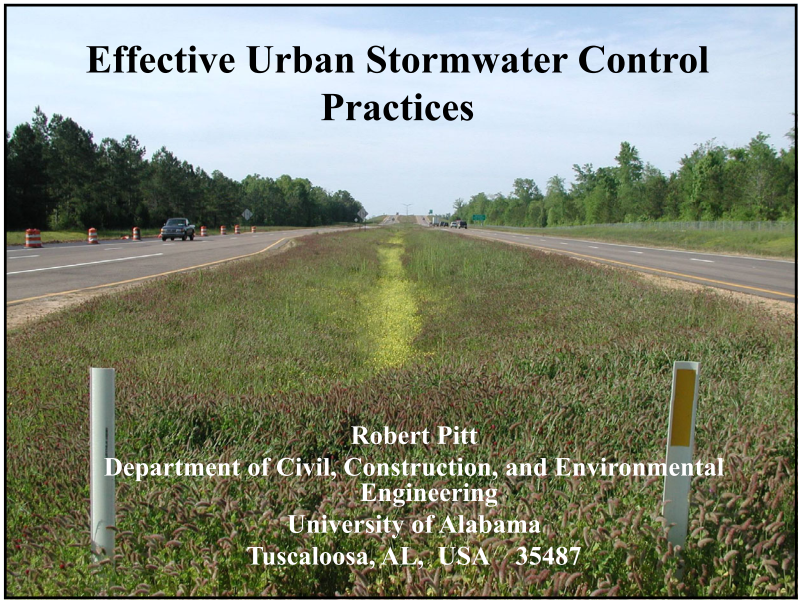
Effective Urban Stormwater Control Practices



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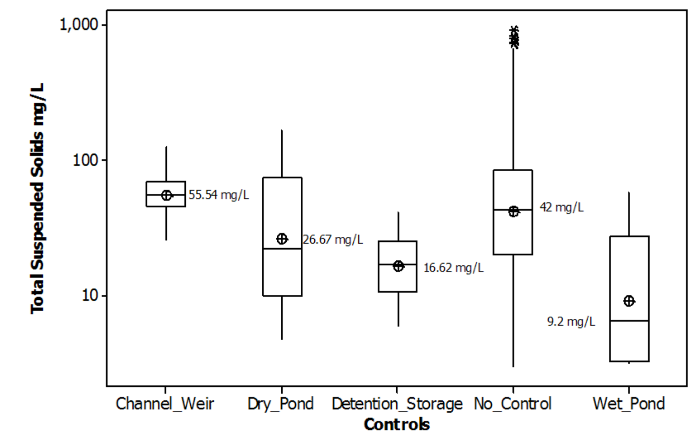
Comparison of Stormwater Control Practices in Residential Land Uses, EPA Rain Zone 2 (National Stormwater Quality Database, NSQD)



2

Relative Effectiveness of Controls

	Cost	Effectiveness
Inappropriate discharge	Low	High
Erosion control	Low to mod.	Low to moderate
Floatable and litter control	Low to mod.	Low to high
Oil&water separators	Moderate	Very low
Critical source control	High	Low to high
Low impact development	Low to mod.	Moderate to high
Public education	Low to mod.	?????
Wet detention ponds	Mod. To high	Usually high

3

Probability distribution of rains (by count) and runoff (by depth).

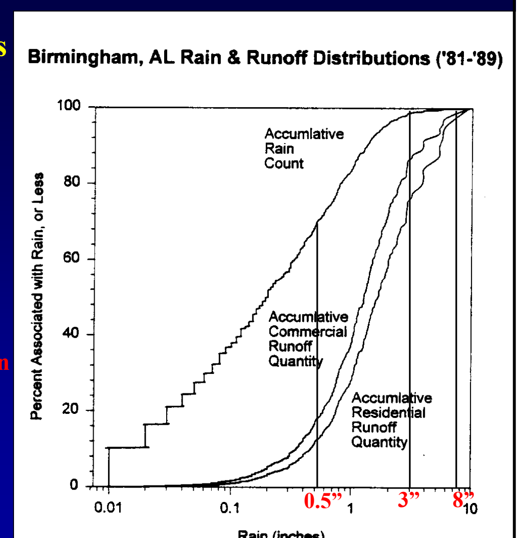
Central Alabama Rain Condition:

<0.5": 65% of rains (10% of runoff)

0.5 to 3": 30% of rains (75% of runoff) **We therefore need to focus on these rains!**

3 to 8": 4% of rains (13% of runoff)

>8": <0.1% of rains (2% of runoff)



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Calculated Benefits of Various Roof Runoff Controls (compared to typical directly connected residential pitched roofs)

Annual roof runoff volume reductions	Birmingham, Alabama (55.5 in.)	Seattle, Wash. (33.4 in.)	Phoenix, Arizona (9.6 in.)
Cistern for reuse of runoff for toilet flushing and irrigation (10 ft. diameter x 5 ft. high)	66	67	88%
Planted green roof (but will need to irrigate during dry periods)	75	77	84%
Disconnect roof drains to loam soils	84	87	91%
Rain garden with amended soils (10 ft. x 6.5 ft.)	87	100	96%

There are therefore a number of potential controls for roof runoff, from the conventional to the unusual, that can result in very large runoff reductions.

