Green Infrastructure: Sussex County
Rutgers Cooperative Extension

Christopher C. Obropta, Ph.D., P.E.
Phone: 732-932-9800 x 6209
Email: Obropta@envsci.rutgers.edu

Jeremiah D. Bergstrom, L.L.A., ASLA
Phone: 732-932-9800 x6126
Email: jbergstrom@envsci.rutgers.edu

www.water.rutgers.edu
Rutgers Cooperative Extension (RCE) helps the diverse population of New Jersey adapt to a rapidly changing society and improve their lives through an educational process that uses science-based knowledge. We focus on issues and needs relating to agriculture and the environment; management of natural resources; food safety, quality, and health; family stability; economic security; and youth development. RCE is an integral part of Cook College, the New Jersey Agriculture Experiment Station and Rutgers, The State University of New Jersey, and is funded by the United States Department of Agriculture, the State of New Jersey, and County Boards of Chosen Freeholders.
The Water Resources Program (WRP) is one of many specialty programs under the Rutgers Cooperative Extension (RCE). The goal of the WRP is to provide solutions for many of the water quality and quantity issues that New Jersey faces today. This is accomplished through research, project development, assessment and extension. In addition to preparing and distributing Fact Sheets, we provide educational programming in the form of lectures, seminars, and workshops as part of our outreach to citizens. With New Jersey Agriculture Experiment Station funding and other State and Federal sources, we conduct research that will ultimately be used by stakeholders to improve water resources in New Jersey.
WATER RESOURCES PROGRAM
Integrating research, education, and extension
- Delivering solutions based on sound science
- Working with various members of the community, including municipalities, NGOs, and individual residents
- Solving water resources issues in New Jersey
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 RCE WRP 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 will provide 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.
Sample of Current Projects

• Developing a water quality trading program for the Upper Passaic River Watershed

• Developing Regional Stormwater Management Plans for the Troy Brook, Morris County; Robinsons Branch, Union and Middlesex Counties; and Pompeston Creek, Burlington County

• Developing a state-wide educational program for homeowners entitled “Stormwater Management in Your Backyard”

• Developing Watershed Restoration Plans for the Upper Salem and Cohanseney Rivers in southern New Jersey and the Musconetcong and Neshanic Rivers in northern New Jersey

• Implementing 50 Rain Gardens in the Cooper River Watershed, Camden County

• Implementing Drinking Water Conservation Strategies in 5 pilot New Jersey communities: Belmar, East Greenwich, Egg Harbor Township, Livingston, and Rahway
WATER RESOURCES PROGRAM
Completed Projects
(as of Winter 2009)
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. 


At the largest scale, the preservation and restoration of natural landscape features (such as forests, floodplains and wetlands) are critical components of green stormwater infrastructure. By protecting these ecologically sensitive areas, communities can improve water quality while providing wildlife habitat and opportunities for outdoor recreation.

Green infrastructure design approaches effectively divert stormwater from the sewer system and direct it to areas where it can be infiltrated, evapotranspirated or re-used. Green infrastructure is designed to keep rainwater out of the sewer system so that it does not contribute to a sewer overflow and also to reduce the amount of untreated stormwater discharging to surface waters. These approaches are often referred to as “green infrastructure” because soil and vegetation are used instead of, or in addition to, pipes, pumps, storage tunnels, and other “hard infrastructure.”
Examples of Green Infrastructure & Design Approaches

SITE
• Green Roofs
• Rain Harvesting
• Downspout Disconnection
• Planter Boxes
• Rain Gardens
• Permeable Pavements
• Vegetated Swales
• Brownfield Redevelopment
• Infill and Redevelopment

NEIGHBORHOOD
• Green Parking
• Green Streets & Highways
• Pocket Wetlands
• Trees & Urban Forestry

WATERSHED
• Riparian Buffers
• Approaches for Green Infrastructure Design
Green Infrastructure: Green Roofs

Basic Info:
• extension of the existing roof
• high quality water proofing and root repellant 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: Porous Pavement

Basic Info:
- Composed of asphalt or concrete mixed with fewer fine particles to create more air space

