Green Infrastructure Planning and Implementation in New Jersey

Presented to Municipalities Seeking Sustainable Jersey Points by Christopher C. Obropta, Ph.D., P.E.
on March 19, 2019
PLAN.
IMPLEMENT.
SUSTAIN.

Language for municipal plans & ordinances
Connect to Sustainable Jersey Green Infrastructure Actions
Funding sources & strategies
Design resources
Education and training resources
Maintenance information
School programs

Coming soon!
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.
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.
The Passaic Valley Sewerage Commission (PVSC) has partnered with Rutgers Cooperative Extension (RCE) Water Resources Program to pilot an outreach and technical assistance program providing guidance and direction to the 48 municipalities in the PVSC service area regarding the benefits and opportunities of implementing green infrastructure practices.

http://water.rutgers.edu/PVSC/PVSC.html
Green Infrastructure

...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.
What is a green infrastructure plan (and why do we need one)?
The Natural Hydrologic Cycle

- Precipitation
- Sublimination
- Transpiration
- Condensation
- Infiltration
- Stormwater Runoff
- Evaporation
More development + impervious surfaces = More stormwater runoff
The Urban Hydrologic Cycle
+ green infrastructure =

- Green Roofs
- Rainwater Harvesting
- Tree Filter/Planter Boxes
- Rain Gardens/Bioretention Systems
- Permeable Pavements
- Vegetated Swales or Bioswales
- Natural Retention Basins
- Green Streets
The Natural Hydrologic Cycle
Hydrologic Impacts of Urbanization

- Disruption of natural water balance
- Increased flood peaks
- Increased stormwater runoff
- More frequent flooding
- Increased bankfull flows
- Lower dry weather flows
Water Quality Impacts of Urbanization (increased nonpoint source pollution)

- Oil and grease from cars
- Fertilizers
- Animal waste
- Grass clippings
- Septic systems
- Sewage leaks
- Household cleaning products
- Litter
- Agriculture
- Sediment
Components of a Green Infrastructure Plan and How Do You Create Them

1. Impervious Cover Assessment (ICA)
2. Green Infrastructure Action Plan (a.k.a. Impervious Cover Reduction Action Plan or RAP)
3. Green Infrastructure Strategic Plan (a.k.a. Green Infrastructure Feasibility Study)
Impervious Cover Assessment (ICA)
Impervious Cover Assessment

• Analysis completed by watershed and by municipality
• Use 2012 Land Use data to determine impervious cover
• Calculate runoff volumes for water quality, 2-, 10- and 100-year design storm and annual rainfall
• Contains three concept designs
<table>
<thead>
<tr>
<th>Watershed</th>
<th>Total Area (ac)</th>
<th>Impervious Cover (ac)</th>
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<td>Subwatershed</td>
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<td>Annual Rainfall of 44” (MGal)</td>
<td>2-Year Design Storm (3.3”) (MGal)</td>
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<td>-----------------------</td>
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<td>Total</td>
<td>97.9</td>
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Green Infrastructure Action Plan
(a.k.a. Impervious Cover Reduction Action Plan or RAP)
Green Infrastructure Action Plan

ICA (Tier1) + the following:

- Community engagement
- Potential green infrastructure sites
- Site level analysis including concept plans, information sheets, and costs
- Short-term 5-year goal
Identify project sites, but what makes a good site?

- Sites with impervious surfaces that are directly connected
- Sites with a lawn area that can be converted to accept stormwater runoff
- Sites with highly visibility – good educational opportunities
- Sites in impaired watersheds
- Sites on municipal owned land/public land
- Sites that provide partnership opportunities
Let’s get started! Download aerial photograph of “Look Here First Sites.”

- Go to Google or Bing Maps
- Type in address
- Aerial or birds eye view
- “Snip It”
- Insert into PowerPoint
- “Crop It”

- Schools
- House of Worship
- Libraries
- Municipal Building
- Public Works
- Firehouses
- Post Offices
- Elks or Moose Lodge
- Parks/ Rec Fields
Let’s Find a Site

Here is one:

Former Agriculture Museum NJ
103 College Farm Road
New Brunswick, NJ 08901
From Bing Maps using the Snipping Tool
Observations:
• Lots of impervious cover
• No stormwater management
• Lots of open space for potential BMPs

Questions for site visit:
• Are there downspouts?
• Are they connected?
• Is there curb along the parking lot?
• Which way is the parking lot graded?
• What is the condition of the parking lot?
Other Questions

• Do the soils around the Ag Museum infiltrate?