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Roof drain disconnections

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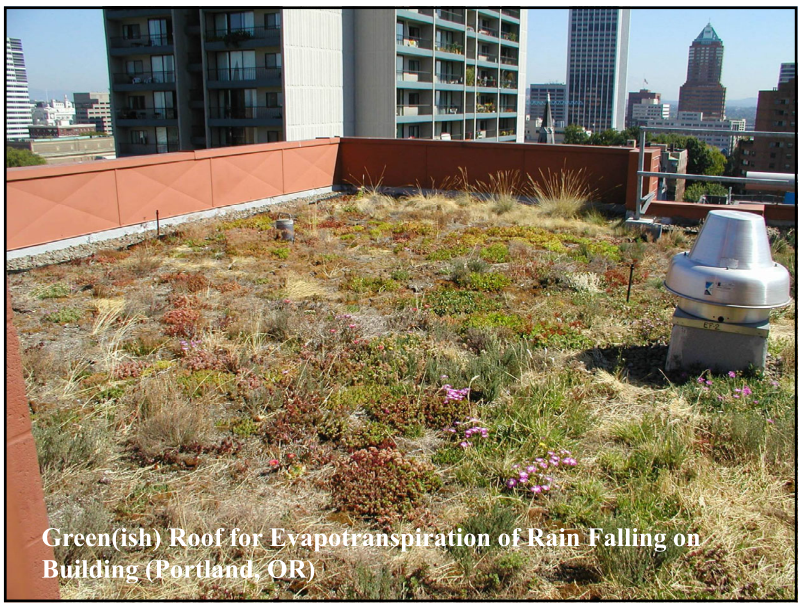

Green(ish) Roof for Evapotranspiration of Rain Falling on Building (Portland, OR)

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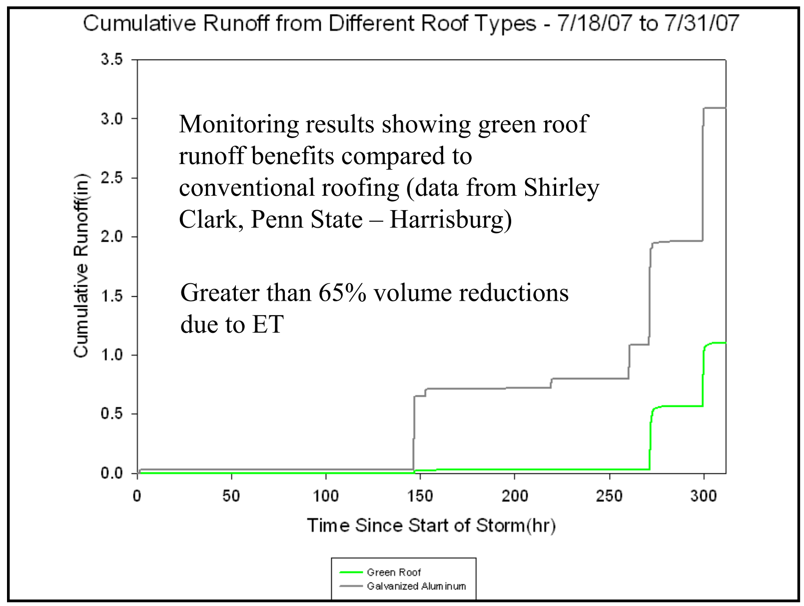

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Rain Garden Designed for Complete Infiltration of Roof Runoff

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Recent Bioretention Retrofit Projects in Commercial and Residential Areas in Madison, WI

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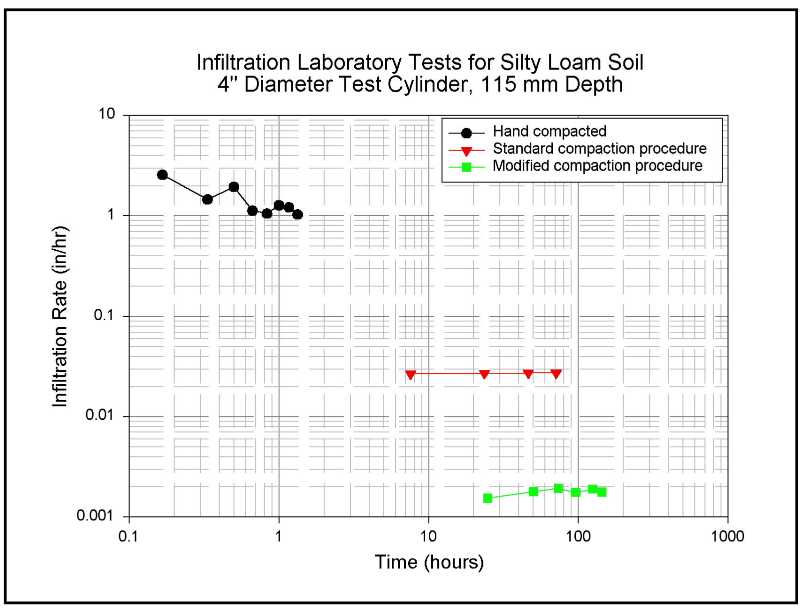
Infiltration Laboratory Tests for Silty Loam Soil
4" Diameter Test Cylinder, 115 mm Depth
Hand compacted
Standard compaction procedure
Modified compaction procedure
Infiltration Rate (in/hr)
Time (hours)

