

Green Infrastructure Planning and Implementation in New Jersey

Presented to Municipalities Seeking Sustainable Jersey Points by Christopher C. Obropta, Ph.D., P.E. on October 10, 2019



RUTGERS
New Jersey Agricultural
Experiment Station





NEW JERSEY GREEN INFRASTRUCTURE MUNICIPAL TOOLKIT

**PLAN.
IMPLEMENT.
SUSTAIN.**

Coming soon!

- ✓ 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



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.



The [Passaic Valley Sewerage Commission \(PVSC\)](http://water.rutgers.edu/PVSC/PVSC.html) 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

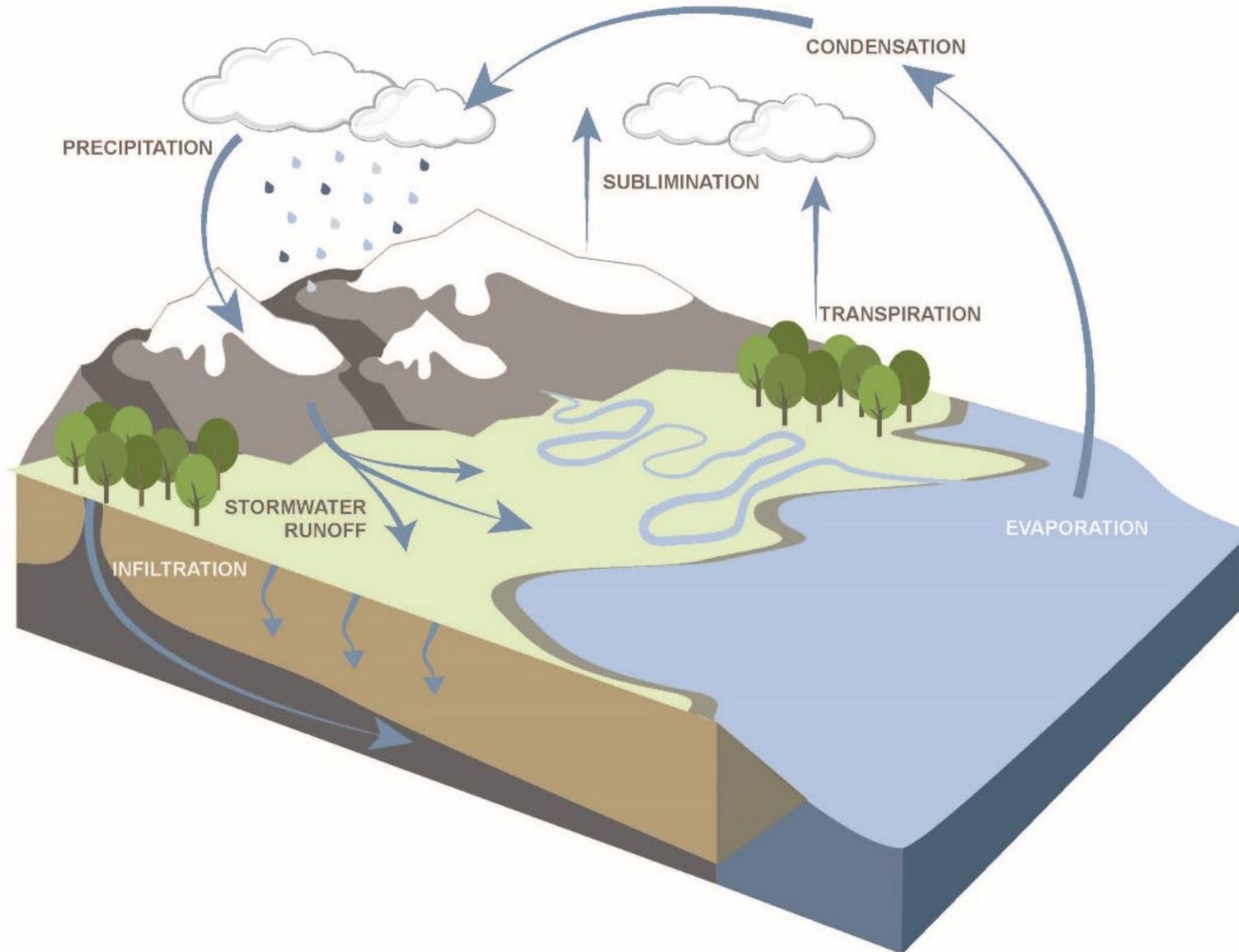
stormwater to maintain or mimic natural systems and treat runoff as a resource.



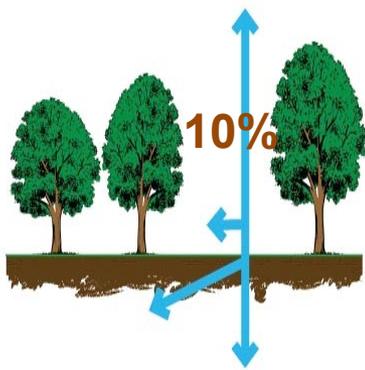
What is a green infrastructure plan (and why do we need one)?



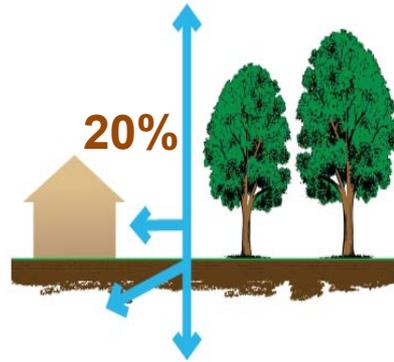
The Natural Hydrologic Cycle



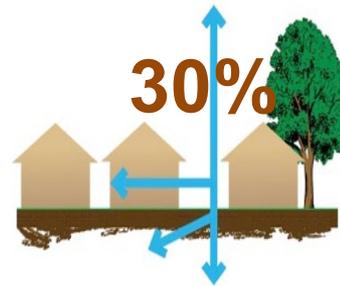
+ impervious surfaces =



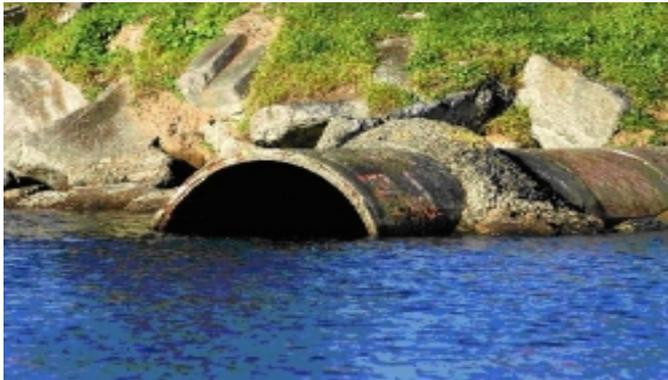
More development



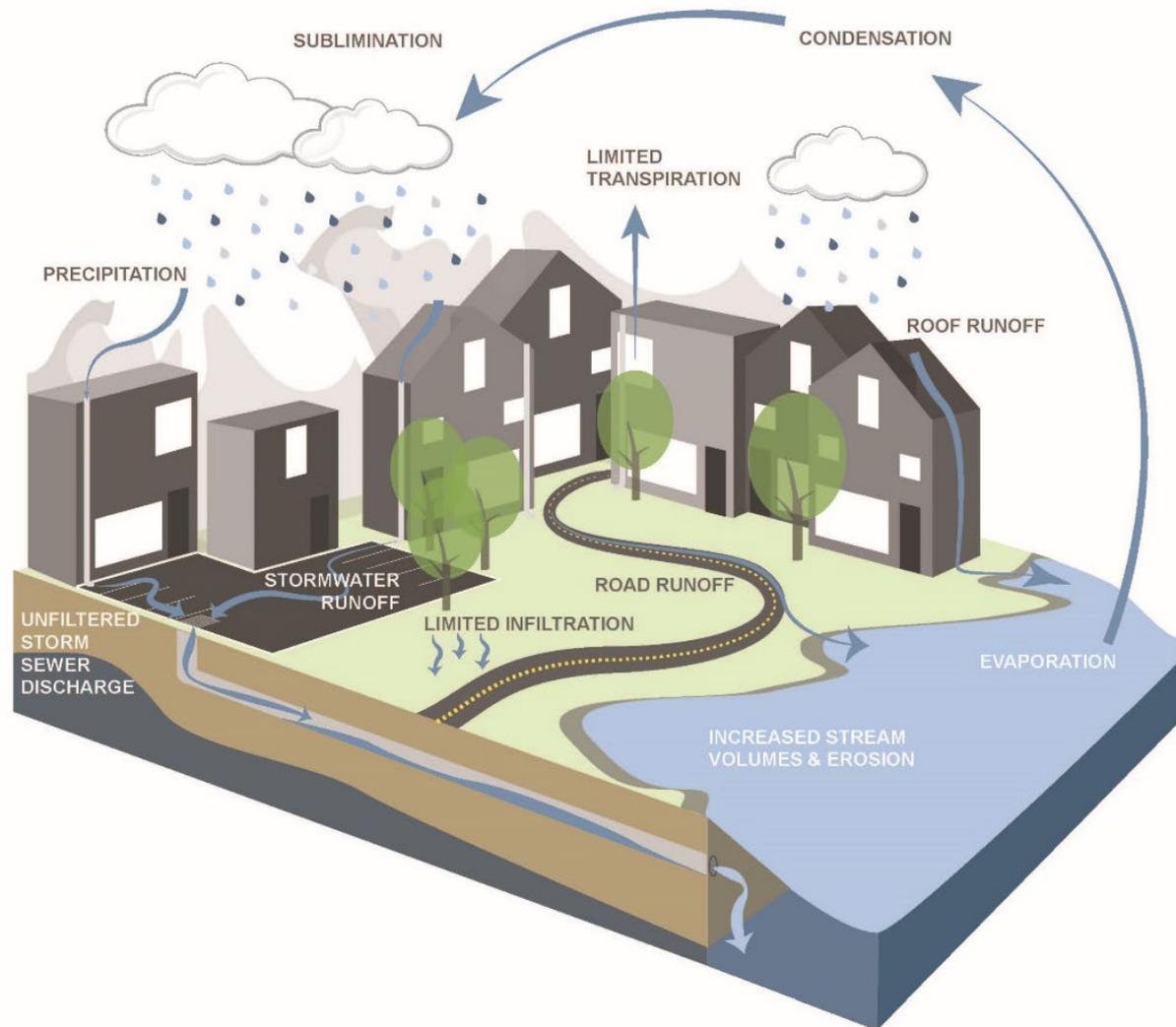
More impervious surfaces



More stormwater runoff



The Urban Hydrologic Cycle

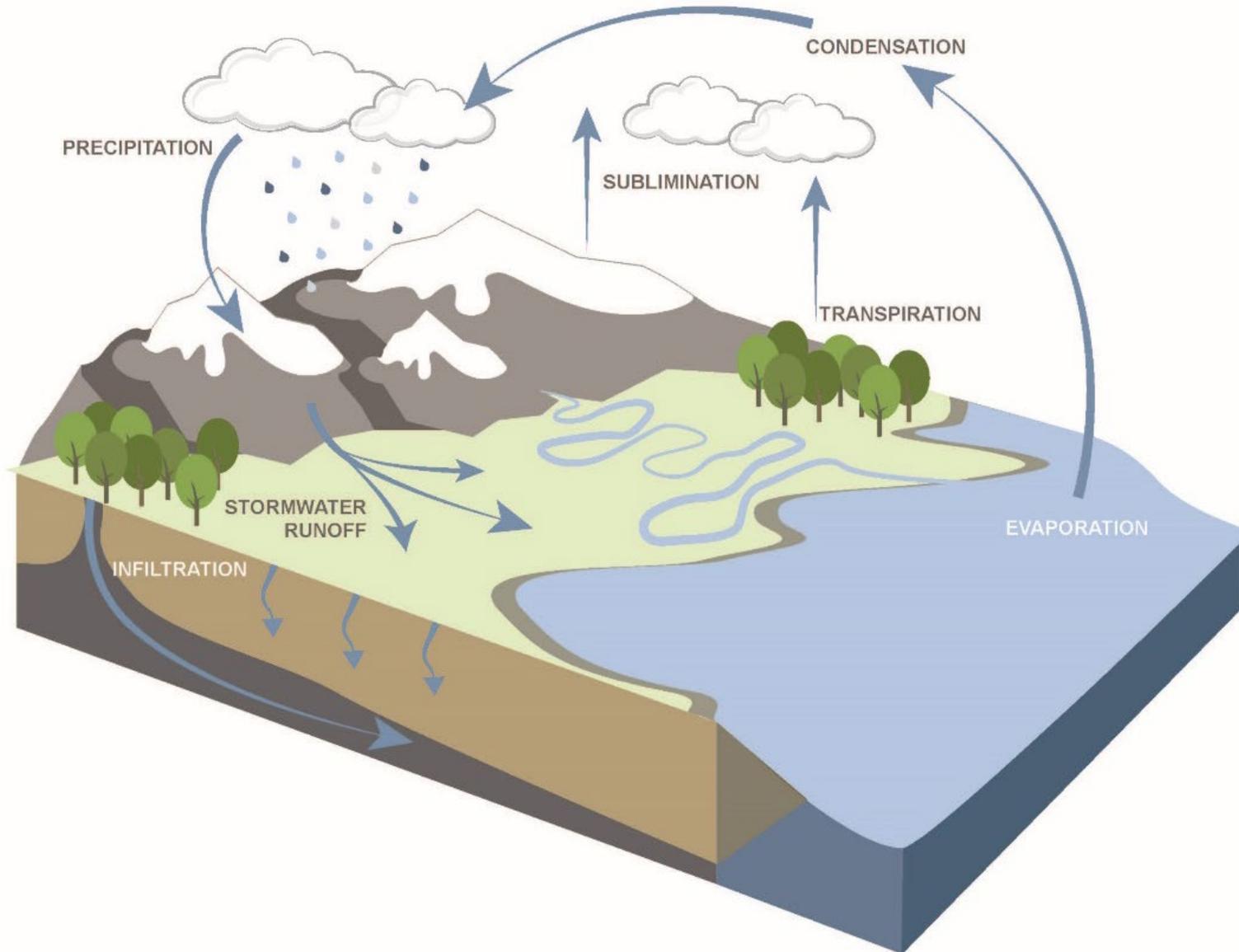


+ green infrastructure =

- Green Roofs
- Rainwater Harvesting
- Tree Filter/Planter Boxes
- Rain Gardens/Bioretenention Systems
- Permeable Pavements
- Vegetated Swales or Bioswales
- Natural Retention Basins
- Green Streets



