RUTGERS
THE STATE UNIVERSITY
OF NEW JERSEY

Climate Resilient Municipalities: Controlling Stormwater, Protecting Streams & Maintaining Water Quality

Presented at the Watershed Tools for Local Leaders Seminar in Bedminster, NJ

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WILLIAM PENN
FOUNDATION

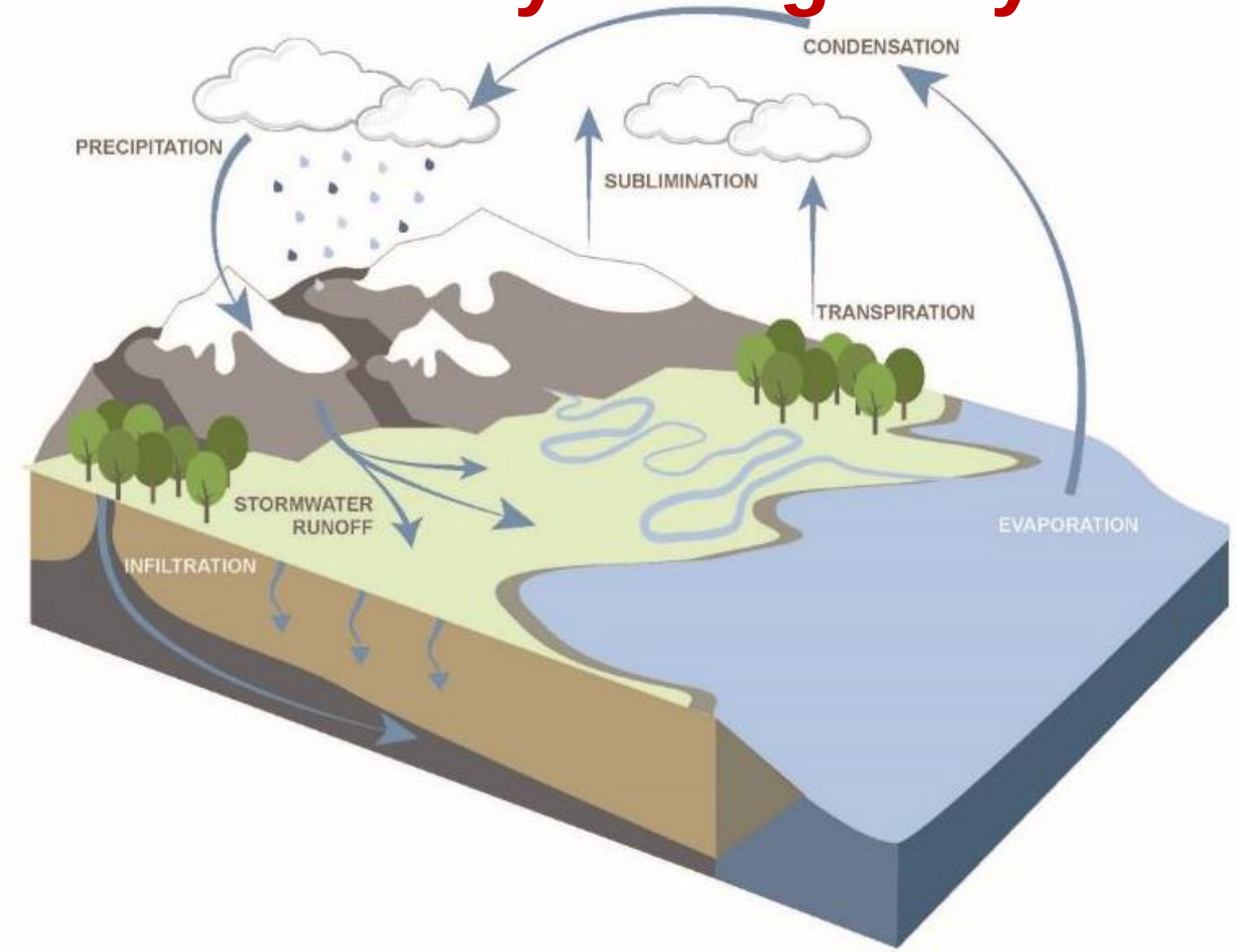
Rutgers Cooperative Extension

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.

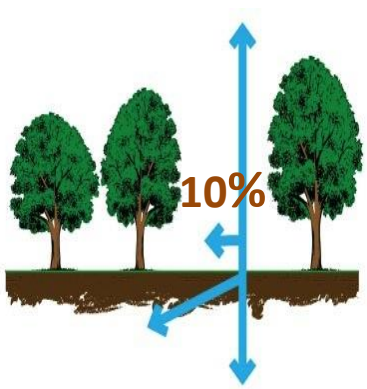
Water Resources Program

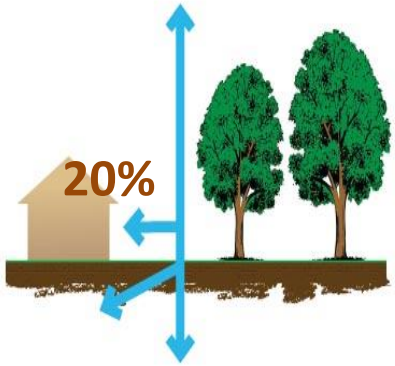
Our Mission is to identify and address community water resources issues using sustainable and practical science-based solutions.