• Who own the property? Will they be open to installing stormwater management measures?

• Are there potential partners to help with the project?

• Do we need permits for altering this site with stormwater best management practices?

• Does the building have a basement?

• Can we lose parking spaces?

• Who will maintain the BMPs?

• Is the project a high priority?
Marlton Elementary School

190 Tomlinson Mill Rd,
Evesham Township, NJ 08053
Marlton Elementary School
190 Tomlinson Mill Rd, Evesham Township, NJ 08053

P.P. = Porous Pavement
RG. = Rain Garden

P.P. Look at Contours for Parking lots to see flow of run off

Disconnect downsputs to go into Rain Garden
Marlton Elementary School
190 Tomlinson Mill Rd,
Evesham Township, NJ 08053

1) Porous pavement?
2) Rain Gardens
3) Red arrow (Water Flow)
Rain Garden: disconnect downspouts and install rain garden
Next Step: Site Visit
What are we looking for during our site visit?

1. What are sources of stormwater and where does it flow?
2. What is the direction and relative slope of site?
3. Where are impervious surfaces on the site?
4. What is the condition of the paved areas?
5. Are impervious surfaces directly connected?
6. Are there opportunities to disconnect?
7. Are there stormwater catch basins?
What are we looking for during our site visit (cont’d)?

9. Is there evidence of ponding water on site?
10. Where are the utilities on the site?
11. Are there pedestrian safety issues?
WHAT SHOULD YOU BRING:

Aerial photo
Pencil
Tape measure
Camera
Green Infrastructure Manual:
http://water.rutgers.edu/GreenInfrastructureGuidanceManual.html
Green Infrastructure Brochure:
Green Infrastructure CHECKLIST:  
http://water.rutgers.edu/GreenInfrastructureGuidanceManual.html  
Also found on pages 132-135 in the Manual

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<th>General Information</th>
<th>Site ID:</th>
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<tbody>
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<td>Name/person completing assessment:</td>
<td>Date:</td>
</tr>
<tr>
<td>Location Address and Cross Streets:</td>
<td>Neighborhood:</td>
</tr>
<tr>
<td>Name of Nearest Waterway:</td>
<td>Property Owner / Tax Parcel ID/Street Segment:</td>
</tr>
<tr>
<td>Contact Information:</td>
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<table>
<thead>
<tr>
<th>Site Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of site and relative visibility to the public (public or private property, lot size, current use, streetscape, etc.):</td>
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</table>

<table>
<thead>
<tr>
<th>Observations</th>
<th>Notes/Remarks</th>
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<tbody>
<tr>
<td>1) What is the source of stormwater runoff and where does it flow (on map or aerial photo indicate water flow direction and existing storm drains)? Is there a noticeable source or deposit of sediment?</td>
<td></td>
</tr>
<tr>
<td>2) What is the direction and relative slope of the site and/or street? (indicate on map or aerial photo)</td>
<td></td>
</tr>
<tr>
<td>3) Where on the site are impervious areas and estimate area in square feet (i.e. rooftops, parking lots, sidewalks)? For streetscapes, what is the building setback and/or sidewalk width?</td>
<td></td>
</tr>
<tr>
<td>4) Do paved areas appear to be in poor condition (cracks, settling, vegetation growth, etc.) or do they appear newly paved or reconstructed?</td>
<td></td>
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<tr>
<td>5) Does stormwater runoff from impervious areas flow directly to the sewer system (such as roof runoff directed into a storm drain)?</td>
<td></td>
</tr>
<tr>
<td>6) Are there opportunities to redirect and disconnect runoff (downspouts, grassed areas, tree pits, curb extensions)?</td>
<td></td>
</tr>
<tr>
<td>7) How many stormwater catch basins are visible? Note location on maps and general condition, i.e. clogged, functioning, shallow (&lt; 3 ft.), or deep (&gt; 3 ft.)</td>
<td></td>
</tr>
<tr>
<td>8) Is there evidence of ponding water at the site or flooding in streets or intersections? (indicate reason; i.e. due to clogged drains, high water table, etc.)</td>
<td></td>
</tr>
<tr>
<td>9) Are there mature trees/vegetation at the site? What types of plants would be appropriate at the site (sun or shade tolerant, height or site line restrictions)?</td>
<td></td>
</tr>
<tr>
<td>10) Where are utilities on the site or in the right of way that could conflict with construction (sewer pipes, utility poles, water, gas, etc.)?</td>
<td></td>
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<tr>
<td>11) Does pedestrian safety need to be addressed? Will parking or bus stops be impacted by construction?</td>
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</table>

