

Addressing Drainage Problems with Sustainable Landscape Solutions

2023 State Master Gardeners' Conference

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*Christopher C. Obropta, Ph.D., P.E.,
Extension Specialist in Water Resources*

obropta@envsci.rutgers.edu

www.water.rutgers.edu

Rutgers Cooperative Extension

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Water Resources Program



*Our mission is to identify
and address water
resources issues by
engaging and
empowering communities
to employ practical
science-based solutions to
help create a more
equitable and sustainable
New Jersey.*

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New Jersey

- Most densely populated state
- 21 Counties, 565 municipalities
- 95% of our waterways are impaired
- Harmful Algal Blooms (HABS) in many of our lakes
- Hammered by Ida, Henri, Sandy, and a bunch of Nor'easters
- Climate change is real – more severe storms and sea level rise



Homeowner Drainage Problems





Homeowner Drainage Problems

Municipal Drainage (Flooding) Problems



Can we manage stormwater better with sustainable landscape solutions?



What happens to the rain in our watersheds?



It runs off of rooftops and pavement...

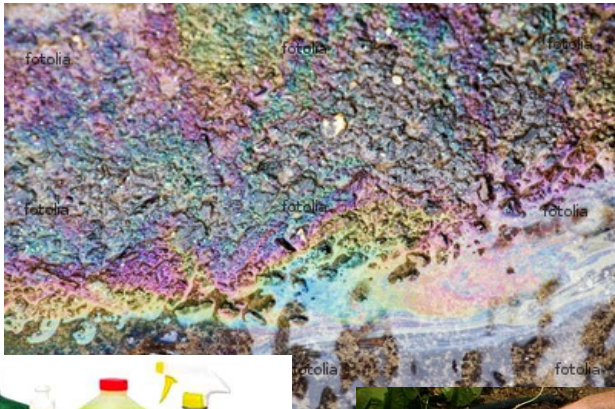
What is stormwater?

Stormwater is the water from rain or melting snows that can become “runoff,” flowing over the ground surface and returning to lakes and streams.

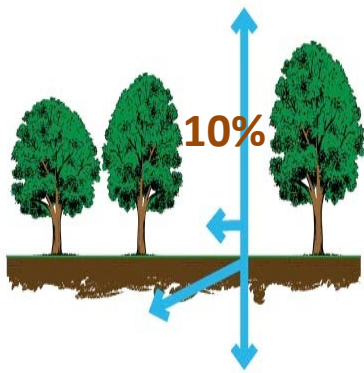


Examples of Nonpoint Source Pollution

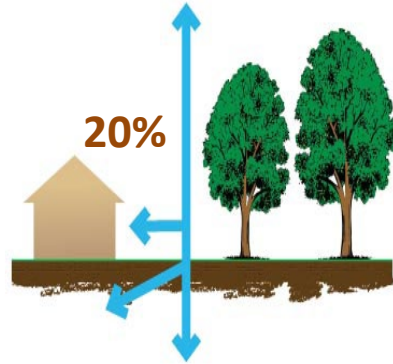
- Oil and grease from cars
- Fertilizers
- Animal waste
- Grass clippings
- Septic systems
- Sewage leaks
- Household cleaning products
- Litter
- Agriculture
- Sediment



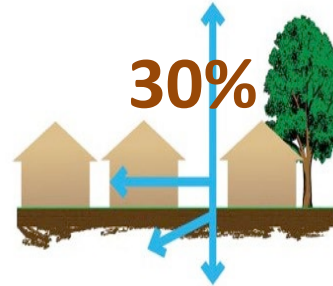
The Impact of Development on Stormwater Runoff



more development



→ *More impervious surfaces*



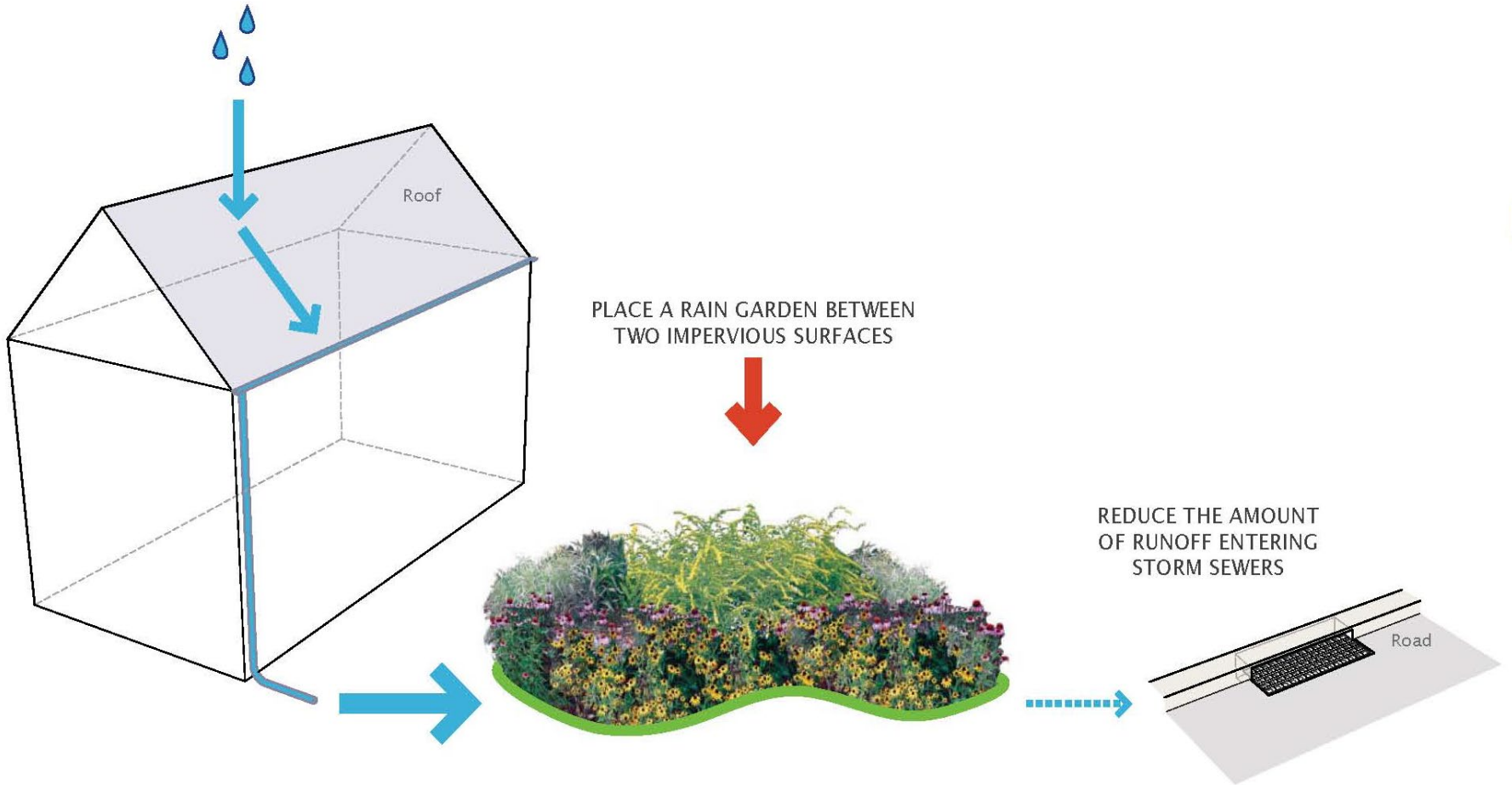
→ *more stormwater runoff*



Connected or Disconnected?

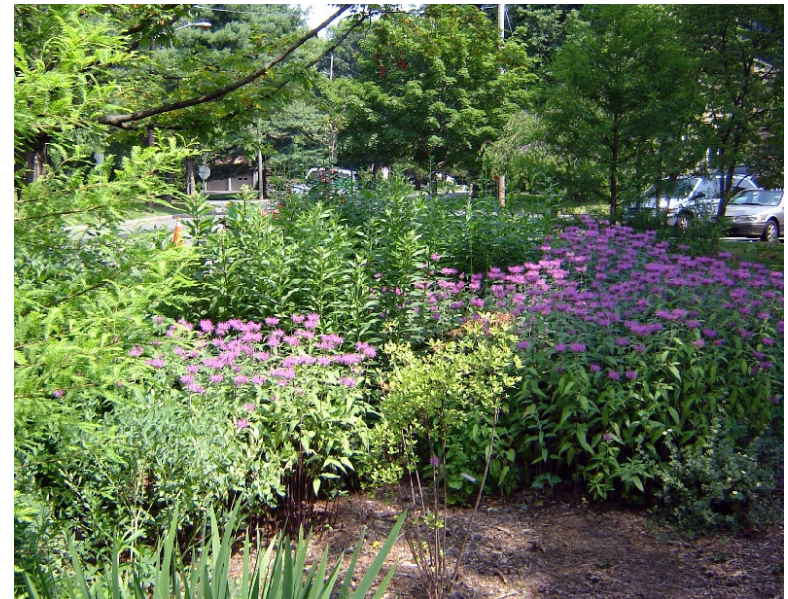


The Solution...



