A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends to do otherwise. (Aldo Leopold)

Rain Gardens

By

Roger Bannerman

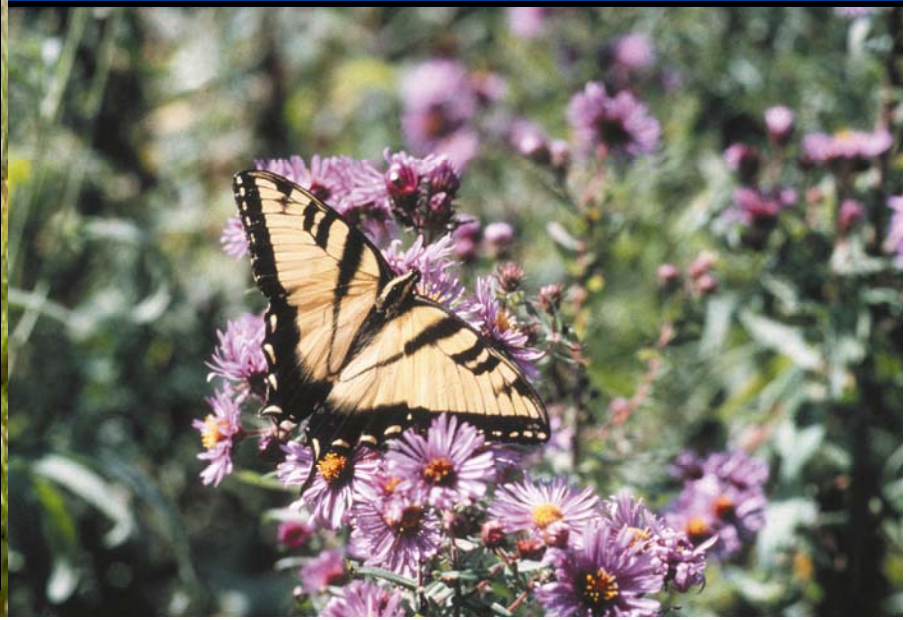
WDNR

What is a rain garden?

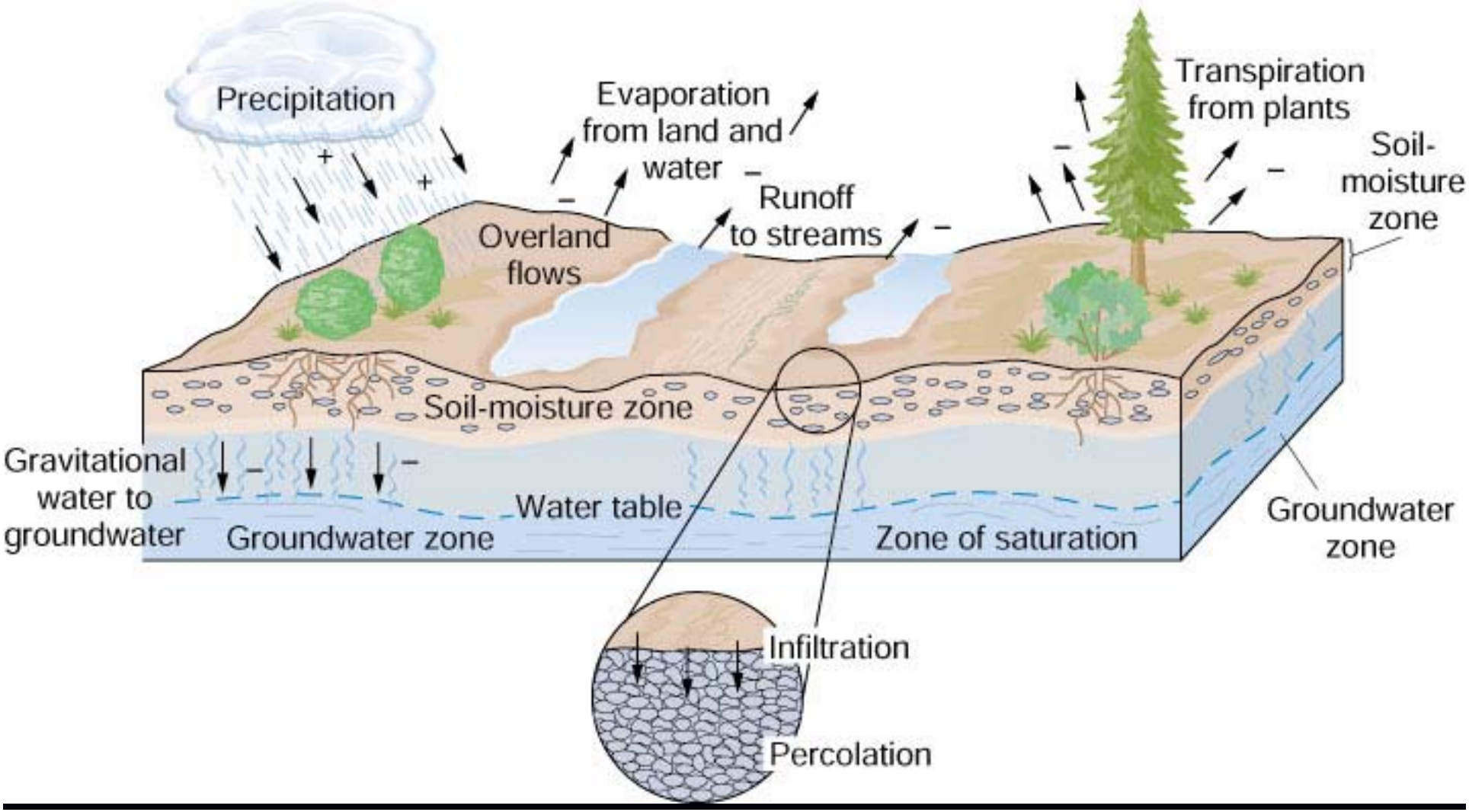
A vegetated shallow depression designed to trap runoff from rainfall and snowmelt.

Benefits of Rain Gardens

- Help Restore and Preserve Natural Hydrology
- Remove Pollutants
- Attract Wildlife



Natural Hydrology



Too Much Dirty Water

Flooding Most Frequent Concern: Lincoln Creek, Milwaukee - 1996

Lake Mendota – Madison Wisconsin


Lake Mendota - 2000

Increases in Urban Runoff for Lake Mendota from 2000 to 2020

- Amounts of Urban Runoff for 2000:

5,600,000,000 gallons
or 17,000 acre-feet

- Amounts of Urban Runoff for 2020:

8,800,000,000 gallons
or 27,500 acre-feet

(Increase of 57%)

Impact of Urbanization on Habitat Structure


High Flows Wash-out Fish Eggs


Lower Baseflow

Lake Wingra, Madison, WI

Loss of Springs Flowing into Lake Wingra

Conventional and Potentially Toxic Pollutants

Good Substrate – Rainbow Darter

Highly Embedded Substrate – Does Not Support Life Cycle


Storm Sewer
Lake Wingra - Sediment Deposit Depth Approximately 3 Feet

Measure Impact of Urbanization- Bacteria Counts

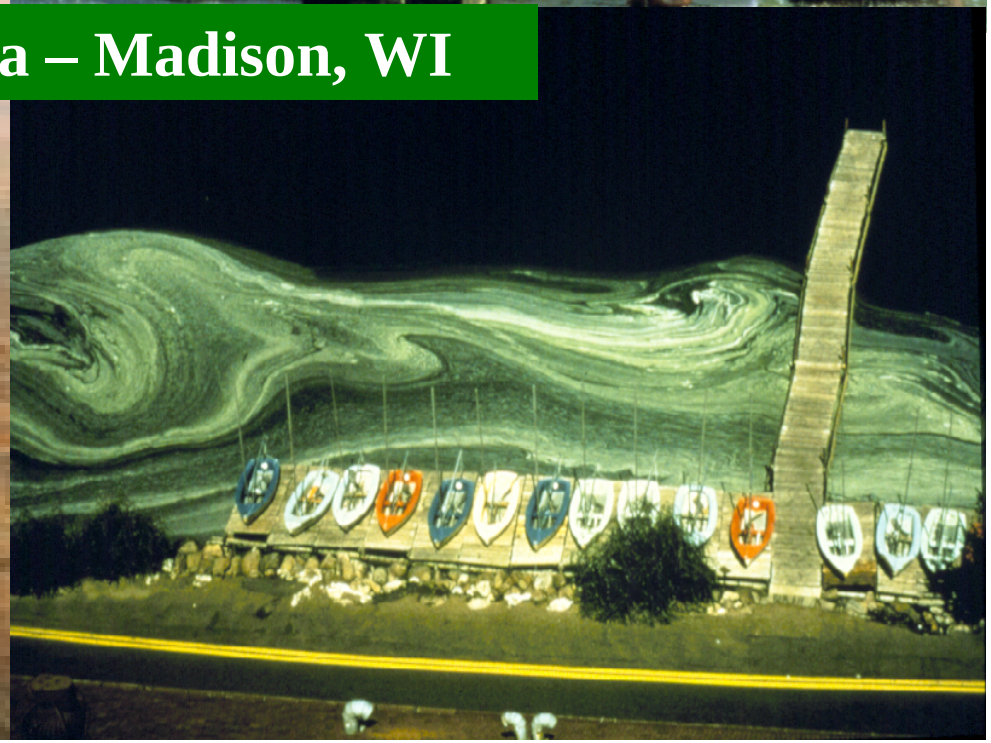
URBAN STREAMS STUDY 1992-93

Bacteria in Lincoln Creek

Lincoln Creek – Milwaukee, WI

Water Quality - Nutrient Enrichment Limits Use of Lakes

Lake Mendota – Madison, WI



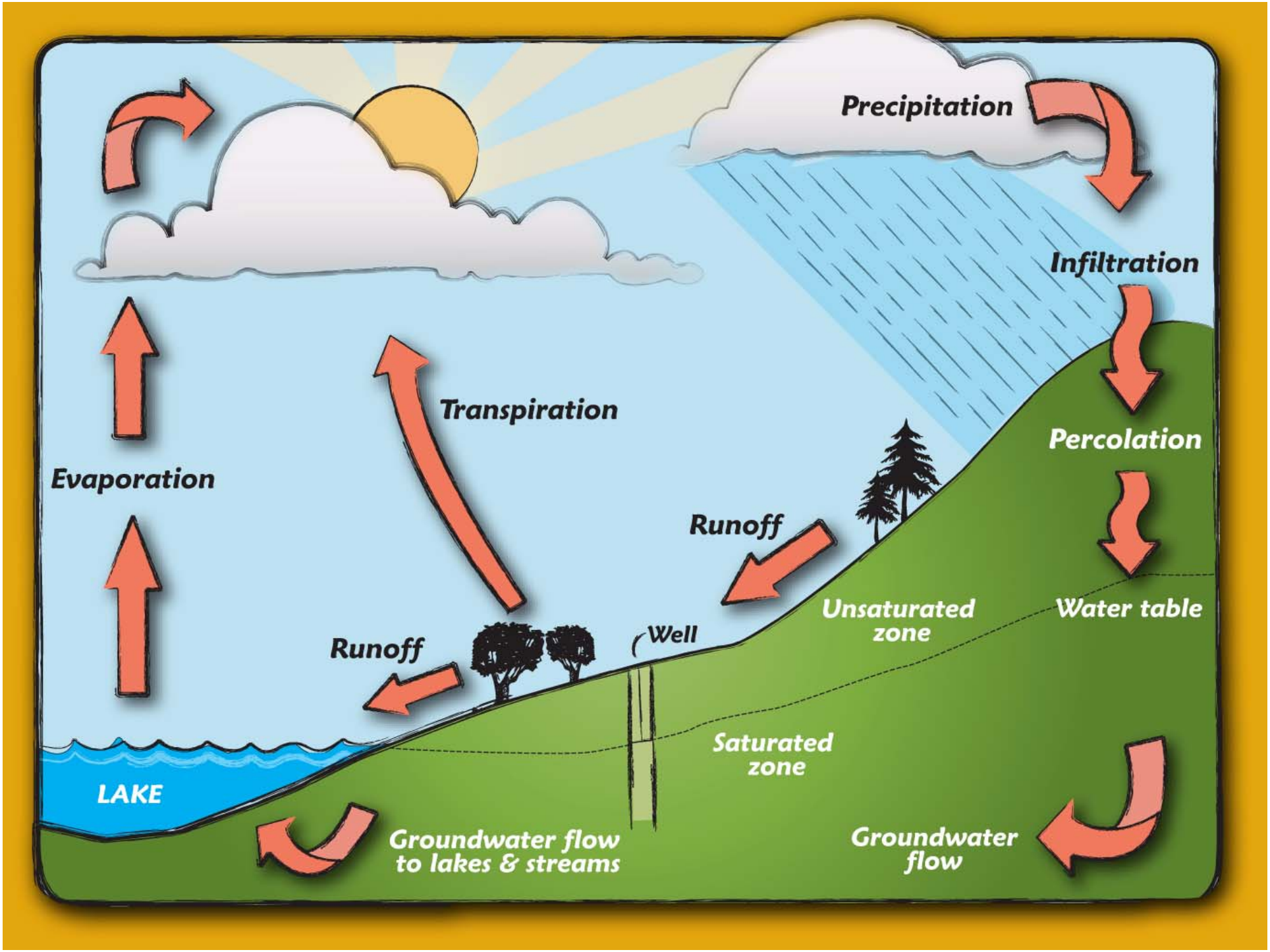
Increase Stream Temperature

Measure Impacts of Urbanization – Fish Shocking

High Quality Stream has 25 Fish Species, but Urban Streams 0 to 8 Species

Impacts of Imperviousness on Surface Water and Groundwater Quantities – Pheasant Branch Creek

Type of Water Resource	***Impervious Increase from 2% to 18%***	***Impervious Increase from 2% to 60%***
Stream Baseflow	-20%	Dry Stream
Surface Runoff	+90%	+485%
Regional Groundwater	-10%	-55%


Precipitation
Infiltration
Percolation
Transpiration
Evaporation
Runoff
Runoff
Well
Unsaturated zone
Water table
Saturated zone
LAKE
Groundwater flow to lakes & streams
Groundwater flow

The Runoff Management Rules

Presentation by the

Wisconsin Department of Natural Resources

Post Construction Infiltration Performance Standards

By design, infiltrate sufficient runoff volume so that the post-development average annual infiltration volume shall be a portion of pre-development infiltration volume.

