Rutgers Cooperative Extension

Stormwater Management in Your Schoolyard Teacher In-Service

January 28, 2014
Duke Farms, Hillsborough, NJ

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New Jersey Agricultural Experiment Station

Welcome to Duke Farms

Rutgers Cooperative Extension

Rutgers Cooperative Extension (RCE) helps the diverse population of New Jersey adapt to a rapidly changing society and improves their lives through an educational process that uses science-based knowledge.

Water Resources Program

The Water Resources Program is one of many specialty programs under Rutgers Cooperative Extension.

Our Mission is to identify and address community water resources issues using sustainable and practical science-based solutions.

This program is funded by

- NJ Department of Environmental Protection

- NJ Agricultural Experiment Station

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Experiment Station

- Rutgers, The State University of New Jersey

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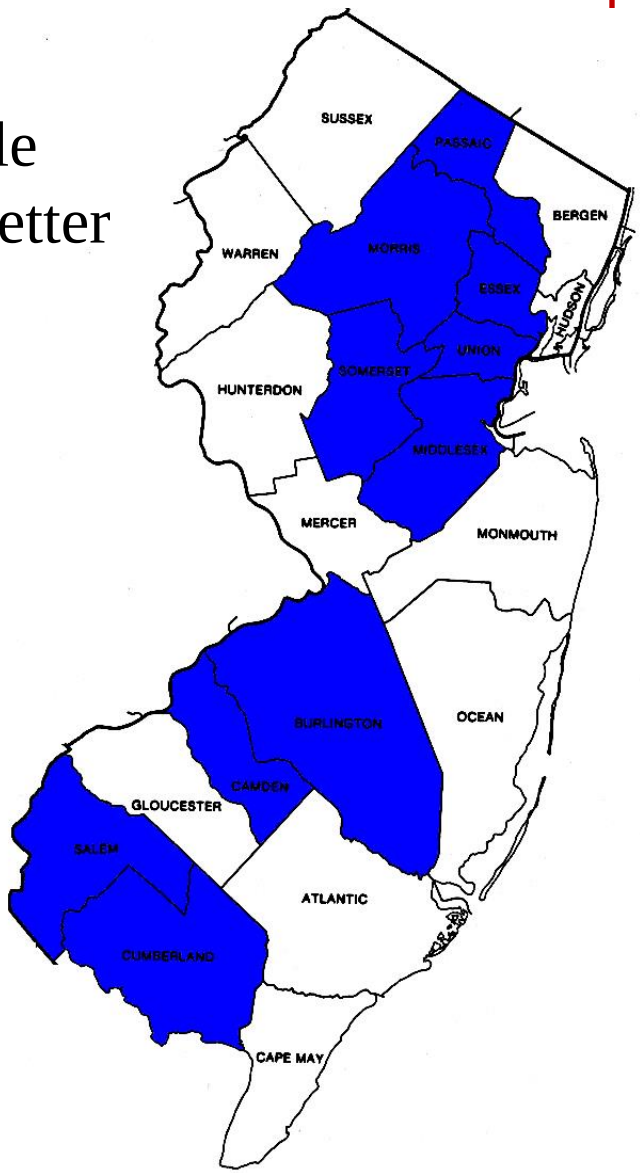
THE STATE UNIVERSITY
OF NEW JERSEY

Environmental County Agents

The Environmental County Agents teach people new skills and information so they can make better informed decisions and improvements to their businesses and personal lives.

- Michele Bakacs, Middlesex and Union
- Pat Rector, Morris and Somerset
- Amy Rowe, Essex and Passaic
- Mike Haberland, Camden and Burlington
- Sal Mangiafico, Salem and Cumberland



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.

Today's Goal

To engage teachers in helping us address stormwater management issues in New Jersey

Objectives

- Link stormwater management education to the NJ Core Curriculum
- Provide teachers knowledge about the science of stormwater management and rain gardens
- Provide teachers with activities that can do with their students
- Provide teachers with tools to work with students to design and build rain garden for their school
- Increase teachers awareness of the resources Rutgers Cooperative Extension has to offer

Agenda

9:00 - 9:30	Introductions
9:30 - 10:15	NJ Core Curriculum Context Standards
10:15 - 10:30	Break
10:30 - 12:00	Introduction to watershed curriculum, soil curriculum, and green infrastructure
12:00 - 1:00	Lunch
1:00 - 2:15	Rain garden installation and maintenance overview
2:15 - 2:30	Break
2:30 - 3:00	Resource discussion

NJ Core Curriculum Content Standards

How our services can tie into today's standards?

Rutgers Cooperative Extension Water Resources Program

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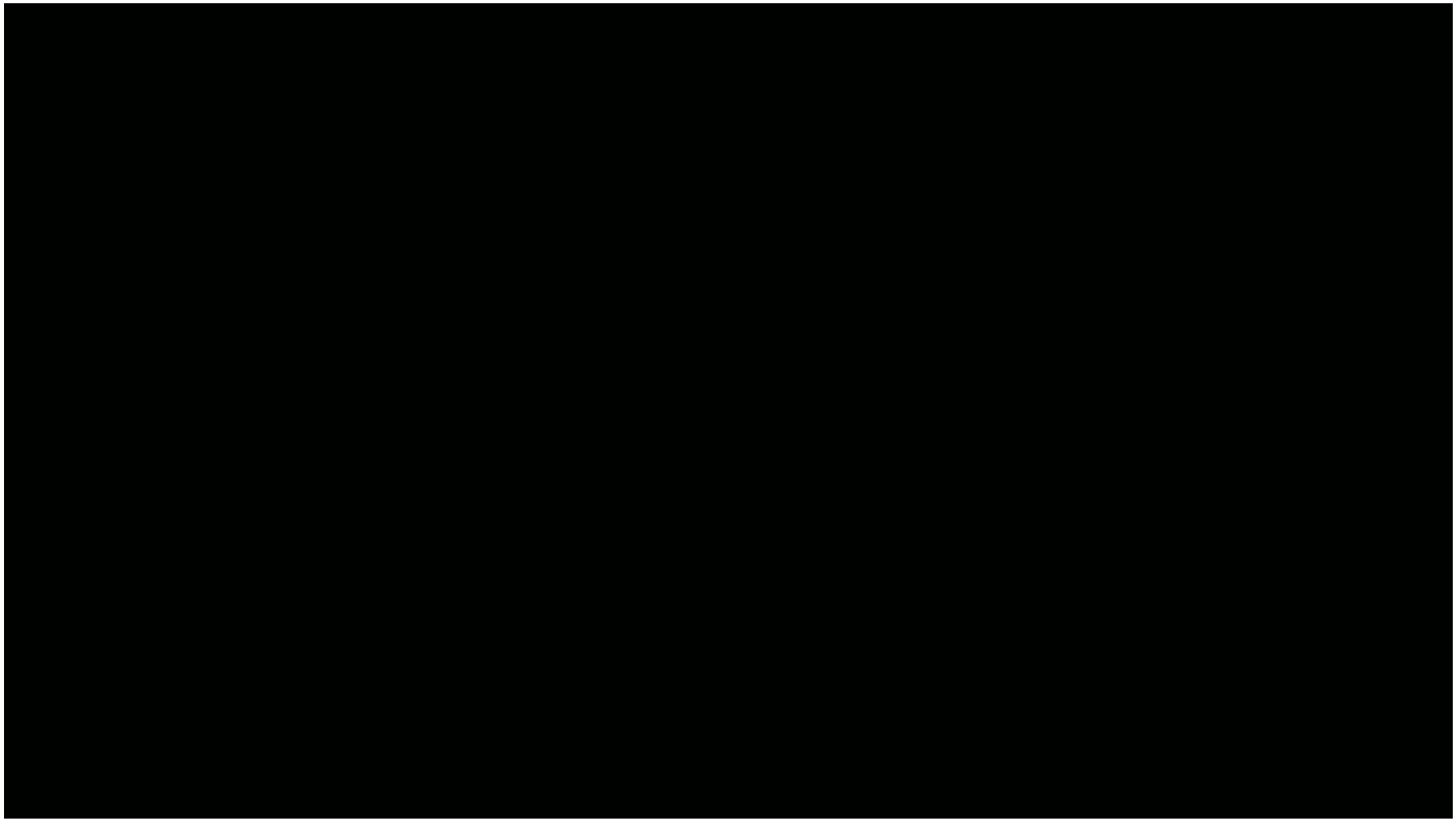
water.rutgers.edu

Stormwater Management In Your Schoolyard



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Water Resources Program

Stormwater Management In Your Schoolyard & NJ Rain Garden Education Curriculum

- These programs provide:
  - educational lectures,
  - hands-on activities,
  - and community-level outreach for students.
- Covers topics of **water quality issues** and **stormwater management practices** such as rain gardens and rain barrels.
- The program can be tailored for grades K-8 or 9-12 depending on the needs and different schedules available.

NJ CCCS – 5.1 Science Practices

- All students will understand that science is both a body of knowledge and an evidence-based, model-building enterprise that continually extends, refines, and revises knowledge. The four Science Practices strands encompass the knowledge and reasoning skills that students must acquire to be proficient in science.

5.1 Science Practices

Rain Garden Curriculum

- Introduction to Watersheds
- Connecting Watersheds to Land Use
- Stormwater Runoff and Nonpoint Source Pollution in Watersheds
- Rain Garden Soil Consideration/Identification
- Rain Garden Native Plant Consideration
- Rain Garden Design Exercise, Presentations, Installation and Maintenance

Standard

- **Strand A. Understand Scientific Explanations:** Students understand core concepts and principles of science and use measurement and observation tools to assist in categorizing, representing, and interpreting the natural and designed world.

5.1 Science Practices

- **Strand B. Generate Scientific Evidence Through Active Investigations:** Students master the conceptual, mathematical, physical, and computational tools that need to be applied when constructing and evaluating claims.

5.1 Science Practices

- **Strand C. Reflect on Scientific Knowledge:** Scientific knowledge builds on itself over time.

Rain Garden Curriculum

- Student Journal
  - Self-reflecting through topic related questions
- Gnome Journal
- Exercises – self & group
- Rain Garden Design Exercise
- Rain Garden Community Presentation

5.1 Science Practices

- **D. Participate Productively in Science:** The growth of scientific knowledge involves critique and communication, which are social practices that are governed by a core set of values and norms.
- **Rain Garden Educational Program** promotes collaboration and investigation.

NJ CCCS – 5.2 Physical Science

- All students will understand that physical science principles, including fundamental ideas about matter, energy, and motion, are powerful conceptual tools for making sense of phenomena in physical, living, and Earth systems science.

5.2 Physical Science

- **Strand B. Changes in Matter:** Substances can undergo physical or chemical changes to form new substances. Each change involves energy.

NJ CCCS – 5.3 Life Science

- All students will understand that life science principles are powerful conceptual tools for making sense of the complexity, diversity, and interconnectedness of life on Earth. Order in natural systems arises in accordance with rules that govern the physical world, and the order of **natural systems can be modeled** and predicted through the use of mathematics.

5.3 Life Science

- **Strand A. Organization and Development:** Living organisms are composed of cellular units (structures) that carry out functions required for life. Cellular units are composed of molecules, which also carry out biological functions.

5.3 Life Science

- **Strand B. Matter and Energy Transformations:** Food is required for energy and building cellular materials. Organisms in an ecosystem have different ways of obtaining food, and some organisms obtain their food directly from other organisms.

5.3 Life Science

- **Strand C. Interdependence:** All animals and most plants depend on both other organisms and their environment to meet their basic needs.
- **Rain Garden Curriculum** provides students with hands-on activities to work with plants.

5.3 Life Science

- **Strand D. Heredity and Reproduction:** Organisms reproduce, develop, and have predictable life cycles. Organisms contain genetic information that influences their traits, and they pass this on to their offspring during reproduction.

5.3 Life Science

- **Strand E. Evolution and Diversity:** Sometimes, differences between organisms of the same kind provide advantages for surviving and reproducing in different environments. These selective differences may lead to dramatic changes in characteristics of organisms in a population over extremely long periods of time.

NJ CCCS – 5.4 Earth Systems Science

- All students will understand that Earth operates as a set of complex, dynamic, and interconnected systems, and is a part of the all-encompassing system of the universe.

5.4 Earth Systems Science

- **Strand F: Climate and Weather:** Earth's weather and climate systems are the result of complex interactions between land, ocean, ice, and atmosphere.

5.4 Earth Systems Science

- **Strand G. Biogeochemical Cycles:** The biogeochemical cycles in the Earth systems include the flow of microscopic and macroscopic resources from one reservoir in the hydrosphere, geosphere, atmosphere, or biosphere to another, are driven by Earth's internal and external sources of energy, and are impacted by human activity.

Additional NJ CCCS

- Mathematics – Measurement & Data
  - CCSS.Math.Content.4.MD.A.2
- Language Arts – Comprehension & Collaboration
  - CCSS.ELA-Literacy.SL.4.1-4.3
  - CCSS.ELA-Literacy.SL.8.1-8.3
- Social Studies
  - 6.3 Active Citizenship in the 21st Century
- 21st Century Life & Careers
  - 9.1 21st Century Life & Career Skills
  - 9.3 Career Awareness, Exploration, and Preparation
  - 9.4 Career and Technical Education
- Comprehensive Heath and Physical Education
  - 2.1.A – Personal Growth and Development
  - 2.6.A. – Fitness

QUESTIONS?

Rutgers Cooperative Extension Water Resources Program

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Eco-Schools USA
NATIONAL WILDLIFE FEDERATION®

NEW JERSEY AUDUBON
www.njaudubon.org

Making K-12 Schools Sustainable Places of Learning
One Eco-School At a Time

What Is the Eco-Schools Program?

- FEE (Foundation for Environmental Education)
- 53 Participating Countries
- 41,000+ K-12 Schools Registered as Eco-Schools
- 900,000 Teachers Engaged
- 12 Million Students Engaged
- 58 Schools in NJ reaching 25K st
- Student - Team Driven
- 3-tiers of Recognition
- Authentic learning

Eco-Schools Pathways to Sustainability!

Energy

Biodiversity

Water

School Grounds

Transportation

Climate Change

Consumption & Waste

Healthy Schools

Sustainable Foods

Healthy Living
(formerly Green Hour)

Eco-Schools Framework

Seven Steps

1. Eco-Action Team
2. School Assessment/ Audit
3. Action Plan
4. Monitor/Evaluation
5. Link to Curriculum
6. Whole Community Involvement
7. Eco-Code/Mission Statement

Eco-Schools Result in:

- Increased Student Achievement
- Increased Financial Savings
- Positive measurable impacts on living systems

Contact Me

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1. EcoSchools Newsletter: Featured Schools, Opportunities/ Resources, Nature Articles,
2. Web-based, NJ-specific tools in each pathways
3. Professional Development Opportunities
4. Upcoming: School visits, phone conference calls, webinars
5. Programmatic support

Introduction to Stormwater Management, Soils and Green Infrastructure

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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.

WHAT IS A WATERSHED?

