RUTGERS
New Jersey Agricultural Experiment Station

Impervious Cover Assessment
for
Greenwich Township, Warren County, New Jersey

Prepared for Greenwich Township by the
Rutgers Cooperative Extension Water Resources Program

March 11, 2015

WILLIAM PENN FOUNDATION

ANJEC
Local Environment Matters

Introduction

Pervious and impervious are terms that are used to describe the ability or inability of water to flow through a surface. When rainfall hits a surface, it can soak into the surface or flow off the surface. Pervious surfaces are those which allow stormwater to readily soak into the soil and recharge groundwater. When rainfall drains from a surface, it is called "stormwater" runoff (Figure 1). An impervious surface can be any material that has been placed over soil that prevents water from soaking into the ground. Impervious surfaces include paved roadways, parking lots, sidewalks, and rooftops. As impervious areas increase, so does the volume of stormwater runoff.

Figure 1: Stormwater draining from a parking lot

New Jersey has many problems due to stormwater runoff, including:

- Pollution: According to the 2010 New Jersey Water Quality Assessment Report, 90% of the assessed waters in New Jersey are impaired, with urban-related stormwater runoff listed as the most probable source of impairment (USEPA, 2013). As stormwater flows over the ground, it picks up pollutants, including animal waste, excess fertilizers, and pesticides and other toxic substances. These pollutants are then able to enter waterways.

- Flooding: Over the past decade, the state has seen an increase in flooding. Communities around the state have been affected by these floods. The amount of damage caused has also increased greatly with this trend, costing billions of dollars over this time span.

- Erosion: Increased stormwater runoff causes an increase in the velocity of flows in our waterways. The increased velocity after storm events erodes stream banks and shorelines, degrading water quality. This erosion can damage local roads and bridges and cause harm to wildlife.

The primary cause of the pollution, flooding, and erosion problems is the quantity of impervious surfaces draining directly to local waterways. New Jersey is one of the most developed states in the country. Currently, the state has the highest percent of impervious cover in the country at 12.1% of its total area (Nowak & Greenfield, 2012). Many of these impervious surfaces are directly connected to local waterways (i.e., every drop of rain that lands on these impervious surfaces ends up in a local river, lake, or bay without any chance of being treated or soaking into the ground). To repair our waterways, reduce flooding, and stop erosion, stormwater runoff from impervious surfaces has to be better managed. Surfaces need to be disconnected with green infrastructure to prevent stormwater runoff from flowing directly into New Jersey's waterways. Disconnection redirects runoff from paving and rooftops to pervious areas in the landscape.

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 principal, 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).

The first step to reducing the impacts from impervious surfaces is to conduct an impervious cover assessment. This assessment can be completed on different scales: individual lot, municipality, or watershed. Impervious surfaces need to be identified for stormwater management. Once impervious surfaces have been identified, there are three steps to better manage these surfaces.

1. ***Eliminate surfaces that are not necessary.*** For example, a paved courtyard at a public school could be converted to a grassed area.

2. ***Reduce or convert impervious surfaces.*** There may be surfaces that are required to be hardened, such as roadways or parking lots, but could be made smaller and still be functional. A parking lot that has two-way cart ways could be converted to one-way cart ways. There also are permeable paving materials such as porous asphalt, pervious concrete, or permeable paving stones that could be substituted for impermeable paving materials (Figure 2).

3. ***Disconnect impervious surfaces from flowing directly to local waterways.*** There are many ways to capture, treat, and infiltrate stormwater runoff from impervious surfaces. Opportunities may exist to reuse this captured water.

Figure 2: Rapid infiltration of water through porous pavement is demonstrated at the USEPA Edison New Jersey test site

Greenwich Township Impervious Cover Analysis

Located in Warren County, New Jersey, Greenwich Township covers over 10.6 square miles south of the Merrill Creek Reservoir. Figures 3 and 4 illustrate that Greenwich Township is dominated by agricultural land uses. A total of 32.1% of the municipality's land use is classified as urban. Of the urban land in Greenwich Township, rural residential is the dominant land use (Figure 5).

The literature suggests a link between impervious cover and stream ecosystem impairment starting at approximately 10% impervious surface cover (Schueler, 1994; Arnold and Gibbons, 1996; May et al., 1997). Impervious cover may be linked to the quality of lakes, reservoirs, estuaries, and aquifers (Caraco et al., 1998), and the amount of impervious cover in a watershed can be used to project the current and future quality of streams. Based on the scientific literature, Caraco et al. (1998) classified urbanizing streams into the following three categories: sensitive streams, impacted streams, and non-supporting streams. Sensitive steams typically have a watershed impervious surface cover from 0 – 10%. Impacted streams have a watershed impervious cover ranging from 11-25% and typically show clear signs of degradation from urbanization. Non-supporting streams have a watershed impervious cover of greater than 25%; at this high level of impervious cover, streams are simply conduits for stormwater flow and no longer support a diverse stream community.

The New Jersey Department of Environmental Protection's (NJDEP) 2007 land use/land cover geographical information system (GIS) data layer categorizes Greenwich Township into many unique land use areas, assigning a percent impervious cover for each delineated area. These impervious cover values were used to estimate the impervious coverage for Greenwich Township. Based upon the 2007 NJDEP land use/land cover data, approximately 7.7% of Greenwich Township has impervious cover. This level of impervious cover suggests that the streams in Greenwich Township are sensitive streams.

