Rain Gardens – Part of the Solution to Storm Water Problems

Prepared by
Roger Bannerman
WDNR


8 22 '95


6 17 '96

Increases in Urban Runoff for Lake Mendota from 2000 to 2020

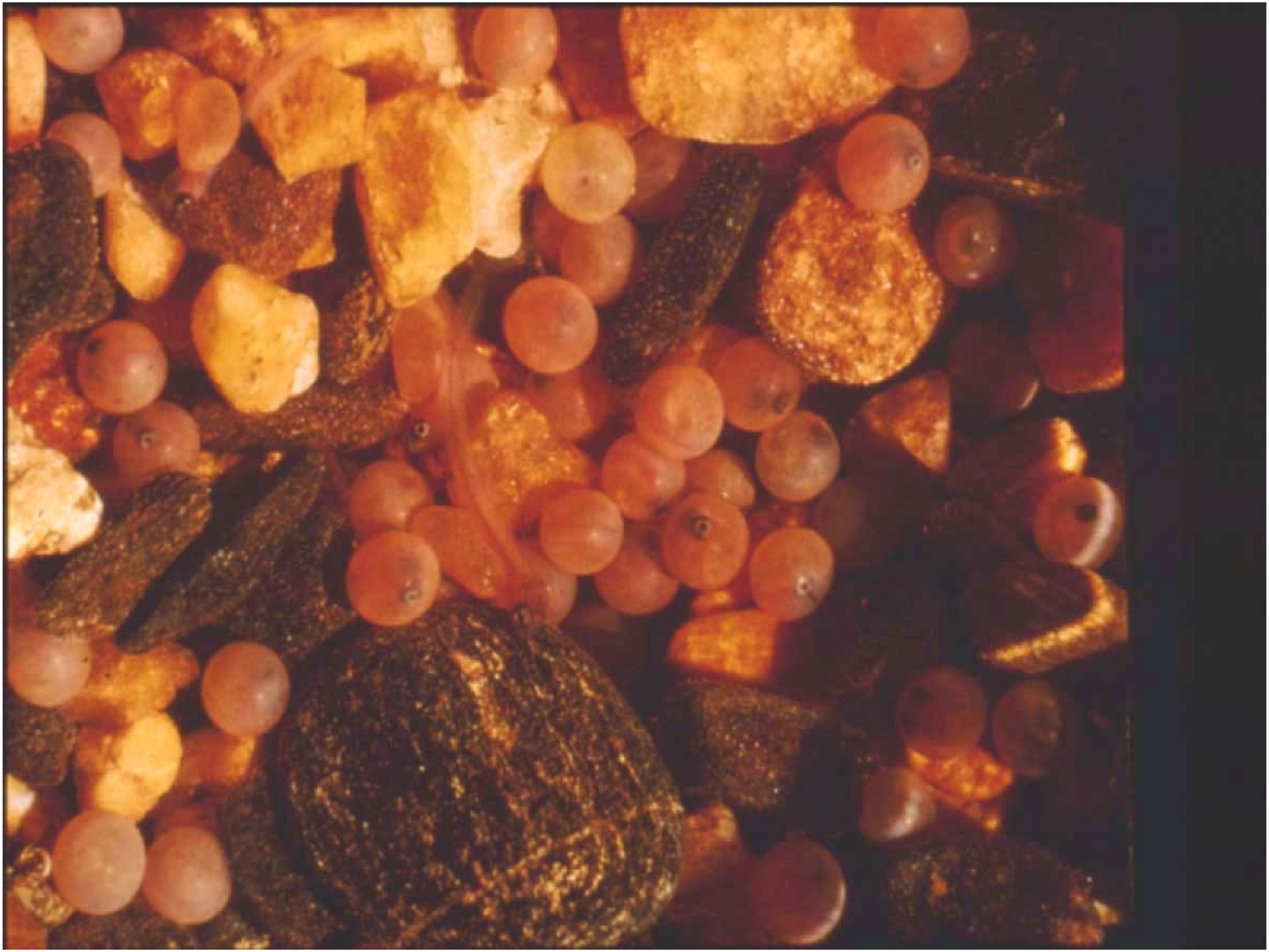
- Amounts of Urban Runoff for 2000:

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

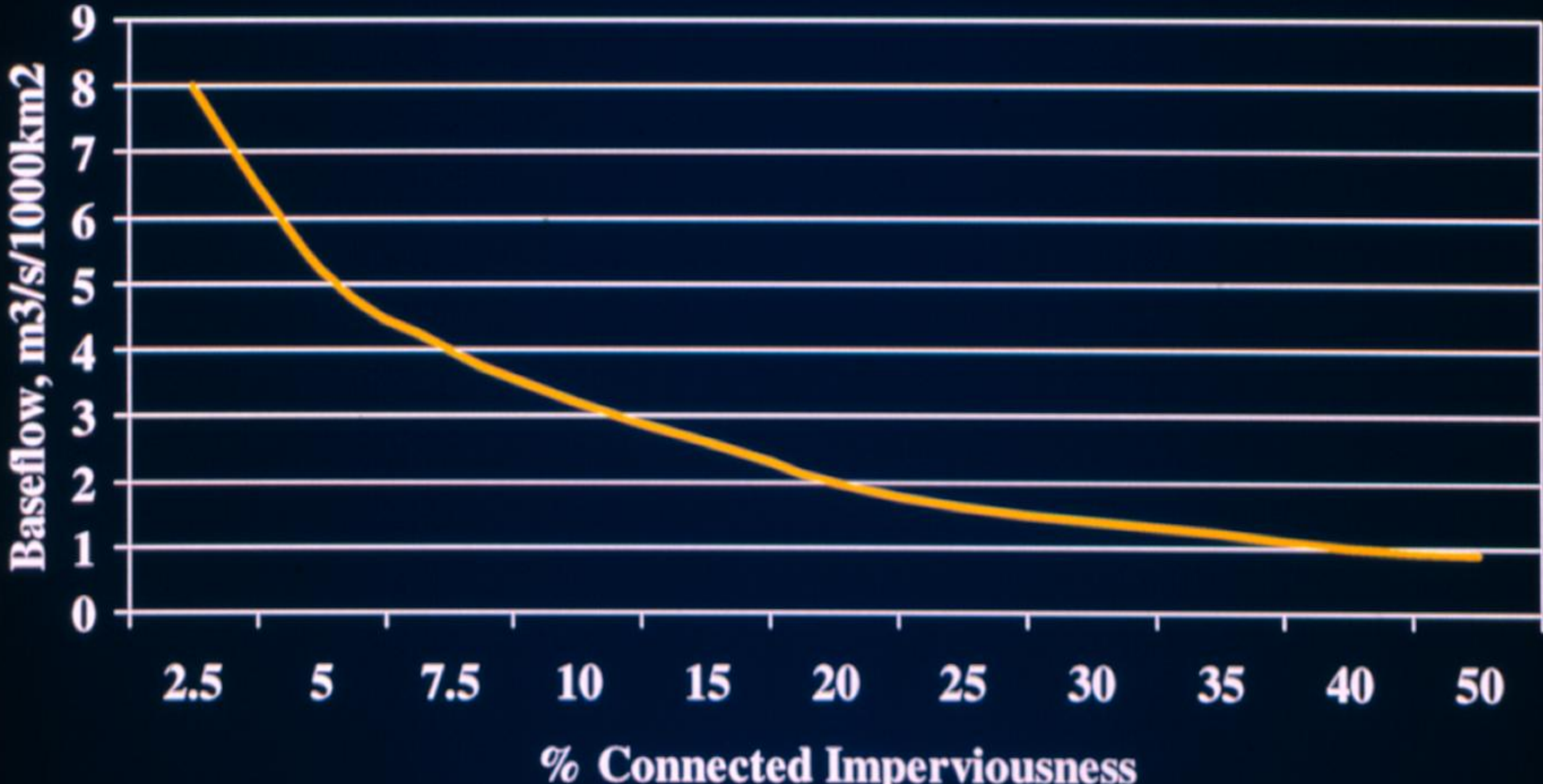
- Amounts of Urban Runoff for 2020:

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

(Increase of 57%)

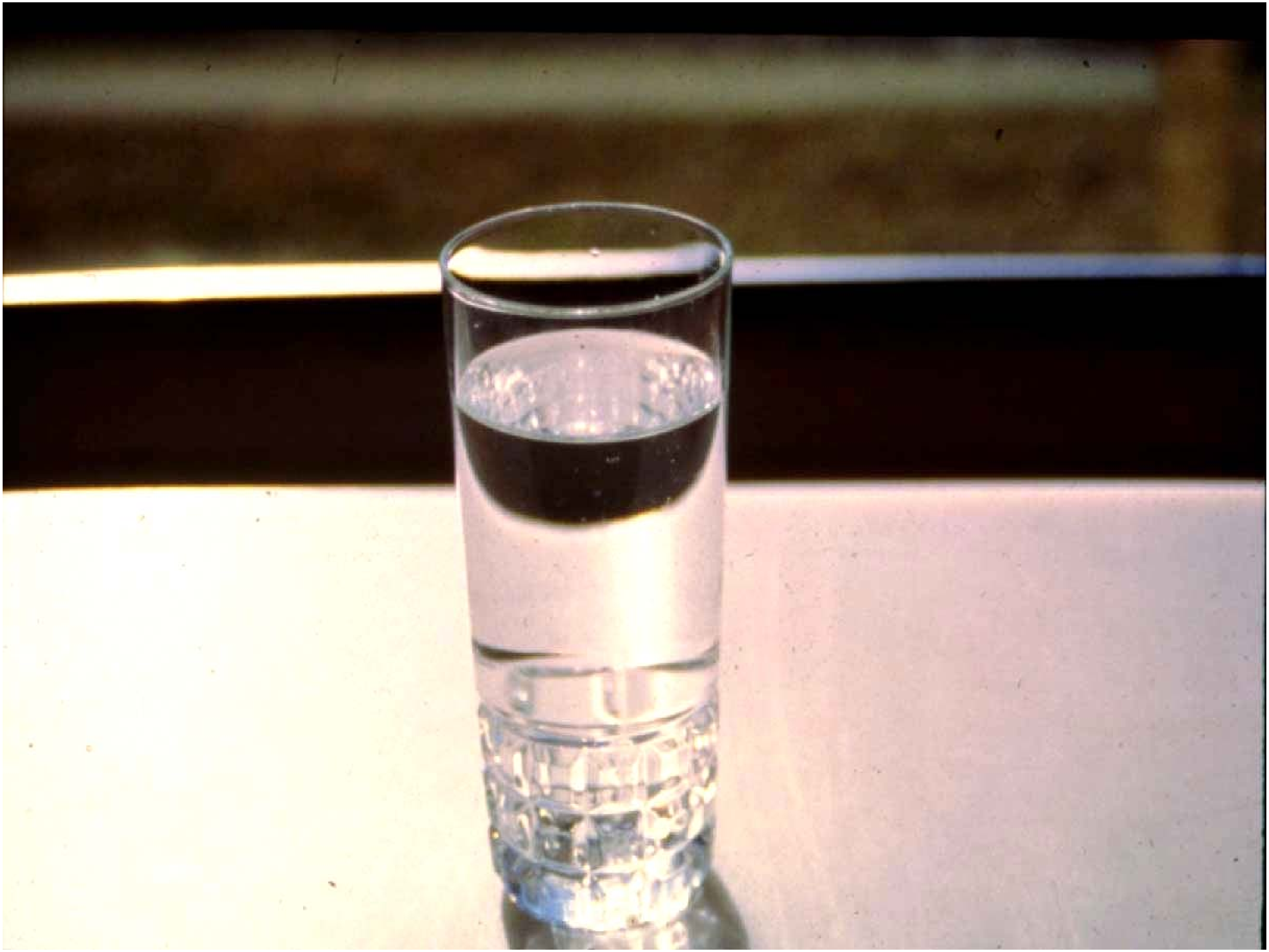


Impacts of Urbanization on Stream Baseflows



Impacts of Imperviousness on Surface and Groundwater Quantities

Type of Resource	Increase Imperviousness From 2 to 18%	Increase Imperviousness From 2 to 60%
Stream Baseflow	-20%	Dry Stream
Surface Runoff	+ 90%	+485%
Regional Groundwater Levels	-10%	-55%