The Natural Hydrologic Cycle

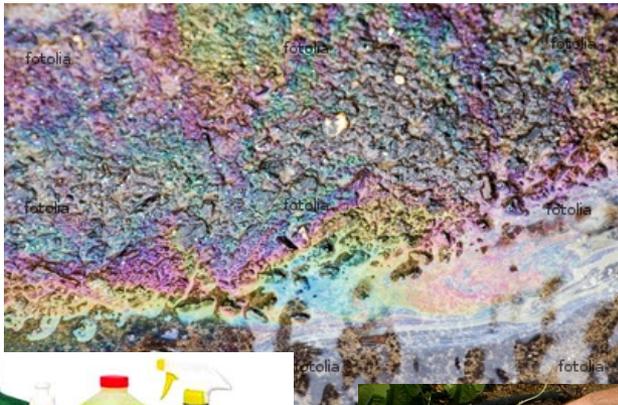


Hydrologic Impacts of Urbanization

- 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

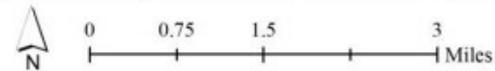
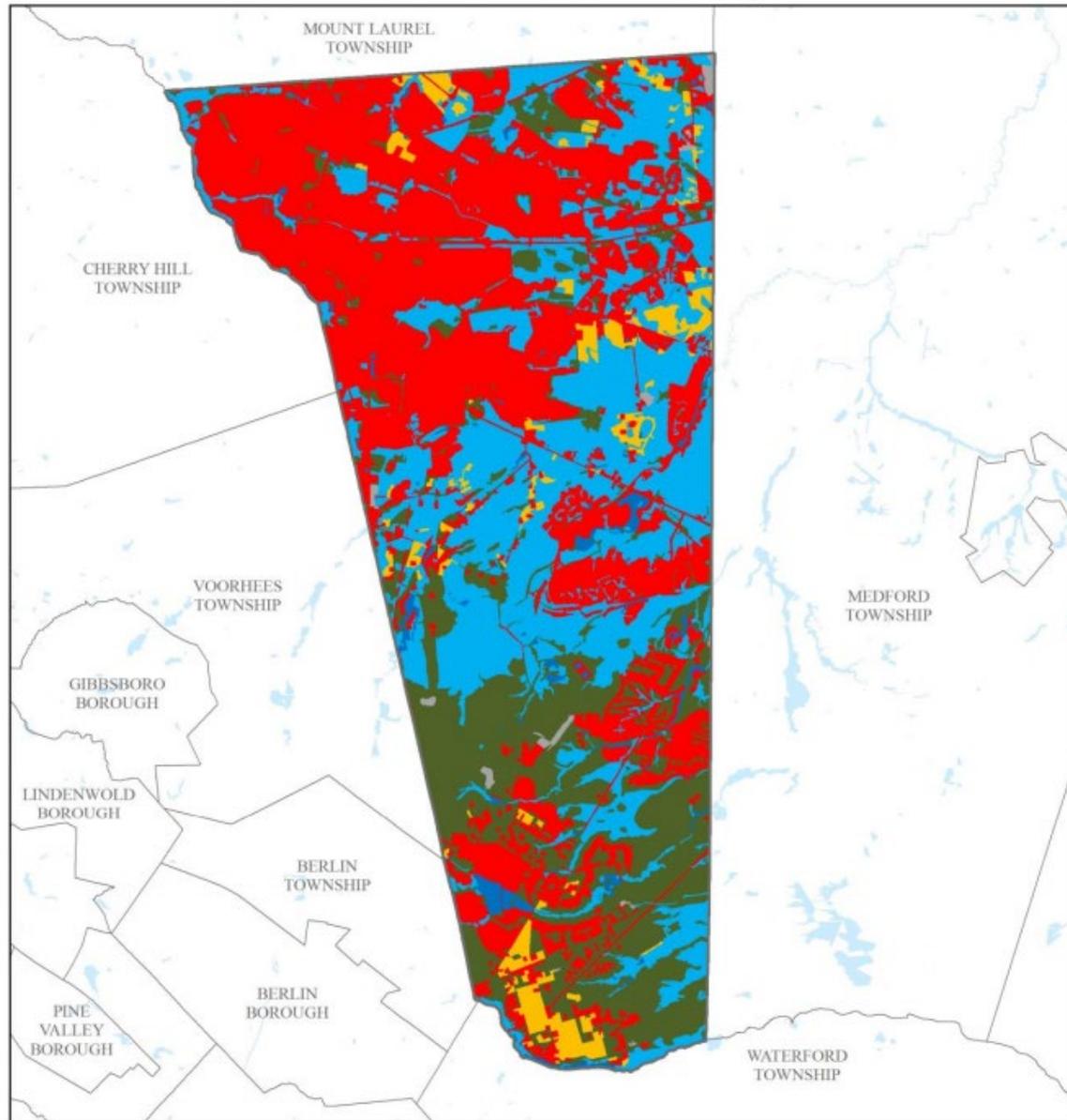
1. Impervious Cover Assessment (ICA)
2. Green Infrastructure Action Plan (a.k.a. Impervious Cover Reduction Action Plan or RAP)
3. Green Infrastructure Strategic Plan (a.k.a. Green Infrastructure Feasibility Study)

IMPERVIOUS COVER ASSESSMENT (ICA)

Impervious Cover Assessment

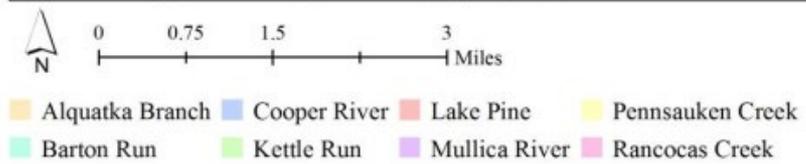
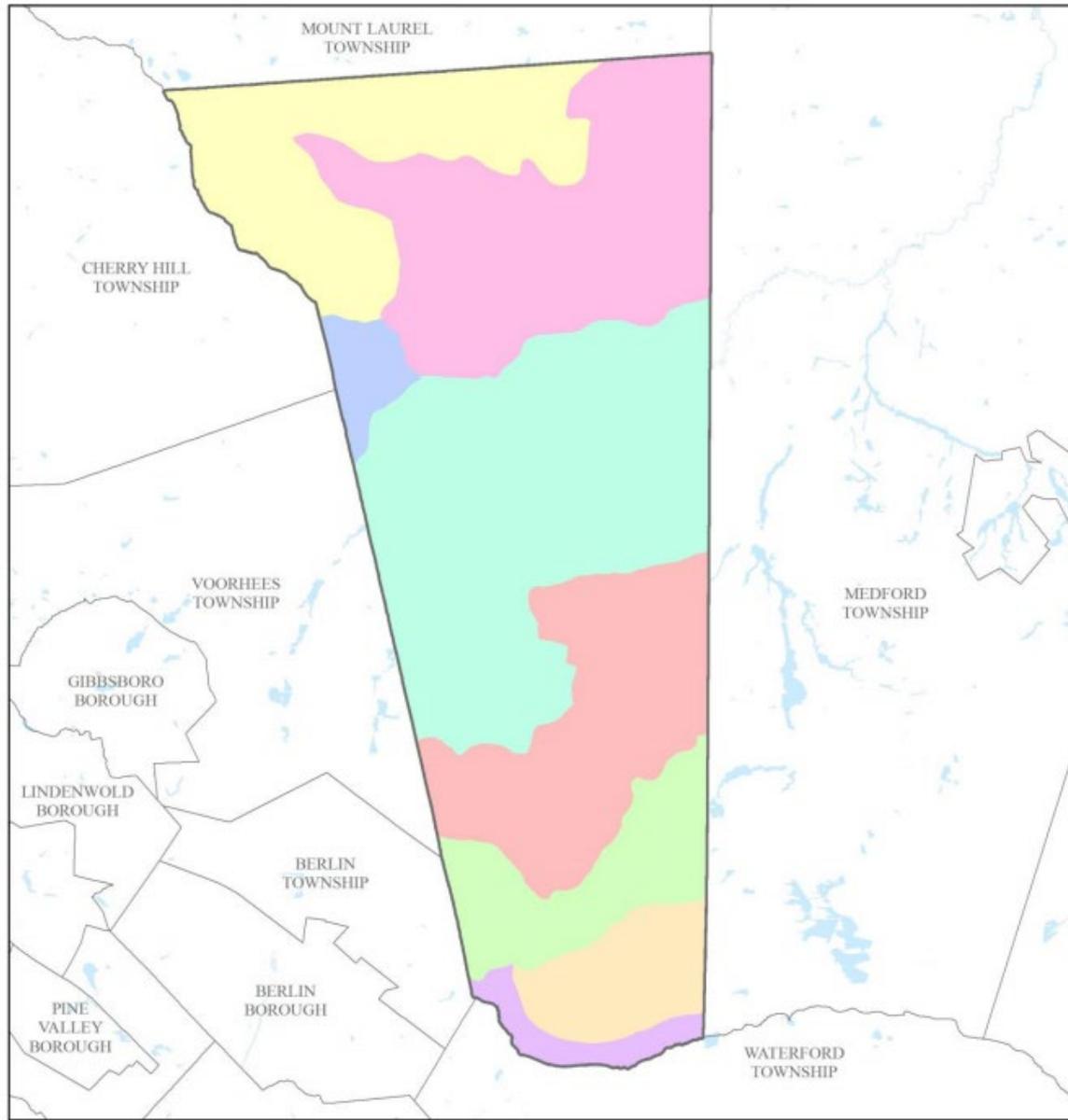
- Analysis completed by watershed and by municipality
- Use 2012 Land Use data to determine impervious cover
- Calculate runoff volumes for water quality, 2-, 10- and 100-year design storm and annual rainfall
- Contains three concept designs

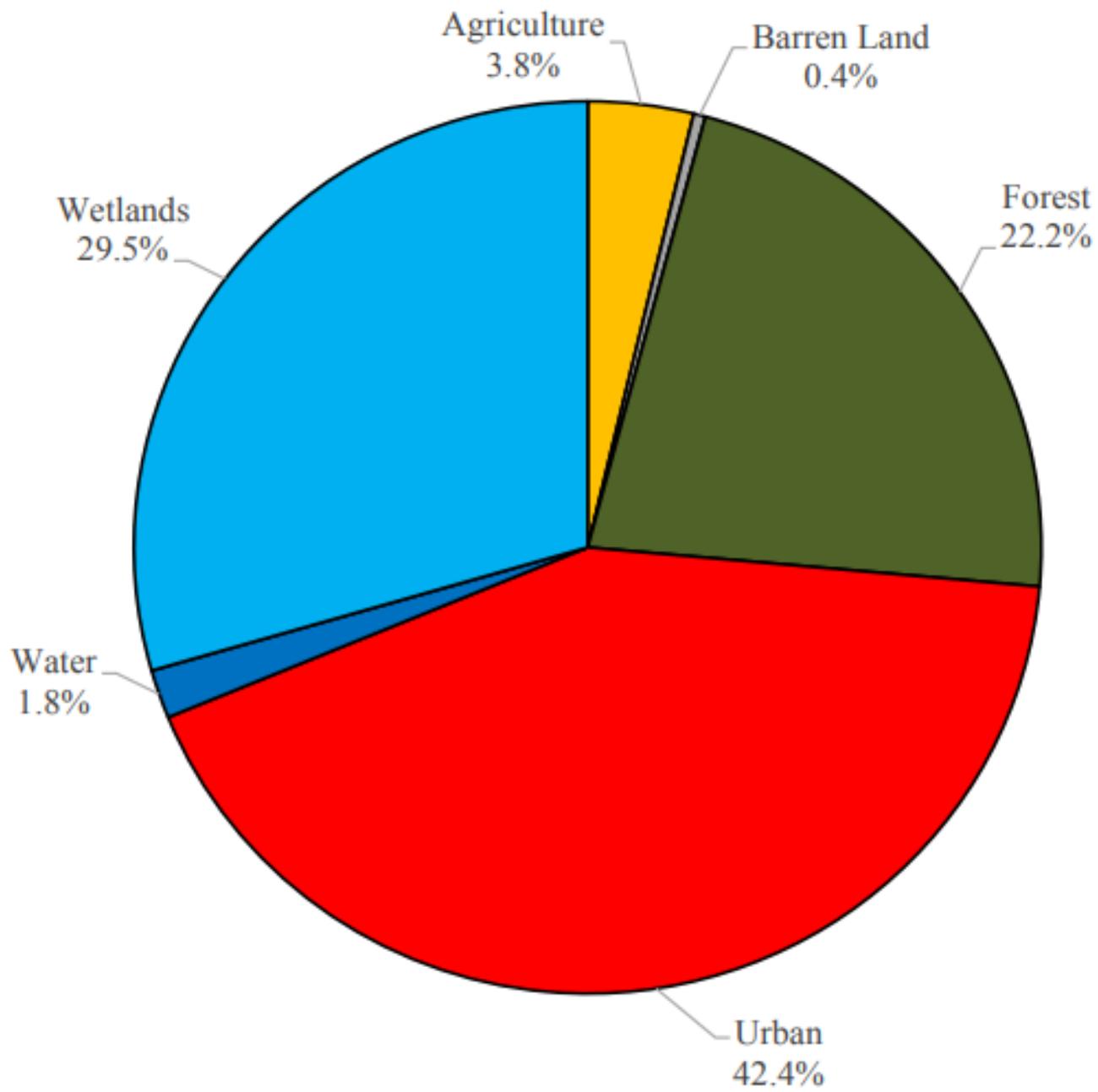
Subwatersheds of Evesham Township

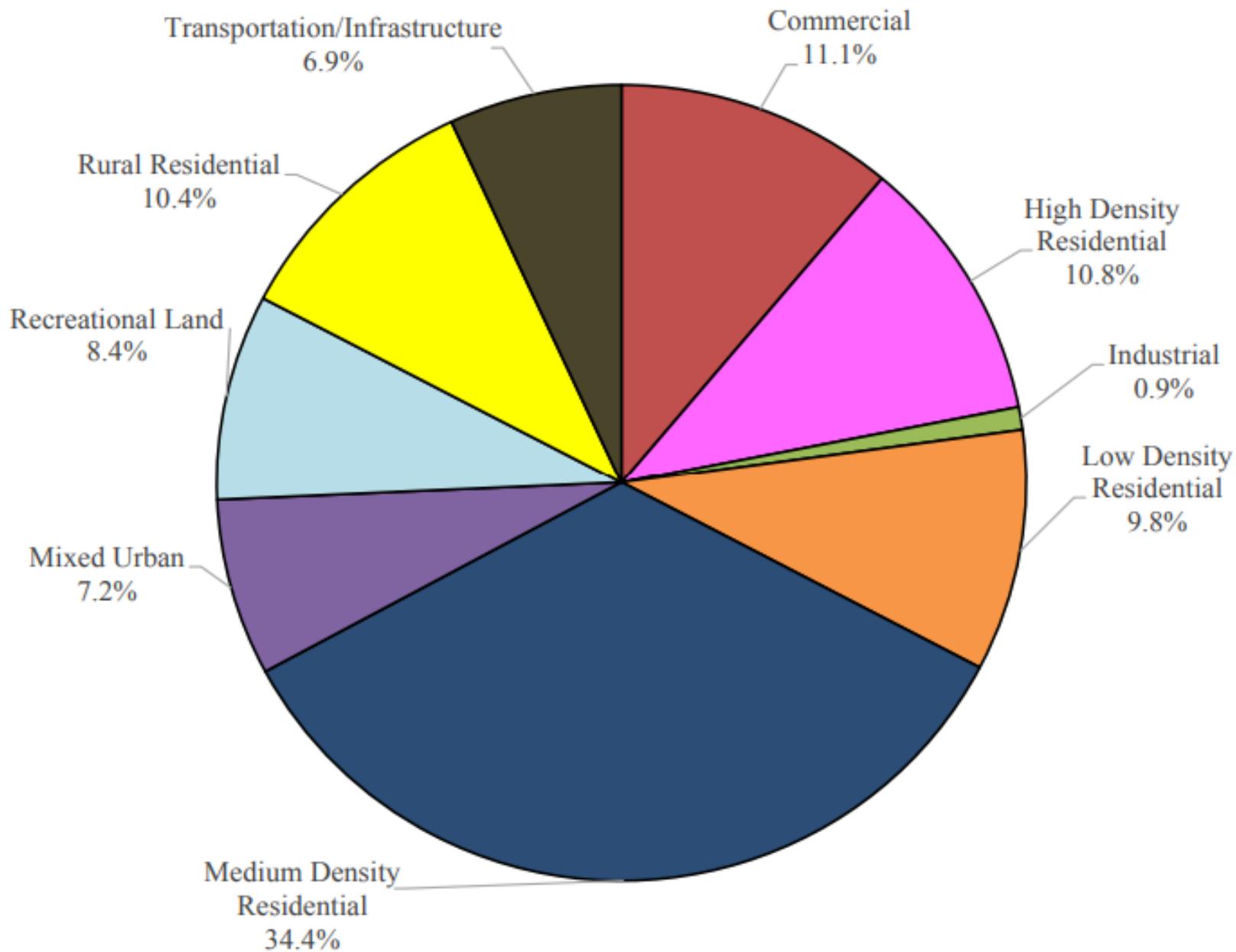


- Agriculture
- Barren Land
- Forest
- Urban
- Water
- Wetlands

Subwatersheds of Evesham Township







| Watershed | Total Area (ac) | Impervious Cover (ac) | % |
|-------------------------|------------------------|------------------------------|--------------|
| Alquatka Branch | 1,026.8 | 14.3 | 1.4% |
| Barton Run | 5,669.5 | 515.6 | 9.3% |
| Cooper River | 415.0 | 184.5 | 45.0% |
| Kettle Run | 1,509.0 | 99.5 | 6.9% |
| Lake Pine | 2,857.2 | 180.9 | 6.4% |
| Mullica River | 383.2 | 16.8 | 4.5% |
| Pennsauken Creek | 2,951.5 | 1,025.8 | 35.1% |
| Rancocas Creek | 4,116.9 | 846.9 | 20.7% |
| Total | 18,929.1 | 2,884.3 | 15.5% |