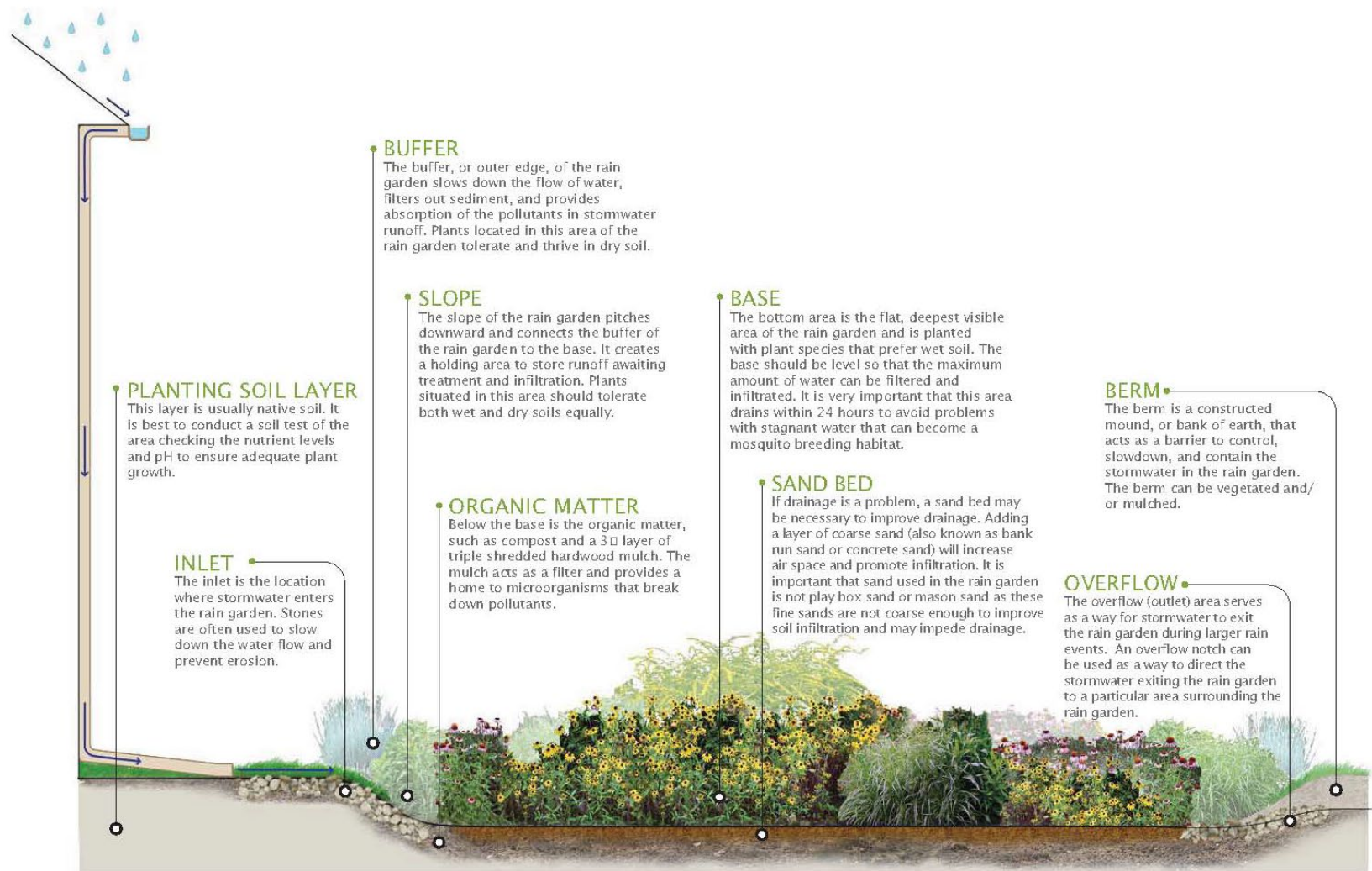
Rain Gardens

A rain garden is a landscaped, shallow depression that is designed to intercept, treat, and infiltrate stormwater at the source before it becomes runoff. The plants used in the rain garden are native to the region and help retain pollutants that could otherwise harm nearby waterways.





PARTS OF A RAIN GARDEN





SITE SELECTION & DESIGN

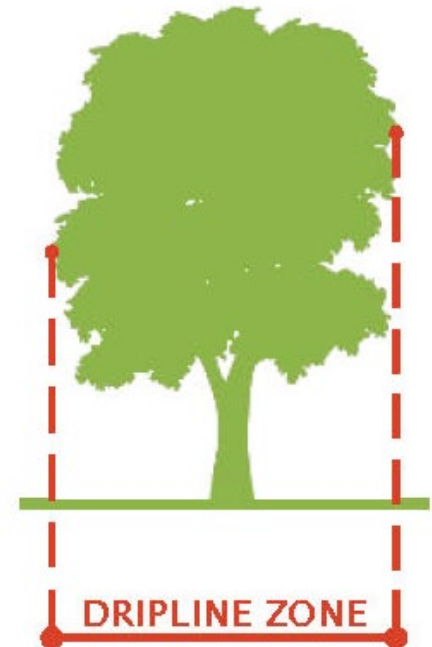
PLANNING YOUR RAIN GARDEN



SITE SELECTION



1. Next to a building with a basement, rain garden should be located min. 10' from building; no basement: 2' from building
2. Do not place rain garden within 25' of a septic system
3. Do not situate rain garden in soggy places where water already ponds
4. Avoid seasonably-high water tables within 2' of rain garden depth
5. Consider flat areas first – easier digging
6. Avoid placing rain garden within dripline of trees
7. Provide adequate space for rain garden








CALL BEFORE YOU DIG

LOCATE YOUR UTILITY LINES!

Call BEFORE You Dig!

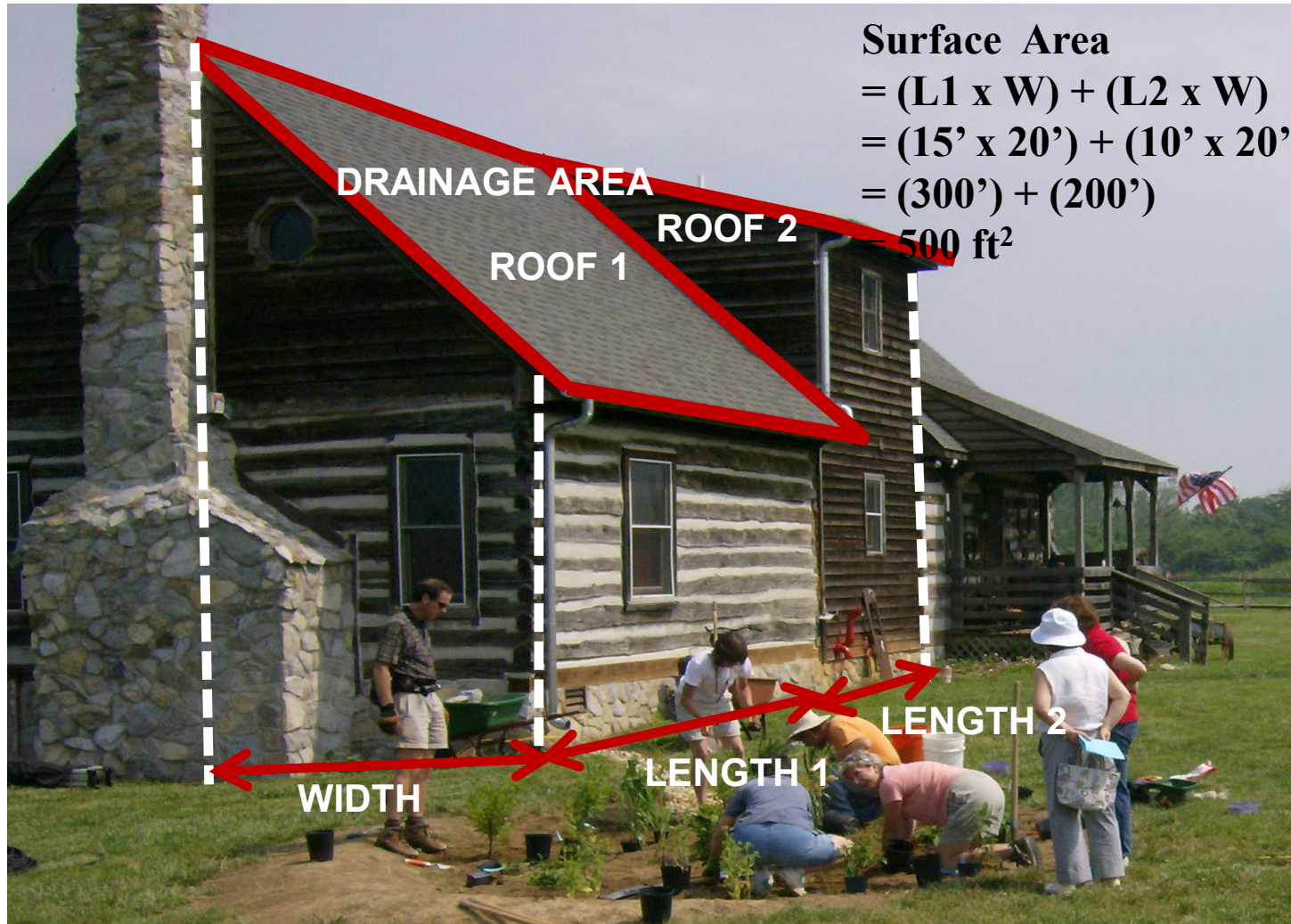
*NJ One Call
1-800-272-1000*

The different colors of the markout flags represent specific utilities.