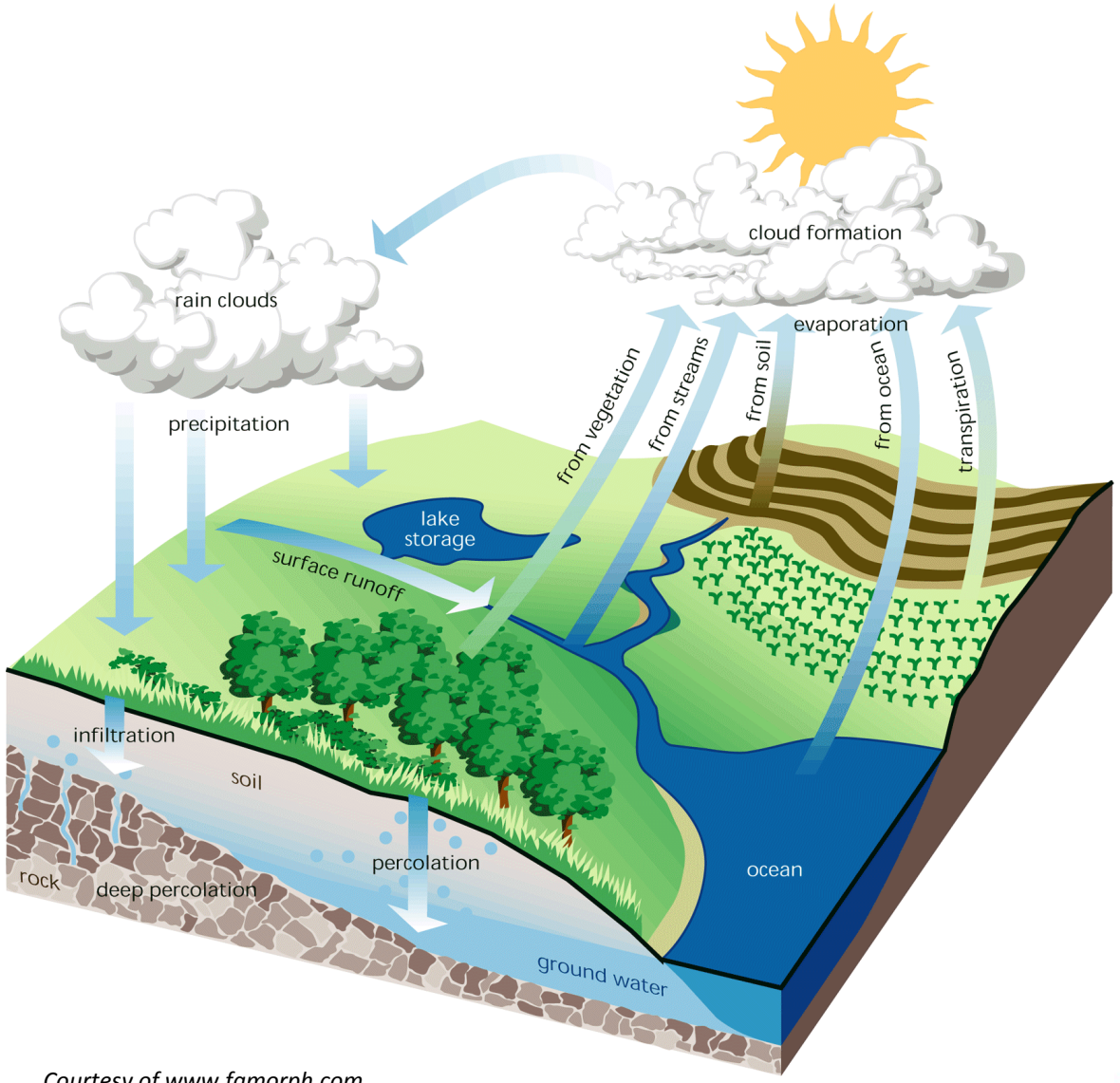
- An area of land that water flows across, through, or under on its way to a stream, river, lake, ocean or other body of water.

- A watershed is like one big bathtub...

Do you know what a watershed is?

Courtesy of Texas Watershed Stewards, Texas A&M AgriLife Extension

HYDROLOGIC CYCLE



Courtesy of www.fgmorph.com

WHERE DOES PRECIPITATION GO?

1. It can ***run off***

Courtesy of Texas Watershed Stewards, Texas A&M AgriLife Extension

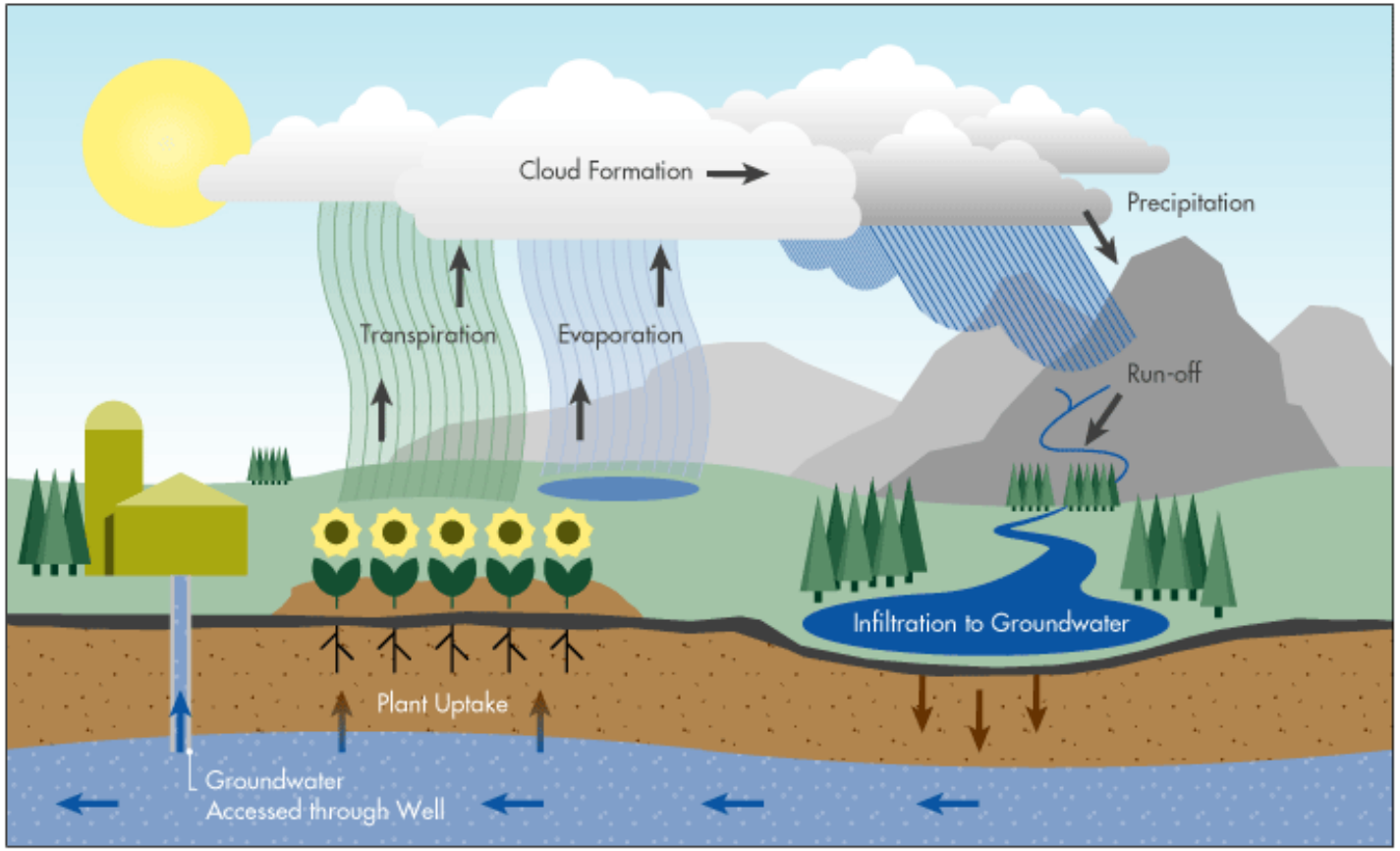
WHERE DOES PRECIPITATION GO?

2. It can be ***absorbed*** by plants and used for photosynthesis and other biological processes

Courtesy of Texas Watershed Stewards, Texas A&M AgriLife Extension

WHERE DOES PRECIPITATION GO?

3. It can ***infiltrate*** through the soil surface and percolate downward to groundwater ***aquifers***



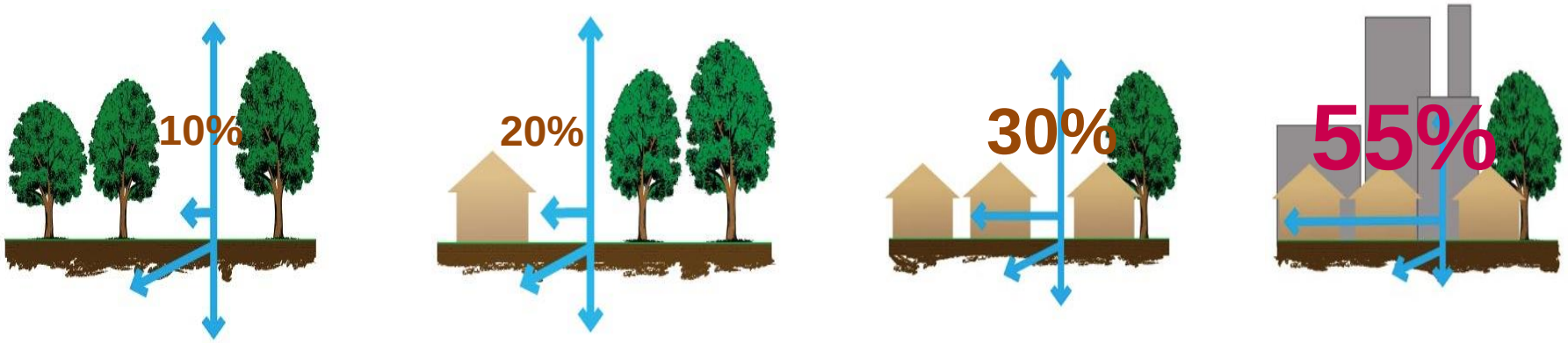
Courtesy of Texas Watershed Stewards, Texas A&M AgriLife Extension

WHERE DOES PRECIPITATION GO?

4. It can *evaporate*

Courtesy of Texas Watershed Stewards, Texas A&M AgriLife Extension

The Impact of Development on Stormwater Runoff



More development → *More impervious surfaces* → *More stormwater runoff*

LAND USE/LAND COVER CHANGES

LAND USE

HOW LAND IS USED BY HUMANS:

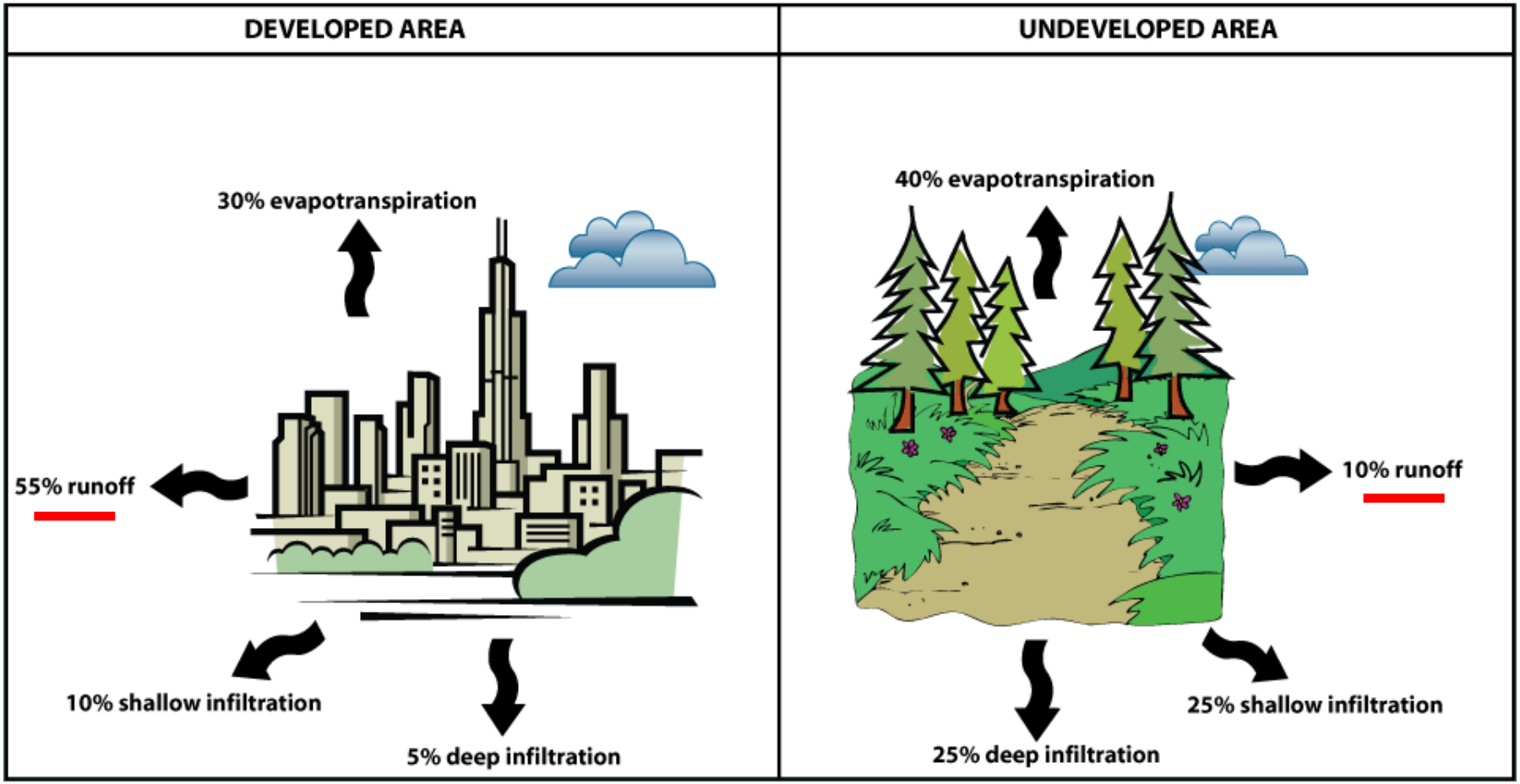
- AGRICULTURE
- INDUSTRY
- URBAN
- RESIDENTIAL
- RECREATION

LAND COVER

BIOLOGICAL AND PHYSICAL FEATURES OF THE LAND:

- FORESTS
- GRASSLANDS
- AGRICULTURAL FIELDS
- RIVERS, LAKES
- BUILDINGS, PARKING LOTS

LAND USE/LAND COVER CHANGES



Courtesy of Texas Watershed Stewards, Texas A&M AgriLife Extension

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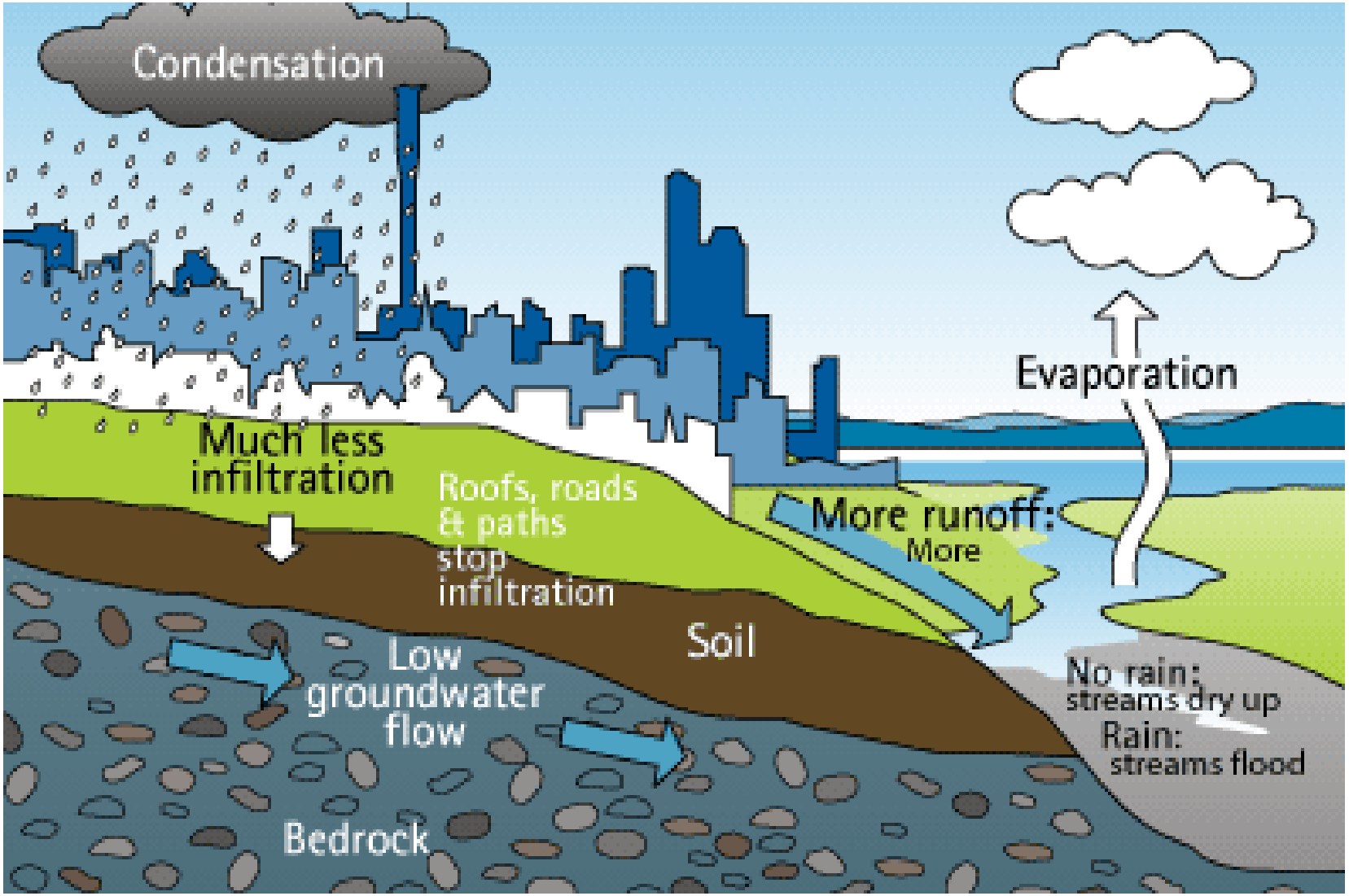
Water Resources Program