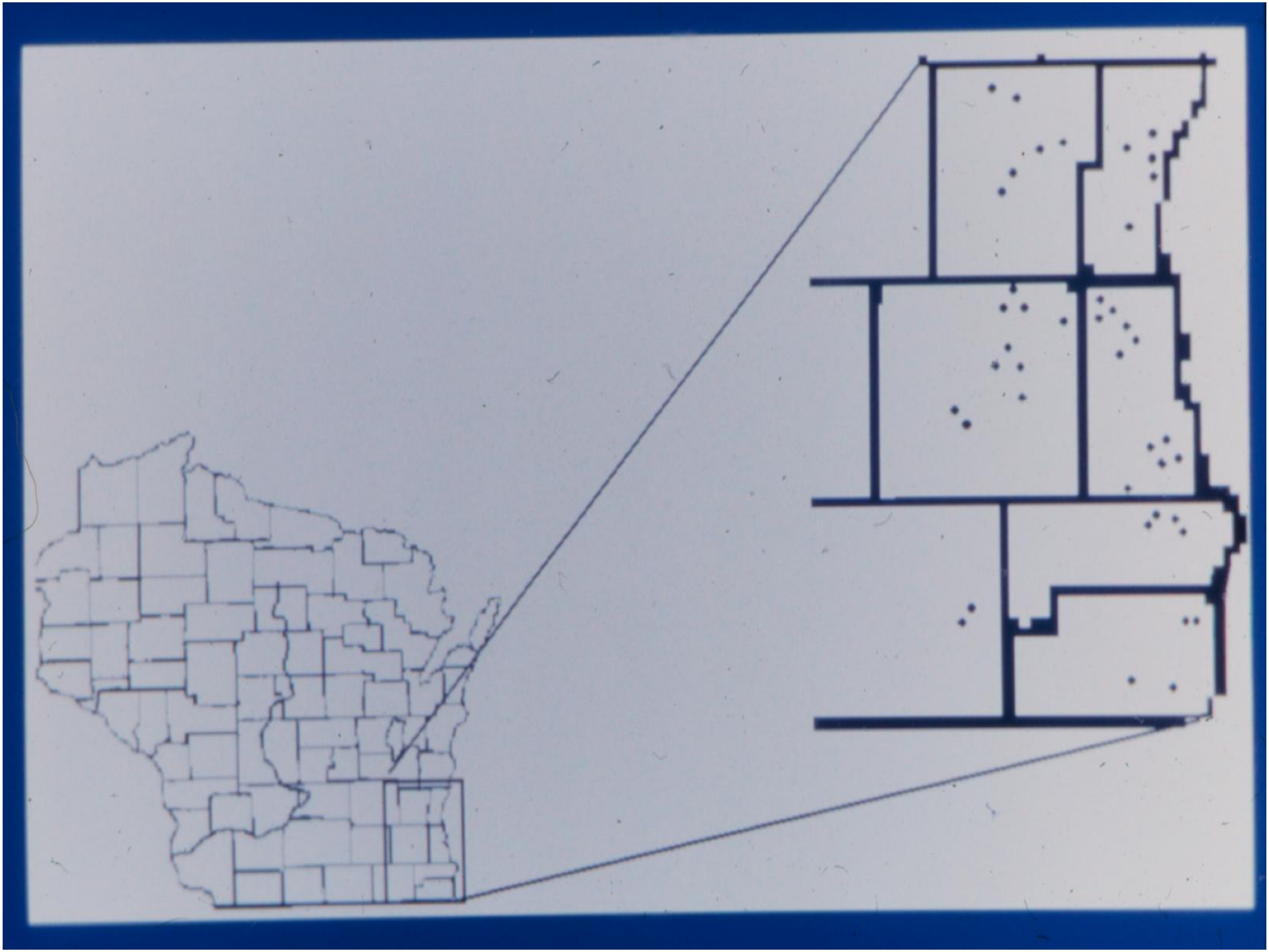
Predicted Temperature Increase

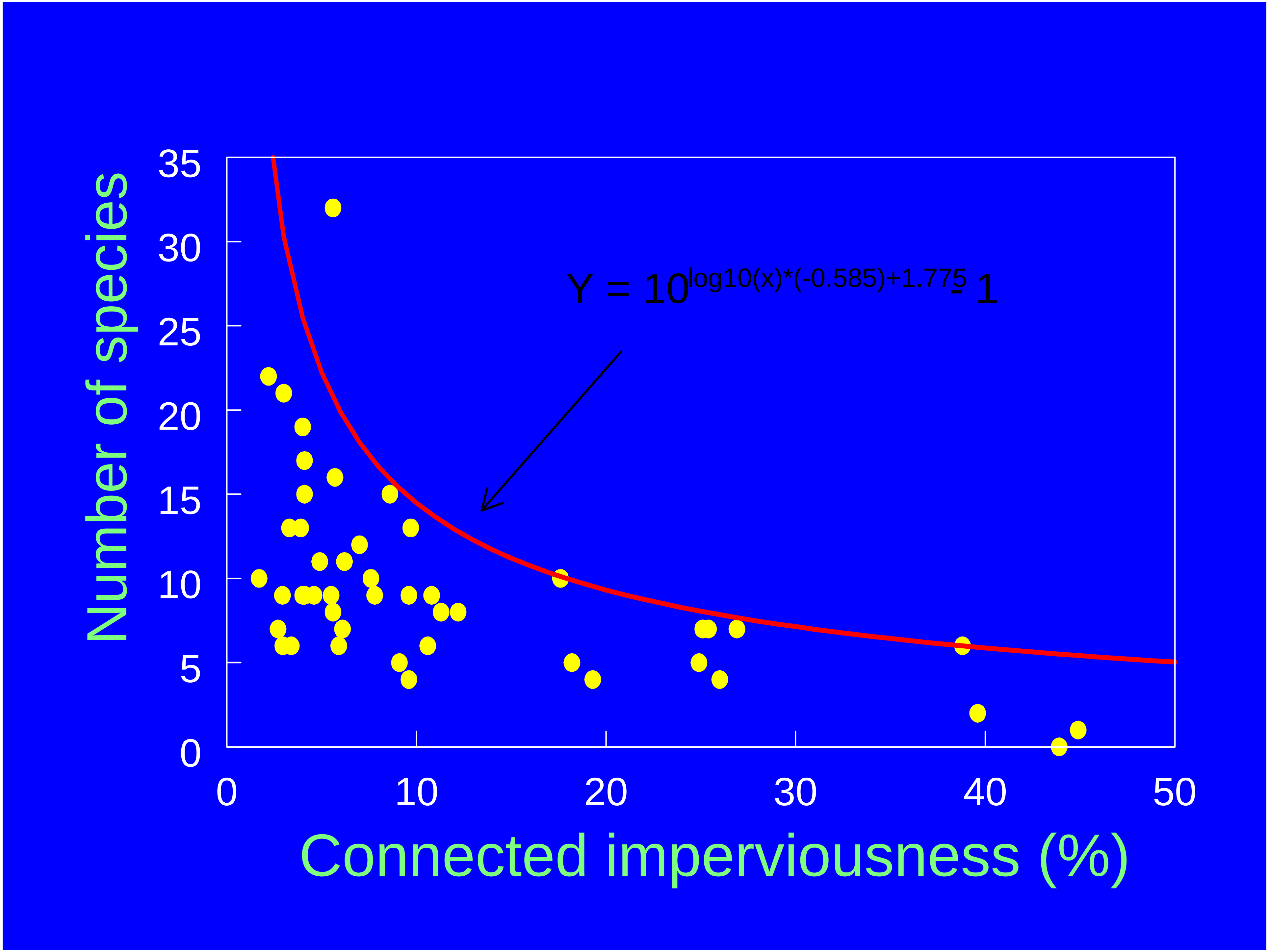
Lowes Creek, Eau Claire

	Mean (°F)	Maximum (°F)
Existing	62	71
Developed (35% Impervious)	67	82

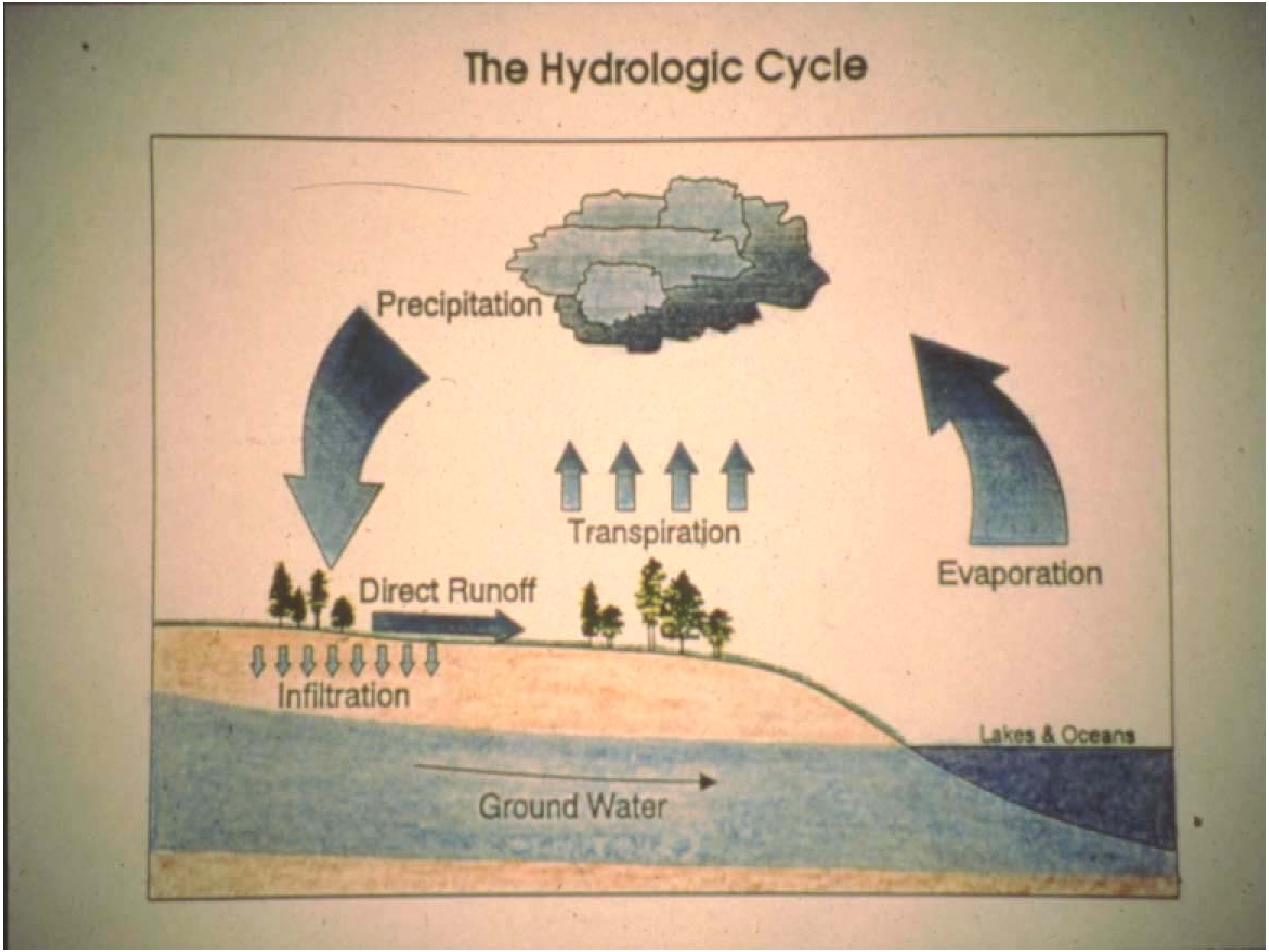
Brown Trout Optimum = 66°F


7-18-77
AH25-007





Number of species
35
30
25
20
15
10
5
0
0
10
20
30
40
50
Connected imperviousness (%)
Y = 10^log10(x)*(-0.585)+1.775 - 1


The Hydrologic Cycle
Precipitation
Transpiration
Evaporation
Direct Runoff
Infiltration
Lakes & Oceans
Ground Water

The Runoff Management Rules

Presentation by the

Wisconsin Department of Natural Resources

Post-Construction Performance Standards - Peak Runoff

- Reduce peak runoff discharge rates, MEP, as compared to pre-development conditions for the 2 – year, 24 hour design storm.

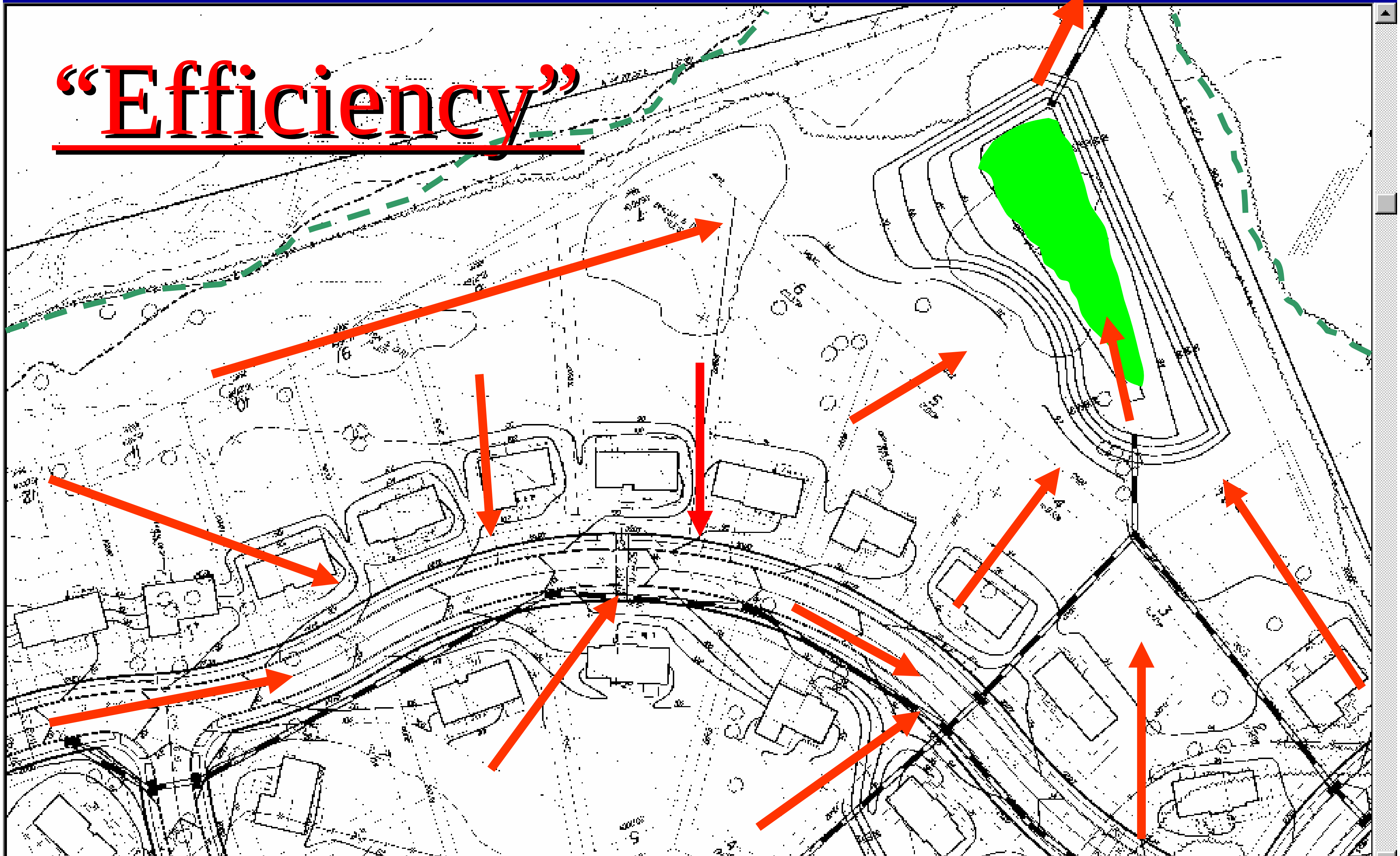
Post Construction Infiltration Performance Standards

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

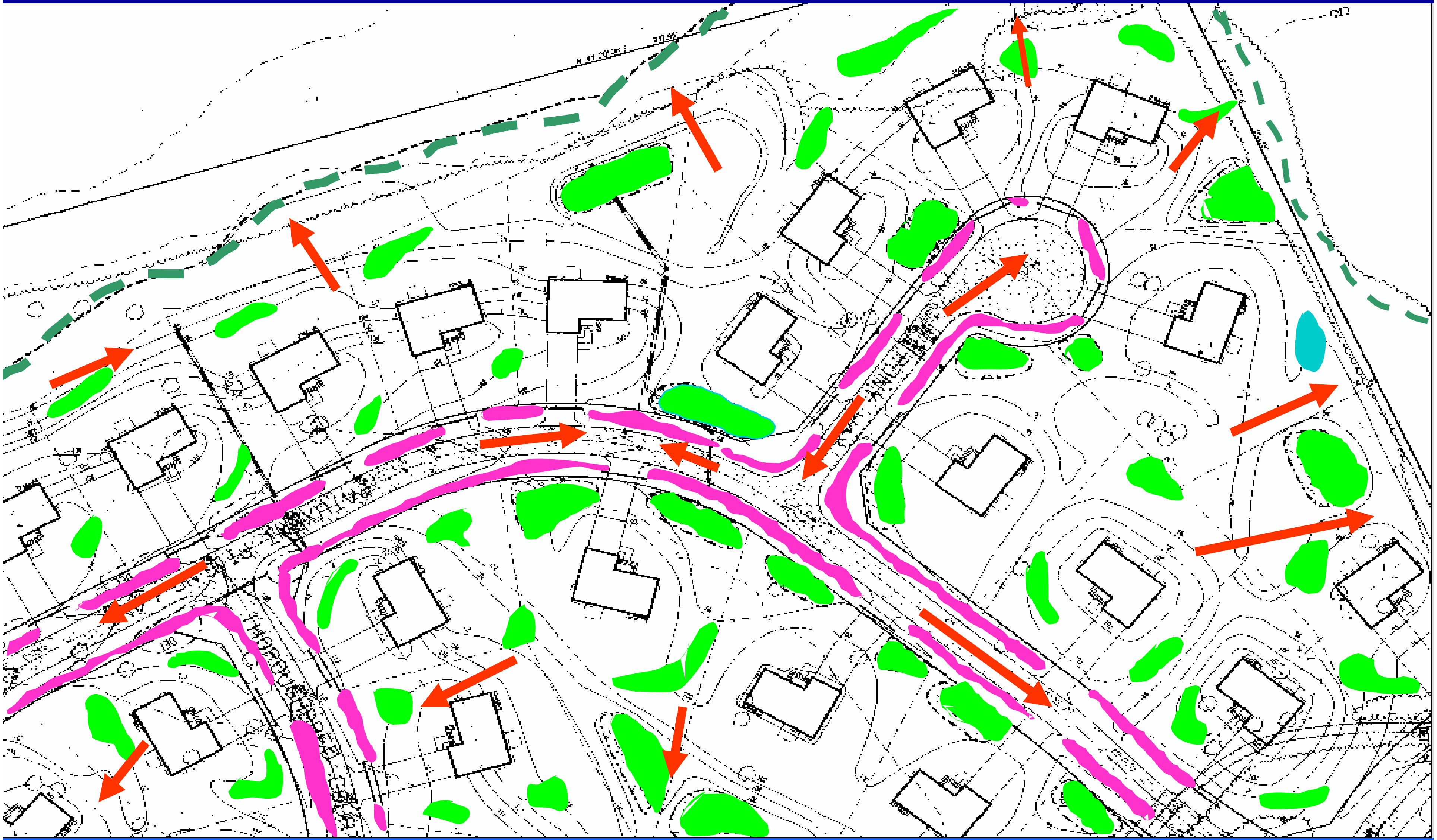
Residential	**Non-residential**
90% (1% Cap)	60% (2% Cap)


The Problem: Conventional Site Design
Collect
Concentrate
Convey
Centralized
Control
Good Drainage Paradigm