<table>
<thead>
<tr>
<th>Rain Gardens</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Are there visible, exterior downspouts on any buildings?</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>2) Are there unpaved areas suitable for landscaping?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3) Is the site subject to ponding or flooding?</td>
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</table>

<table>
<thead>
<tr>
<th>Rainwater Harvesting</th>
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<tr>
<td>1) Are there nearby buildings with visible exterior downspouts?</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>2) Is there a community garden nearby or other use for collected rainwater?</td>
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<table>
<thead>
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<th>Comments</th>
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<tbody>
<tr>
<td>1) Does stormwater flow across sidewalks or along the curb?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Are there existing trees, landscaping or tree pits near the street?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Can water be directed from the street/curb into adjacent areas?</td>
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<tr>
<th>Porous Pavement</th>
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<th>No</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>1) Are there large areas of pavement on the site and are any paved areas not heavily used (i.e. fire lane, overflow)?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Are existing impervious areas in poor condition and in need of replacement?</td>
<td></td>
<td></td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Curb Extensions and Stormwater Planters</th>
<th>Yes</th>
<th>No</th>
<th>Comments</th>
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</thead>
<tbody>
<tr>
<td>1) Is there a heavily used pedestrian crossing? Are there pedestrian crossovers that would be safer if shortened?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2) Is the intersection or street at a location where stormwater can be collected before it enters a storm drain?</td>
<td></td>
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</table>

<table>
<thead>
<tr>
<th>Other Strategies</th>
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<th>No</th>
<th>Comments</th>
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</table>
Concept Plans

Evesham Township
Impervious Cover Assessment
Kettle Run Fire Rescue, 498 Hopewell Road

PROJECT LOCATION:

SITE PLAN:

1. **BIORETENTION SYSTEM**: A rain garden can be used to capture, treat, and infiltrate runoff from the roof of the building. These systems can easily be incorporated into existing landscapes, improving aesthetics and creating wildlife habitat while managing stormwater.

2. **RAINWATER HARVESTING SYSTEM**: A cistern can capture stormwater that drains from the building’s roof. Connecting the downspouts to the cistern will allow the stormwater to be harvested and used for cleaning fire trucks.
Evesham Township
Impervious Cover Assessment
Barton Run Swim Club, 100 Lakeside Drive

**PROJECT LOCATION:**

**SITE PLAN:**

1. **BIORETENTION SYSTEM:** On this property rain gardens can be used to reduce sediment and nutrient loading on local waterways by retrofitting the parking islands. The rain gardens will capture, treat, and infiltrate runoff from the parking lot.

2. **POROUS PAVEMENT:** Parking spaces close to the pool house can be converted to porous asphalt. Porous pavement promotes groundwater recharge and filters stormwater.

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**1 BIORETENTION SYSTEM**

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**2 POROUS PAVEMENT**
Evesham Township
Impervious Cover Assessment
Marlton Elementary School, 190 Tomlinson Mill Road

**PROJECT LOCATION:**

**SITE PLAN:**

**BIORETENTION SYSTEM:** On this property rain gardens can be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. There are opportunities to install rain gardens near entrances to the school.

**POROUS PAVEMENT:** Porous pavement promotes groundwater recharge and filters stormwater. The parking spots close to the school can be retrofitted with porous pavement.
### Marlton Elementary School

**Green Infrastructure Information Sheet**

| Location: | 190 Tomlinson Mill Road  
| Evesham Township, NJ 08053 |
| Municipality: | Evesham Township |
| Subwatershed: | Barton Run |

### Green Infrastructure Description:
- bioretention system (rain garden)  
- porous pavement

### Targeted Pollutants:
- total nitrogen (TN),  
- total phosphorus (TP),  
- total suspended solids (TSS) in surface runoff

### Mitigation Opportunities:
- recharge potential: yes  
- stormwater peak reduction potential: yes  
- total suspended solids removal potential: yes

### Stormwater Captured and Treated Per Year:
- bioretention system #1: 234,446 gal.  
- bioretention system #2: 35,331 gal.  
- bioretention system #3: 117,562 gal.  
- bioretention system #4: 128,192 gal.  
- porous pavement #1: 517,980 gal.  
- porous pavement #2: 133,362 gal.