| Subwatershed | NJ Water Quality Storm (MGal) | Annual Rainfall of 44" (MGal) | 2-Year Design Storm (3.3") (MGal) | 10-Year Design Storm (5.0") (MGal) | 100-Year Design Storm (8.2") (MGal) |
|-------------------------|--------------------------------------|--------------------------------------|--|---|--|
| Alquatka Branch | 0.5 | 17.0 | 1.4 | 2.0 | 3.2 |
| Barton Run | 17.5 | 616.0 | 49.0 | 72.8 | 116.2 |
| Cooper River | 6.3 | 220.4 | 17.5 | 26.1 | 41.6 |
| Kettle Run | 3.4 | 118.9 | 9.5 | 14.0 | 22.4 |
| Lake Pine | 6.1 | 216.1 | 17.2 | 25.5 | 40.8 |
| Mullica River | 0.6 | 20.1 | 1.6 | 2.4 | 3.8 |
| Pennsauken Creek | 34.8 | 1,225.5 | 97.5 | 144.8 | 231.2 |
| Rancocas Creek | 28.7 | 1,011.8 | 80.5 | 119.6 | 190.9 |
| Total | 97.9 | 3,445.9 | 274.1 | 407.2 | 650.0 |

**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:

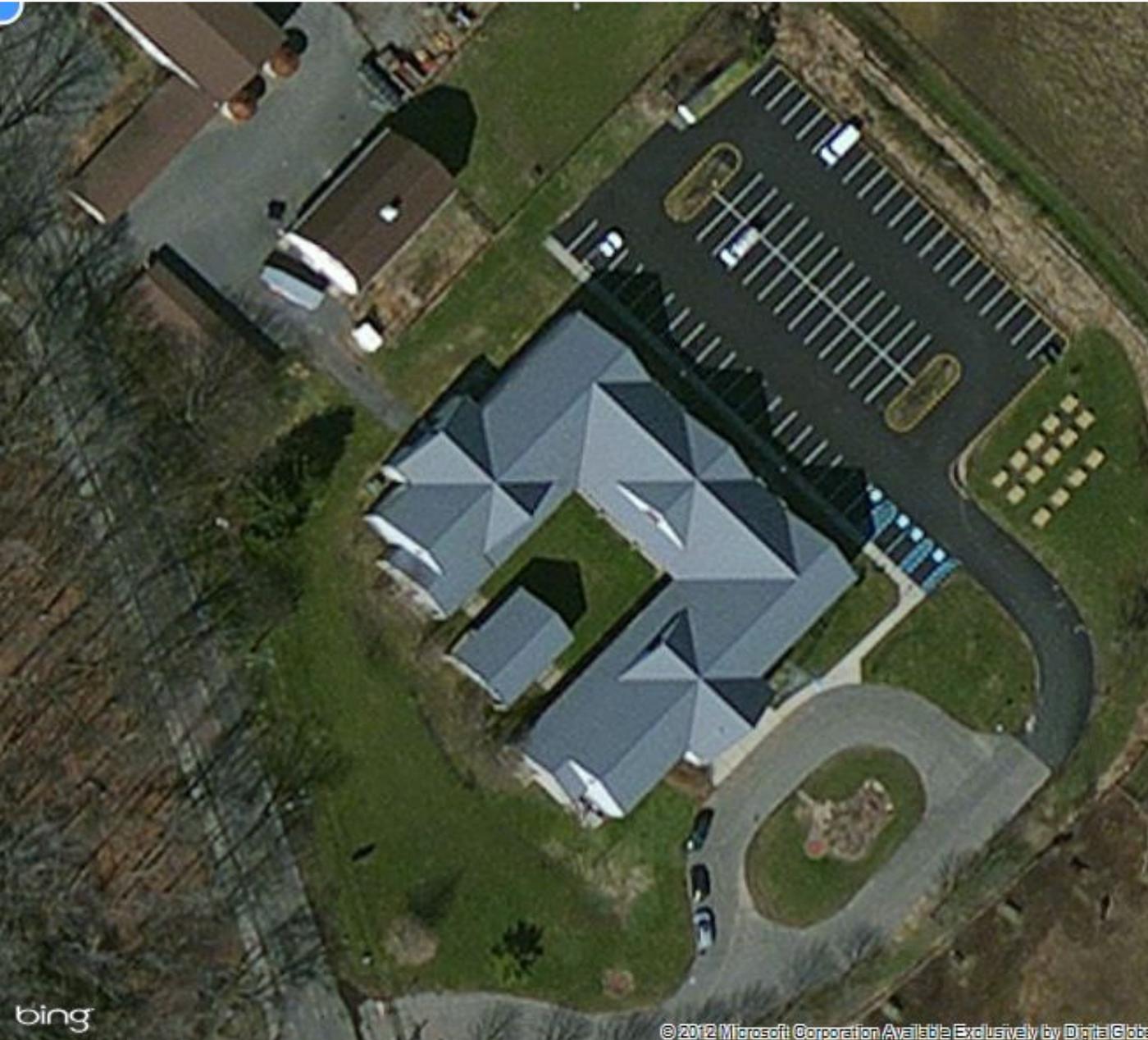
Former Agriculture Museum NJ

103 College Farm Road

New Brunswick, NJ 08901

From Bing Maps using the Snipping Tool

The screenshot displays the Bing Maps interface. At the top, the navigation bar includes the Bing logo, links for Web, Images, Videos, Maps (highlighted with a red underline), News, and Explore. On the right side of the navigation bar, there is a 'Sign in' button with a user icon, a notification bell, and a settings gear. Below the navigation bar is a search bar with a magnifying glass icon. The main map area shows an aerial view of a building complex with a large, semi-transparent snipping tool overlay. The map includes labels for 'AG Extension Way' and 'College Farm Rd'. On the right side of the map, there are zoom controls (+, -, and a target icon). At the bottom right of the map, there are buttons for 'Leave Preview', 'Feedback', and 'Tips', along with a scale bar showing '100 feet' and '25 m', and the copyright notice '© 2015 HERE'. The footer of the page contains links for 'Privacy and Cookies', 'Legal', 'Advertise', 'About our ads', 'Help', and 'Feedback', along with the copyright notice '© 2015 Microsoft'.



Observations:

- Lots of impervious cover
- No stormwater management
- Lots of open space for potential BMPs

Questions for site visit:

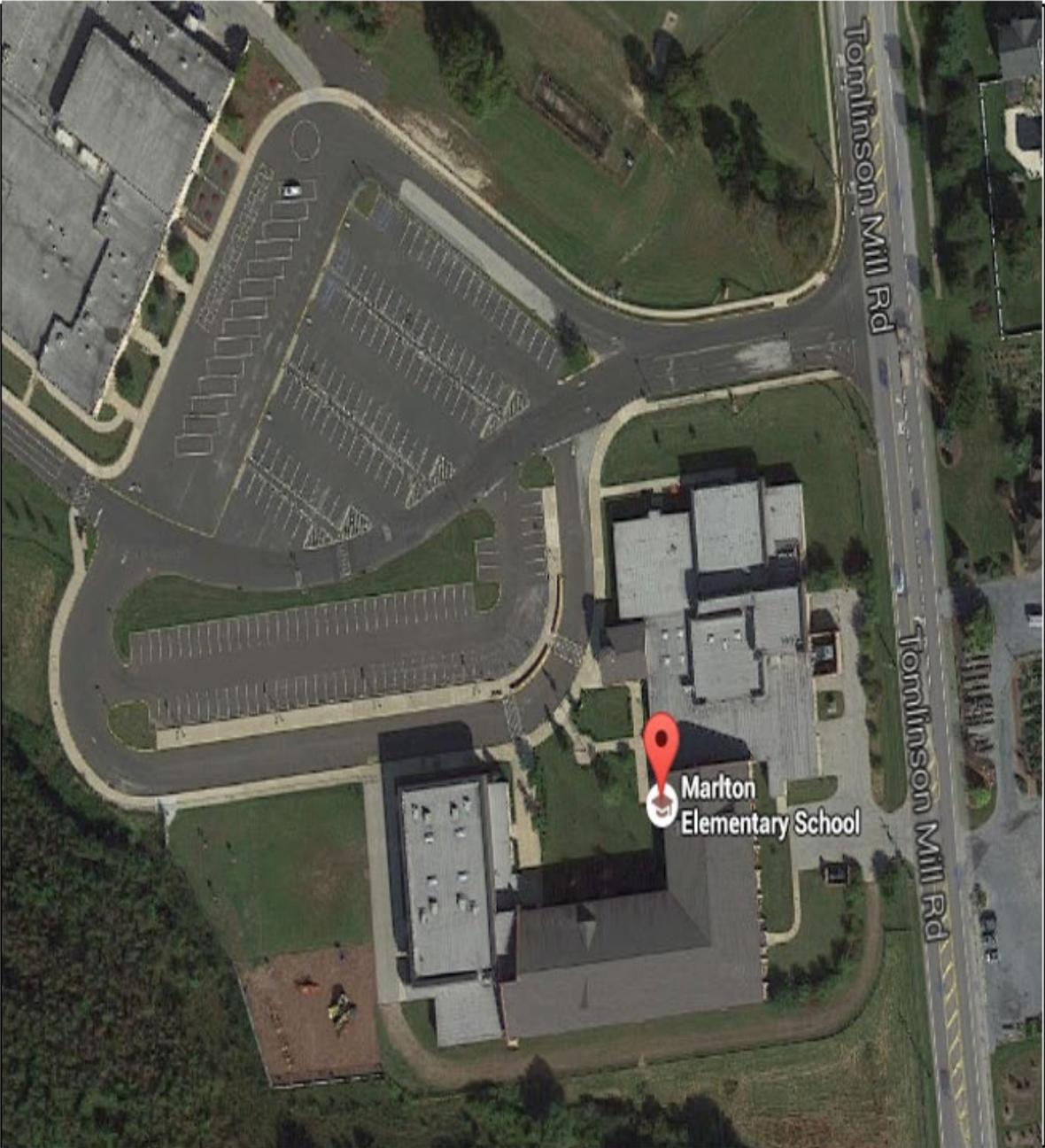
- Are there downspouts?
- Are they connected?
- Is there curb along the parking lot?
- Which way is the parking lot graded?
- What is the condition of the parking lot?

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



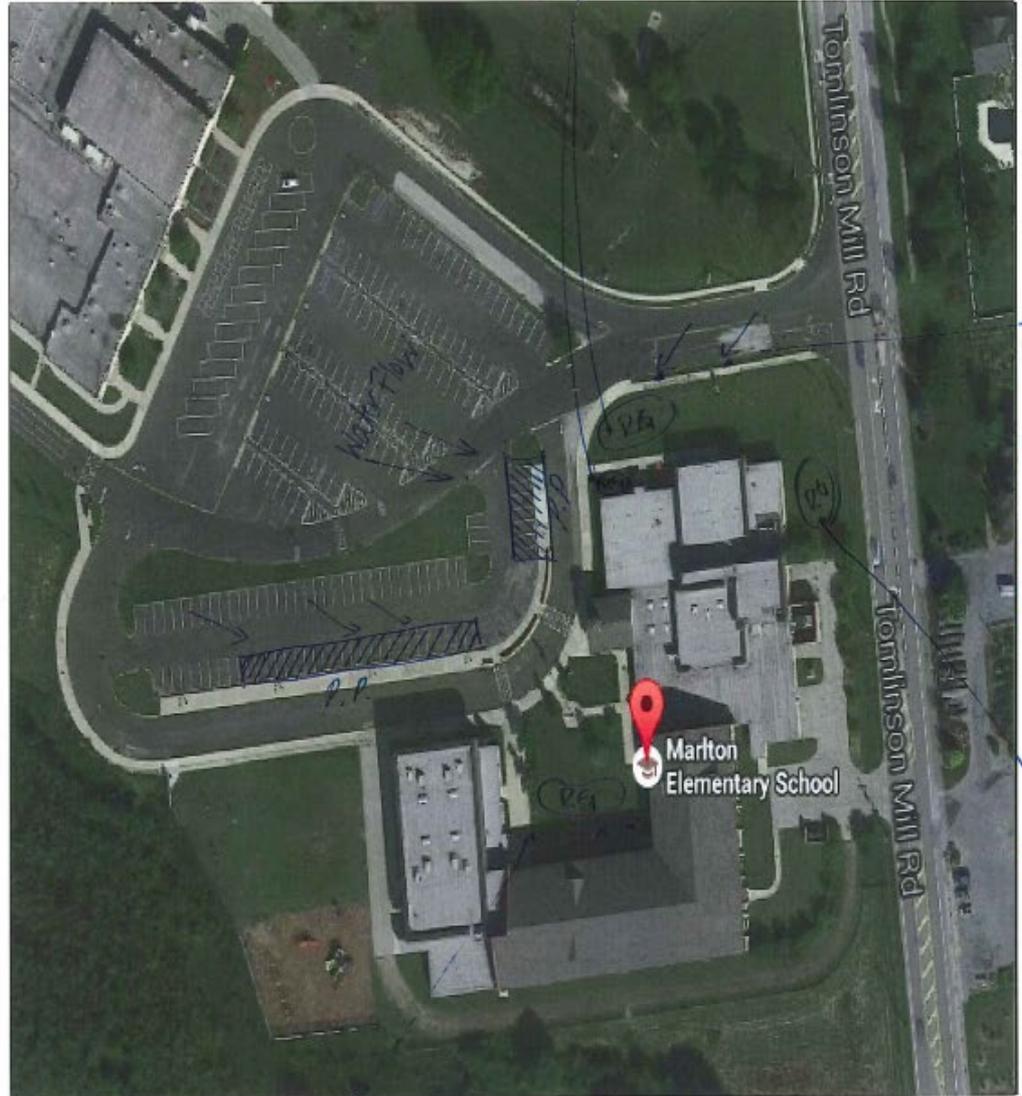
Marlton Elementary School

190 Tomlinson Mill Rd,
Evesham Township, NJ 08053

P.P. = Porous Pavement

R.G. = Rain Garden

P.P. Look at contours for
parking lots to see flow
of run off



2 inlets
for overflow
of rain Garden

Curb
cuts to
allow
flow to
go into
Rain
Garden

inlet
for over
flow

Disconnect downspouts
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)