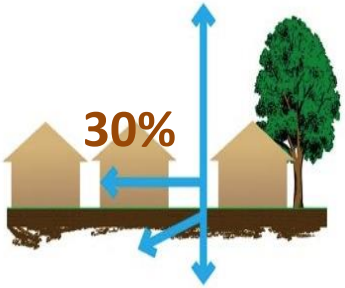
The Natural Hydrologic Cycle



The Impact of Development on Stormwater Runoff

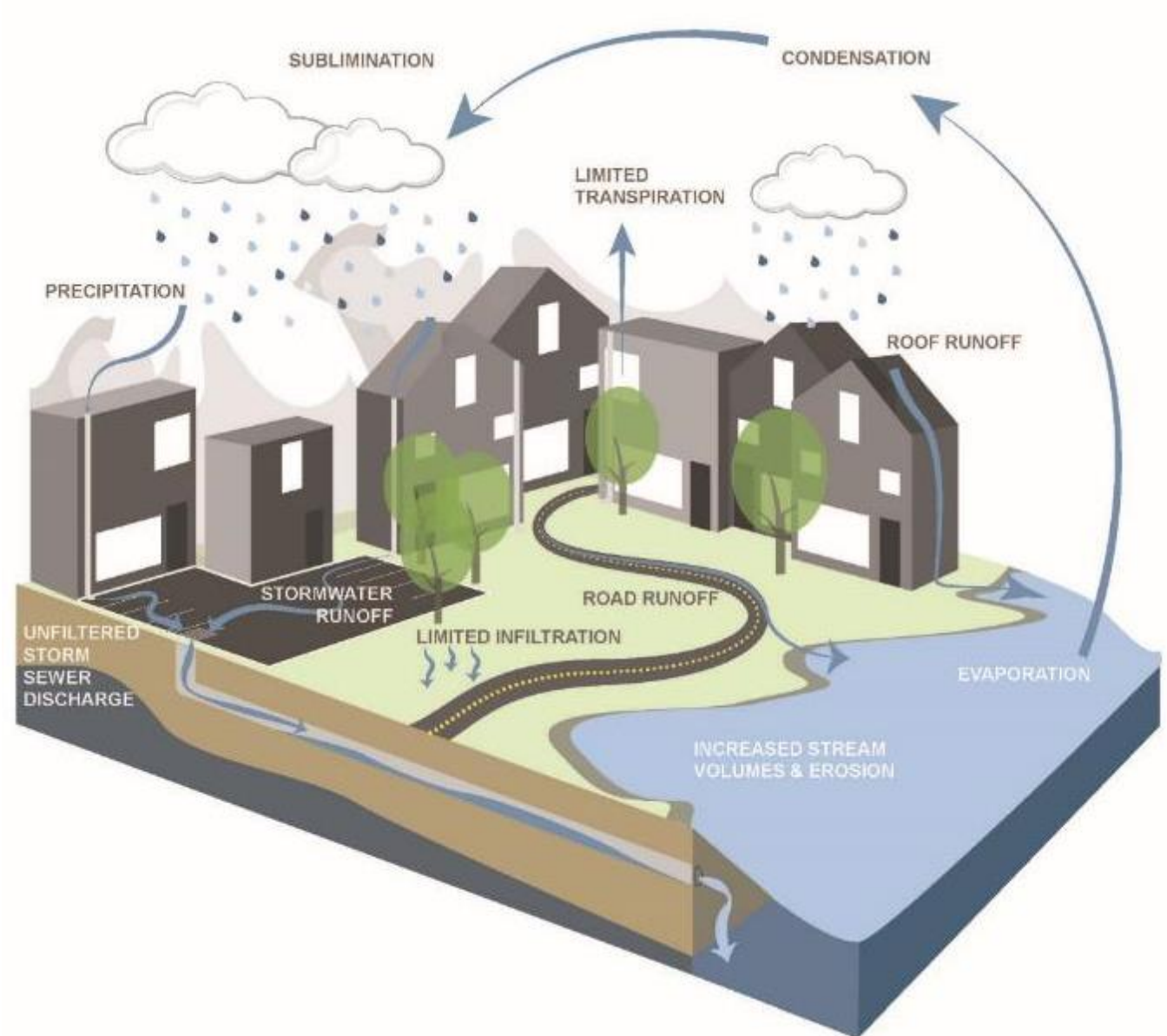




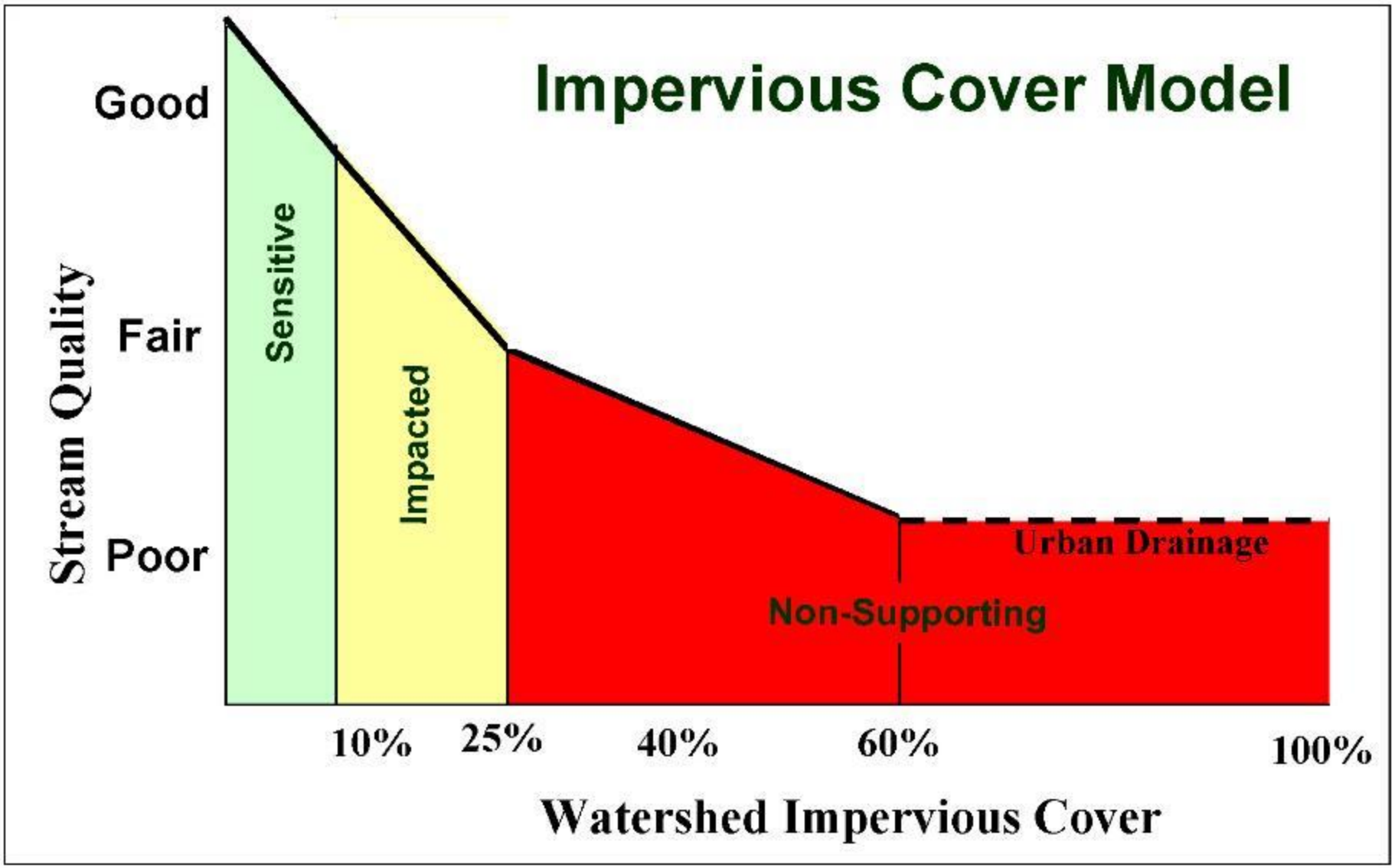


More development → *More impervious surfaces* → *More stormwater runoff*

The Urban Hydrologic Cycle



Original ICM developed based on 200+ reports and papers



Reference: Tom Schueler and Lisa Fraley-McNeal, Symposium on Urbanization and Stream Ecology, May 23 and 24, 2008

How are we dealing with these issues?

- Municipal Separate Storm Sewer System (MS4) Permit
- New Jersey Stormwater Management Regulations (N.J.A.C. 7:8)
  - Municipal Stormwater Management Plan
  - Municipal Stormwater Control Ordinance
  - Stormwater Mitigation Plan
- Clean Stormwater and Flood Reduction Act

MS4 Permit

- Municipal Separate Storm Sewer System (MS4)
- All NJ municipalities have MS4 permits
- General Permit for Tier A, Tier B, Public Complexes, and Highway Agencies
- EPA Requirement

MS4 Permit …

requires municipalities to develop and implement a program to reduce discharges of pollutants entering our waters from stormwater systems to the maximum extent practical.

Stormwater Management Regulations N.J.A.C. 7:8

- Sets forth stormwater management goals for new development:
  - Reduce flood damage
  - Reduce soil erosion
  - Protect public safety through proper design and operation of stormwater management basins
  - Minimize increases in peak runoff
  - Maintain groundwater recharge
  - Protect water quality
- Sets forth the required components of regional and municipal stormwater management plans

Stormwater Management Key Objectives

- Use nonstructural management strategies
- Protect communities from increases in stormwater volume and peak flows as a result of new development
- Maintain groundwater recharge
- Protect waterways from pollution carried in stormwater runoff

NJ.com, August 28, 2011

The approval of a developer's stormwater management plans lies **solely** with the municipality.

Clean Stormwater and Flood Reduction Act

- Authorizes municipalities, counties, and certain authorities to establish stormwater utilities
- Recognizes problems due to inadequate stormwater infrastructure and management
- These problems affect the health, safety, economic well-being, and quality of life of New Jersey residents
- Recognizes that stormwater infrastructure in New Jersey lacks a dedicated source of funding for upgrades and maintenance
- Allows stormwater utilities to assess fees that are based on a fair and equitable approximation of the proportionate contribution of stormwater runoff from real property

Clean Stormwater and Flood Reduction Act

- The Act encourages the use of green infrastructure, where appropriate, required to help decrease pollutant loads and runoff volumes to receiving waters.

Bottom Line: Stormwater Utility will focus on:

- Maintaining and repairing existing stormwater infrastructure
- Constructing new stormwater infrastructure

Green Infrastructure

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

Green Infrastructure projects:

- capture
- filter
- absorb
- reuse

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

Green Infrastructure includes:

- green roofs
- rainwater harvesting
- tree filter/planter boxes
- rain gardens/bioretention systems
- permeable pavements
- vegetated swales or bioswales
- natural retention basins
- trees & urban forestry
- green streets








Parker Urban Greenscapes. 2009.

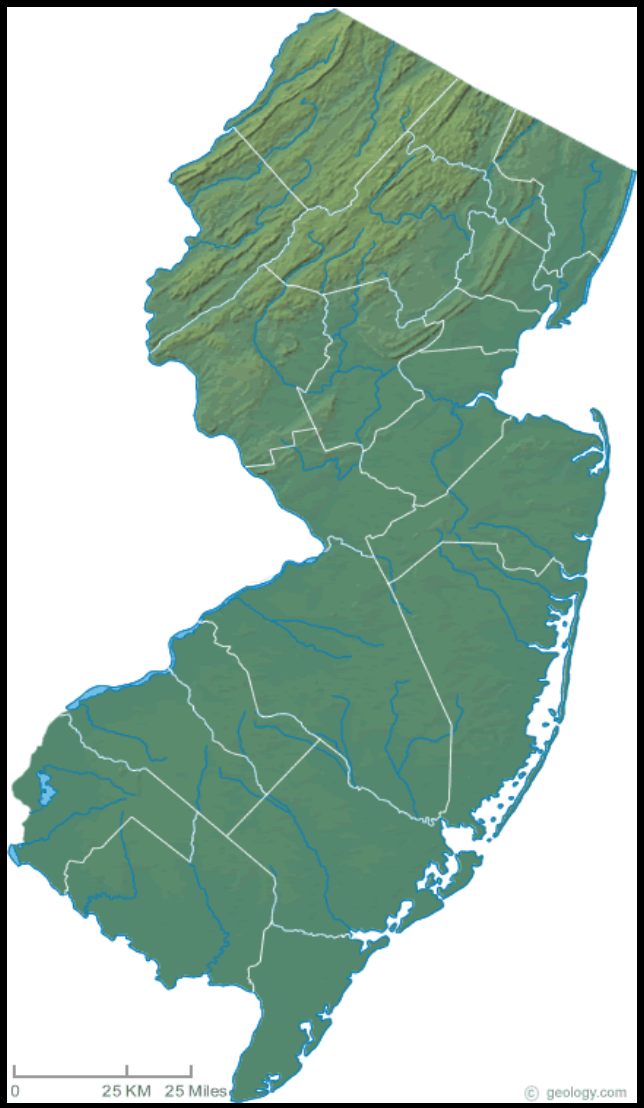
New Jersey Proposed Stormwater Management Regulations

Green Infrastructure will be required for all major development to satisfy the non-structural stormwater management requirements.

Climate change … it's real, it's happening now, and it's affecting New Jersey.

Climate Change in New Jersey

- More warm extremes and fewer cold extremes
- Heavy rains become more intense
- More frequent dry spells
- Rising sea level with increased frequency and intensity of coastal flooding




STOP
4-WAY

NOW WHAT?

- Reduce carbon emissions
- Convert to alternative sustainable fuels (solar and wind)
- Pray
- Manage stormwater runoff more effectively using sustainable practices
- Only through cooperative and collaborative partnership will be successful

Eliminate it !

Disconnect it !

Change it !

Reuse it !

