

RUTGERS

New Jersey Agricultural
Experiment Station



Green Infrastructure: Opportunities for Municipalities

Tuesday • October 12, 2010 • 1:00pm • Sussex County Administrative Center

Rutgers Cooperative Extension Water Resources Program

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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. The goal of the Program is to provide solutions for many of the water quality and quantity issues that New Jersey faces today. This is accomplished through research, education, and outreach.

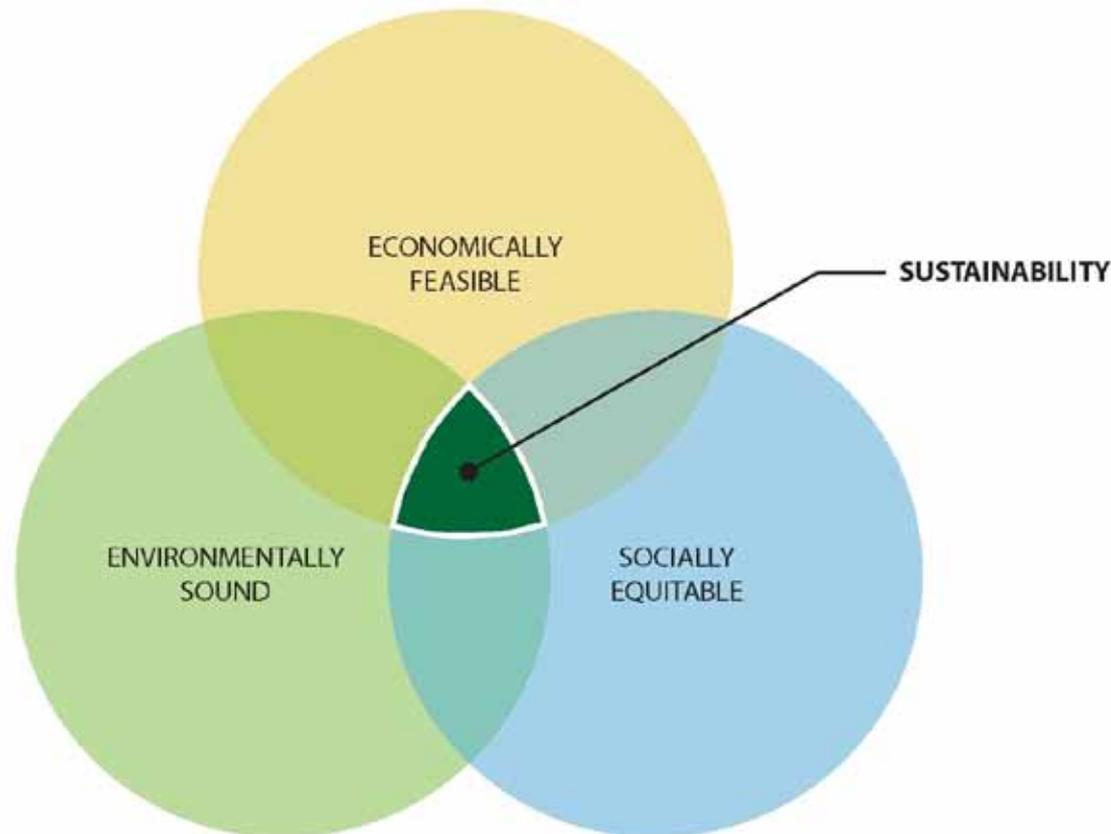




What is Sustainability?

"Design, construction, operations, and maintenance practices that meet the needs of the present without compromising the ability of future generations to meet their own needs."

- Brundtland Report, *Our Common Future* (1987)



Defining the Problem

1. Aging infrastructure
2. Increased maintenance costs
3. Lack of funding for #1 and #2

The current estimate to repair the wastewater infrastructure throughout the State is \$15 billion.

- Fiscal 2008 Budget in Brief. NJ State Office of Management and Budget, Chapter 2, pg 42, Feb 22, 2007, <http://www.state.nj.us/treasury/omb>



Green Infrastructure Initiative

NEED:

Infrastructure throughout the state is deteriorating and needs repairs and replacement. Aging infrastructure will need to be replaced with new technology, better preparing the state for a sustainable future.

OPPORTUNITIES:

The Water Resources Program has been providing technical assistance to municipalities for several years, solving water resources problems. The Green Infrastructure Initiative builds upon these past efforts and partnerships to provide targeted assistance to municipalities and counties throughout the state.

GOAL:

The Green Infrastructure Initiative provides technical assistance to municipalities who want to sustain their water resources, infrastructure, reduce maintenance costs, and prepare for a sustainable future with innovative techniques and technology.



What is Green Infrastructure?

Green infrastructure is an approach to wet weather management that is cost-effective, sustainable, and environmentally friendly. Green Infrastructure management approaches and technologies infiltrate, evapotranspire, capture and reuse stormwater to maintain or restore natural hydrologies.

USEPA. 2009. Green Infrastructure Manual.



Rain Garden in Holmdel, NJ



Native NJ Purple Coneflower



Pervious Pavers

ASLA VIDEO

Video by the American Society of Landscape Architects

The Green Infrastructure Movement

Green Infrastructure:

§ Uses natural processes to slow, treat, or absorb runoff

§ Evapotranspiration

§ Infiltration

§ Techniques may include water capture and reuse

Green Infrastructure can be utilized by cities and municipalities to:

§ Protect and maintain the quality of local waterways

§ Reduce the impact of development and urbanization

§ Decrease the frequency of combined sewer overflows

§ Preserve and restore natural landscape features

§ Provide opportunities for outdoor recreation

For more information, visit:

http://cfpub.epa.gov/npdes/home.cfm?program_id=298



National Case Studies Implementing Green Infrastructure



KEY:
● CITIES
● EDUCATIONAL

- | | |
|----------------------|-----------------|
| Chicago, IL | Lenexa, KS |
| Portland, OR (2) | Kansas City, MO |
| Philadelphia, PA (2) | Edison, NJ |
| Milwaukee, WI | Montpelier, VT |
| Seattle, WA | Chapel Hill, NC |

National Case Studies: Cities

Edison, NJ: EPA's Edison Environmental Center Demonstration Site



EPA 2010

- Permeable pavement and attached rain gardens for research
- Three permeable pavement types installed side-by-side
- Rain gardens of various sizes
- Over 100 instruments installed throughout the site
- Buried tanks for collecting effluent

National Case Studies: Cities

Chicago, Illinois

Types of Green Infrastructure Used: Green Roofs, Rain Gardens, Vegetated Swales & Landscaping, Porous Pavement; Downspout Disconnection, Rain Barrels & Cisterns.