The *Urban* Hydrologic Cycle



Combined Sewer Systems (CSOs)

DURING DRY WEATHER

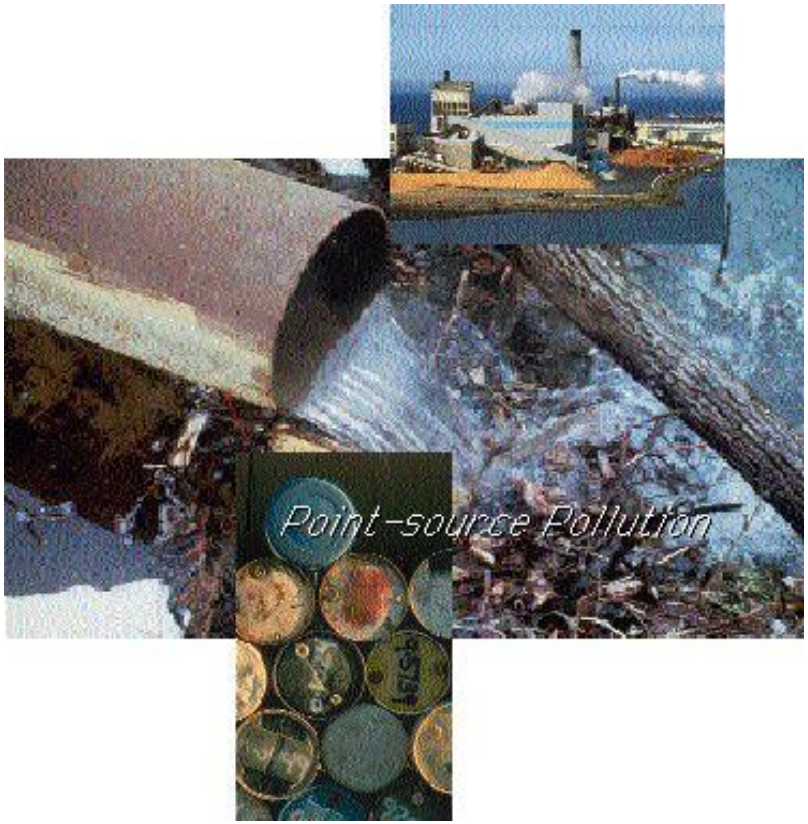
Normal sewage flow is contained within the system and flows to the Wastewater Treatment Plant.

DURING STORMY WEATHER

The combination of stormwater and sewage can exceed normal capacity and overflows into area waterways.

WATER POLLUTION SOURCES

POINT SOURCE POLLUTION



NONPOINT SOURCE POLLUTION

Environmental Health Perspective, National Institute of Health

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Water Resources Program

POINT SOURCE POLLUTION

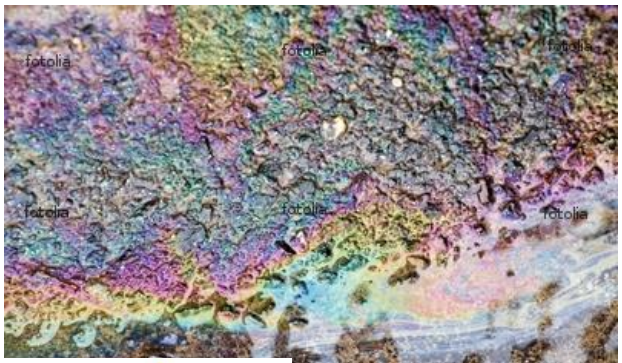
- Comes from a specific source, like a pipe
- Factories, industry, municipal treatment plants
- Can be monitored and controlled by a permit system (NPDES)

Nonpoint Source Pollution (NPS)

- Associated with stormwater runoff
- Runoff collects pollutants on its way to a sewer system or water body
- It cannot be traced to a direct discharge point such as a wastewater treatment facility

EXAMPLES OF NPS

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



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Water Resources Program

IMPACT OF NPS

- Fish and wildlife
- Recreational water activities
- Commercial fishing
- Tourism
- Drinking water quality

Impacts from Changing the Landscape

Hydrologic Effects:

- Disruption of natural water balance
- Increased flood peaks
- Increased stormwater runoff
- More frequent flooding
- Increased bankfull flows
- Lower dry weather flows

History of Stormwater Management

1st Attempt at Stormwater Management

Capture all runoff, pipe it, and send it directly to the river . . .prior to mid 1970's

2nd Iteration of Stormwater Management

Capture runoff, detain it, release it slowly to the river…mid 1970's to 2004

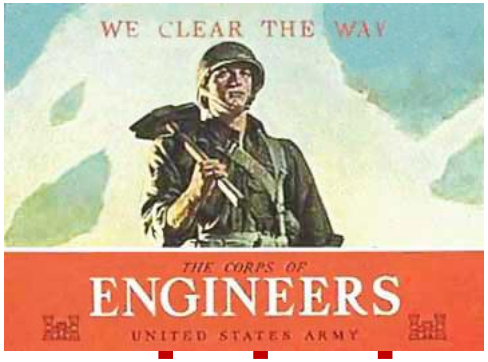
- Detain peak flow during large storm events for 18 hours (residential) or 36 hours (commercial)
- Reduce downstream flooding during major storms
- Use concrete low flow channels to minimize erosion, reduce standing water, quickly discharge low flows
- Does not manage runoff from smaller storms allowing stormwater to pass through the system
- Directly discharges stormwater runoff to nearby stream, waterway, or municipal storm sewer system (at a controlled/managed rate)

3rd Generation of Stormwater Management

- Reduce stormwater runoff volume
- Reduce peak flows and flooding **…and….**
- Maintain infiltration and groundwater recharge
- Reduce pollution discharged to local waterways

abc Action News, August 27, 2012

How NJ's regulations change the way we manage stormwater



How can we minimize the impact of stormwater runoff in our community?

It is all about controlling runoff from impervious surfaces

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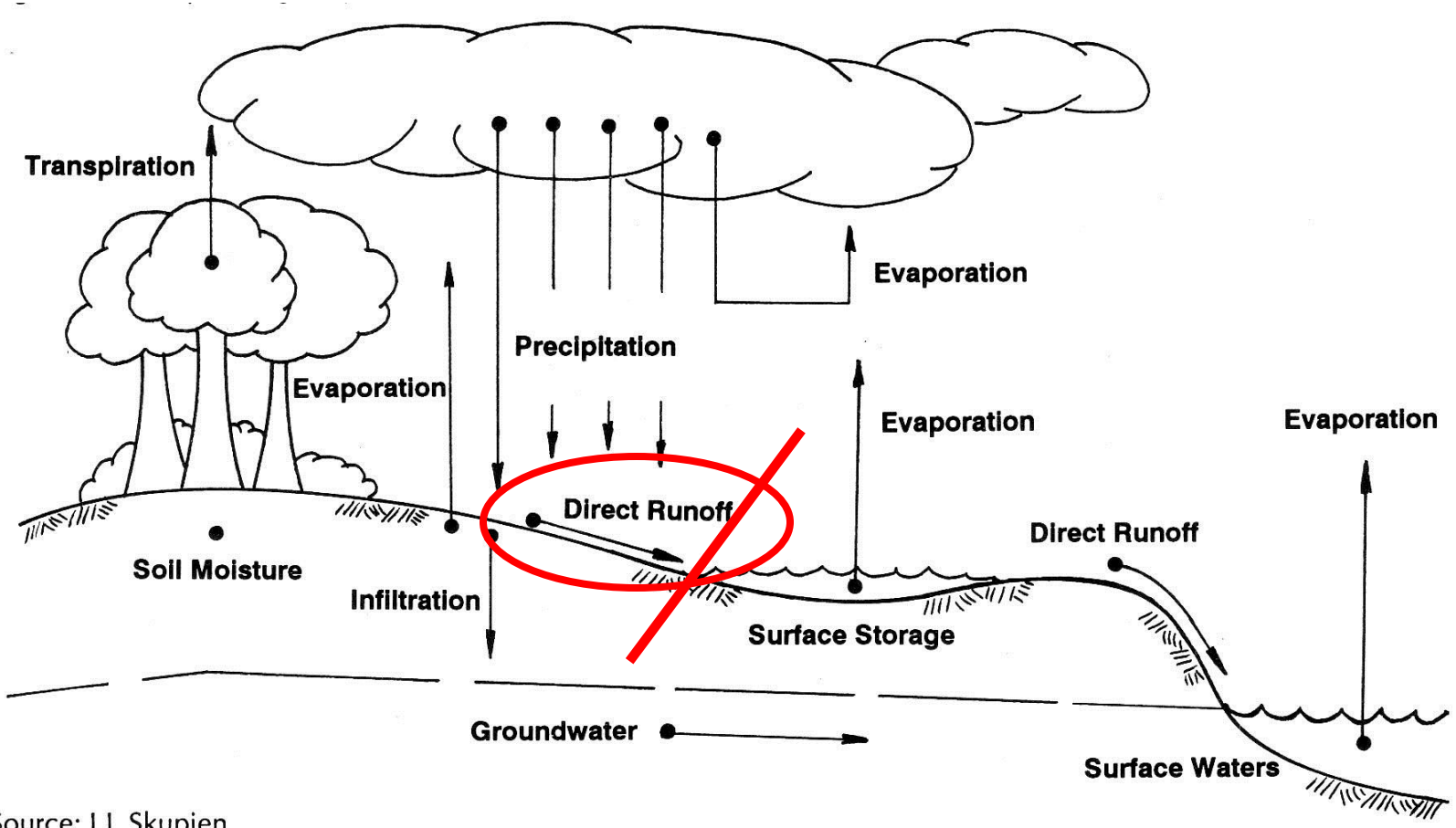
Water Resources Program

The Hydrologic Cycle



Source: J.J. Skupien.

We must deal with impacts from impervious cover

Are there impervious surfaces that you can eliminate?

If we can't eliminate it, can we reduce it?

If we can't eliminate or reduce it, can we disconnect it?

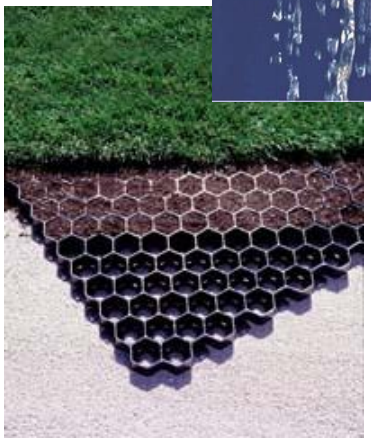
Are there impervious surfaces that you can harvest rainwater for reuse?

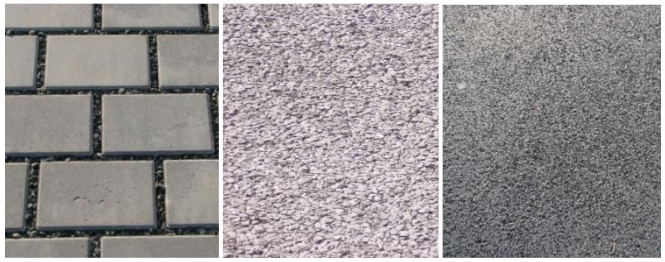
Are there conveyance systems that can be converted to bioswales?

Eliminate it!

Reduce It!
Pervious Pavements

- Underlying stone reservoir
- Porous asphalt and pervious concrete are manufactured without "fine" materials to allow infiltration
- Grass pavers are concrete interlocking blocks with open areas to allow grass to grow
- Ideal application for porous pavement is to treat a low traffic or overflow parking area



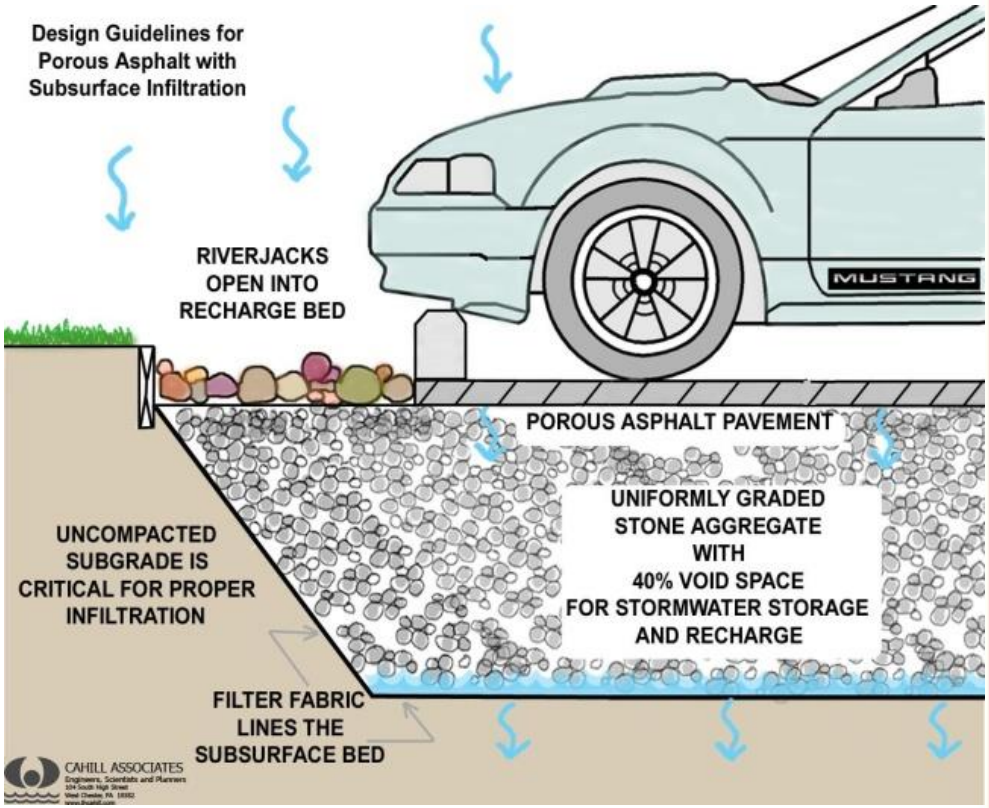


Pervious Pavements

FUNCTIONS

- Manage stormwater runoff
- Minimize site disturbance
- Promote groundwater recharge
- Low life cycle costs, alternative to costly traditional stormwater management methods
- Mitigation of urban heat island effect
- Contaminant removal as water moves through layers of system