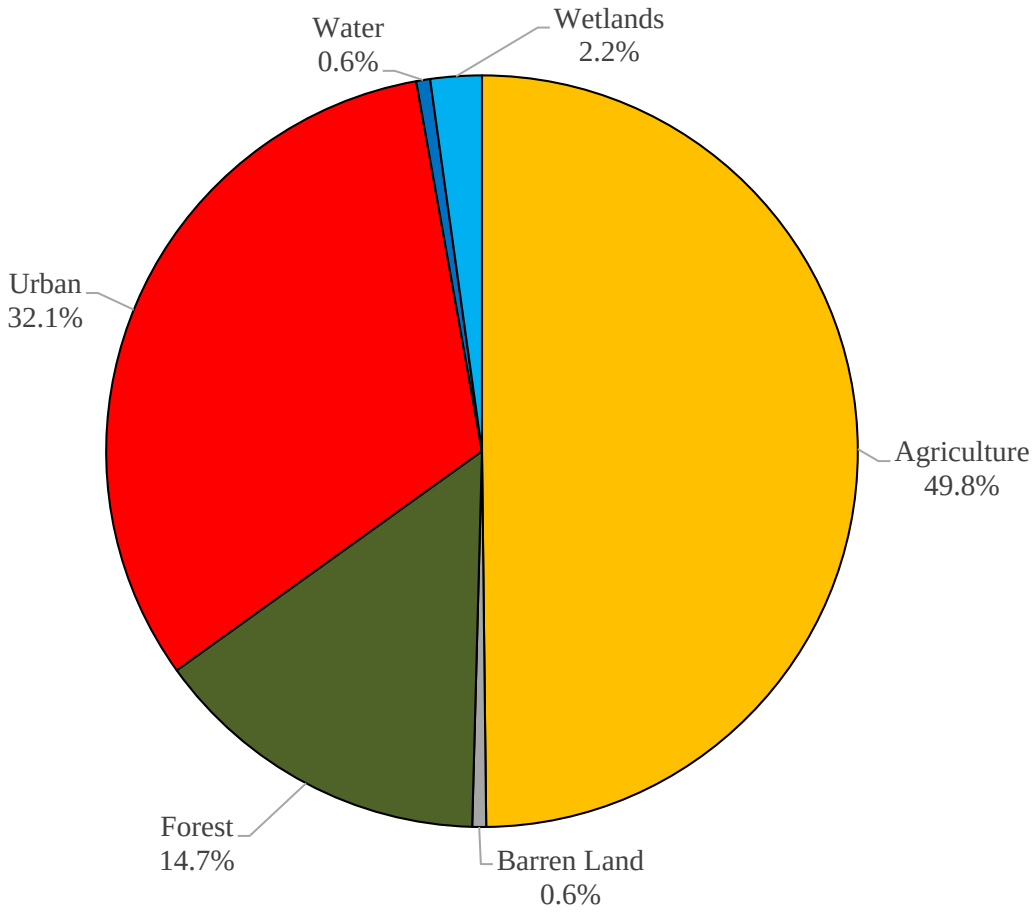


Figure 3: Pie chart illustrating the land use in Greenwich Township

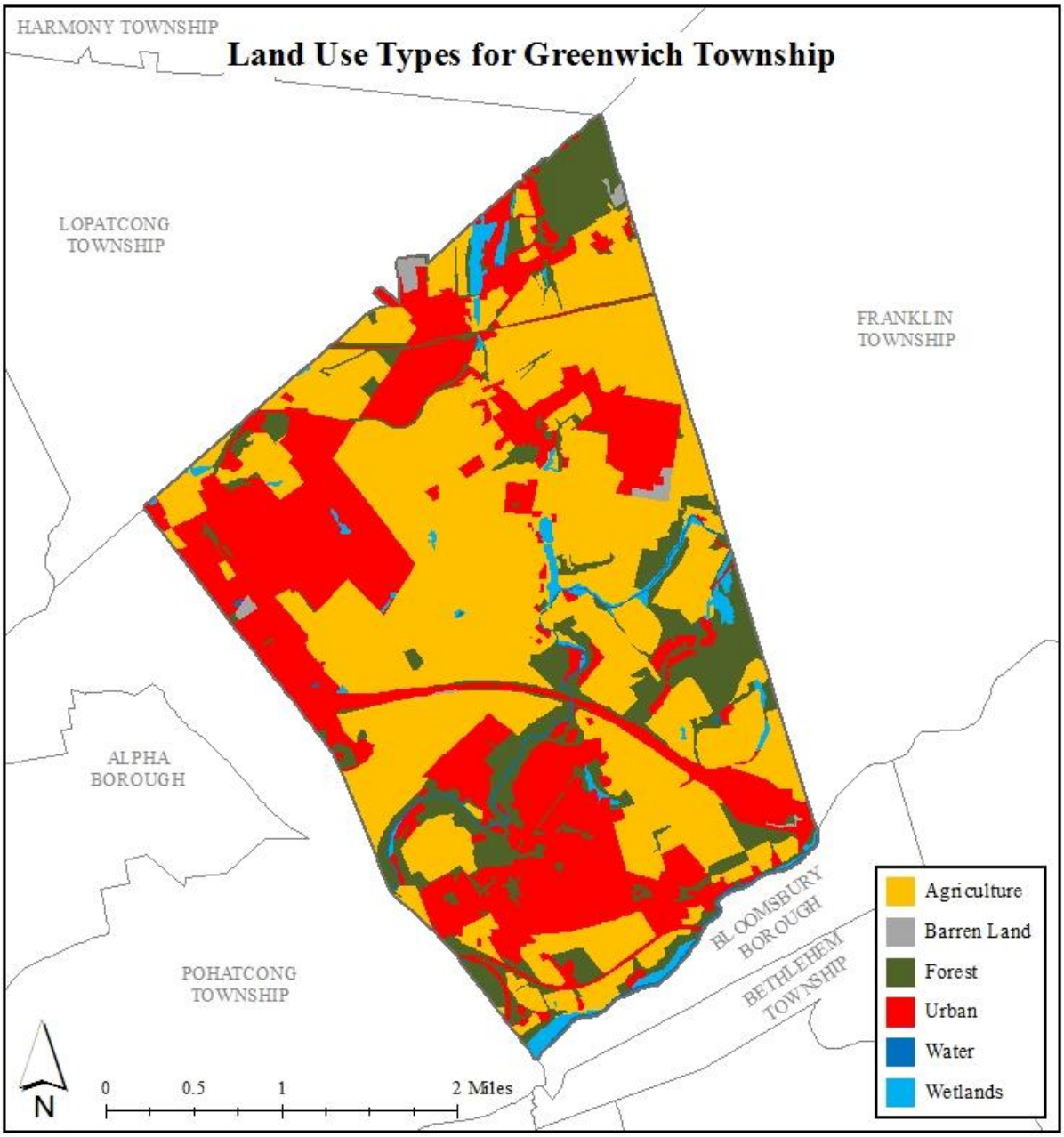


Figure 4: Map illustrating the land use in Greenwich Township

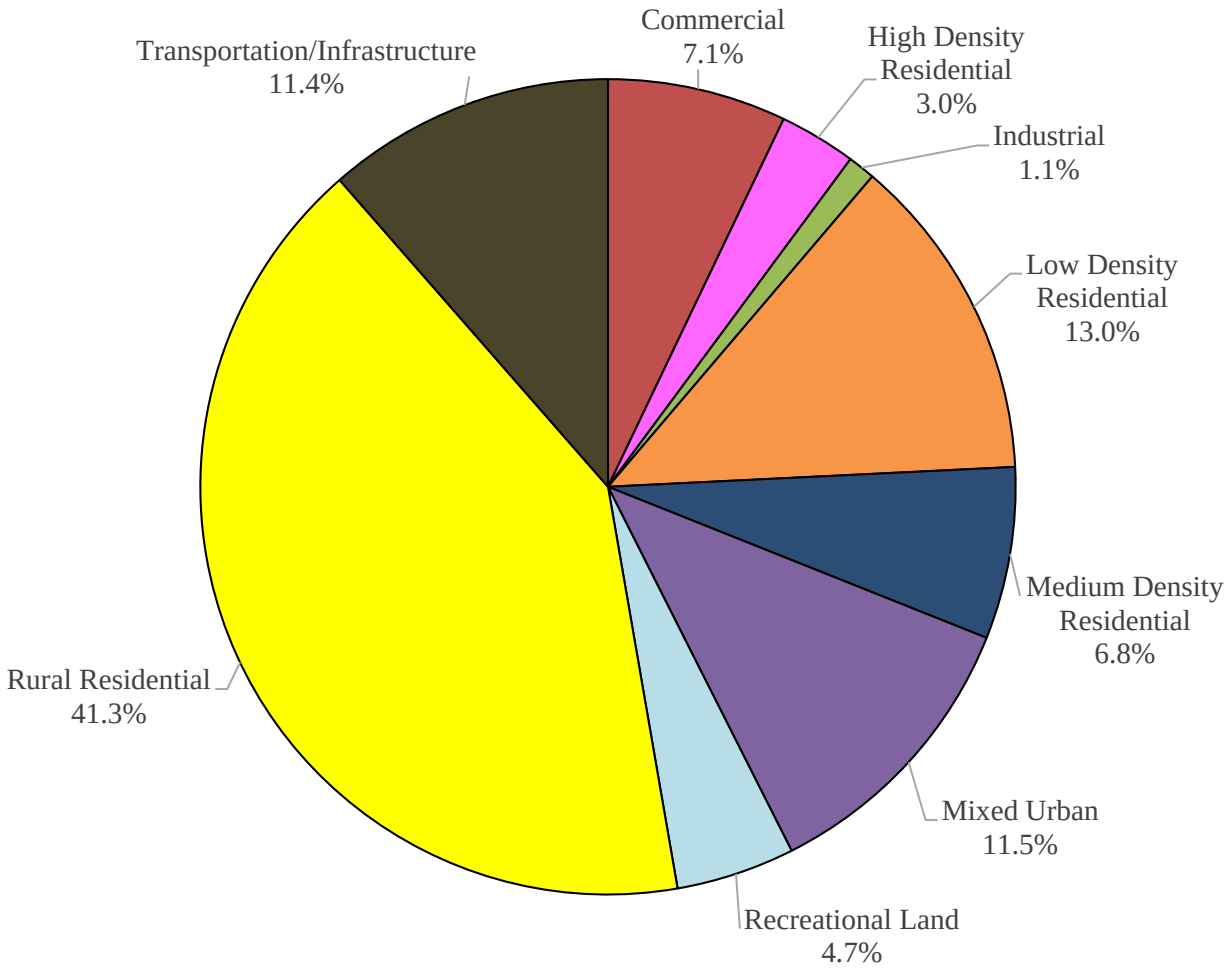


Figure 5: Pie chart illustrating the various types of urban land use in Greenwich Township

Water resources are typically managed on a watershed/subwatershed basis; therefore an impervious cover analysis was performed for each watershed within Greenwich Township (Table 1 and Figure 6). On a subwatershed basis, impervious cover ranges from 4.9% in the Musconetcong Creek subwatershed to 15.5% in the Lopatcong Creek subwatershed. Evaluating impervious cover on a subwatershed basis allows the municipality to focus impervious cover reduction or disconnection efforts in subwatersheds where frequent flooding occurs.

In developed landscapes, stormwater runoff from parking lots, driveways, sidewalks, and rooftops flows to drainage pipes that feed the sewer system. The cumulative effect of these impervious surfaces and thousands of connected downspouts reduces the amount of water that can infiltrate into soils and greatly increases the volume and rate of runoff that flows to waterways. Stormwater