- Chicago green roof program
- Chicago City Hall 20,000 square foot demonstration roof
- Installed more than 80 green roofs in the city as part of their green infrastructure initiative

A green roof installed on Chicago City Hall



National Case Studies: Cities

Portland, Oregon

Types of Green Infrastructure Used: Green Roofs, Rain Gardens, Porous Pavements, Vegetated Swales & Landscaping, Downspout Disconnection, and Rain Barrels.

- Promote sustainable development
- New policy decisions include
 - Green roof requirement for new municipal buildings
 - Homeowners are paid to disconnect their downspouts

Vegetated curb extensions are used throughout Portland to decrease stormwater runoff.



National Case Studies: Cities

Seattle, Washington

Types of Green Infrastructure Used: Green Roofs, Rain Gardens, Vegetated Swales & Landscaping, Downspout Disconnections, and Rain Barrels.

- 1990s Stormwater management projects
- Projects include
 - Viewlands Cascade Project
 - Street Edge Alternatives Project
 - High Point Neighborhood Project

Vegetated swales are an integral part of Seattle's "SEA Street" design.



National Case Studies: Cities

Montpelier, Vermont

Types of Green Infrastructure Used: Rain Gardens and Stormwater Swales

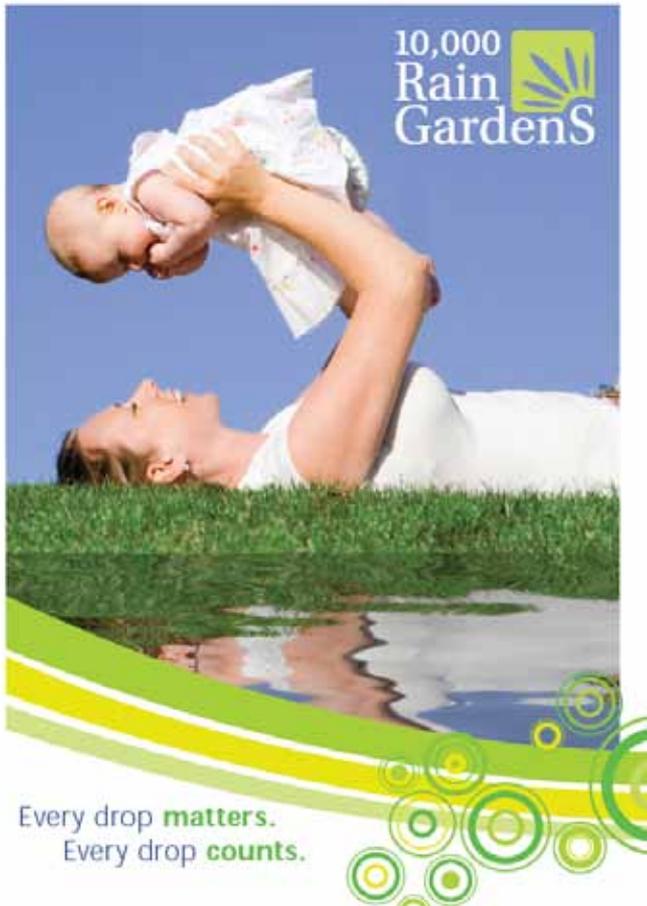
- 133 State Street on VT Capitol Complex
- Installed rain gardens and stormwater swales
- Captured runoff flows into Winooski River and Lake Champlain

Rain gardens and stormwater swales capture runoff from a parking lot on Montpelier's Capitol grounds



National Case Studies: Cities

Kansas City, Missouri: "10,000 Rain Gardens"



- Public initiative for metro area
- Property owners encouraged to create rain gardens
- Goal of 10,000 individual gardens
- Aims to bring widespread use of rain gardens to offset increasing demand on city's stormwater infrastructure



National Case Studies: Cities

Kansas City, Missouri: "10,000 Rain Gardens"



The Epicenter. 2007. Lynn Hinkle.



An opportunity for the future.

The 10,000 Rain Gardens initiative was launched in November 2005 along with a comprehensive public education plan to help citizens learn about their role in water quality. The "rain garden," a shallow, basin-shaped garden filled with deep-rooted grasses and flowers, became both the symbol and central project for the initiative.

In the past two years, several hundred rain gardens as well as rain barrels and bioswales have been installed and are working to reduce runoff.

These personal efforts combined with commercial-sized green solutions, such as green roofs, pervious pavement and bioswales, yield a powerful cumulative effect to reduce flooding, erosion and pollutants in our rivers and streams. Working together, we will improve water quality and make a difference now and for the future.

10,000 Rain Gardens. 2010

National Case Studies: Educational

Glencoe Elementary School (Portland, Oregon)

Types of Green Infrastructure Used: Rain Garden, Bioswale

- 2002-2003, School retrofitted with swales and rain gardens
- Funded by City of Portland
- Results
 - captured 30-40% of runoff that drains into nearby residential areas, retaining 95% of stormwater captured
 - reduced impervious area of the school parking lot by 30%.

Rain Garden at Glencoe Elementary School



National Case Studies: Educational

Penn Alexander School (Philadelphia, Pennsylvania)

Types of Green Infrastructure Used: Porous Pavement, Bioretention, Infiltration Beds, Rain garden

- Porous playground
- Reduced runoff flow
- Reduced amount of pollutants entering city's combined sewer system

Roof leaders from the Penn Alexander School connect to this rain garden.



Economic Benefits of Green Infrastructure



Increased Land Values

- Increase surrounding property values



Reduced Energy Demands & Energy Costs Savings

- Mitigate the effects of urban heat islands
- Reduce energy demands
- Decrease energy costs and emissions from power plants



Lower Life Cycle Costs

- Lower life cycle costs compared to traditional systems

Economic Benefits of Green Infrastructure



Greater Return on Investment

- Integration of energy with other infrastructure creates greater value for investments
- New commercial and industrial opportunities



Save Local Dollars

- Helps avoid unnecessary expenses in engineered infrastructure by supporting ecosystem services

Environmental Benefits of Green Infrastructure



Reduced and Delayed Stormwater Runoff Volumes

- Reduces stormwater runoff volumes
- Reduces peak flows
- Increases stormwater infiltration rates
- Reduces volume of runoff entering our combined or separate sewer systems, and ultimately our lakes, rivers, and streams



Enhanced Groundwater Recharge

- Improves the rate at which groundwater aquifers are 'recharged' or replenished
- Enhanced groundwater recharge boosts the supply of drinking water for private and public uses

Environmental Benefits of Green Infrastructure



Stormwater Pollutant Reductions

- Infiltrate runoff close to its source
- Helps prevent pollutants from being transported to nearby surface waters
- Plants and microbes naturally filter and break down many common pollutants found in stormwater



Reduced Sewer Overflow Events

- Limits the frequency of sewer overflow events
- Reduces runoff volume
- Delays stormwater discharges



Increased Carbon Sequestration

- Increases photosynthesis and other natural processes to remove carbon dioxide in atmosphere