RG2



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 GUIDANCE MANUAL

FOR NEW JERSEY

Green Infrastructure Brochure:

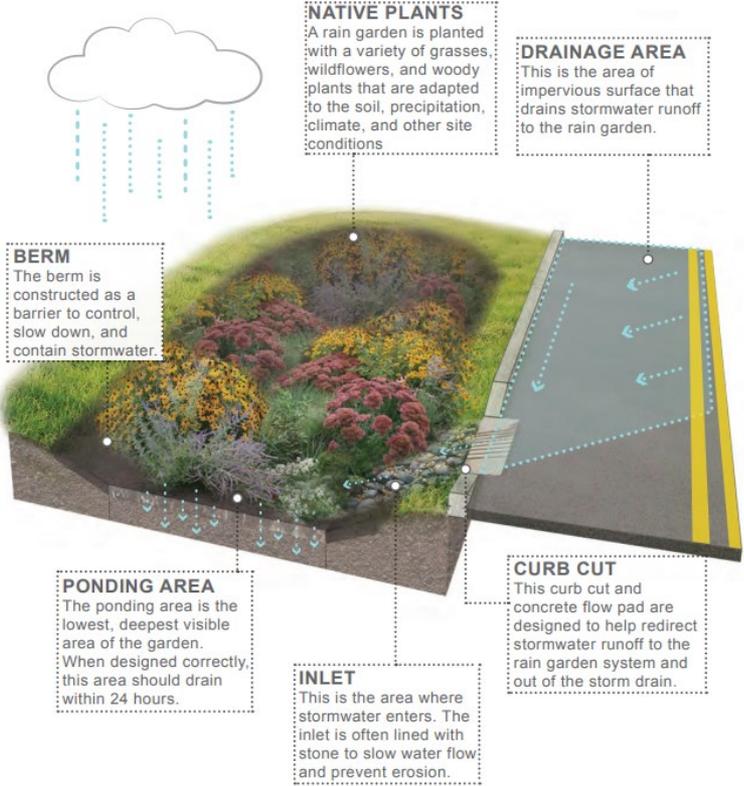
[http://water.rutgers.edu/Green Infrastructure Guidance Manual/GI-Brochure PRINT-FRIENDLY.pdf](http://water.rutgers.edu/Green_Infrastructure_Guidance_Manual/GI-Brochure_PRINT-FRIENDLY.pdf)

RUTGERS
New Jersey Agricultural
Experiment Station

GREEN INFRASTRUCTURE GUIDANCE

**ROAD
CLOSED**

**FOR REDUCING THE IMPACTS OF
IMPERVIOUS COVER ON WATER QUALITY**



Green Infrastructure CHECKLIST:

<http://water.rutgers.edu/GreenInfrastructureGuidanceManual.html>

Also found on pages 132-135 in the Manual



Green Infrastructure Site Assessment Checklist



| | | |
|--|--|----------|
| GENERAL INFORMATION | | Site ID: |
| Name person(s) completing assessment: | | Date: |
| Location Address and Cross Streets: | Neighborhood: | |
| Name of Nearest Waterway: | Property Owner / Tax Parcel ID/Street Segment: | |
| Contact Information: | | |
| SITE DESCRIPTION | | |
| Description of site and relative visibility to the public (public or private property, lot size, current use, streetscape, etc): | | |

| OBSERVATIONS | NOTES/REMARKS |
|--|---------------|
| 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? | |
| 2) What is the direction and relative slope of the site and/or street? (indicate on map or aerial photo) | |
| 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? | |
| 4) Do paved areas appear to be in poor condition (cracks, settling, vegetation growth, etc.) or do they appear newly paved or reconstructed? | |
| 5) Does stormwater runoff from impervious areas flow directly to the sewer system (such as roof runoff directed into a storm drain)? | |
| 6) Are there opportunities to redirect and disconnect runoff (downspouts, grassed areas, tree pits, curb extensions)? | |
| 7) How many stormwater catch basins are visible? Note location on maps and general condition, i.e. clogged, functioning, shallow (< 3 ft), or deep (> 3 ft)? | |
| 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.) | |
| 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)? | |
| 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)? | |
| 11) Does pedestrian safety need to be addressed? Will parking or bus stops be impacted by construction? | |



Green Infrastructure Site Assessment Checklist



| | | | |
|---|------------|-----------|-----------------|
| Choose suggested BMPs or indicate other. Include site photos and a description of recommended BMP location. | | | |
| RAIN GARDENS | YES | NO | COMMENTS |
| 1) Are there visible, exterior downspouts on any buildings? | | | |
| 2) Are there unpaved areas suitable for landscaping? | | | |
| 3) Is the site subject to ponding or flooding? | | | |
| RAIN WATER HARVESTING | YES | NO | COMMENTS |
| 1) Are there nearby buildings with visible exterior downspouts? | | | |
| 2) Is there a community garden nearby or other use for collected rainwater? | | | |
| TREE PITS, TRENCHES, AND STREETScape STRATEGIES | YES | NO | COMMENTS |
| 1) Does stormwater flow across sidewalks or along the curb? | | | |
| 2) Are there existing trees, landscaping or tree pits near the street? | | | |
| 2) Can water be directed from the street/curb into adjacent areas? | | | |
| POROUS PAVEMENT | YES | NO | COMMENTS |
| 1) Are there large areas of pavement on the site and are any paved areas not heavily used (i.e. fire lane, overflow)? | | | |
| 2) Are existing impervious areas in poor condition and in need of replacement? | | | |
| CURB EXTENSIONS AND STORMWATER PLANTERS | YES | NO | COMMENTS |
| 1) Is this a heavily used pedestrian crossing? Are there pedestrian crosswalks that would be safer if shortened? | | | |
| 2) Is the intersection or street at a location where stormwater can be collected before it enters a storm drain? | | | |
| OTHER STRATEGIES | YES | NO | COMMENTS |
| | | | |
| | | | |
| | | | |

Concept Plans

Evesham Township
Impervious Cover Assessment

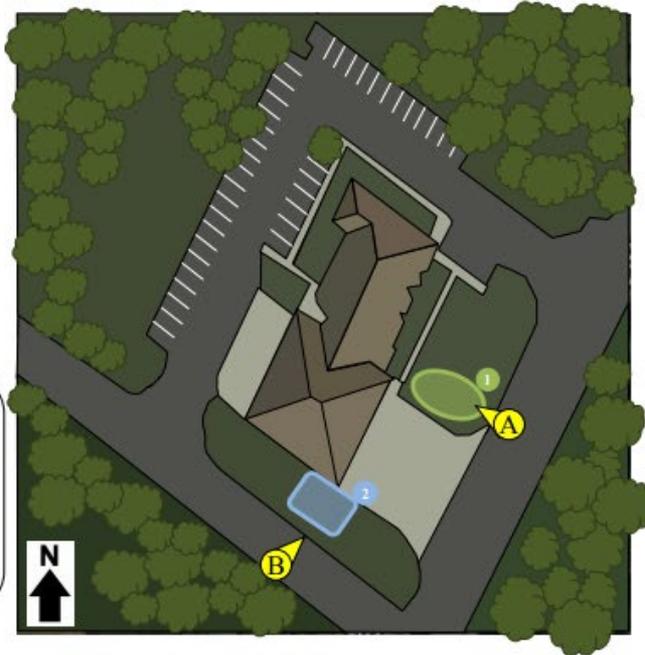
Kettle Run Fire Rescue, 498 Hopewell Road



PROJECT LOCATION:



SITE PLAN:



A



B



- 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 rooftop. Connecting the downspouts to the cistern will allow the stormwater to be harvested and used for cleaning fire trucks.

1 BIORETENTION SYSTEM



2 RAINWATER HARVESTING SYSTEM



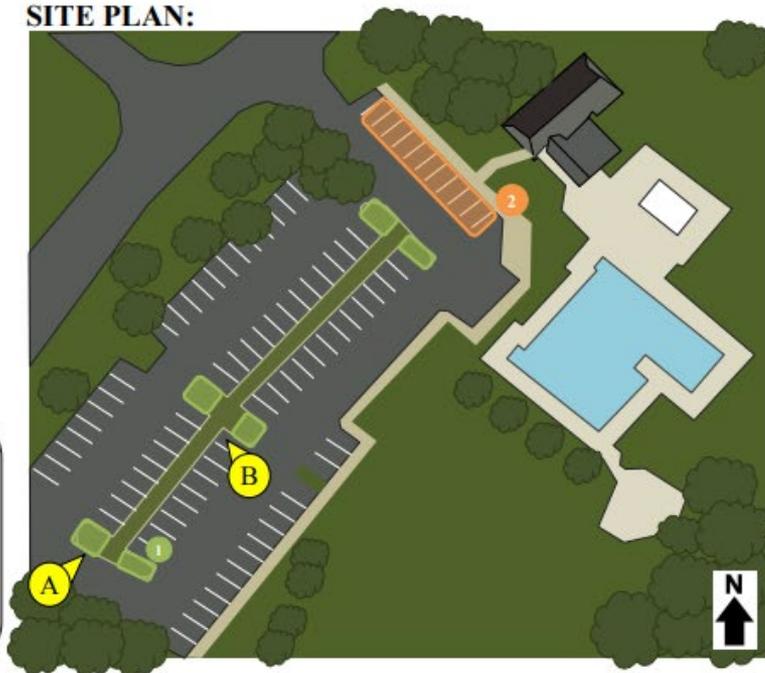
Evesham Township Impervious Cover Assessment

Barton Run Swim Club, 100 Lakeside Drive

PROJECT LOCATION:



SITE PLAN:



A



B



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.

1 BIORETENTION SYSTEM

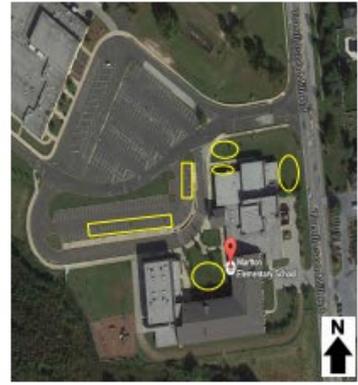


2 POROUS PAVEMENT

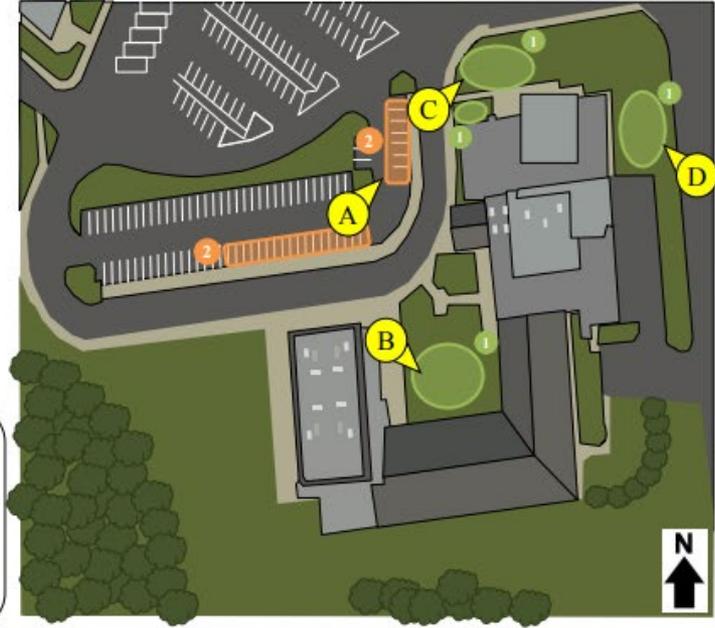


Evesham Township
Impervious Cover Assessment
Marlton Elementary School, 190 Tomlinson Mill Road

PROJECT LOCATION:



SITE PLAN:



- 1 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.
- 2 POROUS PAVEMENT:** Porous pavement promotes groundwater recharge and filters stormwater. The parking spots close to the school can be retrofitted with porous pavement.

1 BIORETENTION SYSTEM



2 POROUS PAVEMENT



A



B



C



D



Green Infrastructure Information Sheet

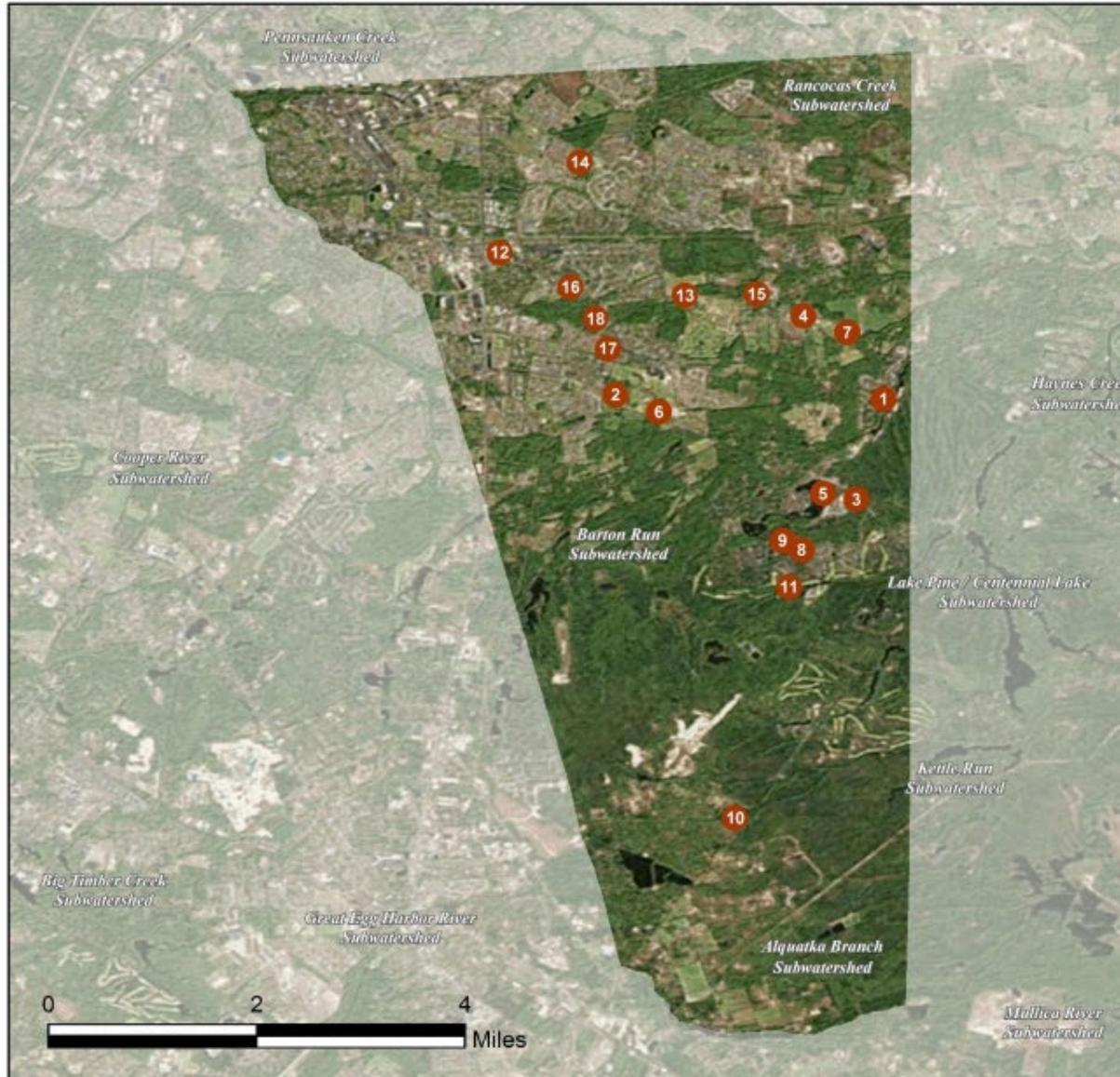
Marlton Elementary School
Green Infrastructure Information Sheet

