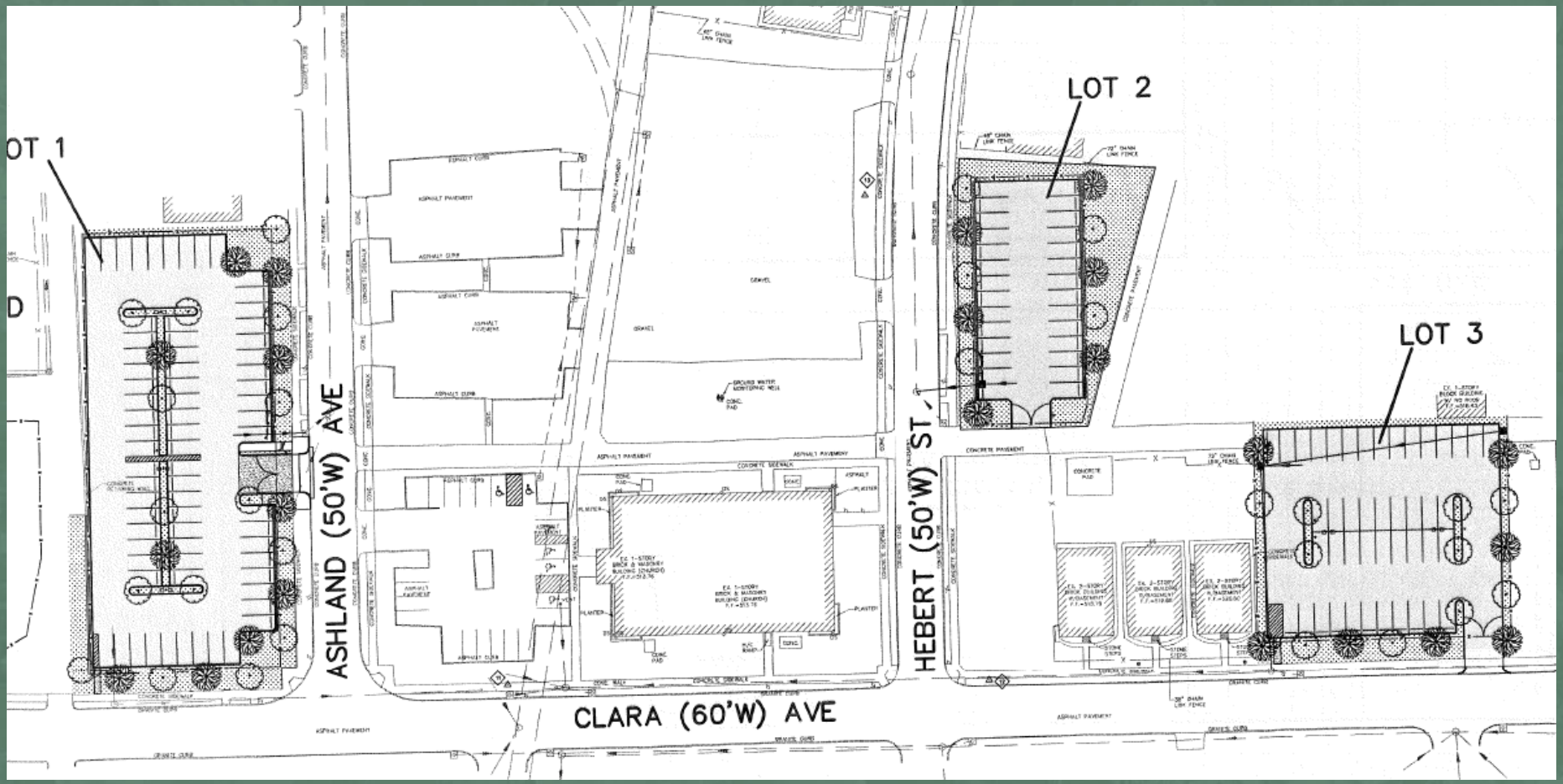


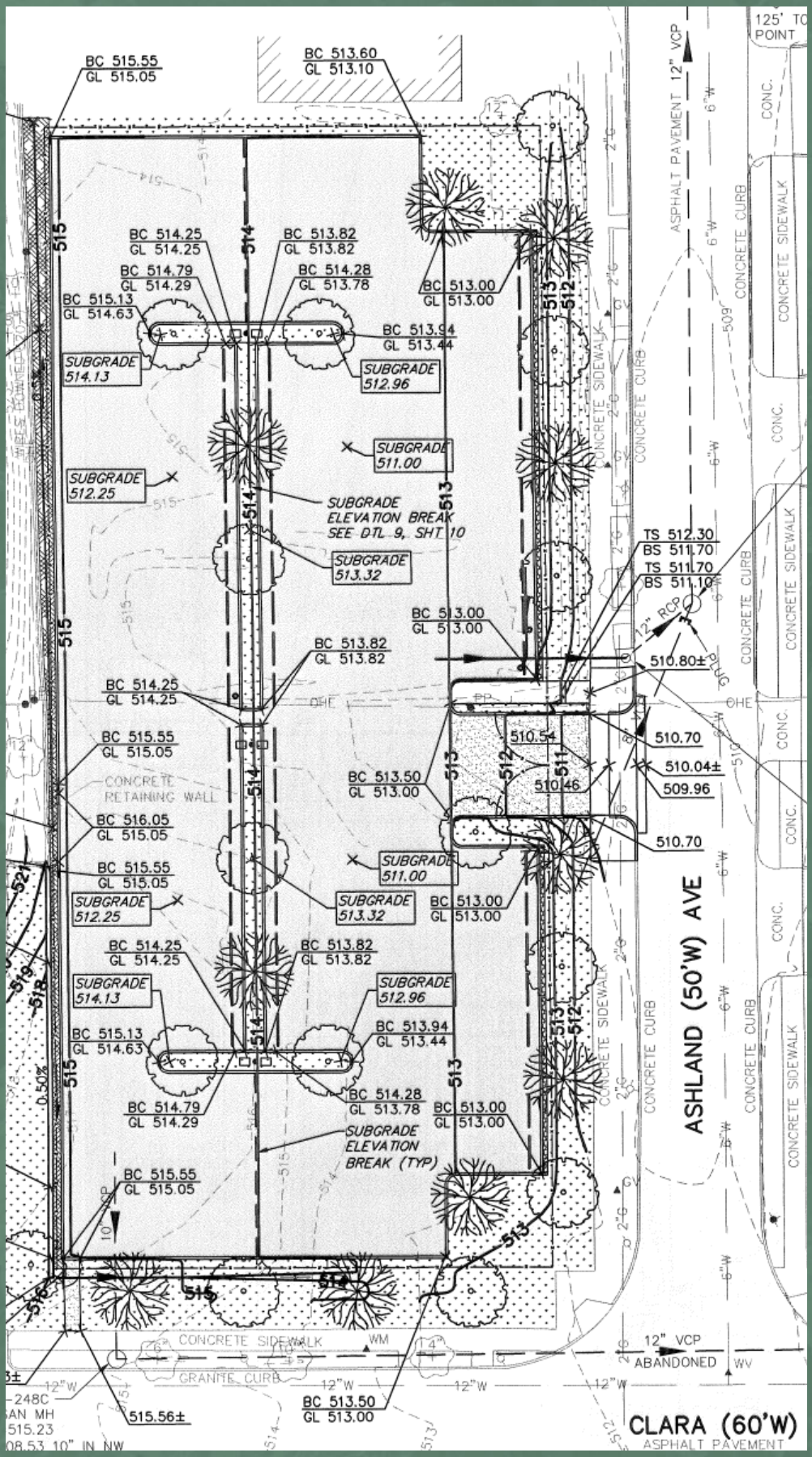

JACOB
2. 24. 2010


Enterprise

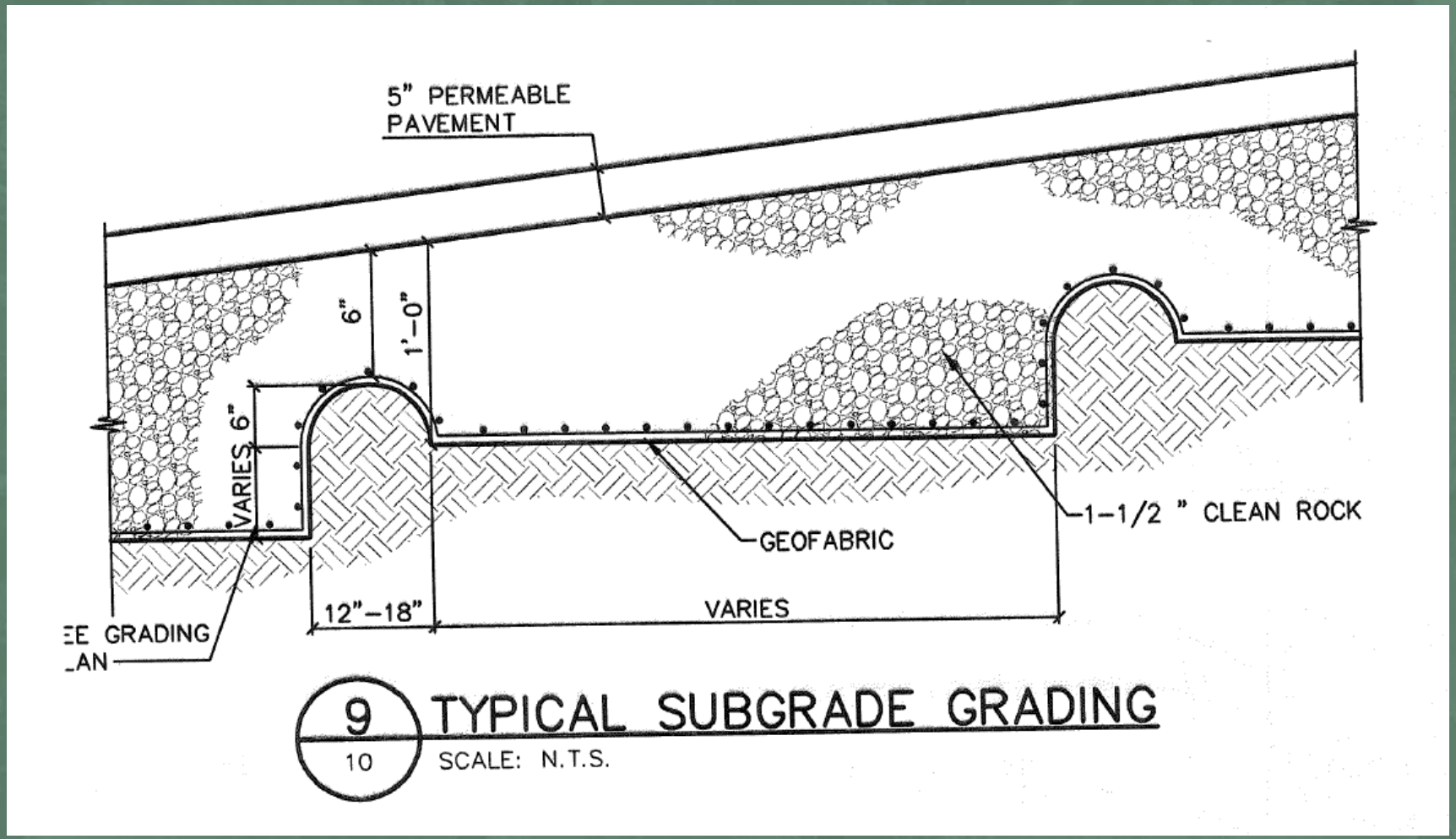

HERON

North St. Louis MSD Harlem Baden Relief –Pervious Parking Lots 2003039AP