Environmental Benefits of Green Infrastructure



Urban Heat Island Mitigation

- Increases mitigation of Urban Heat Island Effect
- Regulates temperature

Improved Air Quality

- Incorporates trees and vegetation in urban landscapes
- Absorbs pollutants from the air through leaf uptake and contact removal
- Cools air and reduces smog



Additional Wildlife Habitat and Recreational Space

- Increases access to recreational space and wildlife habitat (Greenways, parks, urban forests, wetlands, and vegetated swales)



Social Benefits of Green Infrastructure



Improved Human Health

- § Positive impact on human health
- § Reduces levels of inner-city crime and violence, a stronger sense of community, improved academic performance
- § Reduces symptoms associated with attention deficit and hyperactivity disorders



Support for Other Sustainability Projects

- § Serves as a catalyst for other sustainability programs
- § Builds community understanding and appreciation
- § Educational opportunities

Social Benefits of Green Infrastructure



More Aesthetically Pleasing Community Amenities

- New opportunities for beautification of public spaces



Less Risk to Natural Disasters

- More options if something goes wrong
- Loads can be shared or resources can be substituted at the scale most appropriate
- Protects landscape features that absorb floodwaters
- Helps to avoid development in hazardous areas



More Efficient Land Use

- Allows cities to more effectively use their land base

Social Benefits of Green Infrastructure



Support for Business and Job Growth

- Attracts new business and local jobs
- Creates markets for non-potable water redistribution, landscaping, decorative plants, or waste heat recovery



Improve Community Quality of Life

- Provides community leaders information about regional land and water ecosystems
- Fosters collaboration between developers and conservationists by providing and sharing information



Support of Working Lands

- Supports working lands such as farmland and forests, wildlife habitat, as well as ecotourism

Green Infrastructure Design Approaches

SITE

- Green Roofs
- Rain Harvesting
- Downspout Disconnection
- Planter Boxes
- Rain Gardens
- Permeable Pavements
- Vegetated Swales
- Natural Retention Basins

NEIGHBORHOOD

- Green Parking
- Green Streets & Highways
- Pocket Wetlands
- Trees & Urban Forestry
- Brownfield Redevelopment
- Infill and Redevelopment

WATERSHED

- Riparian Buffers
- Habitat Preservation & Restoration



Green Infrastructure Design Approaches

GREEN ROOFS

Basic Info:

- extension of the existing roof
- high quality water proofing and root repellent system
- drainage system, filter cloth
- lightweight growing medium and plants

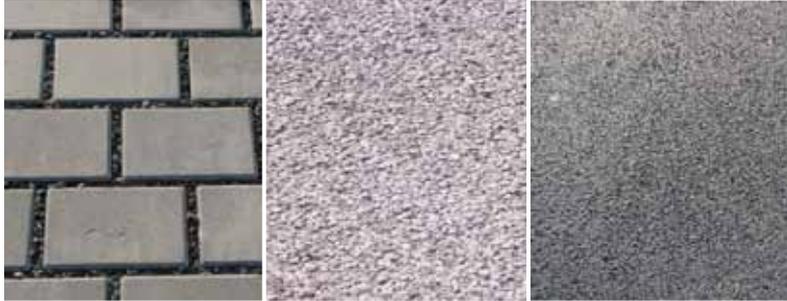
Benefits:

- Economic benefits (lower life cycle costs, savings on energy heating and cooling costs)
- Improved air quality
- Temperature regulation (moderation of Urban Heat Island Effect)
- Carbon dioxide/oxygen exchange
- Amenity space and aesthetics
- Sound insulation



Green Infrastructure Design Approaches

PERMEABLE PAVEMENT



Basic Info:

- Materials that allow runoff to flow through the surface to an underlying storage layer

Benefits:

- 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



Green Infrastructure Design Approaches

RAIN GARDENS

Basic Info:

- “bioretention area”
- man-made depression in the ground
- landscape tool to improve water quality and reduce flooding



Green Infrastructure Design Approaches

RAIN GARDENS



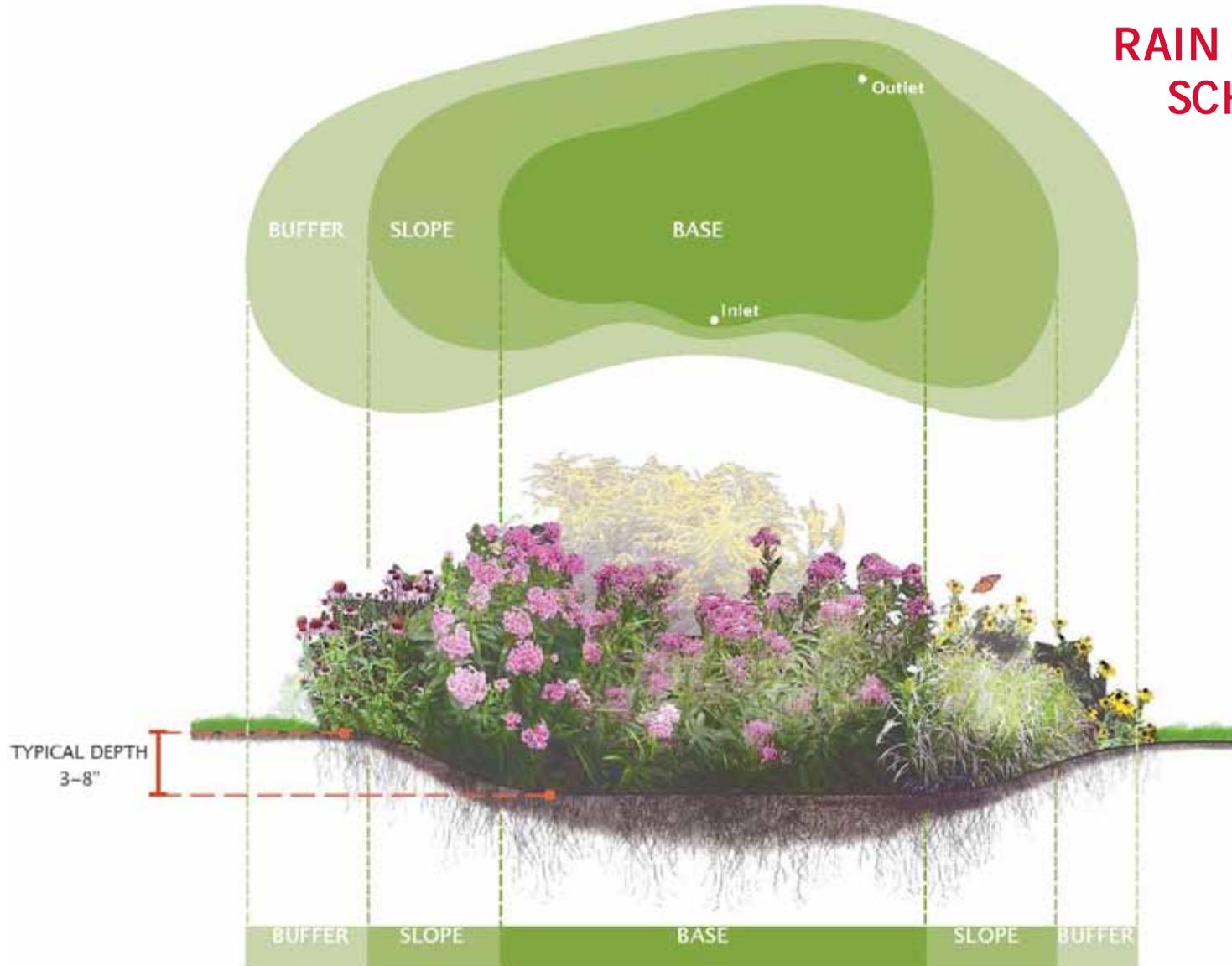
Maplewood, MN

Benefits:

