RUTGERS
New Jersey Agricultural
Experiment Station

Impervious Cover Assessment
for
Berlin Township, Camden County, New Jersey

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

September 28, 2016

WILLIAM PENN
FOUNDATION

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, 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 also has 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 car ways could be converted to one-way car 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

Berlin Township Cover Analysis

Located in Camden County in southern New Jersey, Berlin Township covers approximately 3.3 square miles. Figures 3 and 4 illustrate that Berlin Township is dominated by urban land uses. A total of 68.2% of the municipality's land use is classified as urban. Of the urban land in Berlin Township, medium density 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) 2012 land use/land cover geographical information system (GIS) data layer categorizes Berlin 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 Berlin Township. Based upon the 2012 NJDEP land use/land cover data, approximately 27.4% of Berlin Township has impervious cover. This level of impervious cover suggests that the streams in Berlin Township are likely non-supporting streams.

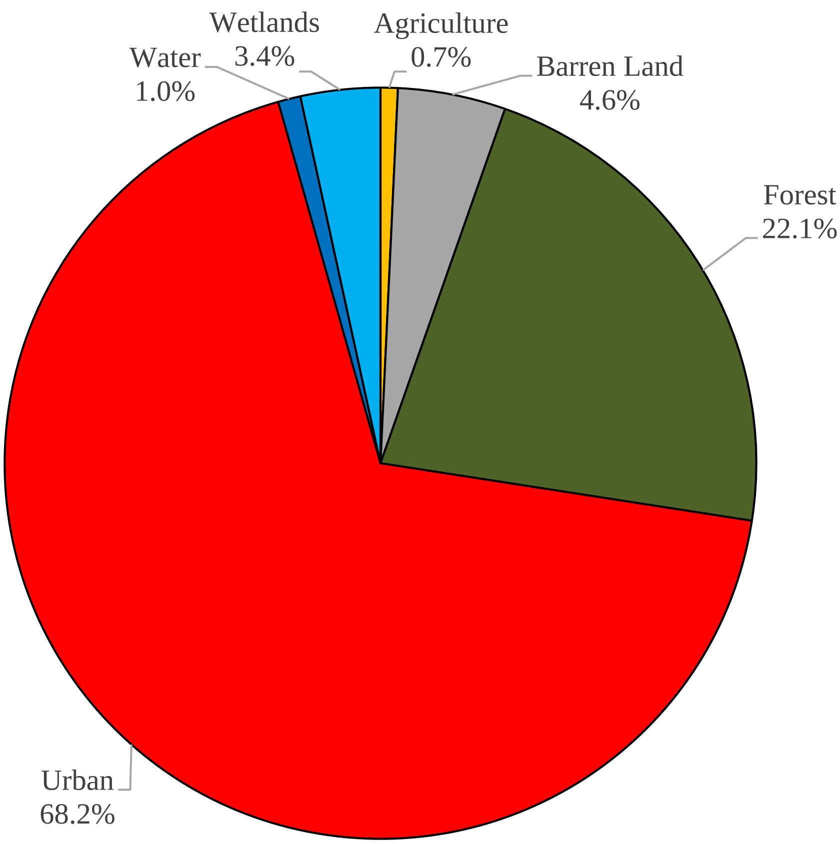


Figure 3: Pie chart illustrating the land use in Berlin Township

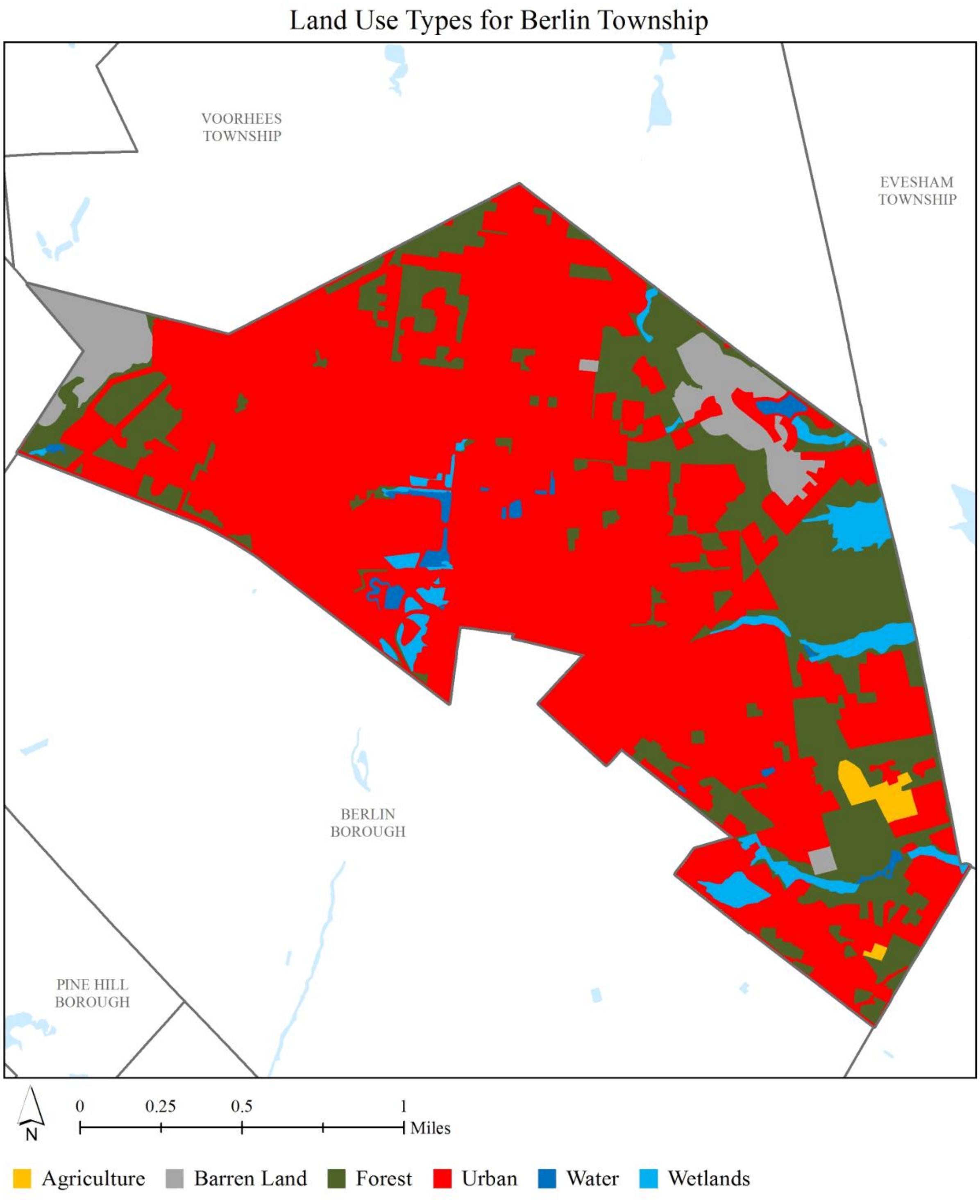


Figure 4: Map illustrating the land use in Berlin Township

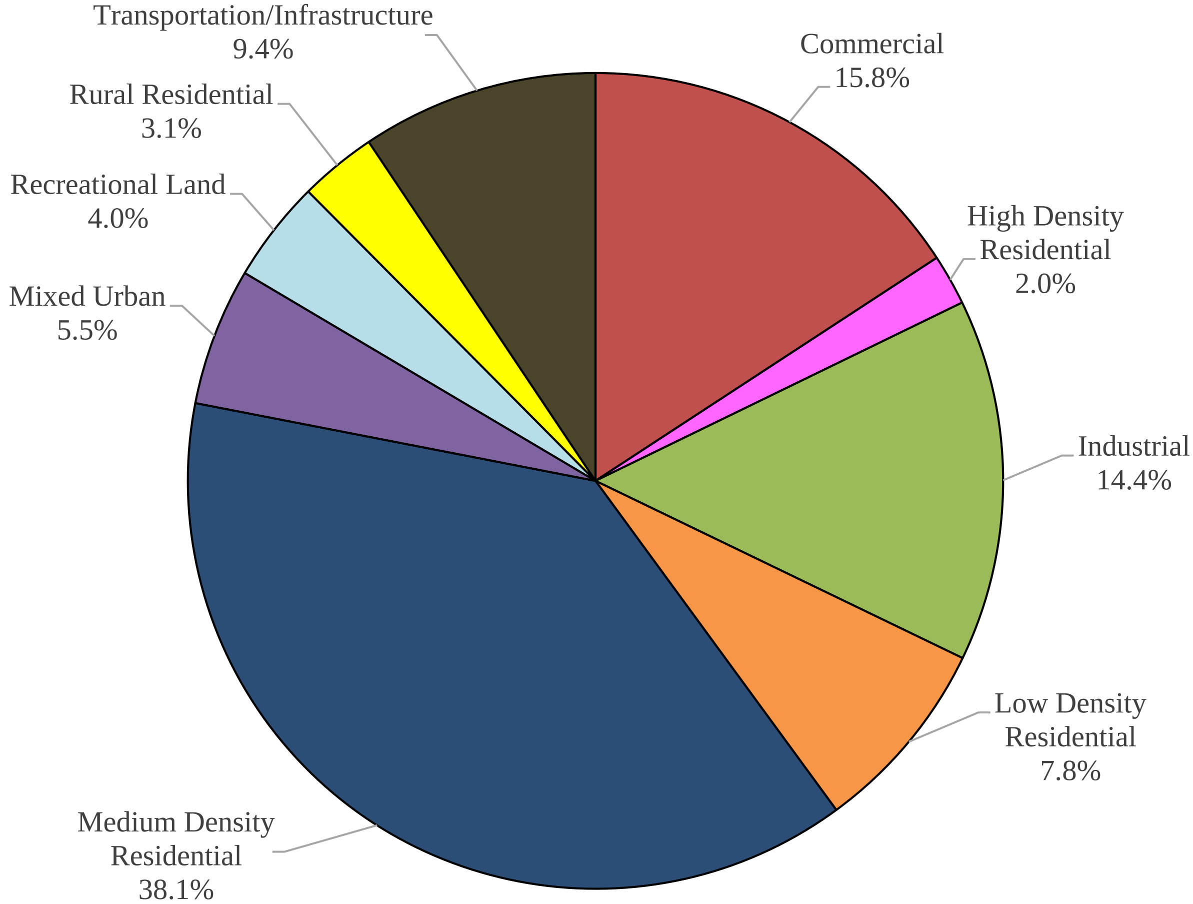


Figure 5: Pie chart illustrating the various types of urban land use in Berlin Township

Water resources are typically managed on a watershed/subwatershed basis; therefore an impervious cover analysis was performed for each subwatershed within Berlin Township (Table 1 and Figure 6). On a subwatershed basis, impervious cover ranges from 11.0% in the Big Timber Creek subwatershed to 37.5% in the Great Egg Harbor River subwatershed. Evaluating impervious cover on a subwatershed basis allows the municipality to focus impervious cover reduction or disconnection efforts in the 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 Berlin Township, Camden 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 (5.1 inches of rain), and the 100-year design storm (8.5 inches of rain). These runoff volumes are summarized in Table 2. A substantial amount of rainwater drains from impervious surfaces in Berlin Township. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Great Egg Harbor River subwatershed was harvested and purified, it could supply water to 87 homes for one year[1].

[1] Assuming 300 gallons per day per home

Table 1: Impervious cover analysis by subwatershed for Berlin Township

Subwatershed	Total Area		Land Use Area		Water Area		Impervious Cover		
	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(%)
Barton Run	324.8	0.51	324.8	0.51	0.0	0.00	104.3	0.16	32.1%
Big Timber Creek	178.5	0.28	177.6	0.28	0.8	0.00	19.5	0.03	11.0%
Great Egg Harbor River	755.8	1.18	743.3	1.16	12.6	0.02	278.6	0.44	37.5%
Kettle Run	540.0	0.84	535.5	0.84	4.5	0.01	103.6	0.16	19.4%
Mullica River	338.4	0.53	335.6	0.52	2.8	0.00	73.8	0.12	22.0%
Total	2,137.4	3.34	2,116.7	3.31	20.7	0.03	580.0	0.91	27.4%