-  ELECTRIC
-  GAS, OIL, STEAM
-  COMMUNICATIONS, CATV
-  WATER
-  SEWER

- **NJ One Call: 1-800-272-1000**
- Free markout of underground gas, water, sewer, cable, telephone, and electric utility lines
- Call at least 3 full working days, but not more than 10 days, prior to planned installation date
- Do not place rain garden within 5' horizontally and 1' vertically from any utilities

DRAINAGE AREA CALCULATION



Surface Area

$$= (L1 \times W) + (L2 \times W)$$

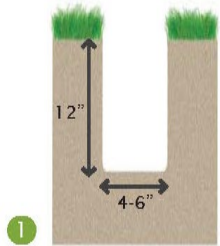
$$= (15' \times 20') + (10' \times 20')$$

$$= (300') + (200')$$

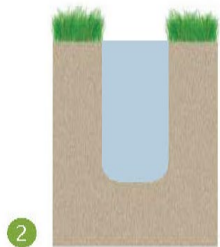
$$= 500 \text{ ft}^2$$



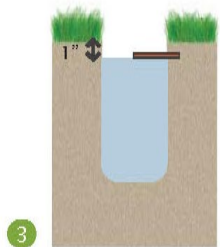
CHECK YOUR SOIL



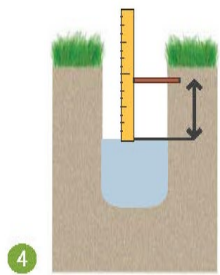
1



2



3



4

- Infiltration/Percolation Test

1. Dig a hole in the proposed rain garden site (12” deep, 4-6” wide)
2. Fill with water to saturate soil and then let stand until all the water has drained into the soil
3. Once water has drained, refill the empty hole again with water so that the water level is about 1” from the top of the hole
4. Check depth of water with a ruler every hour for at least 4 hours
5. Calculate how many inches of water drained per hour

DETERMINING THE DEPTH OF THE RAIN GARDEN



6" DEEP RAIN GARDEN - NO SOIL AMENDMENTS



3" DEEP RAIN GARDEN - SOIL AMENDMENTS



- Depth of rain garden is dependent upon the soil texture found at the site of the rain garden
- Depth is usually 3-8 inches

DETERMINING THE SIZE OF THE RAIN GARDEN



- The size of the rain garden is dependent upon the amount of runoff entering the rain garden

Rain Garden Sizing Table

Based on New Jersey's Water Quality Design Storm (1.25" of rain over 2 hours)

Drainage Area	Size of 3" Deep Rain Garden CLAY SOIL*	Size of 6" Deep Rain Garden SILTY SOIL	Size of 8" Deep Rain Garden SANDY SOIL
500 ft ²	200 ft ²	100 ft ²	75 ft ²
750 ft ²	350 ft ²	150 ft ²	112 ft ²
1,000 ft ²	400 ft ²	200 ft ²	149 ft ²
1,500 ft ²	600 ft ²	300 ft ²	224 ft ²
2,000 ft ²	800 ft ²	400 ft ²	299 ft ²

*SOIL TEXTURE AMENDMENTS NEEDED

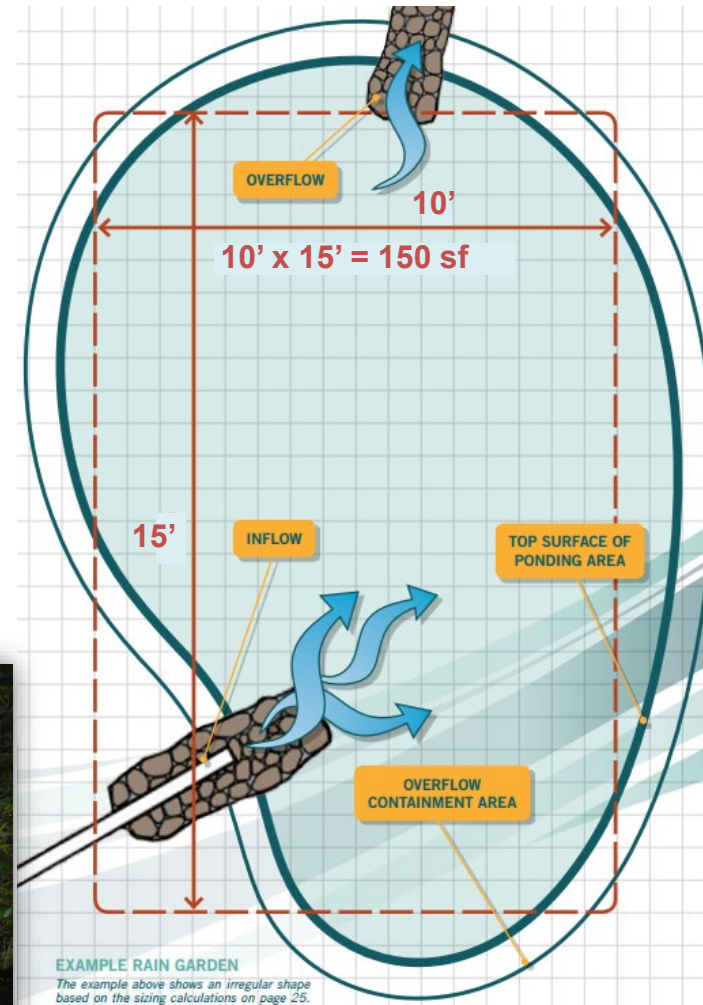
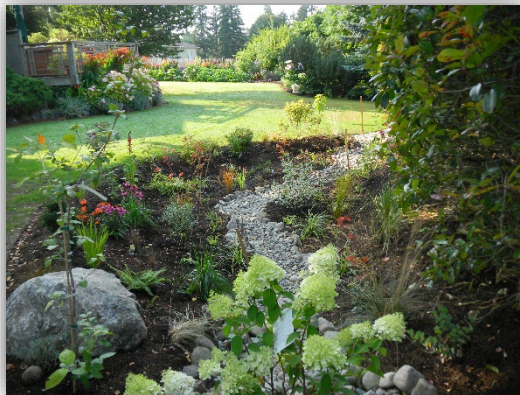
RAIN GARDENS

Typical Size

Modified from Rain Garden Handbook for Western WA

What is a typical rain garden size?

- Typically 100-200 square feet.
- A 100 square foot rain garden will often receive water from an area 5 to 10 times larger than the rain garden..





SOIL AMENDMENTS

- Soil amendments improve the rain garden's infiltration rate and help the plants grow





DETERMINING THE INLET AND OVERFLOW

- Stormwater runoff enters the rain garden from an **inlet**
- Stormwater exits through the **overflow**





PREVENTING EROSION

- Slope no greater than 3:1
- Slow down velocity of water flowing through rain garden
 - Add rocks to inlet area (River Stone)



DETERMINING MULCH QUANTITY



- Allow for a 3” depth mulch (triple-shredded hardwood with no dye) to be spread throughout the entire rain garden
- Every 100 square feet of rain garden needs 1 cubic yards (3” depth)



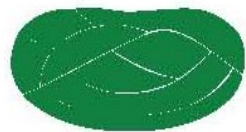
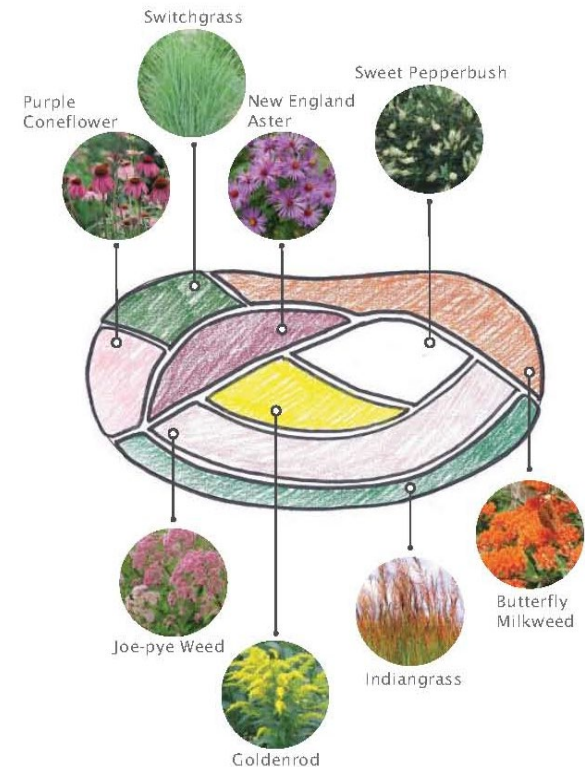


RAIN GARDEN DESIGN

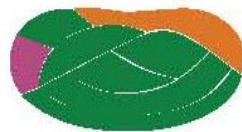
SHAPING YOUR RAIN GARDEN

- Use a garden hose or rope to outline the desired shape of your rain garden on the ground
- Many rain gardens are in the shape of a circle or kidney bean, but your rain garden can take on whatever shape you prefer

Butterfly Habitat Rain Garden: Planting Plan



May



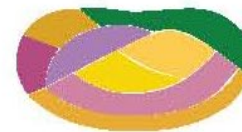
June



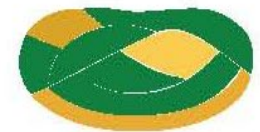
July



August



September



October



THE FUN PART!