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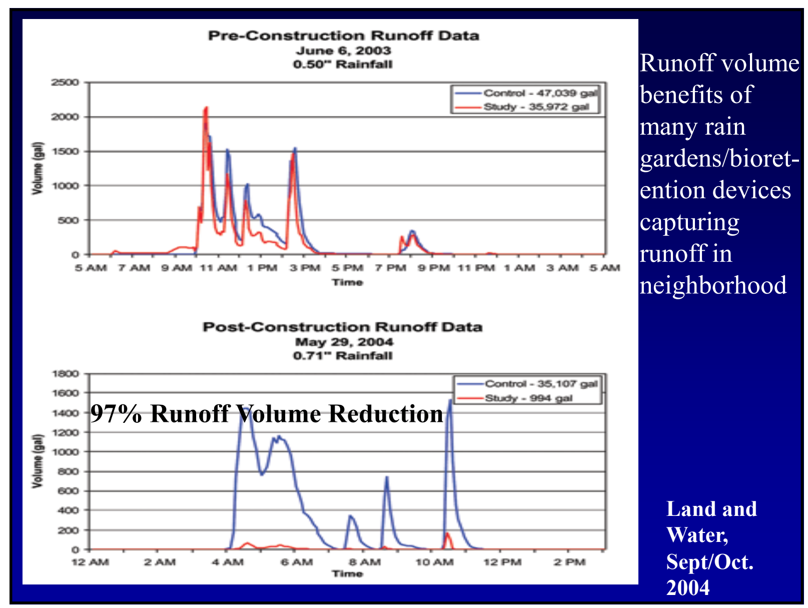
Pre-Construction Runoff Data
June 6, 2003
0.50" Rainfall
Control - 47,039 gal
Study - 35,972 gal
Volume (gal)
Time
Post-Construction Runoff Data
May 29, 2004
0.71" Rainfall
Control - 35,107 gal
Study - 994 gal
97% Runoff Volume Reduction
Runoff volume benefits of many rain gardens/bioretention devices capturing runoff in neighborhood
Land and Water, Sept/Oct. 2004

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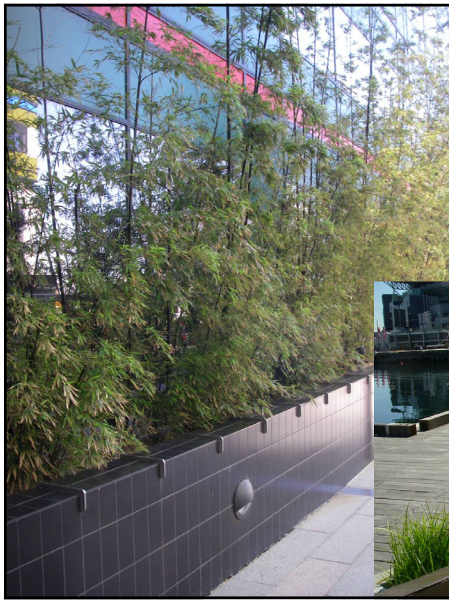
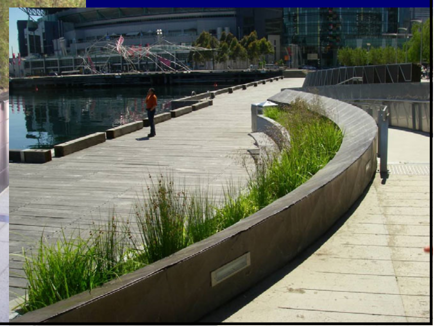
Stormwater filters and bioretention areas in ultra urban setting (Melbourne, Australia)





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Street-side tree filters in downtown area (Melbourne, Australia)

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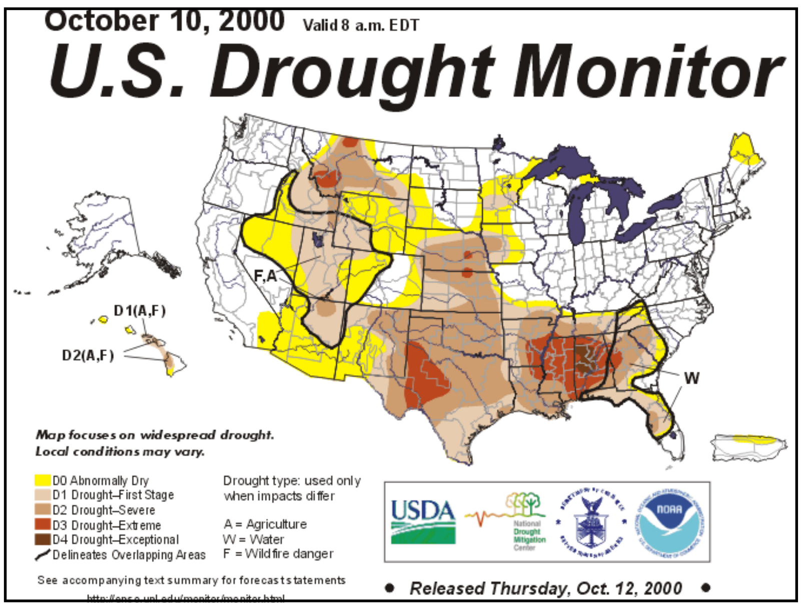