Benefits:
- Manage stormwater runoff
- Minimize site disturbance
- Keep pollutants in place in the soil
- Allows rain water and snow melt to infiltrate through it to be filtered and recharged into the ground as groundwater
- Economic benefits (low life cycle costs, alternative to costly traditional stormwater management methods, stormwater impact fees, support local economies)
Green Infrastructure: Rain Gardens

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

Benefits:
- Recharge groundwater sources
- Help protect communities from flooding and drainage overflow and provide valuable wildlife habitat
- Reduced maintenance costs
Green Infrastructure: Rain Gardens

**Benefits (cont.):**
- Can be placed in strategic areas around the home landscape to capture rainfall and roof and impervious runoff.
- Use native plants that are water and climate tolerant.
- Help control stormwater and nonpoint source pollution while adding to the aesthetics of the landscape.
Your Rain Garden is composed of woody plants (trees and shrubs) and herbaceous species (flowers, grasses, and ground covers) planted in three wetness zones.

The lowest zone supports plant species that can tolerate standing water and fluctuating water levels.

The middle zone is slightly drier, but also supports plant species that can tolerate fluctuating water levels.

The outer edge or highest zone generally contains plant species that prefer drier conditions.
Connolly Park Rain Garden and Swale

Rain Garden Planting Plan

- Big Bluestem
- Joe-pye Weed
- Blue Lobelia
- Beebalm
- Swamp Milkweed
- Indian grass
- Ironweed
- Goldenrod
- Black-eyed Susan
- New England Aster
- Coneflower

Vegetated Swale Plant Species Mix
- Awl-fruited Sedge
- Bladder Sedge
- Blunt Spikenash
- Broadleaf Cattail
- Canada Rush
- Fox Sedge
- Fringed Sedge
- Longhair Sedge
- Soft Rush
- Wood Reedgrass

Existing fence
Existing walkway
Green Infrastructure: Vegetated Swales

Basic Info:

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

Benefits:
- Reduced peak flows
- Removal of pollutants
- Promotion of runoff infiltration
- Lower capital costs.
Green Infrastructure – 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

Building Green USA. 2009. Special Reports.
The Green Infrastructure Movement

Over the past twenty years, communities across the country have been exploring the use of green infrastructure to protect and maintain the quality of their local rivers, streams, lakes, and estuaries from the impact of development and urbanization. In terms of managing stormwater flows and other water in an urban setting, green infrastructure refers to the use of natural processes to slow, treat or absorb runoff.

EPA and other organizations have released a number of policies, memorandums, and resolutions explaining the benefits of using green infrastructure to mitigate overflows from combined and separate sewers, and to reduce stormwater pollution by encouraging implementation in cities and municipal (MS4) programs.
National Case Studies Implementing Green Infrastructure

CITIES
Chicago, IL
Portland, OR (2)
Philadelphia, PA (2)
Milwaukee, WI
Seattle, WA

LENEXA, KS
KANSAS CITY, MO
LANSING, MI
MONTPELIER, VT
CHAPEL HILL, NC
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


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

**Lansing, Michigan**

**Types of Green Infrastructure Used:** Rain Garden

- Rain garden project, extends over 4 city blocks of Michigan Ave.
- Results: ease peak flows for ~90% of storm events
- Increased public education: “Adopt-a-Garden” program
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

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
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
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%.
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
Local Case Studies: New Jersey

The Geraldine R. Dodge Foundation Headquarters
Morristown, NJ

The Willow School
Gladstone, NJ

NJ Meadowlands Commission Headquarters
Lyndhurst, NJ
Local Case Studies: New Jersey

The Geraldine R. Dodge Foundation Headquarters (Morristown, NJ)

Types of Green Infrastructure Used: Green roof, Biowall, water efficient fixtures and controls

Other: photovoltaic panels, geothermal energy, light shelves, sun shades, high performance envelope, under-floor air-conditioning system, efficient lighting, automated building controls, LEED™ Certified (one of few in northern NJ)
Local Case Studies: New Jersey

The Willow School (Gladstone, NJ)