INSTALLING YOUR RAIN GARDEN



STEP ONE

- Delineate rain garden area



- Remove existing grass with a shovel or machinery



STEP TWO

- Excavate to design depth based on necessary storage and soil amendment requirements



STEP THREE

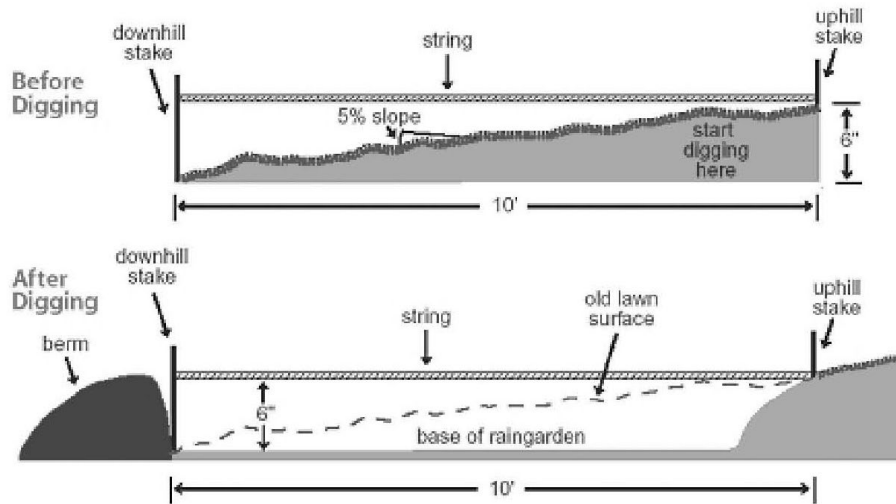
- Add soil amendments, if necessary



- Combine amendments with existing soil using shovels or rototiller
- Loosen and prepare soil for grading and planting

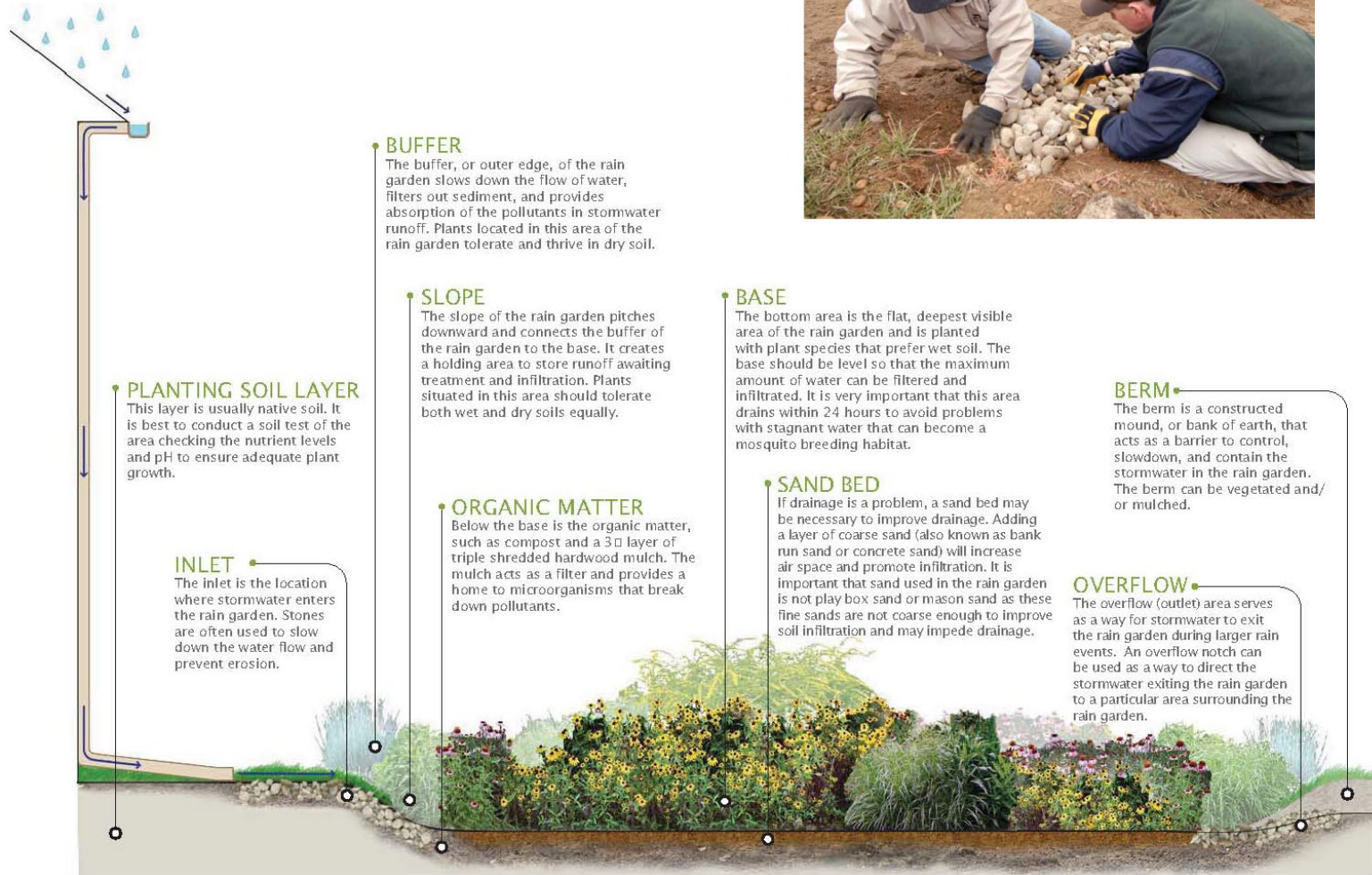
STEP FOUR

- Prepare the berm, if necessary



STEP FIVE

- Prepare the overflow



BUFFER

The buffer, or outer edge, of the rain garden slows down the flow of water, filters out sediment, and provides absorption of the pollutants in stormwater runoff. Plants located in this area of the rain garden tolerate and thrive in dry soil.

SLOPE

The slope of the rain garden pitches downward and connects the buffer of the rain garden to the base. It creates a holding area to store runoff awaiting treatment and infiltration. Plants situated in this area should tolerate both wet and dry soils equally.

BASE

The bottom area is the flat, deepest visible area of the rain garden and is planted with plant species that prefer wet soil. The base should be level so that the maximum amount of water can be filtered and infiltrated. It is very important that this area drains within 24 hours to avoid problems with stagnant water that can become a mosquito breeding habitat.

SAND BED

If drainage is a problem, a sand bed may be necessary to improve drainage. Adding a layer of coarse sand (also known as bank run sand or concrete sand) will increase air space and promote infiltration. It is important that sand used in the rain garden is not play box sand or mason sand as these fine sands are not coarse enough to improve soil infiltration and may impede drainage.

ORGANIC MATTER

Below the base is the organic matter, such as compost and a 3" layer of triple shredded hardwood mulch. The mulch acts as a filter and provides a home to microorganisms that break down pollutants.

PLANTING SOIL LAYER

This layer is usually native soil. It is best to conduct a soil test of the area checking the nutrient levels and pH to ensure adequate plant growth.

INLET

The inlet is the location where stormwater enters the rain garden. Stones are often used to slow down the water flow and prevent erosion.

BERM

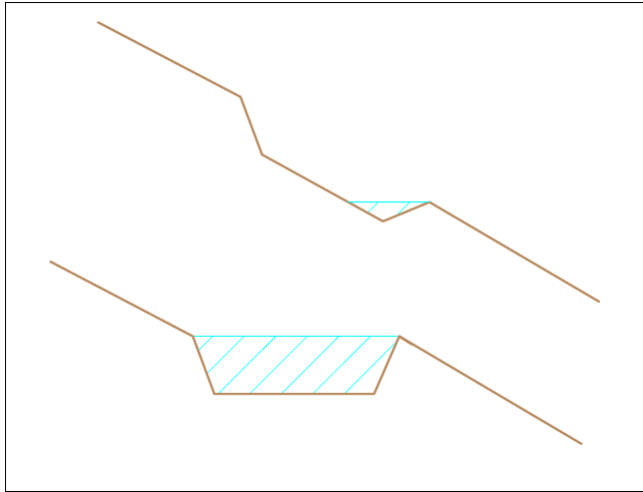
The berm is a constructed mound, or bank of earth, that acts as a barrier to control, slowdown, and contain the stormwater in the rain garden. The berm can be vegetated and/or mulched.

OVERFLOW

The overflow (outlet) area serves as a way for stormwater to exit the rain garden during larger rain events. An overflow notch can be used as a way to direct the stormwater exiting the rain garden to a particular area surrounding the rain garden.

STEP SIX

- Level the rain garden base



STEP SEVEN

- Plant native species



STEP EIGHT

- Apply mulch



- Allow for a 3” depth mulch (triple-shredded hardwood with no dye) to be spread throughout the entire rain garden
- For every 100 square feet of rain garden, you will need about 1 cubic yard of mulch (3” depth)

STEP NINE

- Water Plants



STEP TEN

- Appreciate a job well done





RAIN GARDEN PLANTING DESIGN



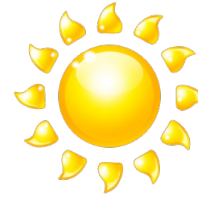
DESIGN AESTHETICS

- Formal or traditional design
 - Shrub bed
 - Perennial garden
 - Hedges
- Naturalized planting & design
 - Butterfly garden
 - Meadow (warm season grasses & wildflowers)
 - Buffer plantings



SITE CONSTRAINTS

- Sun vs. shade
- Exposure/wind
- Soil characteristics
- Hydrologic conditions
- Road salts
- Vehicle/pedestrian traffic



