Costs & Pollutant Removal Benefits of Stormwater Controls

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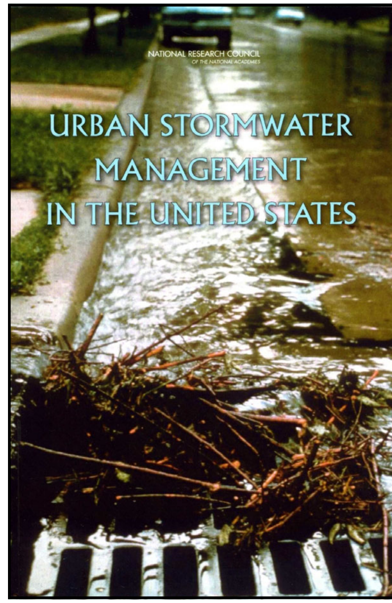

Urban Stormwater Management in the United States, 2009.
Technical Committee Report Prepared under the Water Science and Technology Board, National Research Council

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Lawrence E. Band, University of North Carolina
Roger Bannerman, Wisconsin Department of Natural Resources
Derek B. Booth, Stillwater Sciences, Inc.
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Robert G. Traver, Villanova University
Wendy Wagner, University of Texas School of Law
William E. Wenk, Wenk Associates, Inc.

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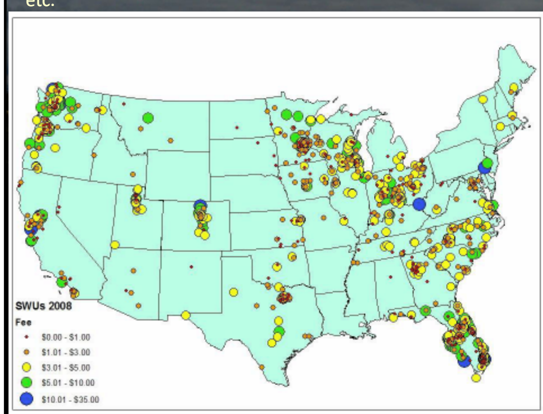
Federal Regulations, State Programs, and Local Codes (Chapter 2)

- EPA Stormwater Program: 100,000s permits for municipalities, industries, construction
- Committee survey to better understand monitoring requirements, compliance, staffing, etc.



Distribution of stormwater utility fees (Western Kentucky University Stormwater Utility Survey, Campbell and Back 2008). Up to $35 per month; typical costs are $3 to 5 per month.

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Stormwater Control Measures (SCMs) (Chapter 5)

- 20 broad categories of SCMs
  - Characteristics, applicability, goals, effectiveness, cost
- Organized as they might be applied from rooftop to stream

TABLE 5-1 Summary of Stormwater Control Measures—When, Where, and Who

Stormwater Control Measure	When	Where	Who
Product Substitution	Continuous	National, state, regional	Regulatory agencies
Watershed and Land-Use Planning	Planning stage	Watershed	Local planning agencies
Conservation of Natural Areas	Site and watershed planning stage	Site, watershed	Developer, local planning agency
Impervious Cover Minimization	Site planning stage	Site	Developer, local review authority
Earthwork Minimization	Grading plan	Site	Developer, local review authority
Erosion and Sediment Control	Construction	Site	Developer, local review authority
Reforestation and Soil Conservation	Site planning and construction	Site	Developer, local review authority
Pollution Prevention SCMs for Stormwater Hotspots	Post-construction or retrofit	Site	Operators and local and state permitting agencies
Runoff Volume Reduction—Rainwater harvesting	Post-construction or retrofit	Rooftop	Developer, local planning agency and review authority
Runoff Volume Reduction—Vegetated	Post-construction or retrofit	Site	Developer, local planning agency and review authority
Runoff Volume Reduction—Subsurface	Post-construction or retrofit	Site	Developer, local planning agency and review authority
Peak Reduction and Runoff Treatment	Post-construction or retrofit	Site	Developer, local planning agency and review authority
Runoff Treatment	Post-construction or retrofit	Site	Developer, local planning agency and review authority
Aquatic Buffers and Managed Floodplains	Planning, construction and post-construction	Stream corridor	Developer, local planning agency and review authority, landowners
Stream Rehabilitation	Postdevelopment	Stream corridor	Local planning agency and review authority
Municipal Housekeeping	Postdevelopment	Streets and stormwater infrastructure	MS4 Permittee
Illicit Discharge Detection and Elimination	Postdevelopment	Stormwater infrastructure	MS4 Permittee
Stormwater Education	Postdevelopment	Stormwater infrastructure	MS4 Permittee
Residential Stewardship	Postdevelopment	Stormwater infrastructure	MS4 Permittee

Note: Nonstructural SCMs are in italics.