Conventional Pipe and Pond Centralized Control

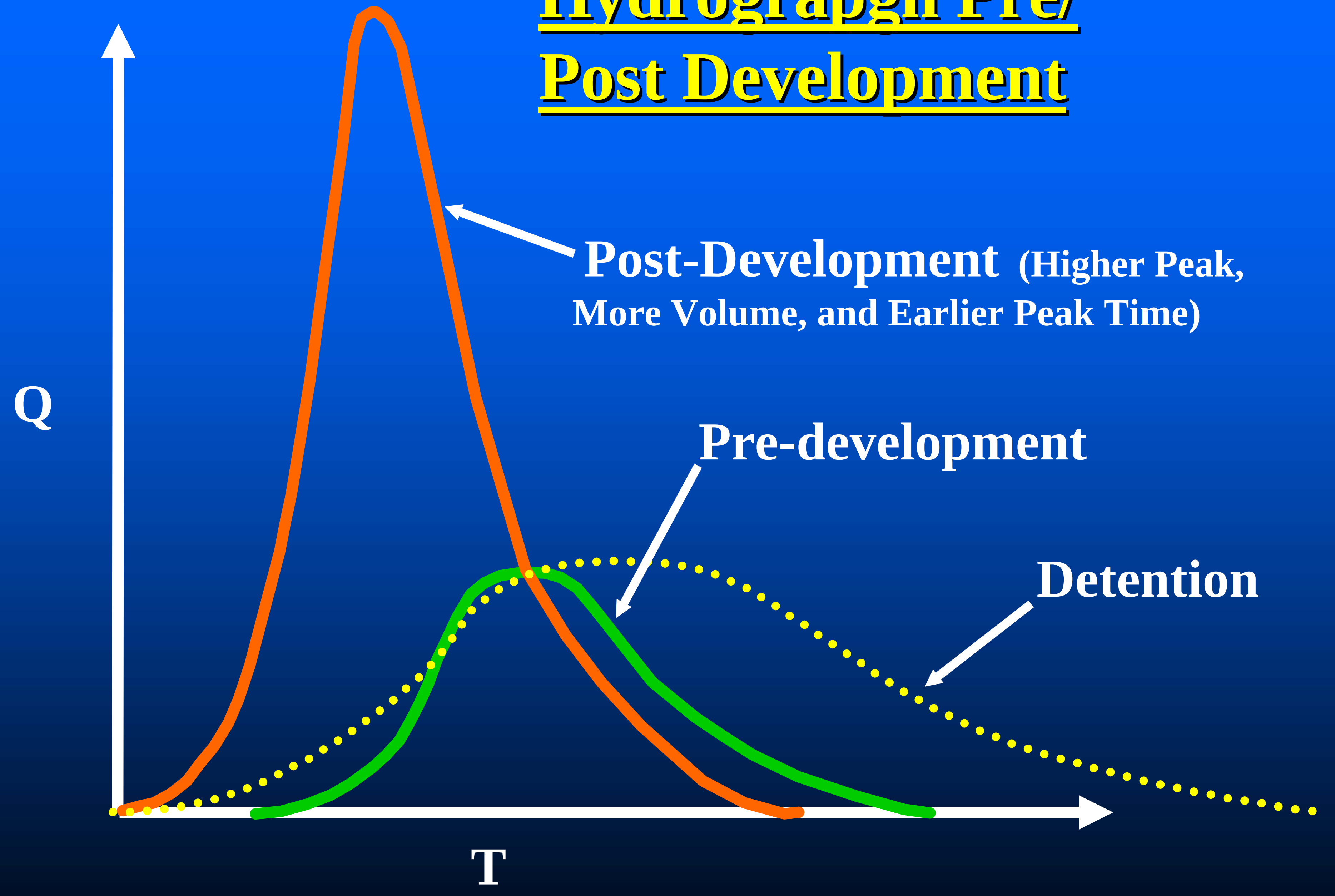


Distributed Small-scale Controls



Maintaining Natural Hydrology Functions

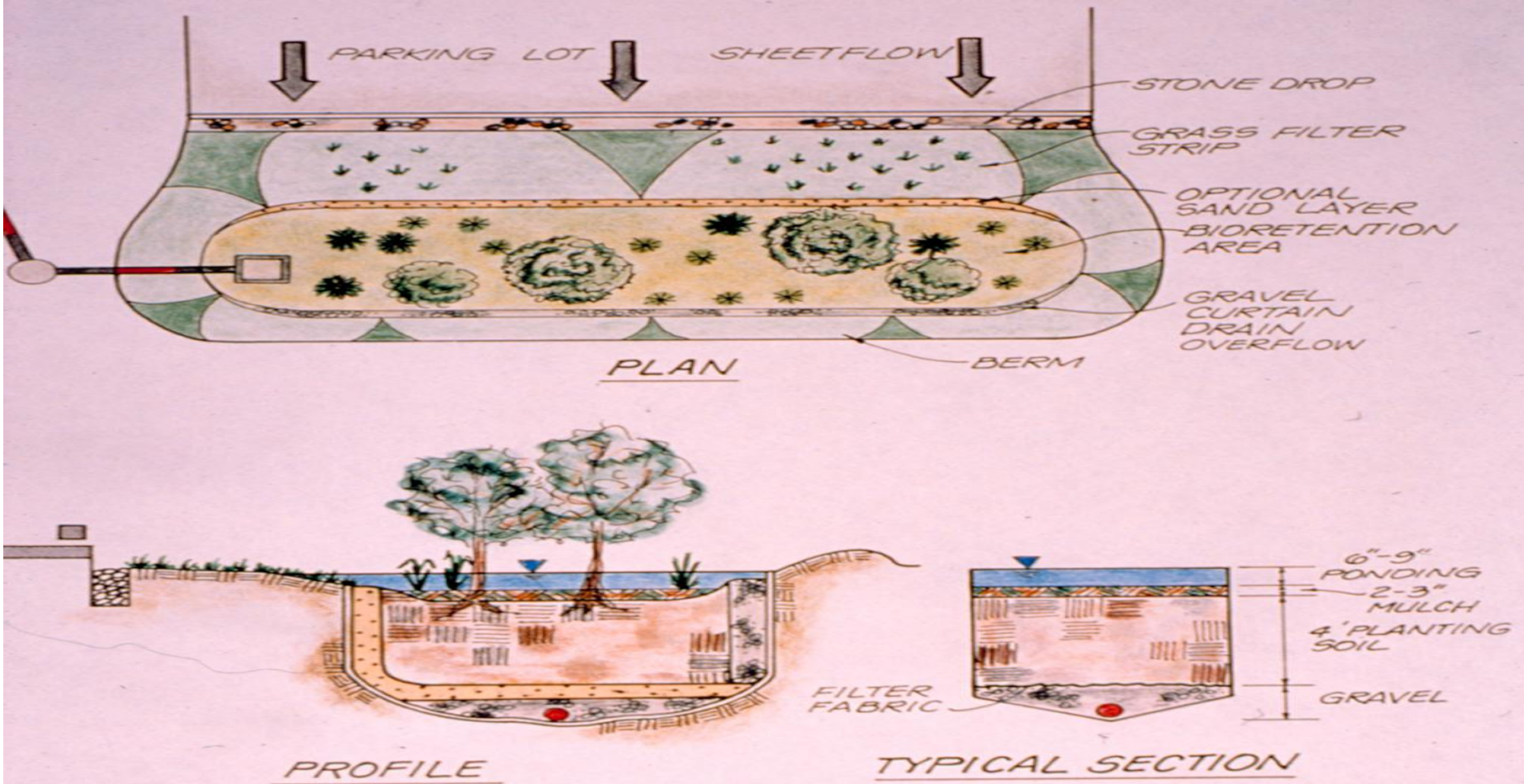
Hydrograpgh Pre/ Post Development




Partnership
for Rain
Gardens

Maplewood, Minnesota (near St. Paul)

Rain gardens installed by city as part of street replacement project

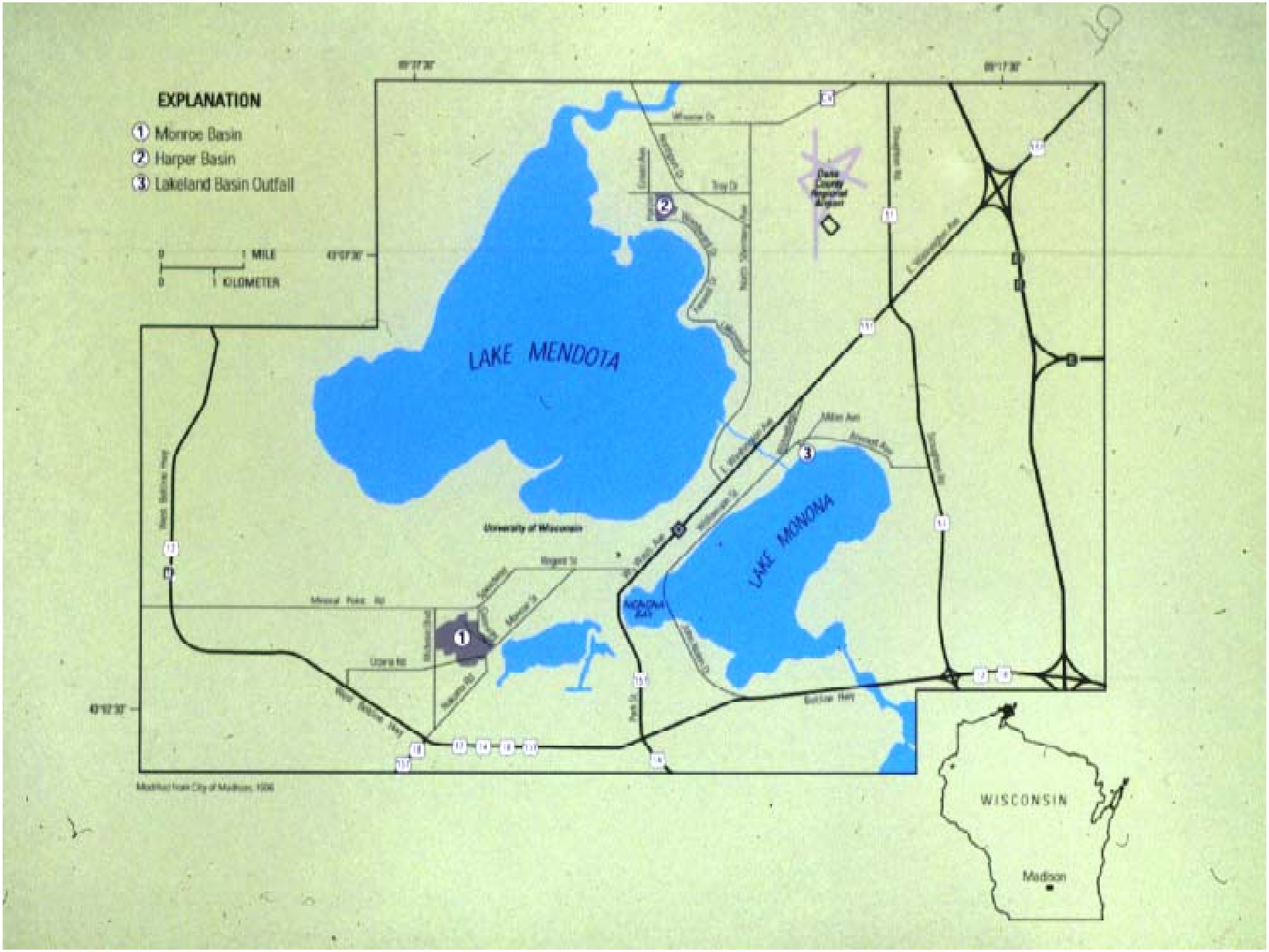


BIORETENTION FILTER

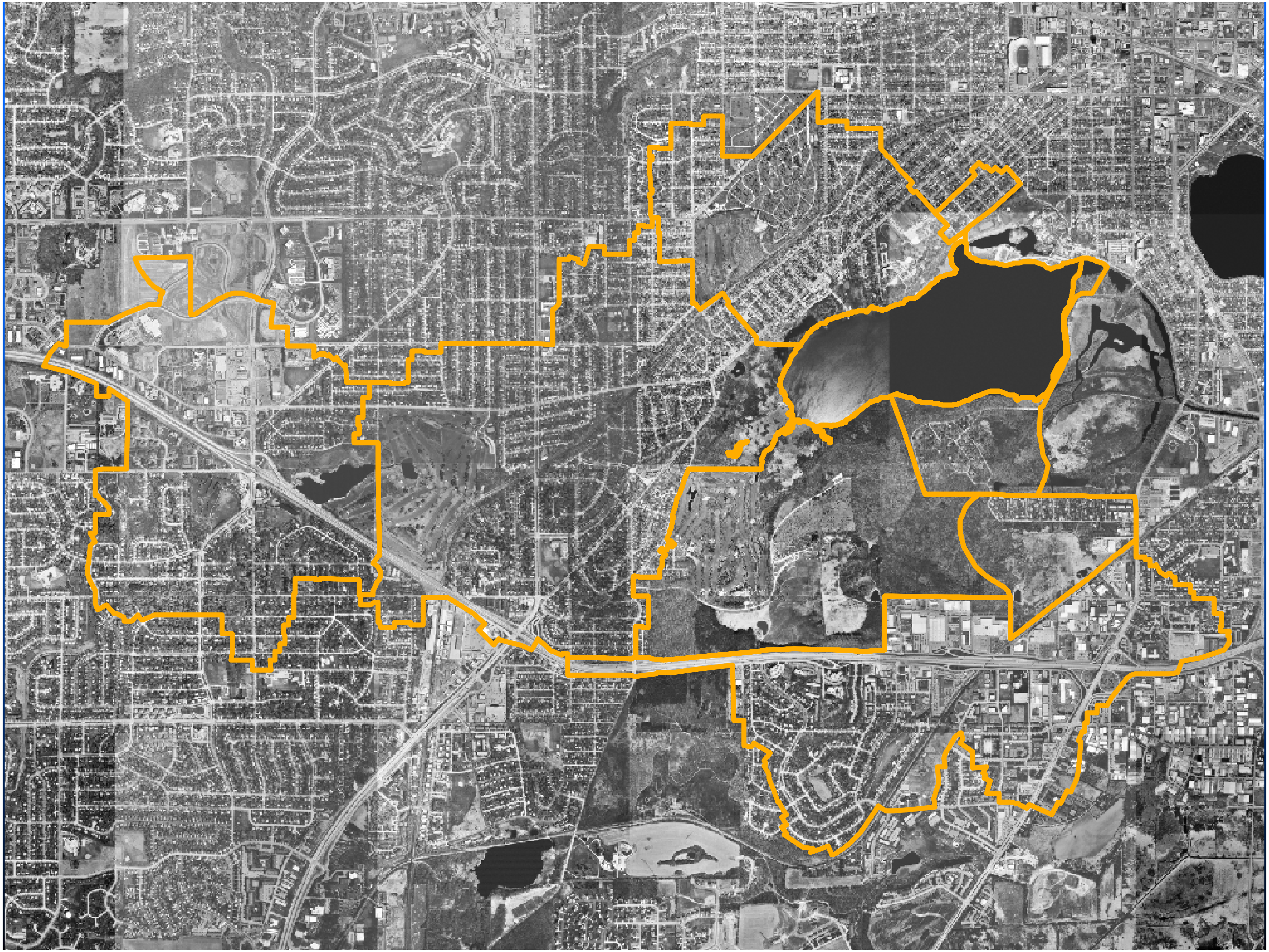
BIORETENTION
% POLLUTANT REMOVAL

		Cu	Pb	Zn	P	TKN	NH4	NO3
BOX	Upper	90	93	87	0	37	54	-97
	Middle	93	99	98	73	60	86	-194
	Lower	93	99	99	81	68	79	23
	Field	**97**	**96**	**95**	**65**	**52**	**92**	**16**

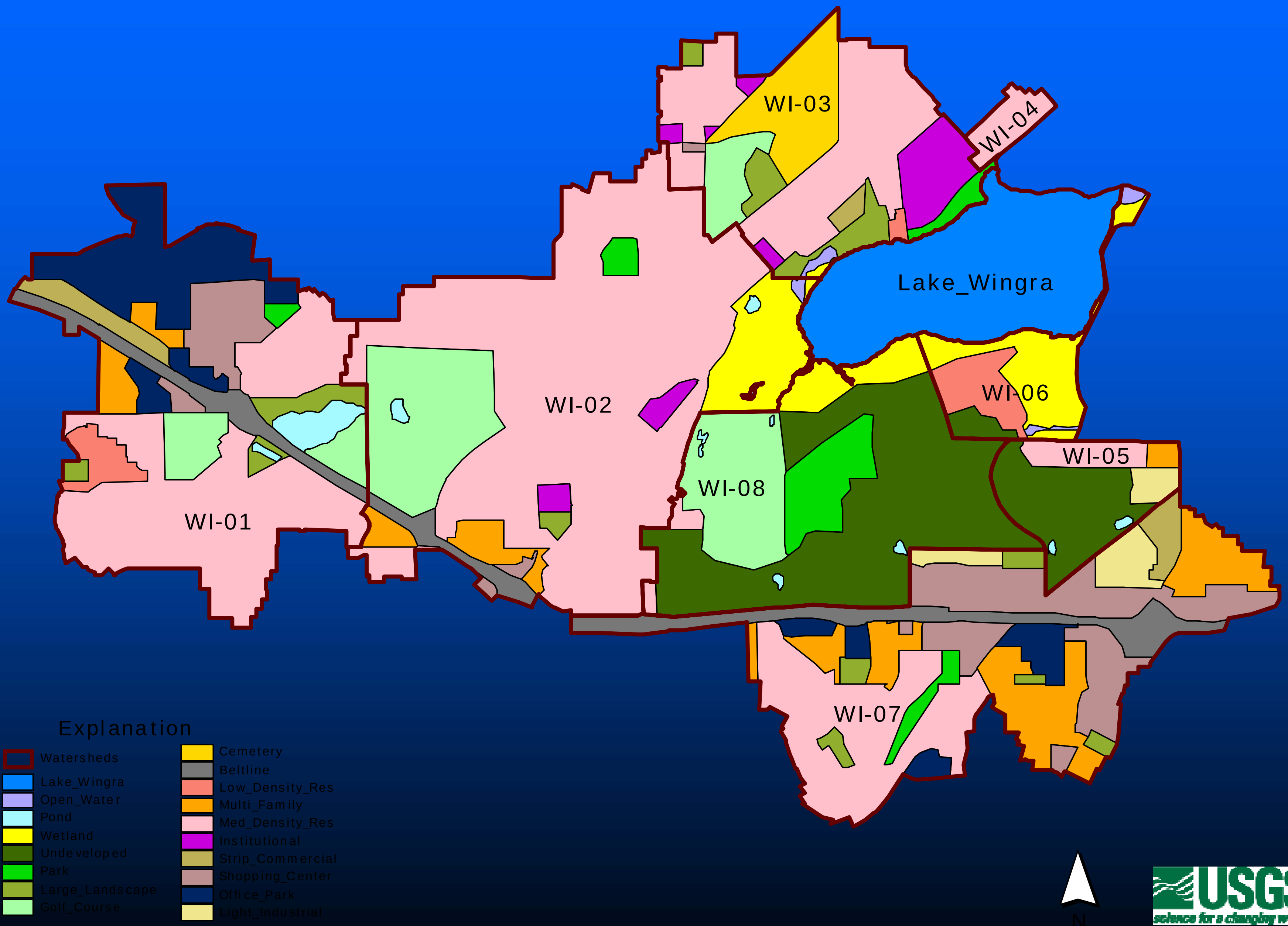
Dr. Allen Davis, University of Maryland



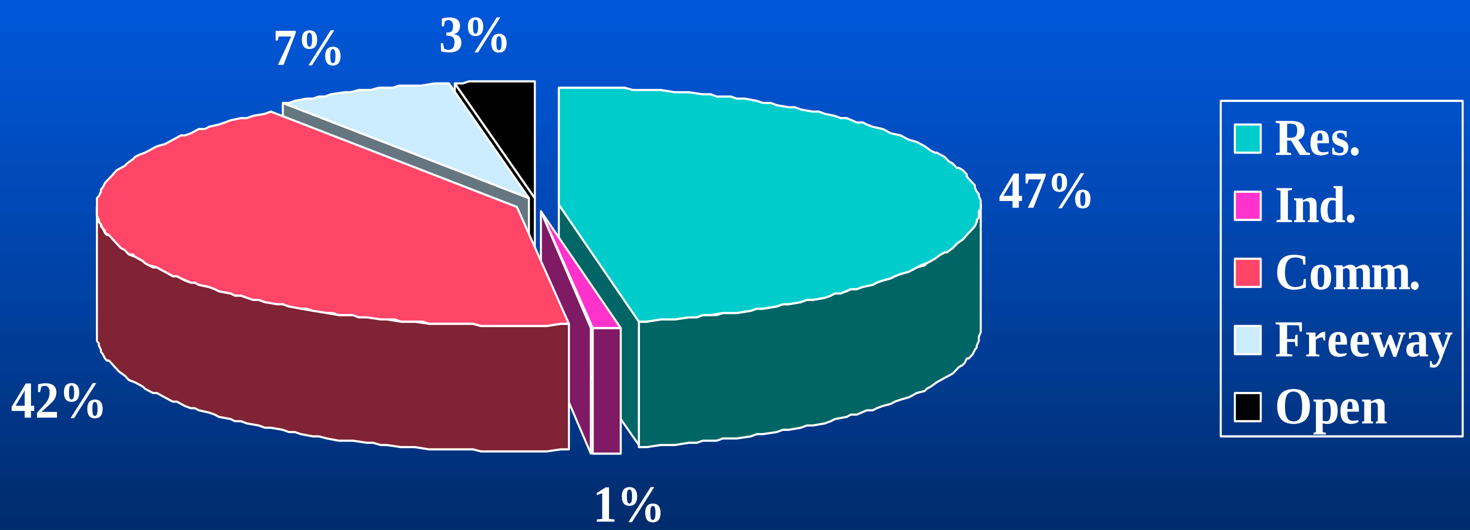
EXPLANATION
1 Monroe Basin
2 Harper Basin
3 Lakeland Basin Outfall
0 1 MILE
0 1 KILOMETER
LAKE MENDOTA
LAKE MONONA
MONONA BAY
University of Wisconsin
Regent St
Mineral Point Rd
Troy Dr
Milton Ave
Dane County Regional Airport
WISCONSIN
Madison
Modified from City of Madison, 1996