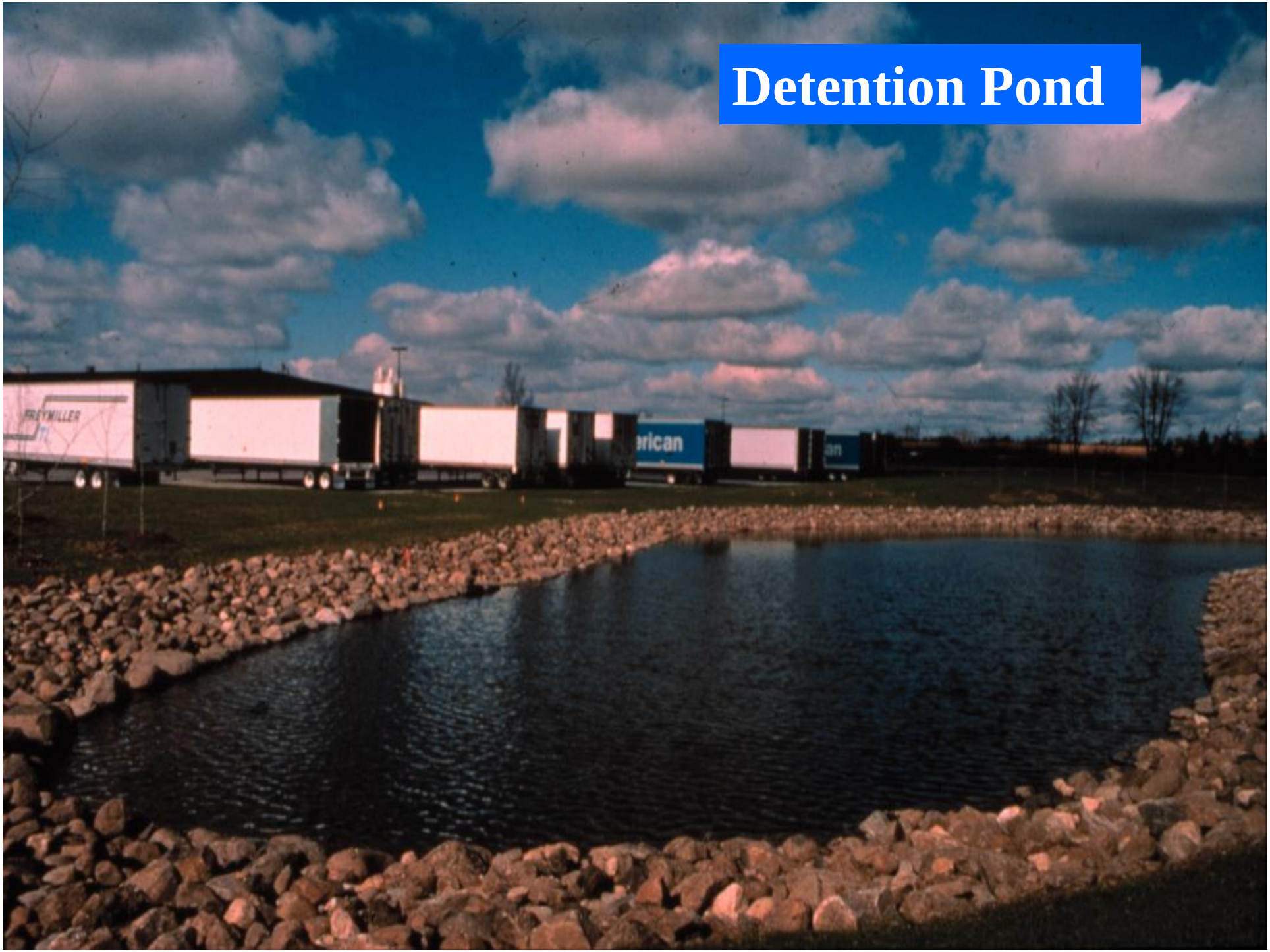
Residential	**Non-residential**
90% (1% Cap)	60% (2% Cap)

Post-Construction Performance Standards – Suspended Solids

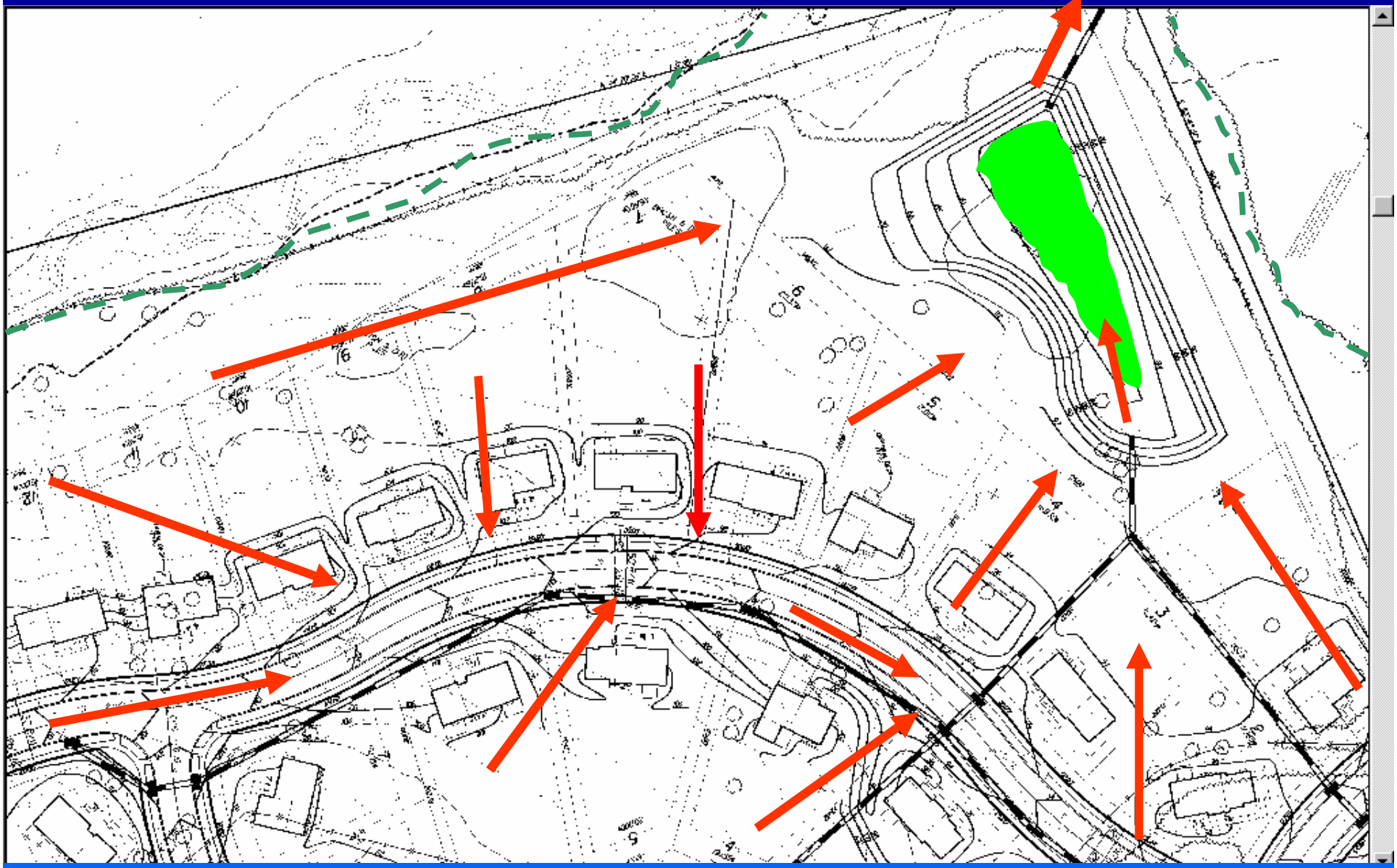
- For New Development, by design, Reduce to the MEP the Average Annual Total Suspended Solids Load for New Development by 80% as Compared to No Runoff Management Controls.

- Reduce Average Annual Total Suspended Solids Load by 40% for Redevelopment.