runoff volumes (specific to Greenwich Township, Warren County) associated with impervious surfaces were calculated for the following storms: the New Jersey water quality design storm of 1.25 inches of rain, an annual rainfall of 44 inches, the 2-year design storm (3.3 inches of rain), the 10-year design storm (4.9 inches of rain), and the 100-year design storm (7.8 inches of rain). These runoff volumes are summarized in Table 2. A substantial amount of rainwater drains from impervious surfaces in Greenwich Township. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Lopatcong Creek subwatershed was harvested and purified, it could supply water to 59 homes for a year[1].

[1] Assuming 300 gallons per day per home

Table 1: Impervious cover analysis by subwatershed for Greenwich Township

Subwatershed	Total Area		Land Use Area		Water Area		Impervious Cover		
	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(%)
Lopatcong Creek	1,246.3	1.95	1,246.5	1.95	0.7	0.00	192.5	0.30	15.5%
Merrill Creek	934.0	1.46	933.6	1.46	0.4	0.00	62.6	0.10	6.7%
Musconetcong River	617.2	0.96	606.9	0.95	10.4	0.02	29.8	0.05	4.9%
Pohatcong Creek	3,982.7	6.22	3,953.7	6.18	29.0	0.05	233.3	0.36	5.9%
Total	6,780.2	10.59	6,739.7	10.53	40.5	0.06	518.2	0.81	7.7%