COMPONENTS

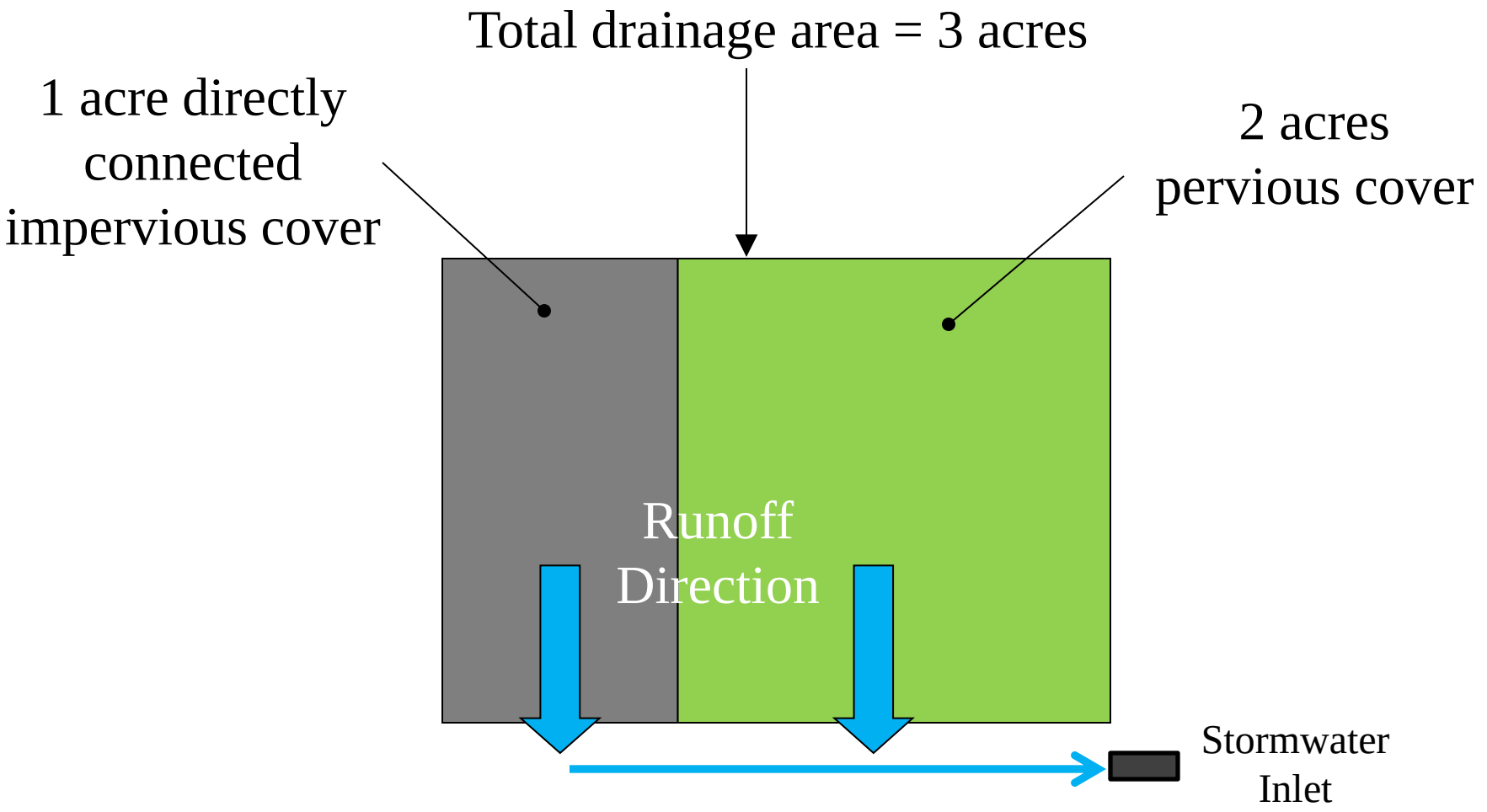


Pervious Pavement

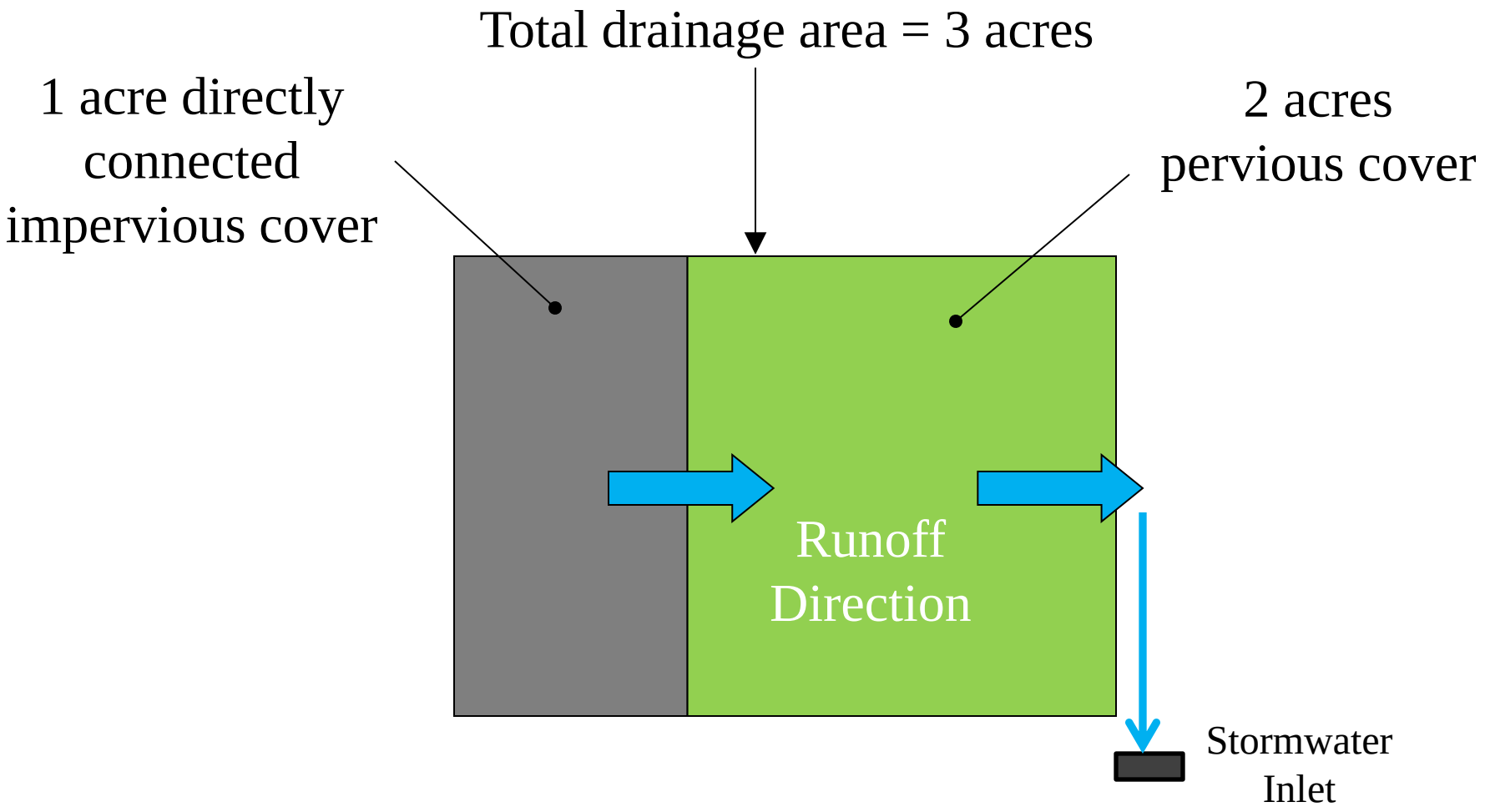
Pervious Pavements

Disconnect It!

For 1.25 inch storm, 3,811 cubic feet of runoff = **28,500 gallons**

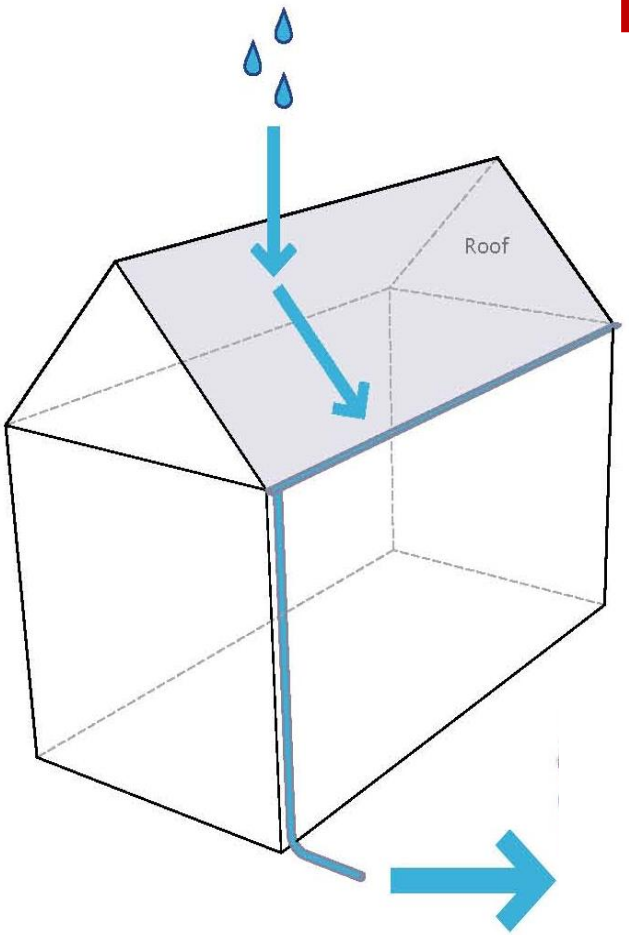


For 1.25 inch storm, 581 cubic feet of runoff = **4,360 gallons**



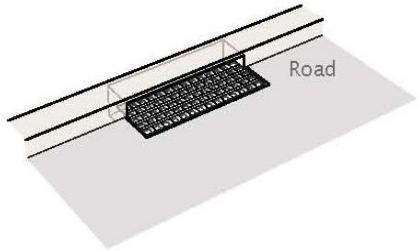
	Volume of Runoff		
Design Storm	**Connected (gallons)**	**Disconnected (gallons)**	**Percent Difference**
1.25 inches (water quality storm)	28,500	4,360	85%

Disconnection with Rain Water Harvesting



Disconnect your downspout by installing a rain barrel

REDUCE THE AMOUNT OF RUNOFF ENTERING STORM SEWERS



Impervious area is now ***"disconnected"*** from flowing directly into the storm sewer system

So Many Barrels to Choose From…

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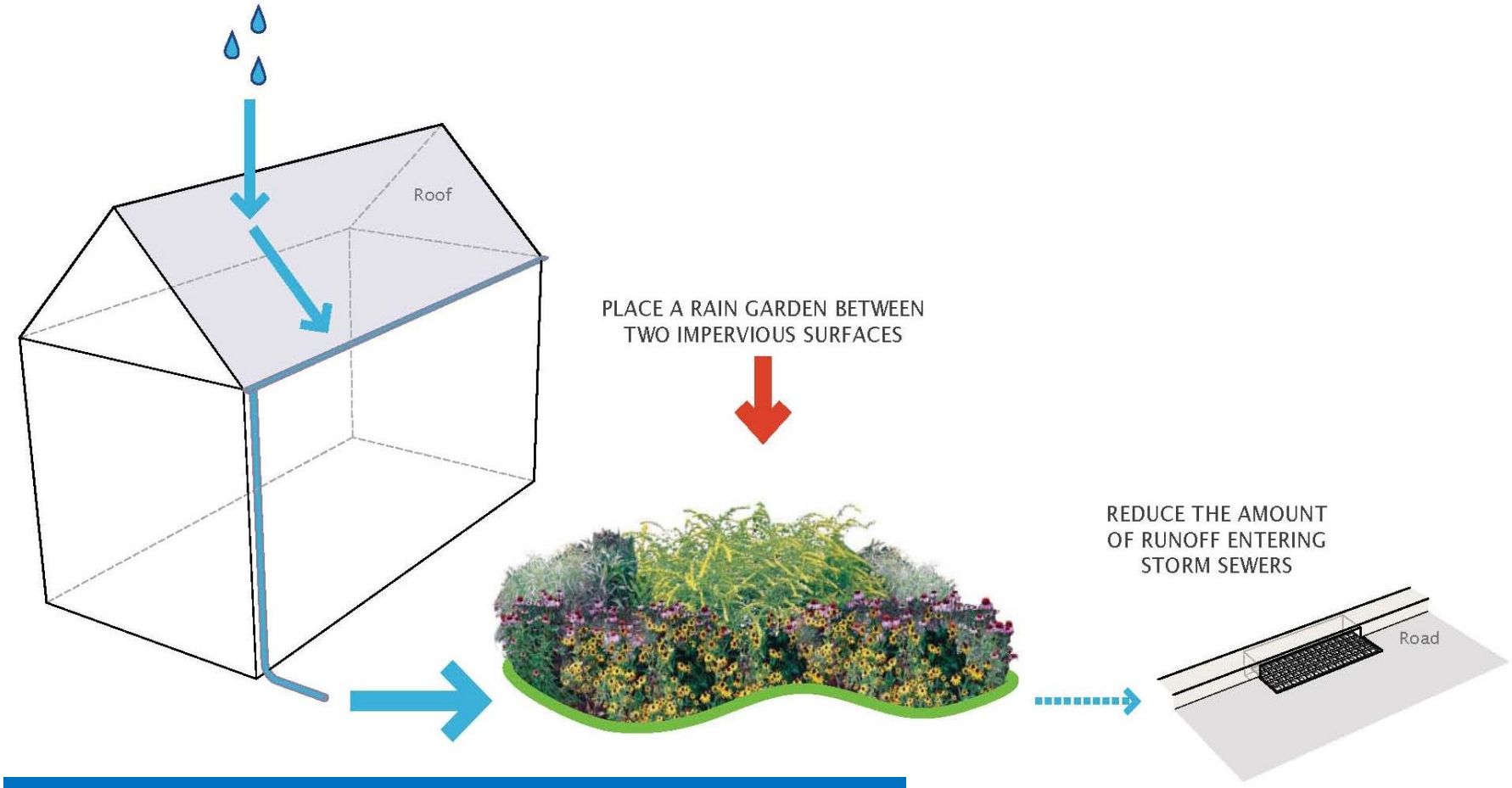
Water Resources Program

Or Larger Rainwater Harvesting Systems…

Disconnection with Rain Gardens



Rooftop runoff is now ***"disconnected"*** from flowing directly into the storm sewer system

Lots of Rain Gardens

Soils in Watershed Management

- Soils play an important role in drainage of our land

- All soils start as bedrock. Wind and rain break rocks into small soil particles over time. This is called the "parent material." Organic material (breakdown of plants and animals) combine with parent material to form soil.

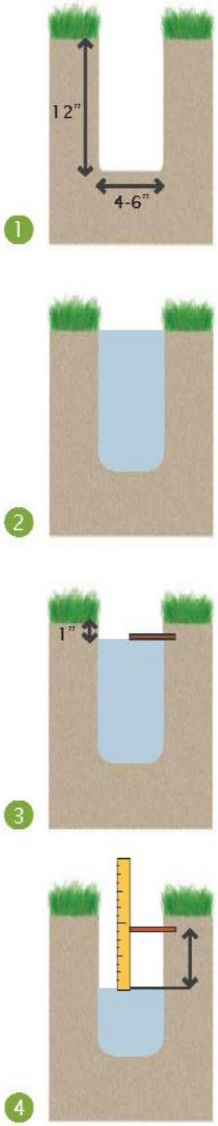
Soil Properties

- Sandy soils (have large particles)
- Clay soils (have the smallest particles)
- Silt soils (have medium particles)
- Loamy soils (have particles of clay, silt and sand)

Clay → Silt → Loam → Sand

Slow Draining → Fast Draining

CHECK YOUR SOIL



- 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

Green Infrastructure is ...

…an approach to stormwater management that is cost-effective, sustainable, and environmentally friendly.

Green Infrastructure projects:

- capture,
- filter,
- absorb, and
- reuse

stormwater to maintain or mimic natural systems and treat runoff as a resource.