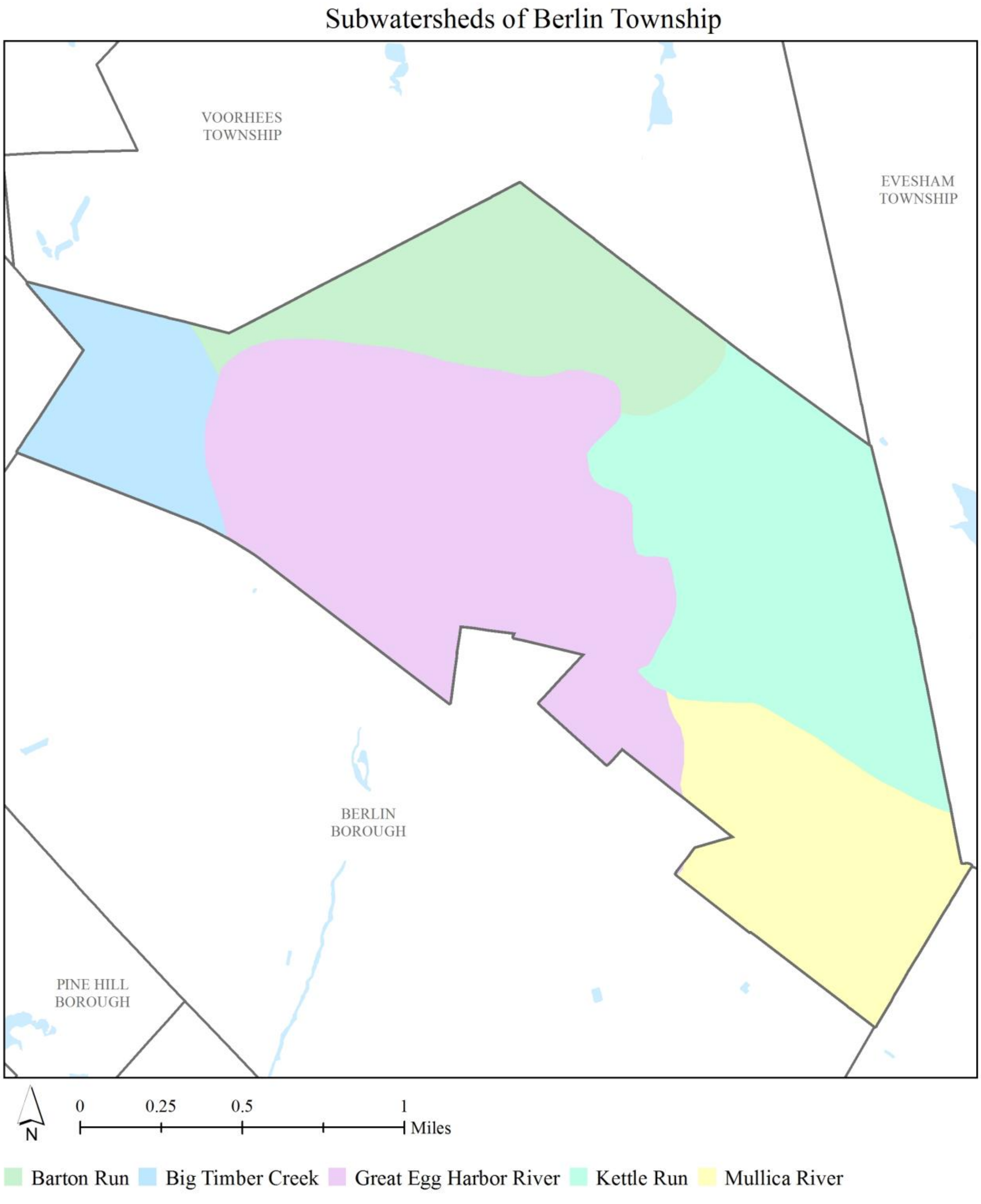


Figure 6: Map of the subwatersheds in Berlin Township

Table 2: Stormwater runoff volumes from impervious surfaces by subwatershed in Berlin 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 (5.1") (MGal)	Total Runoff Volume for the 100-Year Design Storm (8.5") (MGal)
Barton Run	3.5	124.6	9.9	14.7	23.5
Big Timber Creek	0.7	23.3	1.9	2.8	4.4
Great Egg Harbor River	9.5	332.8	26.5	39.3	62.8
Kettle Run	3.5	123.8	9.8	14.6	23.3
Mullica River	2.5	88.2	7.0	10.4	16.6
Total	19.7	692.9	55.1	81.9	130.7

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 Berlin 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, the 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 Berlin Township

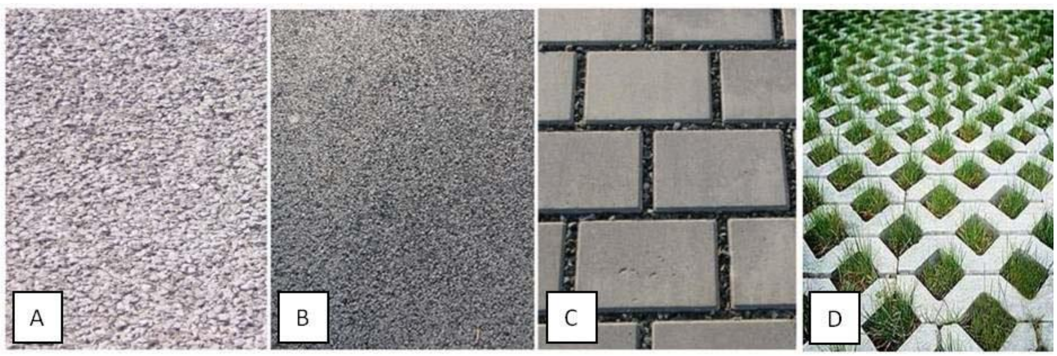
Subwatershed	**Recommended Impervious Area Reduction (10%) (ac)**	**Annual Runoff Volume Reduction[2] (MGal)**
Barton Run	10.4	11.8
Big Timber Creek	2.0	2.2
Great Egg Harbor River	27.9	31.6
Kettle Run	10.4	11.8
Mullica River	7.4	8.4
Total	58.0	65.8