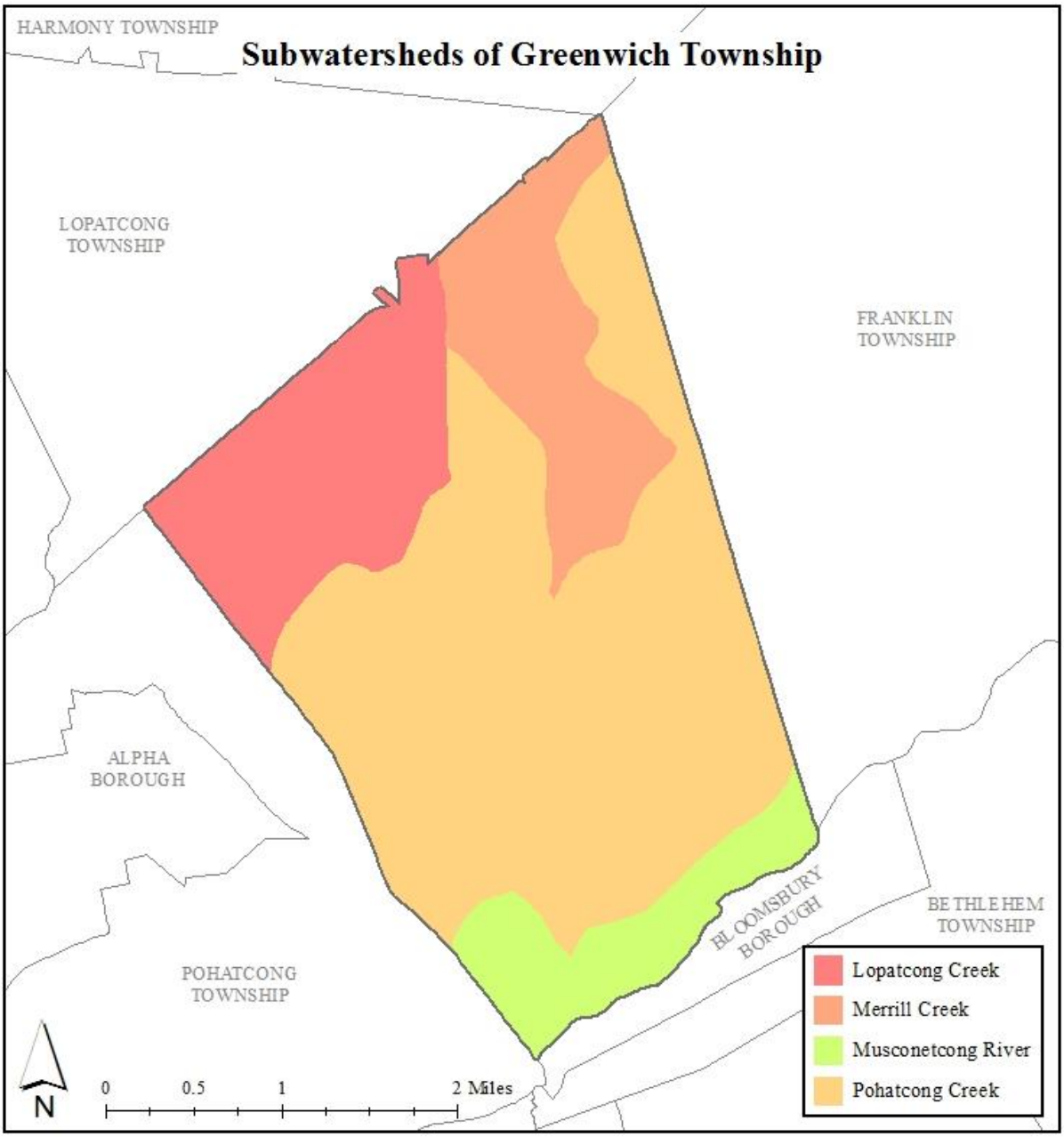


Figure 6: Map of the subwatersheds in Greenwich Township

Table 2: Stormwater runoff volumes from impervious surfaces by subwatershed in Greenwich Township

Subwatershed	Total Runoff Volume for the 1.25" NJ Water Quality Storm (MGal)	Total Runoff Volume for the NJ Annual Rainfall of 44"(MGal)	Total Runoff Volume for the 2-Year Design Storm (3.3") (MGal)	Total Runoff Volume for the 10-Year Design Storm (4.9") (MGal)	Total Runoff Volume for the 100-Year Design Storm (7.8") (MGal)
Lopatcong Creek	6.5	230.0	17.2	25.6	40.8
Merrill Creek	2.1	74.8	5.6	8.3	13.3
Musconetcong River	1.0	35.6	2.7	4.0	6.3
Pohatcong Creek	7.9	278.7	20.9	31.0	49.4
Total	17.5	619.1	46.4	68.9	109.8

The next step is to set a reduction goal for impervious area in each subwatershed. Based upon the Rutgers Cooperative Extension (RCE) Water Resources Program's experience, a 10% reduction would be a reasonably achievable reduction for these subwatersheds in Greenwich Township. While it may be difficult to eliminate paved areas or replace paved areas with permeable pavement, it is relatively easy to identify impervious surfaces that can be disconnected using green infrastructure practices. For all practical purposes, disconnecting an impervious surface from a storm sewer system or a water body is an "impervious area reduction." The RCE Water Resources Program recommends that all green infrastructure practices that are installed to disconnect impervious surfaces should be designed for the 2-year design storm (3.3 inches of rain over 24-hours). Although this results in management practices that are slightly over-designed by NJDEP standards, which require systems to be designed for the New Jersey water quality storm (1.25 inches of rain over 2-hours), these systems will be able to handle the increase in storm intensities that are expected to occur due to climate change. By designing these management practices for the 2-year design storm, these practices will be able to manage 95% of the annual rainfall volume. The recommended annual reductions in runoff volumes are shown in Table 3.

As previously mentioned, once impervious surfaces have been identified, there next steps for managing impervious surfaces are to 1) eliminate surfaces that are not necessary, 2) reduce or convert impervious surfaces to pervious surfaces, and 3) disconnect impervious surfaces from flowing directly to local waterways.

Elimination of Impervious Surfaces

One method to reduce impervious cover is to "depave." Depaving is the act of removing paved impervious surfaces and replacing them with pervious soil and vegetation that will allow for the infiltration of rainwater. Depaving leads to the re-creation of natural space that will help reduce flooding, increase wildlife habitat, and positively enhance water quality as well as beautify neighborhoods. Depaving also can bring communities together around a shared vision to work together to reconnect their neighborhood to the natural environment.

Table 3: Impervious cover reductions by subwatershed in Greenwich Township

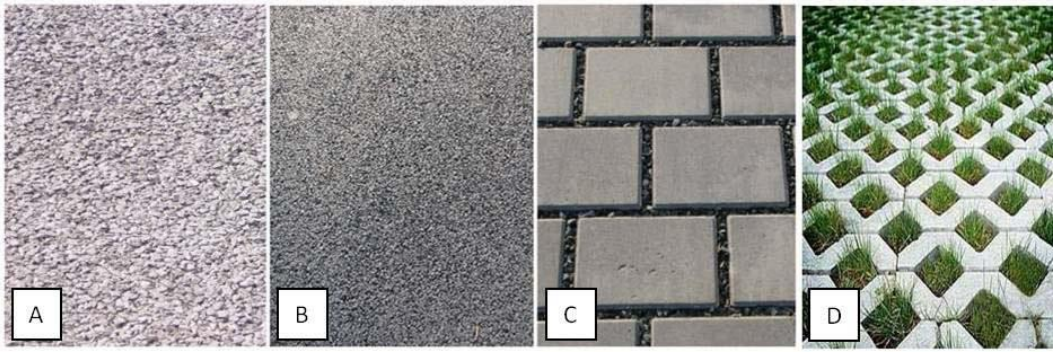
Subwatershed	**Recommended Impervious Area Reduction (10%) (ac)**	**Annual Runoff Volume Reduction [2] (MGal)**
Lopatcong Creek	19.3	21.8
Merrill Creek	6.3	7.1
Musconetcong River	3.0	3.4
Pohatcong Creek	23.3	26.5
Total	51.9	58.8

[2] Annual Runoff Volume Reduction =
Acres of impervious cover x 43,560 ft^2/ac x 44 in x (1 ft/12 in) x 0.95 x (7.48 gal/ft^3) x (1 MGal/1,000,000 gal)
All green infrastructure should be designed to capture the first 3.3 inches of rain from each storm. This would allow the green infrastructure to capture 95% of the annual rainfall of 44 inches.

Pervious Pavement

There are four different types of permeable pavement systems that are commonly being used throughout the country to reduce the environmental impacts from impervious surfaces. These surfaces include pervious concrete, porous asphalt, interlocking concrete pavers, and grid pavers.