- Recharges groundwater sources
- Protects communities from flooding and drainage overflow
- Provides valuable wildlife habitat
- Reduces maintenance costs
- Uses native plants that are water and climate tolerant
- Controls stormwater and nonpoint source pollution
- Adds aesthetics to the landscape

Green Infrastructure Design Approaches

RAIN GARDEN SCHEMATIC

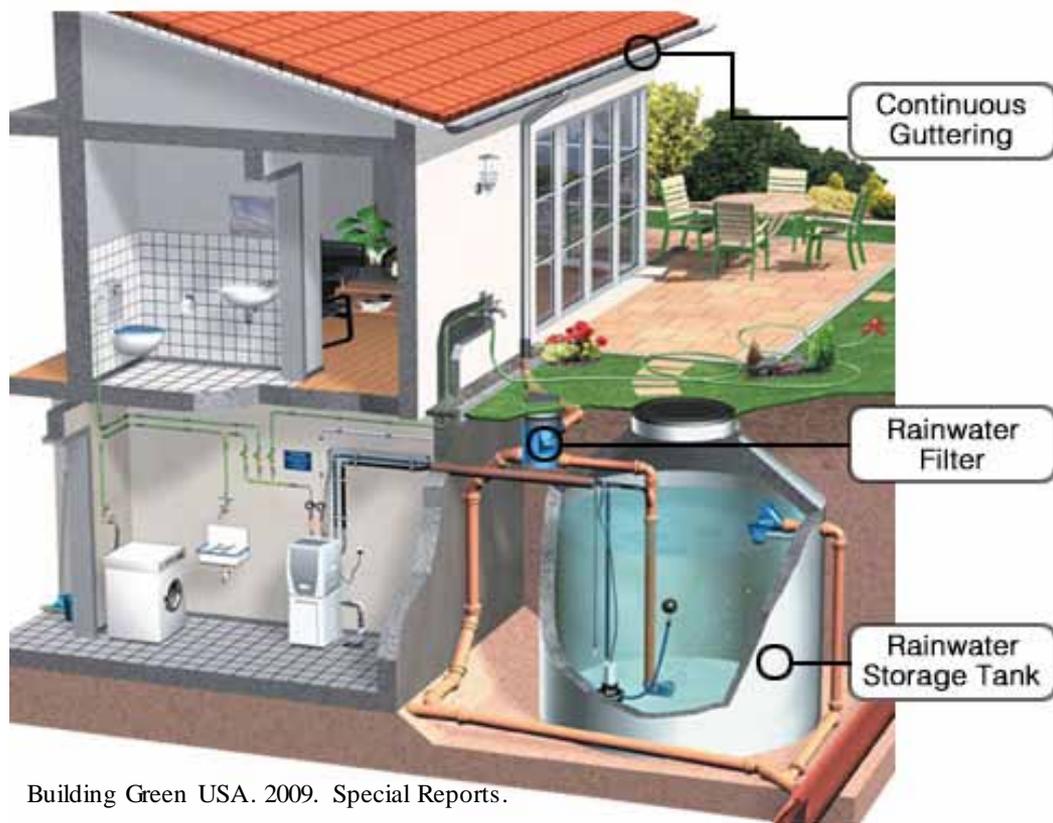


Green Infrastructure Design Approaches

RAINWATER HARVESTING

Basic Info:

- Capture, diversion, and storage of rainwater



Benefits:

- Eliminates need for complex and costly distribution systems
- Provides additional water source
- Prevents scale on appliances
- Landscape irrigation
- Reduces flow to stormwater drains
- Reduces non-point source pollution
- Reduces summer demand peak
- Delays expansion of existing water treatment plants
- Reduces consumers' utility bills

Green Infrastructure Design Approaches

RAINWATER HARVESTING

- Saves drinking water
- Irrigates the landscape
- Reduces utility bills
- Prevents basement flooding
- Reduces pollution



• Downspout
(connects to gutter)

• Flexible Downspout
(plastic)

• Inlet

• Overflow

• Rain Barrel
(55 gallons)

• Faucet

• Platform
(elevated + level)

Residential Rain Barrel

Green Infrastructure Design Approaches

RAINWATER HARVESTING

Above Ground Cisterns



Green Infrastructure Design Approaches

VEGETATED SWALES



Basic Info:

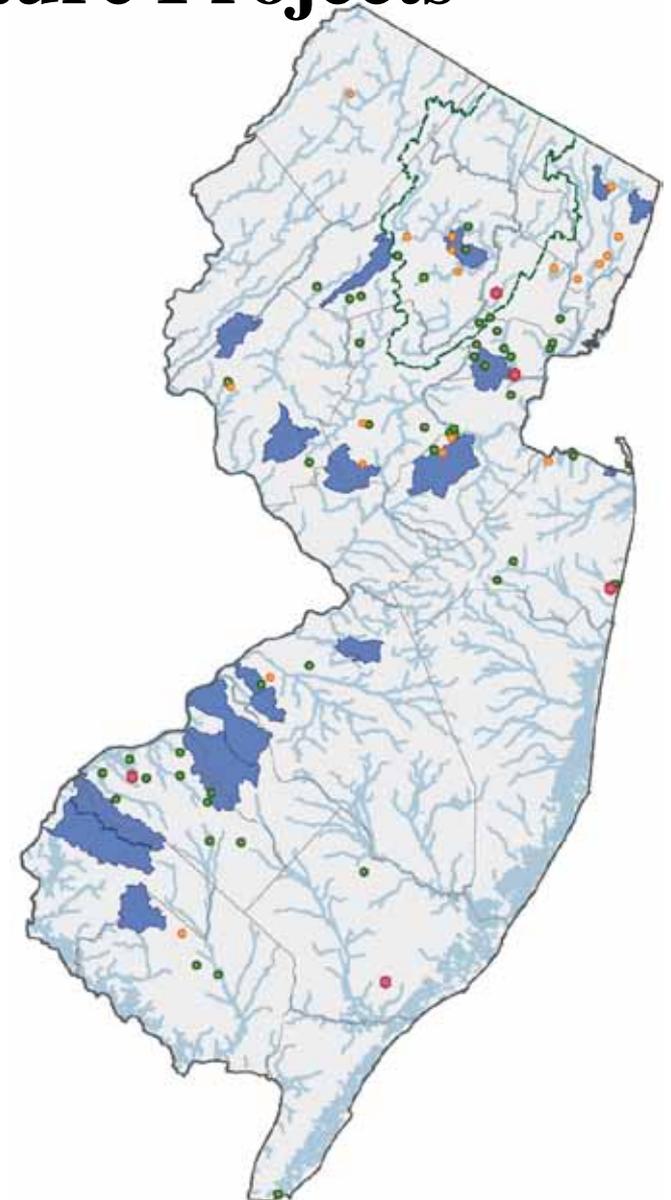
- § Broad, shallow channel with a dense stand of vegetation covering the side slopes and bottom
- § Traps particulate pollutants (suspends solids and trace metals)