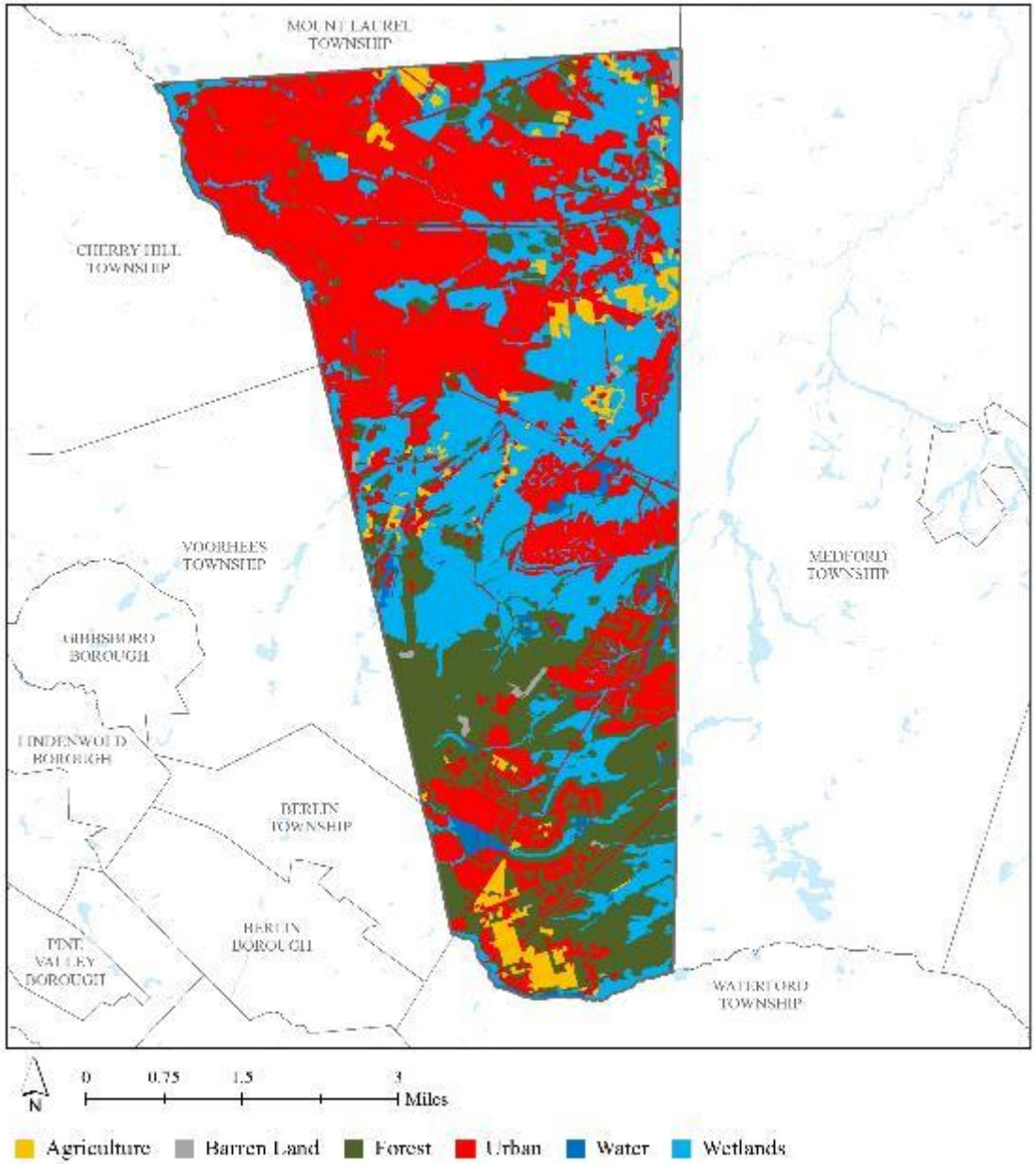
It's all about managing impervious surfaces

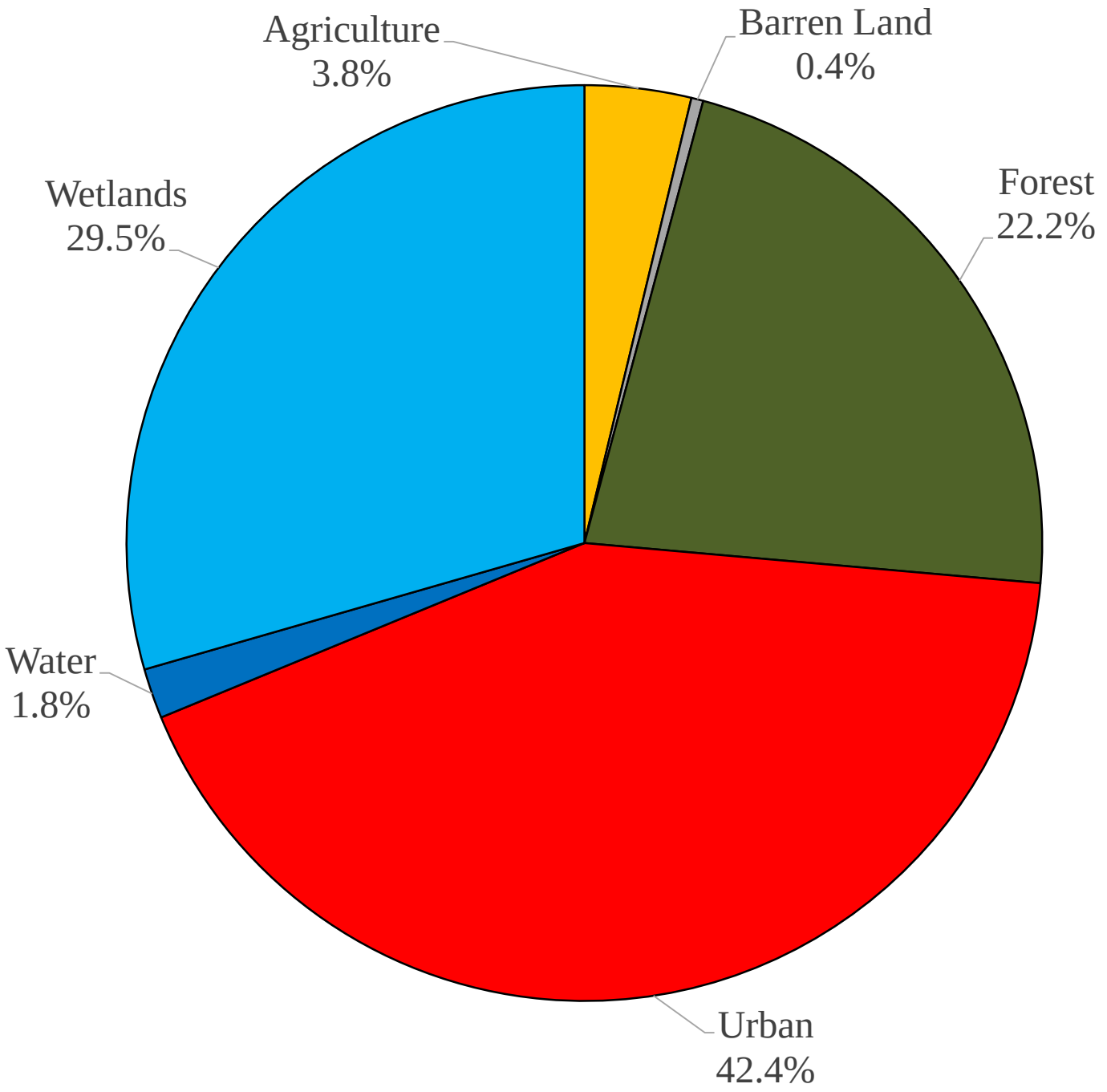
Impervious Cover Assessment (ICA)