### Existing Conditions and Issues:
Marlton Elementary School is surrounded by impervious surface such as asphalt and concrete. The downspouts on the building are connected directly to the sewer system. Bringing runoff from the roof and parking lots directly into the sewer systems leads to sediment and other solids being dumped into local waterways as nonpoint source pollution. High volumes of rain in the sewer system also contribute to flooding.

### Proposed Solution(s):  
Two areas of porous pavement have been proposed within the school parking lot near the catch basins so that the runoff can infiltrate into the ground, instead of going directly to local waterways via the catch basins. The porous pavement would be in parking spaces to avoid the strain of vehicular traffic.

Four potential rain garden sites were identified. The first garden could be located inside the lawn area at the school entrance. The downspouts from the three sides of the building surrounding the rain garden can be redirected so that the rainfall from the roof can be captured, treated, and filtered by the rain garden instead of flowing into the sewer system. The second rain garden can also treat runoff from the roof. The third rain garden could collect stormwater from the vehicle entrance via curb cuts and trench drains. The final rain garden proposal is on the northeastern side of the building and will also use downspouts to capture runoff from there.

### Anticipated Benefits:
Since the bioretention systems are designed to capture, treat, and infiltrate the entire 2-year design storm (3.4 inches of rain over 24 hours), these systems are estimated to achieve a 95% pollutant load reduction for TN, TP, and TSS. Bioretention systems would also provide ancillary benefits, such as enhanced wildlife and aesthetic appeal to the local residents of Evesham Township.

### Marlton Elementary School

**Green Infrastructure Information Sheet**

Porous pavement allows stormwater to infiltrate through to soil layers which will promote groundwater recharge as well as intercept and filter stormwater runoff. The porous pavement system will achieve the same level of pollutant load reduction for TN, TP and TSS as the bioretention system.

### Possible Funding Sources:
- mitigation funds from local developers  
- NJDEP grant programs  
- Municipality of Evesham Township  
- Local social and community groups

### Partners/Stakeholders:
- Evesham Township  
- Marlton Elementary School  
- local community groups  
- residents  
- students and parents  
- Rutgers Cooperative Extension

### Estimated Cost:
- Rain garden #1 would need to be approximately 2,250 square feet. At $5 per square foot, the estimated cost is $11,250.  
- Rain garden #2 would need to be approximately 339 square feet. At $5 per square foot, the estimated cost is $1,695.  
- Rain garden #3 would need to be approximately 1,128 square feet. At $5 per square foot, the estimated cost is $5,640.  
- Rain garden #4 would need to be approximately 1,230 square feet. At $5 per square foot, the estimated cost is $6,150.  

The porous asphalt #1 would cover 3,550 square feet and have a 2-foot stone reservoir under the surface. At $25 per square foot, the cost of the porous asphalt system would be $88,750.  

The porous asphalt #2 would cover 914 square feet and have a 2-foot stone reservoir under the surface. At $25 per square foot, the cost of the porous asphalt system would be $22,850.

The total cost of the project will thus be approximately $136,335.
EVESHAM TOWNSHIP: GREEN INFRASTRUCTURE SITES

1. Barton Run Swim Club
2. Cherokee High School
3. Evesham Fire/Rescue 223/227
4. Evesham Township Municipal Court
5. King’s Grant Community Room
6. Marlton Elementary School
7. Memorial Park
8. Richard L. Rice Elementary School
9. Villa Royal Association

SITES WITHIN THE LAKE PINE SUBWATERSHED:
10. Kettle Run Fire/Rescue 225/228
11. Links Golf Course

SITES WITHIN THE PENNSAUKEN CREEK SUBWATERSHED:
12. Evesham Fire/Rescue 221/229

SITES WITHIN THE RANCOCAS CREEK SUBWATERSHED:
13. Christ Presbyterian Church
14. Frances S. DeMasi Elementary School
15. Marlton Assembly of God
16. Marlton Post Office
17. Robert B. Jaggard Elementary School
18. St. Joan of Arc Parish and School
MARLTON ELEMENTARY SCHOOL

Subwatershed: Barton Run
Site Area: 2,037,458 sq. ft.
Address: 190 Tomlinson Mill Road
Evesham, NJ 08053
Block and Lot: Block 39, Lot 1.01, 1.02

Stormwater is currently directed to existing catch basins. Parking spots by the north and west buildings can be replaced with porous asphalt to capture and infiltrate stormwater runoff from the parking lot. Rain gardens adjacent to the building can capture, treat, and infiltrate roof runoff before it reaches the existing catch basin. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