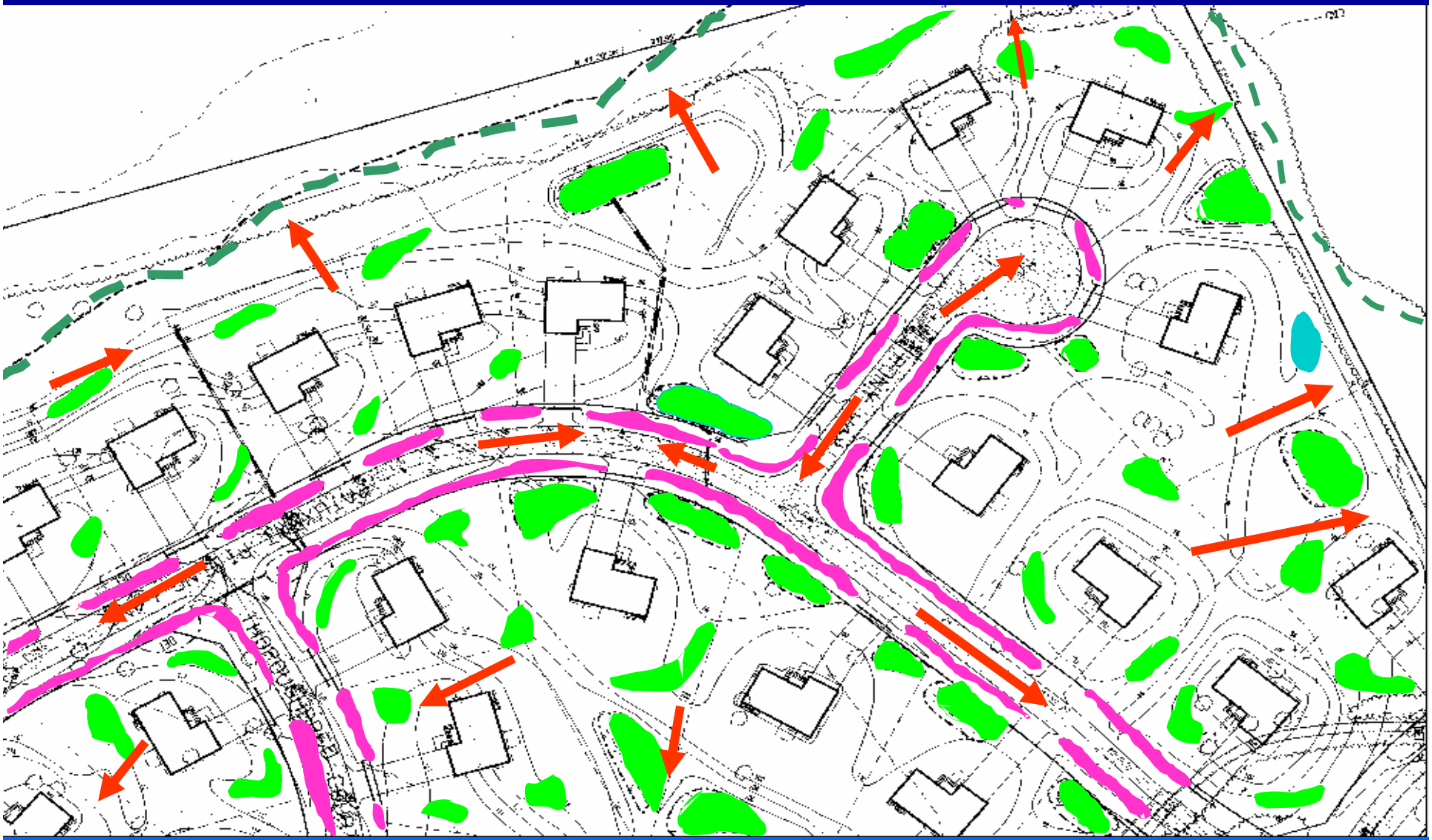

Infiltration Basin -
West Bend, WI


Detention Pond

Conventional Pipe and Pond Centralized Control



Distributed Small-scale Controls



Maintaining Natural Hydrology Functions

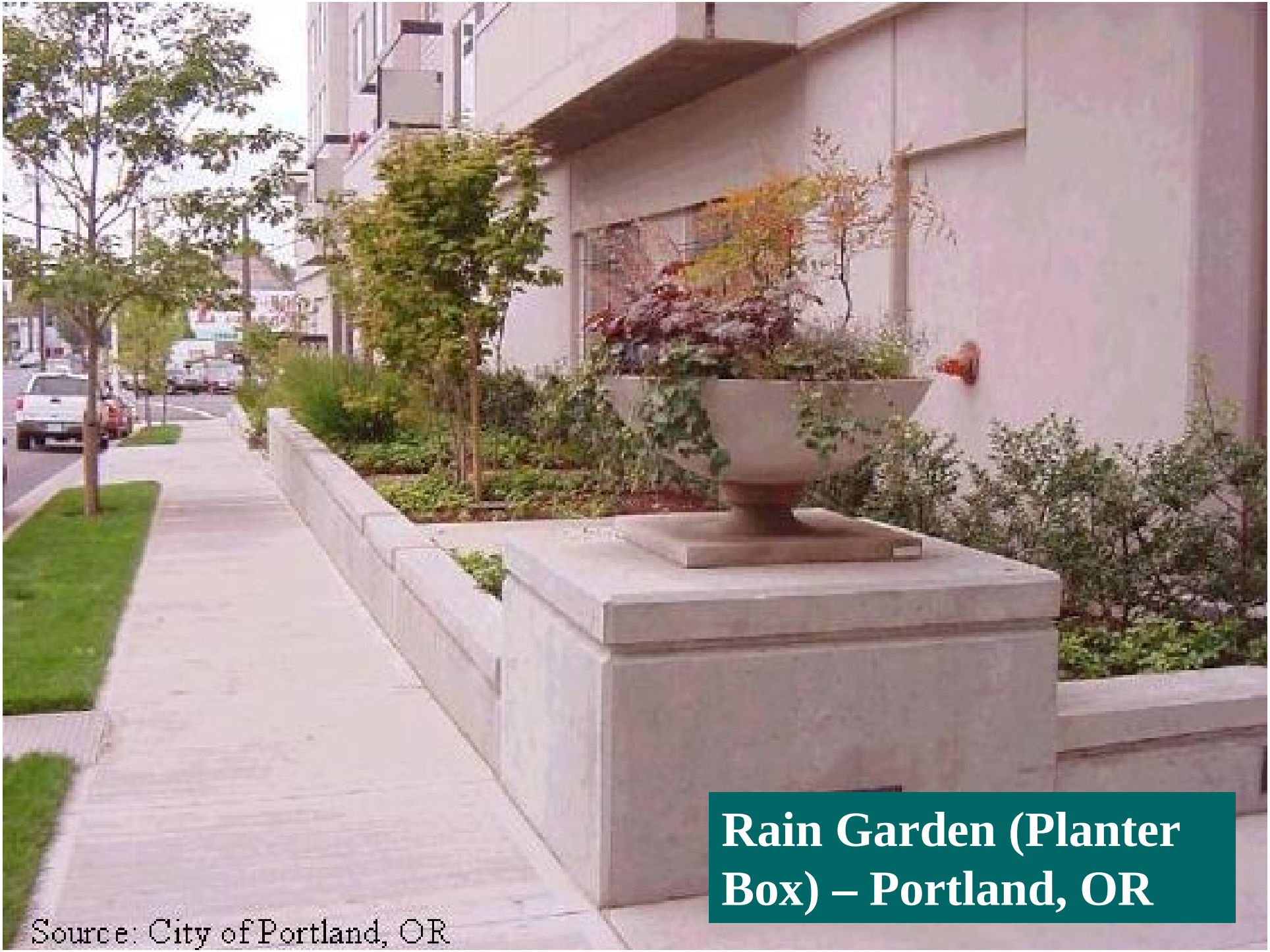
Roofs and Lawn Runoff

Rain Garden (Large Lawn and Roof) - Rock County Office


Rain Garden (1\4 Acre Lot)
– Madison, WI

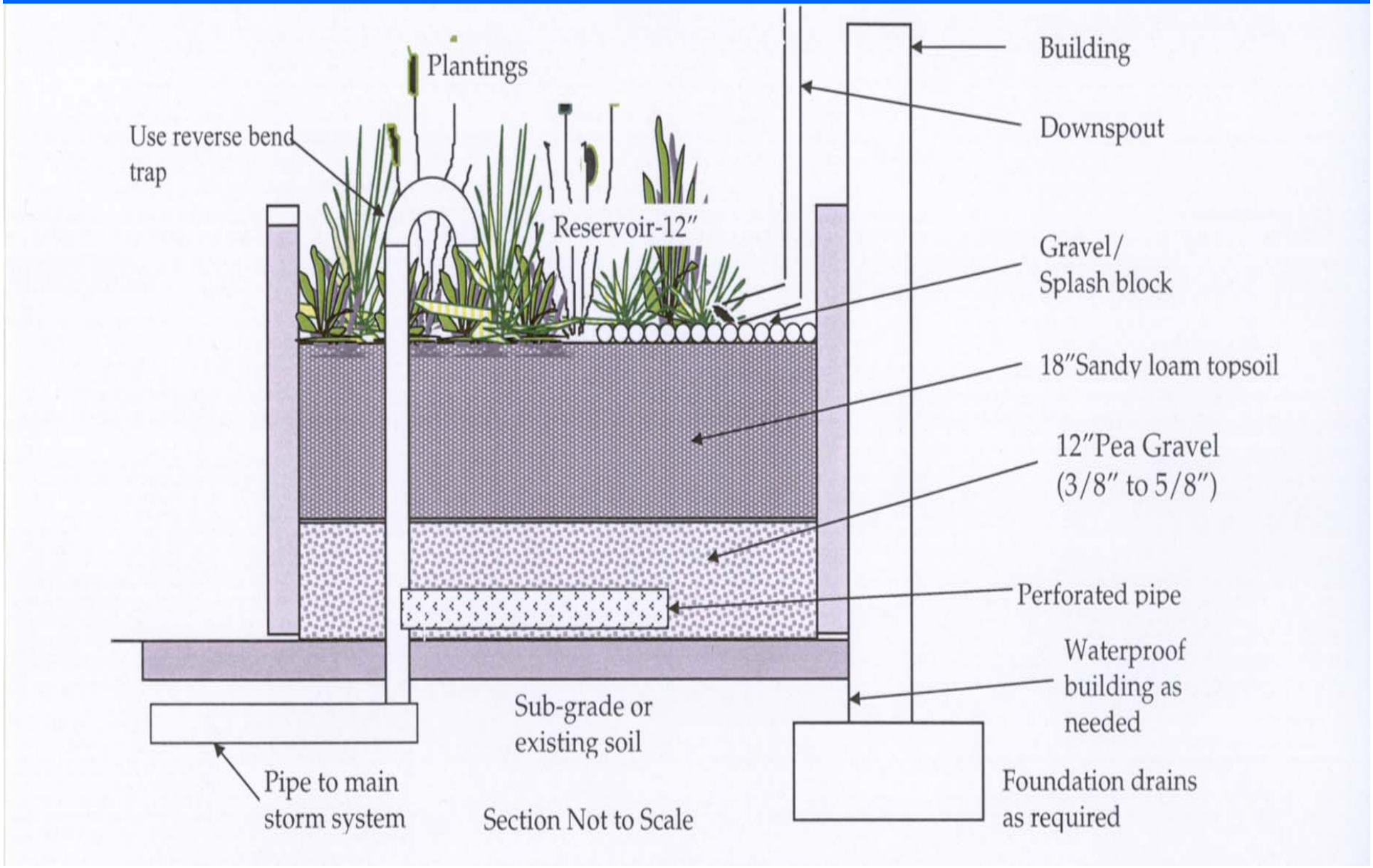

Rain Garden (Small Lot) - Madison, WI

Rain Garden (Very Small Yard) - Chicago



Rain Garden (Planter Box) – Portland, OR

Stormwater Planters




Rain
Gardens

Commercial Roof Runoff

Willy Street Co-Op, Madison

Salvage Yard Roof – Milwaukee, WI

Partnership for Rain Gardens


Rain Garden
-Farm
Building
Roof Runoff

Rain Garden in a Courtyard – Portland, OR

Parking Lot Runoff

Edgewood College, Madison


Source: City of Portland, OR
Source: City of Portland, OR


M.S. CARRIERS


Lake Delton, Wisconsin

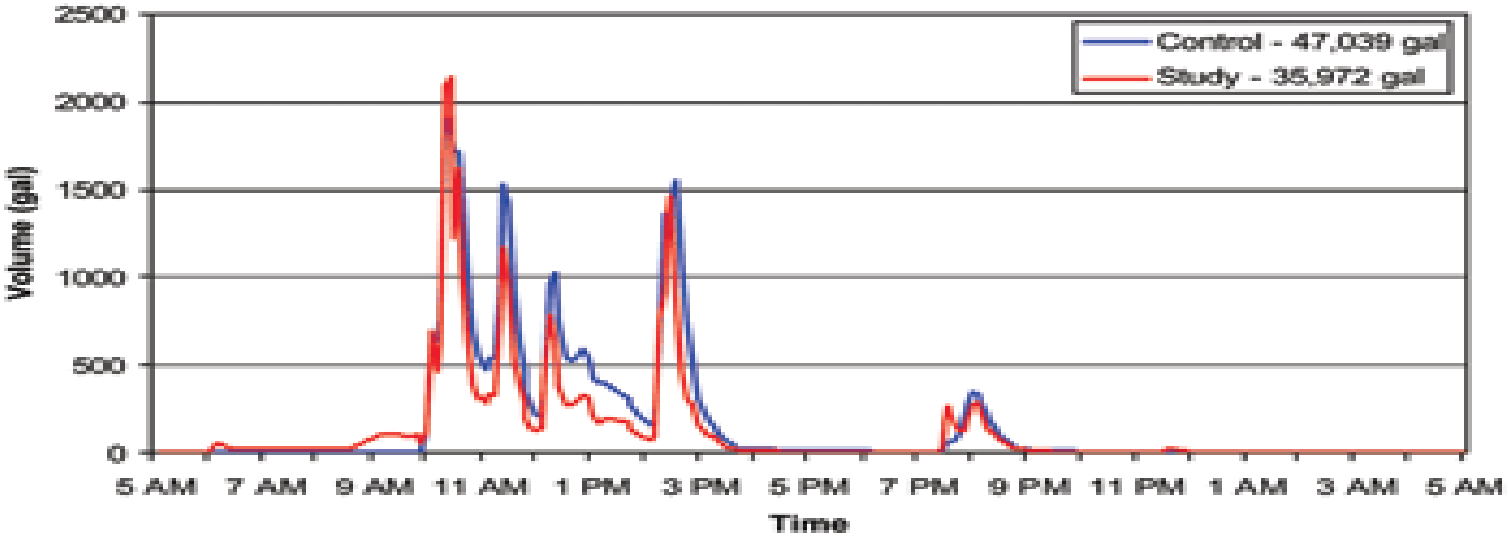

Street Runoff
Maplewood, Minnesota (near St. Paul)
Rain gardens installed by city as part of street replacement project