> *"Permeable pavement is a stormwater drainage system that allows rainwater and runoff to move through the pavement's surface to a storage layer below, with the water eventually seeping into the underlying soil. Permeable pavement is beneficial to the environment because it can reduce stormwater volume, treat stormwater water quality, replenish the groundwater supply, and lower air temperatures on hot days (Rowe, 2012)."*



Permeable surfaces: (A) pervious concrete, (B) porous asphalt, (C) interlocking concrete pavers, (D) grid pavers (Rowe, 2012)

Pervious concrete and porous asphalt are the most common of the permeable surfaces. They are similar to regular concrete and asphalt but without the fine materials. This allows water to quickly pass through the material into an underlying layered system of stone that holds the water, allowing it to infiltrate into the underlying uncompacted soil.

Impervious Cover Disconnection Practices

By redirecting runoff from paving and rooftops to pervious areas in the landscape, the amount of directly connected impervious area in a drainage area can be greatly reduced. There are many cost-effective ways to disconnect impervious surfaces from local waterways.

- Simple Disconnection: This is the easiest and least costly method to reduce stormwater runoff for smaller storm events. Instead of piping rooftop runoff to the street where it enters the catch basin and is piped to the river, the rooftop runoff is released onto a grassed area to allow the water to be filtered by the grass and soak into the ground. A healthy lawn typically can absorb the first one to two inches of stormwater runoff from a rooftop. Simple disconnection also can be used to manage stormwater runoff from paved areas. Designing

a parking lot or driveway to drain onto a grassed area, instead of the street, can dramatically reduce pollution and runoff volumes.

- Rain Gardens: Stormwater can be diverted into shallow landscaped depressed areas (i.e., rain gardens) where the vegetation filters the water and it is allowed to soak into the ground. Rain gardens, also known as bioretention systems, come in all shapes and sizes and can be designed to disconnect and treat a variety of impervious surfaces (Figure 7).

Figure 7: Rain garden outside the RCE of Gloucester County office which was designed to disconnect rooftop runoff from the local storm sewer system

- Rainwater Harvesting: Rainwater harvesting includes the use of rain barrels and cisterns (Figures 8a and 8b). These can be placed below downspouts to collect rooftop runoff. The collected water has a variety of uses including watering plants and washing cars. This practice also helps cut down on the use of potable water for nondrinking purposes. It is important to divert the overflow from the rainwater harvesting system to a pervious area.

Figure 8a: Rain barrel used to disconnect a downspout with the overflow going to flower bed

Figure 8b: A 5,000 gallon cistern used to disconnect the rooftop of the Department of Public Works in Clark Township to harvest rainwater for nonprofit car wash events

Examples of Opportunities in Greenwich Township

To address the impact of stormwater runoff from impervious surfaces the next step is to identify opportunities in the municipality for eliminating, reducing, or disconnecting directly connected impervious surfaces. To accomplish this task, an impervious cover reduction action plan should be prepared. Aerial photographs are used to identify sites with impervious surfaces in the municipality that may be suitable for inclusion in the action plan. After sites are identified, site visits are conducted to photo-document all opportunities and evaluate the feasibility of eliminating, reducing, or disconnecting directly connected impervious surfaces. A brief description of each site discussing the existing conditions and recommendations for treatment of the impervious surfaces is developed. After a number of sites have been selected for inclusion in the action plan, concept plans and detailed green infrastructure information sheets are prepared for a selection of representative sites.

For Greenwich Township, three sites have been included in this assessment. Examples of concept plans and detailed green infrastructure information sheets are provided in Appendix A. The detailed green infrastructure information sheets describe existing conditions and issues, proposed solutions, anticipated benefits, possible funding sources, potential partners and stakeholders, and estimated costs. Additionally, each project has been classified as a mitigation opportunity for recharge potential, total suspended solids removal, and stormwater peak reduction. Finally, these detailed green infrastructure information sheets provide an estimate of gallons of stormwater captured and treated per year by each proposed green infrastructure practice. The concept plans provide an aerial photograph of the site and details of the proposed green infrastructure practices.

Conclusions

Greenwich Township can reduce flooding and improve its waterways by better managing stormwater runoff from impervious surfaces. This impervious cover assessment is the first step toward better managing stormwater runoff. The next step is to develop an action plan to eliminate, reduce, or disconnect impervious surfaces where possible and practical. Many of the highly effective disconnection practices are inexpensive. The entire community can be engaged in implementing these disconnection practices.

References

Arnold, C.L. Jr. and C.J. Gibbons. 1996. Impervious Surface Coverage The Emergence of a Key Environmental Indicator. *Journal of the American Planning Association* 62(2): 243-258.

Caraco, D., R. Claytor, P. Hinkle, H. Kwon, T. Schueler, C. Swann, S. Vysotsky, and J. Zielinski. 1998. Rapid Watershed Planning Handbook. A Comprehensive Guide for Managing Urbanizing Watersheds. Prepared by Center For Watershed Protection, Ellicott City, MD. Prepared for U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds and Region V. October 1998.

May, C.W., R.R. Horner, J.R. Karr, B.W. Mar, E.G. Welch. 1997. Effects of Urbanization on Small Streams in the Puget Sound Lowland Ecoregion. *Watershed Protection Techniques* 2(4): 483-493.

Nowak, D. J., and E. J. Greenfield, 2012. Trees and Impervious Cover in the United States. *Landscape and Urban Planning* 107 (2012): 21-30.
http://www.nrs.fs.fed.us/pubs/jrnl/2012/nrs_2012_nowak_002.pdf

Rowe, A., 2012. Green Infrastructure Practices: An Introduction to Permeable Pavement. Rutgers NJAES Cooperative Extension, FS1177, pp. 4.
http://njaes.rutgers.edu/pubs/publication.asp?pid=FS1177

Schueler, T. 1994. The Importance of Imperviousness. *Watershed Protection Techniques*1(3): 100-111.

United States Environmental Protection Agency (USEPA), 2013. Watershed Assessment, Tracking, and Environmental Results, New Jersey Water Quality Assessment Report.
http://ofmpub.epa.gov/waters10/attains_state.control?p_state=NJ