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<tr>
<th>Impervious Cover</th>
<th>Existing Loads from Impervious Cover (lbs/yr)</th>
<th>Runoff Volume from Impervious Cover (Mgal)</th>
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<td>%</td>
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<td>TP</td>
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<td>26</td>
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<tr>
<td></td>
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<td>266.1</td>
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<td>2,419.1</td>
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<td></td>
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<td>For the 1.25&quot; Water Quality Storm 0.411</td>
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<td>For an Annual Rainfall of 44&quot; 14.45</td>
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<th>Recommended Green Infrastructure Practices</th>
<th>Recharge Potential (Mgal/yr)</th>
<th>TSS Removal Potential (lbs/yr)</th>
<th>Maximum Volume Reduction Potential (gal/storm)</th>
<th>Peak Discharge Reduction Potential (cu. ft./second)</th>
<th>Estimated Size (sq. ft.)</th>
<th>Estimated Cost</th>
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<tr>
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<td>0.651</td>
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<td>49,331</td>
<td>1.85</td>
<td>4,465</td>
<td>$111,625</td>
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### Short term (5 years) goal

**Table 1. Recommended Short Term Impervious Cover Management Goals**

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<tr>
<th>Existing Municipal Impervious Cover</th>
<th>Recommended Short Term (less than 5 years) Impervious Cover Management Goal (%)</th>
<th>Recommended Impervious Cover Management Goal Area (acres)</th>
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<tr>
<td>0% to 10%</td>
<td>1%</td>
<td>10 acres</td>
</tr>
<tr>
<td>10.1% to 25%</td>
<td>2%</td>
<td>15 acres</td>
</tr>
<tr>
<td>&gt;21.1%</td>
<td>5%</td>
<td>20 acres</td>
</tr>
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</table>
Example of a “investment/funding strategy for green infrastructure projects” has been provided in your handouts. Let’s discuss it.
Green Infrastructure Strategic Plan
(a.k.a. Green Infrastructure Feasibility Study)
Green Infrastructure Strategic Plan

ICA (Tier 1) and GI Action Plan (Tier 2) + the following:

- Additional green infrastructure sites
- Policy recommendations
- Water quality and quantify benefits
- Implementation agenda
- Long-term 5-20 year goals
GREEN INFRASTRUCTURE FEASIBILITY STUDY

Evesham Township

Rutgers
New Jersey Agricultural Experiment Station
Stormwater is currently directed to existing catch basins. Parking spots by the north and west buildings can be replaced with porous asphalt to capture and infiltrate stormwater runoff from the parking lot. Rain gardens adjacent to the building can capture, treat, and infiltrate roof runoff before it reaches the existing catch basin. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

<table>
<thead>
<tr>
<th>Impervious Cover</th>
<th>Existing Loads from Impervious Cover (lbs/yr)</th>
<th>Runoff Volume from Impervious Cover (Mgal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>%</td>
<td>sq. ft.</td>
<td>From the 1.25&quot; Water Quality Storm</td>
</tr>
<tr>
<td>26</td>
<td>526,875</td>
<td>For an Annual Rainfall of 44&quot;</td>
</tr>
<tr>
<td></td>
<td>TP 25.4</td>
<td>0.411</td>
</tr>
<tr>
<td></td>
<td>TN 266.1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TSS 2,419.1</td>
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</table>

<table>
<thead>
<tr>
<th>Recommended Infrastructure Practices</th>
<th>Recharge Potential (Mgal/yr)</th>
<th>TSS Removal Potential (lbs/yr)</th>
<th>Maximum Volume Reduction Potential (ga/storm)</th>
<th>Peak Discharge Reduction Potential (cu. ft./second)</th>
<th>Estimated Size (sq. ft.)</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioretention systems</td>
<td>0.516</td>
<td>86</td>
<td>39,068</td>
<td>1.47</td>
<td>4,950</td>
<td>$24,750</td>
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<tr>
<td>Pervious pavement</td>
<td>0.651</td>
<td>109</td>
<td>49,331</td>
<td>1.85</td>
<td>4,465</td>
<td>$111,625</td>
</tr>
</tbody>
</table>
CURRENT CONDITION
CONCEPT DESIGN
Policy Recommendations

• Update stormwater management plan and stormwater control ordinance to incorporate green infrastructure requirements
• Update municipal master plan
• Update zoning ordinance to eliminate barriers for green infrastructure
• Use Center for Watershed Protection “The Code and Ordinance Worksheet” to assess your local code/ordinances
## Long term (5-20 years) goal