Landuse in the Lake Wingra Watershed

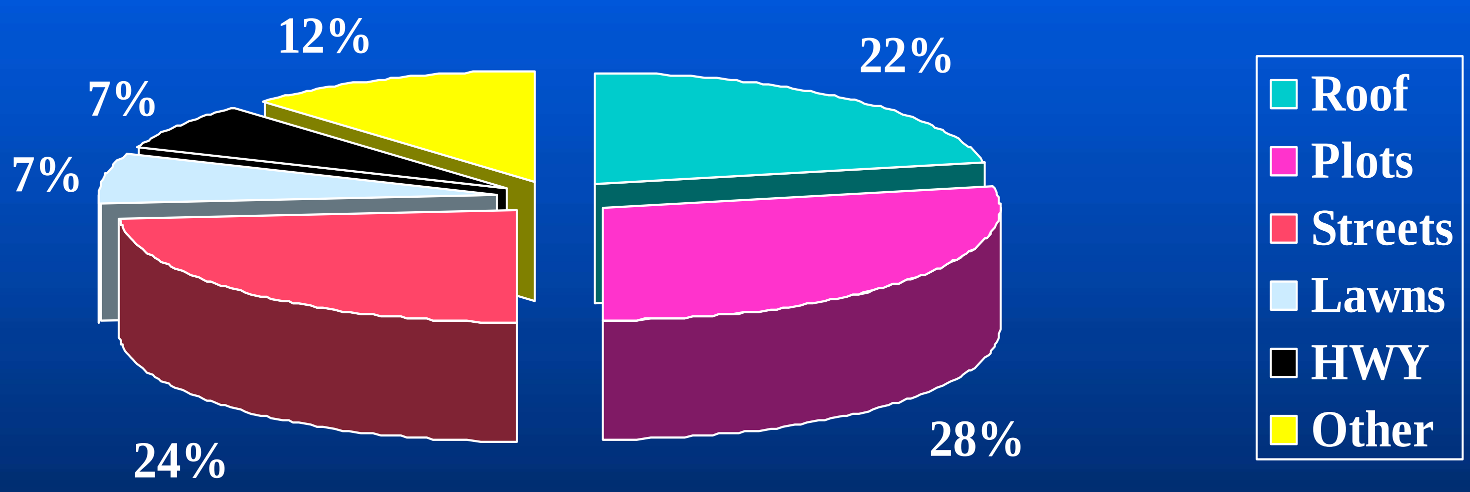


% Runoff Volume by Landuse for 4 Subwatersheds



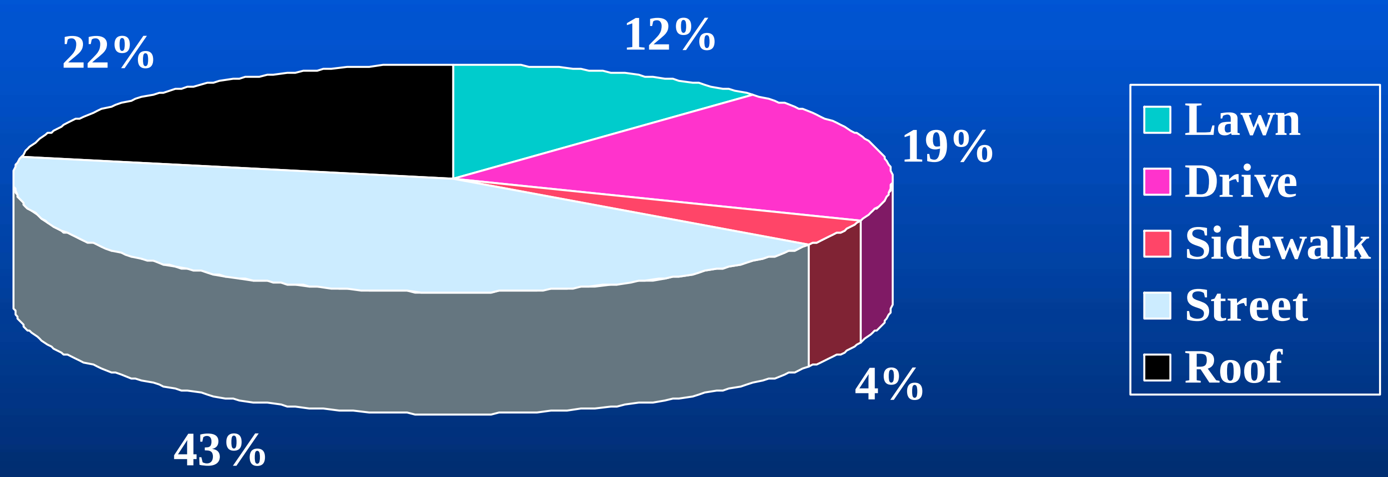

Bioretention in Residential
Right-of-way = 34%
Reduction in Annual Runoff

% Annual Runoff Volumes from Source Areas in 4 Subwatersheds

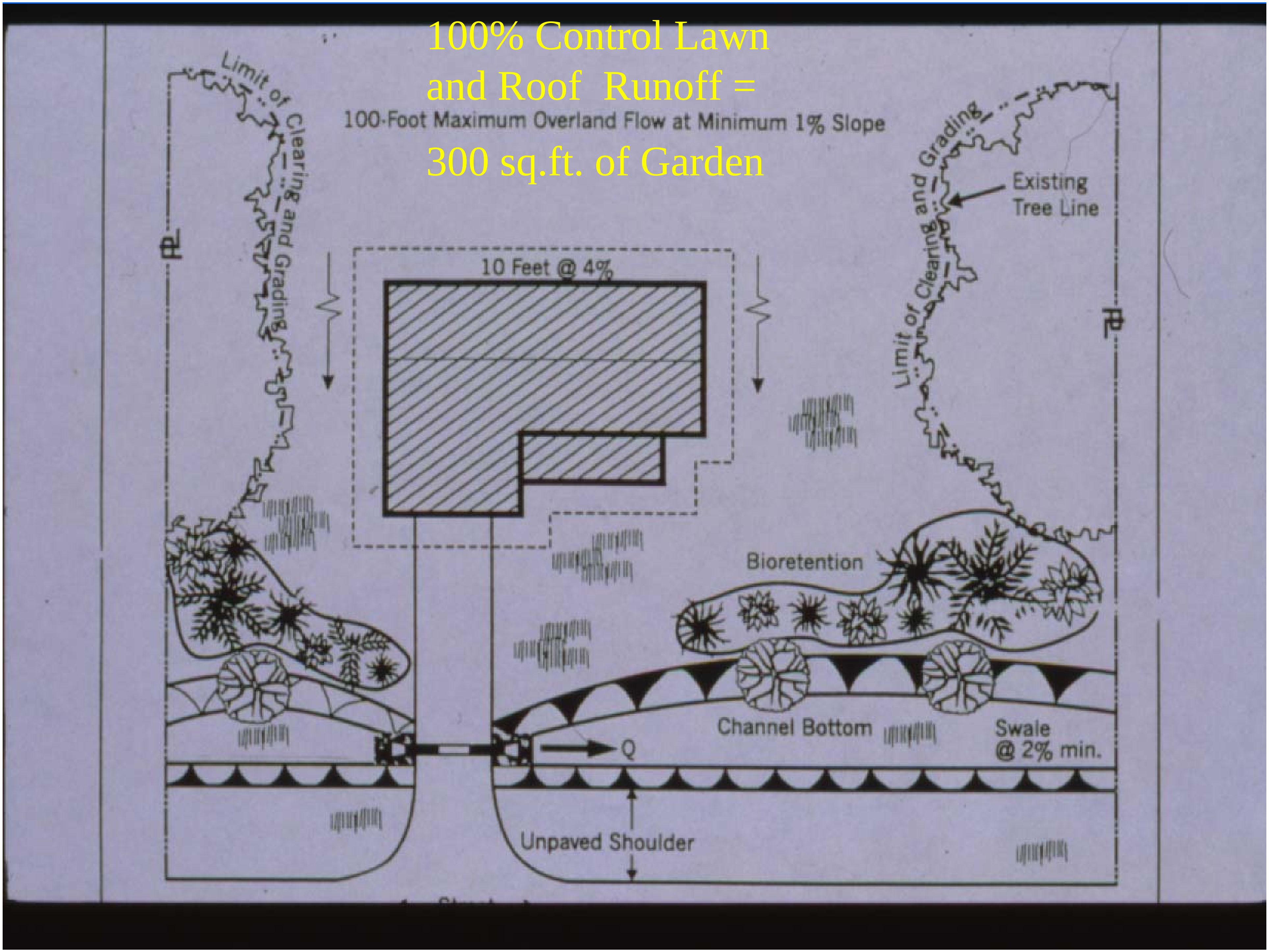



Rain Gardens on Residential Lawns = 15% Reduction in Annual Runoff

Sources of Annual Runoff Volume in Medium Density Residential



100% Control Lawn and Roof Runoff = 300 sq.ft. of Garden




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


1922

Plant List for Backyard Rain Gardens

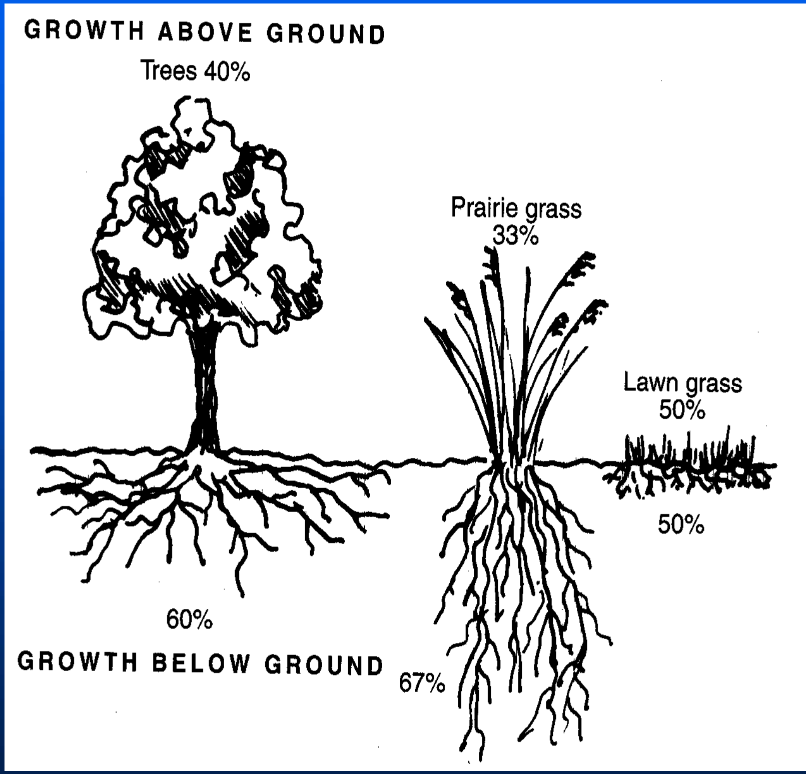
<u>Shade Garden</u>

- Jacobs Ladder
- Celandine Poppy
- Short's Aster
- Zig-Zag Goldenrod

<u>Middle & Big Garden</u>

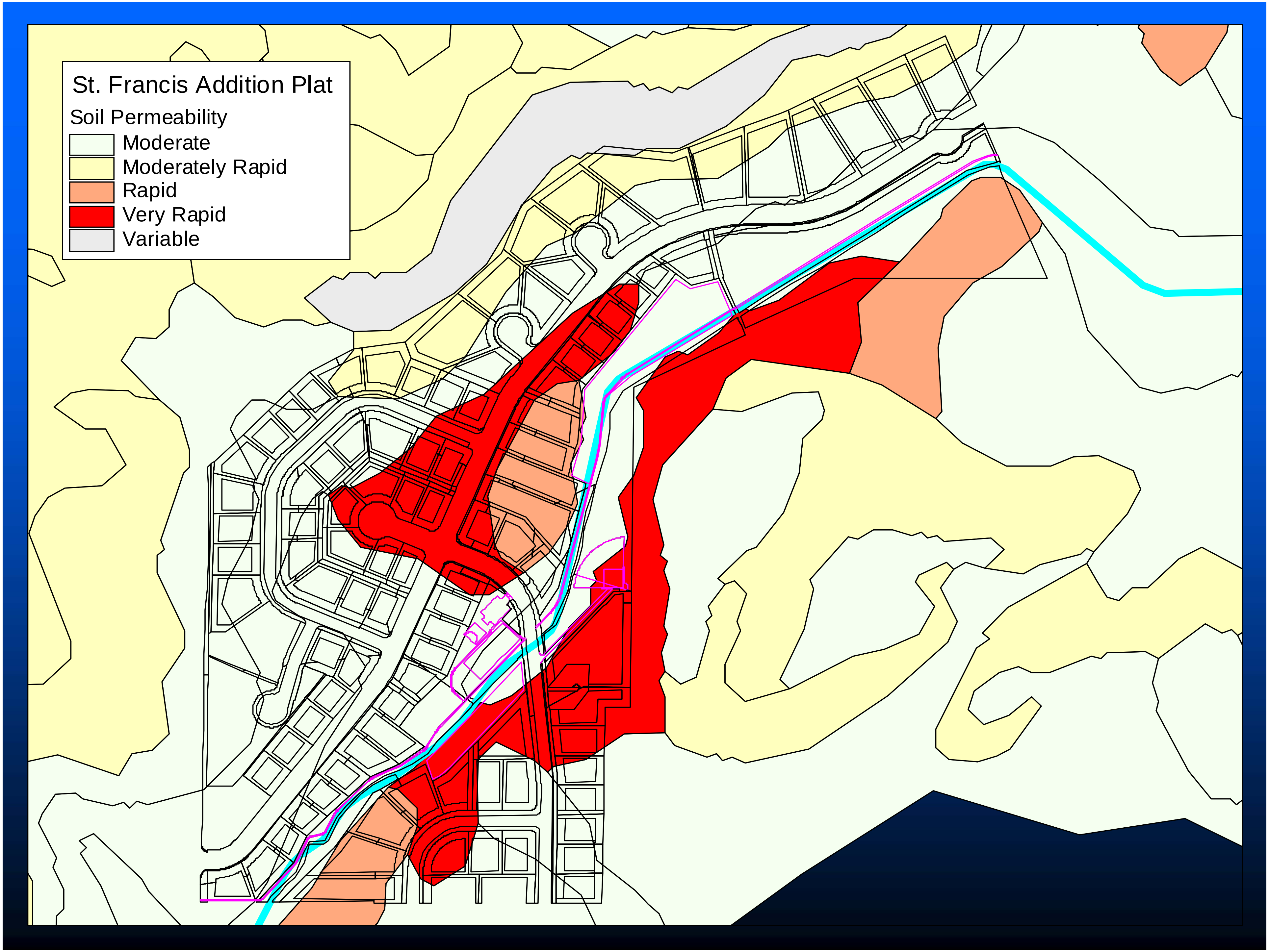
- Blue Flag Iris
- Purple Cone Flower
- Shooting Star
- Sweet Black-eyed Su.
- Smooth Penstemon
- Heartleaf Blue Aster
- Ohio Goldenrod
- Fire Pink
- Silky Wild Rye
- Northern Sea Oats