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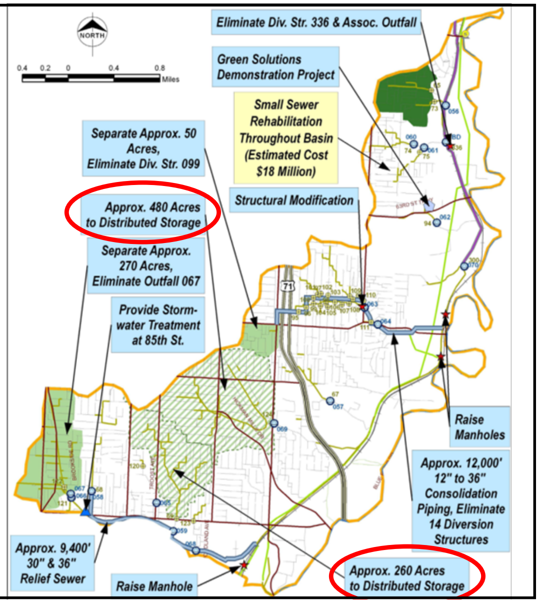
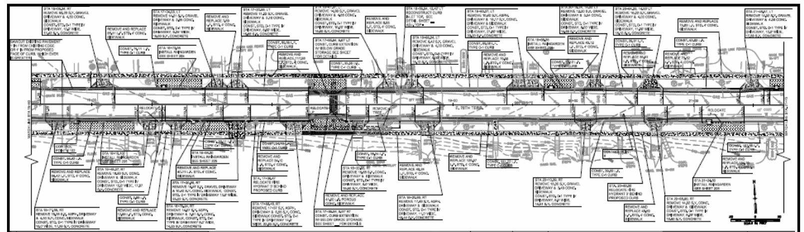
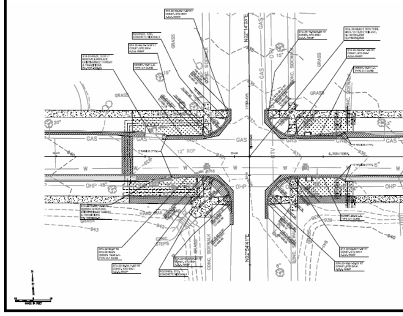
Many of the US's largest stormwater control programs are currently being conducted as part of CSO control programs.

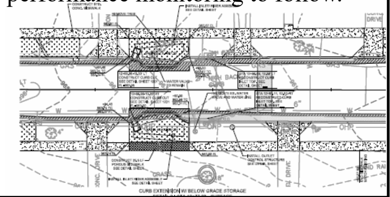
Kansas City's Revised Middle Blue River Plan with Distributed Storage and Green Infrastructure (first time required in consent decree).



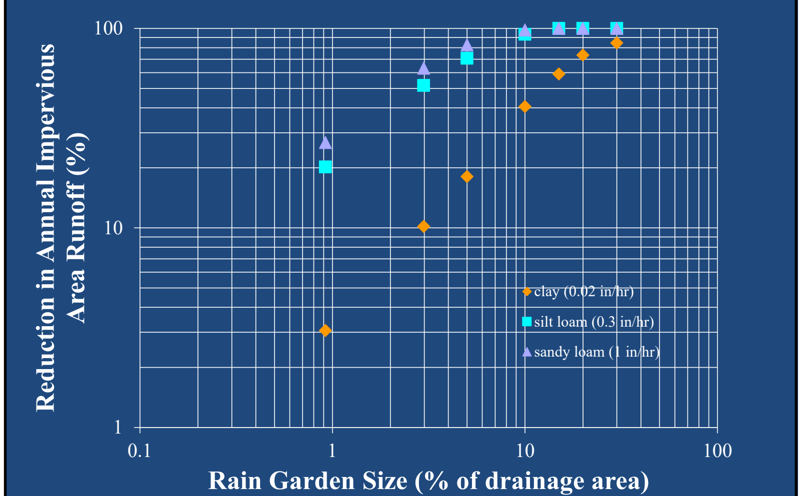


Examples from "65%" plans prepared by URS for project streets. Plans reviewed and modeled by project team, and construction will occur in spring and summer of 2011; performance monitoring to follow.