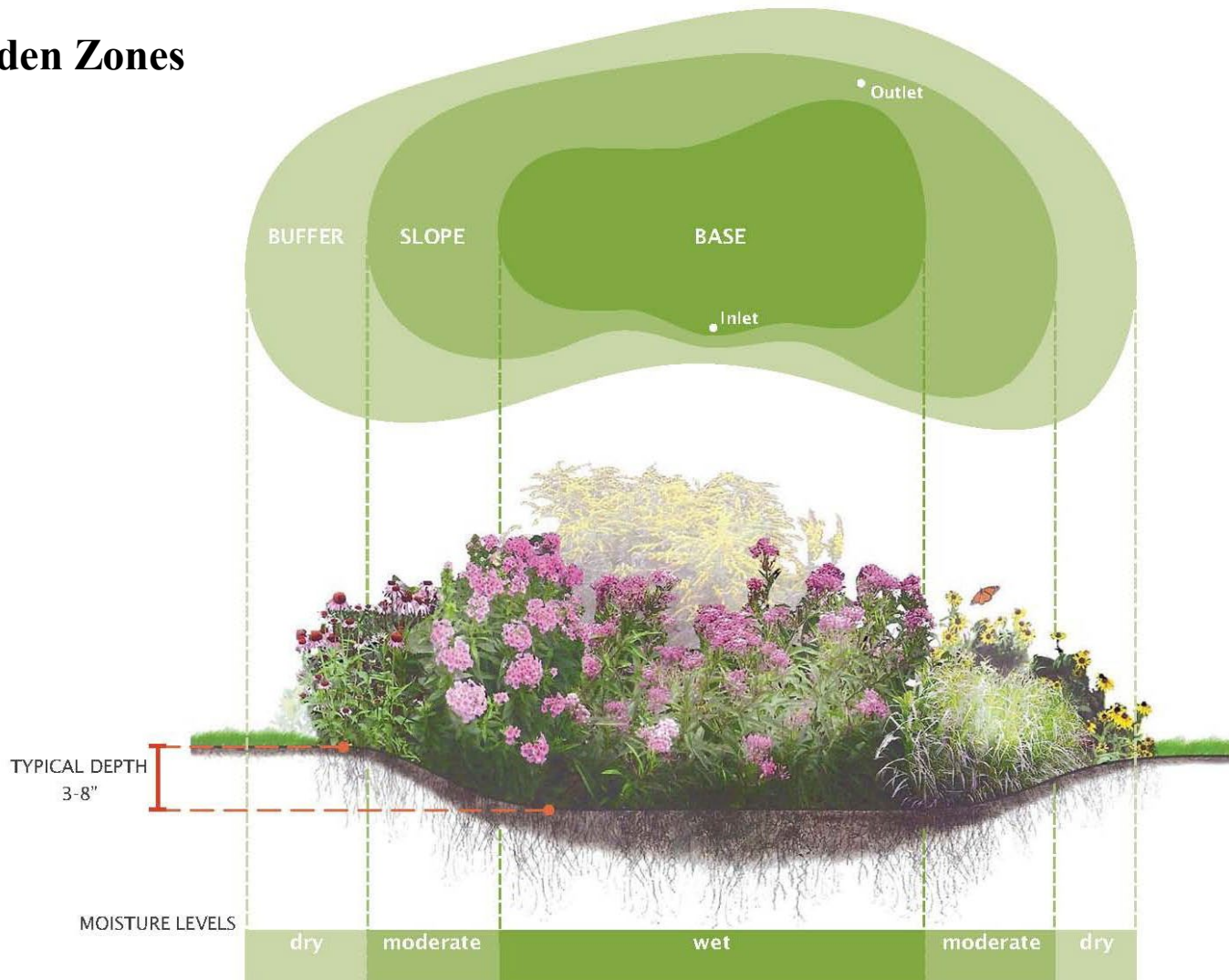
PLANTS IN THE RIGHT PLACE...



Courtesy of Pinelands Nursery & Supply

PLANTING DESIGN: Wet + Dry Conditions

Rain Garden Zones



SELECTING PLANT SPECIES

- Mature plant size
 - Proximity to buildings and utility lines
 - Pruning and shaping
- Seasonal interest
 - Flowers
 - Fall color
 - Winter character
- Beneficial wildlife
 - Flowers for butterflies
 - Fruits for song birds



GRASSES & GROUND COVERS



BUFFER

- Broomsedge
- Bearberry
- Panic grass
- Switchgrass
- Little bluestem
- Indiangrass

BASE

- Big bluestem
- Virginia wild-rye
- Switchgrass
- Wool grass

SLOPE

- Bluejoint grass
- Sedges
- Fowl mannagrass
- Softrush



GRASSES & GROUND COVERS

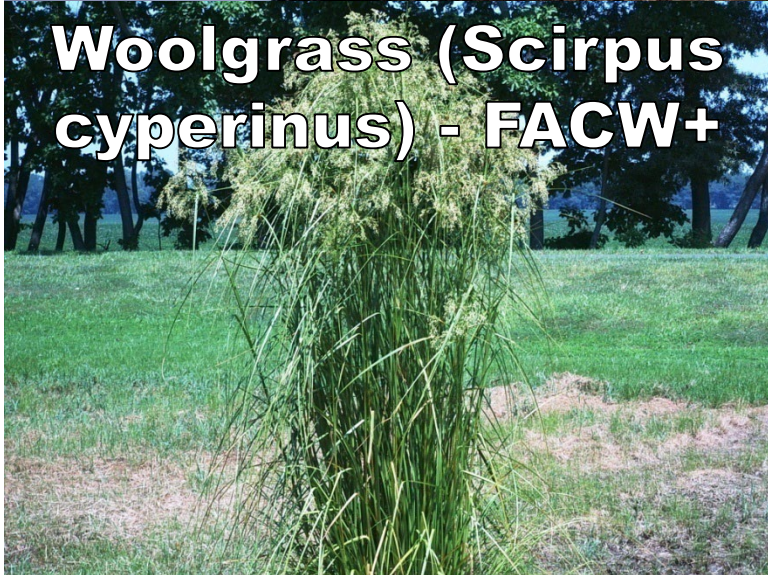
Switchgrass
(*Panicum virgatum*) - FAC



Tussock Sedge
(*Carex stricta*) - OBL



Woolgrass (*Scirpus cyperinus*) - FACW+



Little Bluestem
(*Schizachyrium scoparium*) - FACU



GRASSES & GROUND COVERS

Soft Rush –
Juncus effusus



Panic Grass –
Panicum



WILDFLOWERS & FERNS



BUFFER

- Butterfly milkweed
- Wild indigo
- Purple coneflower
- Beebalm
- Black-eyed susan

BASE

- New England aster
- New York aster
- Columbine
- Coreopsis
- Joe-pye weed
- Blazing star
- Sensitive fern
- Cinnamon fern
- Ironweed

SLOPE

- Swamp milkweed
- Marsh marigold
- Turtlehead
- Boneset
- Rose-mallow/hibiscus
- Blueflag iris
- Cardinal flower
- Blue lobelia
- Monkey flower



WILDFLOWERS



Blue Lobelia –
Lobelia siphilitica



Cardinal Flower -
Lobelia cardinalis



TREES & SHRUBS



BUFFER

- Hackberry
- Red Bud
- Pepperbush
- American Holly
- Bayberry
- Witchhazel
- White Oak
- Red Oak
- Arrowwood
- Viburnum

BASE

- Red Maple
- Service Berry
- River Birch
- Silky Dogwood
- Red-twig Dogwood
- Inkberry Holly
- Winterberry
- Sweetbay
- Magnolia

SLOPE

- River Birch
- Buttonbush
- Silky Dogwood
- Green Ash
- Swamp White Oak
- Pin Oak
- Cranberrybush
- Viburnum



TREES & SHRUBS



**Summersweet
(*Clethra alnifolia*) - FAC+**



**Winterberry Holly
(*Ilex verticillata*) - FACW+**



**River Birch
(*Betula nigra*) - FACW**

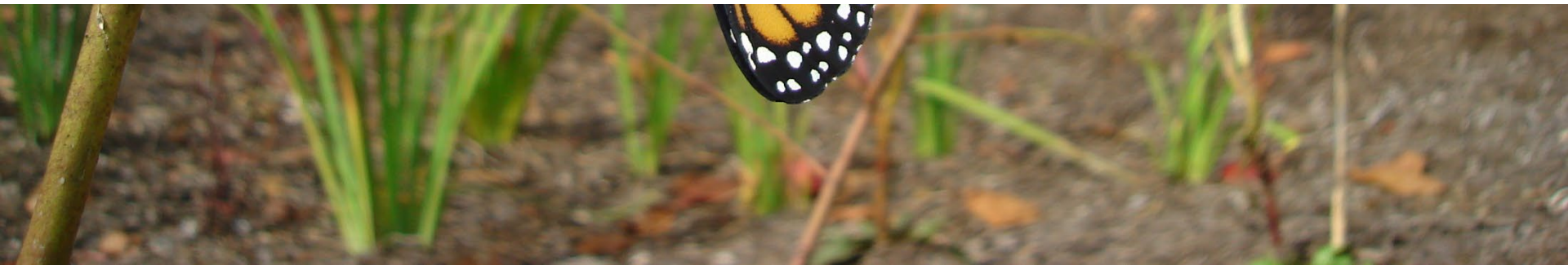


**Inkberry Holly
(*Ilex glabra*) - FACW-**



INSPECTION AND MAINTENANCE

MAINTAINING YOUR RAIN GARDEN



MAINTENANCE MEASURES

WEEKLY TASKS:

1. Watering
2. Weeding
3. Inspecting

ANNUAL TASKS:

1. Mulching
2. Pruning
3. Re-planting
4. Removing sediment
5. Soil Testing
6. Harvesting Plants
7. Cleaning of Gutters
8. Replacing materials (stone, landscape fabric)

Climate Change in New Jersey

- More warm extremes and fewer cold extremes
- Heavy rains become more intense
- More intense dry spells
- Rising sea level with increased frequency and intensity of coastal flooding



NEW JERSEY 24 HOUR RAINFALL FREQUENCY DATA

Rainfall Amounts in Inches

County	1 year	2 year	5 year	10 year	25 year	50 year	100 year
Atlantic	2.72	3.31	4.30	5.16	6.46	7.61	8.90
Bergen	2.75	3.34	4.27	5.07	6.28	7.32	8.47
Burlington	2.77	3.36	4.34	5.18	6.45	7.56	8.81
Camden	2.73	3.31	4.25	5.06	6.28	7.34	8.52
Cape May	2.67	3.25	4.22	5.07	6.34	7.47	8.73
Cumberland	2.69	3.27	4.25	5.09	6.37	7.49	8.76
Essex	2.85	3.44	4.40	5.22	6.44	7.49	8.66
Gloucester	2.71	3.29	4.24	5.05	6.29	7.36	8.55
Hudson	2.73	3.31	4.23	5.02	6.19	7.20	8.31
Hunterdon	2.80	3.38	4.26	5.00	6.09	7.02	8.03
Mercer	2.74	3.31	4.23	5.01	6.19	7.20	8.33
Middlesex	2.76	3.35	4.30	5.12	6.36	7.43	8.63
Monmouth	2.79	3.38	4.38	5.23	6.53	7.66	8.94
Morris	2.94	3.54	4.47	5.24	6.37	7.32	8.35
Ocean	2.81	3.42	4.45	5.33	6.68	7.87	9.20
Passaic	2.87	3.47	4.42	5.23	6.43	7.47	8.62
Salem	2.69	3.26	4.20	5.00	6.22	7.28	8.45
Somerset	2.76	3.34	4.25	5.01	6.15	7.13	8.21
Sussex	2.68	3.22	4.02	4.70	5.72	6.60	7.58
Union	2.80	3.39	4.35	5.17	6.42	7.49	8.69
Warren	2.78	3.34	4.18	4.89	5.93	6.83	7.82