<table>
<thead>
<tr>
<th>Existing Municipal Impervious Cover</th>
<th>Recommended Long Term (5-20 years) Impervious Cover Management Goal (%)</th>
<th>Recommended Impervious Cover Management Goal Area (acres)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0% to 10%</td>
<td>2%</td>
<td>25 acres</td>
</tr>
<tr>
<td>10.1% to 25%</td>
<td>5%</td>
<td>50 acres</td>
</tr>
<tr>
<td>&gt;21.1%</td>
<td>10%</td>
<td>80 acres</td>
</tr>
</tbody>
</table>
Implementation Agenda

• Funding piece from Tier 2
• Maintenance and monitoring - NJDEP provides guidance on maintenance and monitoring of green infrastructure practices - Go to: https://www.njstormwater.org/maintenance_guidance.htm
• Responsible parties
• Timeframe
How does green infrastructure work?
It is all about controlling runoff from impervious surfaces
Step 1: Depave
Step 2: Simple Disconnection
Downspout Disconnection

![Downspout Disconnection](image)

- **Left:** Downspout connected to sewer system
- **Right:** Downspout disconnected from sewer system

- **Left Image:**
  - Standpipe
  - Downspout
  - Standpipe connected
  - Cap

- **Right Image:**
  - Standpipe
  - Downspout
  - Extension elbow
  - Cap
Disconnect your downspout by installing a rain barrel. Impervious area is now “disconnectsed” from flowing directly into the storm sewer system.
So Many Barrels to Choose From…
Or Larger Rainwater Harvesting Systems...
Rooftop runoff is now "disconnected" from flowing directly into the storm sewer system.
Bioretention Systems/Rain Gardens

NATIVE PLANTS
A rain garden is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions.

DRAINAGE AREA
This is the area of impervious surface that drains stormwater runoff to the rain garden.

BERM
The berm is constructed as a barrier to control, slow down, and contain stormwater.

PONDING AREA
The ponding area is the lowest, deepest visible area of the garden. When designed correctly, this area should drain within 24 hours.

INLET
This is the area where stormwater enters. The inlet is often lined with stone to slow water flow and prevent erosion.

CURB CUT
This curb cut and concrete flow pad are designed to help redirect stormwater runoff to the rain garden system and out of the storm drain.
Lots of Rain Gardens
Step 3: Convert to Permeable Pavement

POROUS ASPHALT
It is common to design porous asphalt in the parking stalls of a parking lot. This saves money and reduces wear.

DRAINAGE AREA
The drainage area of the porous asphalt system is the conventional asphalt cartway and the porous asphalt in the parking spaces. Runoff from the conventional asphalt flows into the porous asphalt parking spaces.

SUBGRADE
Porous pavements are unique because of their subgrade structure. This structure includes a layer of choker course, filter course, and soil.

UNDERDRAIN
Systems with low infiltration rates due to soil composition are often designed with an underdrain system to discharge the water.

ASPHALT
This system is often designed with conventional asphalt in areas of high traffic to prevent any damage to the system.
Permeable 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
ADVANTAGES

• 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

[Diagram of components: Design Guidelines for Porous Asphalt with Subsurface Infiltration, Riverjacks open into recharge bed, Porous asphalt pavement, Uncompacted subgrade is critical for proper infiltration, Filter fabric lines the subsurface bed, Uniformly graded stone aggregate with 40% void space for stormwater storage and recharge.]
Permeable Pavers
Grass Pavers
Other Green Infrastructure Practices

• Bioswale
• Stormwater Planters
• Green Roofs
BIOSWALE

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

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

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

INLET
This is the area where stormwater enters. The inlet is often lined with stone to slow water flow and prevent erosion.
STORMWATER PLANTERS

NATIVE PLANTS
A stormwater planter is planted with a variety of grasses, wildflowers, and woody plants that are adapted to the soil, precipitation, climate, and other site conditions.

CURB CUT
This curb cut and concrete flow pad are designed to help redirect stormwater runoff to the rain garden system and out of the storm drain.

CONCRETE WALL
Concrete walls are installed to match the existing curb. These walls create the frame for the stormwater planter and continue to function as a curb.

INLET
This is the area where stormwater enters. The inlet is often lined with stone to slow water flow and prevent erosion.