Annual Runoff Reductions from Paved Areas or Roofs for Different Sized Rain Gardens for Various Soils



Economic Viability of Green Infrastructure in Kansas City

($21,700/acre; other watersheds in area can cost $50,000/acre, but still less than gray controls)

	Control Components for One Example Subarea in Kansas City (preliminary costs, project going out to bid early 2011):	Est. Capital Cost ($M)	Storage Provided (M gal)	Unit Capital Cost ($/gal Stored)
Gray Controls Only	Outfall 059 (475 acres; 19% imperviousness): 1 M gal Storage Tank; 0.5 MGD Pumping Station; 17 MGD Screening; 2,000 ft 48-in. Sewer; 500 ft 8-in. Force Main; Odor Control	20.0	1.0	20.00
Green Solutions	Stormwater Inlet Retrofits	0.7	0.1	2.00-7.00
	Porous Pavement Parking Lots	1.9	0.325	5.50
	Curb Extension Swales	4.1	0.30	11.00
	Porous Pavement in Street ROW	3.6	0.40	11.00
	Green Solution Totals	10.3	1.125	9.00

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USGS
science for a changing world

In cooperation with the Wisconsin Department of Natural Resources

A Comparison of Runoff Quantity and Quality from Two Small Basins Undergoing Implementation of Conventional- and Low-Impact-Development (LID) Strategies: Cross Plains, Wisconsin, Water Years 1999–2005

Scientific Investigations Report 2008–5008

U.S. Department of the Interior
U.S. Geological Survey

The most comprehensive full-scale study comparing advanced stormwater controls available.

Available at: http://pubs.usgs.gov/sir/2008/5008/pdf/sir_2008-5008.pdf

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Parallel study areas, comparing test with control site

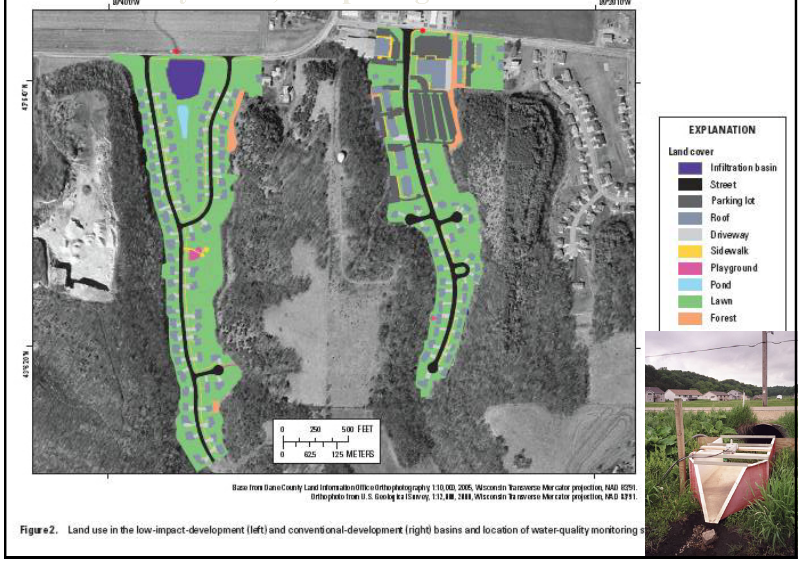

Figure 2. Land use in the low-impact-development (left) and conventional-development (right) basins and location of water-quality monitoring s