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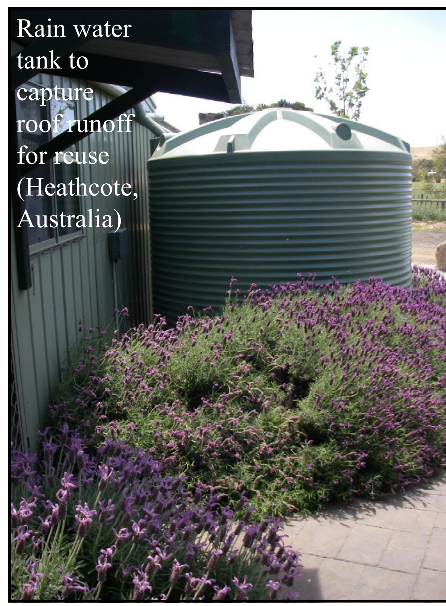

Tankage volume for 4,000 ft² roof (ft³), Birmingham, AL	Fraction of annual roof runoff used for irrigation
1,000	56%
2,000	56
4,000	74
8,000	90
16,000	98

Cistern tank, Kamiros, Rhodes (ancient Greece, 7th century BC)

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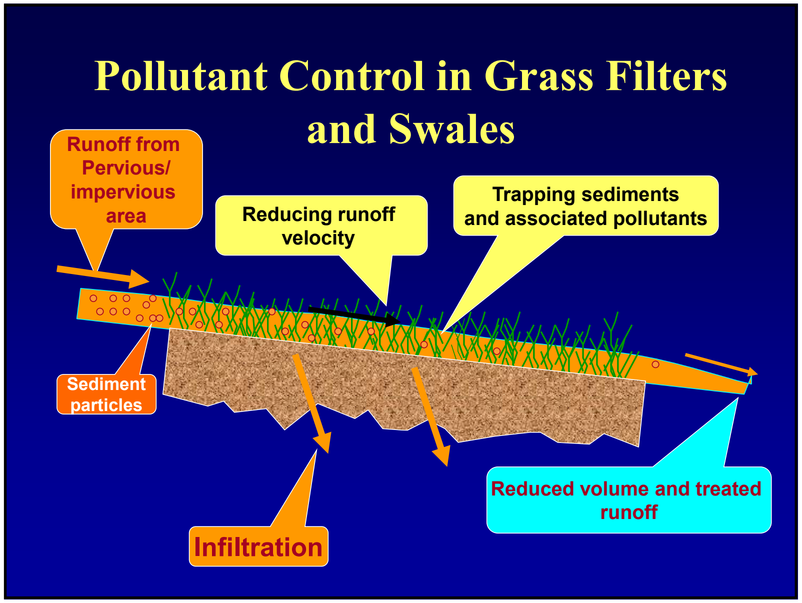
Pollutant Control in Grass Filters and Swales
Runoff from Pervious/ impervious area
Reducing runoff velocity
Trapping sediments and associated pollutants
Sediment particles
Reduced volume and treated runoff
Infiltration

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Neenah Foundry Employee Parking Lot Grass Filter/Biofilter, Neenah, WI

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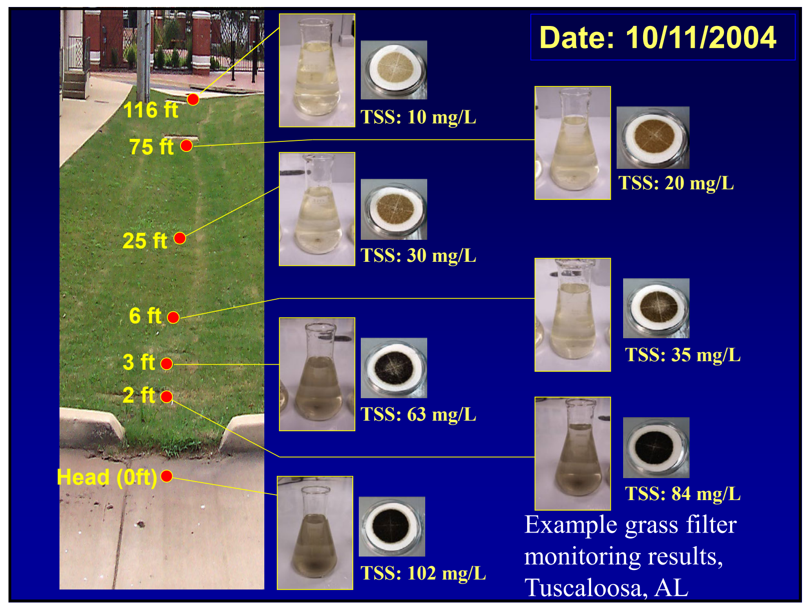
Date: 10/11/2004
116 ft
75 ft
25 ft
6 ft
3 ft
2 ft
Head (0ft)
TSS: 10 mg/L
TSS: 20 mg/L
TSS: 30 mg/L
TSS: 35 mg/L
TSS: 63 mg/L
TSS: 84 mg/L
TSS: 102 mg/L
Example grass filter monitoring results, Tuscaloosa, AL