Benefits:

- § Reduced peak flows
- § Removal of pollutants
- § Promotion of runoff infiltration
- § Lower capital costs.

New Jersey Green Infrastructure Projects

1. Woodbridge Health Center Rain Garden (2009)
Woodbridge, Middlesex County NJ
2. Hillsborough Detention Basin (2008)
Hillsborough, Somerset County NJ
3. Rockaway Mall (2010)
Rockaway Township, Morris County NJ
4. Environmental Justice for the City of Newark (2010)
Newark, Essex County NJ
5. Sustainable South Bronx (2009-2010)
Bronx, NY
6. DPW Green Initiatives: Parsippany-Troy Hills (2007)
Parsippany-Troy Hills, Morris County NJ
7. Community Rain Barrel Programs (2009)
Pennington, Mercer County NJ
8. Cooper River Stormwater Education and Implementation Plan (2010): Camden County NJ
9. Water Harvesting & Green Roof Opportunities (2010-Future)



New Jersey Case Studies

WOODBRIIDGE HEALTH CENTER RAIN GARDEN



New Jersey Case Studies

WOODBRIIDGE HEALTH CENTER RAIN GARDEN

In New Jersey, 90% of rainfall events are less than 1.25 inches, with approximately 44 inches total of rain per year. Therefore, a rain garden will treat and recharge 3.3 ft of water per year.

If a rain garden receives runoff from 1,000 ft², the total volume treated and recharged is 25,000 gallons of water per year.

So, 40 rain gardens will treat 1,000,000 gallons of water per year!



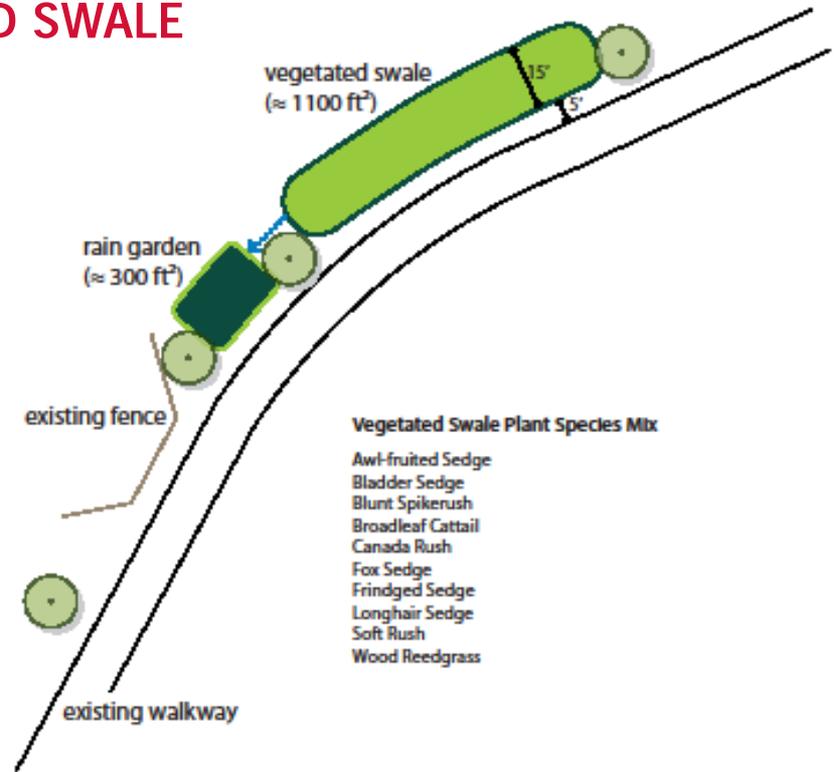
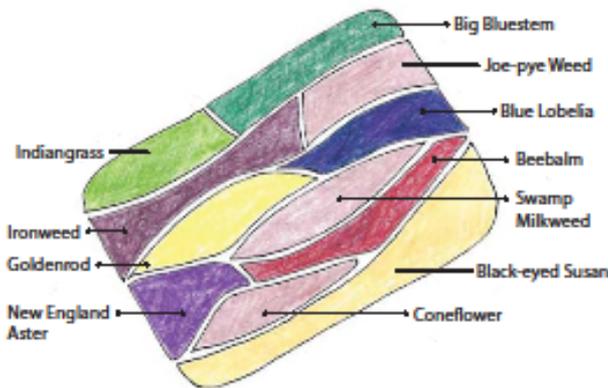
New Jersey Case Studies