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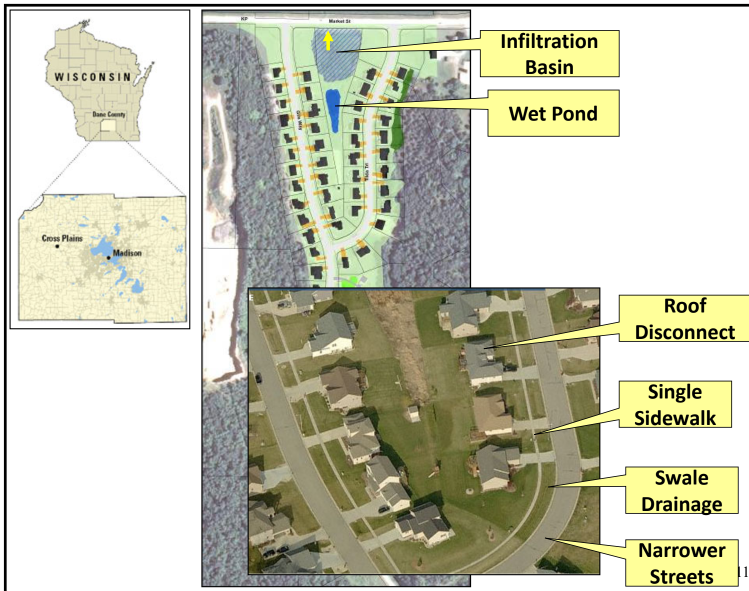

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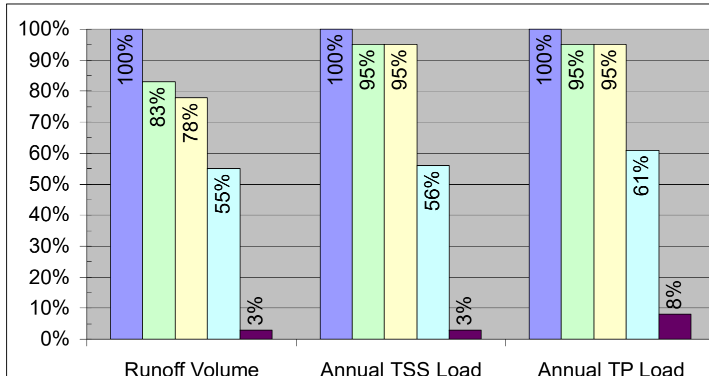
WinSLAMM Modeling Results

WinSLAMM Model Comparison of Development Scenarios



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Monitored Performance of Controls at Cross Plains Conservation Design Development

Water Year	Construction Phase	Rainfall (inches)	Volume Leaving Basin (inches)	Percent of Volume Retained (%)
1999	Pre-construction	33.3	0.46	99%
2000	Active construction	33.9	4.27	87%
2001	Active construction	38.3	3.68	90%
2002	Active construction (site is approximately 75% built-out)	29.4	0.96	97%

WI DNR and USGS data

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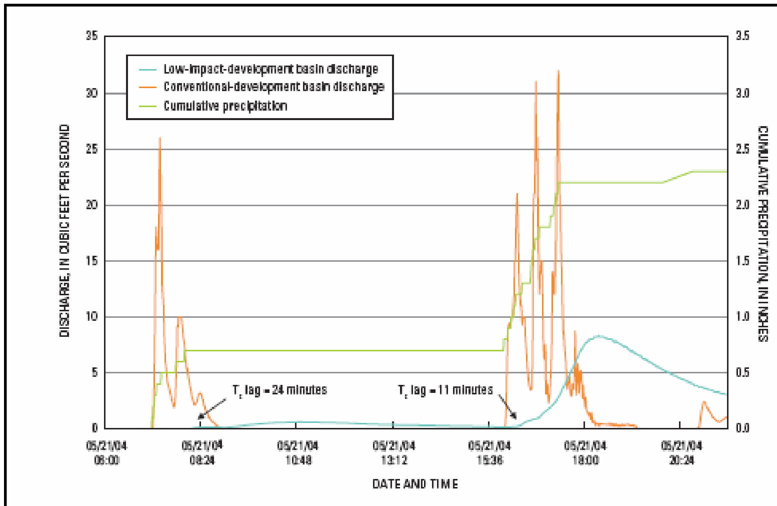

Figure 10. Hydrologic response of low-impact-development (LID) and conventional-development basins to two consecutive precipitation events, Cross Plains, Wis. [T_c, time of concentration]

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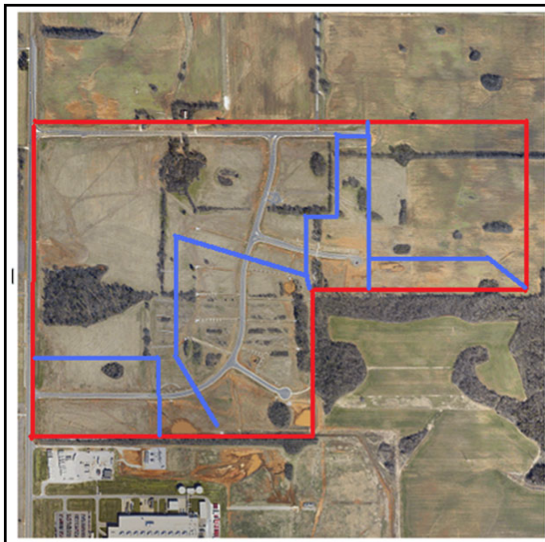