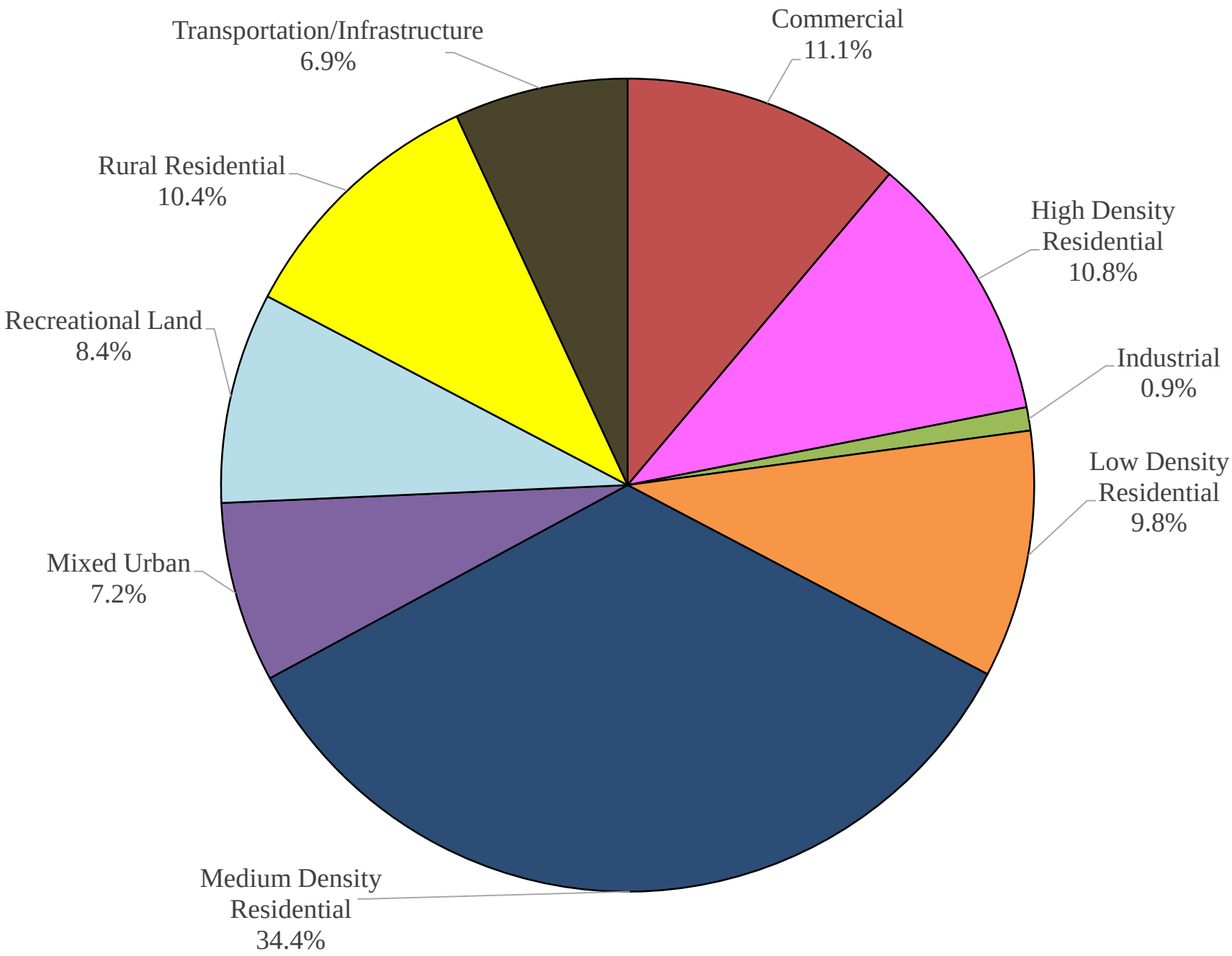
Impervious Cover Assessment

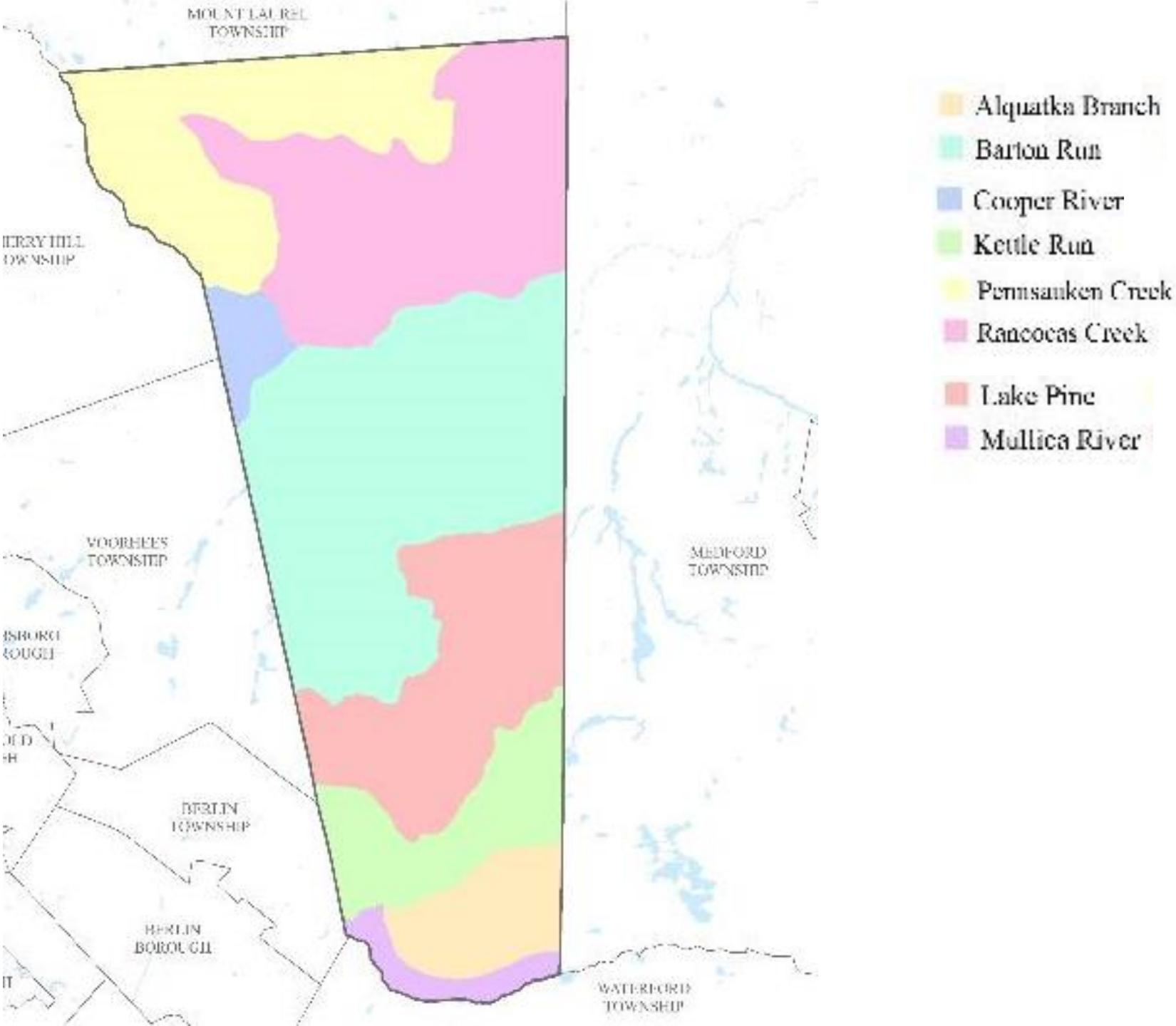
- Analysis completed by watershed and by municipality
- Use 2012 Land Use data to determine impervious cover
- Calculate runoff volumes for water quality, 2, 10 and 100 year design storm and annual rainfall
- Contain three concept designs

Subwatersheds of Evesham Township

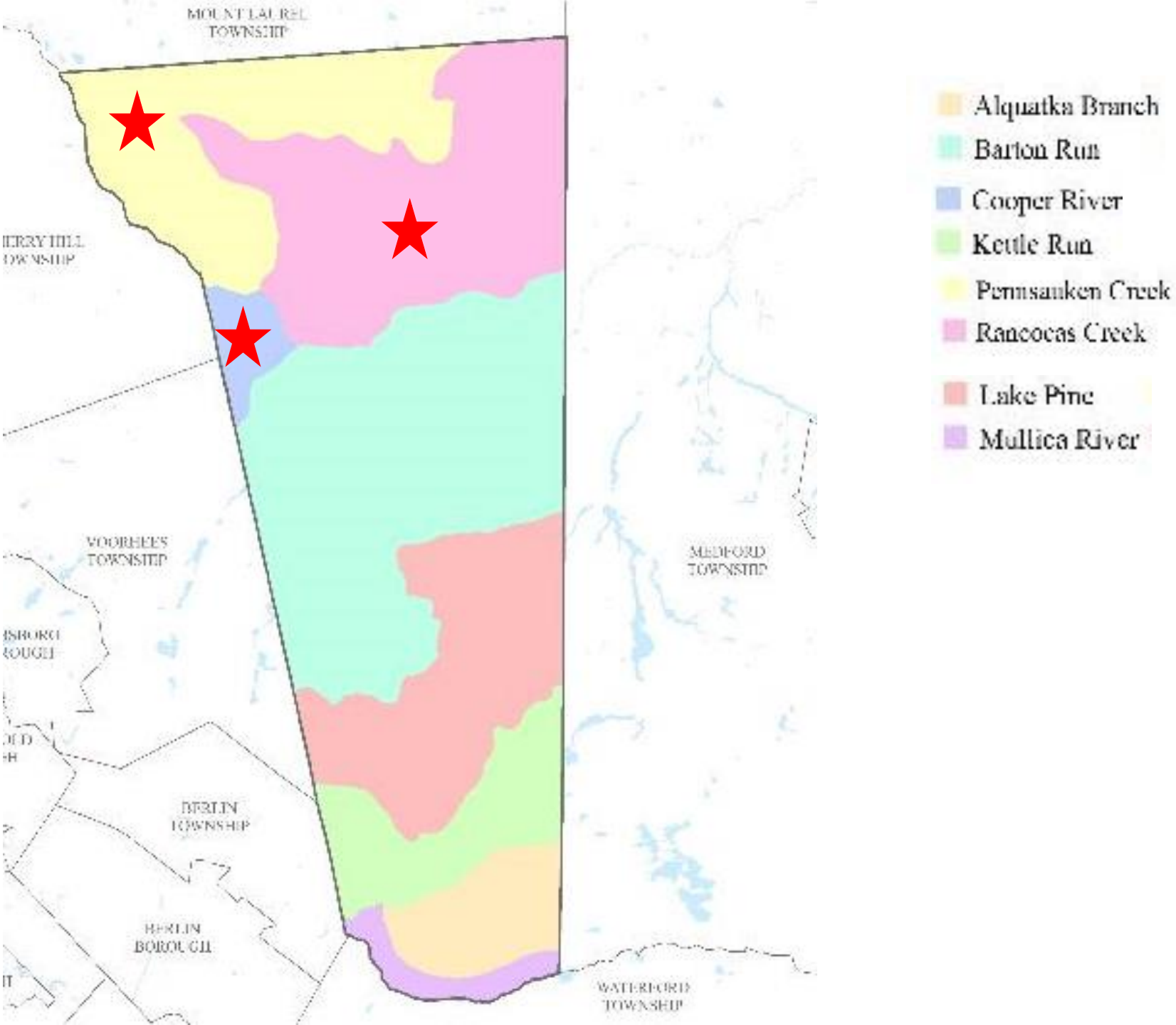



Agriculture
3.8%
Barren Land
0.4%
Forest
22.2%
Wetlands
29.5%
Water
1.8%
Urban
42.4%