Green Infrastructure includes:

- Green Roofs
- Rainwater Harvesting
- Planter Boxes
- Rain Gardens
- Permeable Pavements
- Vegetated Swales


Natural Retention Basins


Rain Gardens


Green Roofs


Permeable Pavements


Rainwater Harvesting

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Rainwater Harvesting

FUNCTIONS

- Collecting, filtering and storing water from roof tops, paved and unpaved areas for multiple uses.
- Harvested water can be used for nonpotable or potable purposes after testing and treatment.
- Surplus water after usage can be used for recharging ground water.
- Systems can range in size from a simple PVC tank or cistern to a contractor designed and built tank/sump with water treatment facilities.


overflow pipe
roof
washer
system

Rainwater Harvesting

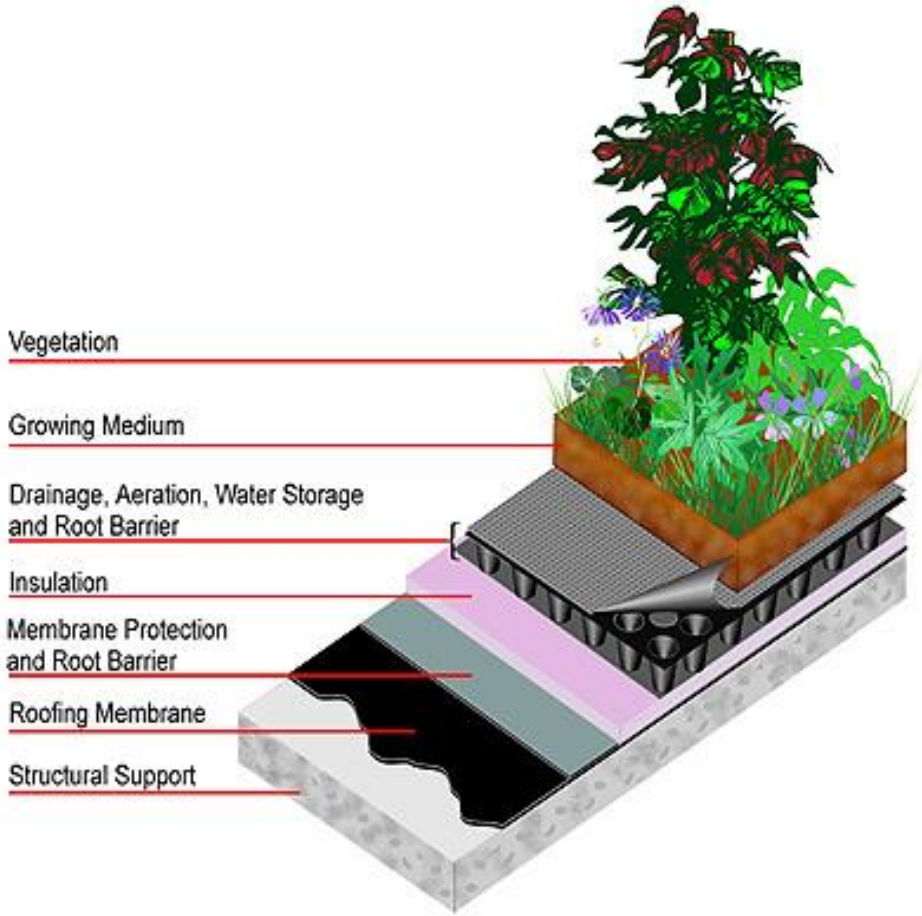
Samuel Mickle School Rainwater Harvesting System

Green Roofs

FUNCTIONS

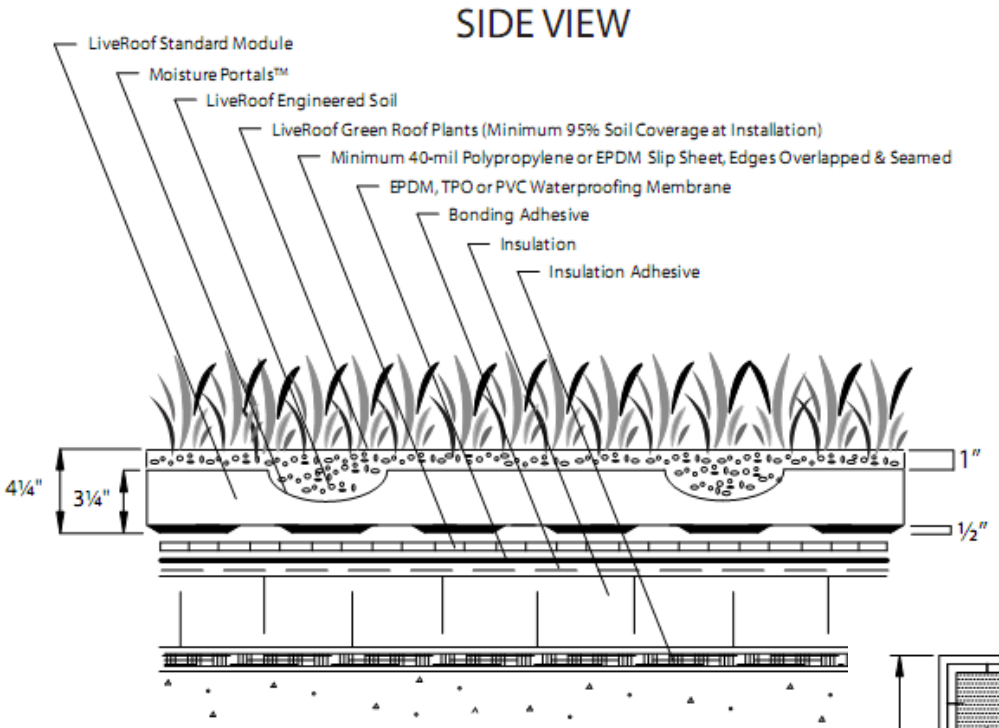
- Improves stormwater management
- Improves air quality
- Temperature regulation (moderation of Urban Heat Island Effect)
- Carbon dioxide/oxygen exchange
- Increased urban wildlife habitat

COMPONENTS

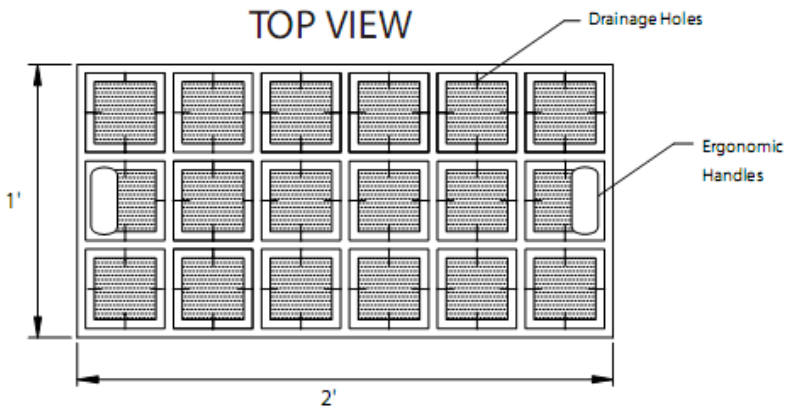


Green Roof Design

Modular System Specifications:




Parker Urban Greenscapes.



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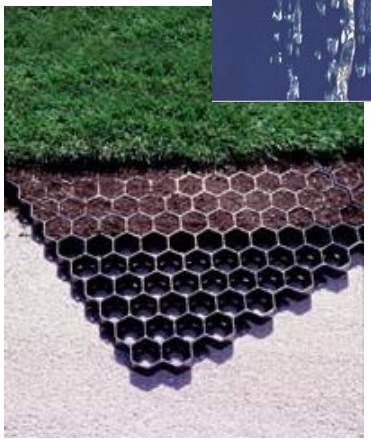
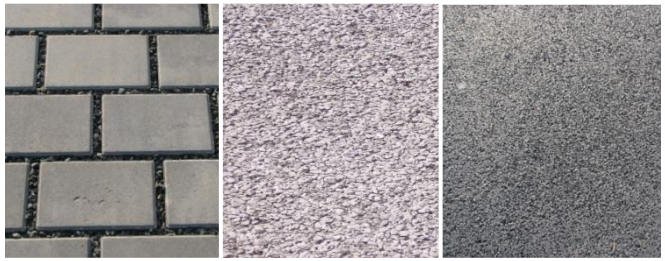
Water Resources Program

Pervious Pavements

- Underlying stone reservoir that temporarily stores surface runoff before infiltrating into the subsoil
- Porous asphalt and pervious concrete are manufactured without "fine" materials, and incorporate void spaces to allow infiltration
- Grass pavers are concrete interlocking blocks or synthetic fibrous grid systems with open areas designed to allow grass to grow within the void areas
- Ideal application for porous pavement is to treat a low traffic or overflow parking area



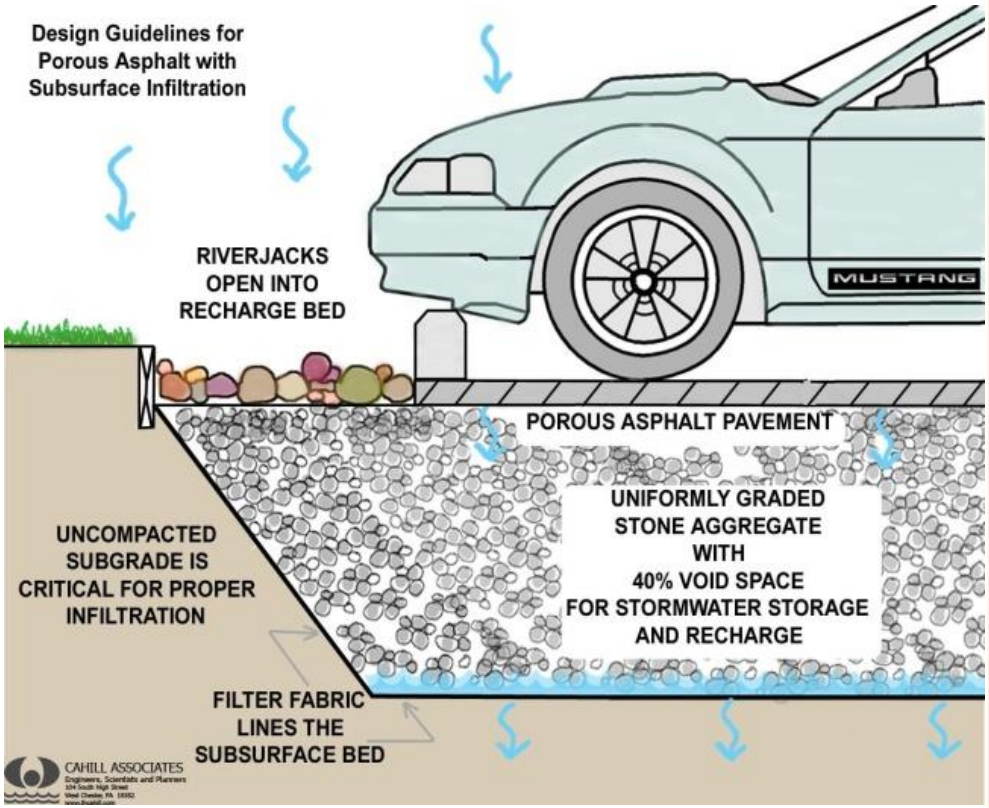


Pervious Pavements

FUNCTIONS

- Manage stormwater runoff
- Minimize site disturbance
- Possibility of groundwater recharge
- Low life cycle costs, alternative to costly traditional stormwater management methods
- Mitigation of urban heat island effect
- Contaminant removal as water moves through layers of system

COMPONENTS



Pervious Pavement

Pervious Pavements

Bioretention Systems & Rain Gardens

Traditional Approach

- Design Dry Detention Basin:
- Treat Water Quality Storm (1.25” rain over 24 hours)
- Detain for 18 hours (residential) or 36 hours (commercial)
- Minimum outflow orifice = three inches
- Use Concrete Low Flow Channels to Minimize Erosion

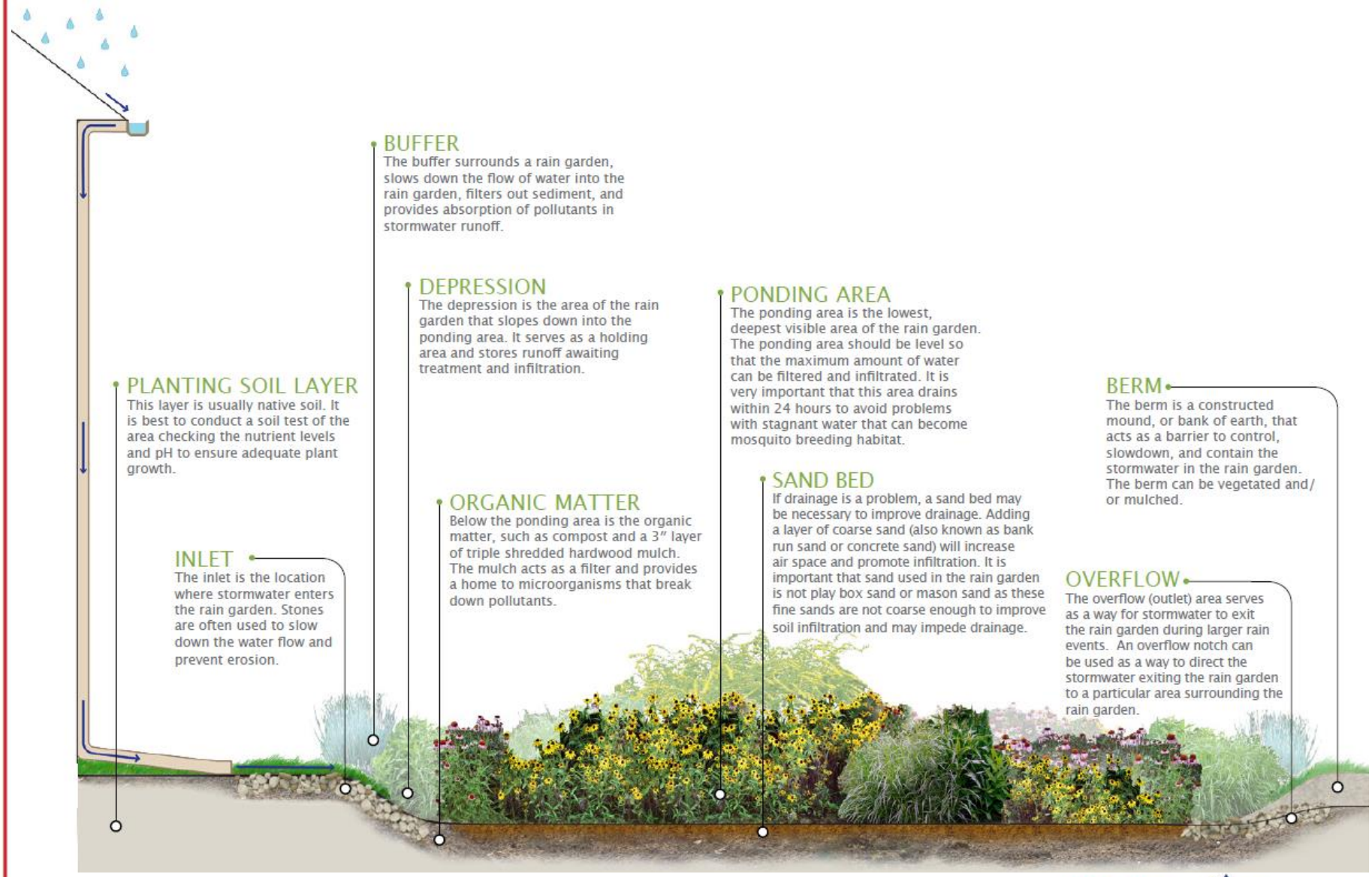
New Approach

- Combines settling of detention basin with physical filtering and absorption processes
- Provides very high pollutant removal efficiencies
- More aesthetically pleasing than conventional detention basins
- Can be incorporated into the landscapes of individual homes

Bioretention Systems & Rain Gardens

NJDEP. 2004. NJ Stormwater BMP Manual.

Bioretention Systems & Rain Gardens



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Curb Extensions/Green Streets

Curb extension with a planted swale that captures stormwater from the gutter: Portland, OR (Credit: Abby Hall)

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New Jersey Agricultural Experiment Station

Water Resources Program

QUESTIONS?