North Huntsville Industrial Park

- On-site bioretention swales
- Level spreaders
- Large regional swales
- Wet detention ponds
- Critical source area controls
- Pollution prevention (no zinc from galvanized metals!)
- Buffers around sinkholes
- Extensive trail system linking water features and open space

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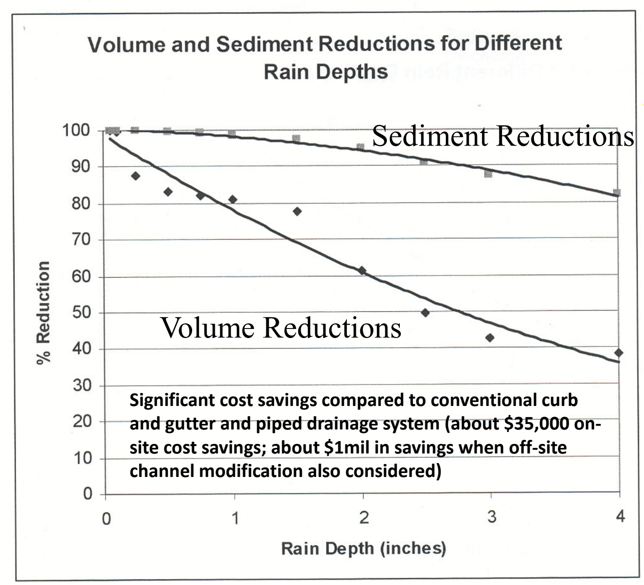

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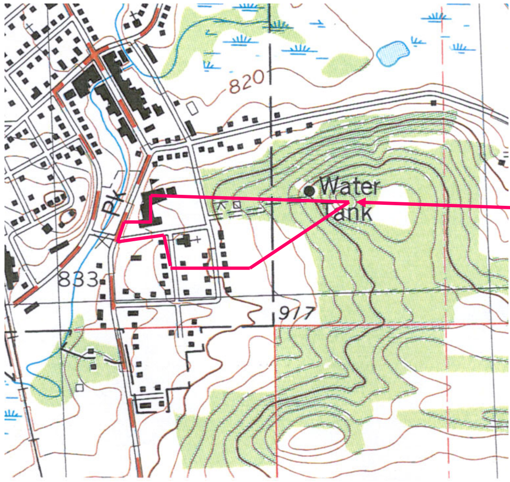
Lodi, Wisconsin, Transportation Area Rain Garden



Drainage Basin Area = 16 acres

Paved Area = 20%

City of Lodi, Columbia County WI

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Lodi, WI, Rain Garden Costs*

Pipe Underdrain and Endwalls	$700
Flow Regulation Structure	$3,000
Plants	$2,200
Shrubs	$450
Backfill	$11,600
Excavation	$2,200
Select Crushed Material/Riprap	$3,850
Storm Sewer and Manholes	$3,500
Total $4.70/sf	$27,500

*** 16 acre drainage area, 20% imperviousness, or $1,700 per acre**

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On-going Millburn, NJ, Monitoring Project to Evaluate Performance and Groundwater Problems Associated with Required Dry Wells

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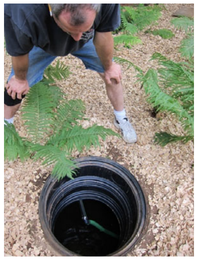
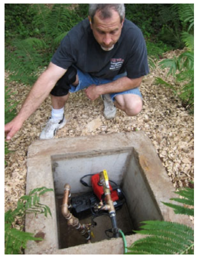

Home restoration using underground water storage tanks for landscaping irrigation instead of dry wells. Monthly water costs of $500 allow payback in about 5 years.