Transportation/Infrastructure
6.9%
Commercial
11.1%
Rural Residential
10.4%
High Density
Residential
10.8%
Recreational Land
8.4%
Industrial
0.9%
Low Density
Residential
9.8%
Mixed Urban
7.2%
Medium Density
Residential
34.4%


MOUNT LAUREL TOWNSHIP
VOORHEES TOWNSHIP
MEDFORD TOWNSHIP
BERLIN TOWNSHIP
BERLIN BOROUGH
WATERFORD TOWNSHIP
Alquatka Branch
Barton Run
Cooper River
Kettle Run
Pennsauken Creek
Rancocas Creek
Lake Pine
Mullica River

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%


MOUNT LAUREL TOWNSHIP
VOORHEES TOWNSHIP
MEDFORD TOWNSHIP
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Pennsauken Creek
Rancocas Creek
Lake Pine
Mullica River

Subwater-shed	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

WE LOOK HERE FIRST:

- ✓Schools
- ✓House of Worship
- ✓Libraries
- ✓Municipal Building
- ✓Public Works
- ✓Firehouses
- ✓Post Offices
- ✓Elks or Moose Lodge
- ✓Parks/ Recreational Fields

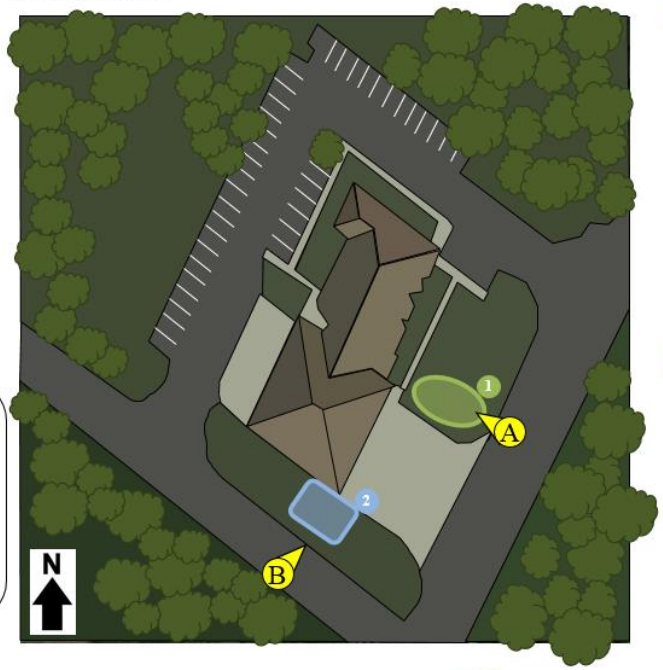
- 20 to 40 sites are entered into a PowerPoint
- Site visits are conducted

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

RUTGERS
New Jersey Agricultural Experiment Station

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.

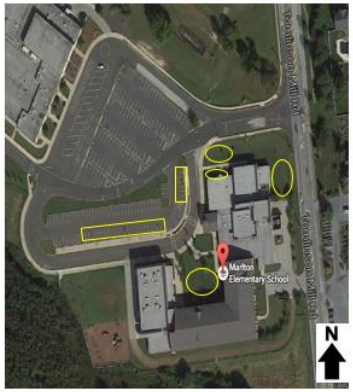
1 BIORETENTION SYSTEM

2 RAINWATER HARVESTING SYSTEM

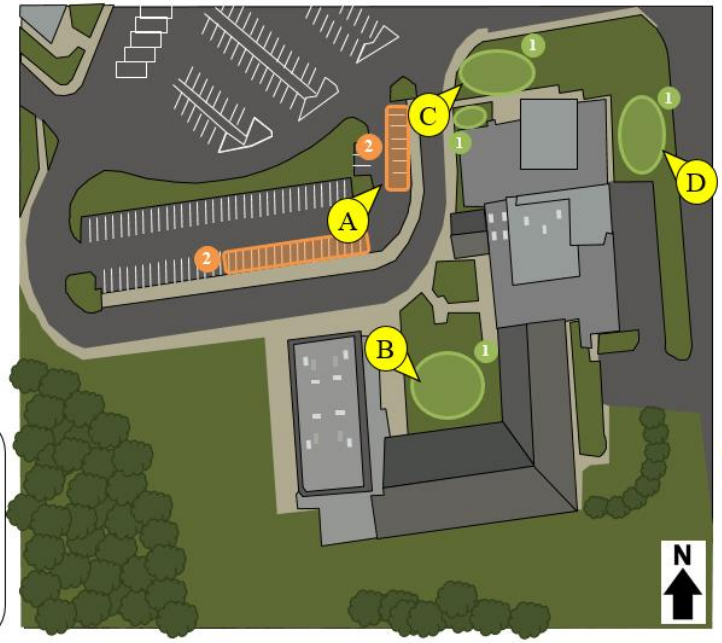
Evesham Township
Impervious Cover Assessment
Marlton Elementary School, 190 Tomlinson Mill Road

RUTGERS
New Jersey Agricultural Experiment Station

PROJECT LOCATION:



SITE PLAN:

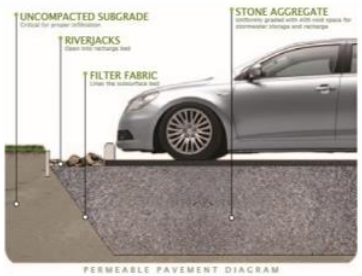


1 **BIORETENTION SYSTEM:** On this property rain gardens can be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. There are opportunities to install rain gardens near entrances to the school.

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

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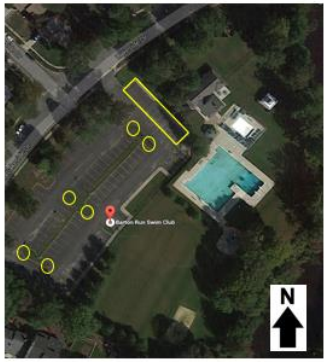
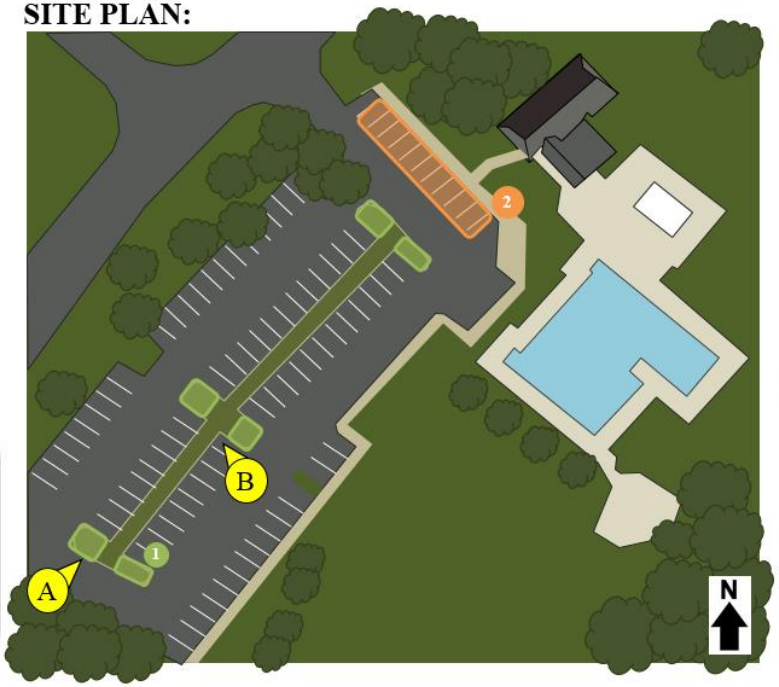
Evesham Township
Impervious Cover Assessment
Barton Run Swim Club, 100 Lakeside Drive

RUTGERS
New Jersey Agricultural Experiment Station

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.