Rutgers Cooperative Extension Water Resources Program

Christopher C. Obropta, Ph.D., P.E.
Phone: 732-932-9800 x6209
Email: Obropta@envsci.rutgers.edu

Rain Garden Installation and Maintenance

January 28, 2014
Duke Farms, Hillsborough, NJ

Christopher C. Obropta, Ph.D., P.E.
Email: Obropta@envsci.rutgers.edu
www.water.rutgers.edu

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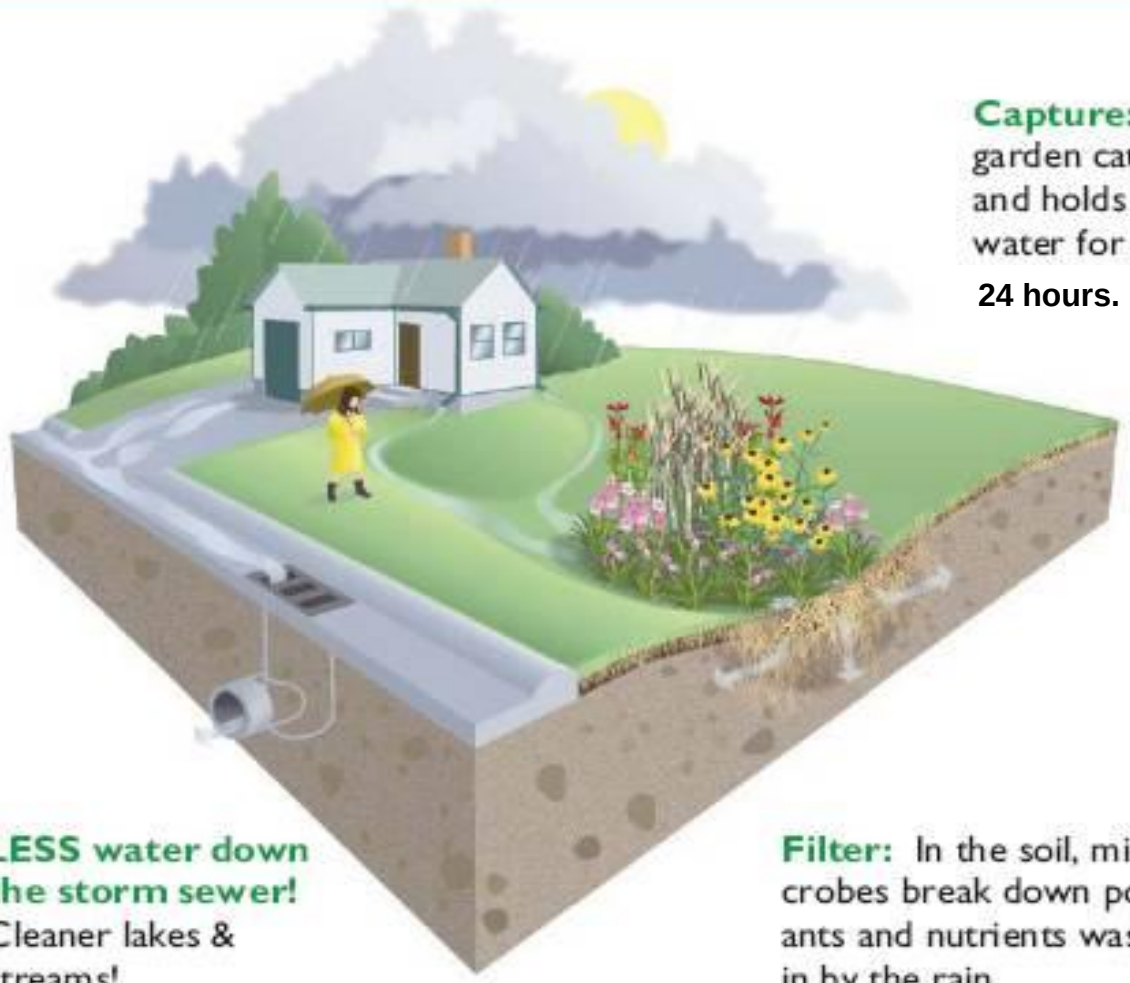
New Jersey Agricultural Experiment Station
water.rutgers.edu

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.

Rain Gardens



Capture: A rain garden catches runoff and holds standing water for no more than **24 hours.**

Soak: Deep-rooted plants loosen the soil, creating a sponge zone. Water soaks in and groundwater aquifers are recharged.

LESS water down the storm sewer!
Cleaner lakes & streams!

Filter: In the soil, microbes break down pollutants and nutrients washed in by the rain.

Courtesy of City of Maplewood, MN

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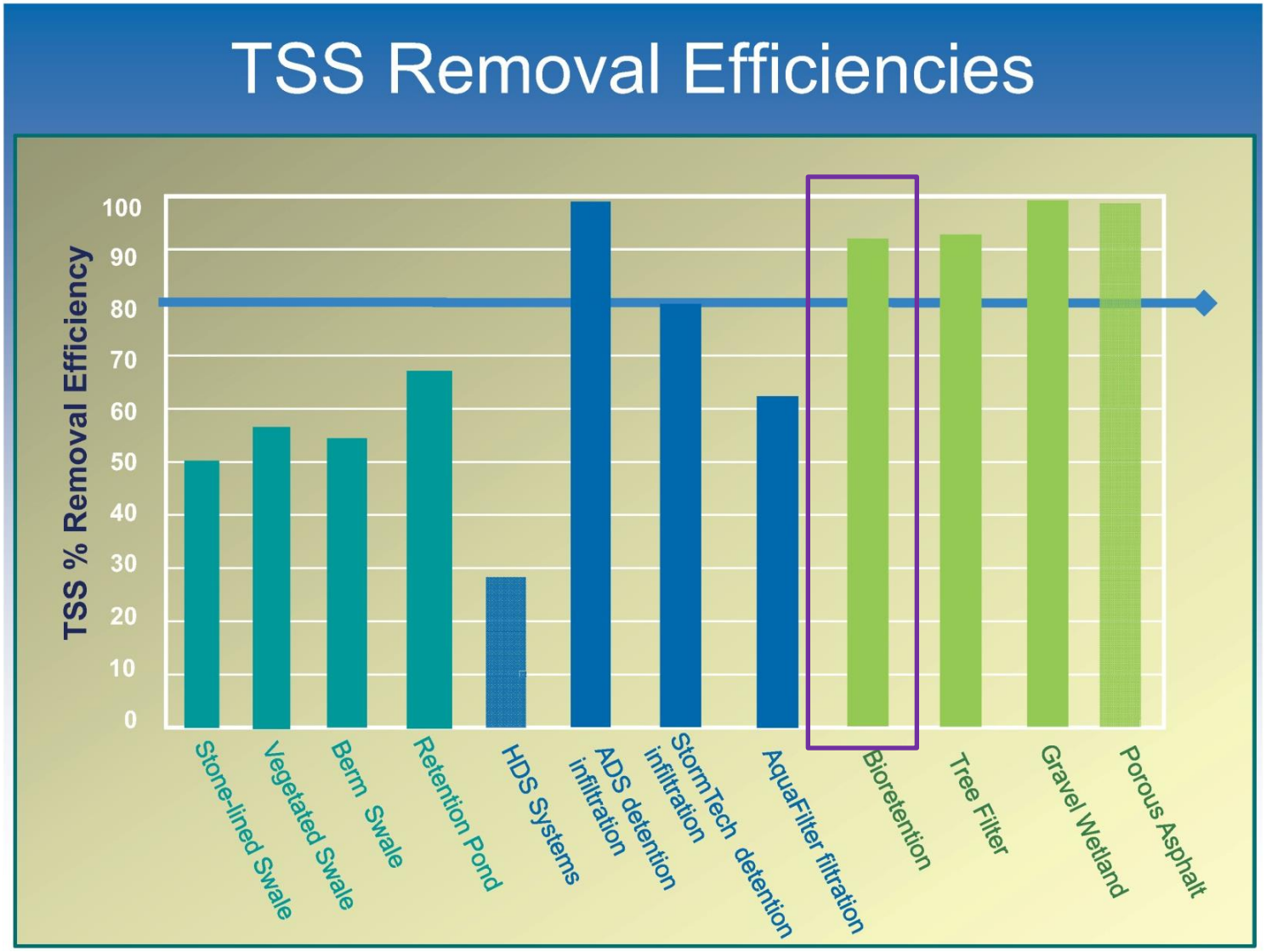
Water Resources Program

What Can Rain Gardens Do?

- Capture and remove 80% of Total Suspended Solids (TSS)
- Protect water quality to the greatest extent practicable (keep nutrients such as nitrogen and phosphorus out of waterways)
- Maintain groundwater recharge

What Does Research Tell Us?

Total Suspended Solids



SOURCE: The University of New Hampshire Stormwater Center, December 2011

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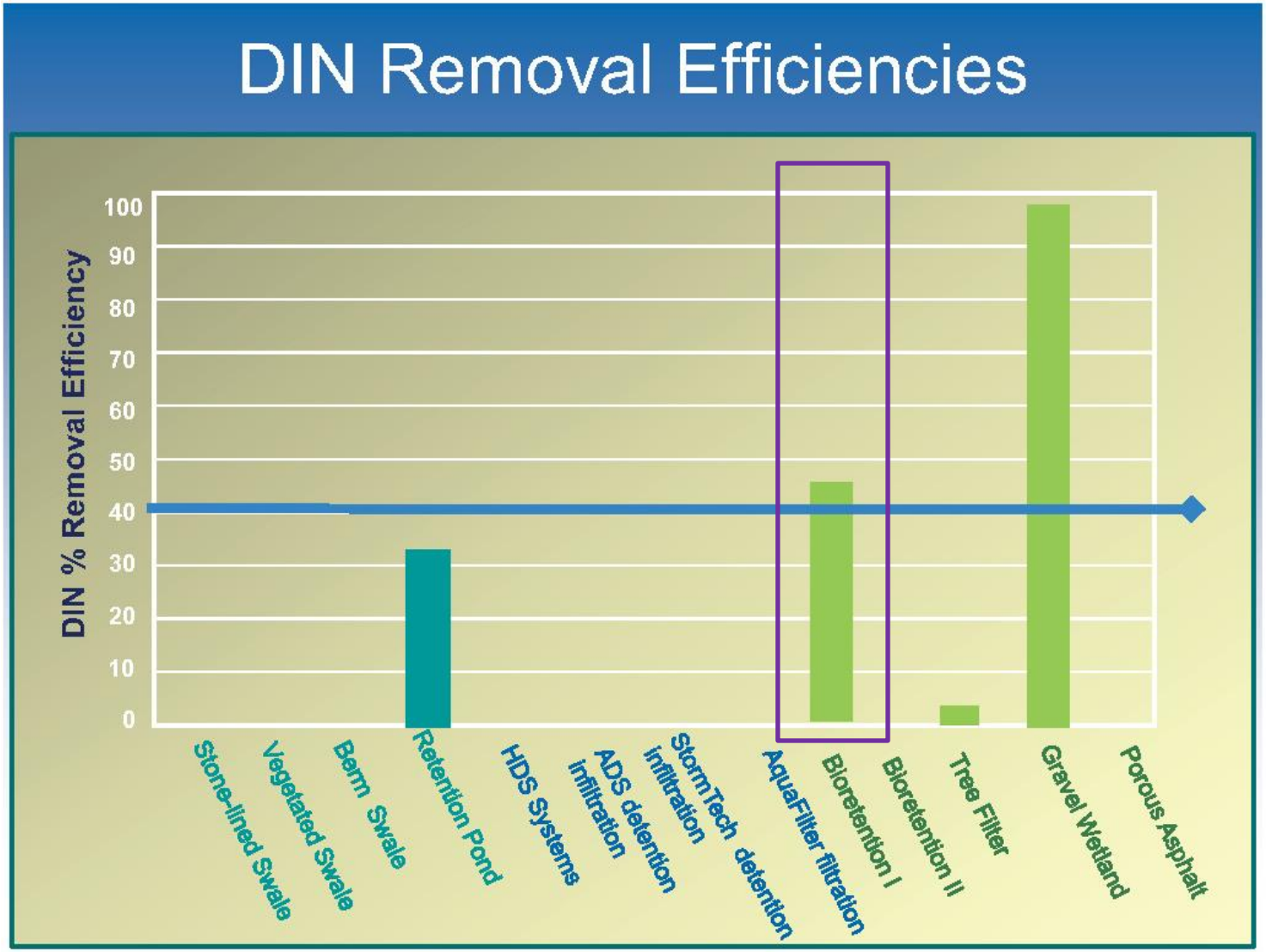
Water Resources Program

What Does Research Tell Us?

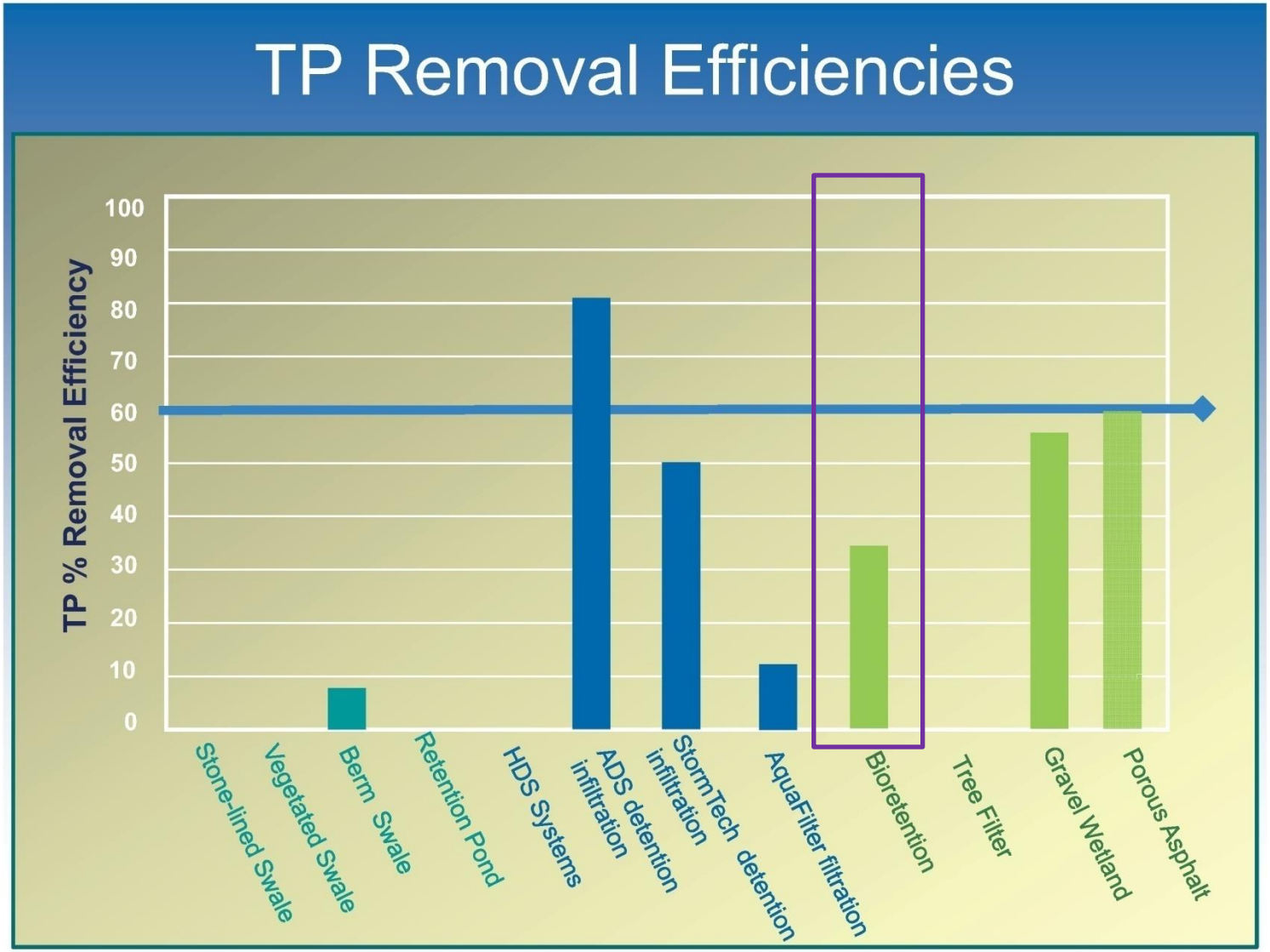
Dissolved Inorganic Nitrogen



SOURCE: The University of New Hampshire Stormwater Center, December 2011

What Does Research Tell Us?

Total Phosphorus



SOURCE: The University of New Hampshire Stormwater Center, December 2011

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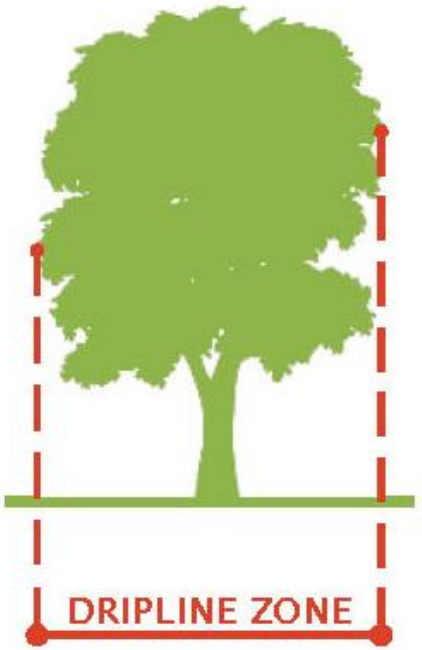
Water Resources Program

Why Rain Gardens?