Linda and Mark Piotrowski
28020 El Dorado Place, Lathrup Village

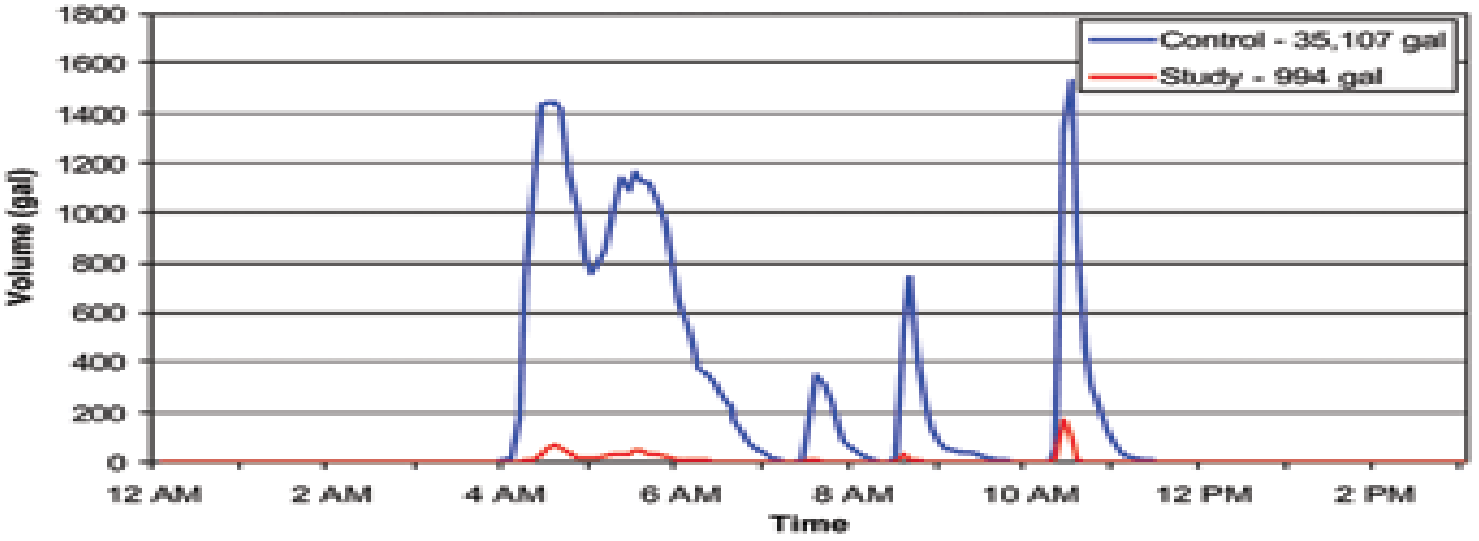
Burnsville, MN

From: Land and Water, Sept/Oct. 2004,

Pre-Construction Runoff Data
June 6, 2003
0.50" Rainfall



Post-Construction Runoff Data
May 29, 2004
0.71" Rainfall

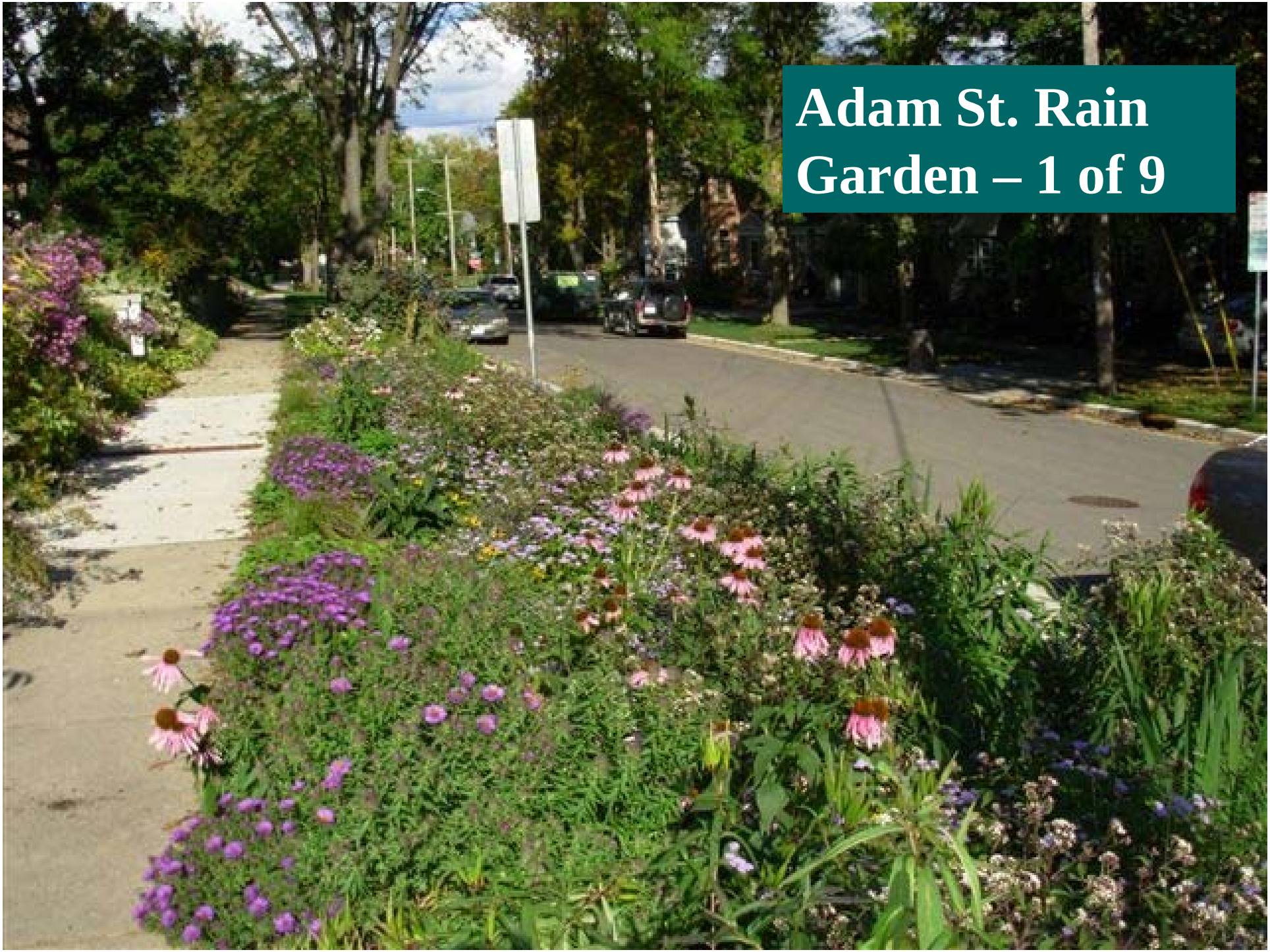


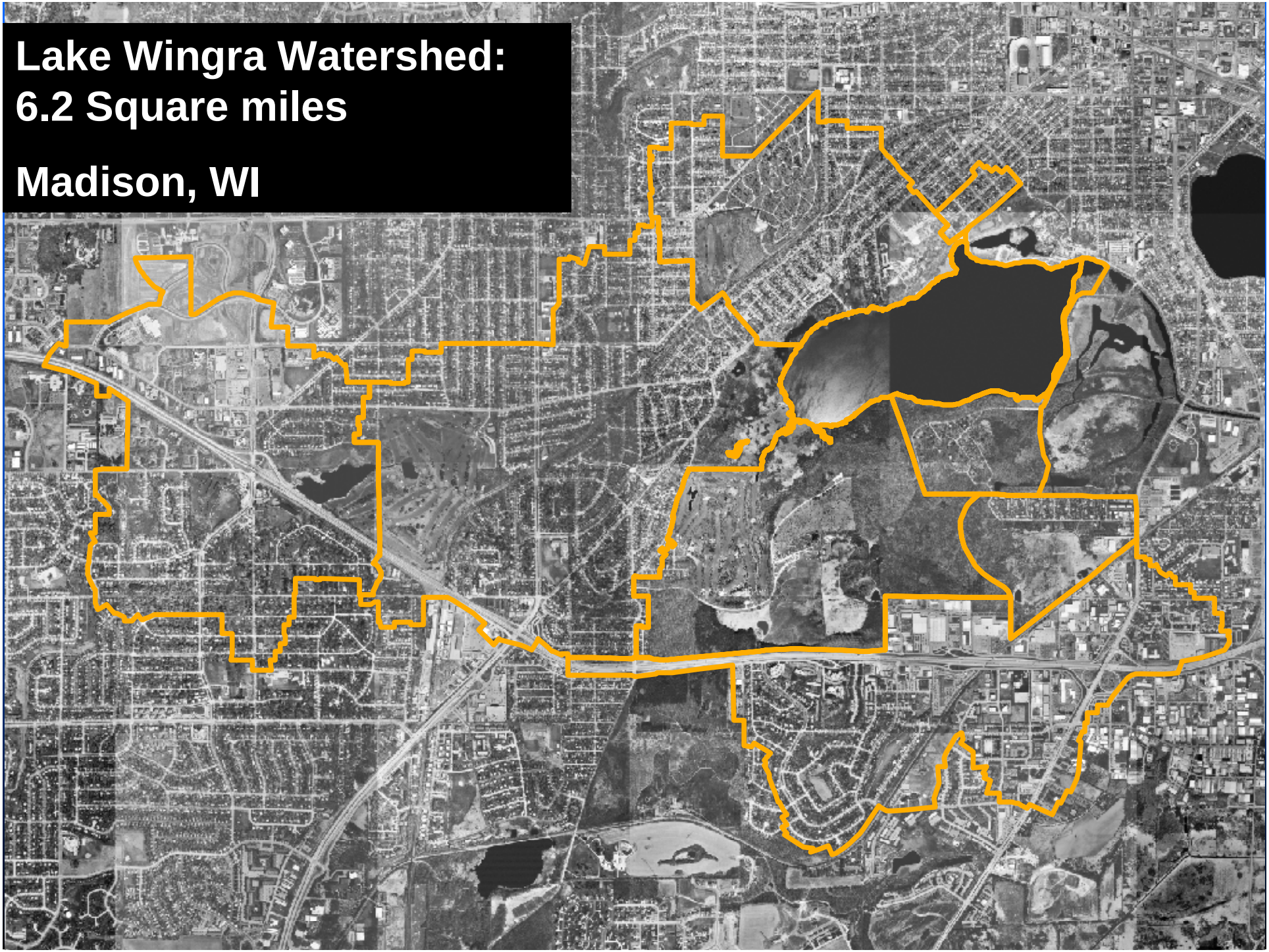

Seattle, WA


Seattle, WA

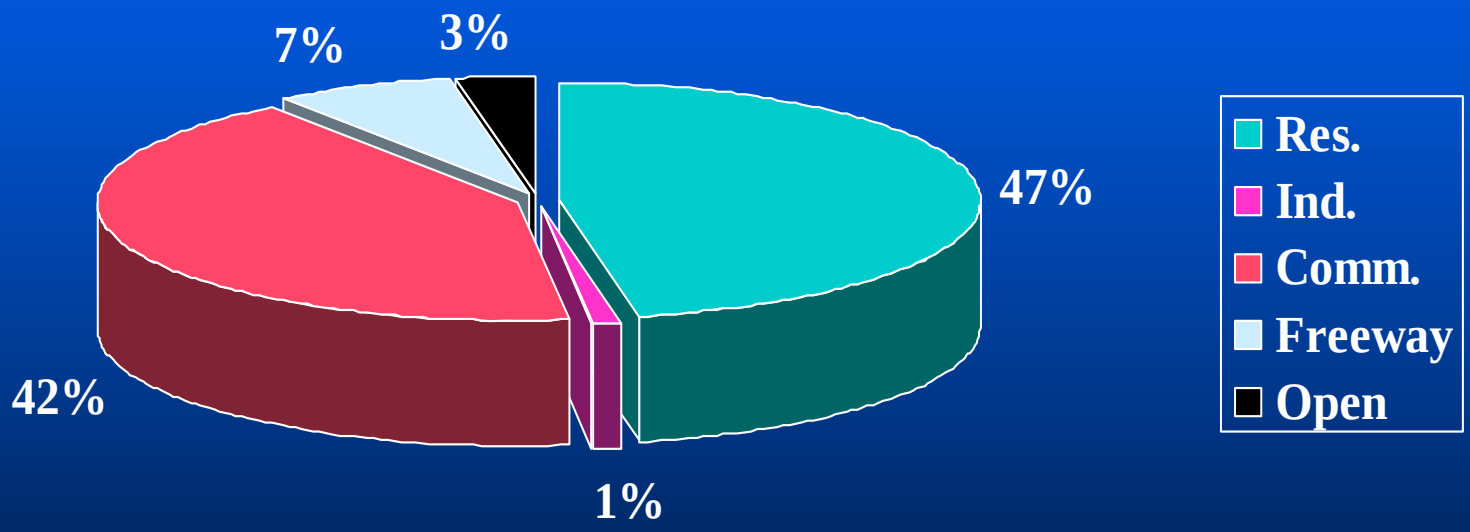

Rain Garden
Street – Adams
St., Madison

Adam St. Inlets to Gardens


Adam St. Rain
Garden – 1 of 9

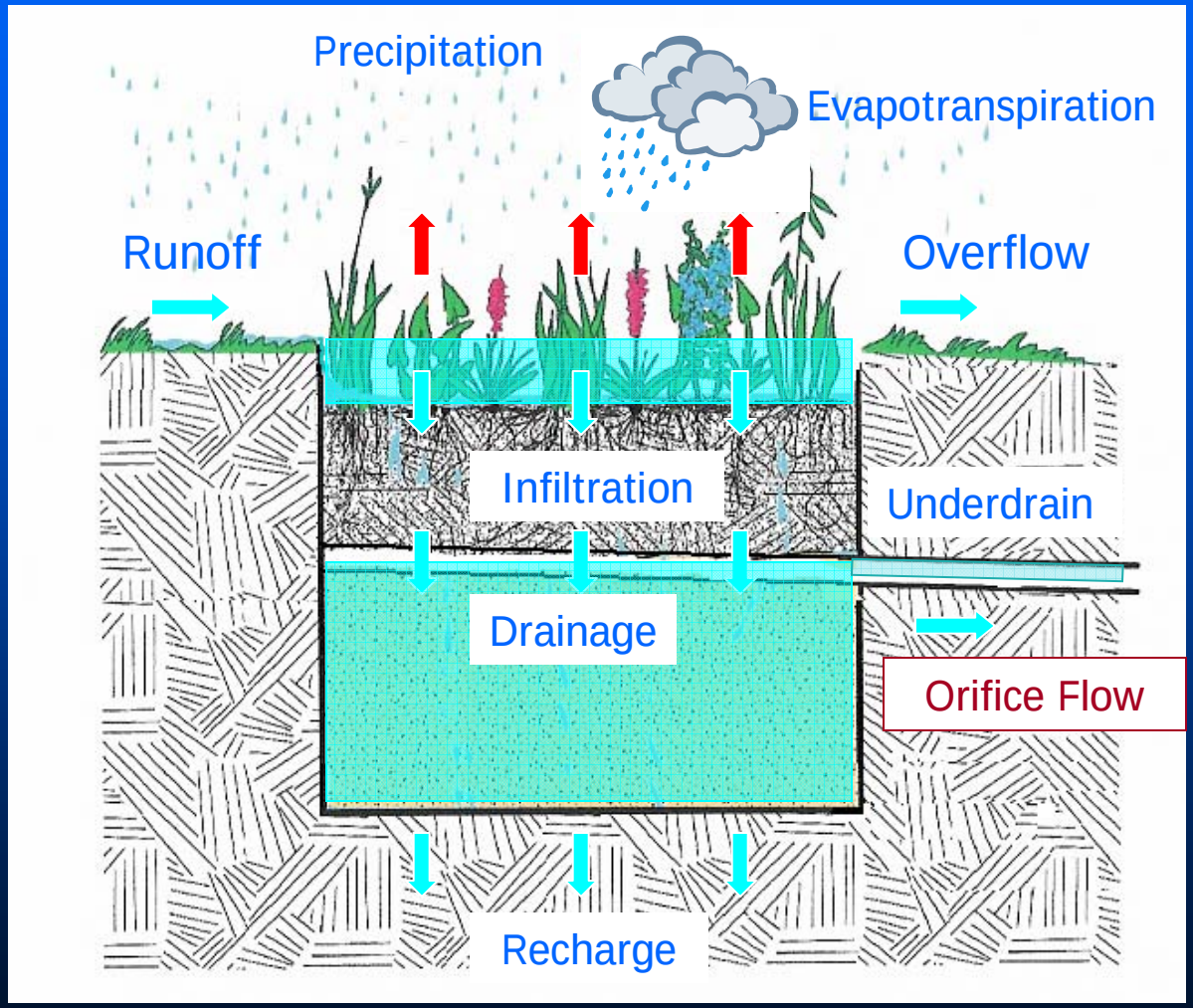

Lake Wingra Watershed:
6.2 Square miles
Madison, WI

% Runoff Volume by Landuse for 4 Subwatersheds




Rain Gardens in Residential Right-of-way = 34%