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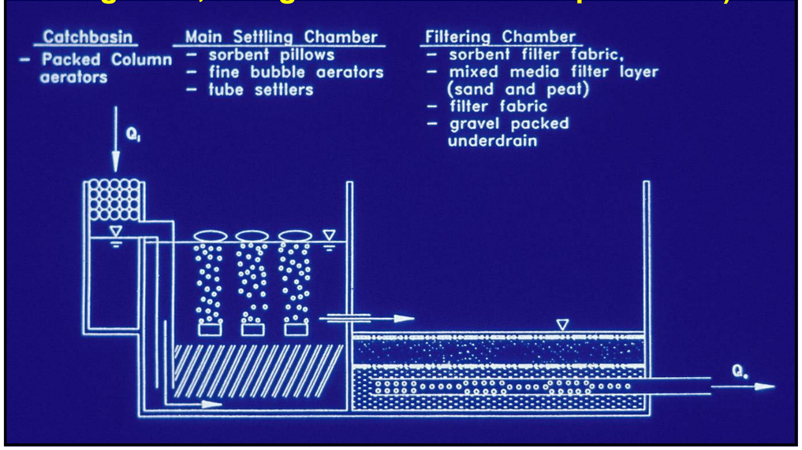
Multi-Chambered Treatment Tank (MCTT) for Critical Source Areas (underground installation with very high removals of heavy metals and toxic organics, along with conventional pollutants)



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Milwaukee, WI, Ruby Garage Public Works Maintenance Yard and Minocqua, WI, MCTT Sites

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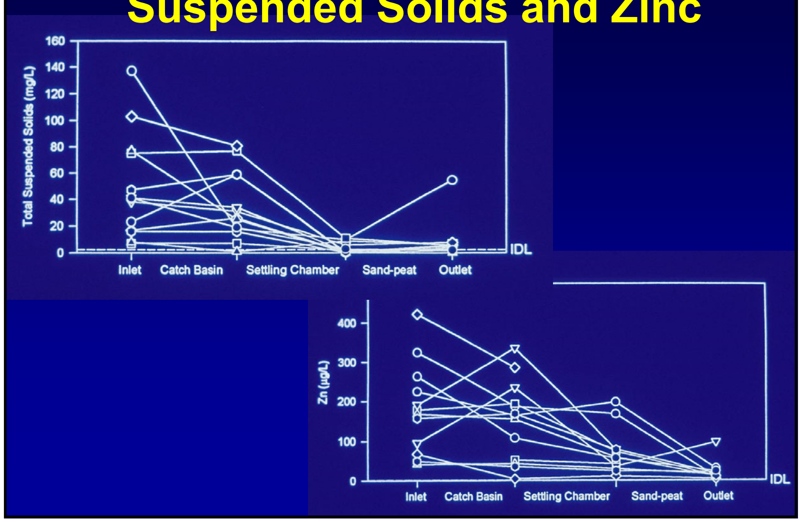
Monitored Test Results for Suspended Solids and Zinc



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Full-Scale MCTT Test Results

(median % reductions and median effluent quality)	Milwaukee (15 events)	Minocqua (7 events)
Suspended Solids	98 (<5 mg/L)	85 (10 mg/L)
Phosphorus	88 (0.02 mg/L)	>80 (<0.1 mg/L)
Copper	90 (3 µg/L)	65 (15 µg/L)
Lead	96 (1.8 µg/L)	nd (<3 µg/L)
Zinc	91 (<20 µg/L)	90 (15 µg/L)
Benzo (b) fluoranthene	>95 (<0.1 µg/L)	>75 <0.1 µg/L)
Phenanthrene	99 (<0.05 µg/L)	>65 (<0.2 µg/L)
Pyrene	98 (<0.05 µg/L)	>75 (<0.2 µg/L)