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 contributes 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. | |
| 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. | |

| |
|--|
| 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



SITES WITHIN THE BARTON RUN SUBWATERSHED:

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.

| Impervious Cover | | Existing Loads from Impervious Cover (lbs/yr) | | | Runoff Volume from Impervious Cover (Mgal) | |
|------------------|---------|---|-------|---------|--|-------------------------------|
| % | sq. ft. | TP | TN | TSS | For the 1.25" Water Quality Storm | For an Annual Rainfall of 44" |
| 26 | 526,875 | 25.4 | 266.1 | 2,419.1 | 0.411 | 14.45 |

| Recommended Green Infrastructure Practices | Recharge Potential (Mgal/yr) | TSS Removal Potential (lbs/yr) | Maximum Volume Reduction Potential (gal/storm) | Peak Discharge Reduction Potential (cu. ft./second) | Estimated Size (sq. ft.) | Estimated Cost |
|--|------------------------------|--------------------------------|--|---|--------------------------|----------------|
| Bioretention systems | 0.516 | 86 | 39,068 | 1.47 | 4,950 | \$24,750 |
| Pervious pavement | 0.651 | 109 | 49,331 | 1.85 | 4,465 | \$111,625 |

GREEN INFRASTRUCTURE RECOMMENDATIONS



Marlton Elementary School

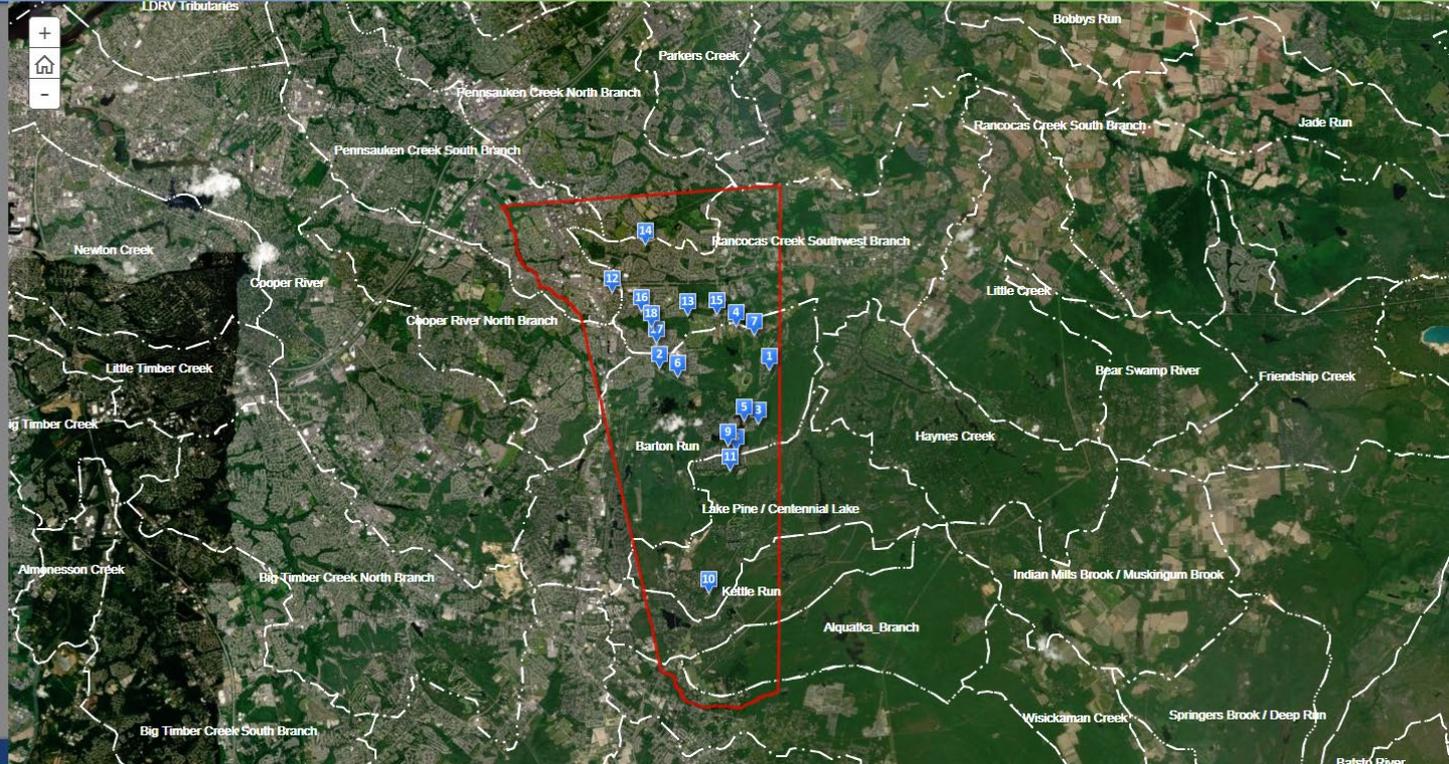
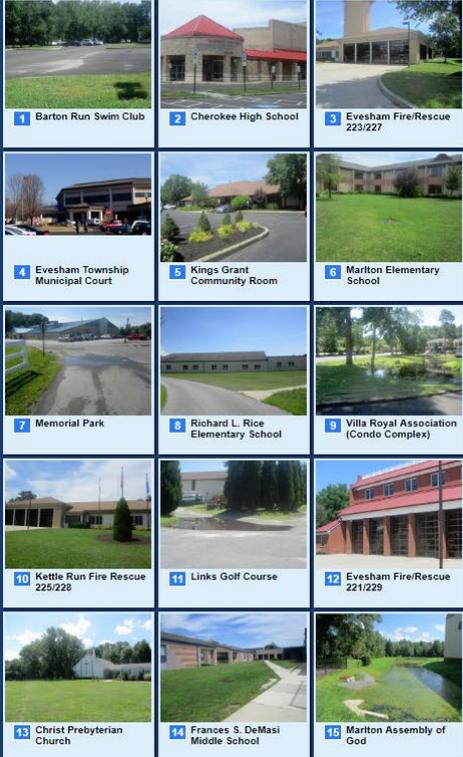
-  bioretention system
-  pervious pavement
-  drainage area
-  property line
-  2015 Aerial: NJOIT, OGIS



Evesham



- ALL SITES
- BARTON RUN
- LAKE PINE
- PENNSAUKEN CREEK
- RANCOCAS CREEK



Evesham



- ALL SITES
- BARTON RUN
- LAKE PINE
- PENNSAUKEN CREEK
- RANCOCAS CREEK

| | | |
|--|---|---|
| 1 Barton Run Swim Club | 2 Cherokee High School | 3 Evesham Fire/Rescue 223/227 |
| 4 Evesham Township Municipal Court | 5 Kings Grant Community Room | 6 Marlton Elementary School |
| 7 Memorial Park | 8 Richard L. Rice Elementary School | 9 Villa Royal Association (Condo Complex) |
| 10 Kettle Run Fire Rescue 225/228 | 11 Links Golf Course | 12 Evesham Fire/Rescue 221/229 |
| 13 Christ Presbyterian Church | 14 Frances S. DeMasi Middle School | 15 Marlton Assembly of God |

Map showing various creeks and landmarks in Evesham, NJ. A red boundary outlines a specific area. A pop-up window for Marlton Elementary School is open, displaying a photo of the school and the address 190 Tomlinson Mill Road Evesham, NJ 08053. A link to 'Download Report (PDF)' is provided.

Short term (5 years) goal

Table 1. Recommended Short Term Impervious Cover Management Goals

| Existing Municipal Impervious Cover | Recommended Short Term (less than 5 years) Impervious Cover Management Goal (%) | Recommended Impervious Cover Management Goal Area (acres) |
|--|--|--|
| 0% to 10% | 1% | 10 acres |
| 10.1% to 25% | 2% | 15 acres |
| >21.1% | 5% | 20 acres |

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

EVEESHAM
TOWNSHIP

WILLIAM PENN
FOUNDATION

RUTGERS

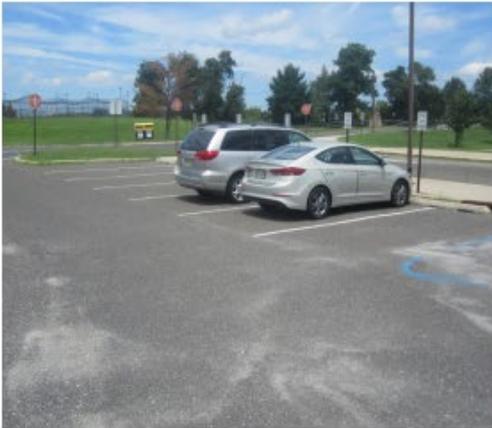
New Jersey Agricultural
Experiment Station





-  bioretention system
-  pervious pavement
-  drainage area
-  property line
-  2015 Aerial: NJOIT, OGIS





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.

| Impervious Cover | | Existing Loads from Impervious Cover (lbs/yr) | | | Runoff Volume from Impervious Cover (Mgal) | |
|------------------|---------|---|-------|---------|--|-------------------------------|
| % | sq. ft. | TP | TN | TSS | From the 1.25" Water Quality Storm | For an Annual Rainfall of 44" |
| 26 | 526,875 | 25.4 | 266.1 | 2,419.1 | 0.411 | 14.45 |

| Recommended Infrastructure Practices | Recharge Potential (Mgal/yr) | TSS Removal Potential (lbs/yr) | Maximum Volume Reduction Potential (gal/storm) | Peak Discharge Reduction Potential (cu. ft./second) | Estimated Size (sq. ft.) | Estimated Cost |
|--------------------------------------|------------------------------|--------------------------------|--|---|--------------------------|----------------|
| Bioretention systems | 0.516 | 86 | 39,068 | 1.47 | 4,950 | \$24,750 |
| Pervious pavement | 0.651 | 109 | 49,331 | 1.85 | 4,465 | \$111,625 |

CURRENT CONDITION



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MARLTON ELEMENTARY SCHOOL

190 Tomlinson Mill Road
Evesham, NJ 08053

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
(<https://owl.cwp.org/mdocs-posts/better-site-design-code-and-ordinance-cow-worksheet-2017-update/>)

Long term (5-20 years) goal

Table 2. Recommended Long-Term Impervious Cover Management Goals and Green Infrastructure Goals

| Existing Municipal Impervious Cover | Recommended Long Term (5-20 years) Impervious Cover Management Goal (%) | Recommended Impervious Cover Management Goal Area (acres) |
|--|--|--|
| 0% to 10% | 2% | 25 acres |
| 10.1% to 25% | 5% | 50 acres |
| >21.1% | 10% | 80 acres |

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?

ASLAVIDEO

Video by the American Society of Landscape Architects



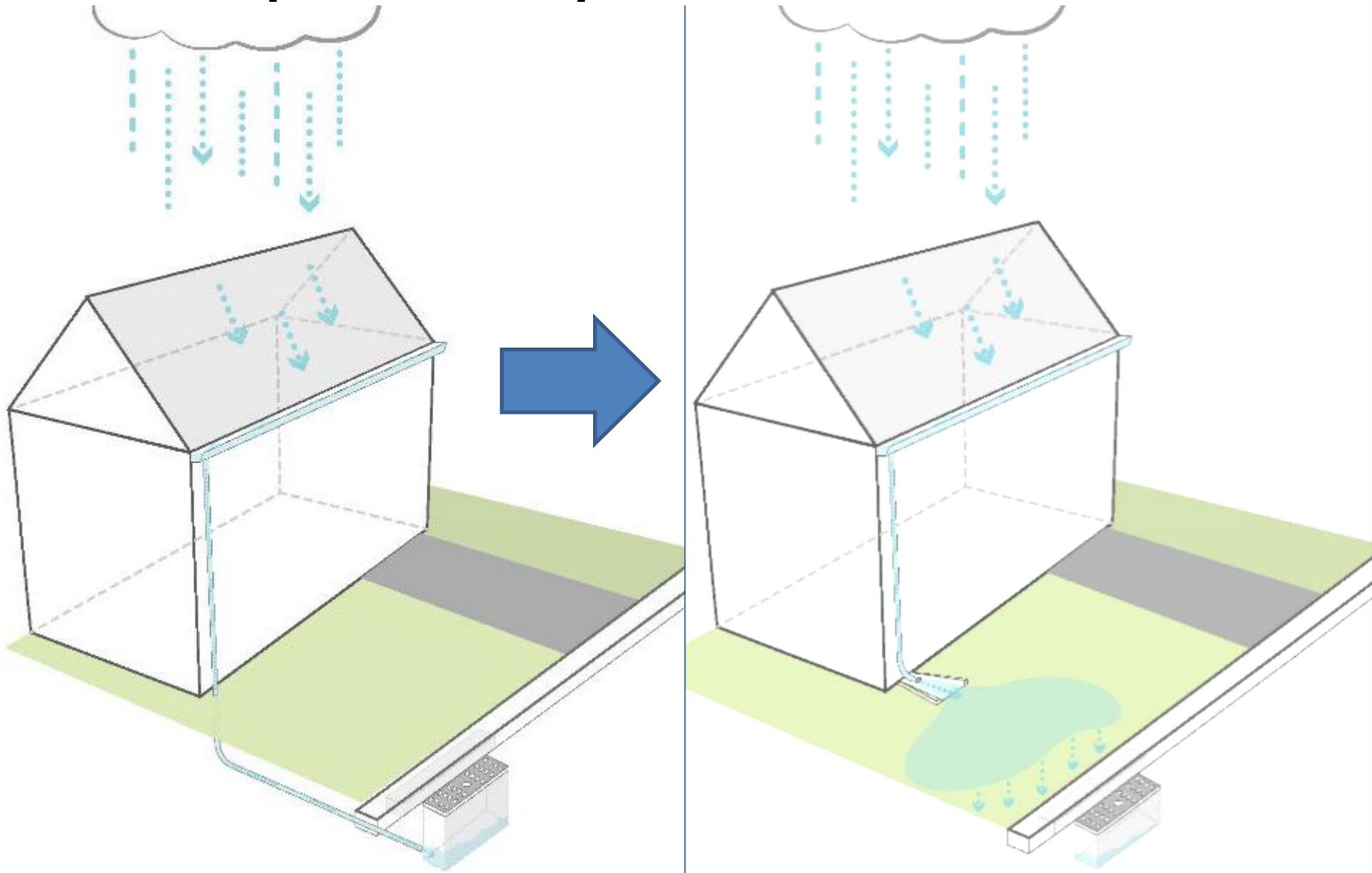
It is all about
controlling runoff
from impervious
surfaces