Value of Using Native Plants

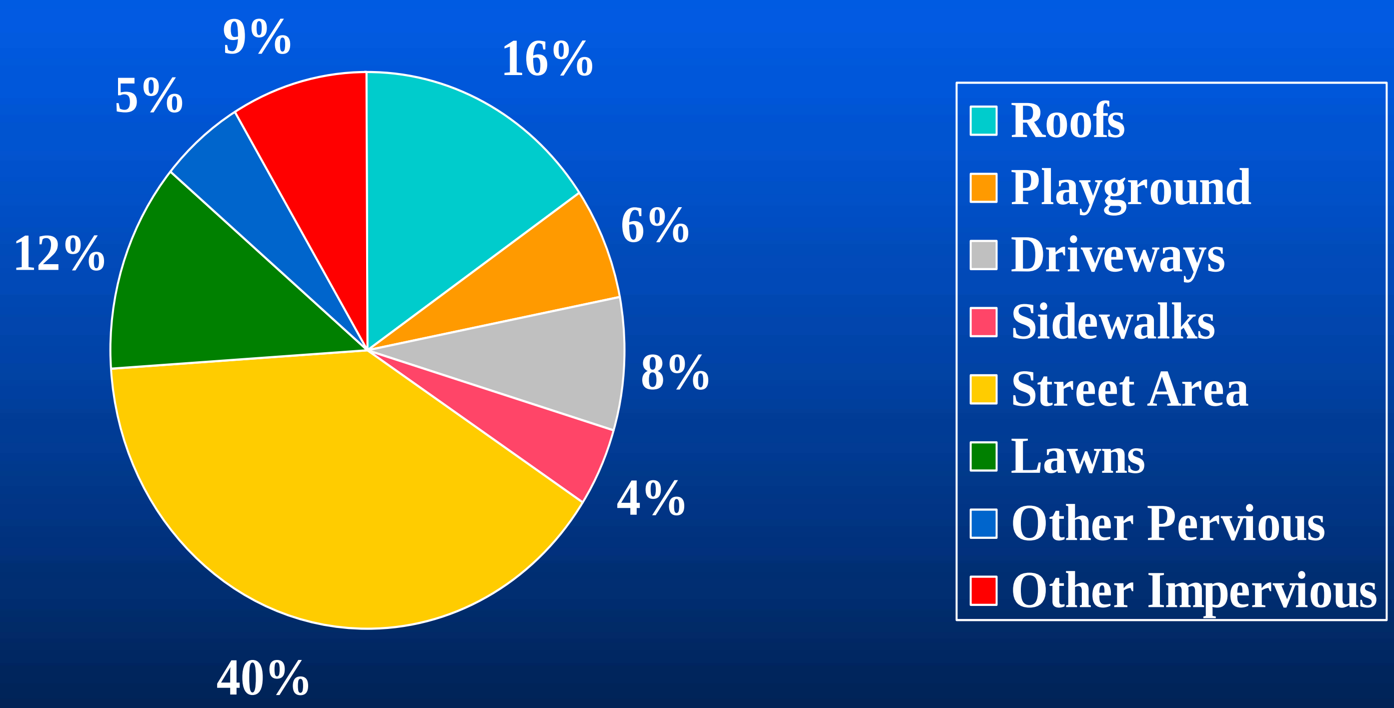


- Deeper roots – absorbs more water
- Uses no fertilizer
- Uses little or no pesticides
- Easy maintenance after first year
- Does not require watering in droughts after establishment


Lake Delton, Wisconsin


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
- Infiltration Trenches in Street Boulevards
- Two Regional Infiltration Basins
- Reduce Street Width from 36 to 32 Feet
- Protection of Riparian Buffer

Steve Apfelbaum: Applied Ecological Services

Infiltration Goals for Area 4 at St Francis

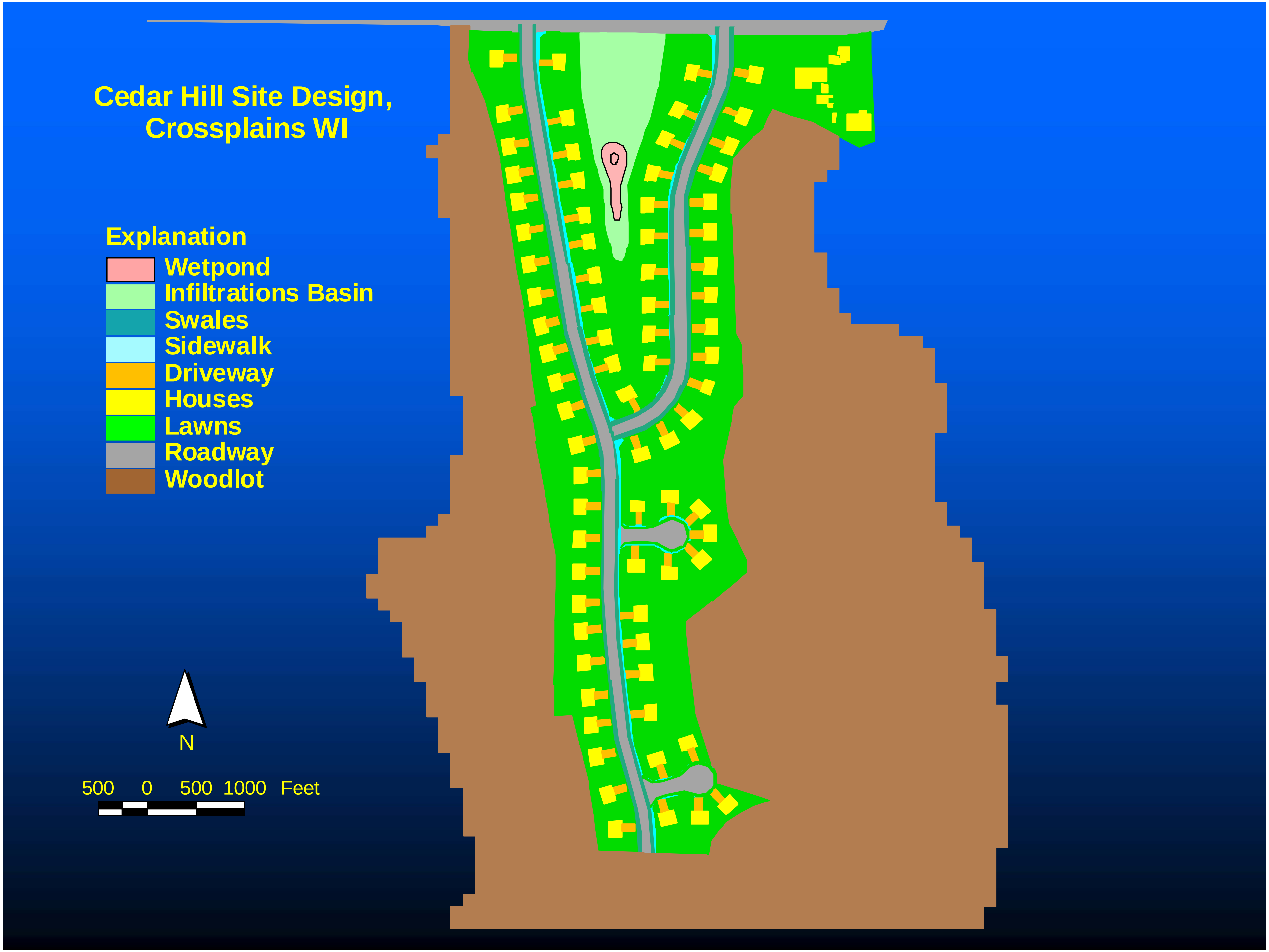
Type of Volume Calculation	Annual Infiltration Volume, inches	Annual Runoff, inches
Predevelopment	28.0	0.8
90% Goal	25.2	3.6
No Controls	24.4	4.4
Volume Change	0.8	0.8 (18% of post annual runoff)

Levels of Control for Each Infiltration Device in Area 4

Type of Practice	Additional Infiltration	Percent of 0.8 inches	% Change to Post Runoff
Rain Garden (1/house)	0	0	0
Infiltration Trenches	3.7	460%	84% (0.7” runoff)
Infiltration Basin	4.4	550%	98% (0.1” runoff)
Rain Garden (3/house & 60% of lawn)	0.5	62%	11% (3.9” runoff)

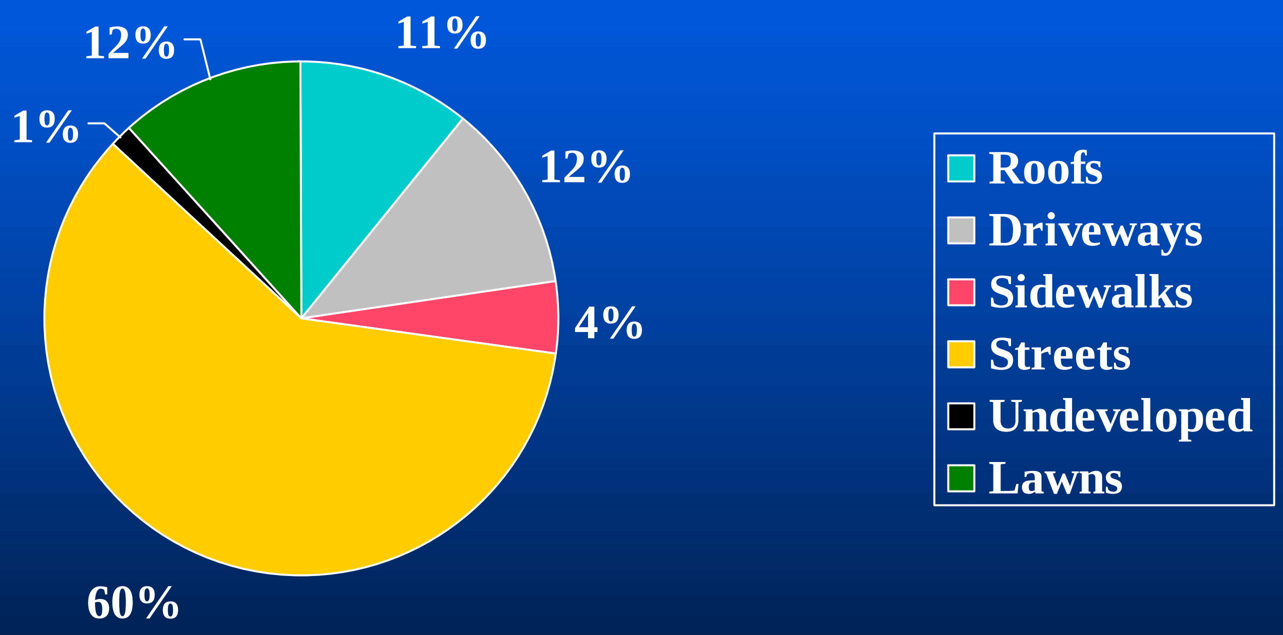

West Bend, WI


FALLS OUTPOSTS
ONTARIO



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

Percent Runoff Volume by Source Area for Cedar Hills



Elements of Low Impact Design for Cedar Hills Development

- Grass Swales
- Detention Pond
- Infiltration Basin
- Reduce Street Width (From 36 to 33 feet – park one side of street)


Joyce Powers
CRM Ecosystems
& Prairie Ridge
Nursery

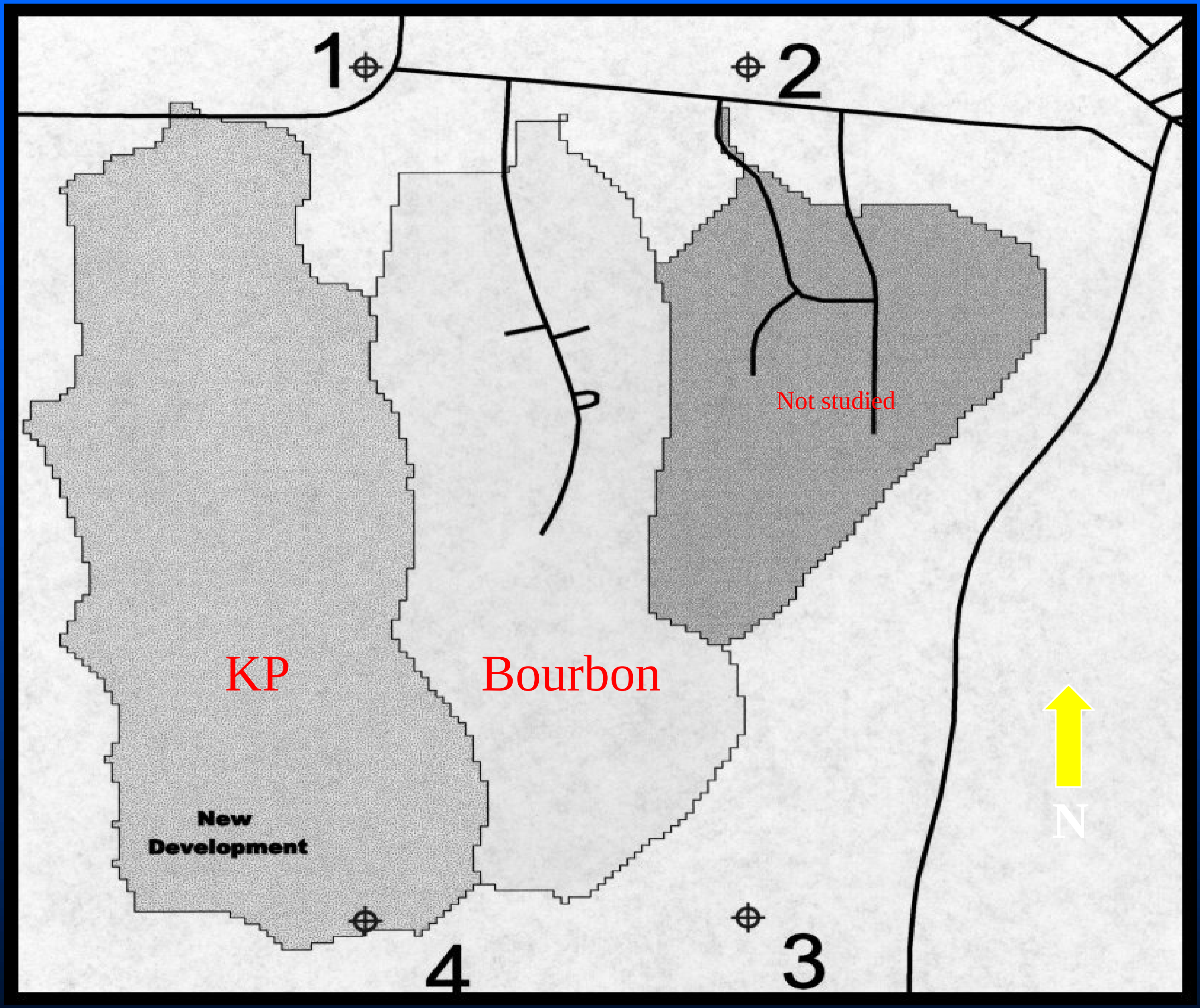

Prairie Nursery

Reductions Goals in Runoff Volume for Cedar Hills

Type of Volume Calculation	Annual Infiltration Volume, in.	Annual Runoff Volume, in.
Pre-development	28.0	0.8
90% Goal	25.2	3.6
No Controls	22.5	6.3
Volume Change to Achieve 90%	2.7	2.7 (43% of Postdevelop. Runoff)

Volume Reduction Estimates for Practices at Cedar Hills

Type of Practice	*Additional Infiltration, inches*	*% of 2.7 inch goal*	*% Reduction in Annual Postdev. Runoff*
33 foot wide streets	0.3	11%	5%
Grass Swales	0.7	26%	11%
Infiltration basin – proper size	1.7	63%	27%
Total	**2.7**	**100%**	**43%**
Infiltration basin – Actual size	4.6	170%	89% (0.7” runoff)



science for a changing world

Bourbon


8/5/2000 15:40

Infiltration Basin Monitoring

• ISCO refrigerated water-quality sampler

• CS double-bubbler stage sensor

•Tipping-bucket raingage

• H-flume

• Temperature probe

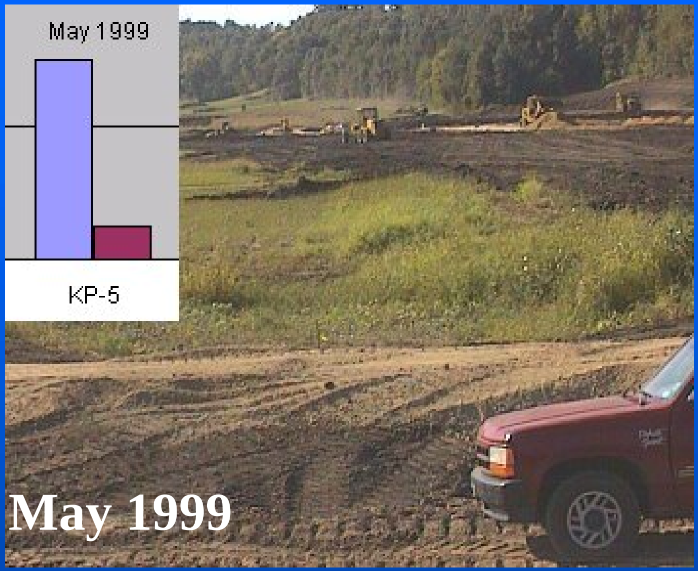
• Marsh-McBirney FLODAR system

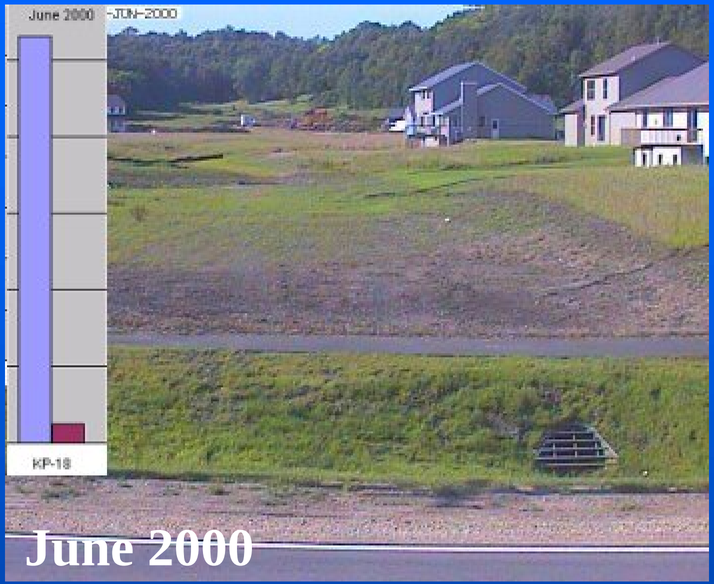
➢ measures stage, velocity and discharge