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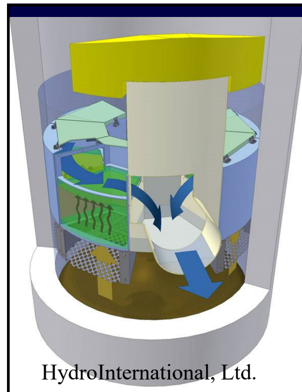
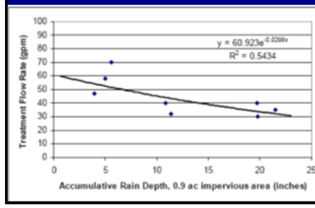
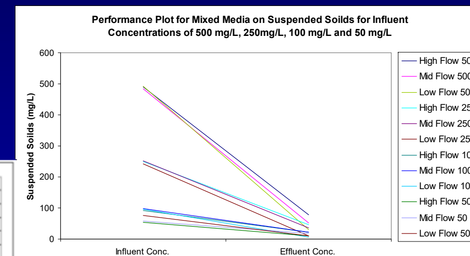
EPA-funded SBIR2 Field Monitoring Equipment for UpFlow Filter, Tuscaloosa, AL

Upflow filter insert for catchbasins



Able to remove particulates and targeted pollutants at small critical source areas. Also traps coarse material and floatables in sump and away from flow path.



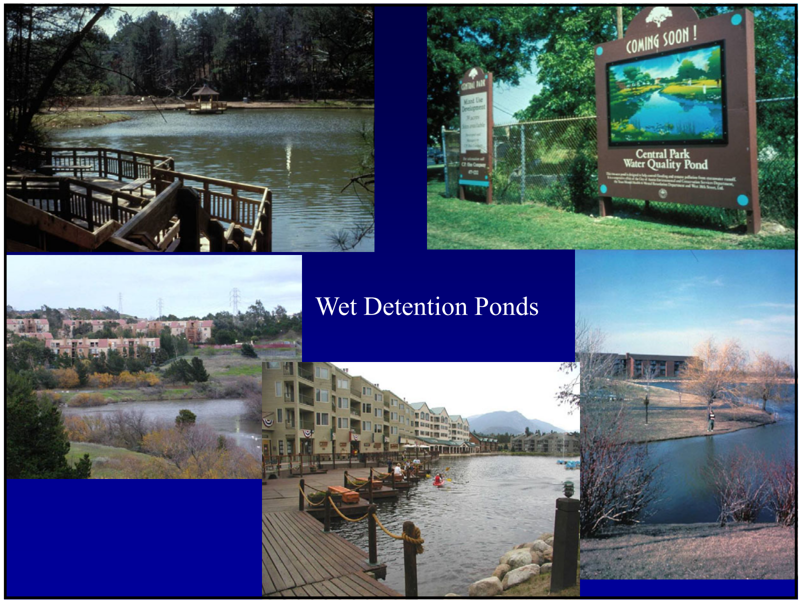


Full-scale commercial unit currently being tested in Tuscaloosa, AL

Installation of full-sized UpFlow Filter at Tuscaloosa for long-term monitoring

Filtration Performance

Constituent and units	Reported irreducible concentrations (conventional high-level stormwater treatment)	Effluent concentrations with treatment trains using sedimentation along with sorption/ion exchange
Particulate solids (mg/L)	10 to 45	<5 to 10
Phosphorus (mg/L)	0.2 to 0.3	0.02 to 0.1
TKN (mg/L)	0.9 to 1.3	0.8
Cadmium (µg/L)	3	0.1
Copper (µg/L)	15	3 to 15
Lead (µg/L)	12	3 to 15
Zinc (µg/L)	37	<20



Wet Detention Ponds

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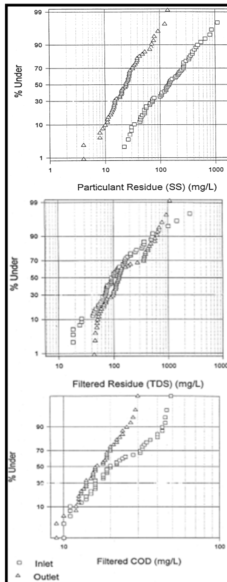

Retrofitted to result in 90% SS control, the long-term monitored results were 87%.

PROBABILITY IN % UNDER	10%	50%	90%
Suspended solids	35	87	97
Total Residue	<0	52	86
Volatile Residue	<0	41	76
Filtered Residue	<0	<0	56
Particulate COD	15	80	95
Total COD	29	60	84
FilteredCOD	<0	24	80
Particulate Phosphorus	-20	60	80
Total Phosphorus	<0	47	81
Filtered Phosphorus	<0	43	83
Particulate TKN	-40	40	80
Total TKN	<0	45	75
Filtered TKN	<0	12	68
Particulate Zinc	-117	70	95
Total Zinc	<0	31	69
Filtered Zinc	<0	<0	59

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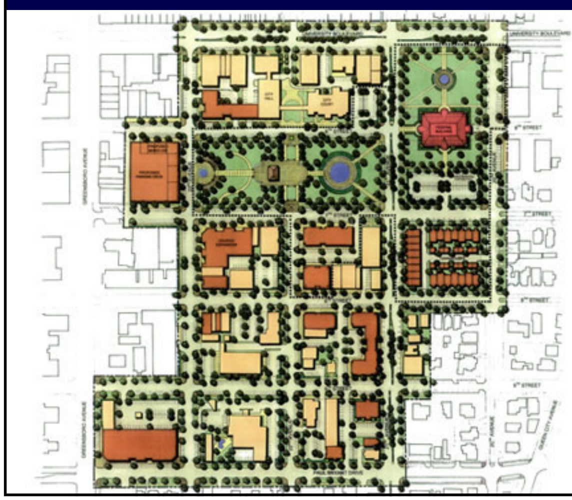
Downtown Tuscaloosa Redevelopment



DOWNTOWN TUSCALOOSA URBAN RENEWAL/REDEVELOPMENT PROJECT

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Conducted a preliminary evaluation of the downtown Tuscaloosa area that contains the redevelopment sites.