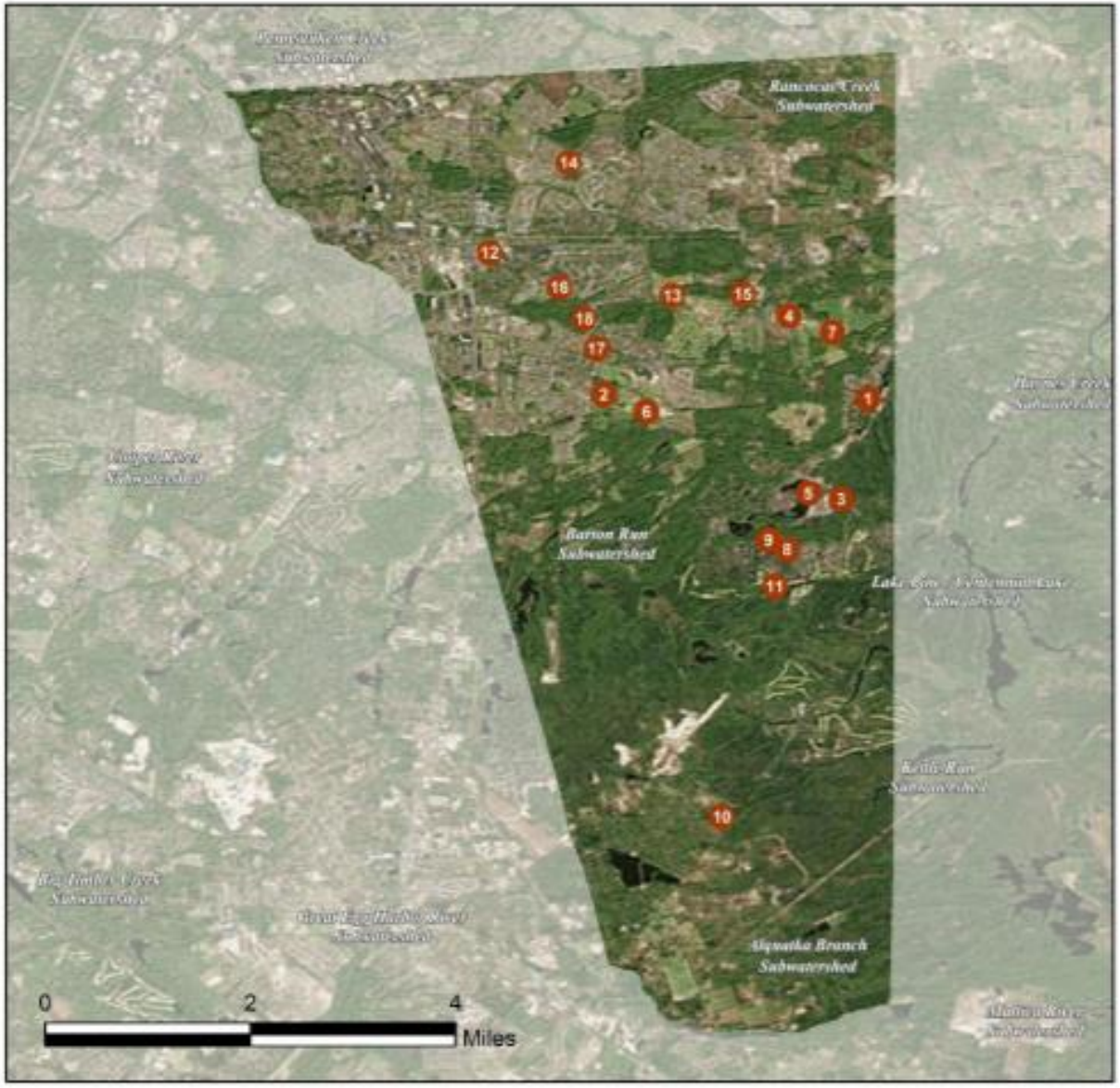
2 **POROUS PAVEMENT:** Parking spaces close to the pool house can be converted to porous asphalt. Porous pavement promotes groundwater recharge and filters stormwater.

1 BIORETENTION SYSTEM

2 POROUS PAVEMENT

Impervious Cover Reduction Action Plan (RAP)

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

BARTON RUN SWIM CLUB

Subwatershed: Barton Run

Site Area: 169,977 sq. ft.

Address: 100 Lakeside Drive
Marlton, NJ 08053

Block and Lot: Block 44.3, Lot 16

Stormwater is currently directed to an existing catch basin. Installing rain gardens in the parking lot islands can capture, treat, and infiltrate stormwater runoff from the parking lot. Replacing parking spaces with porous pavement can capture and infiltrate runoff from the other side of the parking lot. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability 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"
30	51,770	2.5	26.1	237.7	0.040	1.42

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	0.288	48	21,834	0.82	2,765	$13,825
Pervious pavement	0.352	59	26,651	1.00	2,410	$60,250

GREEN INFRASTRUCTURE RECOMMENDATIONS

Barton Run Swim Club

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

0 50' 100'

Green Infrastructure Feasibility Study

WHAT IS GREEN INFRASTRUCTURE?

Green infrastructure is an approach to stormwater management that is cost-effective, sustainable, and environmentally friendly. Green infrastructure projects capture, filter, absorb, and reuse stormwater to maintain or mimic natural systems and to treat runoff as a resource. As a general principle, green infrastructure practices use soil and vegetation to recycle stormwater runoff through infiltration and evapotranspiration. When used as components of a stormwater management system, green infrastructure practices such as bioretention, green roofs, porous pavement, rain gardens, and vegetated swales can produce a variety of environmental benefits. In addition to effectively retaining and infiltrating rainfall, these technologies can simultaneously help filter air pollutants, reduce energy demands, mitigate urban heat islands, and sequester carbon while also providing communities with aesthetic and natural resource benefits (USEPA, 2013).

A community garden that harvests and recycles rainwater

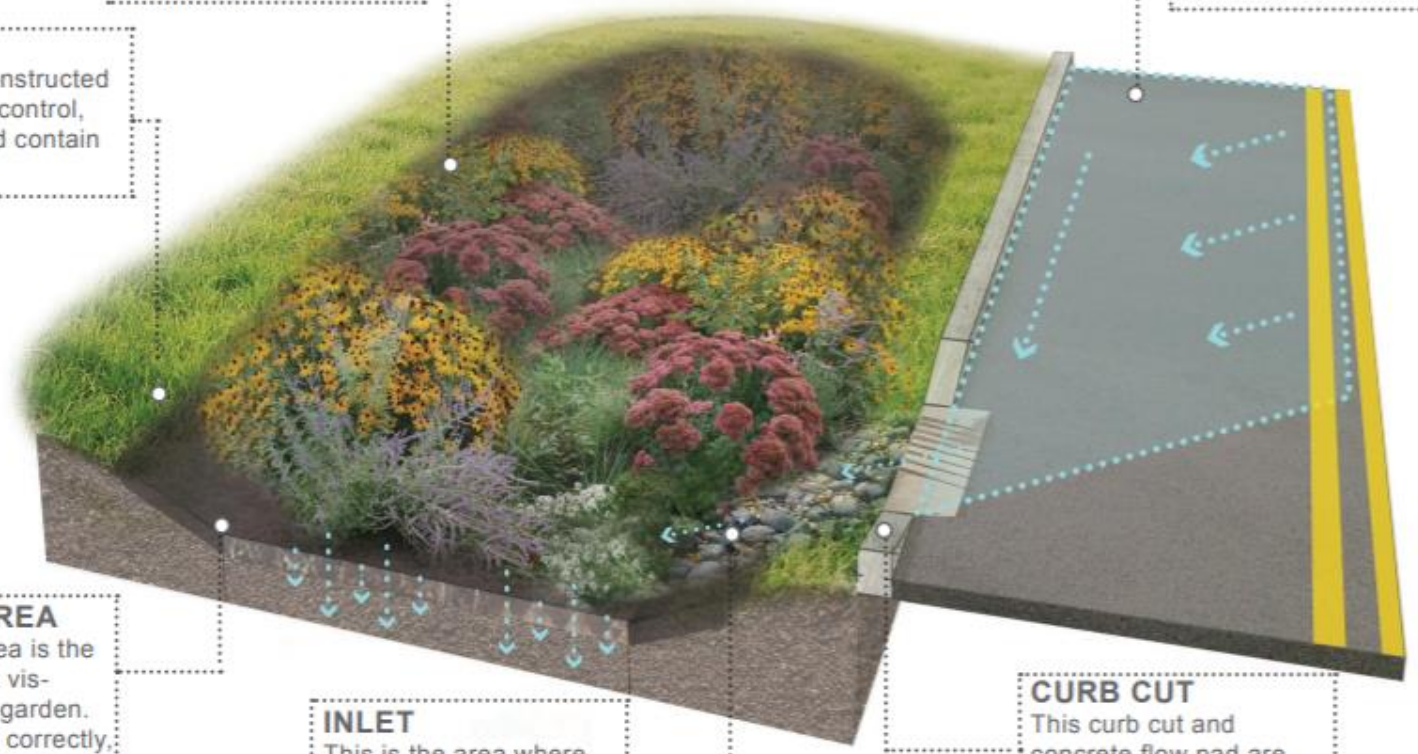
Rain barrel workshop participants

A rain garden after planting

BIORETENTION SYSTEMS

A rain garden, or bioretention system, is a landscaped, shallow depression that captures, filters, and infiltrates stormwater runoff. The rain garden removes nonpoint source pollutants from stormwater runoff while recharging groundwater. A rain garden serves as a functional system to capture, filter, and infiltrate stormwater runoff at the source while being aesthetically pleasing. Rain gardens are an important tool for communities and neighborhoods to create diverse, attractive landscapes while protecting the health of the natural environment. Rain gardens can also be installed in areas that do not infiltrate by incorporating an underdrain system.

Rain gardens can be implemented throughout communities to begin the process of re-establishing the natural function of the land. Rain gardens offer one of the quickest and easiest methods to reduce runoff and help protect our water resources. Beyond the aesthetic and ecological benefits, rain gardens encourage environmental stewardship and community pride.



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 is captured in the rain garden system.

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.