Reduction in Annual Runoff

How a Rain Garden with an Under Drain Works



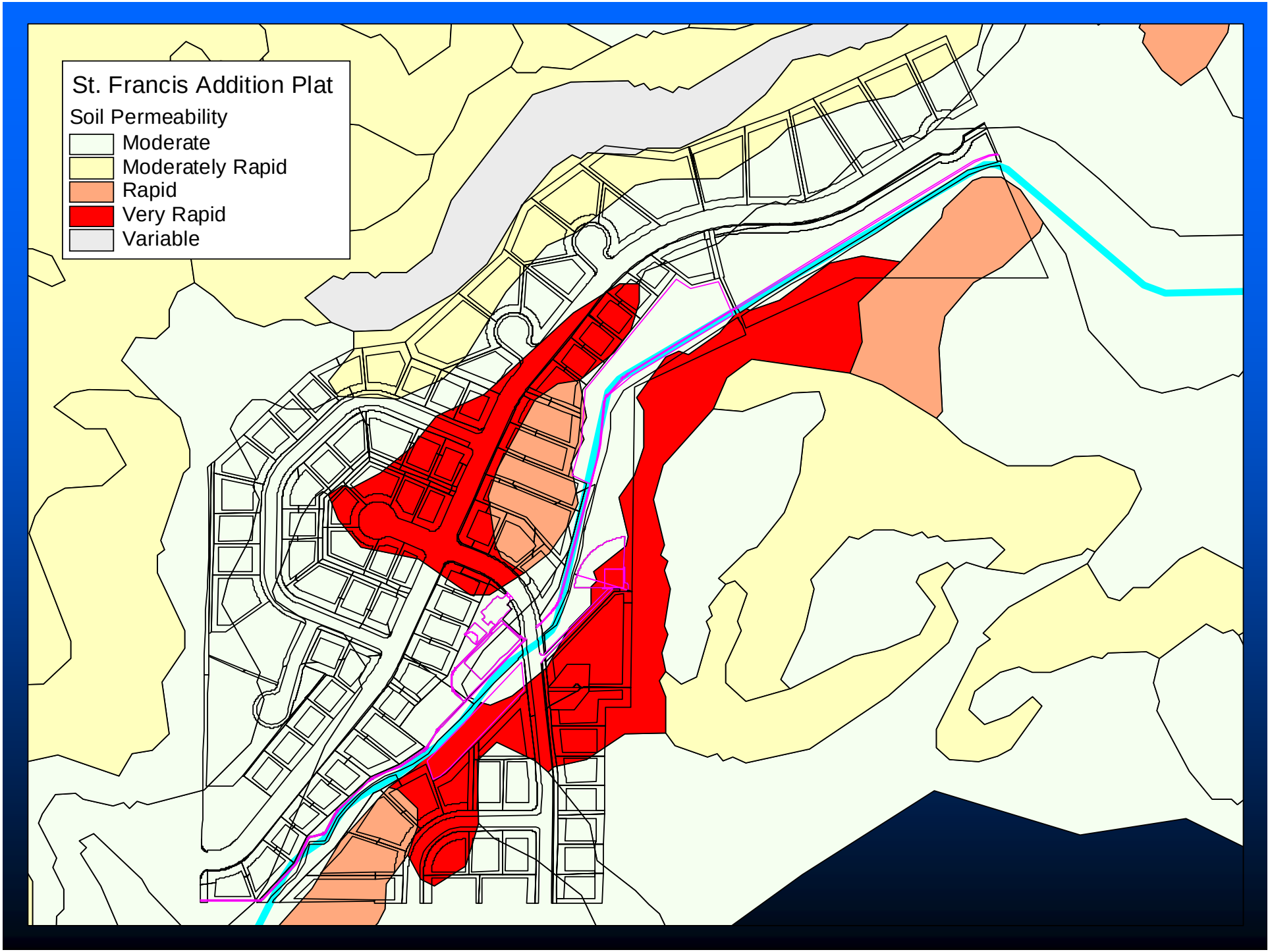
Rain Garden with Under Drain – Lodi, WI; WDOT (John Voorhees)


Cell C

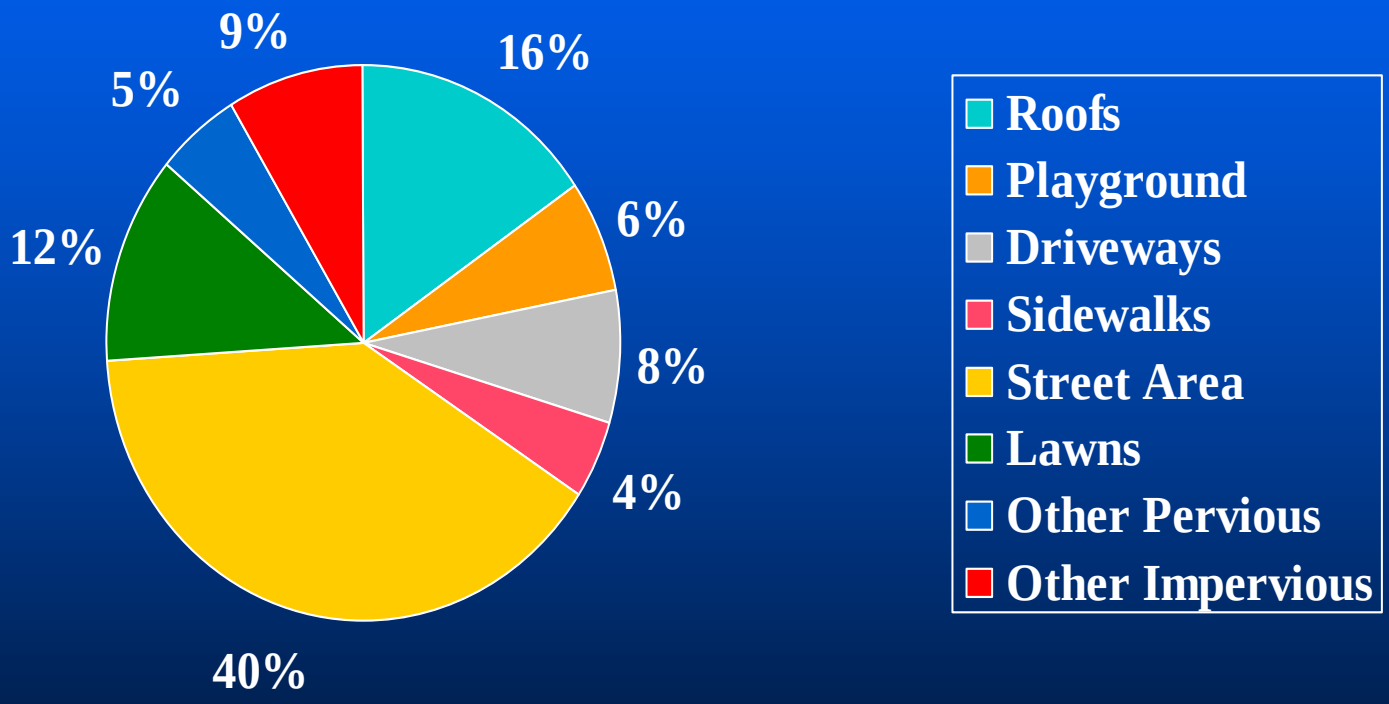
Rain Garden with Under Drain, Maryland


Rain Gardens in Low Impact Development (LID)
Brewery Creek, WI


St Francis
Development –
Cross Plains, WI


St. Francis Addition Plat
Soil Permeability
Moderate
Moderately Rapid
Rapid
Very Rapid
Variable

% Annual Runoff Volume by Source Area for St Francis



Elements of Low Impact Design for St. Francis Development

- Rain Gardens (200 sq. ft. each house)
- Infiltration Trenches in Street Boulevards
- Two Regional Infiltration Basins
- Protection of Riparian Buffer