CONNOLLY PARK RAIN GARDEN AND SWALE



area of detail

Rain Garden Planting Plan



New Jersey Case Studies

HILLSBOROUGH DETENTION BASIN

Location: Hillsborough, Somerset County NJ

Year: 2008

Grant Funding: Township of Hillsborough, NJ



New Jersey Case Studies

HILLSBOROUGH DETENTION BASIN



New Jersey Case Studies

VEGETATED DETENTION BASINS



New Jersey Case Studies

VEGETATED DETENTION BASIN



New Jersey Case Studies

VEGETATED DETENTION BASIN



New Jersey Case Studies

VEGETATED DETENTION BASIN



New Jersey Case Studies

VEGETATED DETENTION BASIN



New Jersey Case Studies

VEGETATED DETENTION BASINS



New Jersey Case Studies

ROCKAWAY MALL URBAN STORMWATER RETROFIT & BMP DEMONSTRATION

Location: Rockaway Township, Morris County NJ

Year: 2010

Grant Funding: NJDEP 319(h) grant pending

Partners: Rockaway River Watershed Cabinet, Simon Properties, Rockaway Township

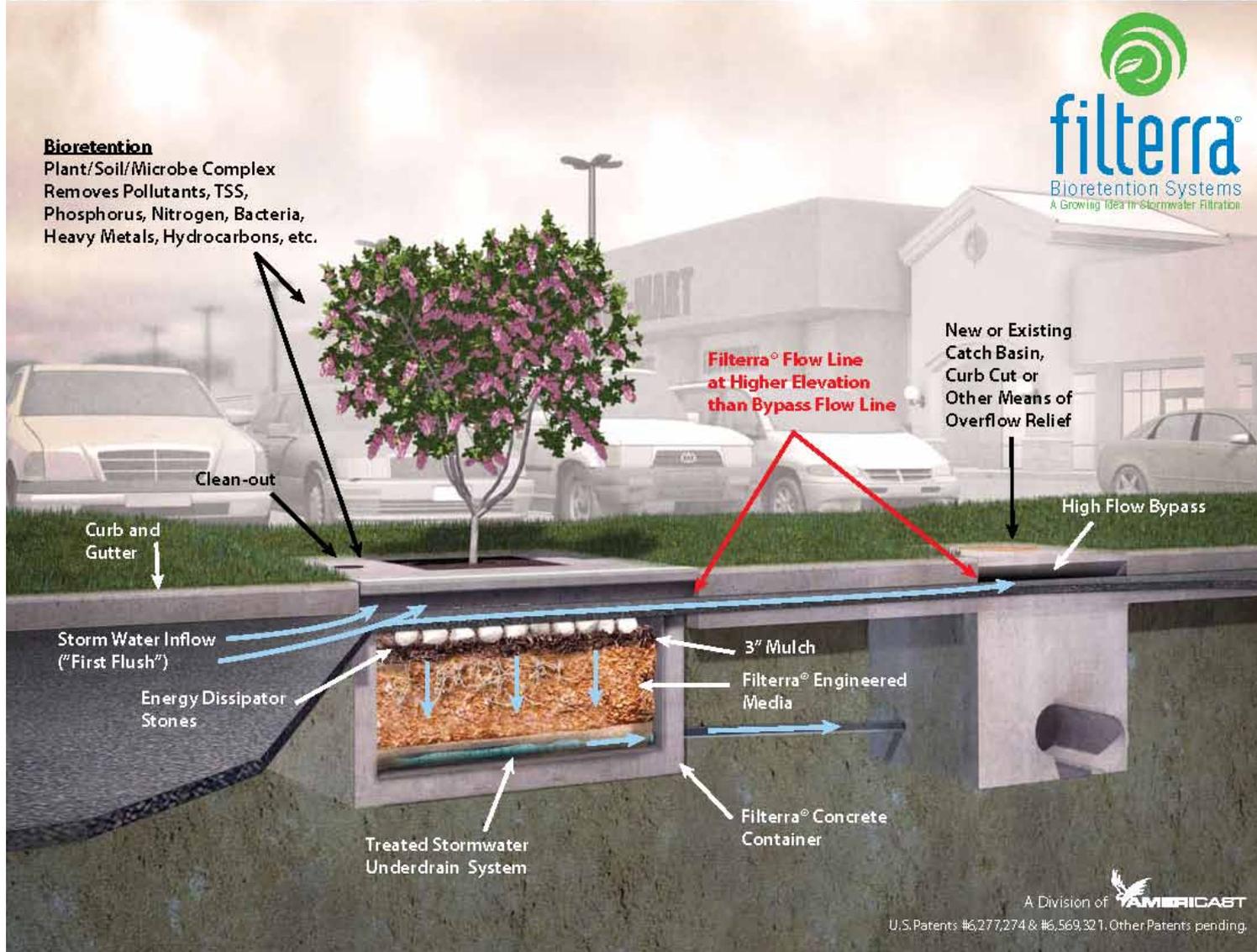


General Info:

- 1.2 million square feet
- First opened 1977, updated 1993
- Super regional shopping center
- 5 anchor stores & over 180 specialty stores

New Jersey Case Studies

ROCKAWAY MALL URBAN STORMWATER RETROFIT & BMP DEMONSTRATION



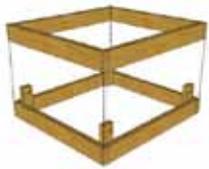
New Jersey Case Studies

ROCKAWAY MALL URBAN STORMWATER RETROFIT & BMP DEMONSTRATION



New Jersey Case Studies

ENVIRONMENTAL JUSTICE FOR THE CITY OF NEWARK



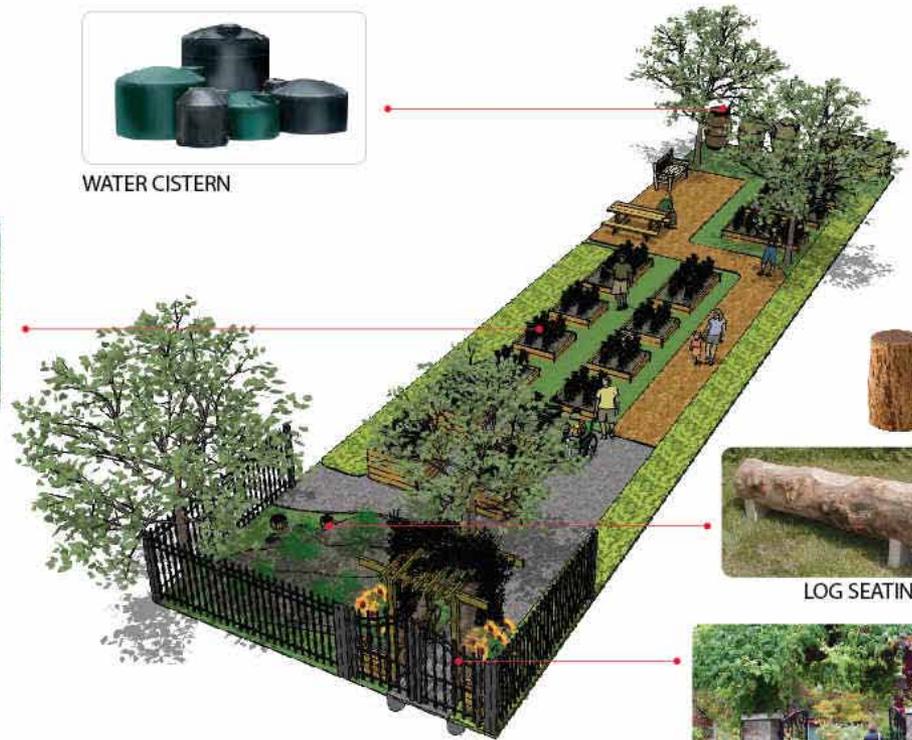
RAISED PLANTER BED



RAISED GARDEN BEDS



WATER CISTERN



LOG SEATING



LOG SEATING



TRELLIS ENTRANCEWAY



PROPOSED COMMUNITY GARDEN + STORMWATER MANAGEMENT DEMONSTRATION SITE

New Jersey Case Studies

SUSTAINABLE SOUTH BRONX



New Jersey Case Studies

DPW Green Initiatives – Parsippany-Troy Hills Municipal Building & Public Works Yard