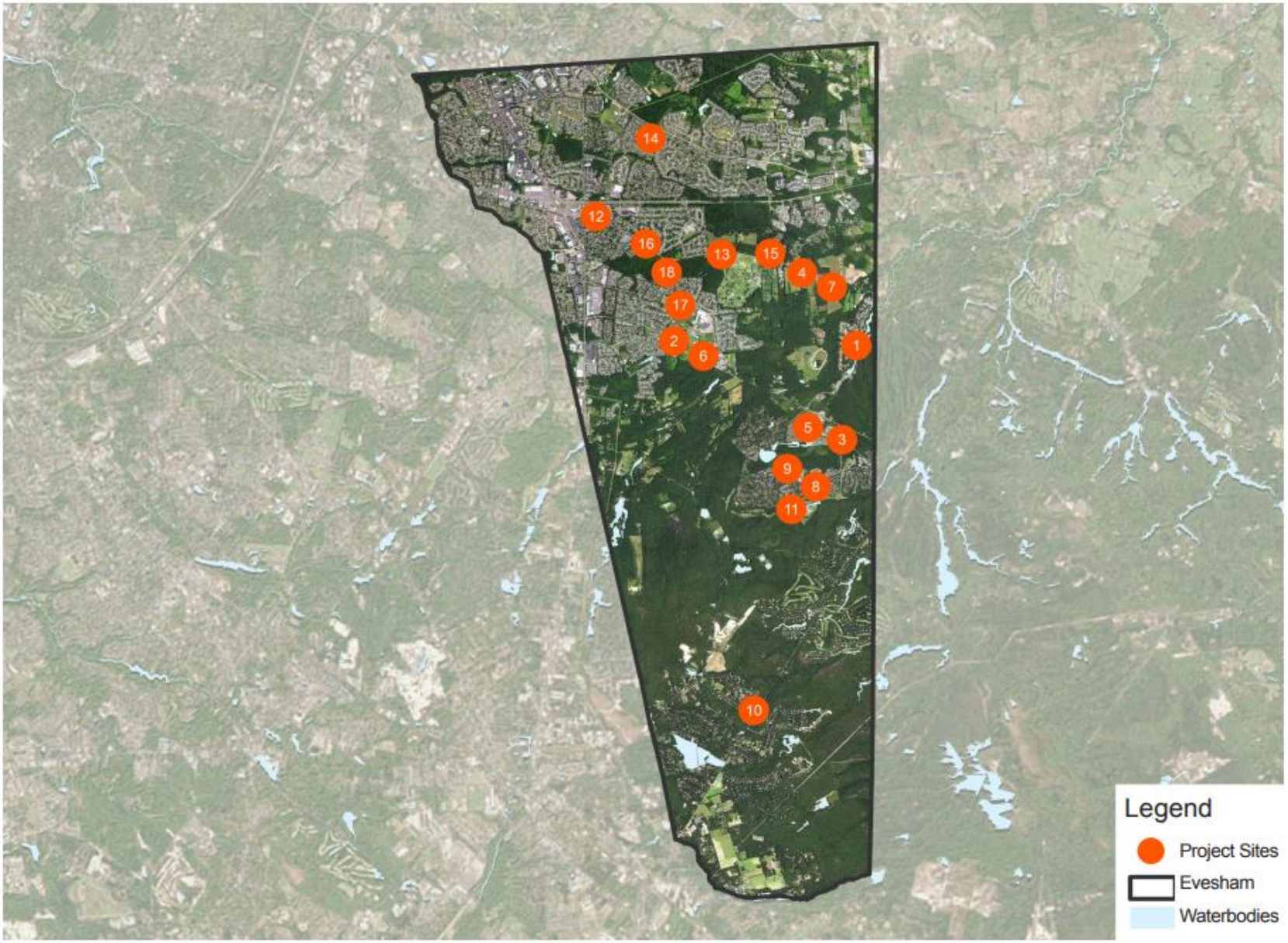
INLET
This is the area where stormwater enters. The inlet is often lined with stone to slow water flow and prevent erosion.

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.

POTENTIAL PROJECT SITES WITHIN STUDY AREA

Site	Name	Address	Page #
1	Barton Run Swim Club *	100 Lakeside Drive, Marlton, NJ 08053	40
2	Cherokee High School	120 Tomlinson Mill Road, Marlton, NJ 08053	44
3	Evesham Fire/Rescue 223/227	150 Merchants Way, Marlton, NJ 08053	46
4	Evesham Township Municipal Court	984 Tuckerton Road, Marlton, NJ 08053	48
5	King's Grant Community Room	50 Landings Drive, Marlton, NJ 08053	50
6	Marlton Elementary School *	190 Tomlinson Mill Road, Evesham, NJ 08053	52
7	Memorial Park	1004 Tuckerton Road, Marlton, NJ 08053	56
8	Richard L. Rice Elementary School	50 Crown Royal Parkway, Marlton, NJ 08053	58
9	Villa Royal Association	5 Crown Royal Parkway, Marlton, NJ 08053	60
10	Kettle Run Fire/Rescue 225/228 *	498 Hopewell Road, Marlton, NJ 08053	62
11	Links Golf Course	100 Majestic Way, Marlton, NJ 08053	66
12	Evesham Fire/Rescue 221/229	26 East Main Street, Marlton, NJ 08053	68
13	Christ Presbyterian Church	515 East Main Street, Marlton, NJ 08053	70
14	Frances S. DeMasi Elementary School	199 Evesboro Medford Road, Marlton, NJ 08053	72
15	Marlton Assembly of God	625 East Main Street, Marlton, NJ 08053	74
16	Marlton Post Office	123 East Main Street, Marlton, NJ 08053	76
17	Robert B. Jaggard Elementary School	2 Wescott Road, Marlton, NJ 08053	78
18	St. Joan of Arc Parish and School	100 Willow Bend Road, Marlton, NJ 08053	80

* Contains a concept design


14
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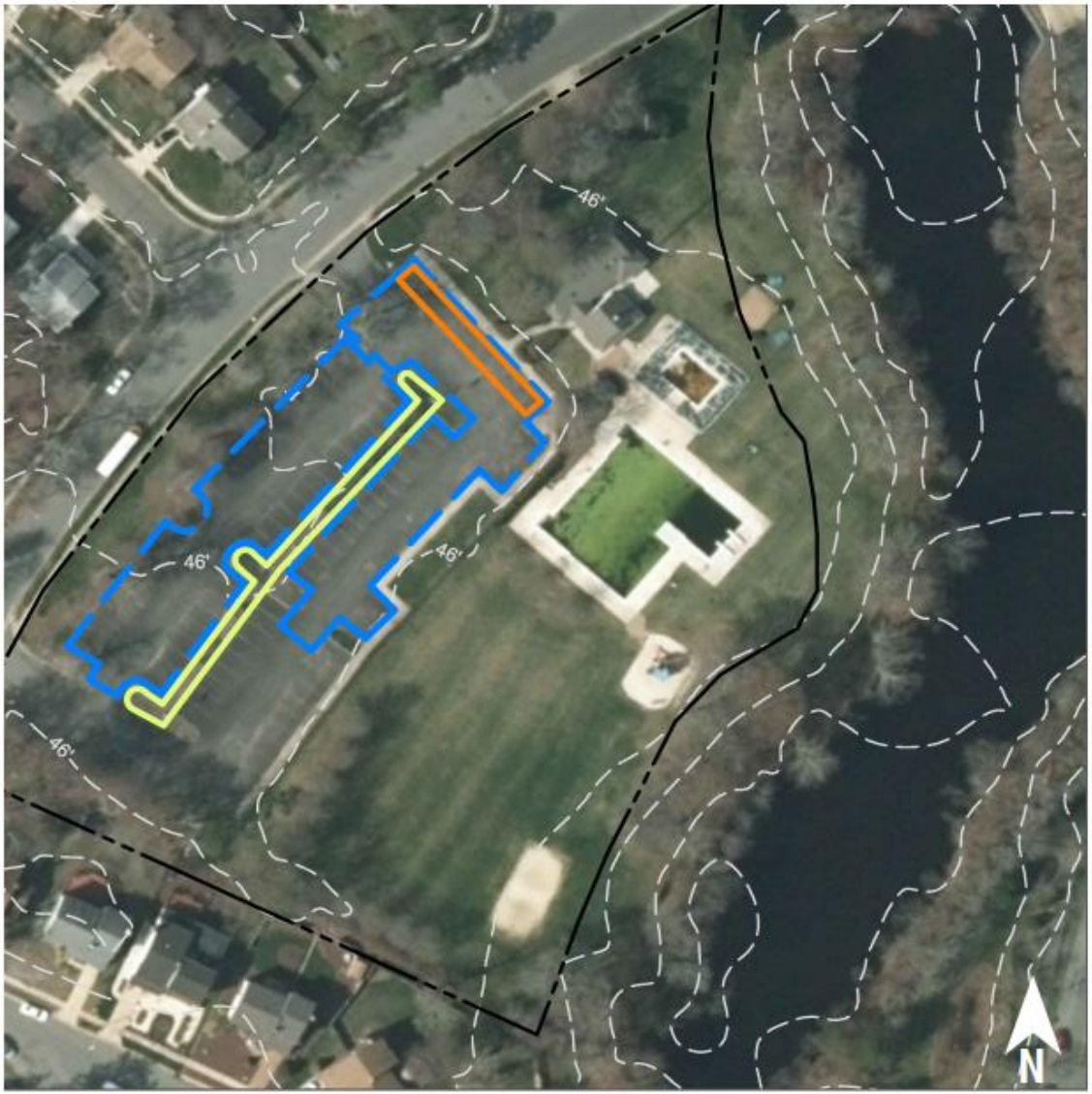
Legend
Project Sites
Evesham
Waterbodies



bioretention system

pervious pavement

drainage area

property line

2015 Aerial: NJOIT, OGIS

0' 50' 100'

Stormwater is currently directed to an existing catch basin. Installing rain gardens in the parking lot islands can capture, treat, and infiltrate stormwater runoff from the parking lot. Replacing parking spaces with porous pavement can capture and infiltrate runoff from the other side of the parking lot. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability 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"
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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
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Pervious pavement	0.352	59	26,651	1.00	2,410	$60,250

CURRENT CONDITION

CONCEPT DESIGN

bioretention system

pervious pavement

drainage area

property line

2015 Aerial: NJOIT, OGIS

0' 50' 100'

MARLTON ELEMENTARY SCHOOL

190 Tomlinson Mill Road
Evesham, NJ 08053

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

CONCEPT DESIGN

bioretention system

rainwater harvesting

drainage area

property line

2015 Aerial: NJOIT, OGIS

0' 50' 100'

KETTLE RUN FIRE/RESCUE 225/228

498 Hopewell Road
Marlton, NJ 08053

Stormwater is currently directed to an existing detention basin. Cisterns adjacent to the building can harvest roof runoff to be used for washing department vehicles. Installing a rain garden on the east side of the building can capture, treat, and infiltrate additional roof runoff. 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"
45	42,532	2.1	21.5	195.3	0.033	1.17

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	0.071	12	5,348	0.20	680	$3,400
Rainwater harvesting	0.094	16	7,099	0.27	2,800 (gal)	$5,600