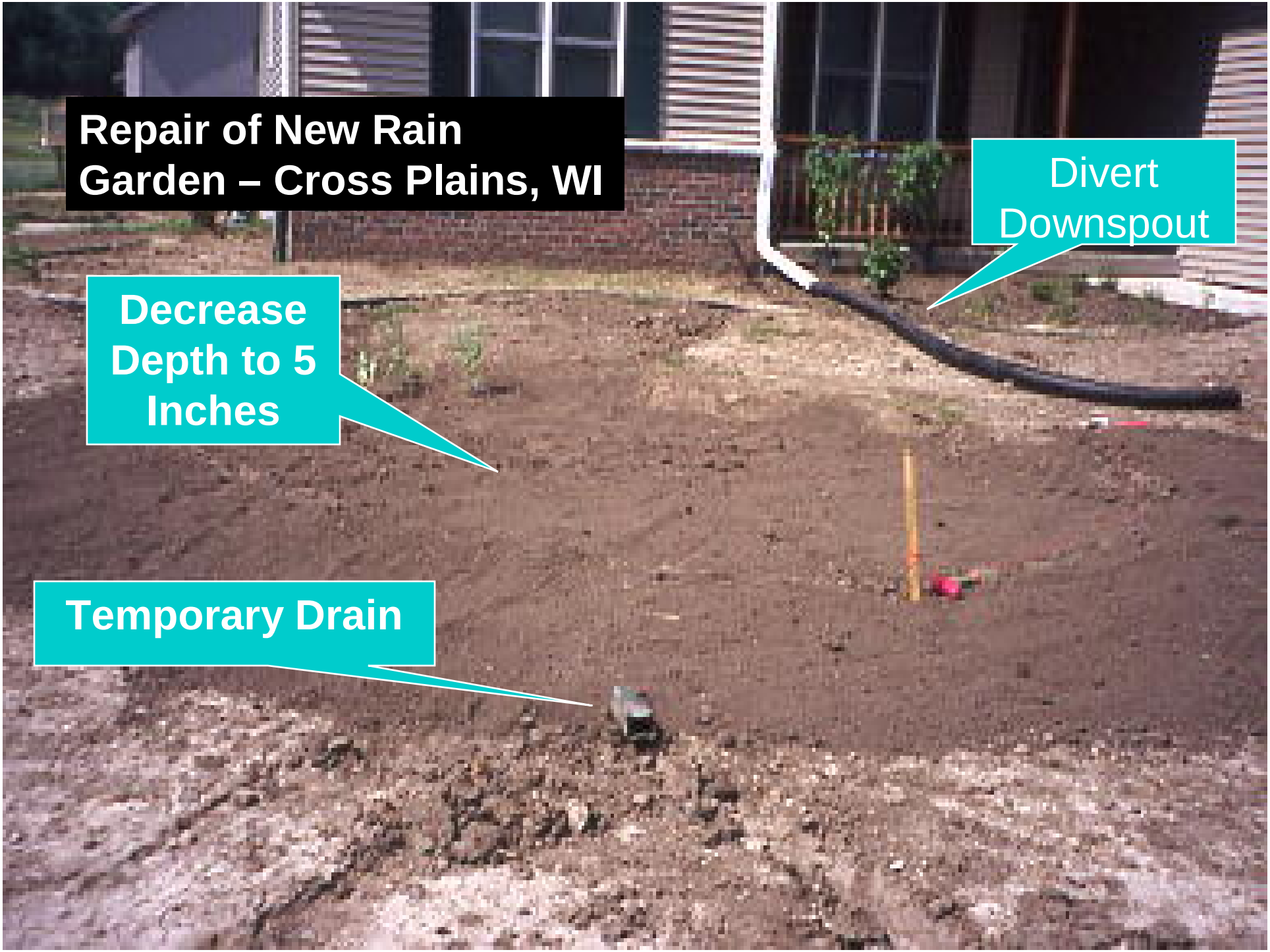
Steve Apfelbaum: Applied Ecological Services

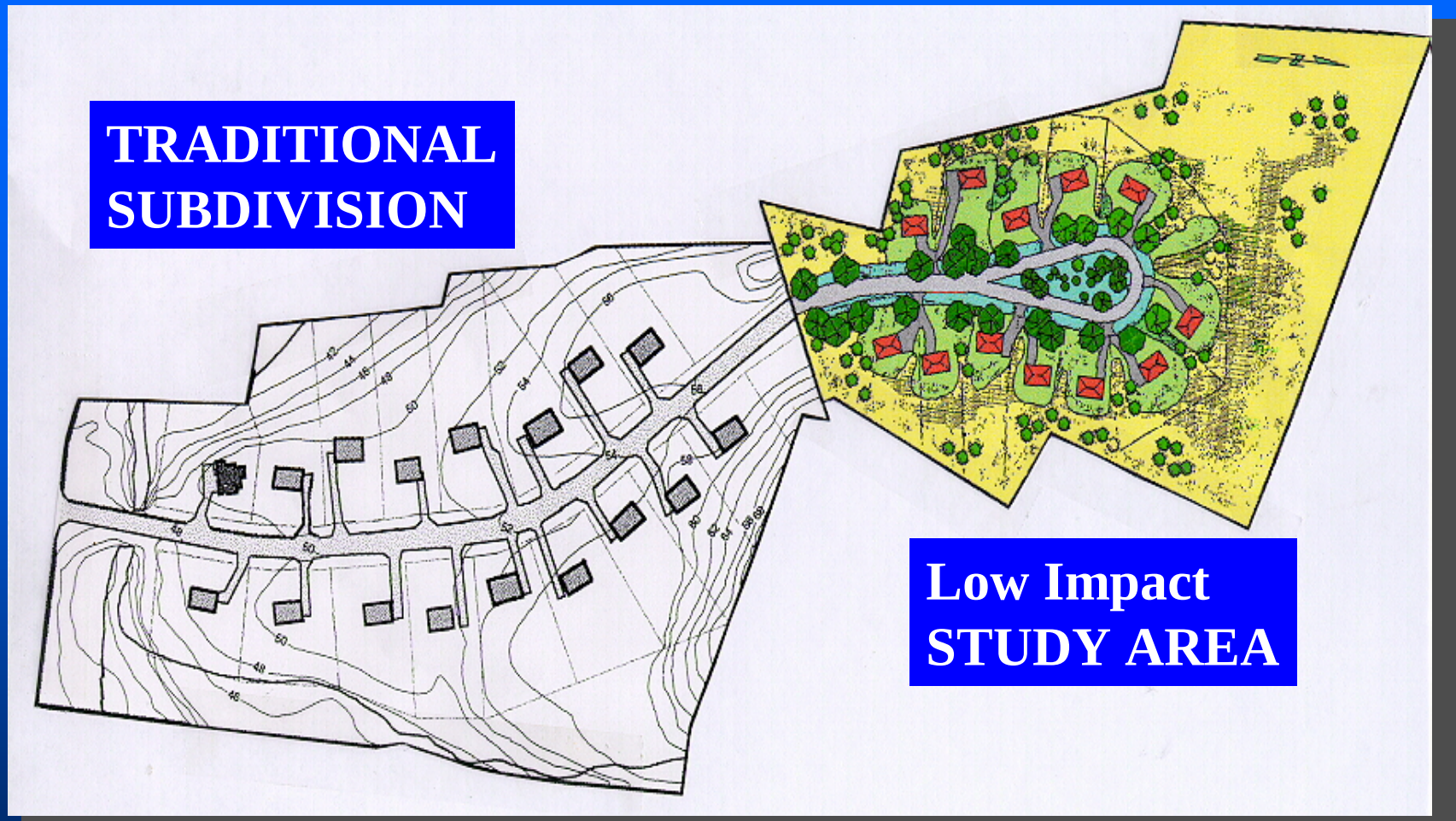
Rain Garden, Cross Plains, WI

Infiltration Trenches, Cross Plains, WI

Infiltration Basin – Cross Plains, WI


New Rain Garden – Cross Plains, WI


Repair of New Rain Garden – Cross Plains, WI
Divert Downspout
Decrease Depth to 5 Inches
Temporary Drain



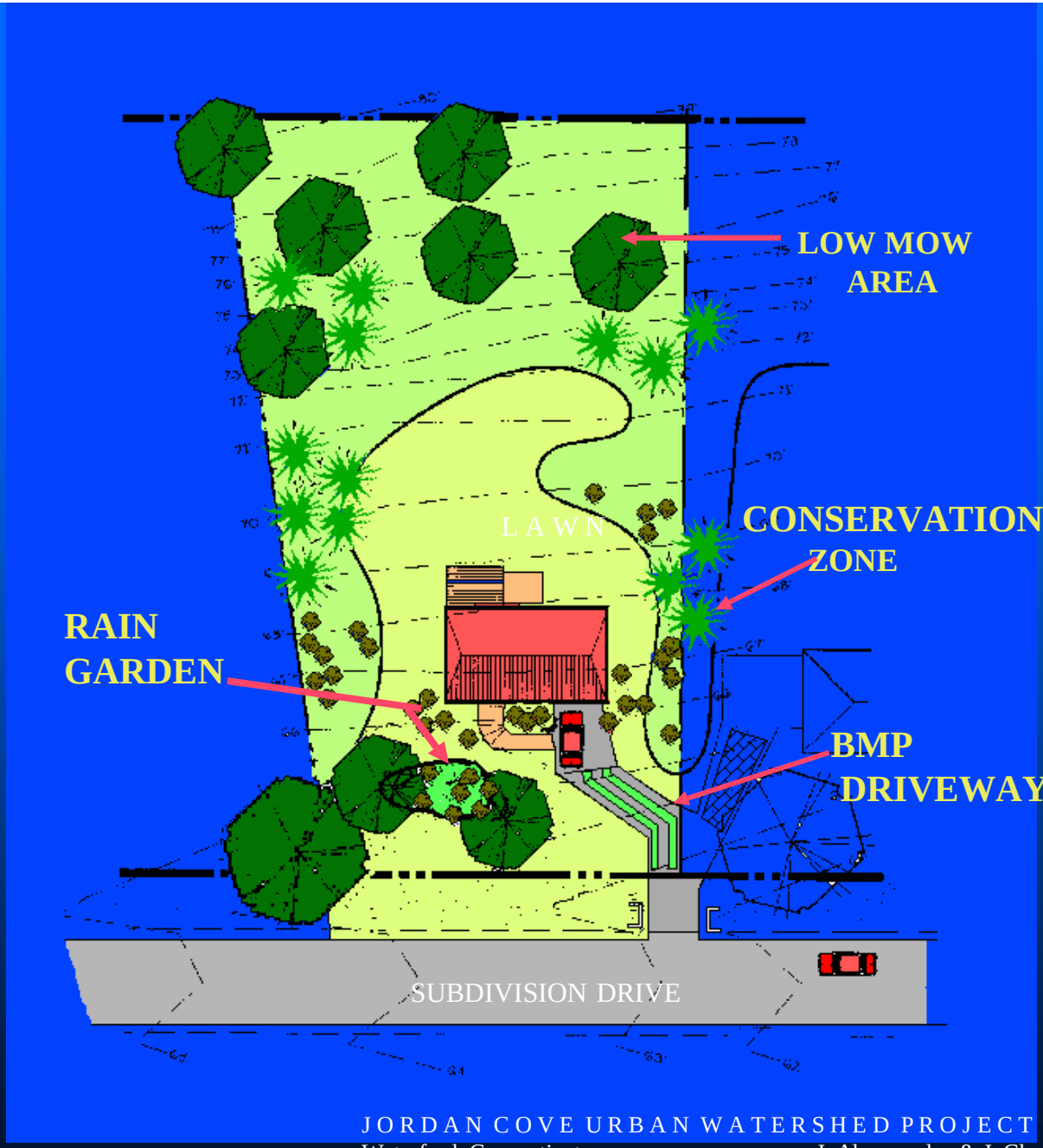
JORDAN COVE URBAN WATERSHED PROJECT

Waterford, Connecticut

J. Alexopoulos & J. Clausen

This project is funded in part by the CT DEP through the US EPA
Nonpoint Source grant under § 319 of the Clean Water Act

TYPICAL HOME LOT



BMP STUDY AREA

JORDAN COVE URBAN WATERSHED PROJECT
Waterford, Connecticut

J. Alexopoulos & J. Clausen
D. Gerwick, Engineering

This project is funded in part by the CT DEP through the US EPA Nonpoint Source grant under § 319 of the Clean Water Act

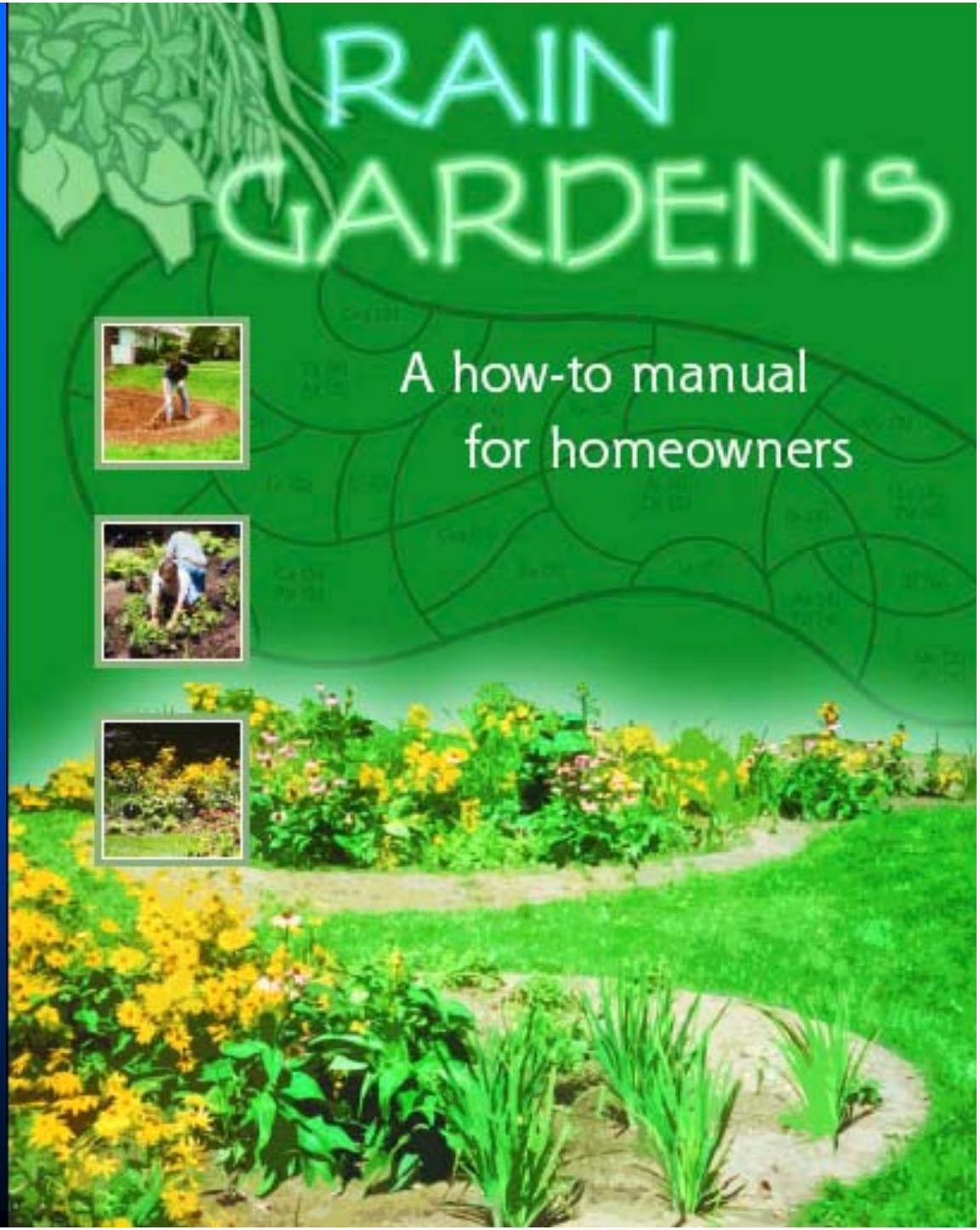

Wild Ones
RAIN GARDEN
PROJECT
SAT. 6/23/01
9:00 am - NOON
Everyone is welcome!