Future Adjusted (per NJDEP Factors 2023)

County	2-YR	10-YR	100-YR
Atlantic	4.04	6.40	12.37
Bergen	4.01	6.24	11.60
Burlington	3.93	6.11	11.63
Camden	3.91	6.17	11.84
Cape May	3.93	6.29	11.52
Cumberland	3.92	6.16	12.18
Essex	4.09	6.37	11.52
Gloucester	3.92	6.21	12.06
Hudson	3.94	5.97	10.22
Hunterdon	4.02	6.15	11.40
Mercer	3.84	5.86	11.33
Middlesex	3.99	6.20	11.48
Monmouth	4.02	6.22	11.26
Morris	4.35	6.71	12.19
Ocean	4.04	6.34	11.41
Passaic	4.20	6.64	12.93
Salem	3.91	6.15	11.15
Somerset	3.97	6.21	12.15
Sussex	3.99	6.06	11.37
Union	4.07	6.36	11.73
Warren	4.01	6.11	10.71

DETERMINING THE SIZE OF THE RAIN GARDEN FOR CLIMATE CHANGE

Rain Garden Sizing Table

Based on New Jersey's Water Quality Design Storm (1.5" of rain over 2 hours)

Drainage Area	Size of 3" Deep Rain Garden CLAY SOIL*	Size of 6" Deep Rain Garden SILTY SOIL	Size of 8" Deep Rain Garden SANDY SOIL
500 ft ²	250 ft ²	125 ft ²	94 ft ²
750 ft ²	438 ft ²	188 ft ²	140 ft ²
1,000 ft ²	500 ft ²	250 ft ²	186 ft ²
1,500 ft ²	750 ft ²	375 ft ²	280 ft ²
2,000 ft ²	1000 ft ²	500 ft ²	374 ft ²

***SOIL TEXTURE
AMENDMENTS NEEDED**

Bioswale

NATIVE PLANTS

A bioswale is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions. The vegetation helps filter stormwater runoff as it moves through the system.

CONVEYANCE

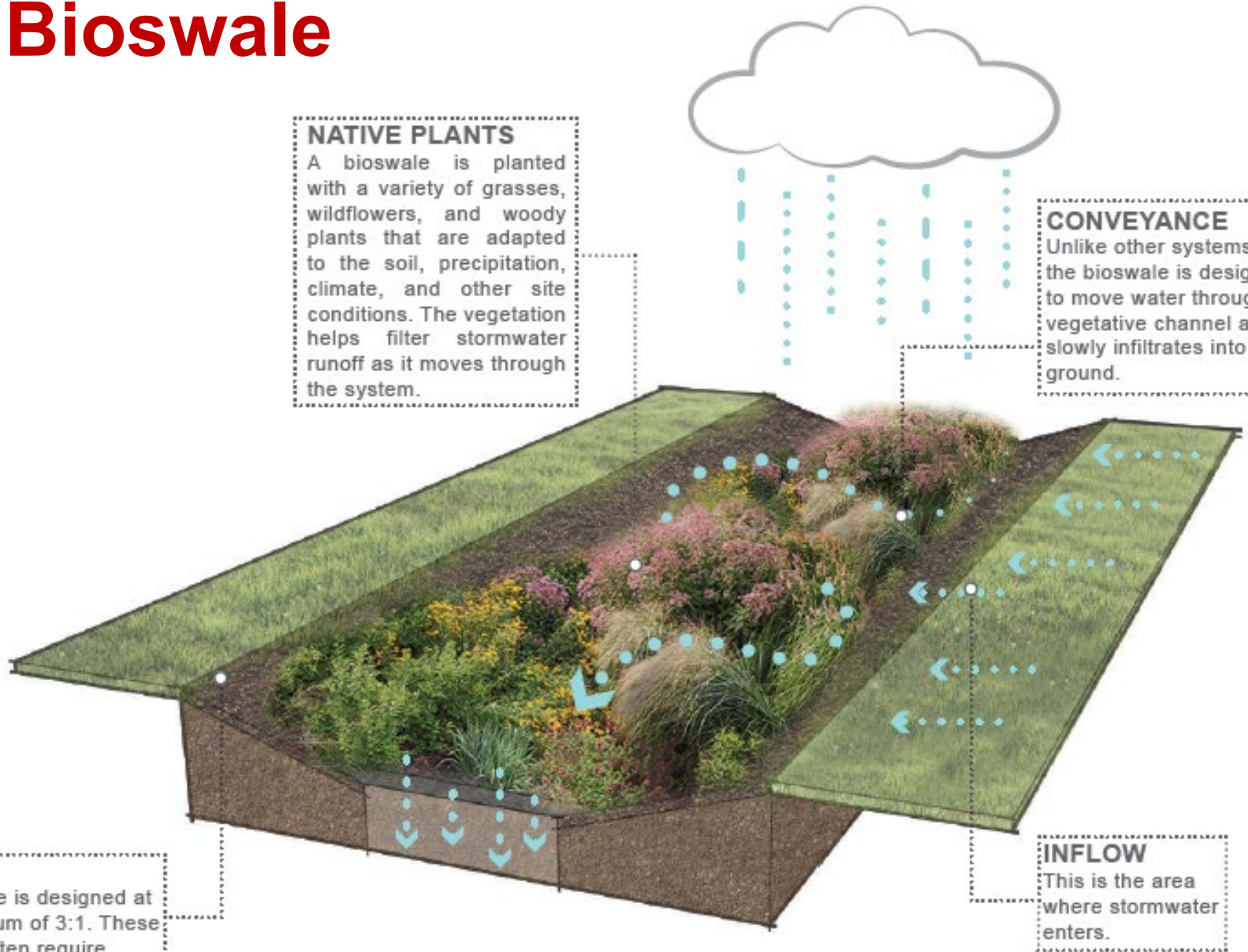
Unlike other systems, the bioswale is designed to move water through a vegetative channel as it slowly infiltrates into the ground.

SLOPE

The slope is designed at a maximum of 3:1. These slopes often require erosion control materials for stabilization.

INFLOW

This is the area where stormwater enters.