Appendix A

Examples of Impervious Cover Reduction Action Plan Projects

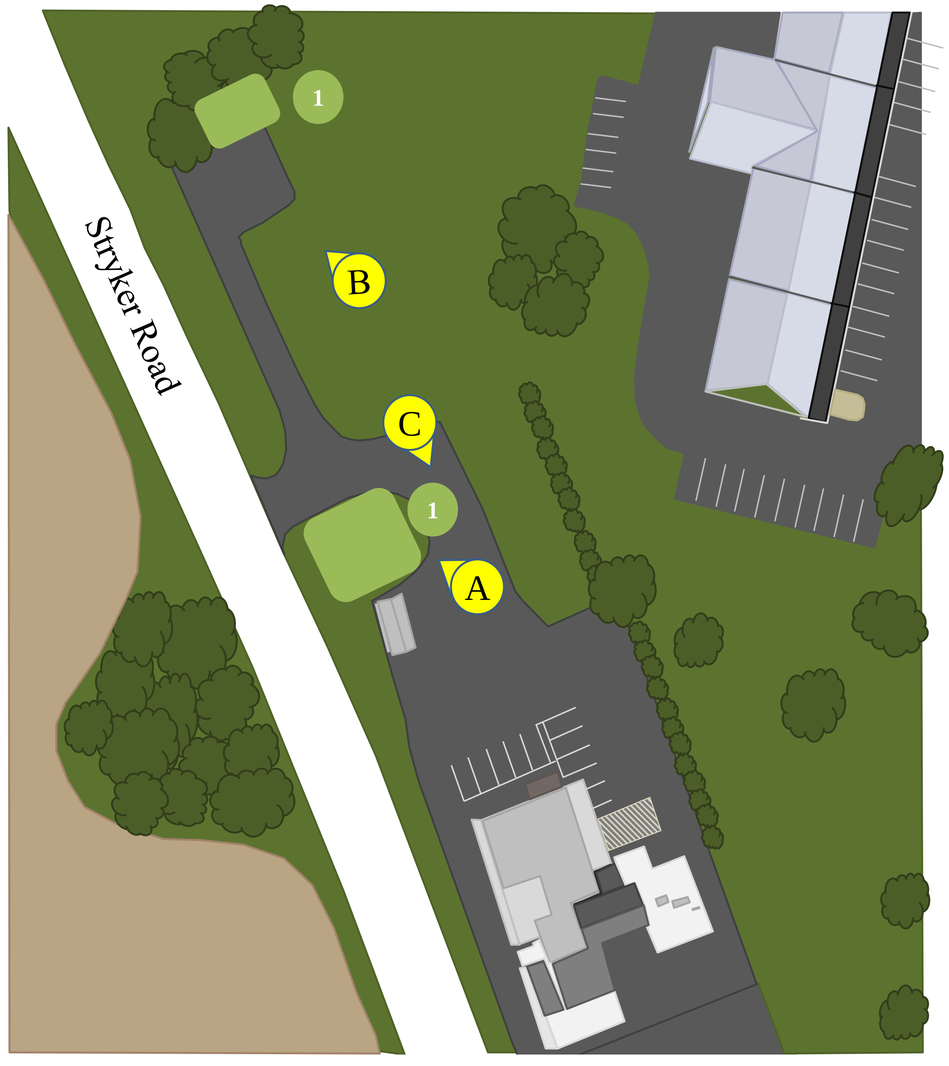
Concept Plans and Detailed Green Infrastructure Information Sheets

Greenwich Township
Impervious Cover Assessment
Rath's Deli / Rita's Italian Ice, 450 County Road 519

RUTGERS
New Jersey Agricultural Experiment Station

PROJECT LOCATION:

SITE PLAN:



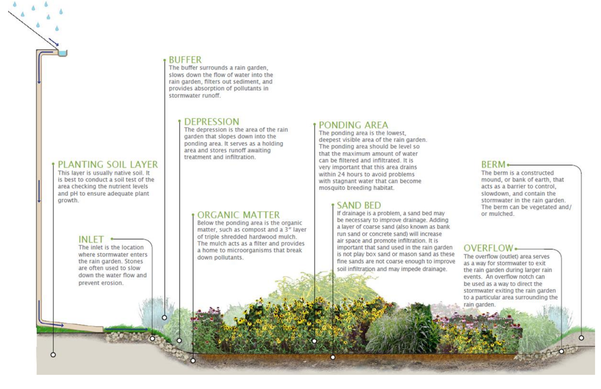
A

B

C

1 **BIORETENTION SYSTEM:** Two bioretention systems could be installed at this site. One bioretention system could be installed at the northern point of the parking lot extension. Another bioretention system could be installed in the grass area behind the Rita's Italian Ice shed. The parking area is graded so that stormwater would flow northward into both of these systems. Bioretention systems will reduce runoff and allow stormwater infiltration, decreasing the amount of contaminants that reaches catch basins.

1 BIORETENTION SYSTEM



Rath's Deli / Rita's Italian Ice
Green Infrastructure Information Sheet

Location: 450 County Road 519 Stewartsville, NJ 08886	**Municipality:** Greenwich Township
	Subwatershed: Lopatcong Creek
Green Infrastructure Description: bioretention systems (rain gardens)	**Targeted Pollutants:** total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes stormwater peak reduction potential: yes TSS removal potential: yes	**Stormwater Captured and Treated Per Year:** bioretention system #1: 144,100 gal. bioretention system #2: 36,500 gal.

Existing Conditions and Issues:

This site contains several impervious surfaces including driveways, parking areas, a shed, and a large delicatessen. These impervious surfaces are directly connected to a storm sewer system. The site's impervious surfaces produce stormwater runoff during rain events. The parking area behind the building slopes down toward a Rita's Italian Ice shed and grassy area. The Rita's Italian Ice shed does not have a gutter/downspout system. The parking lot surface is in good condition. There is overhead electrical wiring to the buildings and other utility markers near a dumpster to the northeast of the building. All of the downspouts on Rath's Deli appear to be directly connected. There is another parking area to the northwest of the building which has a long driveway connecting the two, but it is otherwise disconnected by a grass field. This second parking lot appears to be adjacent to a local waterway. The upper parking area empties into this lower parking area by means of overland flow via the driveway or the grass field. The overland flow over the grass may present an erosion issue.

Proposed Solution(s):

Two bioretention systems could be installed at this site to treat runoff from the parking areas and enhance the site's aesthetic quality. The first system would be installed to the south of the main building in the grass area adjacent to the Rita's Italian Ice shed. The second system could be installed in the northernmost corner of the second smaller lot to the north.

Anticipated Benefits:
Since the bioretention systems would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.3 inches of rain over 24 hours), these systems are estimated to achieve a 95% pollutant load reduction for TN, TP, and TSS. A bioretention system would also provide ancillary benefits such as enhanced wildlife habitat and aesthetic appeal.

Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs
Greenwich Township
Rath's Deli / Rita's Italian Ice
local social and community groups

Partners/Stakeholders:
Greenwich Township
Rath's Deli / Rita's Italian Ice
local social and community groups
local residents
Rutgers Cooperative Extension

Estimated Cost:
Bioretention system #1 would need to be 1,400 square feet. At $5 per square foot, the estimated cost of this bioretention system is $7,000. Bioretention system #2 would need to be 350 square feet. At $5 per square foot, the estimated cost of this bioretention system is $1,750. The total cost of the project would be approximately $8,750.