SUBGRADE
Stormwater planter systems are unique because of their subgrade structure. This structure is layered with bioretention media, choker course, compact aggregate, and soil separation fabric.
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
• Great for new construction

COMPONENTS
Modular System Specifications

Parker Urban Greenscapes.
How to use your green infrastructure plan
Impervious Cover Assessment

• Draws attention to problems
• Identifies impervious cover criteria (i.e., 2%, 10%, and 25%)
• Provides some concepts for green infrastructure opportunities
• Great conversation starter
Green Infrastructure Action Plan

• Identifies 10 to 20 projects on public or quasi-public lands
• Gives municipality examples of types of projects needed to fix problem
• Moves the conversation to project choice instead of willingness to do a project
• Sets realistic goals
BELLEVILLE ELEMENTARY SCHOOL #10
(Front of School)
Directly Connected Downspouts
Directly Connected Downspouts
Belleville Elementary School #10

527 Belleville Avenue,
Belleville, NJ 07109
The paved area adjacent to the building can be depaved and replaced with a rain garden to capture, treat, and infiltrate rooftop runoff. Rainwater can be harvested by installing cisterns around the building. The water can then be used for watering gardens, washing vehicles, or for other non-potable uses. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

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<td>From the 1.25&quot; Water Quality Storm</td>
</tr>
<tr>
<td>66</td>
<td>66,110</td>
<td>0.052</td>
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<th>Estimated Size (sq. ft.)</th>
<th>Estimated Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bioretention system</td>
<td>0.098</td>
<td>16</td>
<td>7,532</td>
<td>0.28</td>
<td>960</td>
<td>$4,800</td>
</tr>
<tr>
<td>Rainwater harvesting</td>
<td>0.060</td>
<td>10</td>
<td>4,600</td>
<td>0.17</td>
<td>5,000 (gal)</td>
<td>$10,000</td>
</tr>
</tbody>
</table>
Funding Implementation

• Leverage existing projects
• Build partnerships
• Write grants
Who should I partner with?

Locally
• RCE Environmental County Agents
• Municipal Green Teams (Sustainable Jersey)
• Green Teams for Schools (Sustainable Jersey)
• Environmental Commissions
• Boy Scouts and Girl Scouts

Statewide
• The Nature Conservancy
• Association of Environmental Commissions
• Trust for Public Lands
• New Jersey Tree Foundation
Grant/Funding Opportunities

- Sustainable Jersey ($2k, $10k and $35k)
- ANJEC (Association of NJ Environmental Commissions)
- NJDEP
- NJ American Waters
- Home and School Associations
Resources for You!
Our green infrastructure initiative in urban centers focuses on capturing stormwater with cost-effective practices before it enters the combined sewer systems.
Projects & Programs

Agricultural Watershed Planning & Implementation
- Watershed Restoration & Protection Plan for Assiscunk Creek, Burlington County, NJ
- Assiscunk Creek Watershed Agricultural Mini-Grant Program
- Biofilter Wetland at Harrow Run, Water Quality Evaluation of Pollutant Removal Efficiency from a Tailwater Recovery System
- Watershed Restoration Plan for the Upper Cohanse River Watershed
- Upper Cohanse River Watershed Agricultural Mini-Grant Program
- Watershed Restoration Plan for the Upper Salem River Watershed
- Upper Salem River Watershed Agricultural Mini-Grant Program

Green Infrastructure Program
- Camden Green Infrastructure Initiative
- Fixing Flooding: One Community at a Time
  Innovative Solutions using Green Infrastructure Conference
- Green Infrastructure Education and Implementation Program
- Green Infrastructure Guidance Manual for New Jersey
- Green Infrastructure Solutions for New Jersey Conference

Municipal/Community Training
- Rain Gardens & Rain Barrels
- Watershed Planning & Implementation

Keep the Rain from the Drain ~ Impervious Cover Reduction Program

Municipal Stormwater Management
Keep the Rain from the Drain ~ Impervious Cover Reduction Program