Sue Ellingson
1922


Call Diggers Hotline
1-800-242-8511

Rain Garden Manual on WDNR Web Site

http://www.dnr.state.wi.us/org/water/wm/nps/rg/index.htm



Using Size Factor and Depth to Determine Final Rain Garden Size with 100% Control

Type of Soil	3 to 5 Inches Deep	6 to 7 Inches Deep	8 Inches Deep
Sandy	0.19	0.15	0.08
Silty	0.34	0.25	0.16
Clayey	0.43	0.32	0.20

Less than 30 feet from downspout

Soil Type	All Depths Between 3 and 8 inches
Sandy	0.03
Silty	0.06
Clayey	0.10

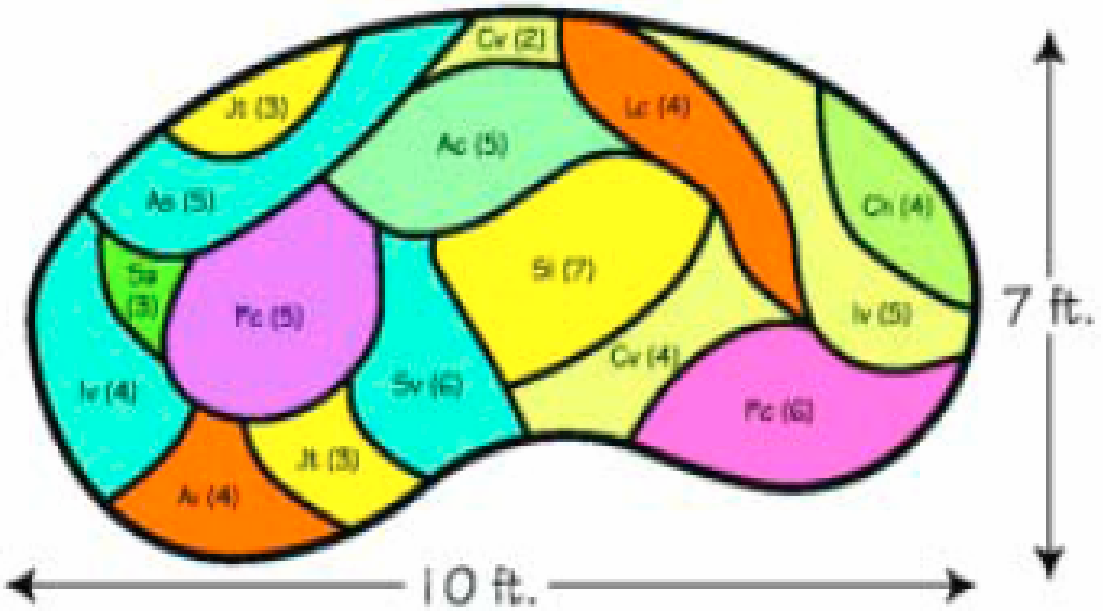
More than 30 feet from downspout

Example 1: 500 sq ft x .25 = 125 sq ft rain garden

Example 2: 500 sq ft x .43 = 215 sq ft rain garden

10 feet wide; full to partial sun with clay soils

Total Area: 70 sq. ft.



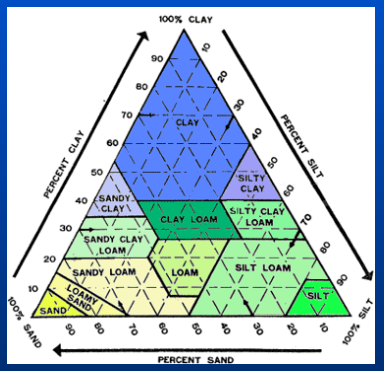
Symbol	Species Name	Common Name	No. of Plants
Ac	Acorus calamus	Sweet flag	5
As	Asclepias incarnata	Swamp milkweed	4
Als	Alisma subcordatum	Water plantain	5
Csh	Carex hystricina	Bottle brush sedge	4
Cxv	Carex vulpinoidea	Fox sedge	6
Iv	Iris virginica-shreveii	Wild blue flag iris	9
Jt	Juncus torreyi	Torrey's rush	6
Lc	Lobelia cardinalis	Cardinal flower	4
Pc	Pontederia cordata	Pickerel weed	11
Sl	Sagittaria latifolia	Arrowhead	7
Sa	Scirpus atrovirens	Green bulrush	3
Sv	Scirpus validus creber	Soft-stemmed bulrush	6
		Total Plants needed	70

USGS
science for a changing world

Long-Term Water Budget of Two Rain Gardens in Madison, WI

Madison Rain Garden Study – Bill Selbig, USGS

- Primary objectives
  - – Evaluate effectiveness of rain gardens at infiltrating storm water with:
    - » Different soils
      - Sand
      - Clay
    - » Different vegetation
      - Turf Grass
      - Native species