Greenwich Township
Impervious Cover Assessment
Greenwich Elementary School, 101 Wyndham Farm Boulevard

RUTGERS
New Jersey Agricultural Experiment Station

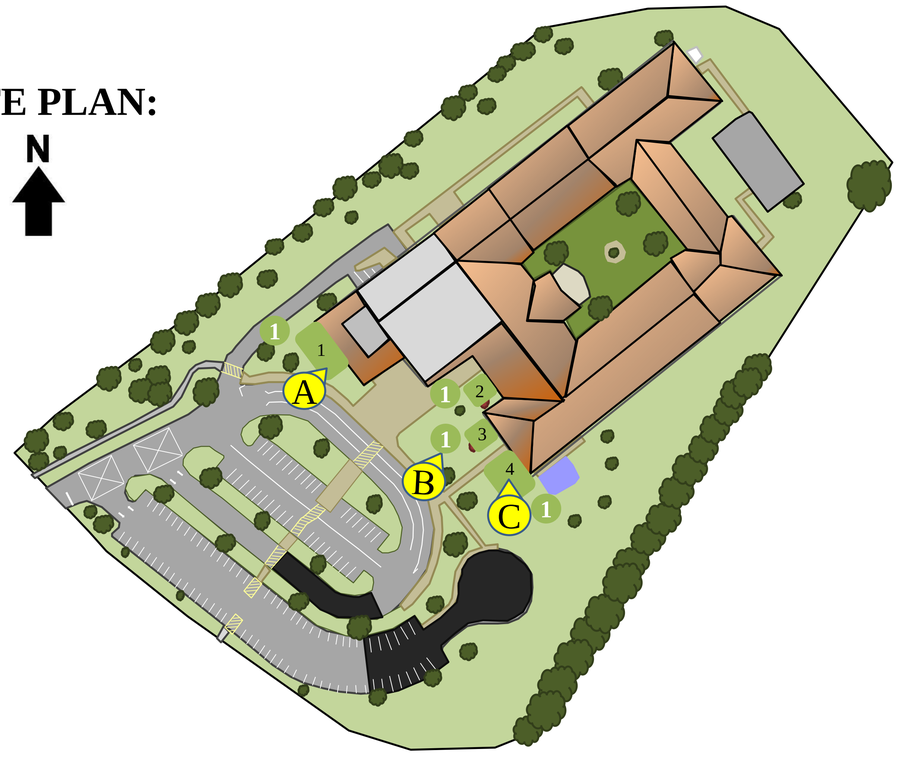
PROJECT LOCATION:

A

B

SITE PLAN:

N

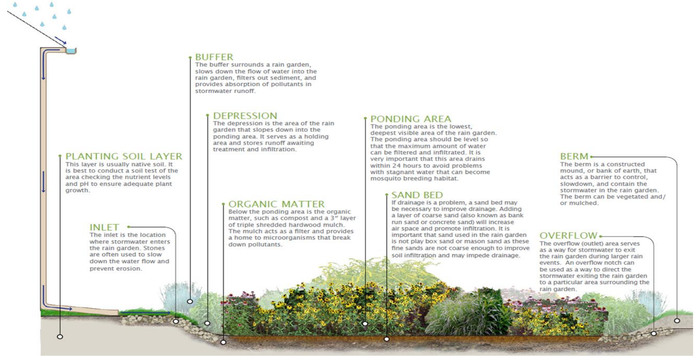


C

1 **BIORETENTION SYSTEM:** Bioretention system #1 could be built in the northwest area with the catch basin used for overflow. Bioretention systems #2 and #3 could be built in the turfgrass area to the right of the entrance. A fourth bioretention system could be built in the southeast corner. These bioretention systems will capture roof top runoff and allow stormwater infiltration, decreasing the amount of contaminants that reaches catch basins.

EDUCATIONAL PROGRAM: The RCE Water Resources Program's *Stormwater Management in Your Schoolyard* program can be delivered at Greenwich Elementary School to educate the students about stormwater management and engage them in designing and building the bioretention systems.

1 BIORETENTION SYSTEM



EDUCATIONAL PROGRAM

Greenwich Elementary School
Green Infrastructure Information Sheet

Location: 101 Wyndham Farm Boulevard Stewartsville, NJ 08886	**Municipality:** Greenwich Township
	Subwatershed: Pohatcong Creek
Green Infrastructure Description: bioretention systems	**Targeted Pollutants:** total nitrogen (TN), total phosphorus (TP), and 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: 59,979 gal. bioretention system #2: 104,664 gal. bioretention system #3: 33,168 gal. bioretention system #4: 114,692 gal.

Existing Conditions and Issues:
This site is located off of Wyndham Farm Boulevard with the area in front of the school on the south site being the focus of the project. Toward the southwest corner there is a turfgrass area with a catch basin. To the right of the main entrance there is a turfgrass area with three connected downspouts. Toward the southeast corner there is another turfgrass area with two connected downspouts.

Proposed Solution(s):
There is the potential to install four bioretention systems collecting rooftop runoff from the roof of the school. Bioretention system #1 could be built in the northwest area with the catch basin used for overflow. Bioretention systems #2 and #3 could be built in the turfgrass area right of the entrance. A fourth bioretention system could be built in the southeast corner, and the two connected downspouts there could be disconnected to flow into this rain garden.

Anticipated Benefits:
A bioretention system is estimated to achieve a 30% removal rate for TN and a 60% removal rate for TP (NJDEP BMP Manual). TSS loadings may be reduced by up to 80%. If these bioretention systems are designed to capture and infiltrate stormwater runoff from the 2-year design storm (3.3 inches of rain over 24 hours), these systems will prevent approximately 95% of the TN, TP, and TSS from flowing directly into local waterways. A bioretention system would also provide ancillary benefits such as enhanced wildlife habitat and aesthetic appeal. Rutgers Cooperative Extension could additionally present the *Stormwater Management in Your Schoolyard* program to students and include them in bioretention system planting efforts to enhance the program. This may also be used as a demonstration project for the Greenwich Township Department of Public Works staff to launch educational programming.

Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs like 319(h) and 604(b)
Greenwich Township home and school associations
Boy Scouts, Girl Scouts, or service project

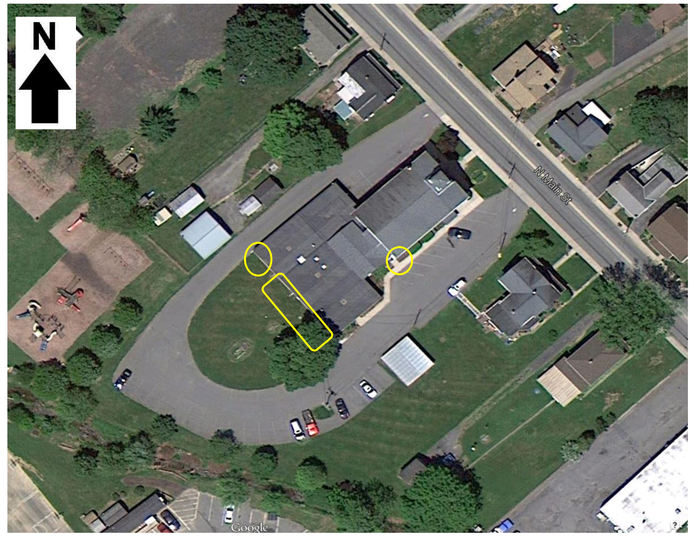
Partners/Stakeholders:
Greenwich Township
Greenwich Elementary
Rutgers Cooperative Extension

Estimated Cost:
Bioretention system #1 would need to be approximately 580 square feet. At $5 per square foot, the estimated cost of the bioretention system would be $2,900. Bioretention system #2 would need to be approximately 400 square feet. At $5 per square foot, the estimated cost of the bioretention system would be $2,000. Bioretention system #3 would need to be approximately 300 square feet. At $5 per square foot, the estimated cost of the bioretention system would be $1,500. Bioretention system #4 would need to be approximately 1,130 square feet. At $5 per square foot, the estimated cost of the bioretention system would be $5,650. The total cost of the project would be approximately $12,050.