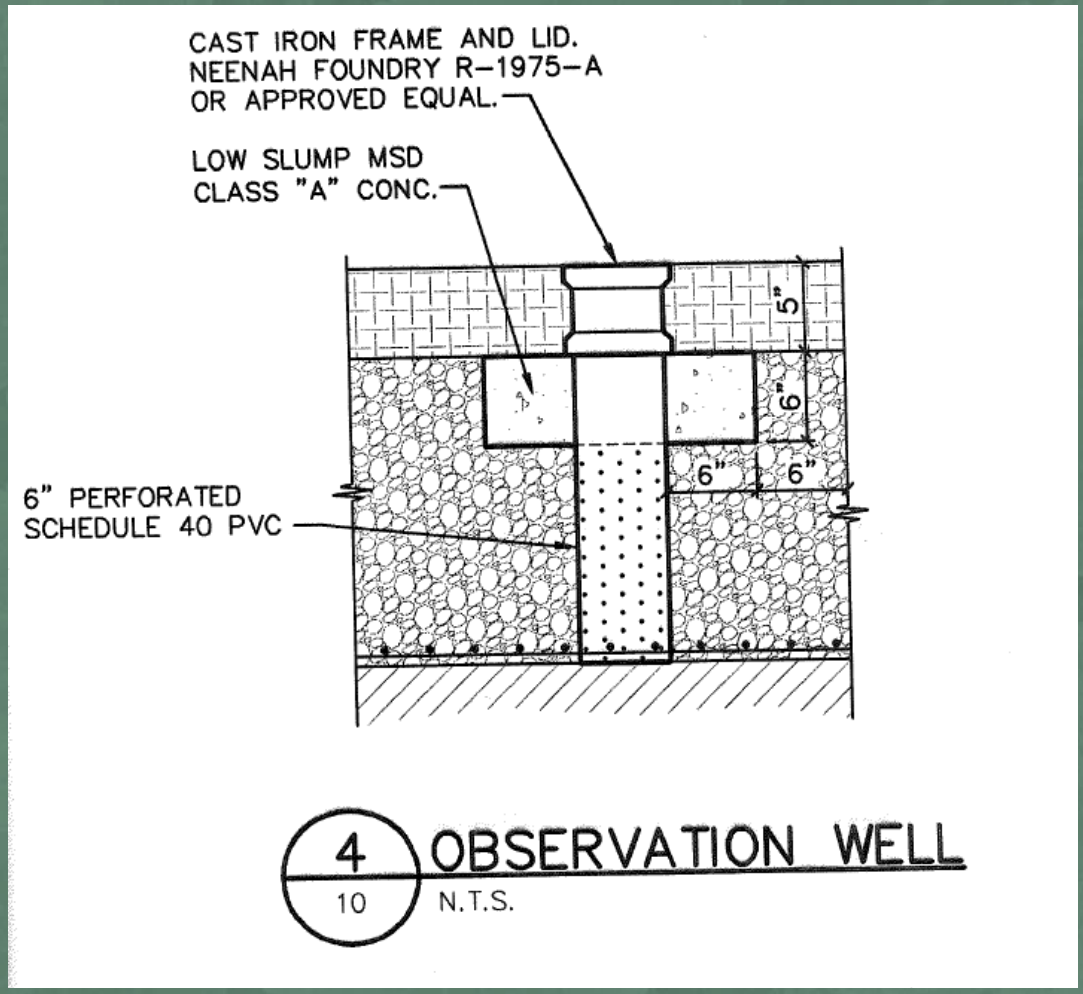



BC 515.55
GL 515.05
BC 513.60
GL 513.10
BC 514.25
GL 514.25
BC 513.82
GL 513.82
BC 514.79
GL 514.29
BC 514.28
GL 513.78
BC 515.13
GL 514.63
BC 513.94
GL 513.44
BC 513.00
GL 513.00
SUBGRADE
514.13
SUBGRADE
512.96
SUBGRADE
511.00
SUBGRADE
512.25
SUBGRADE
ELEVATION BREAK
SEE DTL 9, SHT 10
SUBGRADE
513.32
TS 512.30
BS 511.70
TS 511.70
BS 511.10
12" RCP
510.80±
510.54
510.70
510.04±
509.96
510.46
BC 513.50
GL 513.00
BC 516.05
GL 515.05
CONCRETE
RETAINING WALL
SUBGRADE
514.13
SUBGRADE
512.96
SUBGRADE
ELEVATION
BREAK (TYP)
515.56±
ASPHALT PAVEMENT 12" VCP
CONCRETE CURB
CONCRETE SIDEWALK
CONC.
ASHLAND (50'W) AVE
CLARA (60'W)
ASPHALT PAVEMENT
12" VCP
ABANDONED
GRANITE CURB
OHE
PP
WM
WV
125' TO
POINT