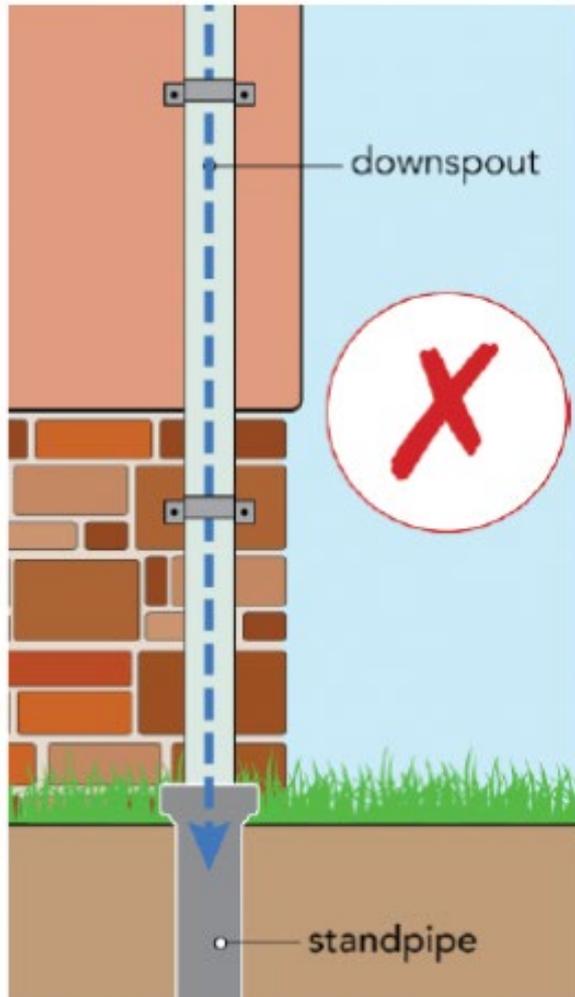
Step 1: Depave



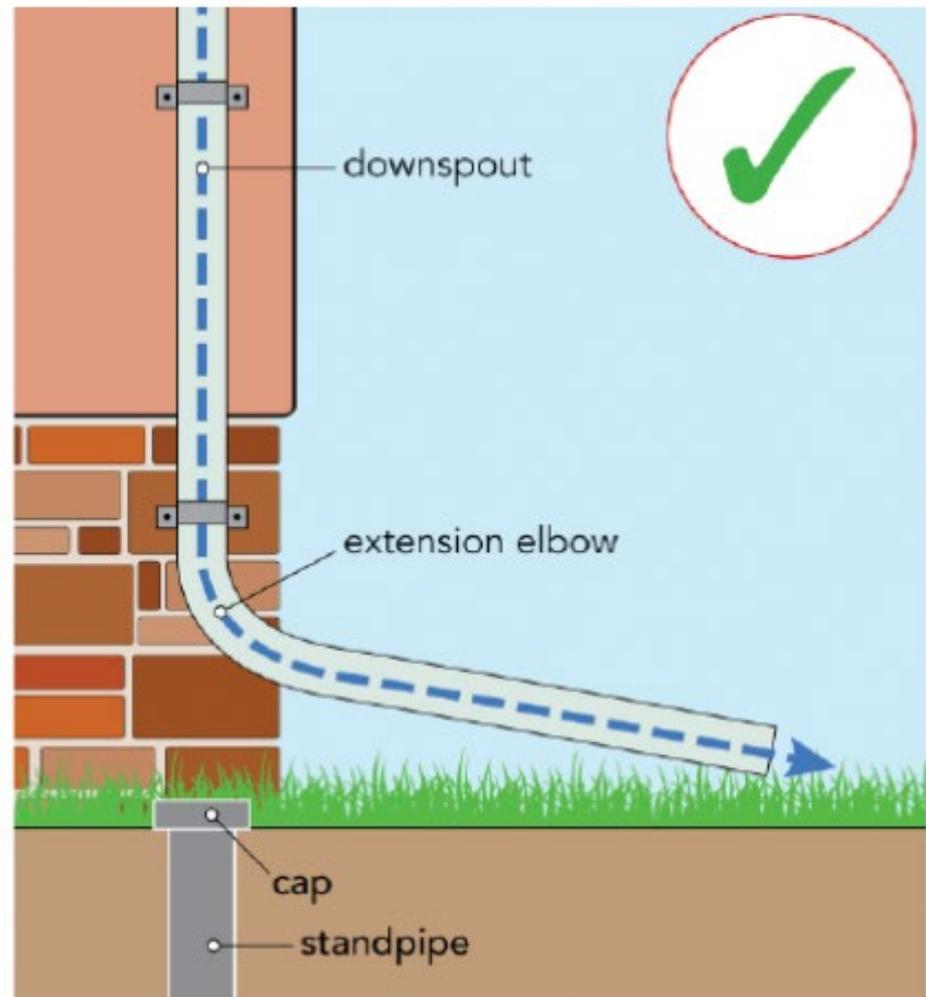
Step 2: Simple Disconnection



Downspout Disconnection

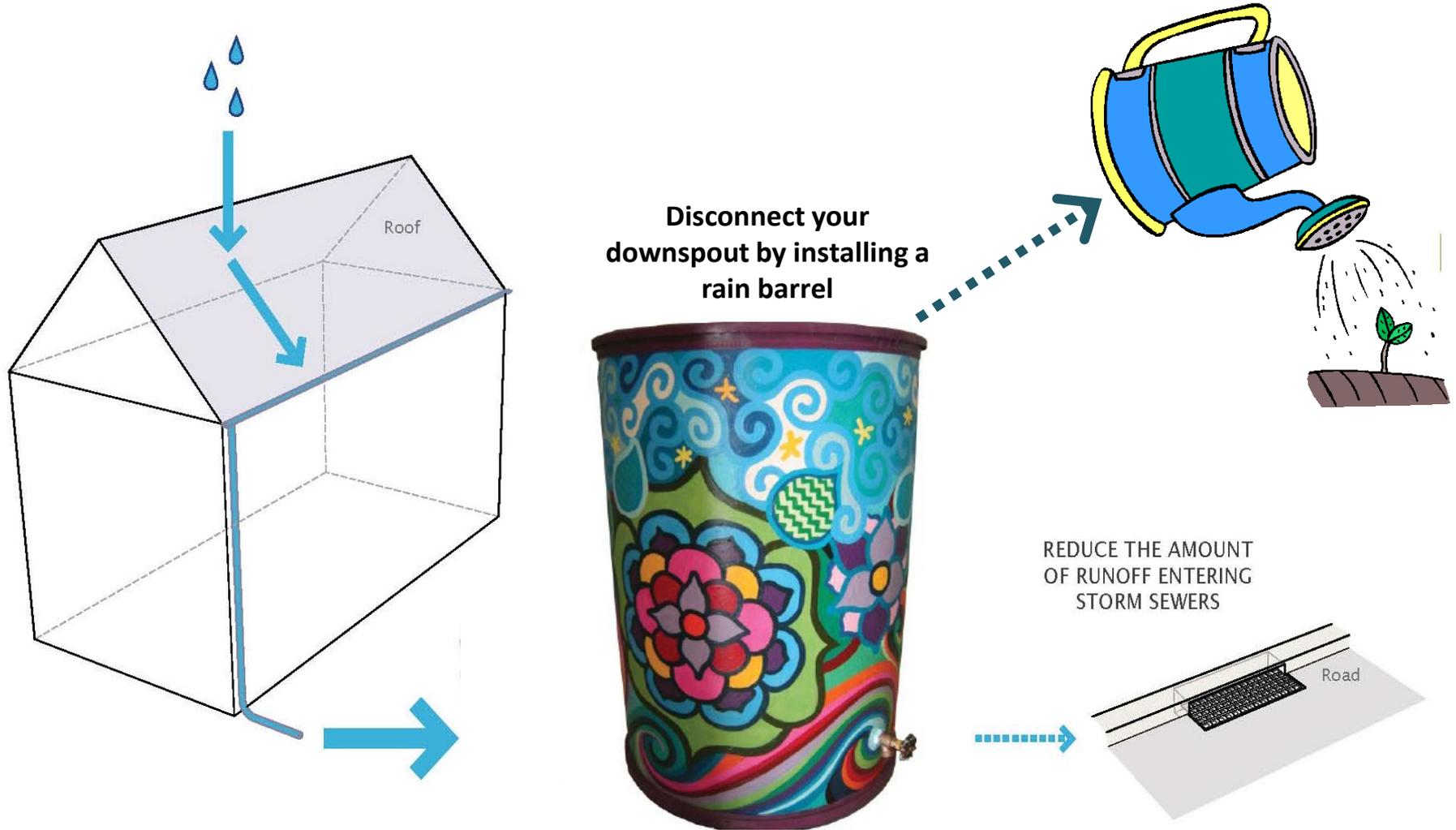


**DOWNSPOUT CONNECTED
TO SEWER SYSTEM**



**DOWNSPOUT DISCONNECTED
FROM SEWER SYSTEM**

Disconnect to a Rain Barrel or Cistern

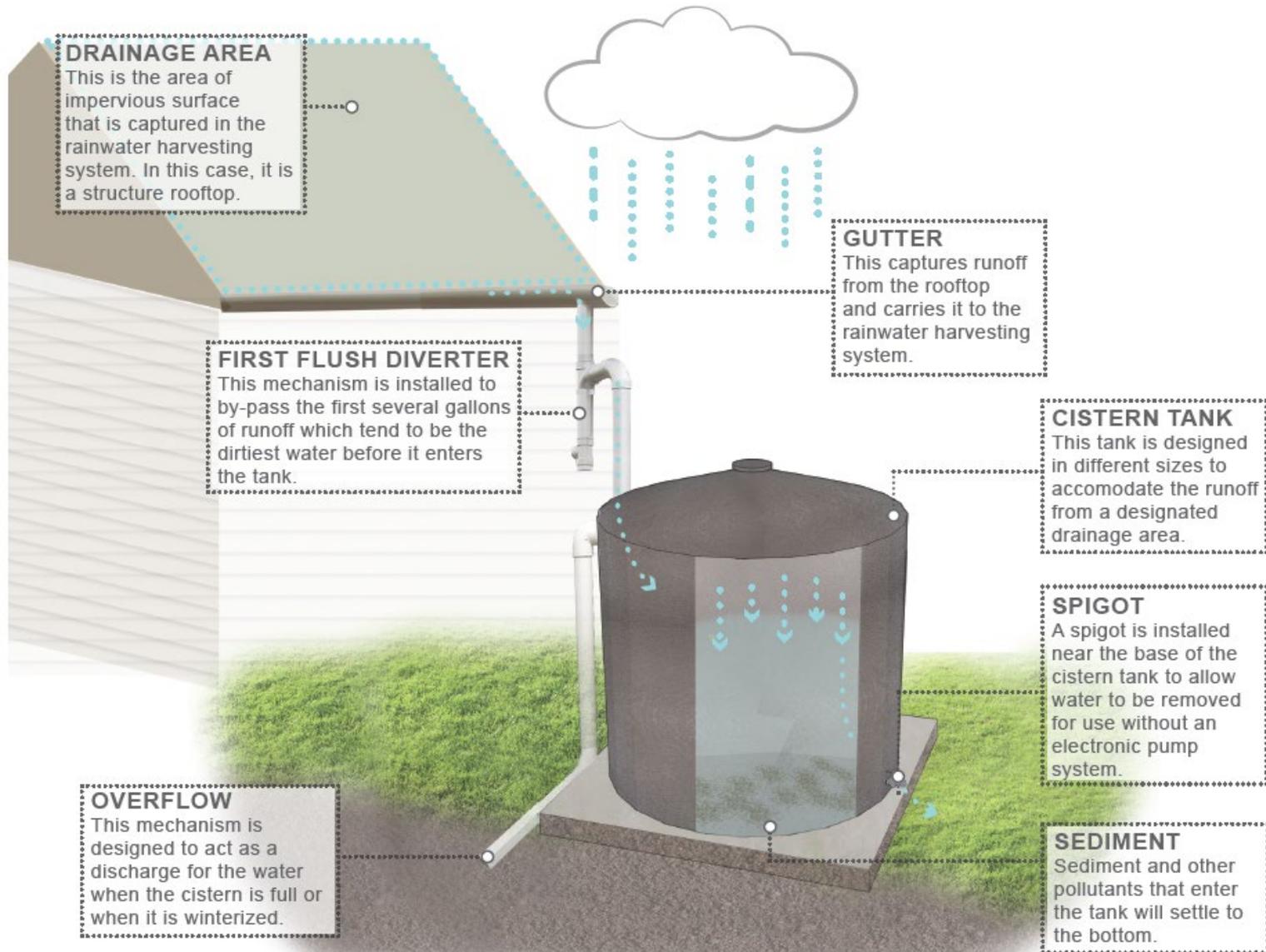


Impervious area is now "disconnected" from flowing directly into the storm sewer system

So Many Barrels to Choose From...



Rainwater Harvesting Systems



Or Larger Rainwater Harvesting Systems...