Bioswale



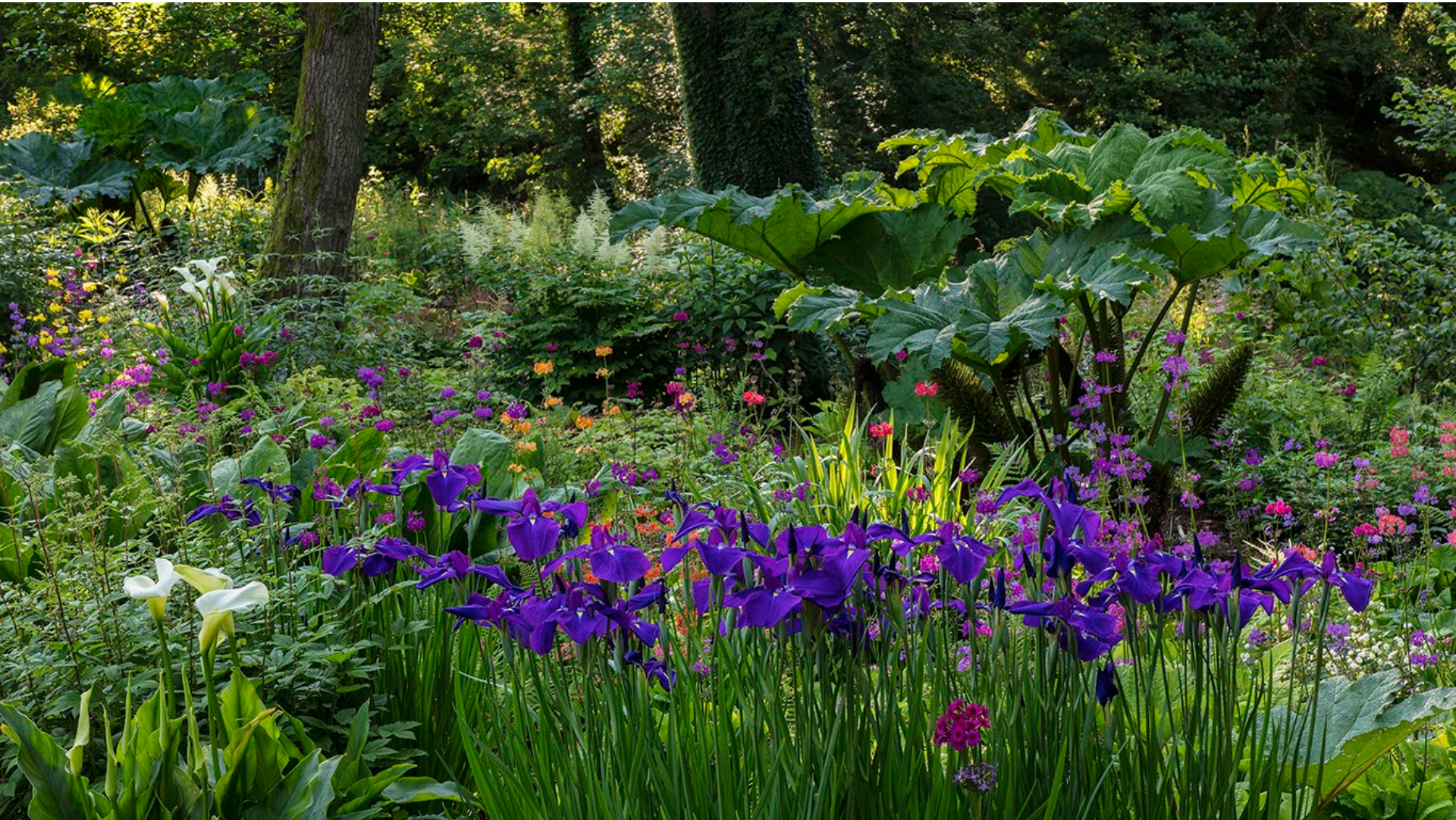
Native Meadow



Naturalize Detention Basin



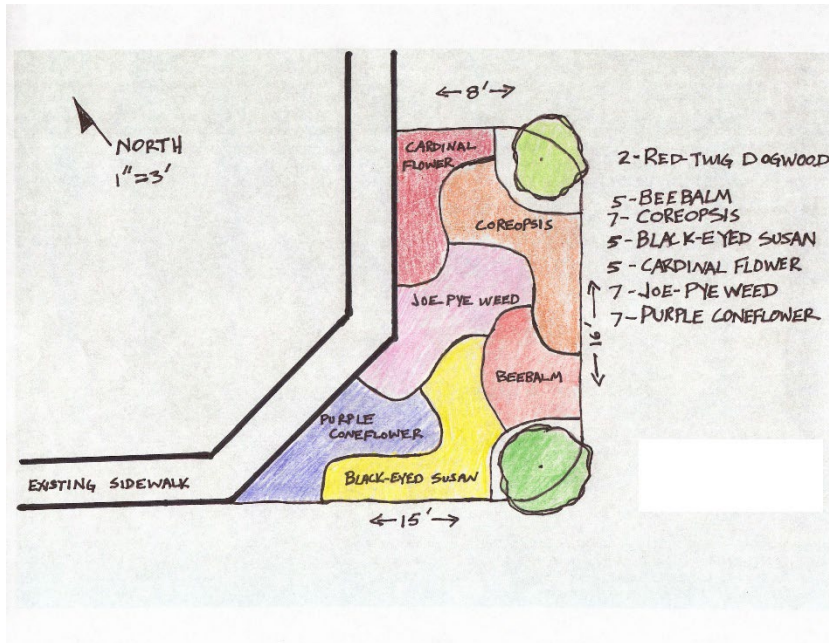
**If it is too wet,
try a Biofilter Wetland**



Installed Rain Gardens from the Rain Garden Rebate Program

Design Example for Roof Runoff

Design



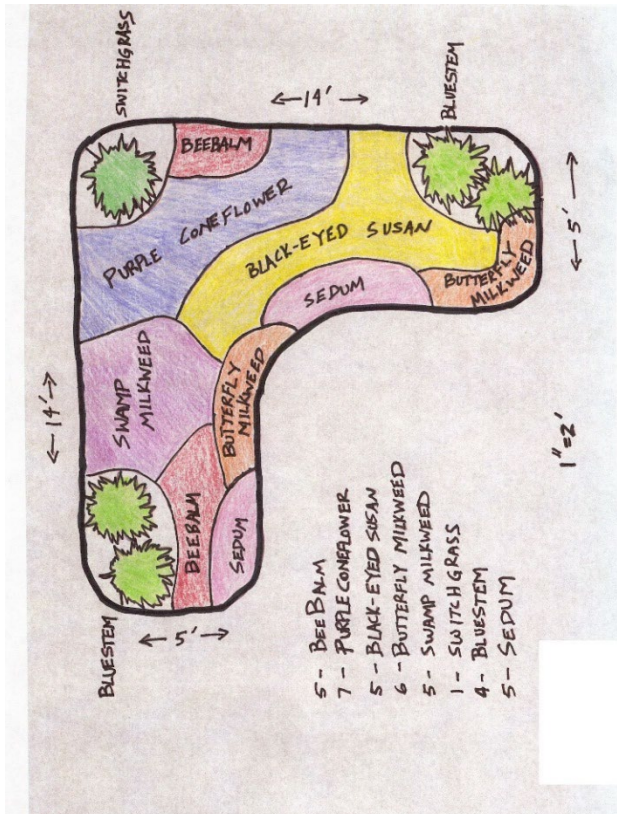
Installed Rain Garden





Design Example for Parking Lot Runoff

Design



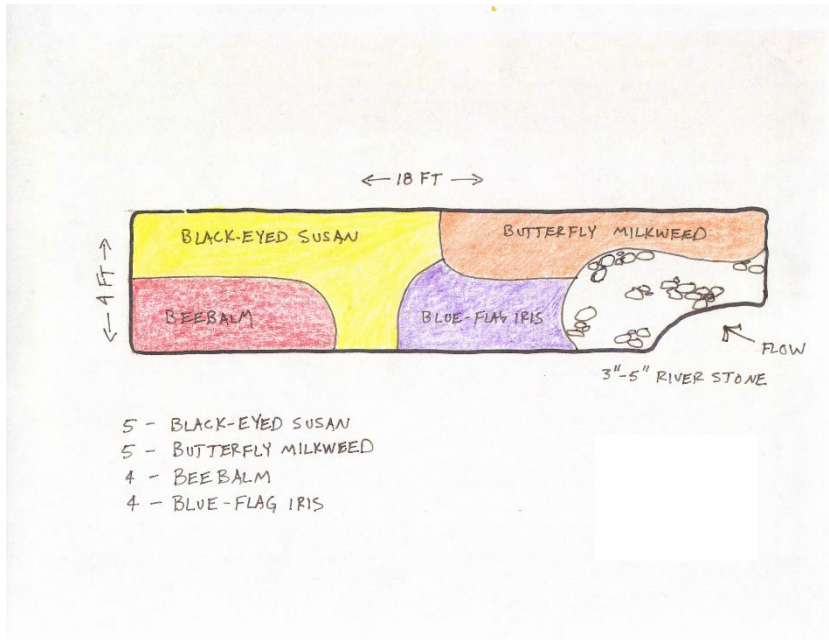
Installed Rain Garden



Roof, Sump Pump and Driveway Runoff – WOW!