Level Stepped Subgrade



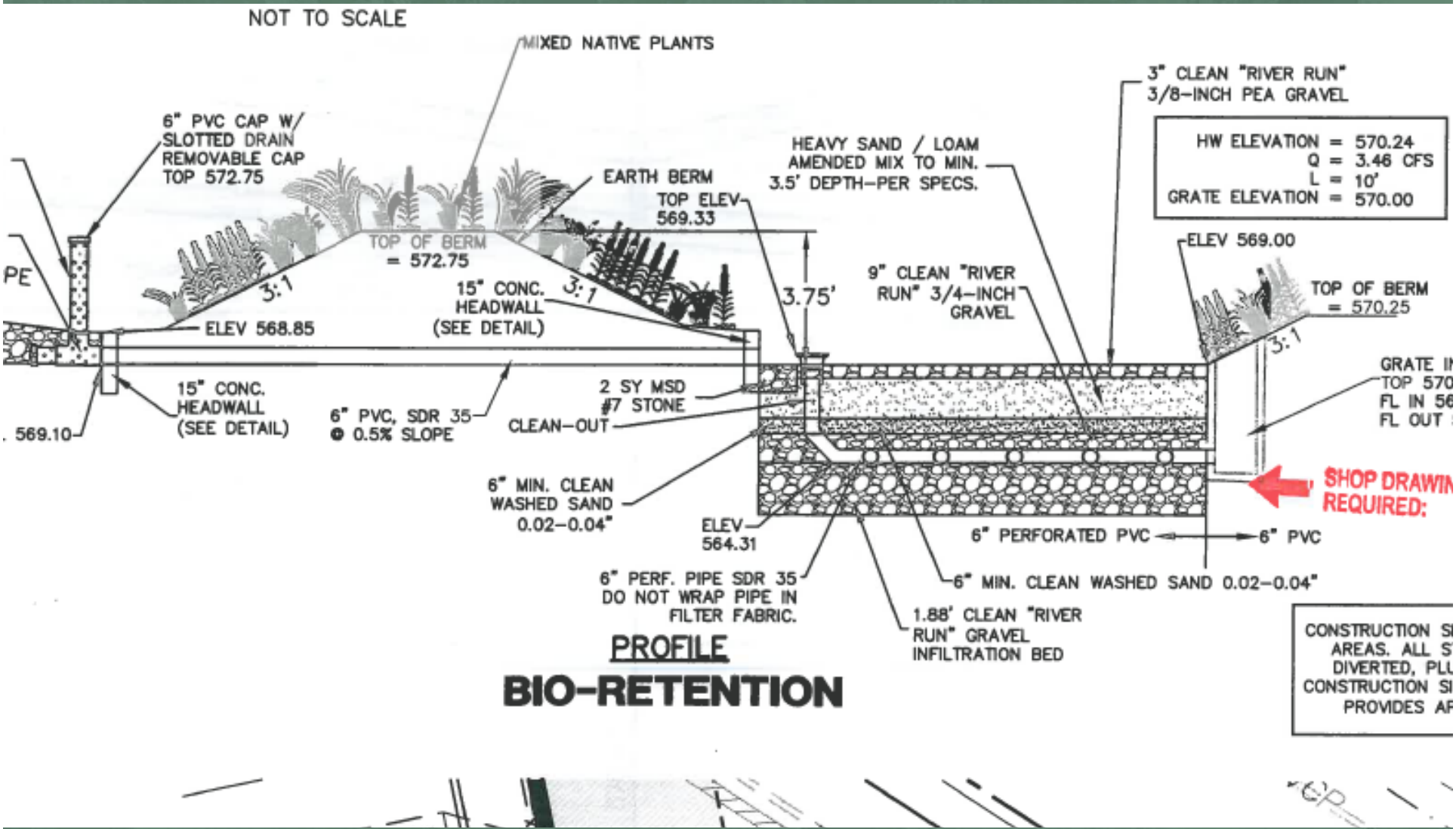
Monitoring Wells



Make your BMP Look Like Landscaping

- If you are landscaping anyway, then design it to serve as your BMP also
- Think about maintenance, and access for maintenance
- What will you have to mow?
- What is easier to just landscape (berms, raingarden all landscaped, transition areas)
- Still need to use turf grass borders & defined edges