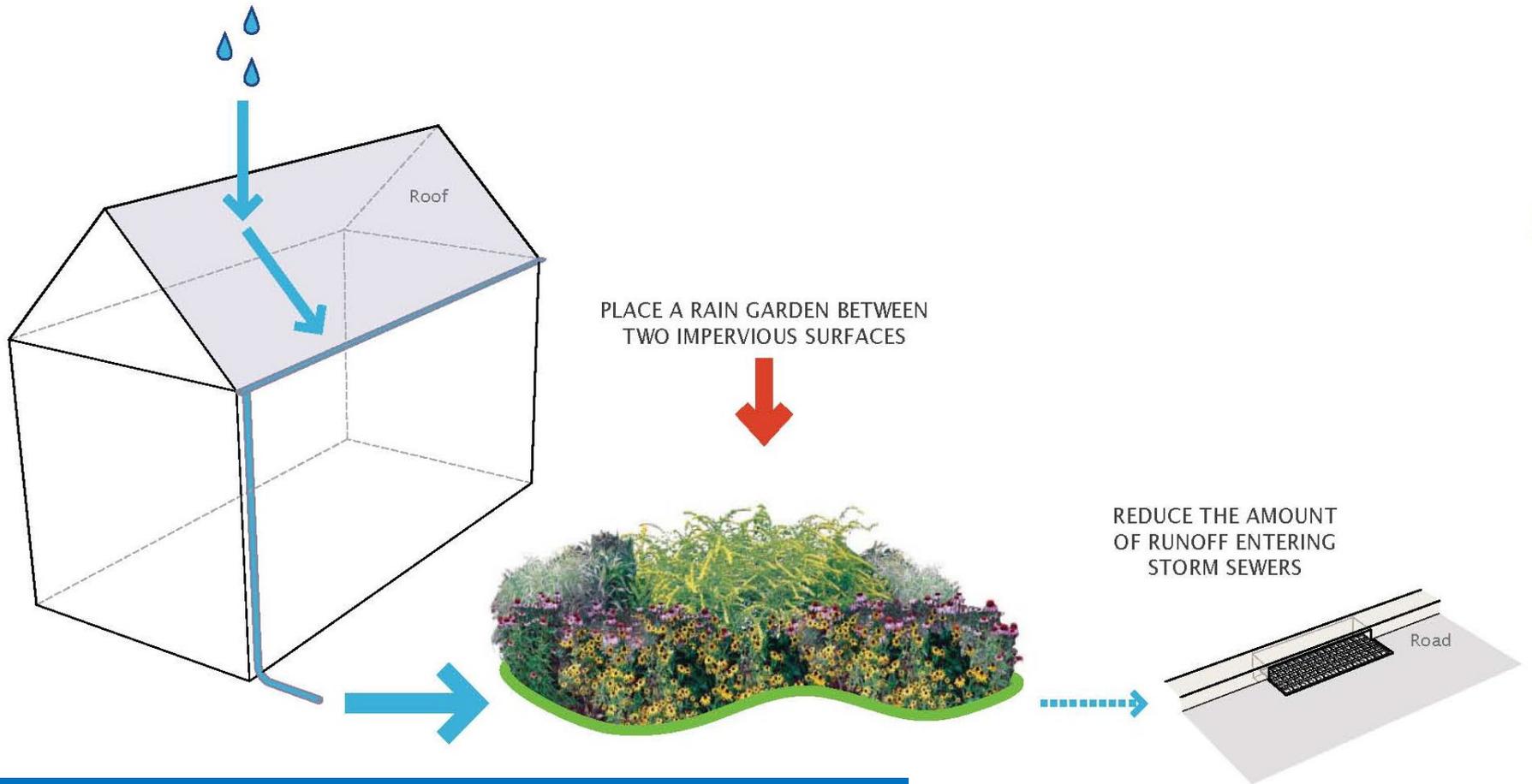






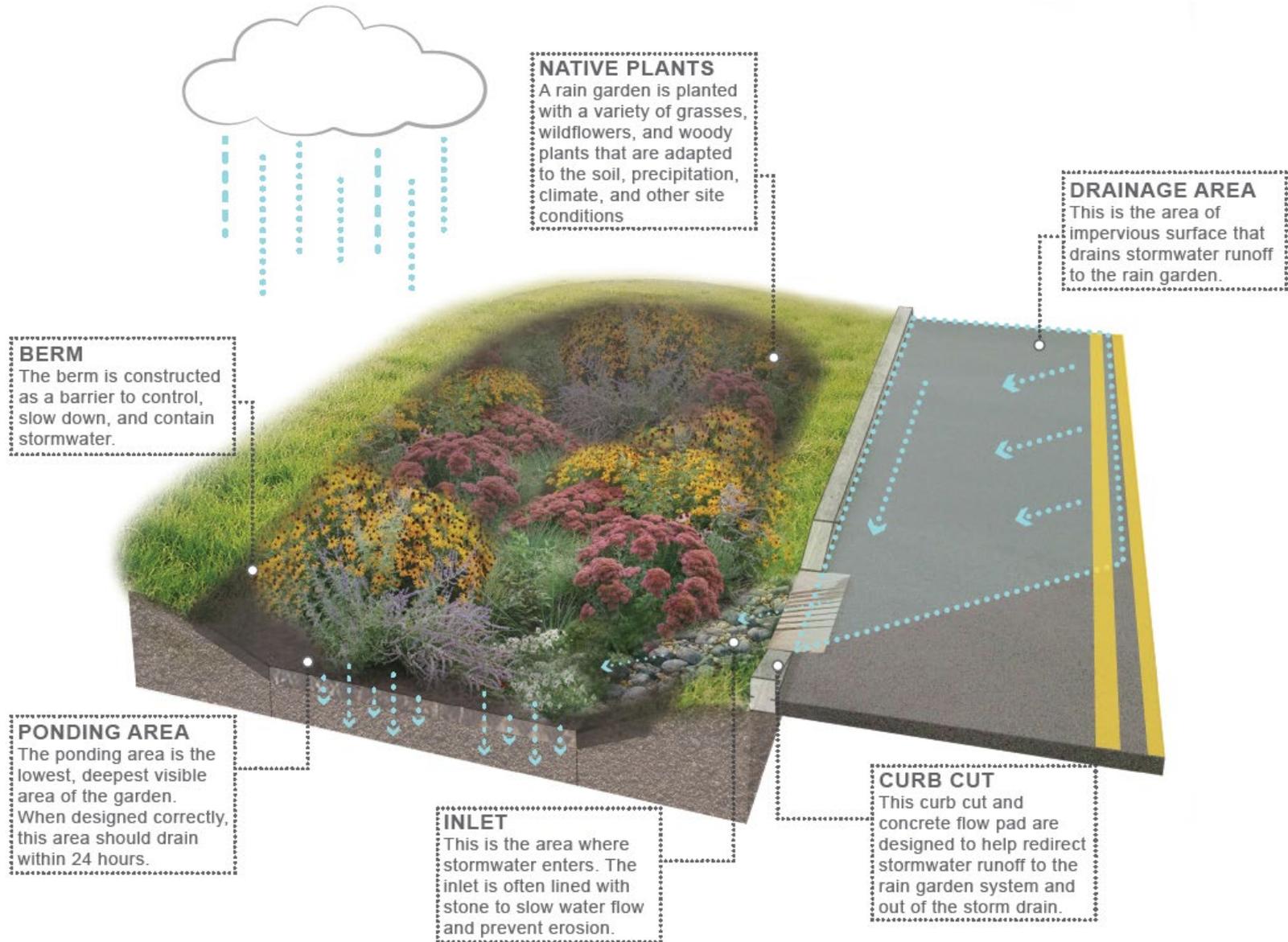


Disconnect to a Rain Garden



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

Bioretention Systems/Rain Gardens



Lots of Rain Gardens









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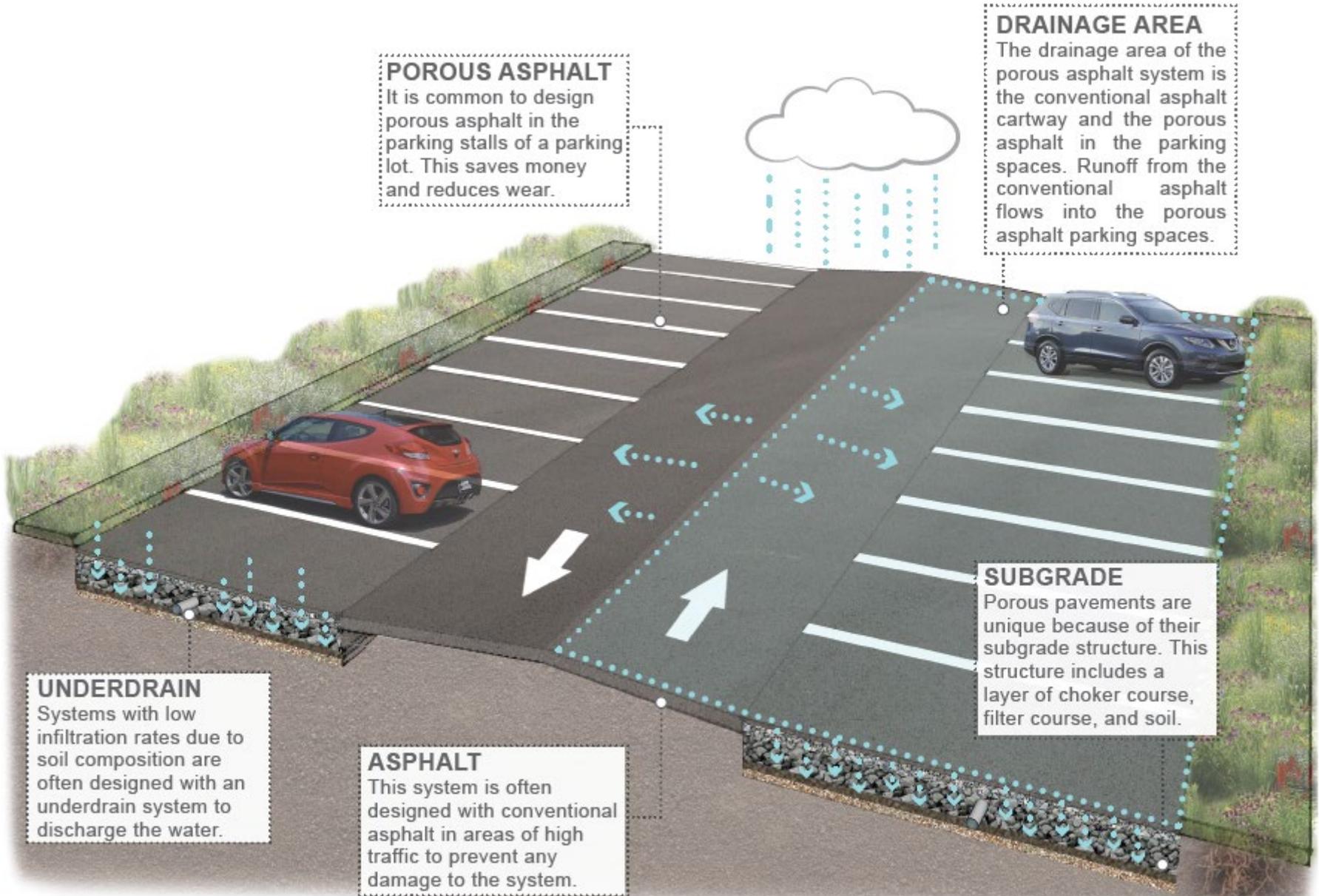
Step 3: Convert to Permeable Pavement

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.



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.

SUBGRADE

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

Permeable Pavements

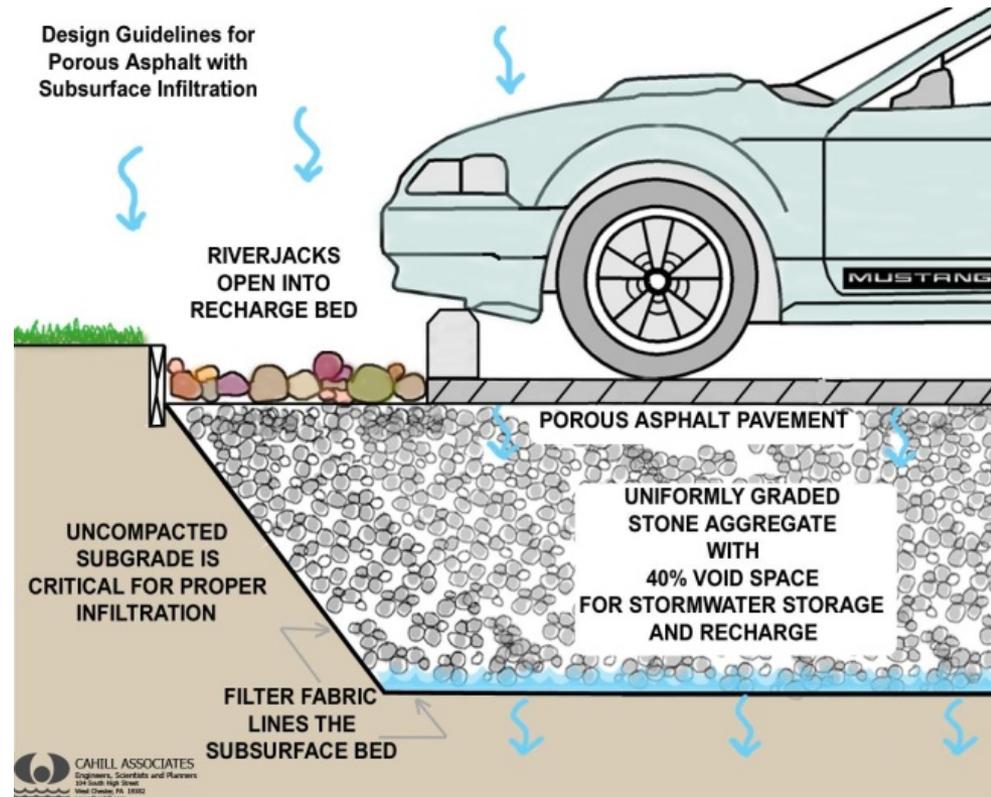
- Underlying stone reservoir
- Porous asphalt and pervious concrete are manufactured without "fine" materials to allow infiltration
- Grass pavers are concrete interlocking blocks with open areas to allow grass to grow
- Ideal application for porous pavement is to treat a low traffic or overflow parking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



Porous Asphalt



A photograph showing a sidewalk made of pervious concrete. The sidewalk is light gray and has a porous, aggregate-like texture. It runs alongside a brick building on the left, which has a metal handrail. To the right of the sidewalk is a concrete curb and an asphalt road. The background features green trees and a clear blue sky.

Pervious Concrete



Permeable Pavers

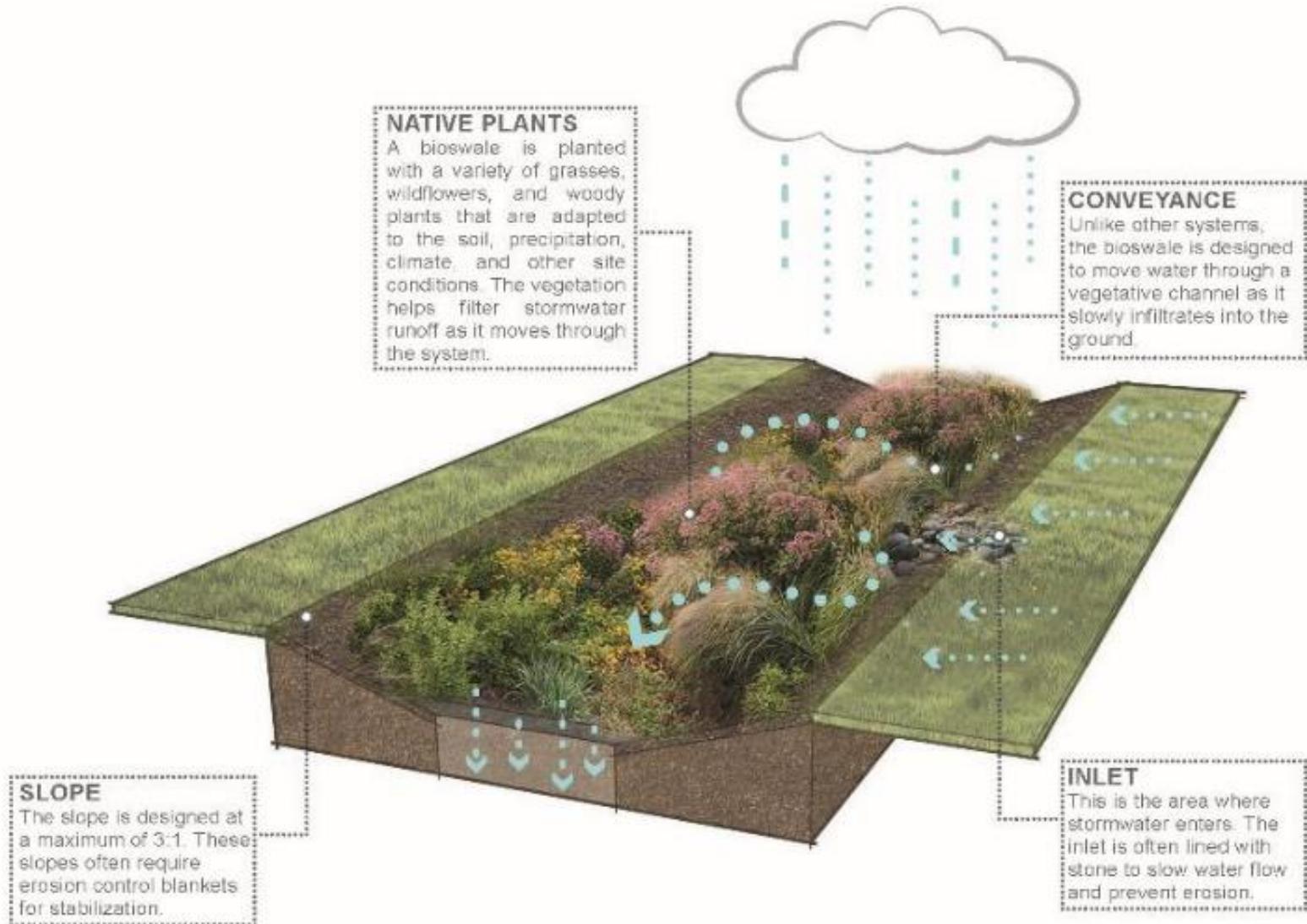
A photograph showing a driveway paved with interlocking concrete grass pavers. The pavers are arranged in a grid pattern, with green grass growing through the openings. The driveway is covered with fallen autumn leaves and some dry grass. In the background, there is a chain-link fence and a dark vehicle parked on the left. The overall scene is outdoors during autumn.