Design

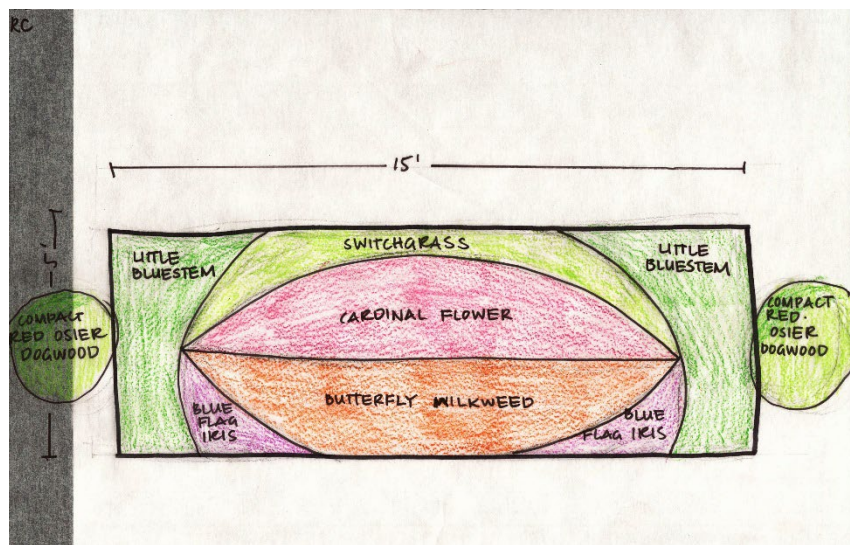
Installed Rain Garden





Roof Runoff from Rain Barrel Overflow

Design

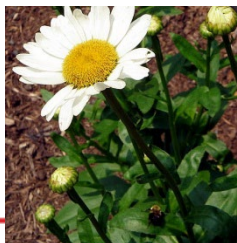


Installed Rain Garden





Lots of Rain Gardens















10/12/2018



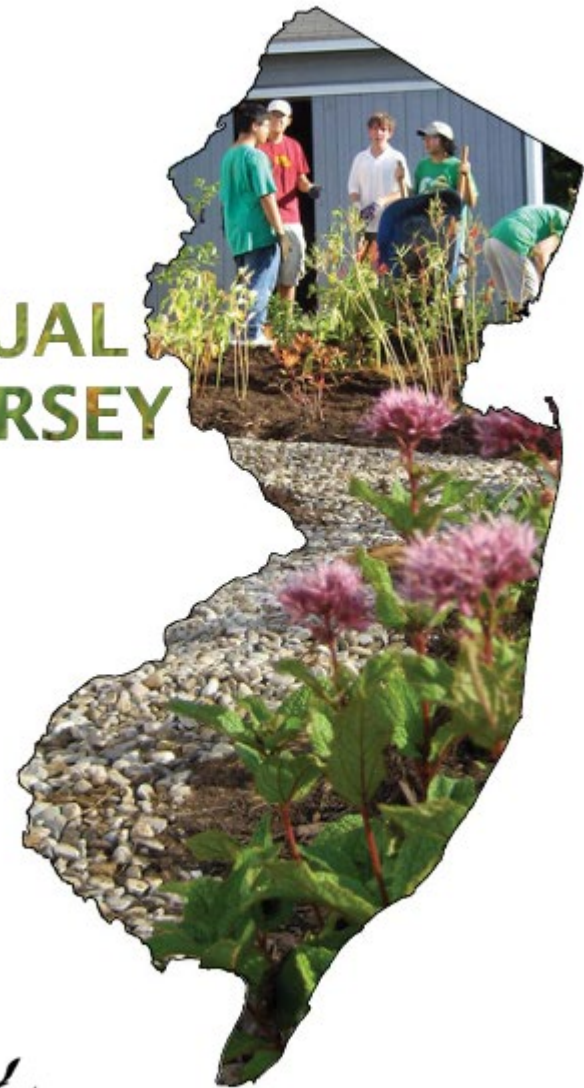
10/12/2015

Season 2



10/12/2018

RAIN GARDEN MANUAL OF NEW JERSEY





Rain Garden 4+

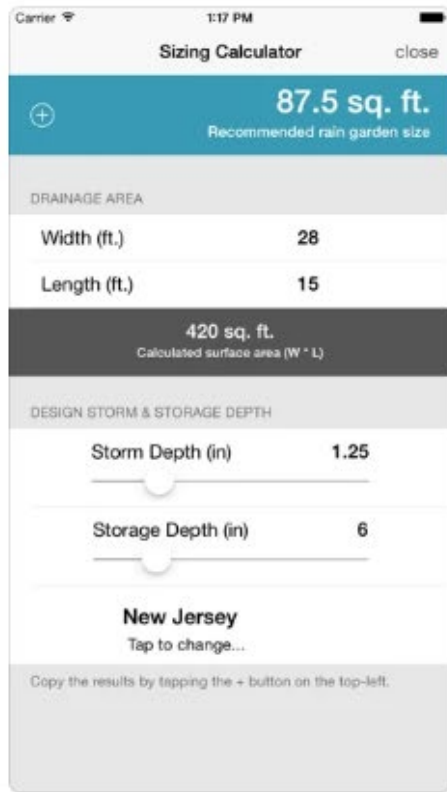
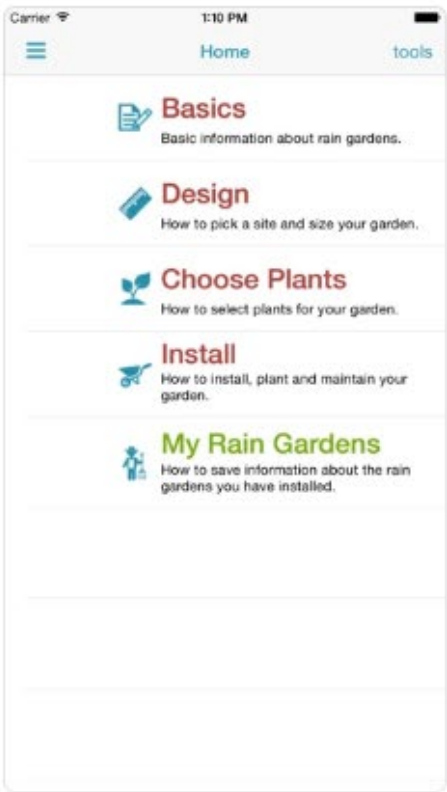
University of Connecticut

Designed for iPhone

★★★★☆ 2.6 • 11 Ratings

Free

iPhone Screenshots



Rain Garden Rebates are Available

- Rebates of up to \$600 per home.
- Rebate availability may vary.

Qualifying homeowners are residents of the following areas:

- Evesham • Pemberton • Lumberton • Mt. Holly • Mt. Laurel
- Gibbsboro • Berlin Twp. • Berlin Borough • Millville
- Vineland • Swedesboro • Woolwich • Mullica Hill • Oldsman Twp. • Carney's Point • Morristown* • Hanover Twp.* • Mt. Olive* • Stanhope Twp.* • Hopatcong Borough* • Netcong Borough* • Roxbury Township* • Egg Harbor* • Hammonton* • Winslow*

* Rebate only available for lakeside properties

For more on rain garden rebates:

If you have questions, please reach out to Stephen Elliott at stephen@pinelandsalliance.org, or over the phone at 609 859 8860 ext 127

Below is the website where you can sign up for the education session: (next session will be in Spring 2024)

<https://www.sjwatersavers.org/makeover-sessions/>

Let's get back to flooding – bioretention is an option but does it take up too much space?



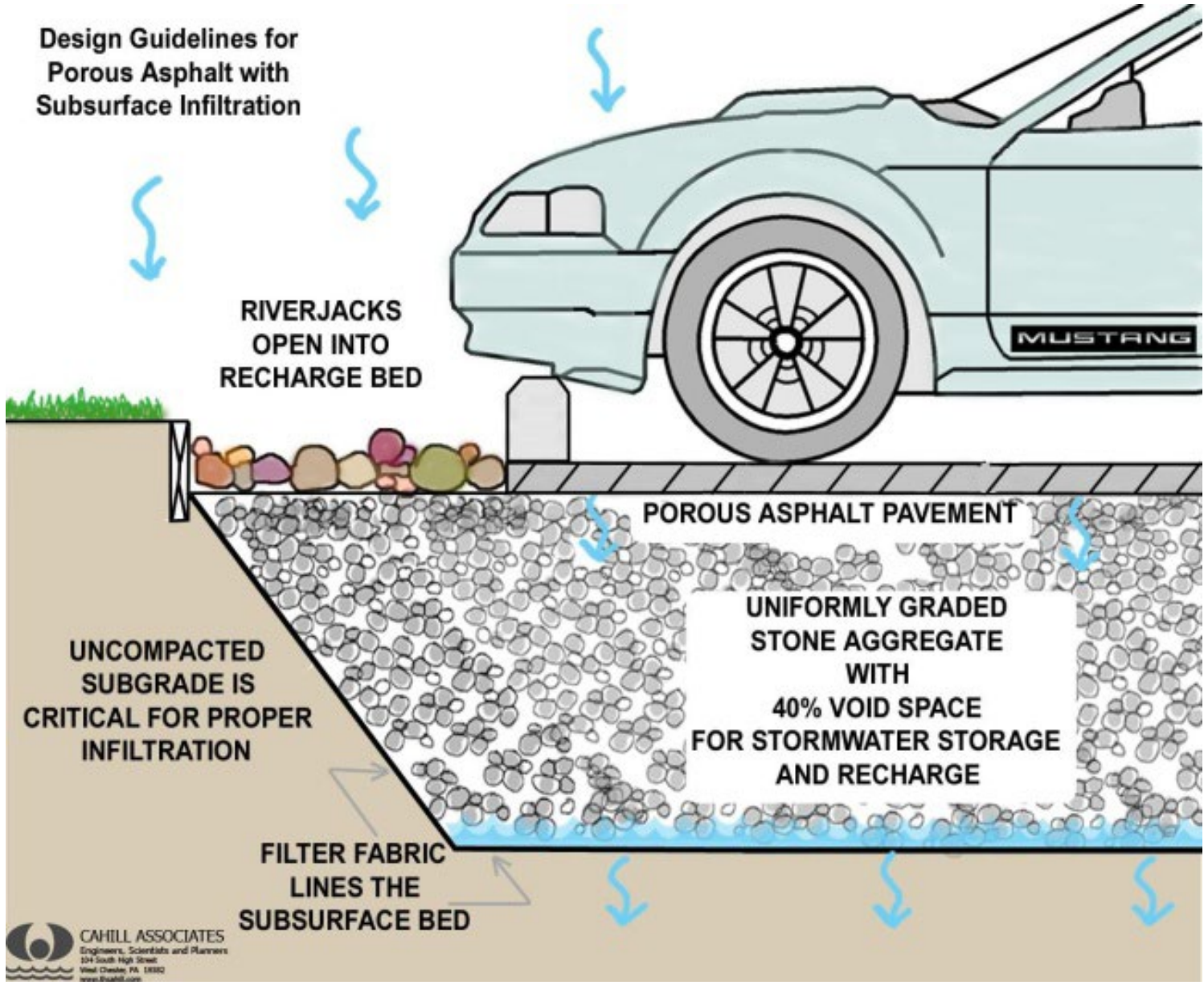


7. 24. 2003





**Design Guidelines for
Porous Asphalt with
Subsurface Infiltration**



Green Infrastructure Champions Program

Green Infrastructure Champions are key players in implementing green infrastructure as a stormwater management approach in their community.



Cheryl Reardon works for the ANJEC



Nathaniel Sajdak works for the Wallkill River Watershed Management Group



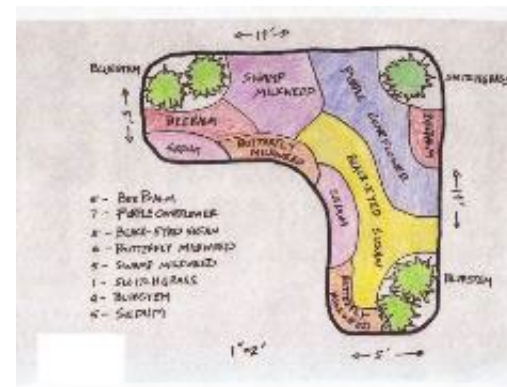
Laura McBride created the Deal Lake Watershed Alliance

Rutgers inputs to the Green Infrastructure Champion Program

- 10 training classes on various aspects of green infrastructure planning and implementation
- Professional staff to provide technical support to develop a design for a green infrastructure demonstration project
- Networking opportunities with other Green Infrastructure Champions for mutual support
- Assistance with grant writing and submission

GI Champions Classes

1. How to identify green infrastructure projects in your town
2. Moving from planning to implementation of green infrastructure
3. Maintaining green infrastructure practices/projects
4. Stormwater management regulations, policies, and ordinances
5. Green infrastructure planning and implementation for Sustainable Jersey points



GI Champions Classes

6. Green infrastructure projects for schools
7. How to design and build a rain garden
8. Retrofitting traditional detention basins with green infrastructure
9. Developing green infrastructure master plans for an entire site or neighborhood
10. Using green infrastructure to promote climate resiliency

Classes Start on January 12, 2024



THANK YOU!

www.water.rutgers.edu

*Christopher C. Obropta, Ph.D., P.E.,
Extension Specialist in Water Resources*

obropta@envsci.rutgers.edu

and

Hollie DiMuro, Project Coordinator

hdimuro@envsci.rutgers.edu