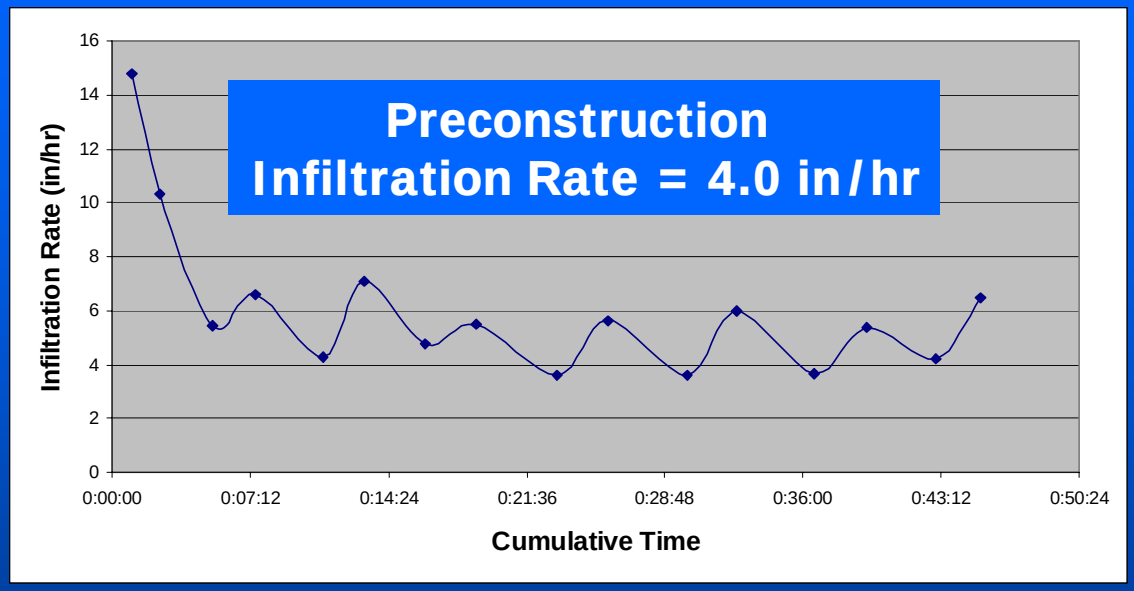
Two Locations Selected

Silt/Clay Soils

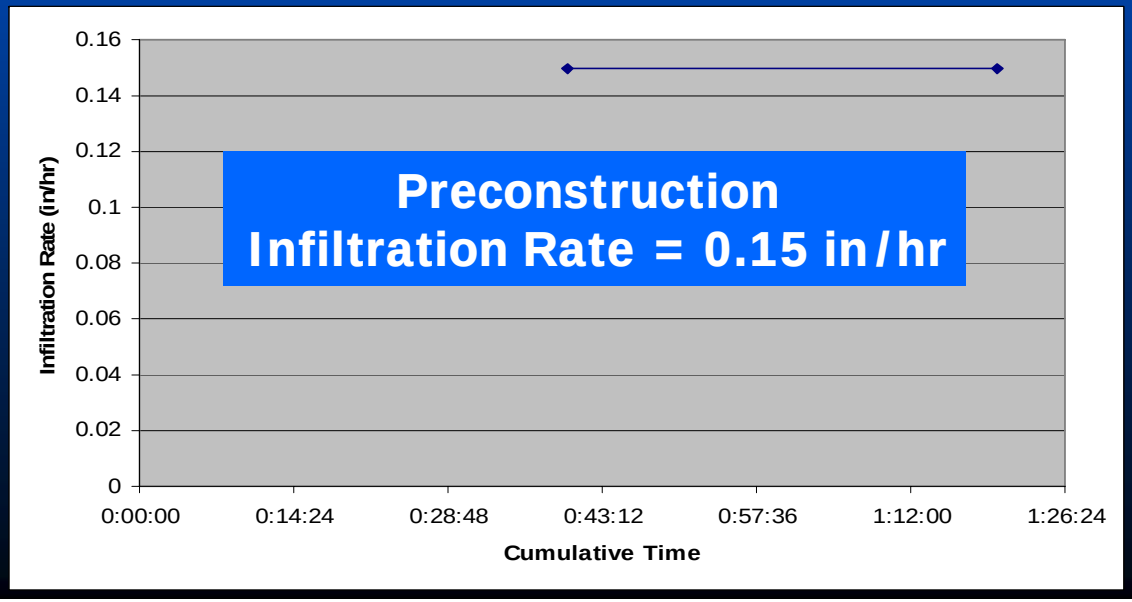
Sandy Soils

Verification of Infiltration Rates

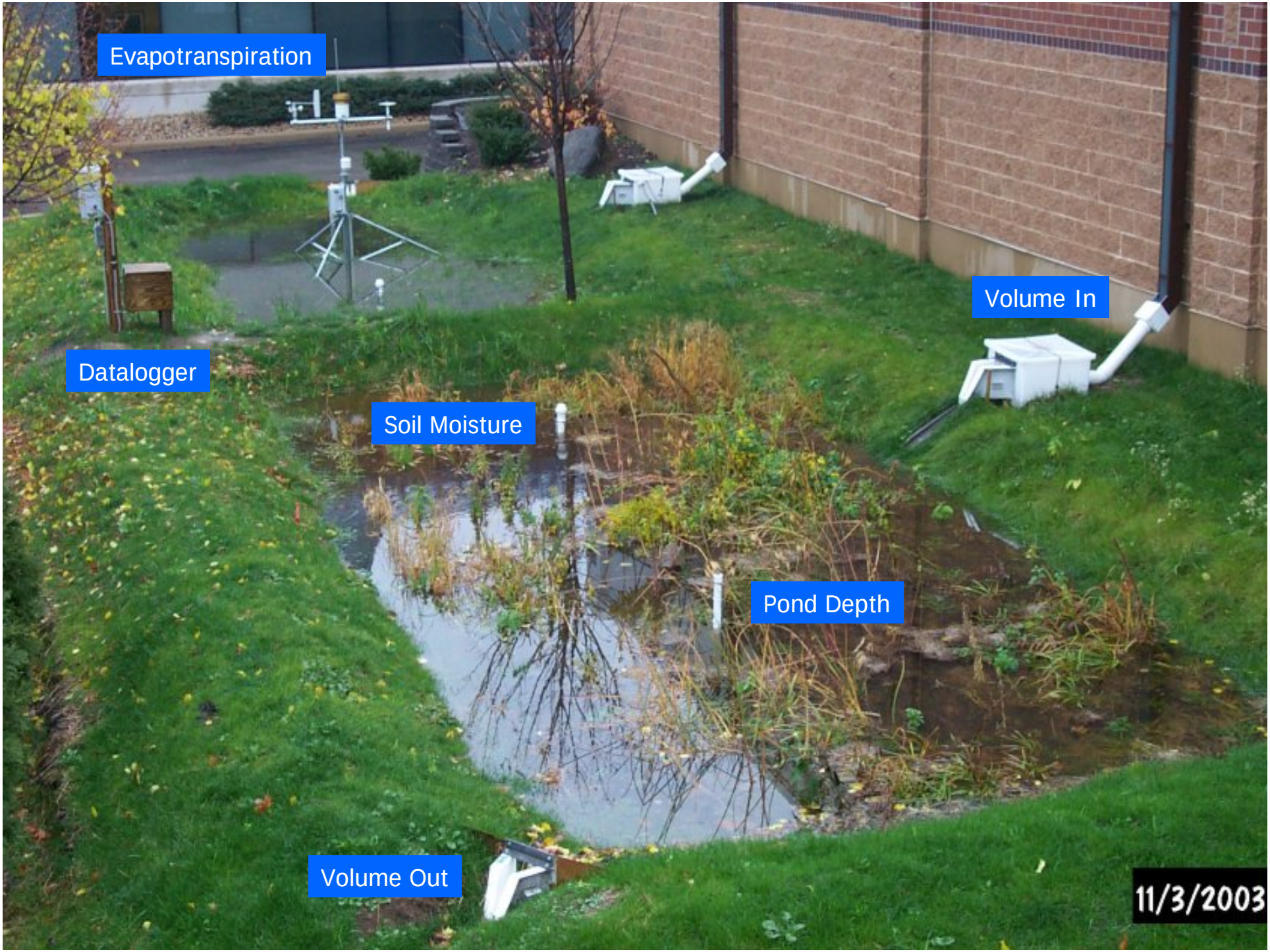
SAND SOILS



CLAY SOILS



Adding Compost


Evapotranspiration
Volume In
Datalogger
Soil Moisture
Pond Depth
Volume Out
11/3/2003

Performance Summary for 2007

Plant Type	Rain Depth	Volume In, Gallons	Volume Out, Gallons	# Events with Ponding	Percent Reduction
Gardens in Clay Soil					
Turf	27.8	46,000	107	19	99%
Native		42,000	0	9	100%
Gardens in Sandy Soil					
Turf	26.4	5,500	0	15	100%
Native			0	11	100%

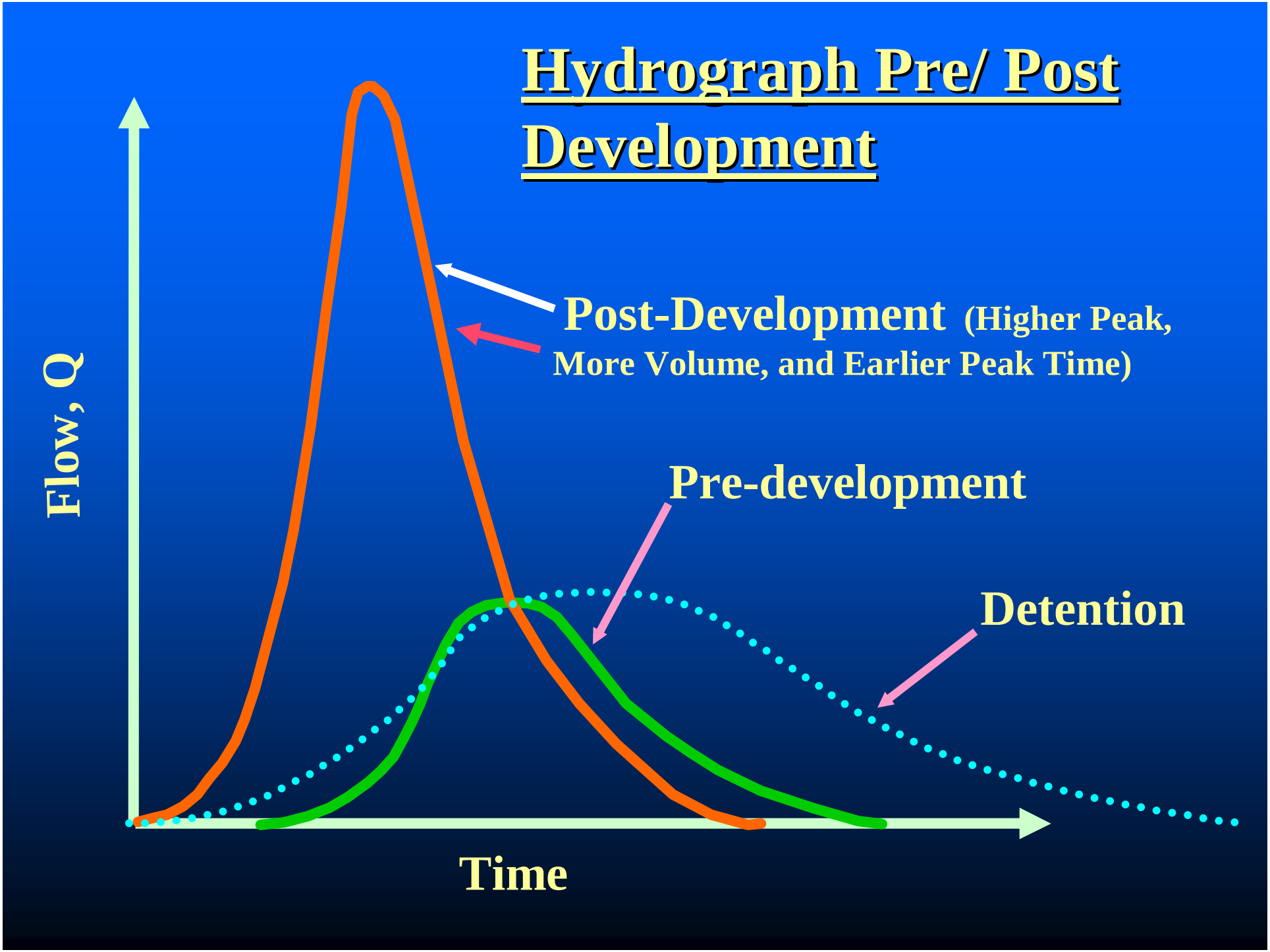
Sources of Rain Garden Information

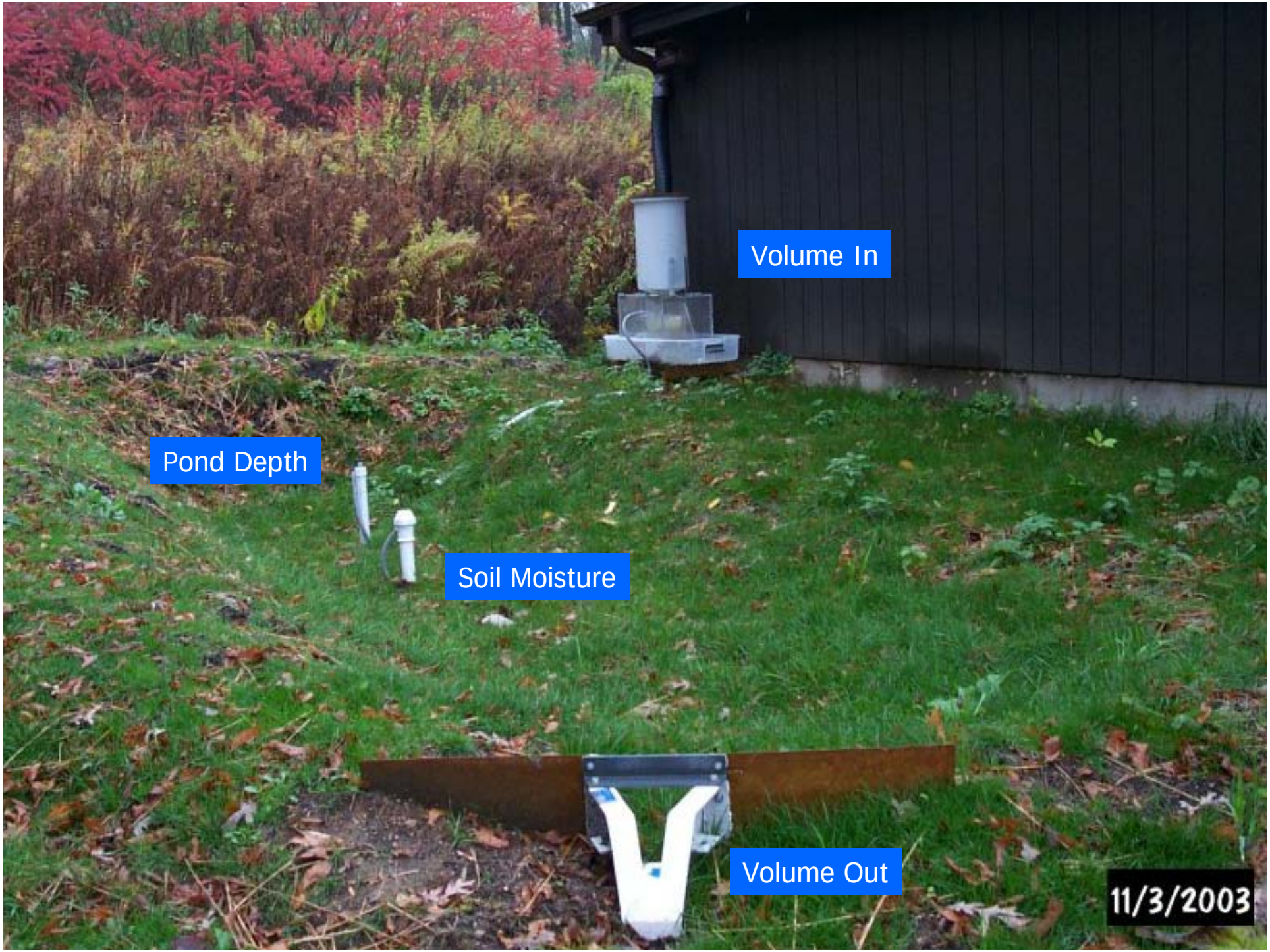
- Many web sites:
  - http://clean-water.uwex.edu/pubs/raingarden/rgmanual.pdf
  - www.appliedeco.com/raingardens.cfm
- Wisconsin's Rain Garden Manual: Google Rain Garden Manual

Too Much Dirty Water

Rain Garden, Madison

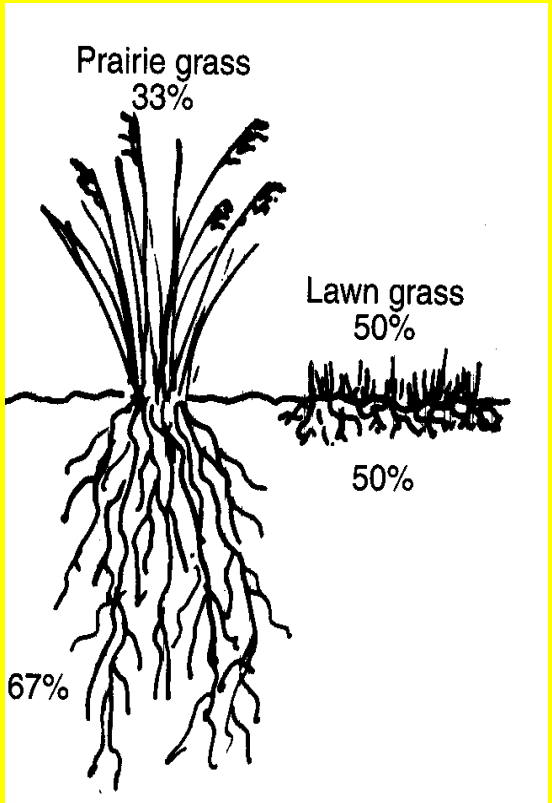

Questions?


Hydrograph Pre/ Post Development
Post-Development (Higher Peak, More Volume, and Earlier Peak Time)
Pre-development
Detention
Flow, Q
Time


Volume In
Pond Depth
Soil Moisture
Volume Out
11/3/2003

Value of Using Native Plants

Amount of plant material
above and below ground



- Deeper roots – absorbs more water
- Uses no fertilizer
- Uses little or no pesticides
- Maintenance similar to other gardens
- Does not require watering in droughts after establishment

Storm Sewer Discharge to Lake Wingra


Cell A

Summary

- All rain gardens have so far performed quite well
  - Sand soil infiltrates faster than clay soil
  - Native vegetation appears to infiltrate better than turf grass
- 5:1 ratio captured nearly 100% of runoff
- Infiltration rates improved after rain gardens constructed
- ET likely more rapid in native rain garden

Why Study Rain Gardens?

Field verify hydrologic models

Few studies documenting performance of rain gardens

- in undisturbed substrate
- under varying native soil conditions or vegetation type