Location: Parsippany-Troy Hills, Morris County NJ

Year: 2007

Grant Funding: NJDEP 319(h)

Partners: Whippany River Watershed Action Committee, NJDEP



New Jersey Case Studies

DPW Green Initiatives – Parsippany-Troy Hills Municipal Building & Public Works Yard



Example: Greening Public Works Yards

Compliance Action Plans for DPW Sites

- NJDEP conducts inspections of DPW sites to ensure compliance with State environmental regulations
 - These are routine inspections for permitted and unpermitted facilities.
 - *They may or may not be unannounced.*
- Compliance Assistance

Inspection Form

Compliance Assistance Inspection Form June 18, 2010

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION
COMPLIANCE ASSISTANCE
INSPECTION FORM
MUNICIPAL DEPARTMENT OF PUBLIC WORKS (DPW) SITES

COUNTY: _____ MUNICIPALITY: _____

DPW LOCATION: _____
STREET ADDRESS: _____
PROPERTY OWNER: _____
MAILING ADDRESS: _____

SITE CONTACT PERSON & TELEPHONE NO: _____
NAME OF INSPECTOR: _____
COUNTY AGENCY: _____ TELEPHONE NO: _____
DATE & TIME OF INSPECTION: _____

OPERATING AUTHORITY (if any): _____

TYPE OF SOLID WASTE FACILITY PERMIT AND* _____
UNIVERSAL RECYCLING APPROVAL* _____
LIMITED RECYCLING APPROVAL* _____
EXEMPT PURSUANT TO 7 J.A.C. 14 - DATE OF EXEMPTION LETTER _____
RECYCLING USE DETERMINATION - LETTER DATED _____
OTHER (i.e. RECYCLING DEPOT OR COMPOSTING CENTER) _____
HAZARDOUS WASTE GENERATOR ID# (if applicable) _____

SOLID WASTE SECTION:

RECYCLES
MATERIALS OBSERVED ON SITE - CHECK ALL THAT APPLY:

— CLASS RECYCLABLE MATERIALS (Source separated non-potentially harmful waste such as metal, glass, paper, plastic containers, and unpainted and other household items)
Where is the recycling facility for the materials? _____
Storage of materials (Circle all that apply): Contaminated On Site Ground Other: _____

— CLASS RECYCLABLE MATERIALS
Where is the recycling facility for the materials? _____
Storage of materials (Circle all that apply): Contaminated On Site Ground Other: _____
Where are the disposal sites for the materials? _____

* If Applicable, list all unrecycled waste streams in other yards.
* If Approval Facilities are in New Jersey, see them permitted by NJDEP.

- Checklist:
- ü Recyclable Materials
 - ü Used Oil
 - ü Batteries
 - ü Air Pollution Controls
 - ü Litter and Debris Controls
 - ü Underground Storage Tanks
 - ü "Right To Know" Regulations
 - ü Stormwater Management

North Brunswick Department of Public Works

Rutgers Cooperative Extension Water Resources Program prepared a Compliance Action Plan for the DPW facility in North Brunswick, NJ



- Site Inspections
- Employee Interviews
- Photo Documentation
- Completed Inspection Form
- Recommended Actions for Compliance
- Engineering Concept Designs
- Cost Estimates

A Proactive Approach to Achieve Compliance

- Identify Potential Violations



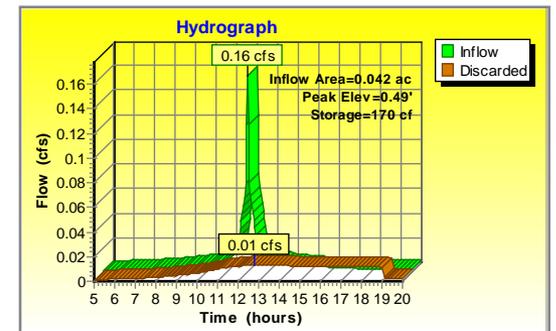
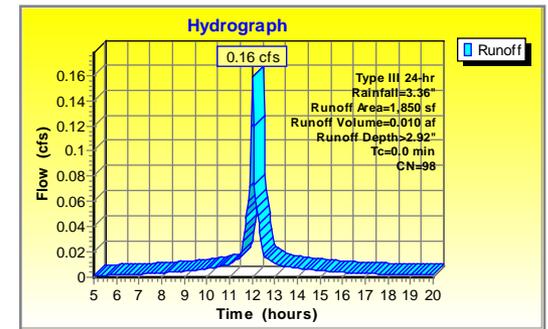
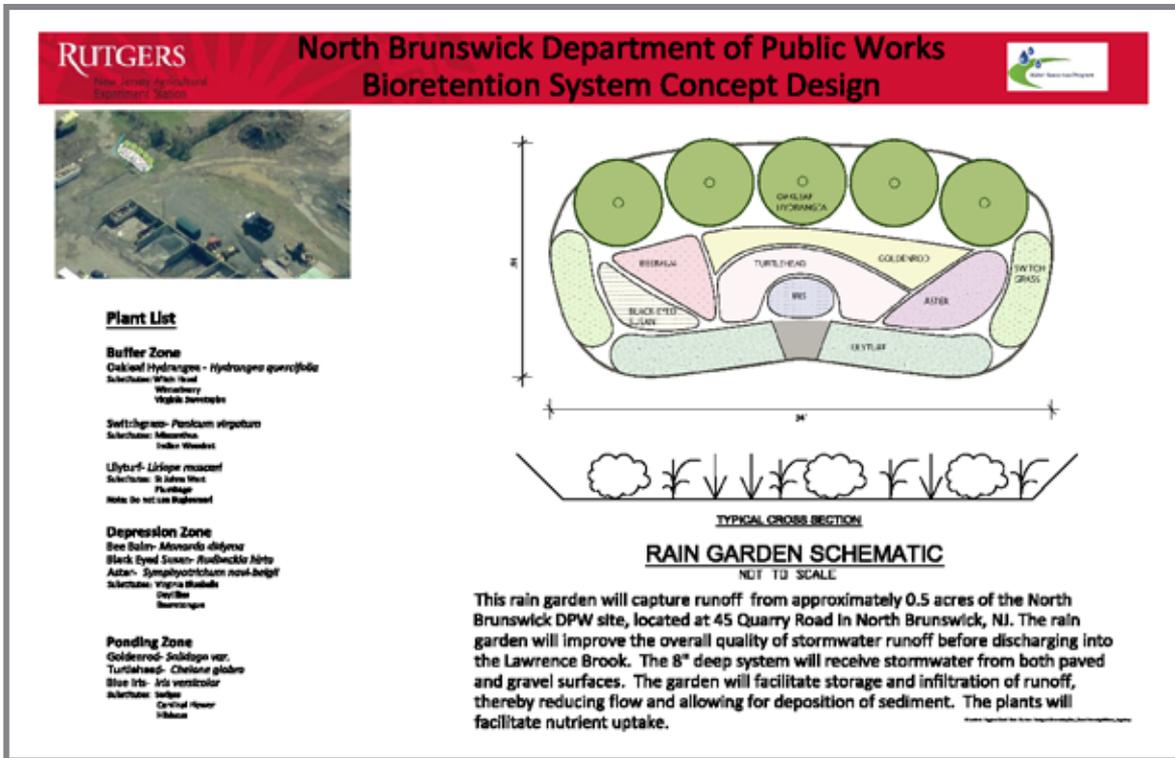
- Document Existing Management Measures Meeting Compliance Standards