- Rain gardens are one of the most effective tools to manage stormwater
- They are inexpensive, easy and fun to build
- They can fit into any landscape
- And they work!

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

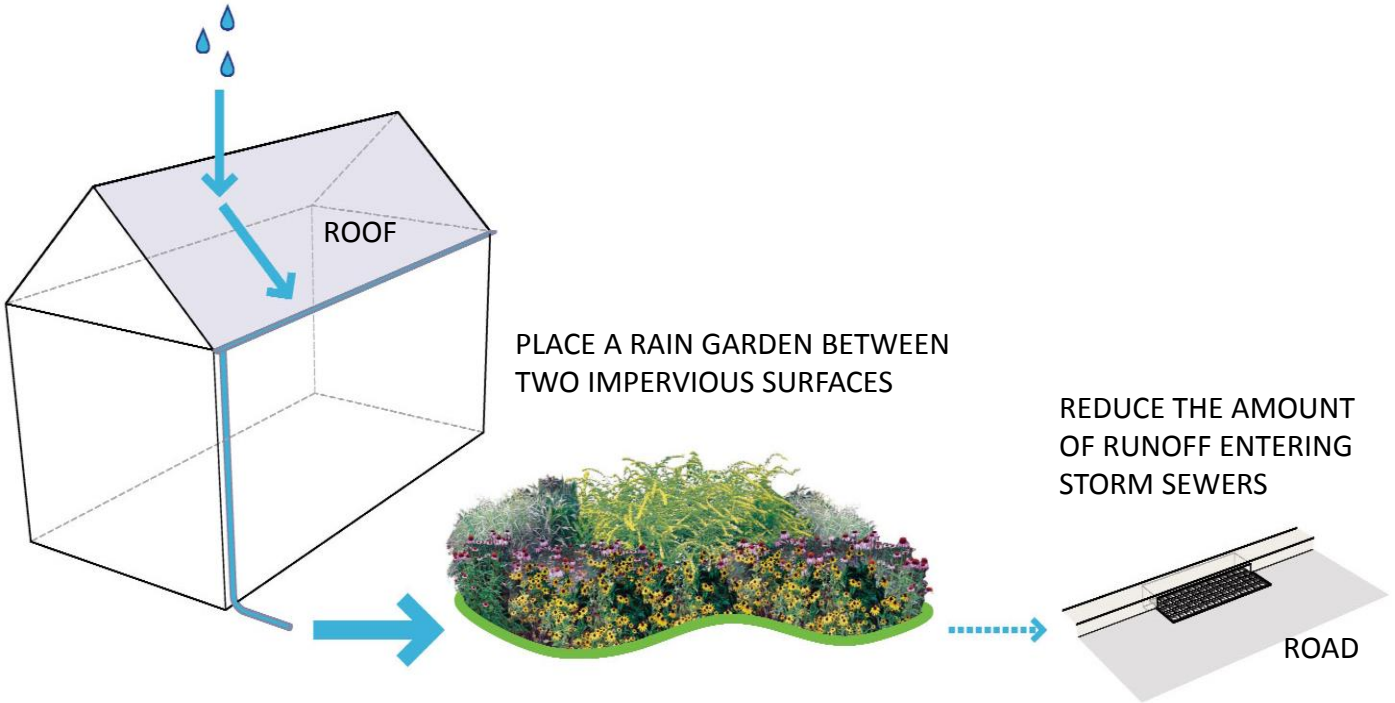


Call Before You Dig

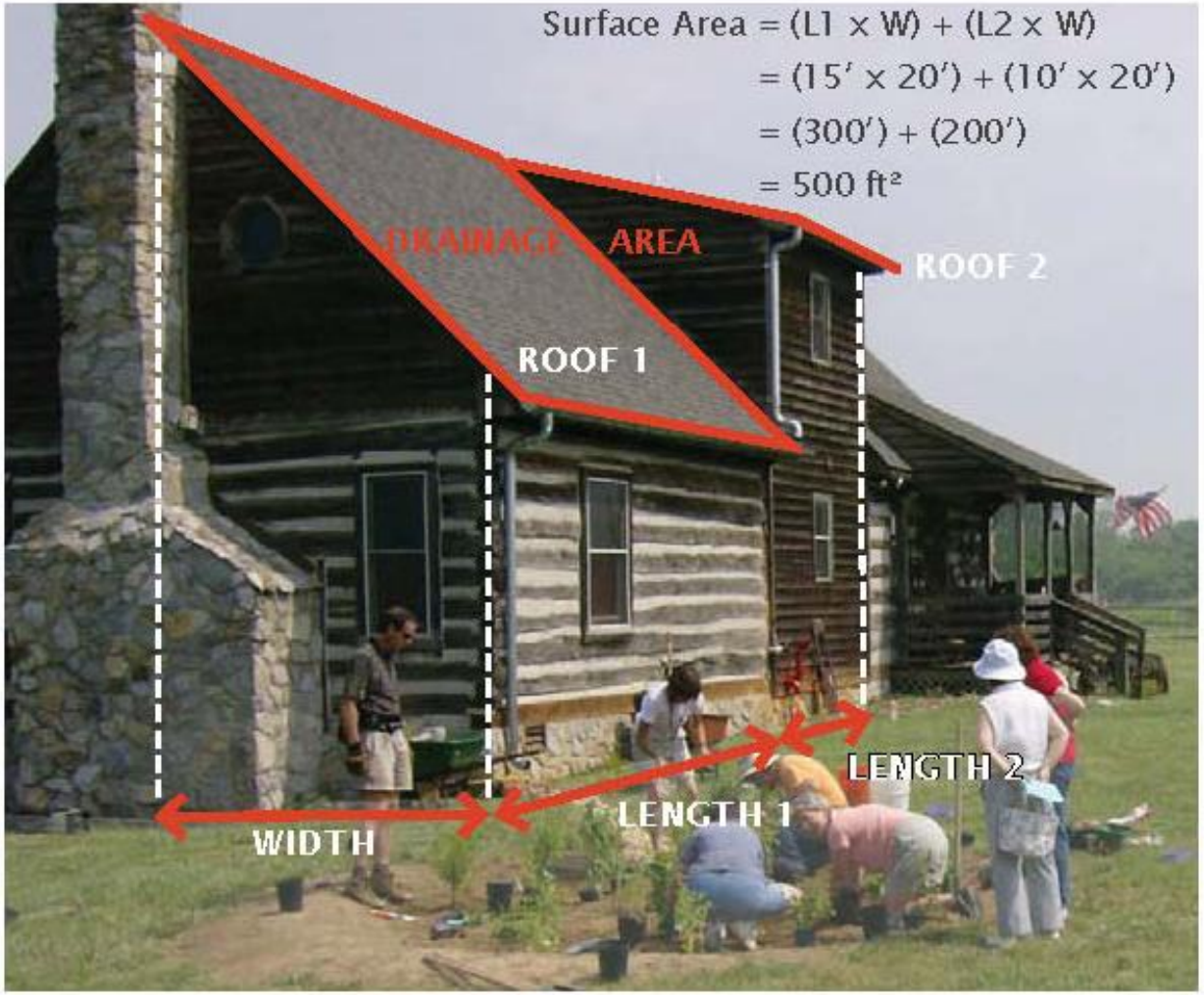
- **NJ One Call: 1-800-272-1000**
- Free markout of underground gas, water, sewer, cable, telephone, and electric utility lines
- Call at least 3 full working days, but not more than 10 days, prior to planned installation date
- Do not place rain garden within 5’ horizontally and 1’ vertically from any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

Understanding Your Property

- How does rainwater flow through your yard?
- Where does the runoff travel to once it leaves your yard?



Drainage Area Calculation



Drainage Area: Rooftop Scenario

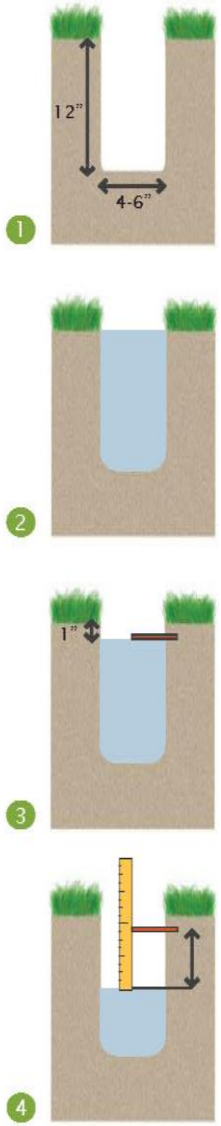
Drainage Area:
The Road, Driveway, or Parking Lot Scenario

A curb cut and a stone buffer provides the inlet for runoff to enter the rain garden from the adjacent roadway.

Lions Lake Park
Voorhees, NJ

Make observations after a rainstorm to determine the direction of the runoff and the drainage area of the rain garden.

Check Your Soil



- 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

Check Your Soil

- Soil Test
  - The infiltration test will give an initial evaluation of the site's soil conditions
  - The soil test will give an accurate reading of the soil fertility, texture, mechanical

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New Jersey Agricultural Experiment Station

Soil Testing Laboratory
Rutgers, The State University
P.O. Box 902
Milltown, NJ 08850-0902
Phone: (732) 932-9295

Soil Test Report
Lab No: 2008-7162

Name: Rutgers University, Env. Science
Chris Obrupta/Gregory Rusciano
Address: 14 College Farm Road
New Brunswick, NJ 08901
Phone: (732) 932-2739
Fax: (732) 932-8644
Referred To: Rutgers Cooperative Ext.

Date Received: 10/02/2008
Date Reported: 10/09/2008
Serial No: -
Sample ID: Dorsett

Crop or Plant
New Perennial - Mixed Perennial

Soil Tests and Interpretation

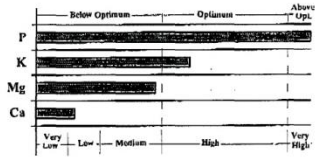
pH: 5.90 Medium acidic; pH is slightly low for the growth of most crops except for acid-loving plants.

Lime Requirement Index: 7.85
Adams-Evans LRI is a measure of the soil's buffering capacity (resistance to change in pH). It is used to determine liming rate, when necessary.

Macronutrients (pounds/acre)

Phosphorus:	607	(Above Optimum)
Potassium:	176	(Optimum)
Magnesium:	138	(Below Optimum)
Calcium:	698	(Below Optimum)

by Mehlich 3 extraction



Micronutrients (parts per million)

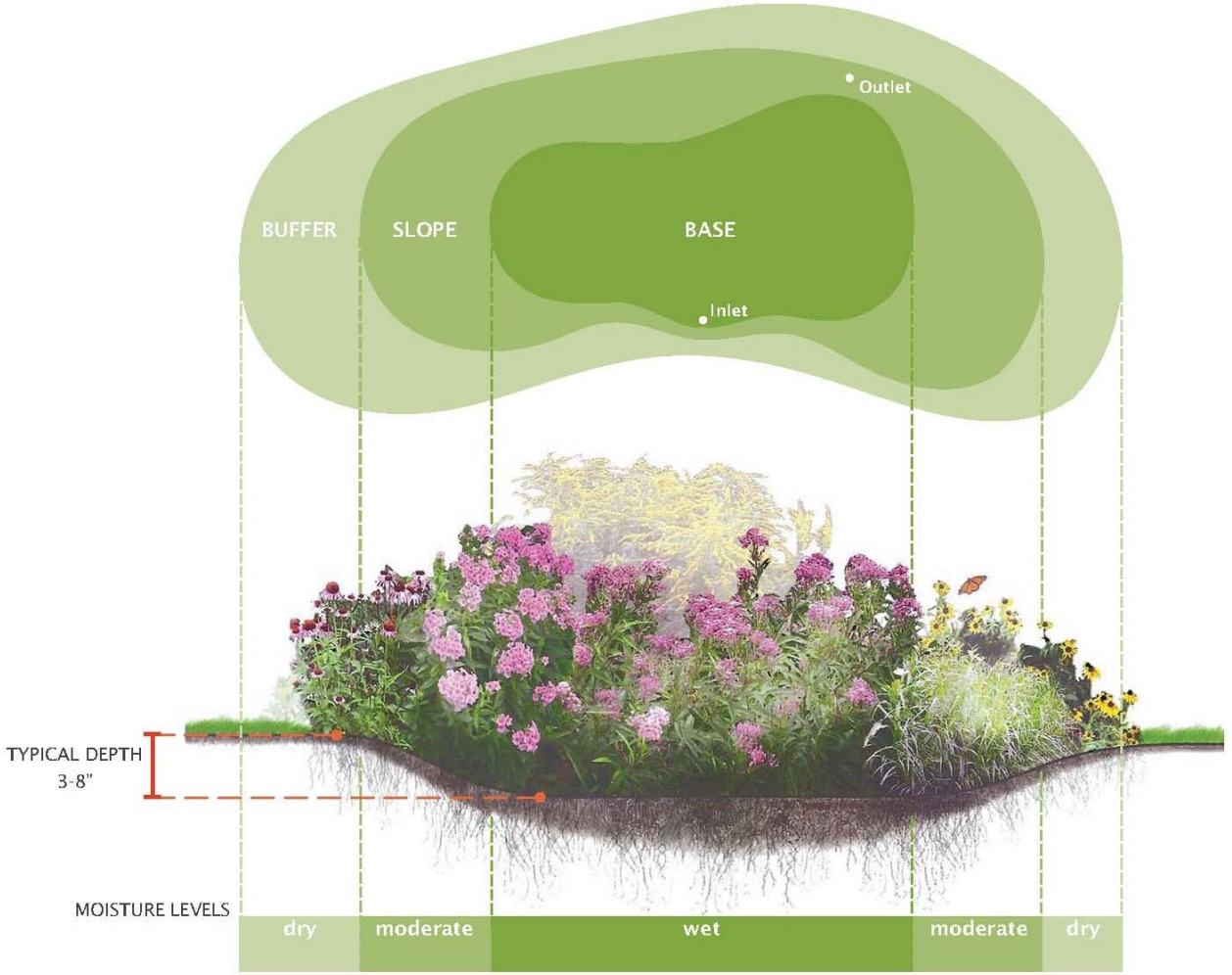
Zinc:	Copper:	Manganese:	Boron:	Iron:
4.6 (Adequate)	1.6 (Adequate)	7.5 (Adequate)	5.9 (Adequate)	211 (High)

Special Tests and Results
No special tests requested.