Grass Pavers

Other Green Infrastructure Practices

- Bioswale
- Stormwater Planters
- Green Roofs

BIOSWALE



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

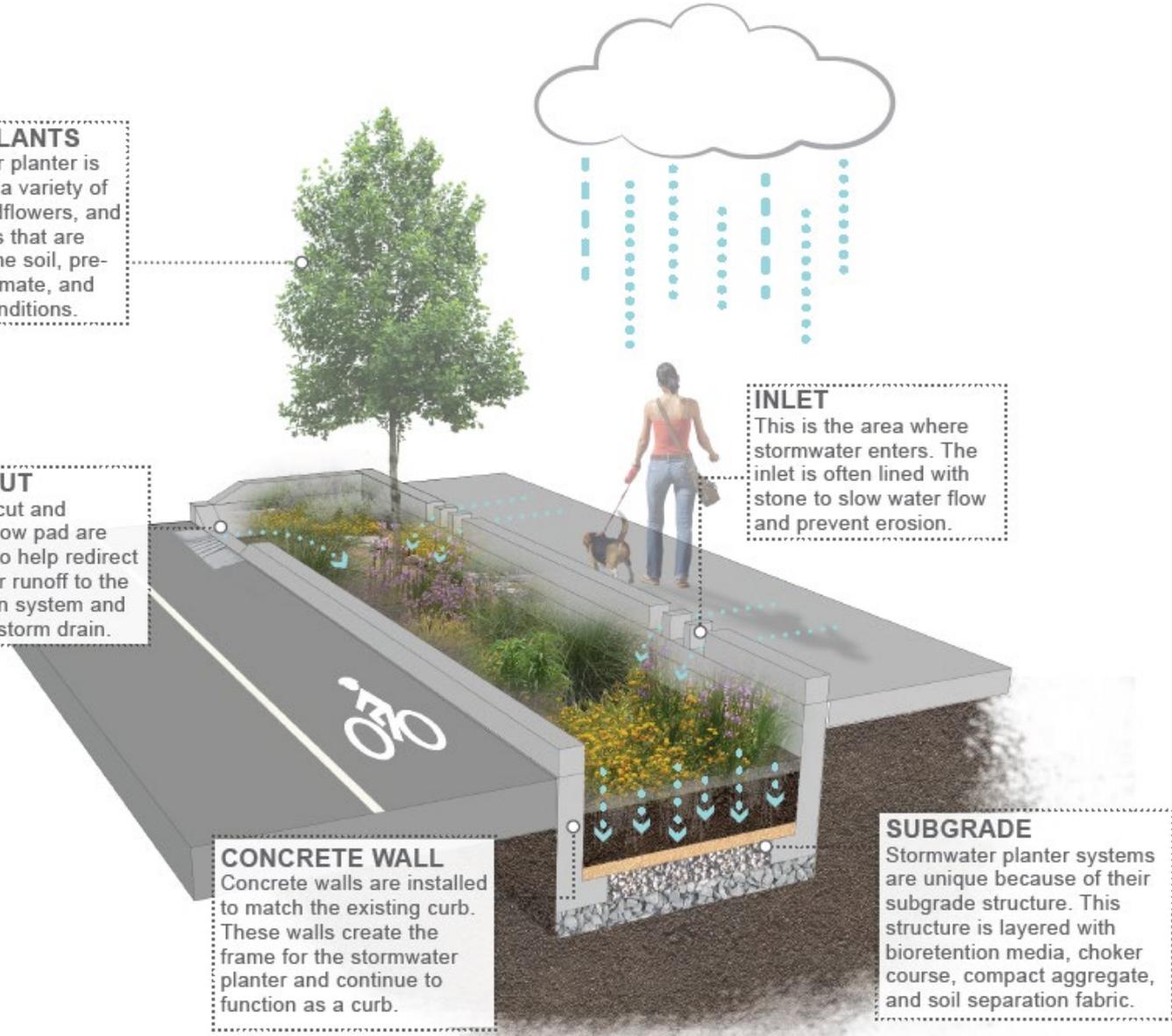
Concrete walls are installed to match the existing curb. These walls create the frame for the stormwater planter and continue to function as a curb.

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.



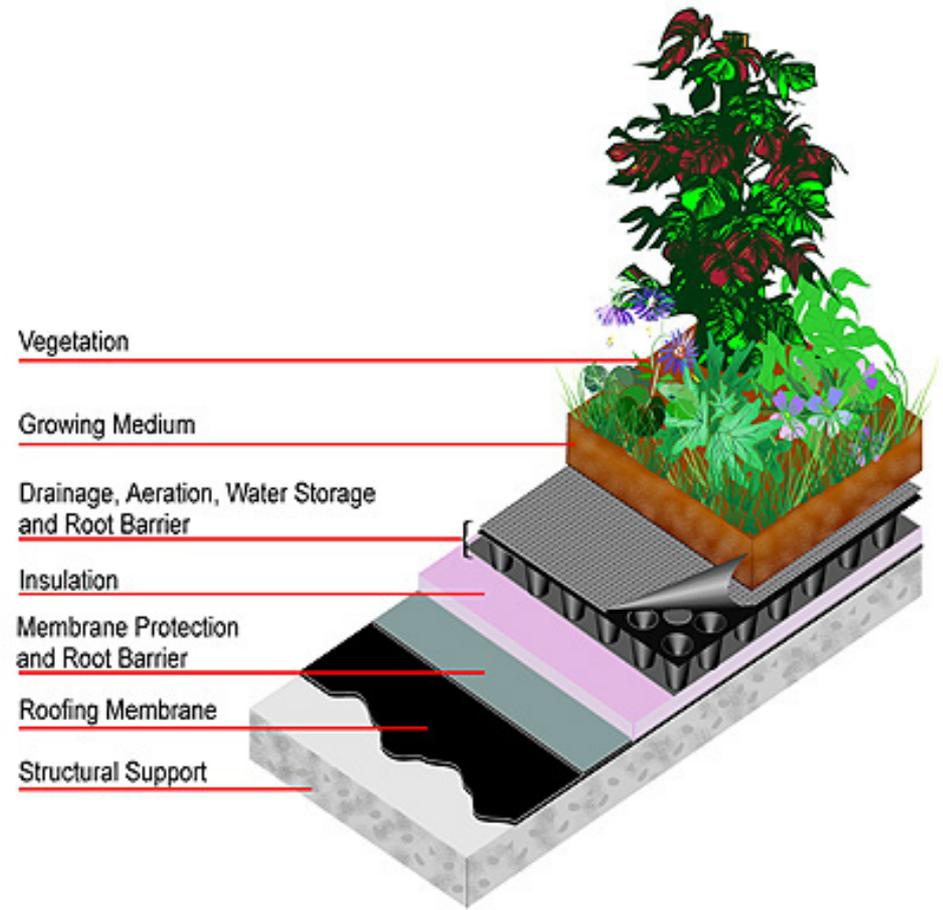


GREEN ROOFS

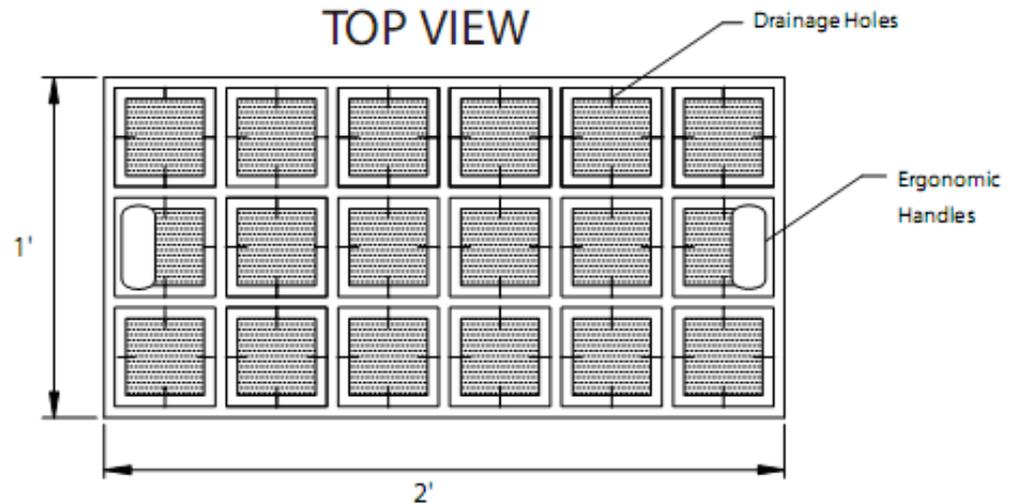
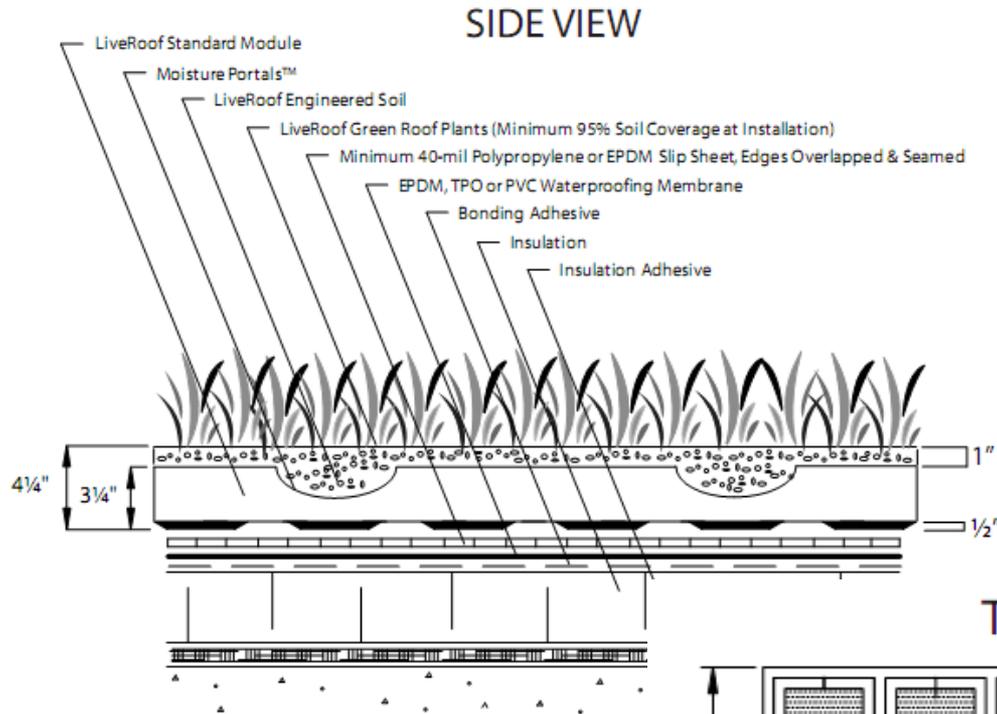
FUNCTIONS

- 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



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

Address: 527 Belleville Avenue, Belleville, NJ 07109



 property line  2015 Aerial: NJOIT, OGIS



1

BELLEVILLE ELEMENTARY SCHOOL #10 (Front of School)



Directly Connected Downspouts



Directly Connected Downspouts



Belleville Elementary School #10



527 Belleville Avenue,
Belleville, NJ 07109



-  bioretention system
-  rainwater harvesting
-  drainage area
-  property line
-  2015 Aerial: NJOIT, OGIS

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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.

| Impervious Cover | | Existing Loads from Impervious Cover (lbs/yr) | | | Runoff Volume from Impervious Cover (Mgal) | |
|------------------|---------|---|------|-------|--|-------------------------------|
| % | sq. ft. | TP | TN | TSS | From the 1.25" Water Quality Storm | For an Annual Rainfall of 44" |
| 66 | 66,110 | 3.2 | 33.4 | 303.5 | 0.052 | 1.81 |

| Recommended Infrastructure Practices | Recharge Potential (Mgal/yr) | TSS Removal Potential (lbs/yr) | Maximum Volume Reduction Potential (gal/storm) | Peak Discharge Reduction Potential (cu. ft./second) | Estimated Size (sq. ft.) | Estimated Cost |
|--------------------------------------|------------------------------|--------------------------------|--|---|---------------------------|----------------|
| Bioretention system | 0.098 | 16 | 7,532 | 0.28 | 960 | \$4,800 |
| Rainwater harvesting | 0.060 | 10 | 4,600 | 0.17 | 5,000 (gal) | \$10,000 |



"Protecting Public Health and the Environment"

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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!

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Our green infrastructure initiative in urban centers focuses on capturing stormwater with cost-effective practices before it enters the combined sewer systems.

ABOUT Us

Rutgers Cooperative Extension
Water Resources Program

G.H. Cook Campus
14 College Farm Road
New Brunswick, NJ 08901

www.water.rutgers.edu

~Creating Solutions for
Water Resources Issues in New Jersey~

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

NEWS

- [In the News - October 3, 2017](#)
- [SEBS/NJAES Newsroom](#)

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Projects & Programs

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|--|--|
| Agricultural Watershed Planning & Implementation | Municipal/Community Training |
| Green Infrastructure Program | Rain Gardens & Rain Barrels |
| Keep the Rain from the Drain ~ Impervious Cover Reduction Program | Watershed Planning & Implementation |
| Municipal Stormwater Management | |

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 Cohansey River Watershed](#)
- [Upper Cohansey River Watershed Agricultural Mini-Grant Program](#)
- [Watershed Restoration Plan for the Upper Salem River Watershed](#)
- [Upper Salem River Watershed Agricultural Mini-Grant Program](#)

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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](#)

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](#)

HUNTERDON COUNTY**Delaware Twp**

- *ICA*
- *RAP*
- *RAP web map*

Franklin Twp

- *ICA*
- *RAP*
- *RAP web map*

East Amwell Twp

- *ICA*
- *RAP*
- *RAP web map*

Raritan Twp

- *ICA*
- *RAP*
- *RAP web map*

Flemington Boro

- *ICA*
- *RAP*
- *RAP web map*

Readington Twp

- *ICA*
- *RAP*
- *RAP web map*

MIDDLESEX COUNTY**Dunellen Boro**

- *ICA*
- *RAP*
- *RAP web map*

North Brunswick Twp

- *ICA*
- *RAP*
- *RAP web map*

NEW JERSEY HIGHLANDS WATERSHED CLUSTER**Alpha**

- *ICA*
- *RAP*
- *RAP web map*
- *Feasibility Study*

Lopatcong

- *ICA*
- *RAP*
- *RAP web map*
- *Feasibility Study*

Branchville

- *ICA*
- *RAP*
- *RAP web map*
- *Feasibility Study*

Mount Arlington

- *ICA*
- *RAP*
- *RAP web map*
- *Feasibility Study*

Greenwich

- *ICA*
- *RAP*
- *RAP web map*
- *Feasibility Study*

Mount Olive

- *ICA*
- *RAP*
- *RAP web map*
- *Feasibility Study*

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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)

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E-learning Tools

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- *Asking the Right Questions in Stormwater Review* (April, 2015)
- *Understanding Your Impervious Cover Assessment (ICA) Report* (March, 2015)

Quality of Life Issues

POLLUTION

FLOODING

EROSION

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

Staff to Contact

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

Staff to Contact

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



QUESTIONS?

**The great aim of education is
not knowledge but action.**

- Herbert Spencer