Land Use	Area (ac)	Area (%)
Commercial	72.9	66.0
Residential	15.7	14.2
Institutional	11.0	10.0
Other	10.8	9.77
TOTAL	***110***	***100***

Soils are mostly hydrologic group B which is classified as silt, loam, and silt-loam, having typical infiltration rates of about 0.5 in/hr, although most of the soils are highly disturbed and will need to be restored.

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Separated area into six subareas of several blocks each and conducted detailed field surveys and modeling for each land use. This is one subarea.

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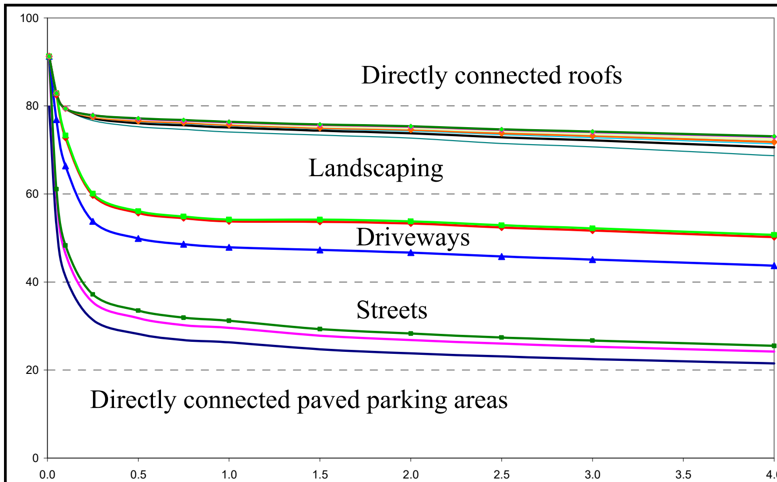

Major sources of suspended solids in the drainage area for different sized rains. Fairly consistent pattern because of the large amounts of impervious surfaces in the drainage basin and the highly efficient drainage system.

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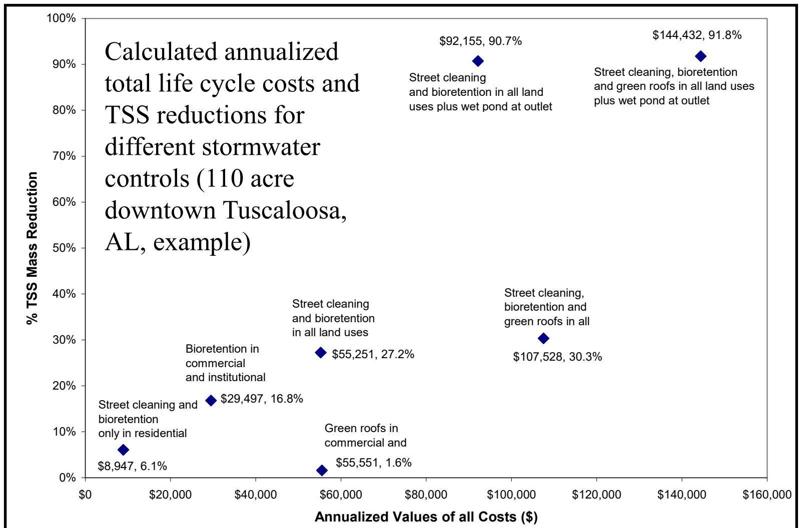
Calculated annualized total life cycle costs and TSS reductions for different stormwater controls (110 acre downtown Tuscaloosa, AL, example)



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North Huntsville Industrial Park Conservation Design

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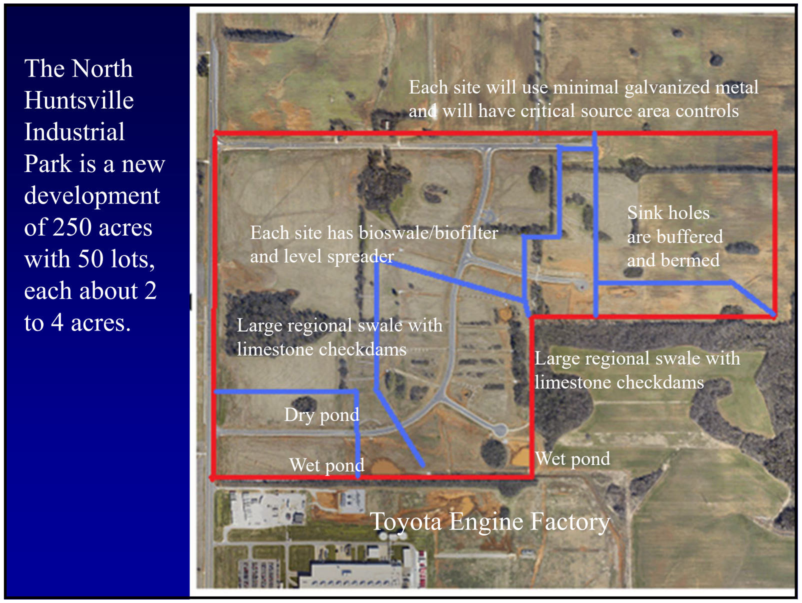
The North Huntsville Industrial Park is a new development of 250 acres with 50 lots, each about 2 to 4 acres.
Each site will use minimal galvanized metal and will have critical source area controls
Each site has bioswale/biofilter and level spreader
Sink holes are buffered and bermed
Large regional swale with limestone checkdams
Large regional swale with limestone checkdams
Dry pond
Wet pond
Wet pond
Toyota Engine Factory