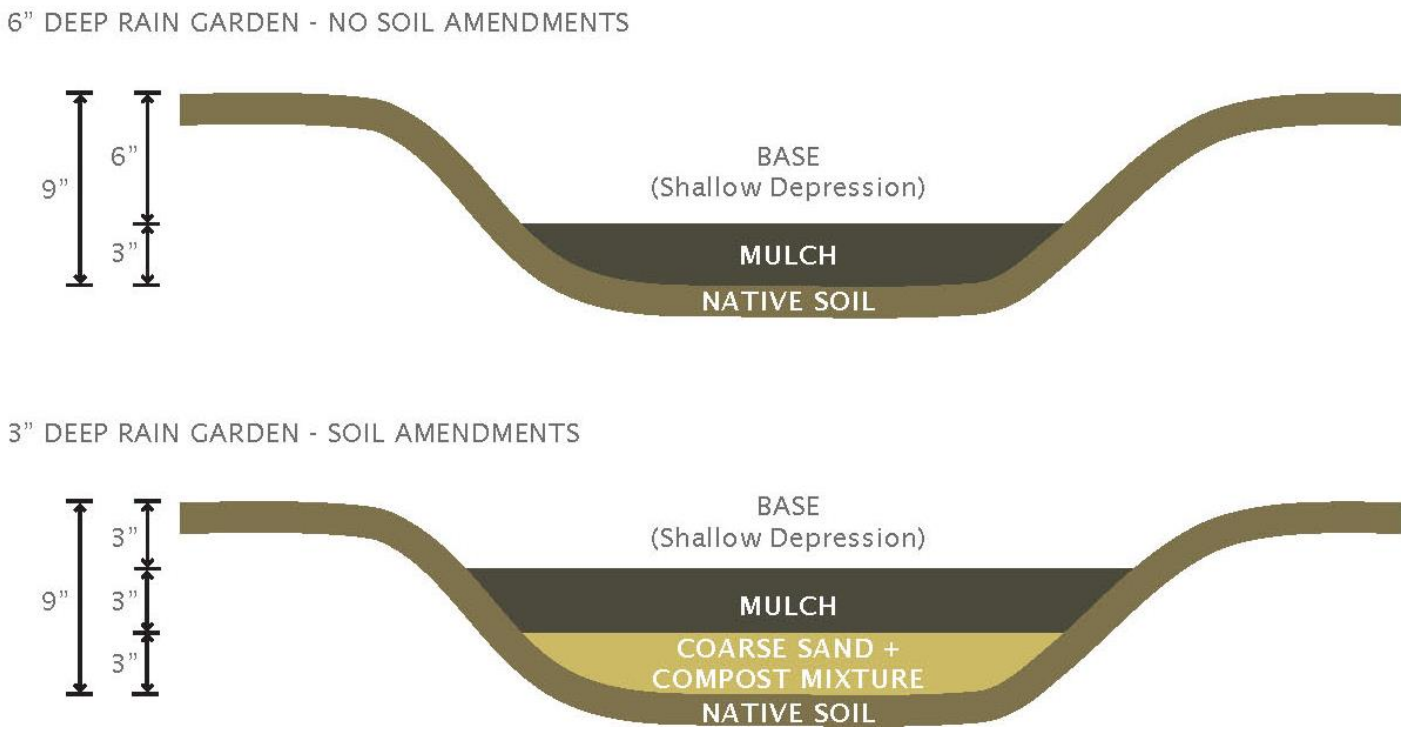
Lime Recommendation
The soil test indicates a moderately acidic soil; the pH is below the best range for the growth of most Perennial. This soil should be treated with 15 pounds/1000 sq. ft. of limestone. Spread uniformly on the surface, then mix thoroughly to a 6 inch depth by shovel or by tilling.

Soil Test Report for Lab No. 2008-7162

Determining the Depth of the Rain Garden



Determining the Depth of the Rain Garden



- 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

Soil Texture Amendments

- Soil texture amendments improve the rain garden's infiltration rate.

Soil Quality Amendments

- Soil quality amendments improve the rain garden's growing conditions for plants
- Improve soil's nutrient capacity

REMEMBER:
Your rain garden should NOT be permanently filled with water – it should drain within 24 hours.

Determining the Inlet and Overflow

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

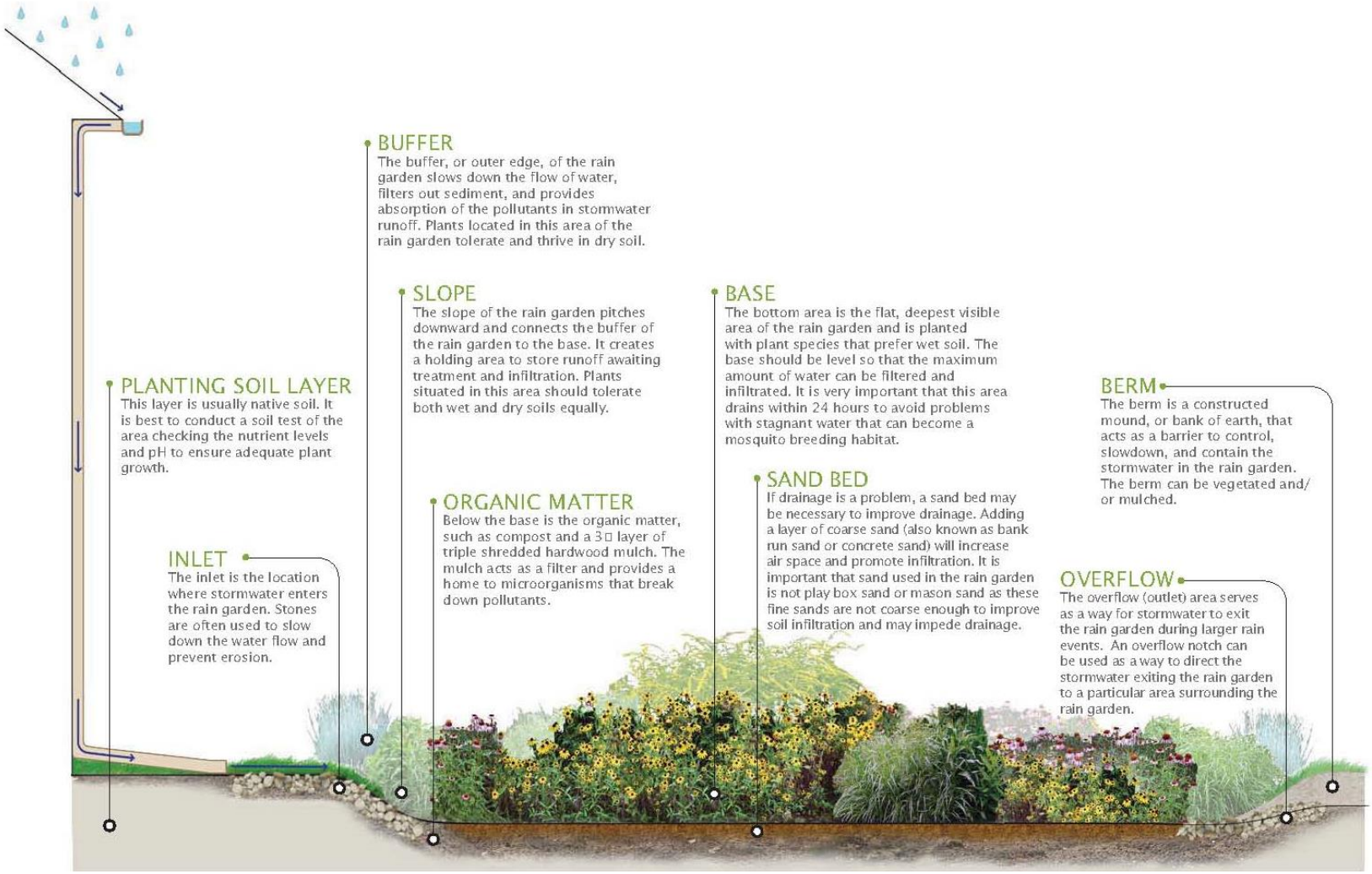
Preventing Erosion

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

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)

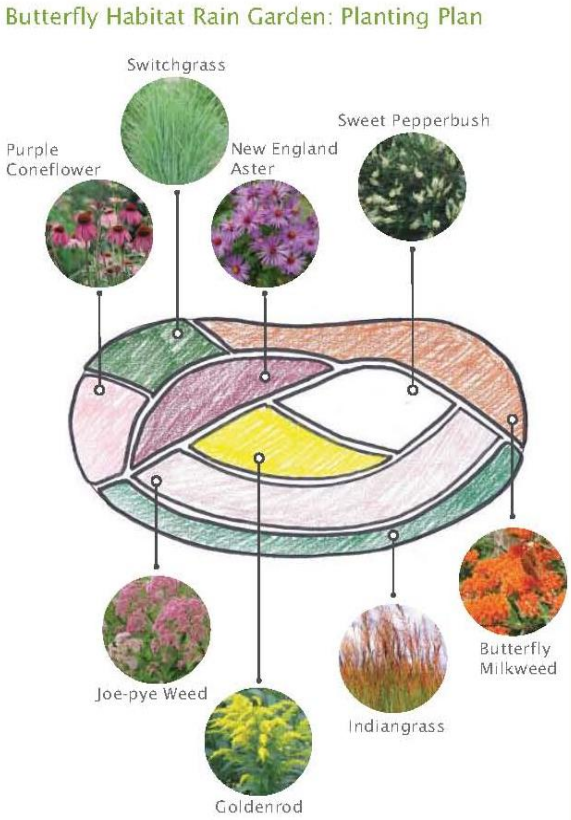
Parts of a Rain Garden

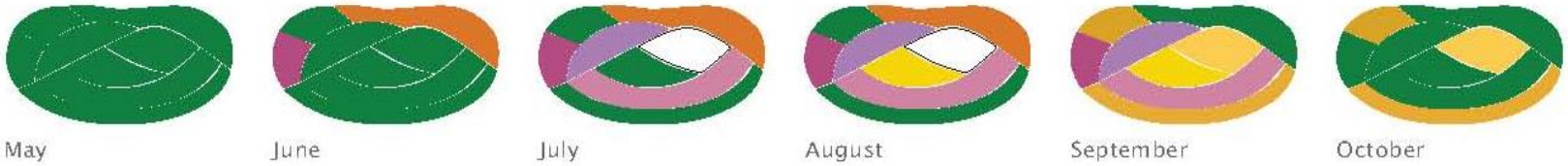


Rain Garden Design

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





Selecting Plants for Your Rain Garden

- The success of your rain garden depends on selecting the right plants for the right place
- Plant your rain garden with plants adapted for your specific site
- **Native plants** can thrive without a lot of care, extra water, fertilizer, or pesticides
- **Native plants** are tolerant to dry and wet conditions

Plant Selection

- Select species based upon the following qualities:
  - Plant size
  - Moisture tolerances
  - Sun preferences
  - Plant aggressiveness
  - Salt tolerance
  - Habitat creation

Planting Design Tips

- Plants that prefer wet conditions should be planted in the deepest part (the base) of the rain garden
- Create depth in the rain garden by placing large and tall plants in the back, smaller plants in the front
- Plant masses of the same species together in odd numbers
- Incorporate plants that have visual interest in the fall and winter
- Native plants provide habitat to animals and require less watering

THE FUN PART!

INSTALLING YOUR RAIN GARDEN

GETTING STARTED

- It is most effective to start the actual construction of the rain garden in the spring when the abundant rains will allow for best plant establishment and easier digging
- Summer/autumn start will also work, but the plants may need more watering until they become established

INSTALLATION STEPS

1. Remove existing grass
2. Excavate to desired elevation and grade
3. Add soil amendments

INSTALLATION STEPS

4. Prepare berm (if necessary)
5. Prepare overflow
6. Level the base (lowest area)

INSTALLATION STEPS

7. Plant native species

8. Apply mulch

9. Water plants

10. Appreciate a job well done

TOOLS & MATERIALS NEEDED

- Rakes and shovels
- Rototiller
- Wheelbarrow
- String level or survey equipment
- Measuring tape
- Triple-shredded hardwood mulch
- Plants

- Soil amendments, if necessary: fertilizer, pH adjustments (lime), coarse sand
- Optional: decorative stone, signage, seating, pipe extensions, pavers for path
- Work crew (friends, neighbors, and family)

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

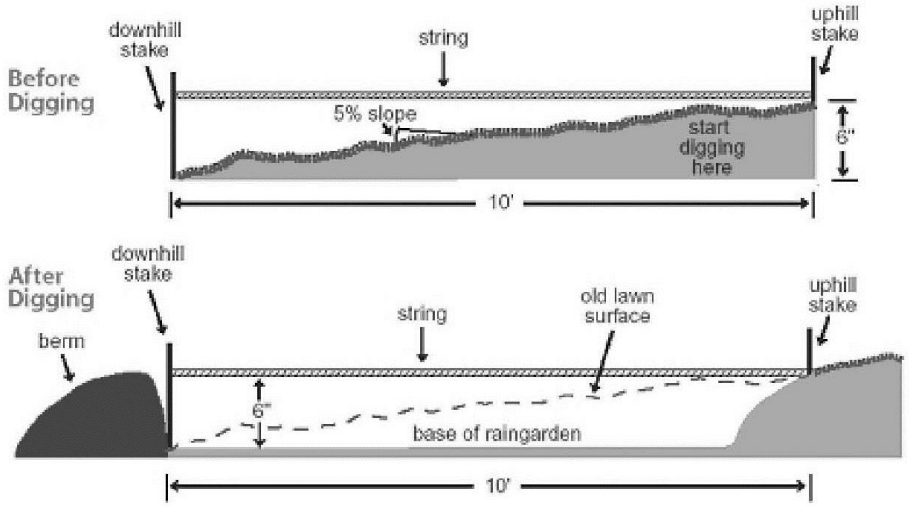


- Combine amendments with existing soil using shovels or rototiller

- Loosen and prepare soil for grading and planting

Step Four

- Prepare the berm, if necessary

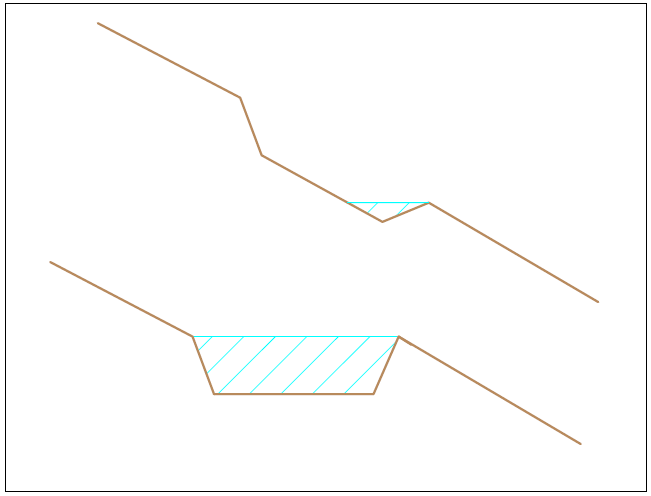


Step Five

- Prepare the overflow

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

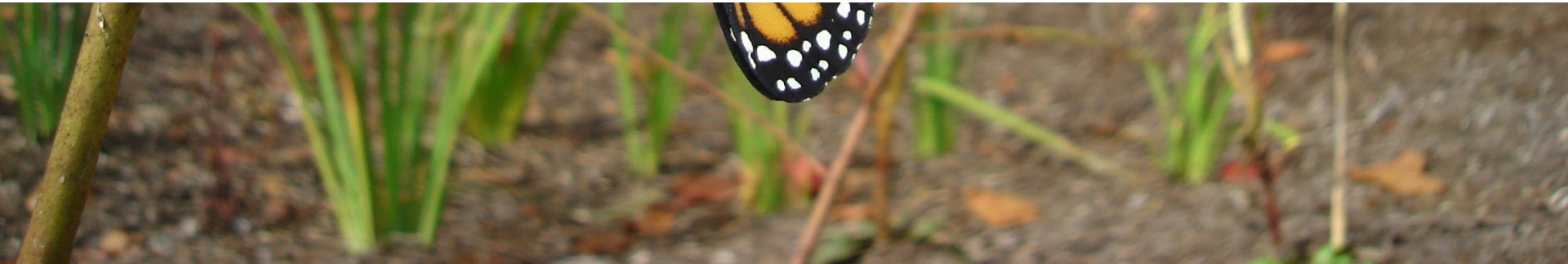
- Water Plants

Step Ten

- Appreciate a job well done

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)

Weekly Maintentance: **Watering**

- Water plants regularly – particularly during the first 1-2 growing seasons
- Be careful that the plants don't get too wet or too dry

Weekly Maintenance: **Weeding**

- During the first few years, you will need to weed often during the growing season
- You will need to weed less and less as the plants grow and surpass the weeds
- Watch out for aggressive invasive species

Invasive Plants in New Jersey

http://www.invasivespeciesinfo.gov/unitedstates/nj.shtml

Weekly Maintenance: **Inspecting**

- What am I inspecting for?
  - Invasive plants
  - Plant health
  - Excessive sediment
  - Movement of sediment within the rain garden

Weekly Maintenance: **Inspecting**

- Observe the rain garden during rain events and note any successes

Success: Stormwater runoff picks up oil and grease from the parking lot, flows through a curb cut, and into a rain garden. The rain garden traps the nonpoint source pollutants before they reach the nearby lake.

Weekly Maintenance: **Inspecting**

- Observe the rain garden during rain events and note any problems

Problem: Gullying after rain event

Solution: Add a berm, more plants, river rocks, and/or more mulch

Weekly Maintenance: **Inspecting**

- Observe the rain garden during rain events and note any problems

Problem: Rain garden is not infiltrating within 24 hours

Solution: Add sand wicks, preferably 1’ deep if possible, and fill with pockets of coarse sand