Greenwich Township
Impervious Cover Assessment
Stewartsville Presbyterian Church, 550 North Main Street

RUTGERS
New Jersey Agricultural Experiment Station

PROJECT LOCATION:

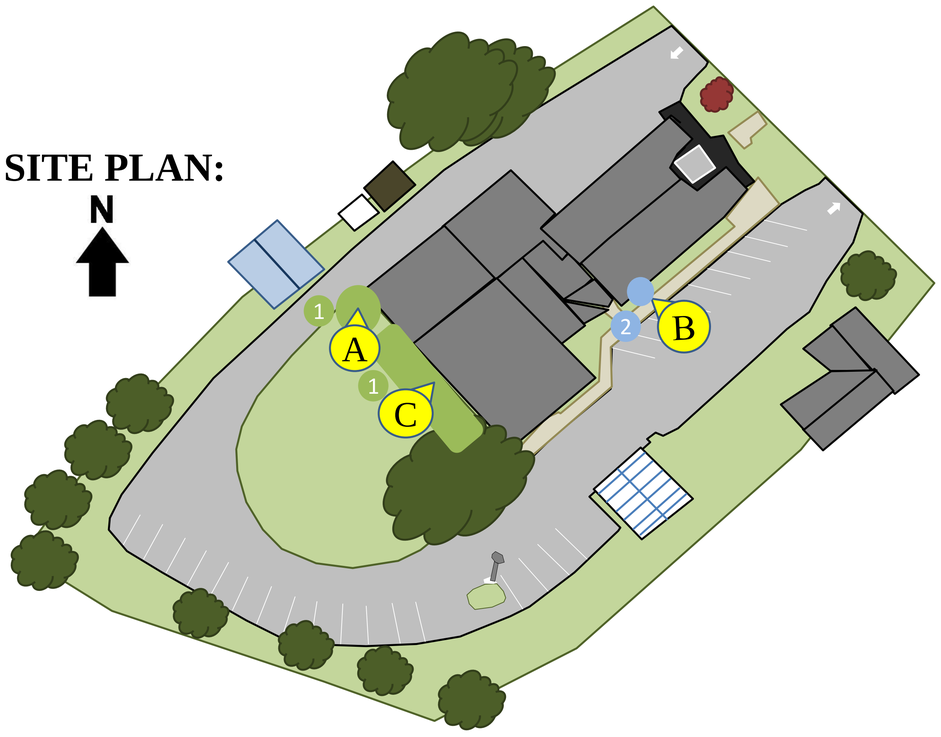


A

B

C

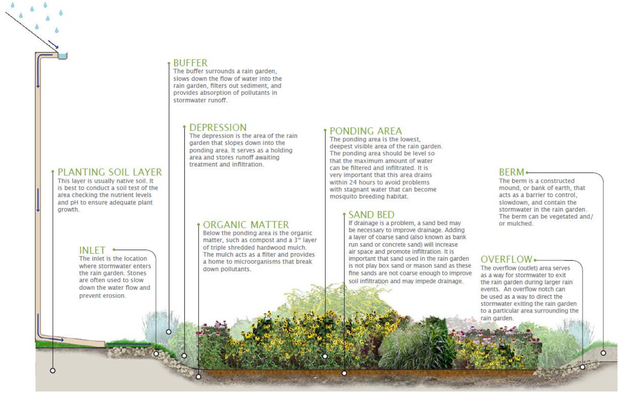
SITE PLAN:



1 **BIORETENTION SYSTEM:** A bioretention system could be installed near the northwestern corner of the building where downspouts drain into the grass as well as along the western side of the building. A bioretention system will reduce runoff and allow stormwater infiltration, decreasing the amount of contaminants that reaches catch basins.

2 **RAINWATER HARVESTING SYSTEM:** The rainwater harvesting system will help capture the stormwater that drains from the building's rooftop. Connecting the downspouts to the cistern will allow the stormwater to be collected and used for gardening.

1 BIORETENTION SYSTEM



2 RAINWATER HARVESTING SYSTEM

Stewartsville Presbyterian Church
Green Infrastructure Information Sheet

Location: 550 North Main Street Stewartsville, NJ 08886	**Municipality:** Greenwich Township
	Subwatershed: Pohatcong Creek
Green Infrastructure Description: bioretention system (rain garden) rainwater harvesting system (cistern)	**Targeted Pollutants:** total nitrogen (TN), total phosphorus (TP), and 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: 17,092 gal. bioretention system #2: 34,237 gal. cistern: 6,887 gal.

Existing Conditions and Issues:
This site is on North Main Street, and the project focuses on the turf grass area to the northwest face of the building. This area has an outflow from the inside of the building at the center of the building face. There is a downspout at each of the two corners of the western side of the rear building flowing into the area. There also is a community garden in the area. On the east side of the building there is a small planted area with a downspout.

Proposed Solution(s):
Two bioretention systems could be built on the church property. Bioretention system #1 could be installed in the turf grass area with a downspout directing rooftop runoff into it from the northwest corner of the rear building. Bioretention system #2 could be installed off the west side of the rear building where it could collect runoff from two downspouts. A cistern could be installed on the east side of the building by redirecting the downspout into it. The harvested water can be used to water the nearby plants and possibly the community garden.

Anticipated Benefits:
The bioretention systems are designed to capture and infiltrate stormwater runoff from the 2-year design storm (3.3 inches of rain over 24 hours), these systems will prevent approximately 95% of the TN, TP, and TSS from flowing directly into local waterways. A bioretention system would also provide ancillary benefits such as enhanced wildlife habitat and aesthetic appeal.

A cistern can harvest rainwater which can be used for watering plants or other purposes which cuts back on the use of potable water for nondrinking purposes.

Possible Funding Sources:
local community groups (Boy Scouts, Girl Scouts, etc.)
mitigation funds from local developers
NJDEP grant programs

Greenwich Township
Rutgers Cooperative Extension

Partners/Stakeholders:
Greenwich Township
parishioners
Stewartsville Presbyterian Church
Rutgers Cooperative Extension

Estimated Cost:
Bioretention system #1 would need to be approximately 160 square feet. At $5 per square foot, the estimated cost is $800. Bioretention system #2 would need to be approximately 330 square feet. At $5 per square foot, the estimated cost is $1,650. The rainwater harvesting system would consist of a 500 gallon slimline cistern, and the estimated cost is $1,000. The total estimated cost of the project is $3,450.