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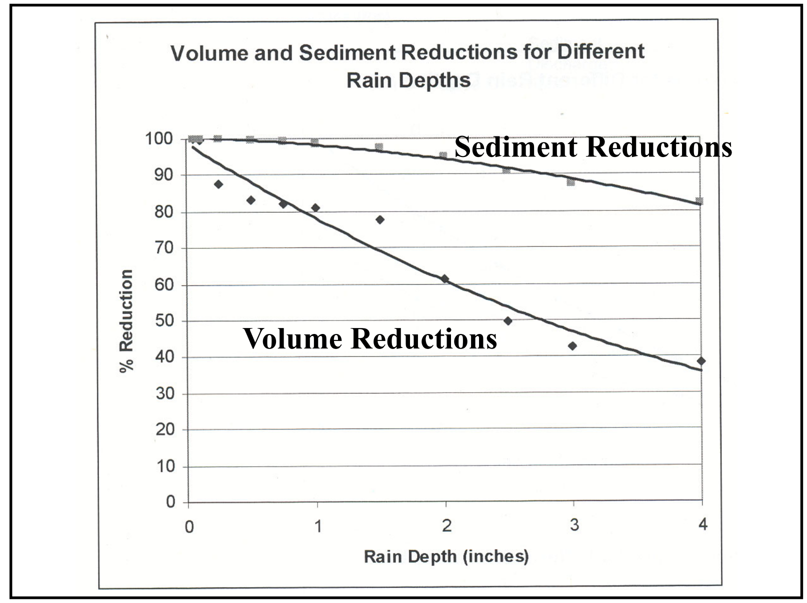
Volume and Sediment Reductions for Different Rain Depths
Sediment Reductions
Volume Reductions
% Reduction
Rain Depth (inches)
0
10
20
30
40
50
60
70
80
90
100
0
1
2
3
4

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Cedar Hill Site Design, Crossplains WI
Explanation
Wetpond
Infiltrations Basin
Swales
Sidewalk
Driveway
Houses
Lawns
Roadway
Woodlot
N
500 0 500 1000 Feet

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• Grass Swales
• Wet Detention Pond
• Infiltration Basin/Wetland
• Reduced Street Width
WI DNR photos

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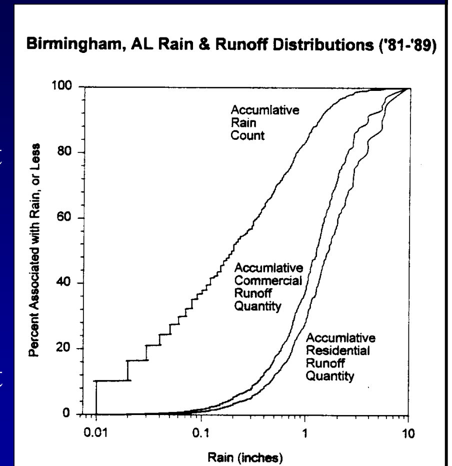
Reductions in Runoff Volume for Cedar Hills (calculated using WinSLAMM and verified by site monitoring)

Type of Control	Runoff Volume, inches	Expected Change (being monitored)
Pre-development	1.3	
No Controls	6.7	515% increase
Swales + Pond/wetland + Infiltration Basin	1.5	78% decrease, compared to no controls 15% increase over pre-development

Combinations of Controls Needed to Meet Many Stormwater Management Objectives

- Smallest storms should be captured on-site for reuse, or infiltrated
- Design controls to treat runoff that cannot be infiltrated on site
- Provide controls to reduce energy of large events that would otherwise affect habitat
- Provide conventional flooding and drainage controls



Pitt, *et al.* (2000)

Appropriate Combinations of Controls

- No single control is adequate for all problems
- Only infiltration reduces water flows, along with soluble and particulate pollutants. Only applicable in conditions having minimal groundwater contamination potential.
- Wet detention ponds reduce particulate pollutants and may help control dry weather flows. They do not consistently reduce concentrations of soluble pollutants, nor do they generally solve regional drainage and flooding problems.
- A combination of bioretention and sedimentation practices is usually needed, at both critical source areas and at critical outfalls.