12' ACCESS DRIVE TO BIO-RETENTION AREA
18' Wide MSD Sanitary Sewer Easmt. DB 18473, Pg 3035
Wide Roadway Easmt. DB 1107, 515
TW 581.50
BW 572.00
SAN MH
28K21945
T=568.65
FL=558.45
10' Parking Setback
30' Building Setback
GRATE INLET
TOP 569.60
FL 564.50
GRATE INLET
TOP 581.40
FL 562.38
28610-00
FL 562.20
PROPOSED MODULAR BLOCK RETAINING WALL W/ 6' VINYL CHAIN-LINK FENCING
TW 580.00
BW 570.00
1789 S.F. BIO-RETENTION SEE DETAIL SHEET C3.0
2 SY MSD #7 STONE
UNDERGROUND STORM WATER DETENTION PIPES W/ OUTFALL STRUCTURE PER CLAYTON ENGINEERING PLANS P002861000 100YR HW 567.42
TW 579.00
BW 572.75
6" PERFORATED PVC STANDPIPE
TOP 572.75
FL 569.10
SEDIMENT FOREBAY
TW 578.75
BW 570.50
9 SY MSD #7 STONE
FL 564.00
FL 570.50
MANHOLE
TOP 578.90
FL IN 572.61
FL OUT 564.10
M.S.D. INSPECTION REQUIRED
PROP.10' EASEMENT
PROP.10' EASEMENT
1-7
1-3
1-10
1-11
1-12
M.S.D. INSPECTION REQUIRED
M.S.D. INSPECTION REQUIRED
M.S.D. INSPECTION REQUIRED
S.57°06'00"E. 319.6
CLEAN OUT
FL 564.00
TOP OF BERM 570.2
BERM 572.75
40' W. CROSS ACCESS ESMT.
PROP. 10' WIDE UTILITY ESMT.
TOP OF BERM
12" VCP
MANHOLE
TOP 578.15
FL 570.77
TW 573.00
BW 573.00
CURB INLET, DIVERSION STRUCTURE
TOP 578.92
FL IN 573.33
FL OUT 571.00 FILTER
FL OUT 572.75 STR. #11
'00"W. 637.04'
48" RCP (BUILT UNDER P-28317-09)
N/F
DAVID F. MUNGENAST, TRUST
DB 17834, PG 2776
LOC #28K330301


NOT TO SCALE
MIXED NATIVE PLANTS
6" PVC CAP W/ SLOTTED DRAIN REMOVABLE CAP TOP 572.75
EARTH BERM
TOP ELEV 569.33
TOP OF BERM = 572.75
3:1
3:1
15" CONC. HEADWALL (SEE DETAIL)
ELEV 568.85
3.75'
HEAVY SAND / LOAM AMENDED MIX TO MIN. 3.5' DEPTH–PER SPECS.
3" CLEAN "RIVER RUN" 3/8–INCH PEA GRAVEL
HW ELEVATION = 570.24
Q = 3.46 CFS
L = 10'
GRATE ELEVATION = 570.00
ELEV 569.00
9" CLEAN "RIVER RUN" 3/4–INCH GRAVEL
TOP OF BERM = 570.25
3:1
15" CONC. HEADWALL (SEE DETAIL)
569.10
6" PVC, SDR 35 @ 0.5% SLOPE
2 SY MSD #7 STONE
CLEAN–OUT
6" MIN. CLEAN WASHED SAND 0.02–0.04"
ELEV 564.31
6" PERFORATED PVC
6" PVC
6" PERF. PIPE SDR 35 DO NOT WRAP PIPE IN FILTER FABRIC.
6" MIN. CLEAN WASHED SAND 0.02–0.04"
1.88' CLEAN "RIVER RUN" GRAVEL INFILTRATION BED
SHOP DRAWIN
REQUIRED:
CONSTRUCTION SI
AREAS. ALL S
DIVERTED, PLU
CONSTRUCTION SI
PROVIDES AF
PROFILE
BIO–RETENTION


Turf Grass Top
Can Pose
Problems…

What Can We All Do?

- WORK TOGETHER (Plant suppliers, landscapers, contractors, engineers, owners) to make sure the BMPs are designed, constructed, and maintained properly
- PROMOTE these techniques
- MIMIC predevelopment hydrology
- USE NATIVE PLANTS…for their multiple benefits
- COST BENEFITS for the long term
- USE DISPERSED MICRO PRACTICES
- USE DISPERSED MICRO PRACTICES
- USE DISPERSED MICRO PRACTICES

Presentation Outline

- Part 1 – Old Items
  - EPA Phase II Stormwater Permit Review
  - MSD Design Requirements
  - Best Management Practice (BMP) Options
- Part 2 – New Items
  - Environmental Site Design
  - BMP Landscape Guide
  - A Few Updates to the Guide
  - Some Recent Examples

Thank You!

Questions?

- www.stlmsd.com Rules, Regulations, and Design Requirements
- www.mde.state.md.us 2000 Maryland Stormwater Design Manual Volumes I & II
- www.grownative.org GROW native!
- www.shawnature.org Shaw Nature Reserve
- www.showmeraingardens.com Show Me Rain Gardens

MSD