USGS
science for a changing world

Visual Clues to TSS Concentration Variation

Blue = KP Red = Bourbon





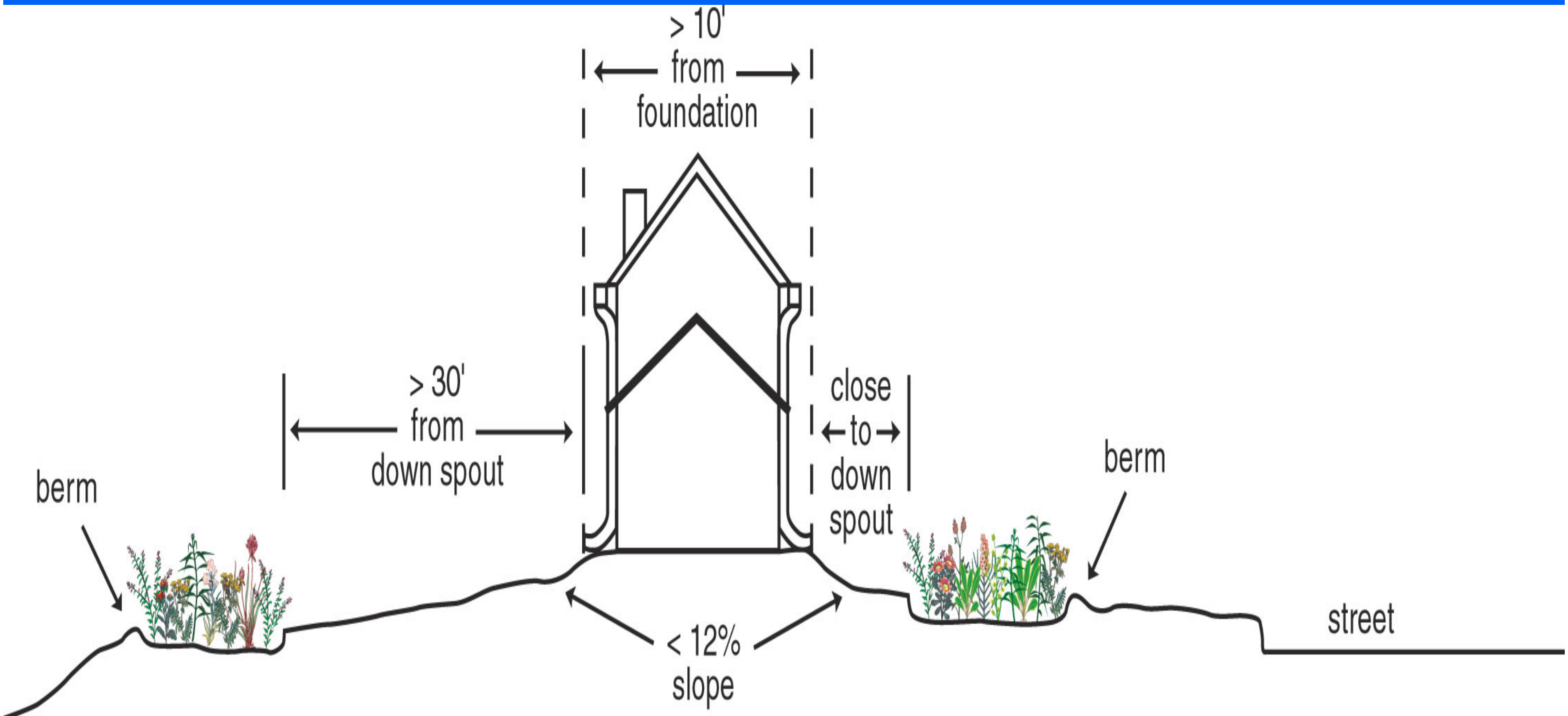
Performance of Low-Impact Design Based on Annual Precipitation

Water Year	Construction Phase	Rainfall (inches)	Volume Leaving Basin (inches)	Percent of Volume Retained (%)
1999	Pre	33.3	0.46	99%
2000	Active	33.9	4.27	87%
2001	Active	38.3	3.68	90%
2002	Active*	29.4	0.96	97%

*** Site is approximately 75% built-out**

Benefits of Rain Garden

- Help Protect and Restore Natural Hydrology of Your Watershed
- Trap Pollutants
- Attract Birds and Butterflies
- Attractive Addition to Property
- Enhance Beauty of City

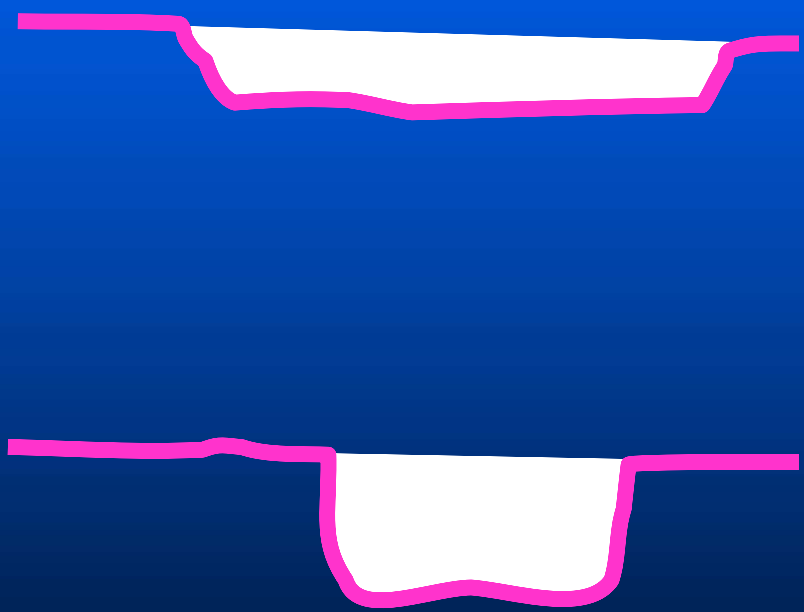

> 10'
from
foundation
> 30'
from
down spout
close
to
down
spout
berm
berm
street
< 12%
slope

How Big to Make the Rain Garden

- How deep to make rain garden?
- What type of soil is at the site?
- What is the area draining to the rain garden?


Rain Garden Size: Any size
will provide some benefit –
most between 70 and 300
square feet

Rain Garden Depth

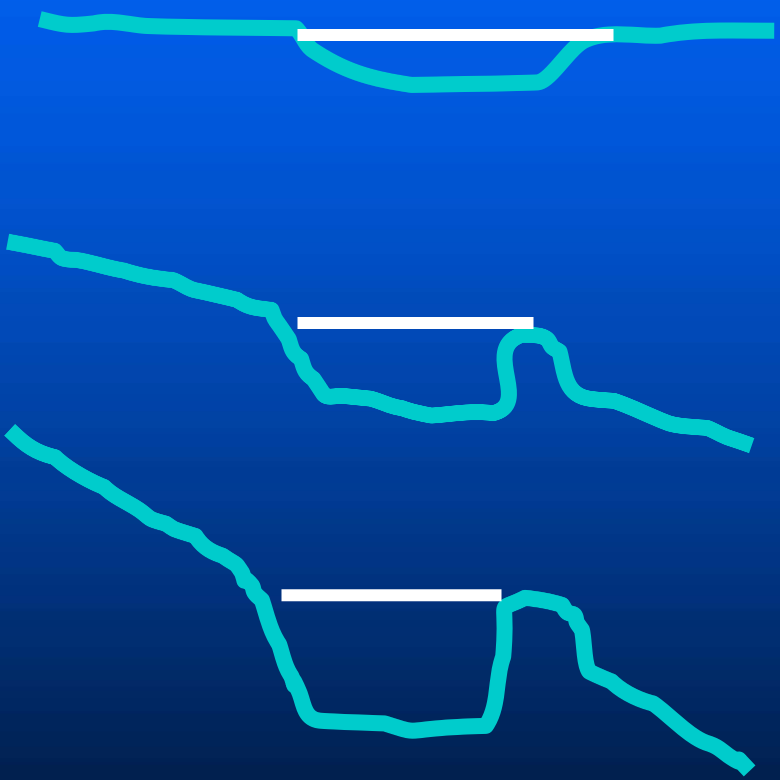


Balance Between Depth and Surface Area

- **Minimize drain time – less than 1 day.**
- **Minimize digging.**
- **Suggest depths between 3 to 8 inches**

Selection of Rain Garden Depth – Slope Very Important

- Slope < 4% = 3 to 5 inches deep.
- Slope of 5 to 7 % = 6 to 7 inches deep.
- Slope of 8 to 12 % = about 8 inches deep.
- Slope > 12 % suggest another site.



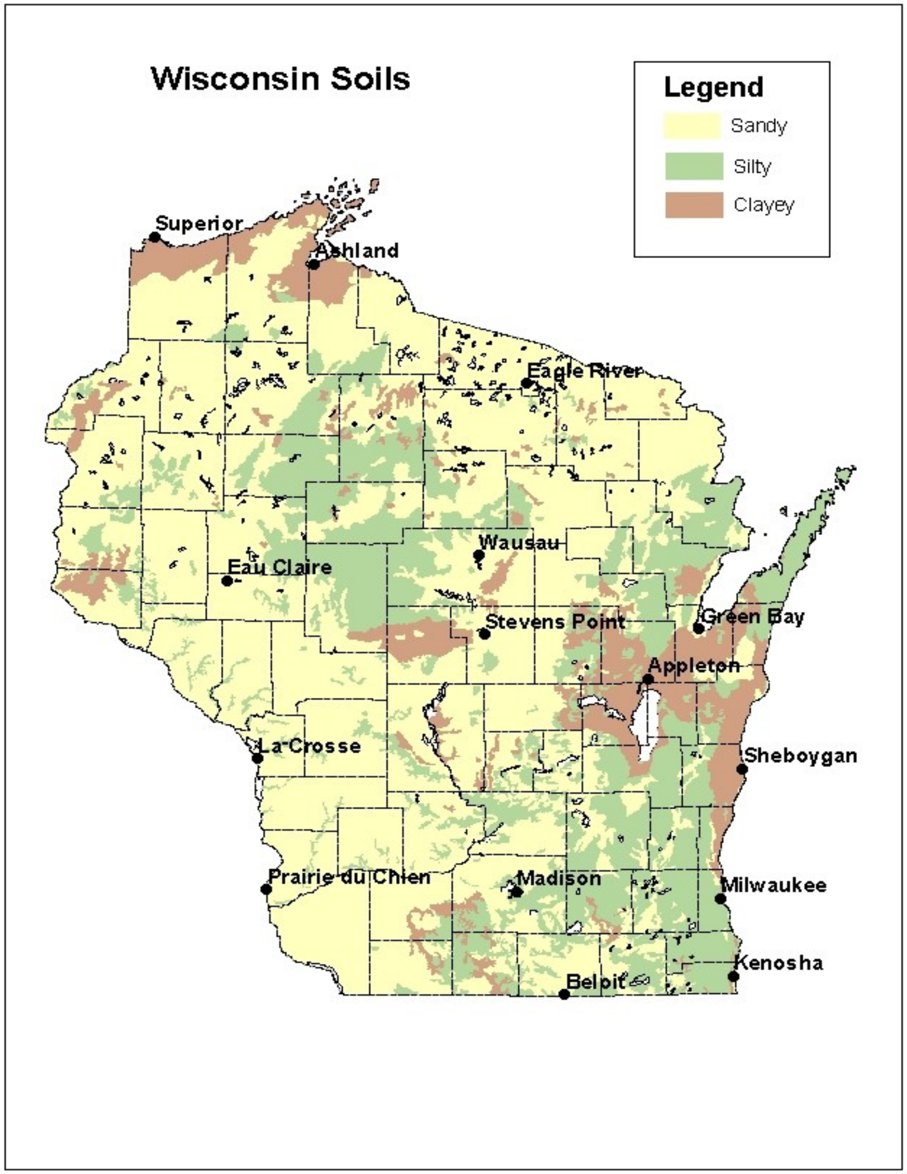
Importance of Soil Type

Higher the Infiltration Rate the Smaller the Rain Garden Surface Area.

- Infiltration Rate of Sandy Soils: 2.5 in/hr
- Infiltration Rate of Silty Soils: 0.5 in/ hr
- Infiltration Rate of Clayey Soils: 0.3 in/hr

Determination of Soil Type

- Best method is to have soil analyzed.
- Use soil map – not too dependable because of possible disturbed soils in construction area.
- Use feel of soil.
- Do perk test – six inches deep

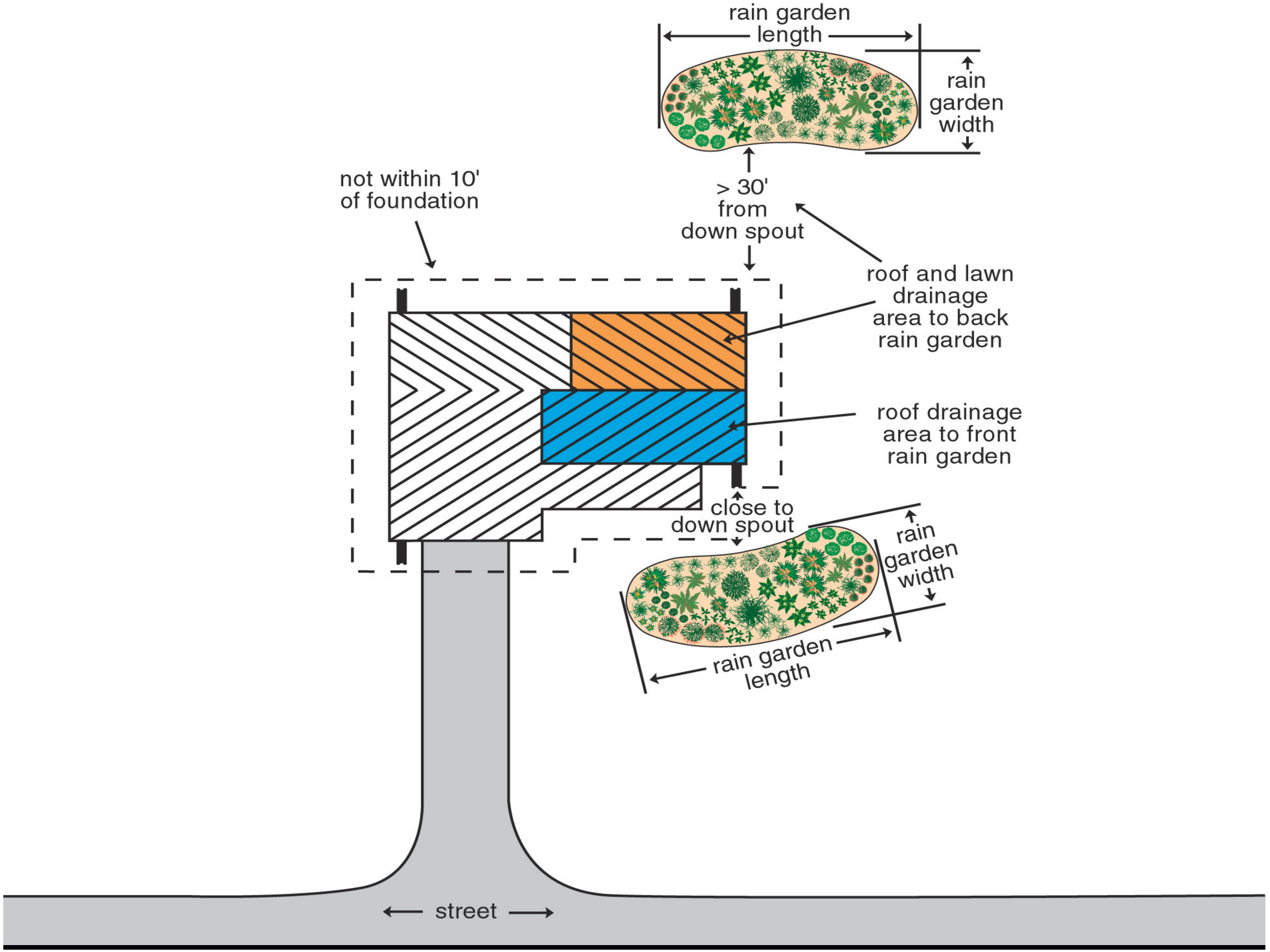


Wisconsin Soils
Legend
Sandy
Silty
Clayey
Superior
Ashland
Eagle River
Wausau
Eau Claire
Stevens Point
Green Bay
Appleton
La Crosse
Sheboygan
Prairie du Chien
Madison
Milwaukee
Kenosha
Beloit

Size of Drainage Area

Question: Is the rain garden treating rooftop and lawn or just rooftop runoff?