- Impervious Cover Assessments and Impervious Cover Reduction Action Plans for Coastal Communities
- National Fish and Wildlife Foundation ~ Incorporating Green Infrastructure Resiliency in the Raritan River Basin
- Impervious Cover Assessments, Impervious Cover Reduction Action Plans, and Green Infrastructure Reduction Action Plans for New Jersey Future’s Mainstreaming Green Infrastructure Program
- Salem County and Cumberland County, NJ ~ Impervious Cover Assessments and Impervious Cover Reduction Action Plans
- William Penn Foundation - Technical Support Program for Municipalities and Watershed Partners
<table>
<thead>
<tr>
<th>HUNTERDON COUNTY</th>
<th>NEW JERSEY HIGHLANDS WATERSHED CLUSTER</th>
</tr>
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<tbody>
<tr>
<td>Delaware Twp</td>
<td>Alpha</td>
</tr>
<tr>
<td>Franklin Twp</td>
<td>• ICA</td>
</tr>
<tr>
<td></td>
<td>• RAP</td>
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<td>• RAP web map</td>
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<td></td>
<td>Lopatcong</td>
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<td></td>
<td>• ICA</td>
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<td>• RAP</td>
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<td>• RAP web map</td>
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<tr>
<td>East Amwell Twp</td>
<td>Branchville</td>
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<tr>
<td>Raritan Twp</td>
<td>• ICA</td>
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<td>MIDDLESEX COUNTY</td>
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<td>Dunellen Boro</td>
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<td>North Brunswick Twp</td>
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<td>• RAP</td>
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<td></td>
<td>• RAP web map</td>
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</table>


E-learning Tools

- Inventory and Assessment of Your Stormwater Infrastructure (January, 2017)

- Green Infrastructure Overview: Examples and Properties of a Variety of Stormwater Management Solutions (November, 2016)

- Ideas and Resources for Implementing Green Infrastructure in Your Community - Planning documents, programs, and ordinances (May, 2016)

- Impervious Cover Assessment (ICA) and Impervious Cover Reduction Action Plan: The Answer to All Your Problems (December, 2015)

- Asking the Right Questions in Stormwater Review (April, 2015)

- Understanding Your Impervious Cover Assessment (ICA) Report (March, 2015)
E-learning Tools

- *Inventory and Assessment of Your Stormwater Infrastructure* (January, 2017)


- *Ideas and Resources for Implementing Green Infrastructure in Your Community - Planning documents, programs, and ordinances* (May, 2016)

- *Impervious Cover Assessment (ICA) and Impervious Cover Reduction Action Plan: The Answer to All Your Problems* (December, 2015)


- *Understanding Your Impervious Cover Assessment (ICA) Report* (March, 2015)
Quality of Life Issues

- **POLLUTION**
  - 90% of NJ waterways are considered 'impaired'
  - primary source is urban-related stormwater runoff

- **FLOODING**

- **EROSION**
Hollie DiMuro, Program Associate, graduated in May 2015 from Rutgers, The State University of New Jersey with a B.S. in Environmental Planning and Design and a minor in Environmental Policy, Institutions, and Behaviors. Hollie interned with the Water Resources Program from May 2014 to July 2015. During her internship, Hollie assisted with rain barrel workshops, participated in the construction and maintenance of rain gardens, and she assisted with the design of stormwater best management practices and green infrastructure practices for municipalities within the Raritan River Basin. In her role as a Program Associate, Hollie will be providing technical support to the Water Resources Program by organizing and coordinating municipal action teams to promote green stormwater infrastructure in New Jersey’s urban and suburban communities. She also will be assisting the Water Resources Program with grant management and project resource allocation.

Room 105, 848-932-6728, dimuro@envsci.rutgers.edu
Sara Mellor, Program Associate, graduated in May 2010 from Rutgers, The State University of New Jersey, with a B.S. in Environmental Policy, Institutions, and Behaviors. Sara interned with the Water Resources Program from May 2009 to May 2010 and has worked part time as a Program Coordinator with the Water Resources Program from May 2010 to May 2011. During the internship and tenure as a Program Coordinator, Sara has participated in water quality sampling, flow monitoring, and stream visual assessments for watershed restoration and protection plans, assisted in the coordination, construction, and maintenance of rain gardens, helped develop and run rain barrel workshops, organized the "One Barrel at a Time Co-op," created flyers, press releases, and other forms of promotional materials for the program, supported Water Resources Program staff in community educational outreach projects, supervised project volunteers, researched ways to inform the public about the importance of conserving water, and contributed to the development of evaluation tools to measure programmatic impact. As a Program Associate with the Rutgers Cooperative Extension Water Resources Program, Sara will be coordinating and presenting rain barrel workshops throughout New Jersey, designing, constructing, and coordinating the installation of rain gardens and natural landscaped systems throughout New Jersey, and participating in community and youth outreach projects pertaining to water resources.

Room 216, 848-932-6747, saramellor@envsci.rutgers.edu
The great aim of education is not knowledge but action.

- Herbert Spencer