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NASECA 7th Annual Conference
BIOFILTRATION STUDY

Typical Bioretention Costs

- Retrofit Site
  - $100,000 per acre of imperviousness
  - Engineered soil is 5% of total device cost
- Redevelopment Site
  - $50,000 per acre of imperviousness
  - Engineered soil is 10% of total device cost
- New Development Site
  - $35,000 per acre of imperviousness
  - Engineered soil is 15% of total device cost

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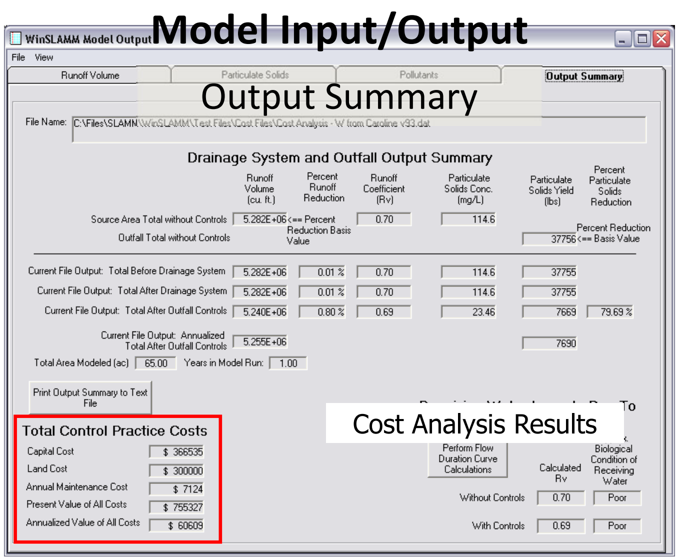

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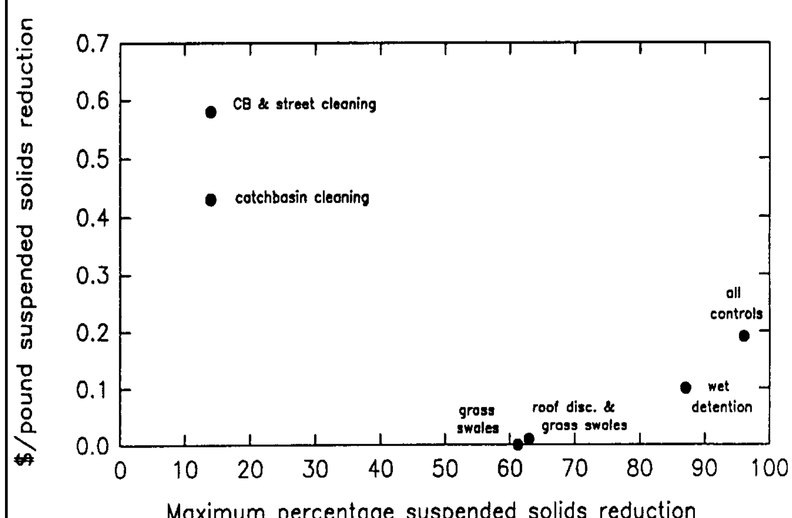
Cost-Benefit Analysis for Various Stormwater Controls, WinSLAMM



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Relative Costs and Effectivenesses of Controls

	Costs (capital costs in parentheses)	Effectiveness
Inappropriate discharge control (designed for retrofit)	Low	High
Erosion control	Low to mod.	Low to moderate
Floatable and litter control	Low to mod.	Low to high
Public works practices (street and catchbasin cleaning)	Moderate to high	Usually low
Critical source control (designed for retrofit)	High ($10,000 to $50,000 per paved acre)	Low to high
Low impact development (costly to retrofit)	Low to high (cost savings to $50,000 per watershed acre)	Moderate to high
Public education (on-going)	Low to mod.	?????
Wet detention ponds (costly and hard to retrofit)	Mod. To high ($1,000 to $10,000 per watershed acre)	Usually high

Performance Data and Cost Sources for Stormwater Controls

- *Costs of Urban Stormwater Control Practices* (Narayanan and Pitt, 2006*)*: http://www.unix.eng.ua.edu/~rpitt/Publications/StormwaterTreatability/Arvind%20and%20Pitt%20stormwater%20cost%20report.pdf

- *International BMP Database* (ASCE/WERF/EPA, continuously updated): http://www.bmpdatabase.org/

Appropriate Combinations of Controls

- No single type of 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.
- Sedimentation practices 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 biofiltration and sedimentation practices is usually needed, at both critical source areas and at critical outfalls.