Alexopoulos & Clausen


rain garden length
rain garden width
not within 10' of foundation
> 30' from down spout
roof and lawn drainage area to back rain garden
roof drainage area to front rain garden
close to down spout
rain garden width
rain garden length
street

Calculation of Drainage Area

Size of Roof

Example Calculation

- Length = 100 feet
- Width = 20 feet
- L X W = 2000 sq feet
- 2000 sq. ft. / 4 = 500 square feet

Size Factors for Rain Gardens Less Than 30 feet from Downspout – 100% Control

Type of Soil	3 to 5 Inches Deep	6 to7 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

Garden Size Calculation for Silty Soils and 4 Inch Depth

Size of Rooftop Draining to Garden X Size Factor = Size of Garden

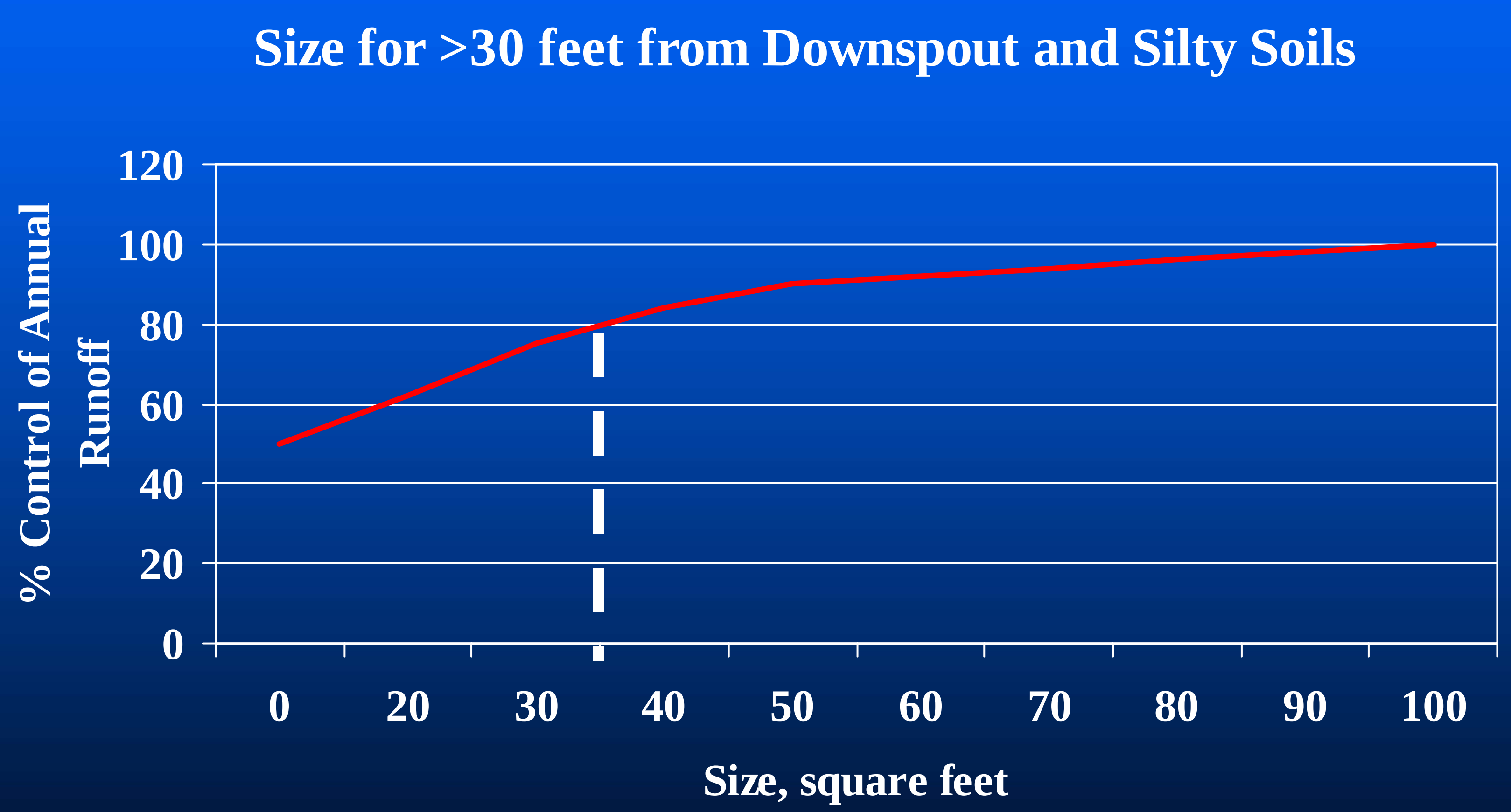
500 square feet X 0.34 = 170 square feet

Shape = 10 feet X 17 feet

Size Factors for Rain Gardens More Than 30 Feet from Downspout – 100% Control

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

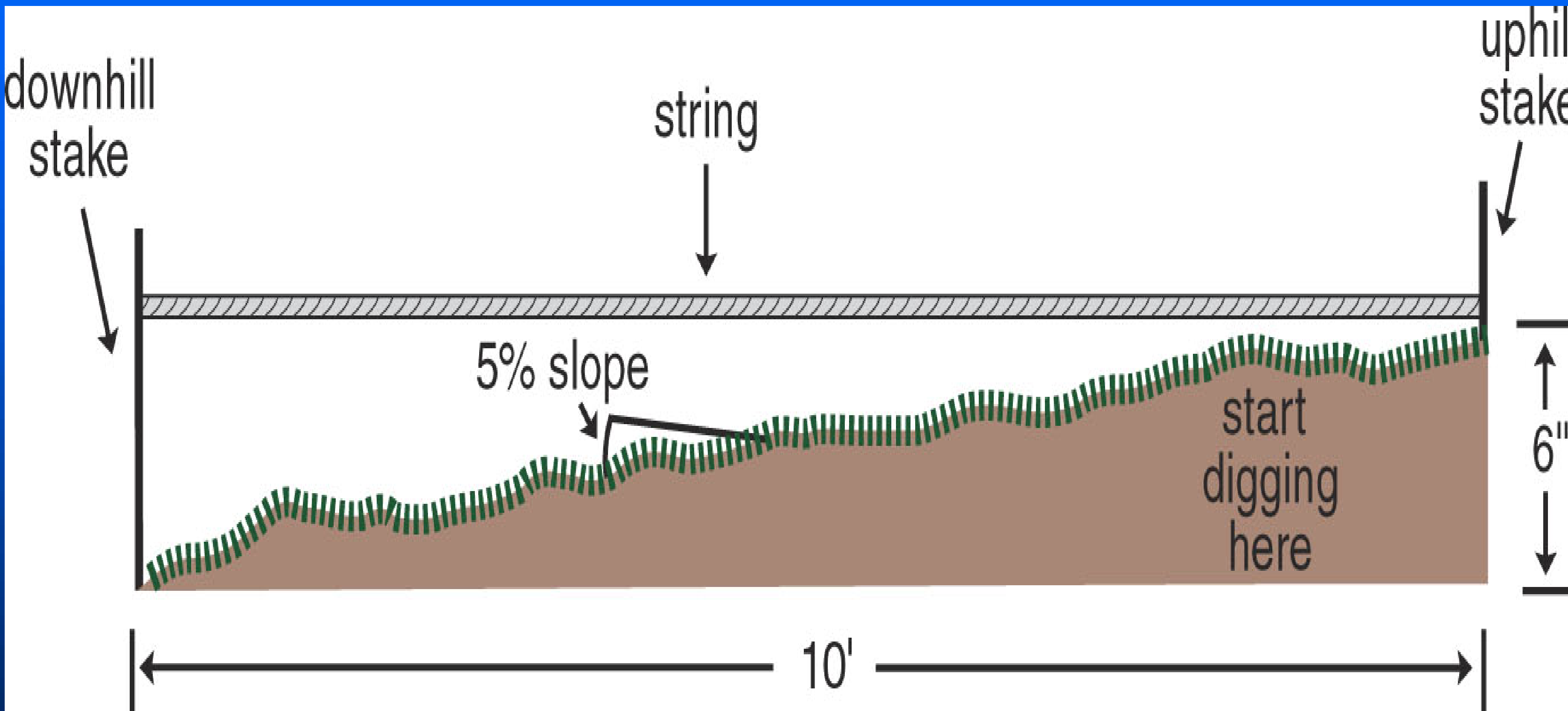
Variation in Rain Garden Size with Percent Reduction in Annual Runoff

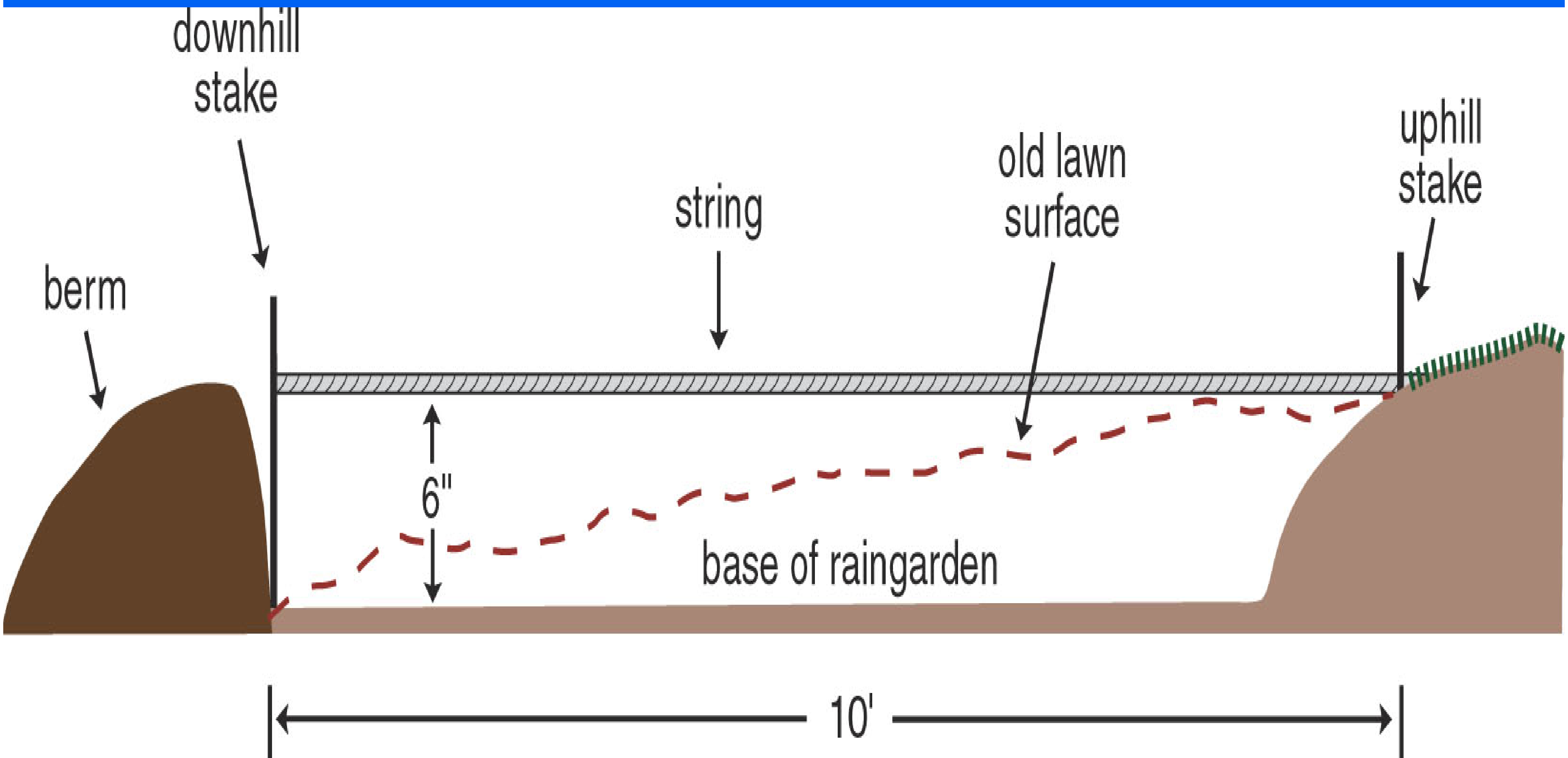


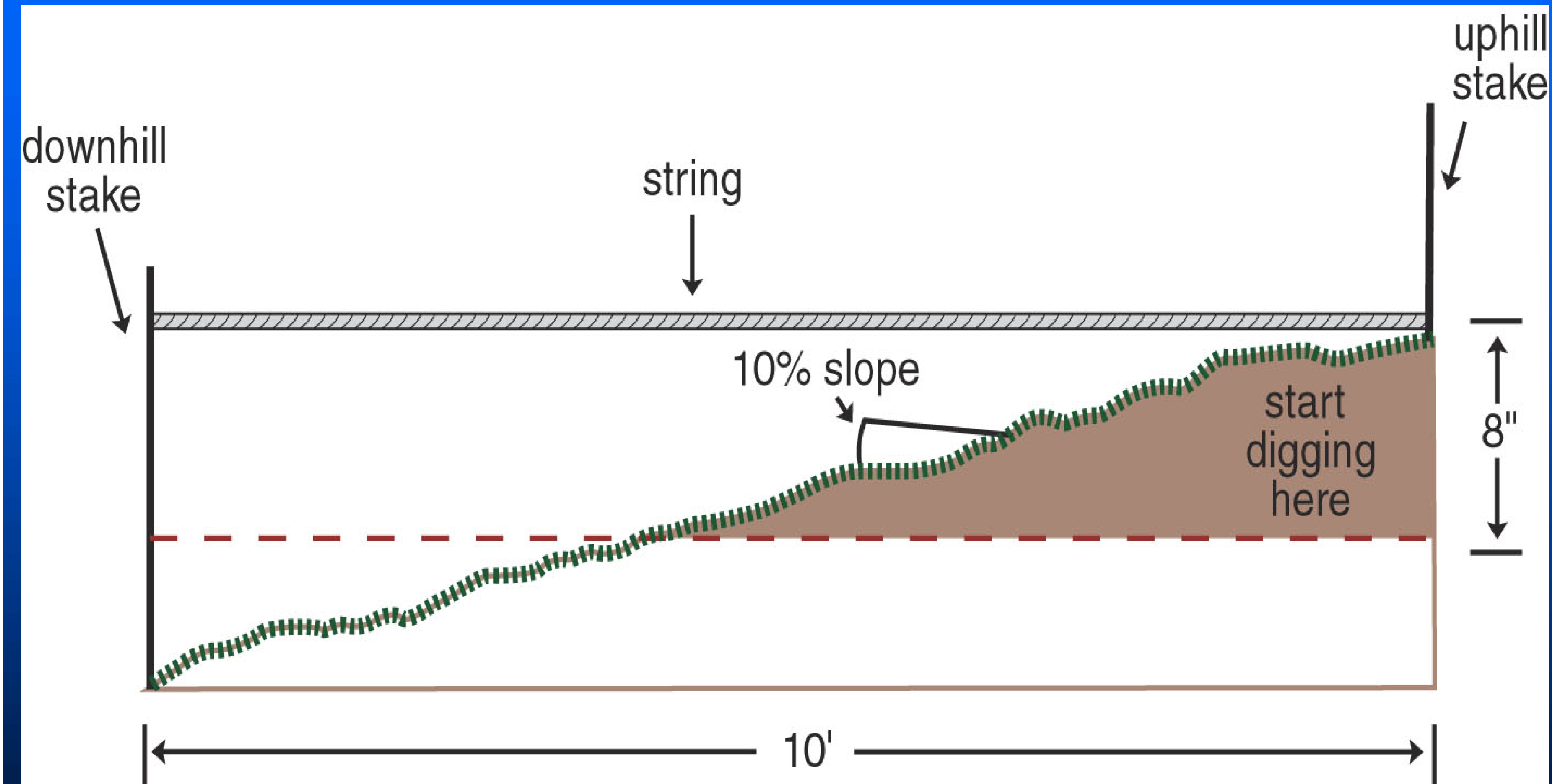
Size of Bannerman Rain Garden

- Size = 180 square feet or 30% of roof area.
- Depth is about 3.5 inches.
- Volume of Garden is about 55 cubic feet or it holds about 400 gallons of water.
- Volume is equal to the runoff from a 1 inch rainfall. Controls 60% of annual roof runoff.
- Infiltration rate is about 2 inches/hour

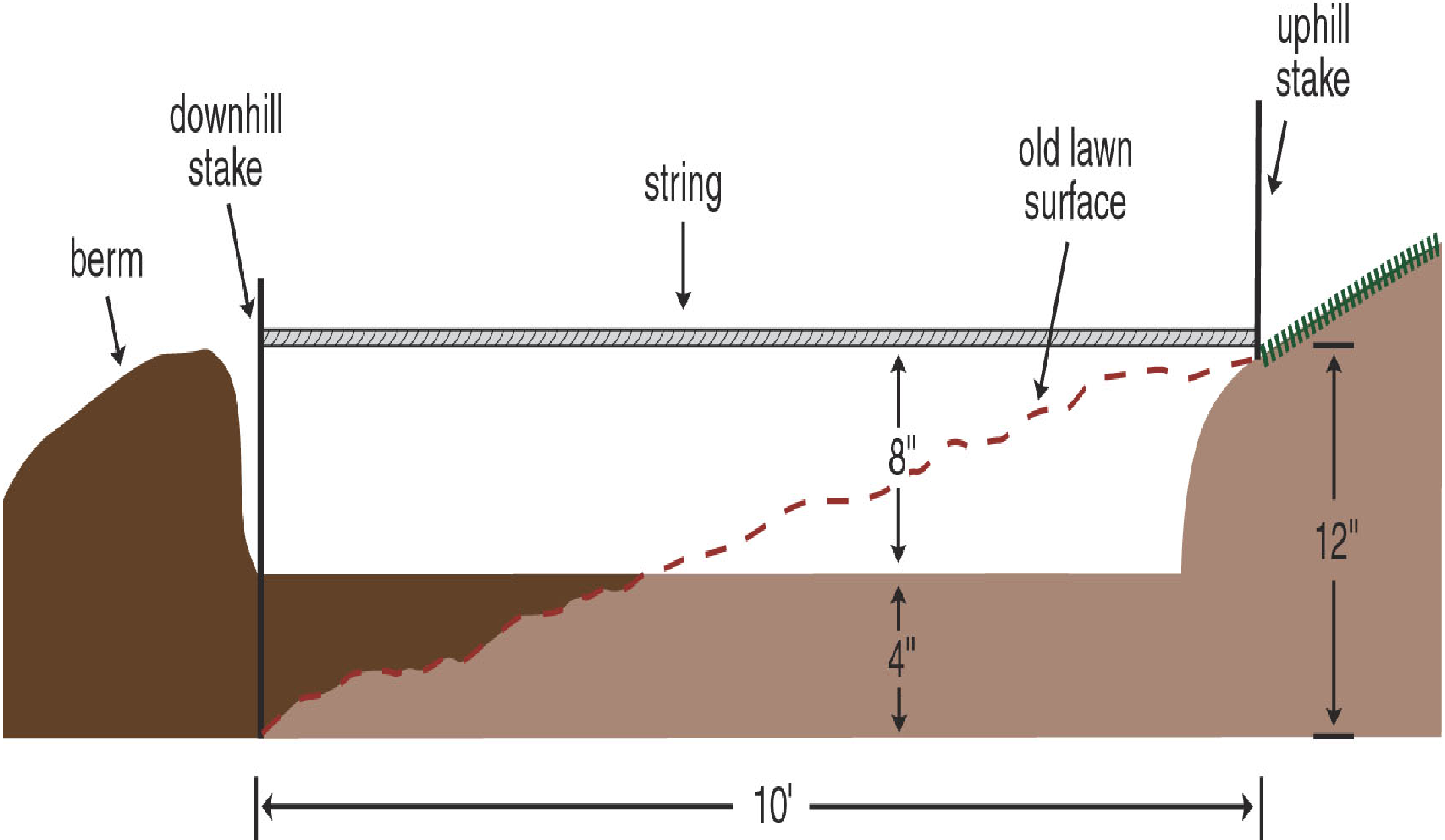

Keith Baker:
Lawson Ridge
Native
Landscaping


downhill stake
string
uphill stake
5% slope
start digging here
6"
10'


downhill stake
berm
string
old lawn surface
uphill stake
6"
base of raingarden
10'



uphill
stake
downhill
stake
string
10% slope
start
digging
here
8"
10'


uphill
stake
downhill
stake
string
old lawn
surface
berm
8"
4"
12"
10'