A Proactive Approach to Achieve Compliance

- Often, potential violations can be quickly and easily addressed with simple changes in material storage and housekeeping practices.
- A compliance action plan saves time and money.
 - alert the municipality to observed on-site issues not meeting environmental regulatory requirements
 - avoid a lengthy inspection process
 - prevent costly violation fees

- Recommended Projects and Management Measures to Achieve Compliance



New Jersey Case Studies

Cooper River Stormwater Education & Implementation Plan Cherry Hill DPW Rain Garden



PLANTING PLAN Area: 500 ft²

- Red Twig Dogwood
- Royal Fern
- Bee Balm
- New England Aster
- Swamp Milkweed
- Arrowwood Viburnum
- Purple Coneflower
- Black Eyed Susan
- River Birch
- Lilyturf

PARKING LOT

BALD CYPRESS

OVERFLOW

SIGNAGE

OUTLET

INLET

DOWNSPOUT

RAIN GARDEN

WHITE PINE

EXISTING GARDEN

NOTE: Lilyturf to be removed and re-planted along front edge of proposed rain garden (refer to planting plan).

DPW BUILDING



New Jersey Case Studies

Cherry Hill DPW Rain Garden



New Jersey Case Studies

County Route 579 at Goose Island Road, Franklin Township



New Jersey Case Studies

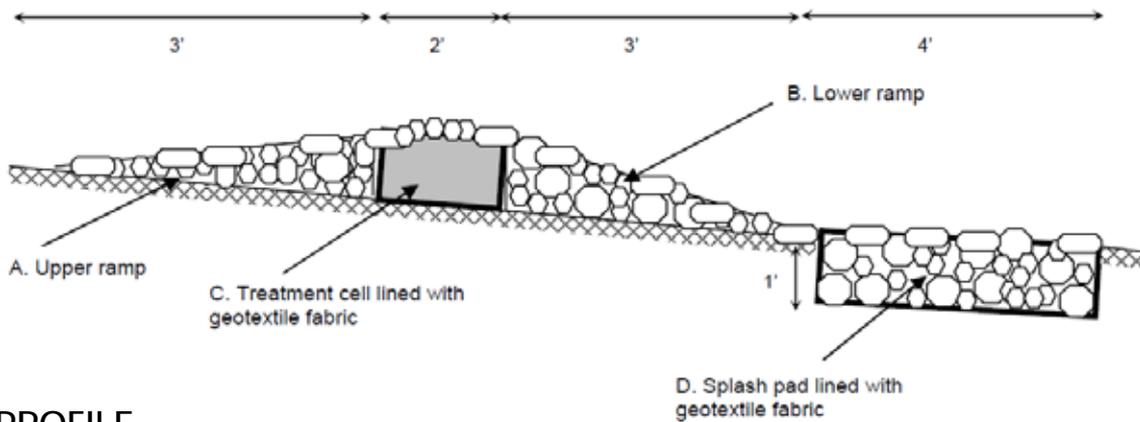
County Route 579 at Goose Island Road, Franklin Township



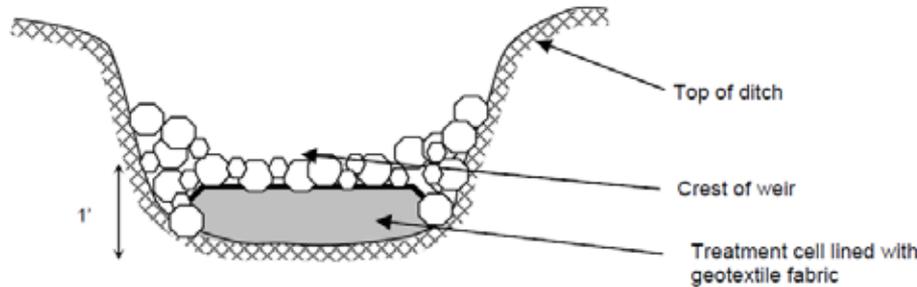
Looking upgradient from storm drain inlet at corner of intersection with Goose Island

New Jersey Case Studies

County Route 579 at Goose Island Road, Franklin Township



PROFILE



CROSS-SECTION

Potential Solutions:

- Check dams in series using concrete settling basin and gabion structures
- Vegetated swale upstream of storm drain inlet with native plants to slow runoff down and allow for infiltration.
- Gravel wetland with underdrain outlet to catch basin to capture sediment and provide temporary storage during runoff events.

Green Roof Opportunities



Parker Urban Greenscapes. 2009.



Parker Urban Greenscapes. 2009.

LiveRoof® Modular System

Hackensack Riverkeeper Green Roof



Recommendations for Municipalities

- § Evaluate existing infrastructure for green opportunities
- § Identify local partners and technical assistance
- § Prioritize needs
- § Identify funding
- § Develop implementation strategy

Or...



Hire Rutgers Cooperative Extension Water Resources Program

Next Steps for Municipalities

- § Review stormwater outfall inventory from MS4 Permit
- § Detention basin inventory
- § Assess impervious coverage
 - Disconnection vs. Connection
- § Assess riparian buffers and adjacent road infrastructure
 - aerial photographs (Google Earth)
- § Evaluate roadside maintenance practices
- § Identify alternative management opportunities for public properties
 - No mow zones along shorelines
 - Use of Integrated Pest Management Strategies
- § Kill all geese and deer



QUESTIONS?

**WHAT WOULD YOU LIKE TO LEARN
MORE ABOUT?**

Upcoming Seminars...

Detention Basin Retrofits and Maintenance

Friday, October 29, 2010

1:00-3:00PM

Byram Township Municipal Building

Green Infrastructure: Projects & Programs for Green Teams & Environmental Commissions

Monday, November 8, 2010

6:30-8:30PM

Sussex County Administrative Center

Green Infrastructure Planning, Design & Implementation: Training for Design Professionals

Tuesday, November 30, 2010

1:00-3:00PM

Sussex County Administrative Center



Visit www.water.rutgers.edu to register for each seminar.

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Rutgers Cooperative Extension *Water Resources Program*

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