Types of Green Infrastructure Used: Rainwater Harvesting, Reduced permeable paving, Vegetated swales, Rain garden

Other: photovoltaic panels, recycled and salvaged building materials, daylight harvesting, passive solar heating, geothermal heating and cooling systems, indoor air quality, advanced stormwater and wastewater management systems, LEED™ Gold Certification
Local Case Studies: New Jersey

The New Jersey Meadowlands Commission Headquarters (Lyndhurst, NJ)

Types of Green Systems Used: photovoltaic panels, solar tubes, use of FSC wood, low-VOC-emitting building materials, day light dimming, low-flow fixture toilets and fixtures, LEED™ Platinum Certification (Center for Environmental and Scientific Education)
The solar farm at Rutgers is made up of over 7,000 panels and is located on seven acres on the university's Livingston campus in New Jersey.

The 1.4 MW solar farm is expected to meet about 10 percent of the university's energy needs, saving us about $300,000 annually by the end of the 15-year program.

SunDurance Energy, a New Jersey company, was selected to do the Rutgers solar project. SunDurance looked to Yingli Green Energy to provide the PV modules.
How can green infrastructure benefit your community?
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
New Jersey Green Infrastructure Projects

   Woodbridge, Middlesex County NJ

   Hillsborough, Somerset County NJ

3. Rockaway Mall (2010)
   Rockaway Township, Morris County NJ

4. DPW Green Initiatives: Morris County (2008)

   Parsippany-Troy Hills, Morris County NJ

6. Community Rain Barrel Programs (2009)
   Pennington, Mercer County NJ

7. Water Harvesting & Green Roof Opportunities (2010-Future)
Woodbridge Health Center Rain Garden
Woodbridge Health Center Rain Garden
Cherry Hill DPW Rain Garden
Hillsborough Detention Basin

**Location:** Hillsborough, Somerset County NJ  
**Year:** 2008  
**Grant Funding:** Township of Hillsborough, NJ
Hillsborough Detention Basin
Hillsborough Detention Basin
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
Rockaway Mall Urban Stormwater Retrofit & BMP Demonstration
Rockaway Mall Urban Stormwater Retrofit & BMP Demonstration
DPW Green Initiatives – Morris County Stormwater Wetland BMP Project

Location: Morris County Roads and Bridges Facility, Wharton, NJ
Year: 2008
Grant Funding: NJDEP 319(h)
Partners: Rockaway River Watershed Cabinet
DPW Green Initiatives – Morris County Stormwater Wetland BMP Project
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
DPW Green Initiatives – Parsippany-Troy Hills Municipal Building & Public Works Yard
Community Rain Barrel Programs

Benefits:
- Saves drinking water
- Landscape irrigation
- Reduces utility bills
- Prevents basement flooding
- Pervious area connections
- Reduces flooding and pollution
Community Rain Barrel Programs

One Barrel at a Time Co-op Program

- Aesthetic appeal, accessible to general public
- Highlights work of local artists from communities all across NJ
- Currently 35 rain barrels on display in public locations in both NJ and New York City.

artist: Tamara Petrosino
artist: Jon Horowitz
artist: Dorothy Cohen
artist: Helen Haniffy
Rainwater Harvesting Opportunities
Green Roof Opportunities

LiveRoof® Modular System
Hackensack Riverkeeper Green Roof

BEFORE
How Can Green Infrastructure Benefit the Communities of Sussex County?
Economic Benefits

• Reduce stormwater flows to Waste Water Treatment Plant in Sussex Borough and other communities with Combined Sewer Overflows (CSO’s)

• Managing costs for upgrades and replacement of aging infrastructure

• Minimizing maintenance costs for existing stormwater management facilities
Environmental Benefits

• Increasing ground water recharge to improve water supply

• Protecting high quality surface waters from degradation

• Maintaining the highest quality of life for residents of Sussex County
Social Benefits

• Balancing growth and redevelopment with New Jersey Highlands and Water Supply Planning Goals

• Minimizing the need for regulatory oversight of daily activities

• Reducing the footprint of our current actions, preserving resources for future generations
Together we can sustain the water resources of Sussex County.