Jennifer Baker
Prairie Nursery

List of Plants in Bannerman Rain Garden

- Blue False Indigo
- Red Milkweed
- Nodding Pink Onion
- Prairie Blazing Star
- Sq. Stemmed Sticky Monkey
- Sweet Black-Eyed Susan
- Ohio Goldenrod
- Prairie Dropseed

- Early summer
- Summer
- Summer
- Summer
- Summer
- Fall
- Fall
- All

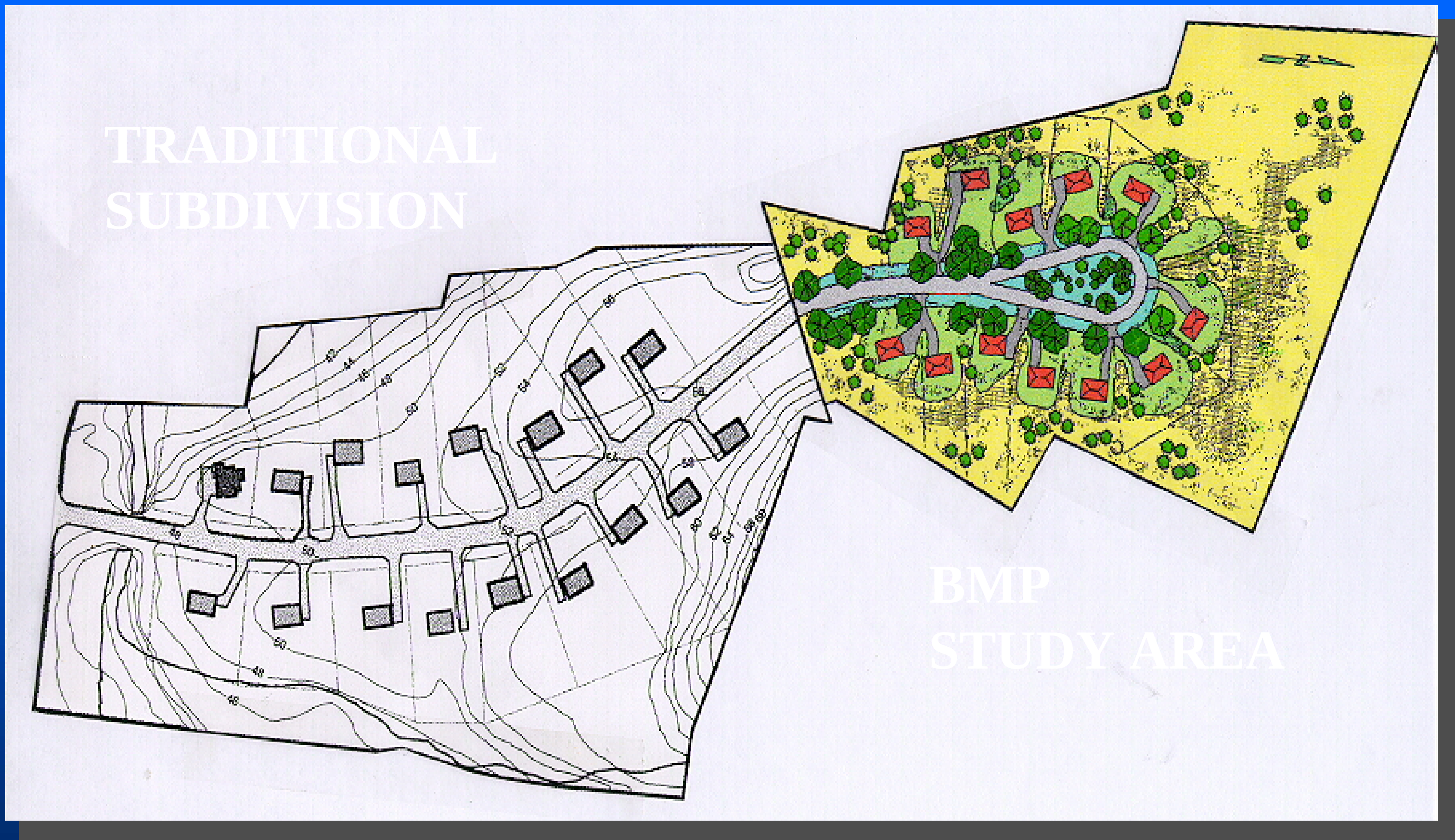

Deep Tilling

Maintenance of Rain Gardens

- First year requires vigilant weeding.
- Some watering at first, especially plants on berm.
- Dead plant debris should be removed in the spring.

Cost of Rain Gardens

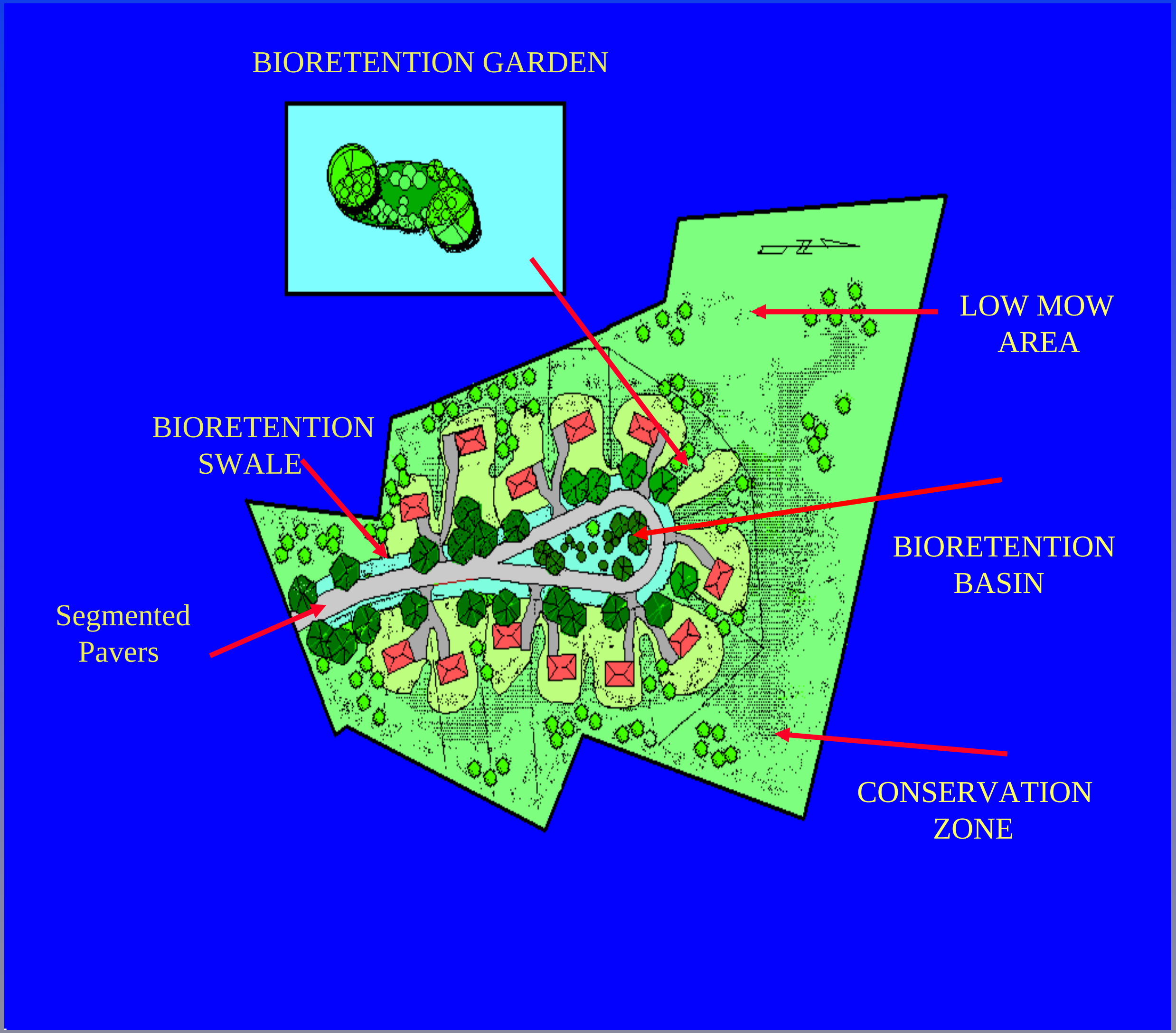
Cost of Landscape Contract in Dane County is about $12 to $15 per Square Foot. Includes Design, Construction, Plants, and Planting.



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



BMP STUDY AREA

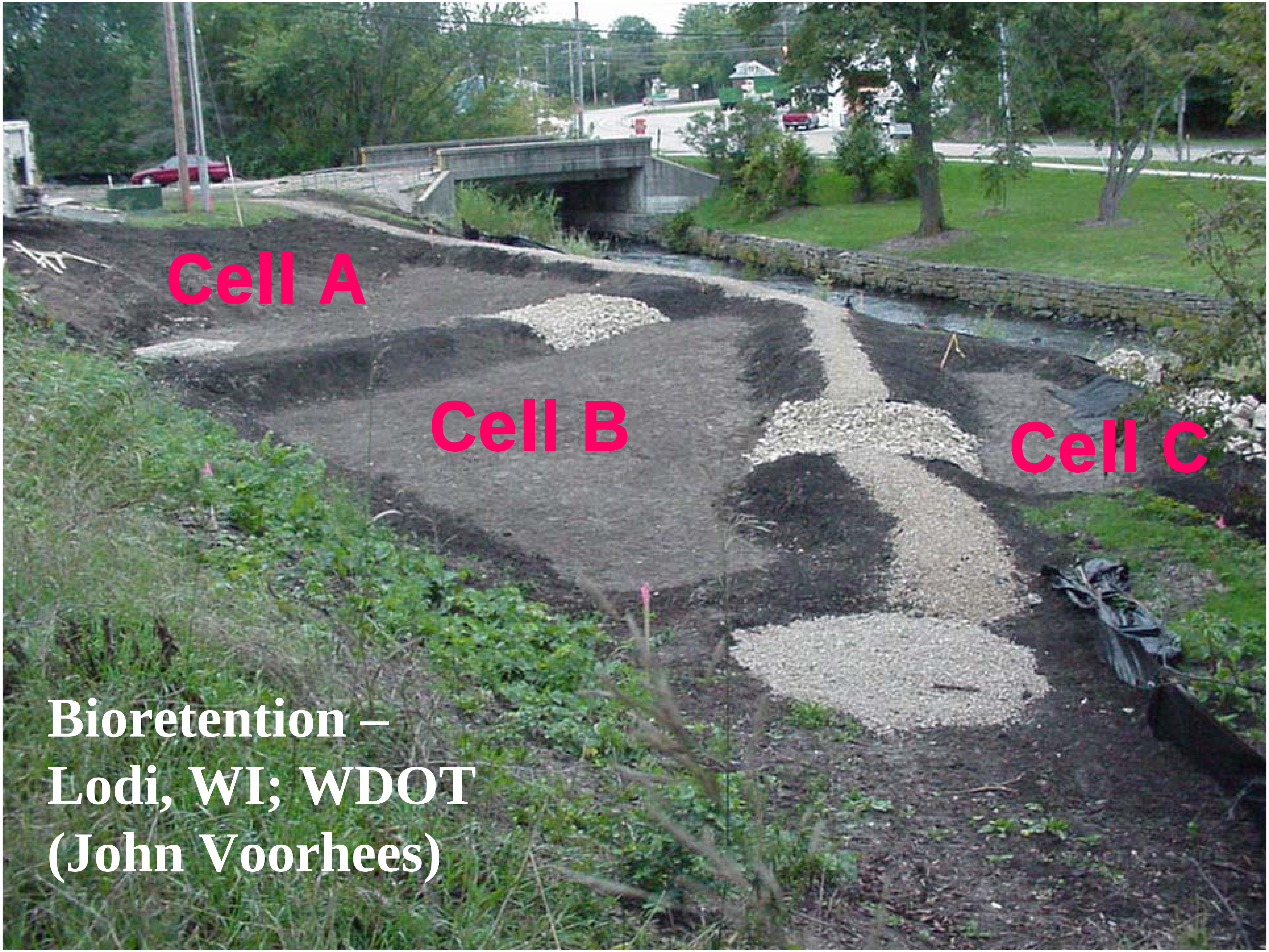
J O R D A N C O V E U R B A N W A T E R S H E D P R O J E C T

Waterford, Connecticut

J. Alexopoulos & J. Clausen

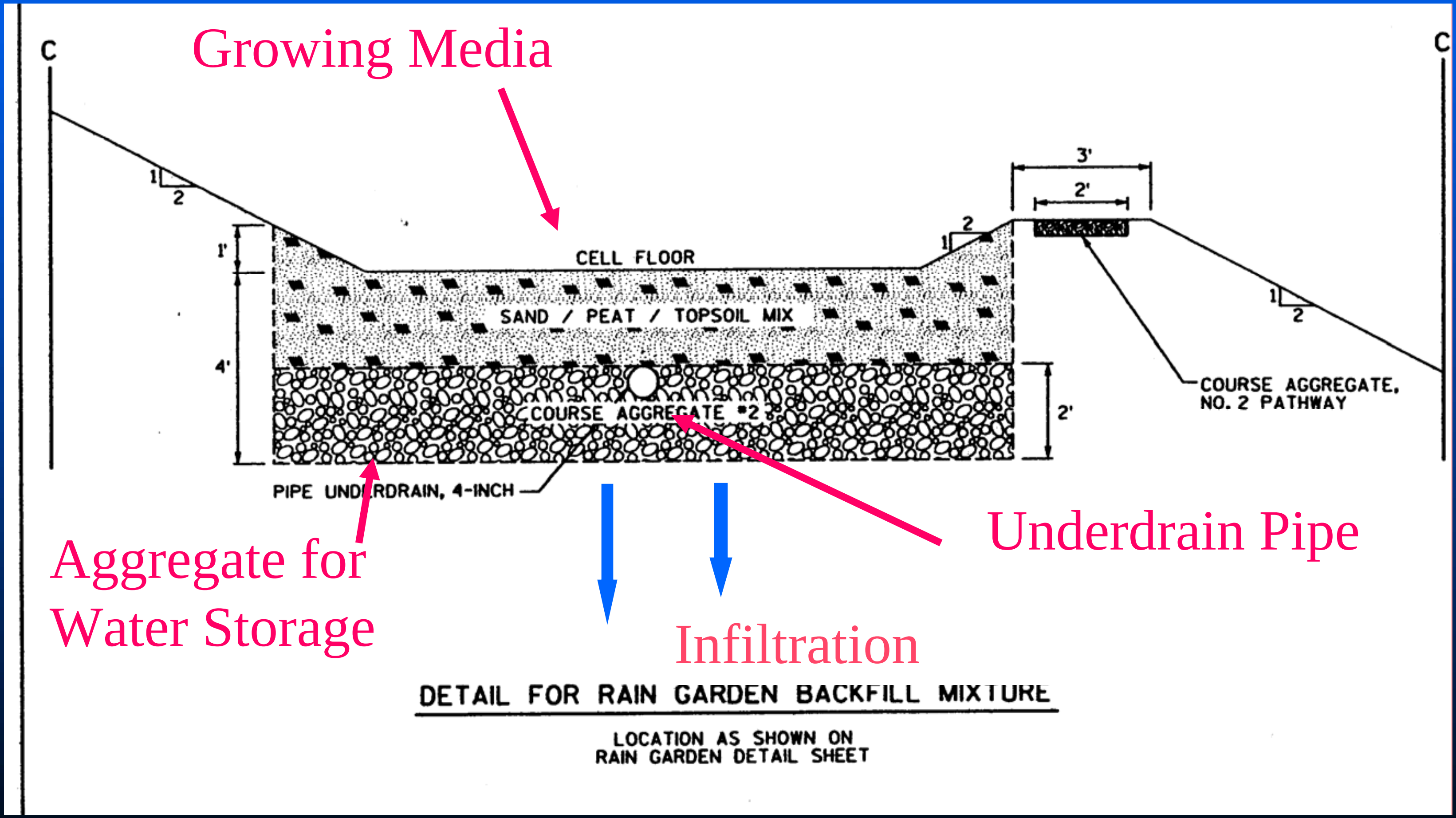
D. Gerwick, Engineering

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



Bioretention –
Lodi, WI; WDOT
(John Voorhees)

Bioretention Design



Partnership for Rain Gardens

Partnership for Rain Gardens

Partnership for Rain Gardens


WELCOME
PULL
Partnership for Rain Gardens


Auto Paradise
Rain Gardens At Work!


773
bobcat


UNIVERSITY OF WISCONSIN - EXTENSION