CURRENT CONDITION

CONCEPT DESIGN

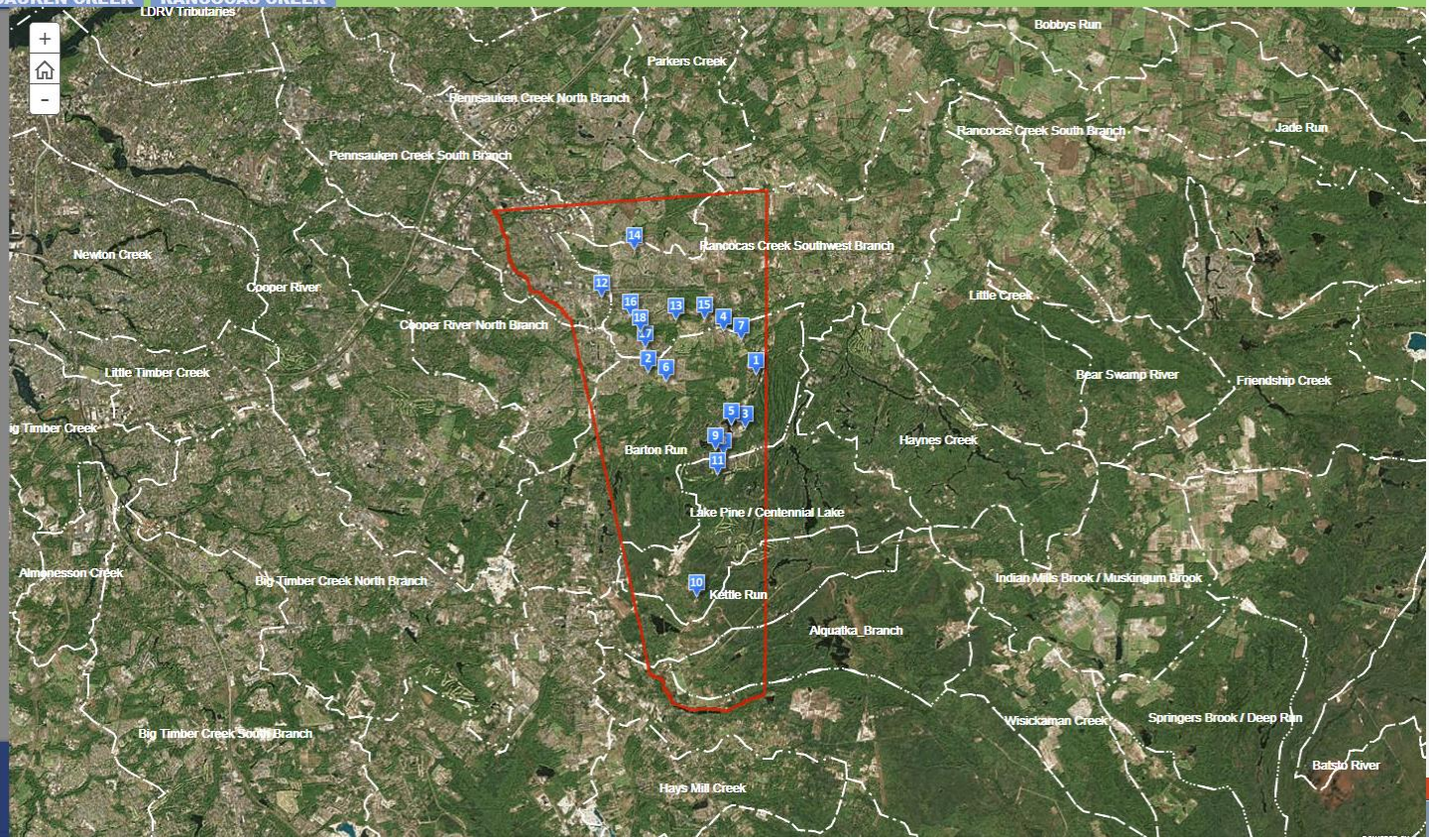
The Green Infrastructure Web Map

www.water.rutgers.edu/Projects/William_Penn/Evesham/index.html

Evesham

RUTGERS New Jersey Agricultural Experiment Station

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

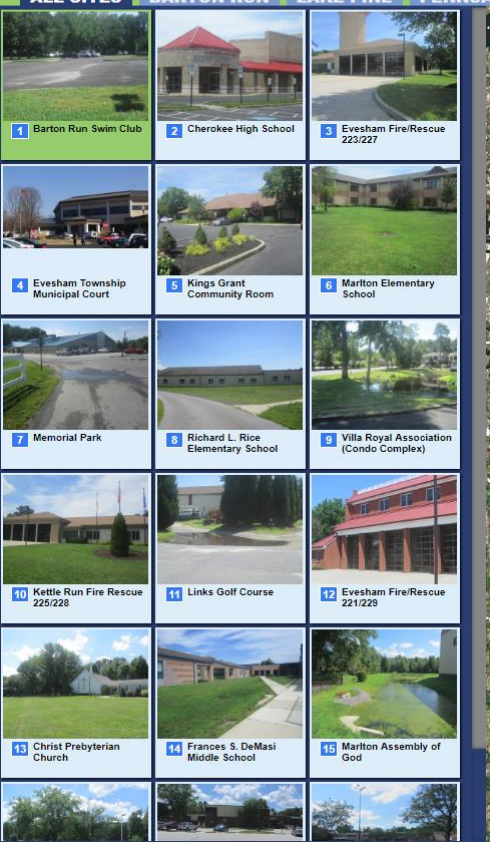


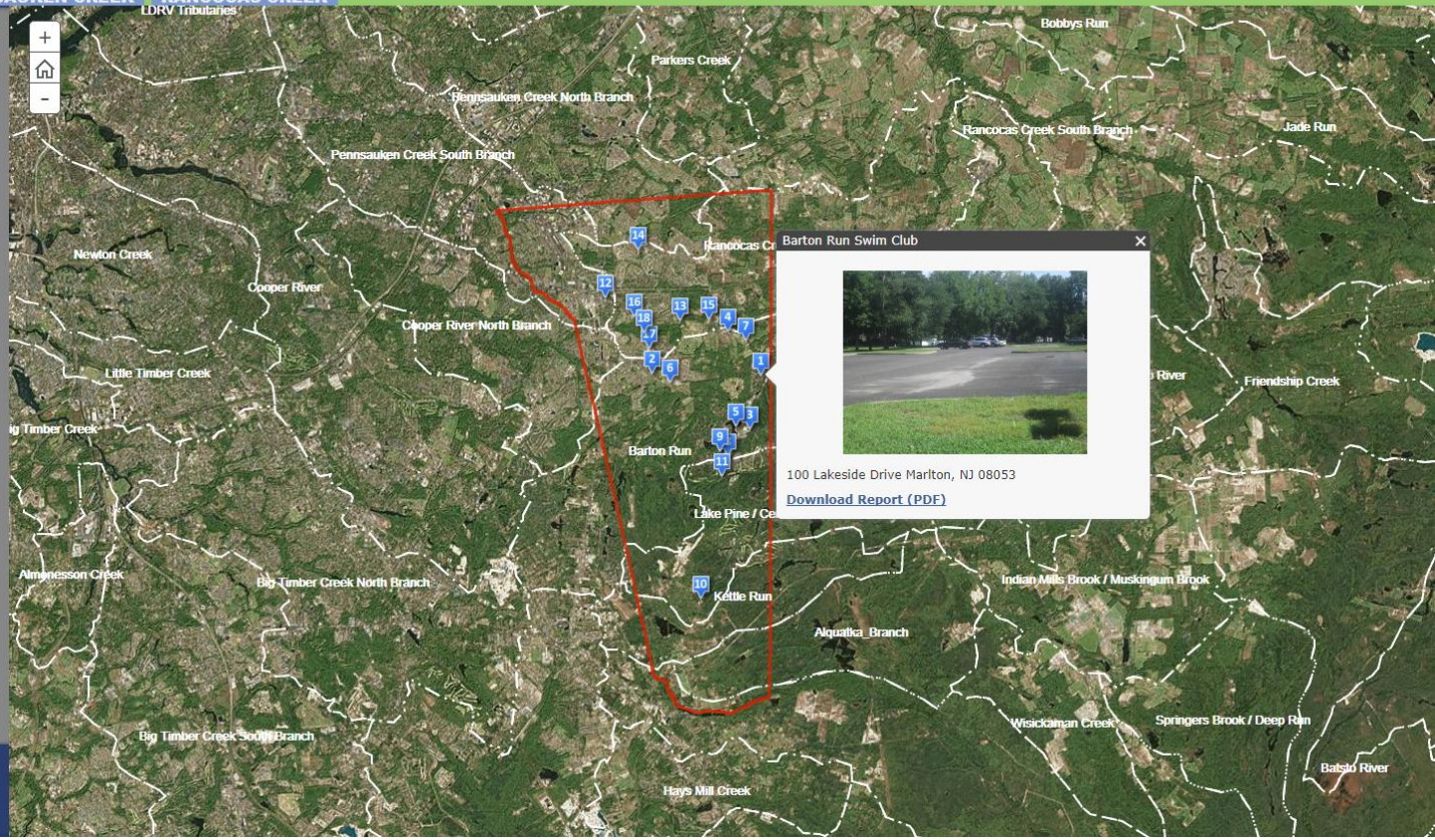
www.water.rutgers.edu/Projects/William_Penn/Evesham/index.html

Evesham

RUTGERS New Jersey Agricultural Experiment Station

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





Final Thoughts

- Plans promote action and will provide a foundation for stormwater utilities
- Plans will enable stormwater utility to quickly install highly visible green infrastructure
- Public will see fees translated into on-the-ground projects

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Questions?

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