[2] Annual Runoff Volume Reduction =
Acres of IC 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 BMPs should be designed to capture the first 3.3 inches of rain from each storm. This would allow the BMP 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 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 a 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 Berlin 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 Berlin 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

Berlin 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.

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Appendix A

Examples of Impervious Cover Reduction Action Plan Projects

Concept Plans and Detailed Green Infrastructure Information Sheets

Berlin Township
Impervious Cover Assessment
Greengrove Baptist Church, 240 Cushman Avenue

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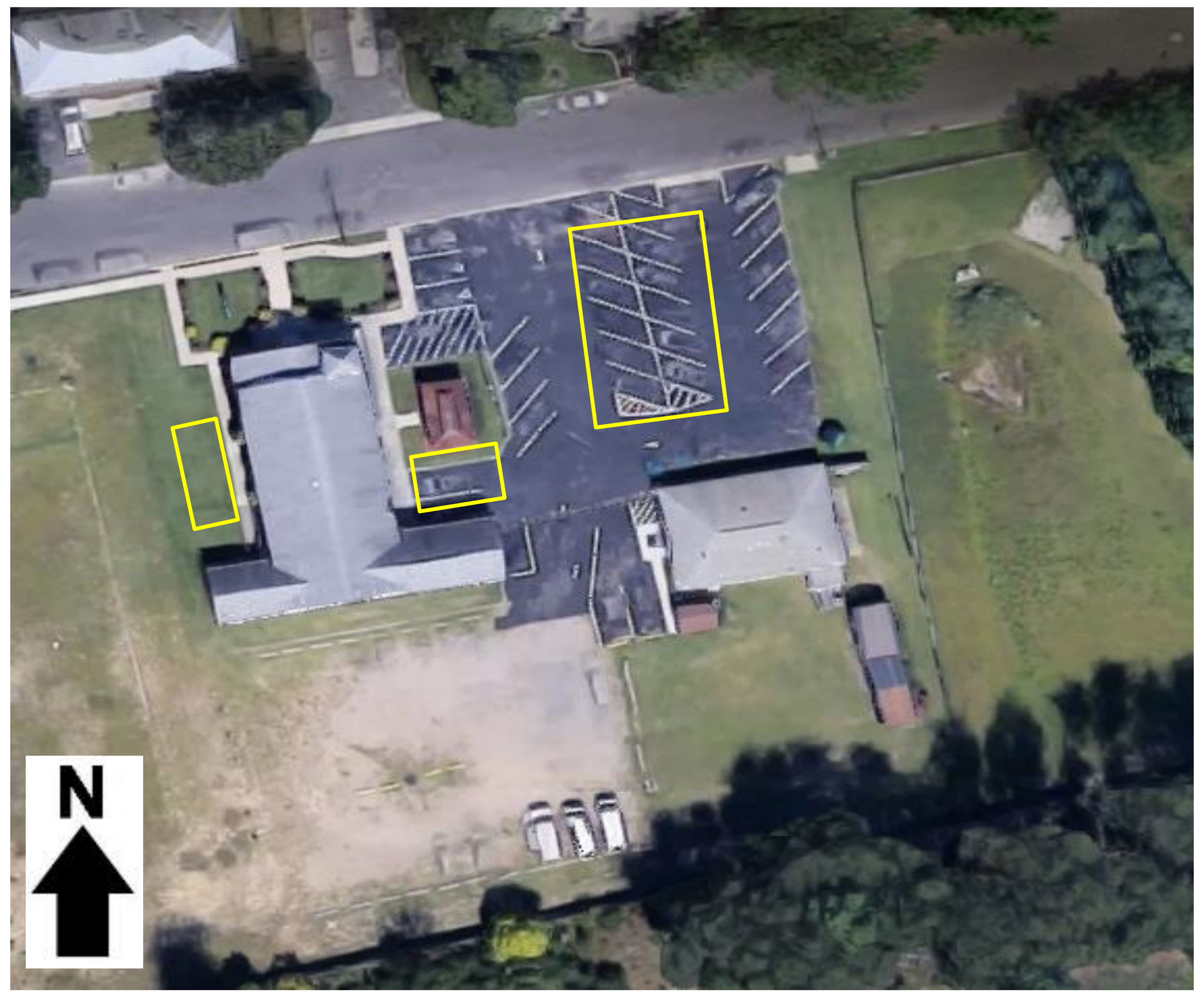
PROJECT LOCATION:



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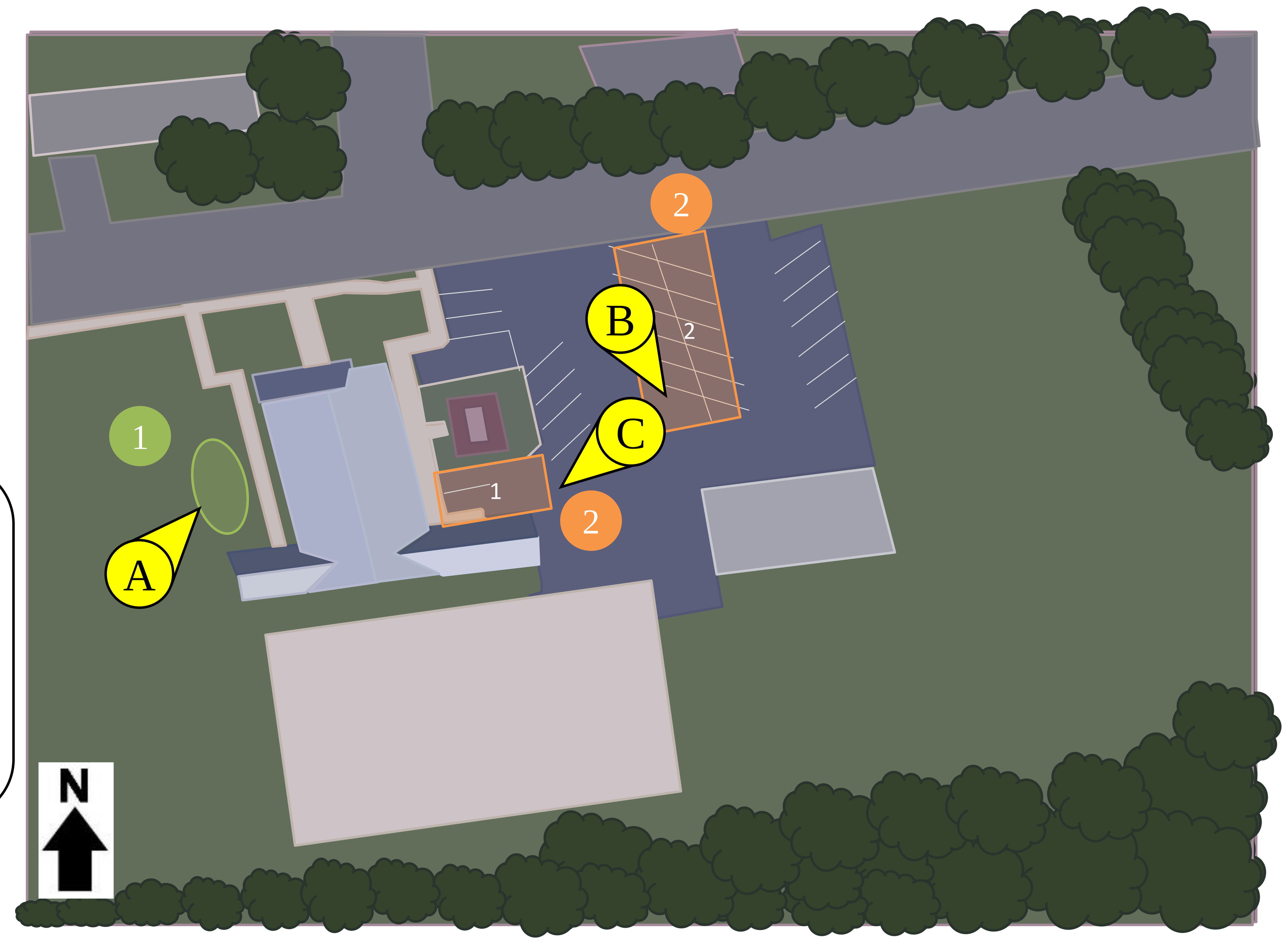
SITE PLAN:

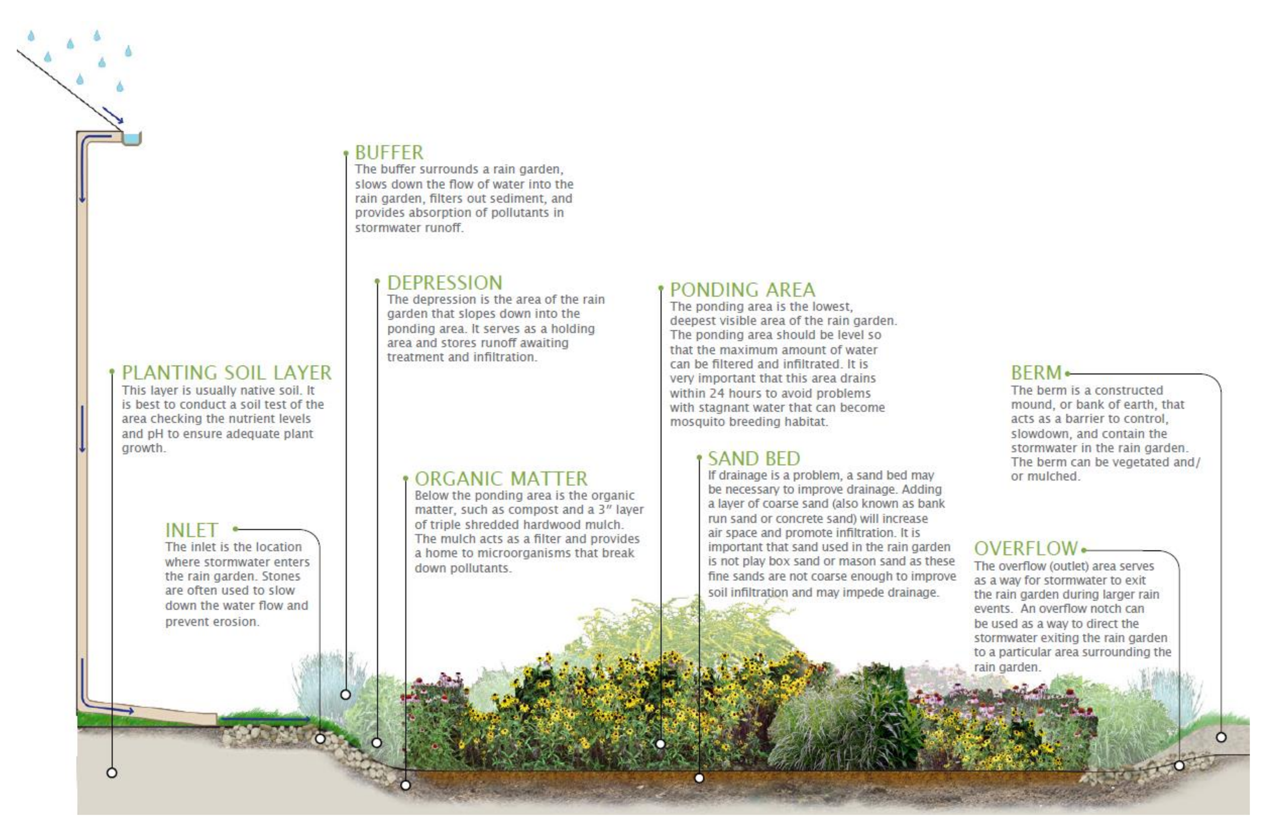


C

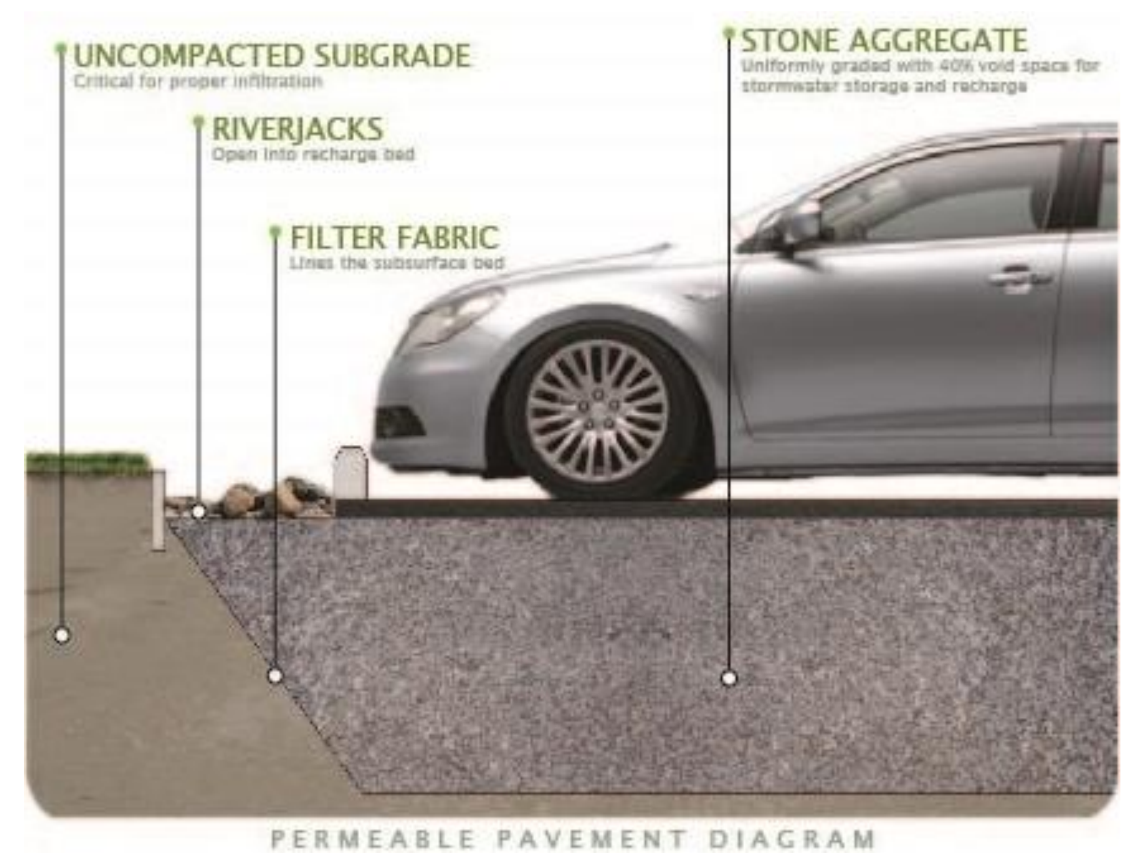
1 **BIORETENTION SYSTEMS:** Rain gardens can be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. This site has an area located on the west side of the building where a rain garden could collect the runoff from the downspouts coming off the building.

2 **POROUS PAVEMENT:** A portion of the northern parking lot can be retrofitted with porous pavement to allow some of the runoff from the parking lot to infiltrate. Additional runoff could be captured by redirecting roof runoff into porous parking spaces near the building.

1 BIORETENTION SYSTEM



2 POROUS PAVEMENT



Greengrove Baptist Church
Green Infrastructure Information Sheet

Location: 240 Cushman Avenue West Berlin, NJ 08901	**Municipality:** Camden County **Subwatershed:** Mullica River
Green Infrastructure Description: bioretention system (rain garden) porous pavement	**Targeted Pollutants:** total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes TSS removal potential: yes stormwater peak reduction potential: yes	**Stormwater Captured and Treated Per Year:** rain garden: 44,820 gal. porous pavement #1: 39,870 gal. porous pavement #2: 130,230 gal.

Existing Conditions and Issues:
A pavement area on the eastern side of the church has visible cracks. There is a catch basin at the bottom of the slope on the eastern hill as well as one broken downspout and one disconnected downspout on the eastern side of the building.

Proposed Solution(s):
A rain garden can be placed on the west side of the building by disconnecting downspouts into it. In the paved parking area adjacent to the building, porous pavement could be utilized to capture some runoff from the surrounding pavement as well as by directing downspouts into it. Additional porous pavement can be placed in parking spaces in the middle of the parking lot to capture water before reaching the catch basin located in the parking lot.

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. This bioretention system would provide additional benefits such as aesthetic appeal and wildlife habitat.

Porous pavement allows stormwater to penetrate 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
grants from foundations
home and school associations

Partners/Stakeholders:
Berlin Township
local community groups (Boy Scouts, Girl Scouts, etc.)
Rutgers Cooperative Extension

Estimated Cost:

The rain garden would be 430 square feet in size. At $5 per square foot, the estimated cost of the rain garden would be $2,150. The porous pavement adjacent to the building would be 560 square feet, and the porous pavement in the center of the parking lot would be 2,420 square feet. Each would have a 2-foot stone layer. At $25 per square foot, the cost would be $14,000 and $60,500 respectively. The total cost of the project will thus be approximately $76,650.

Berlin Township
Impervious Cover Assessment
Senior Center & Luke Avenue Sports Complex,
235 Pine Avenue

PROJECT LOCATION:

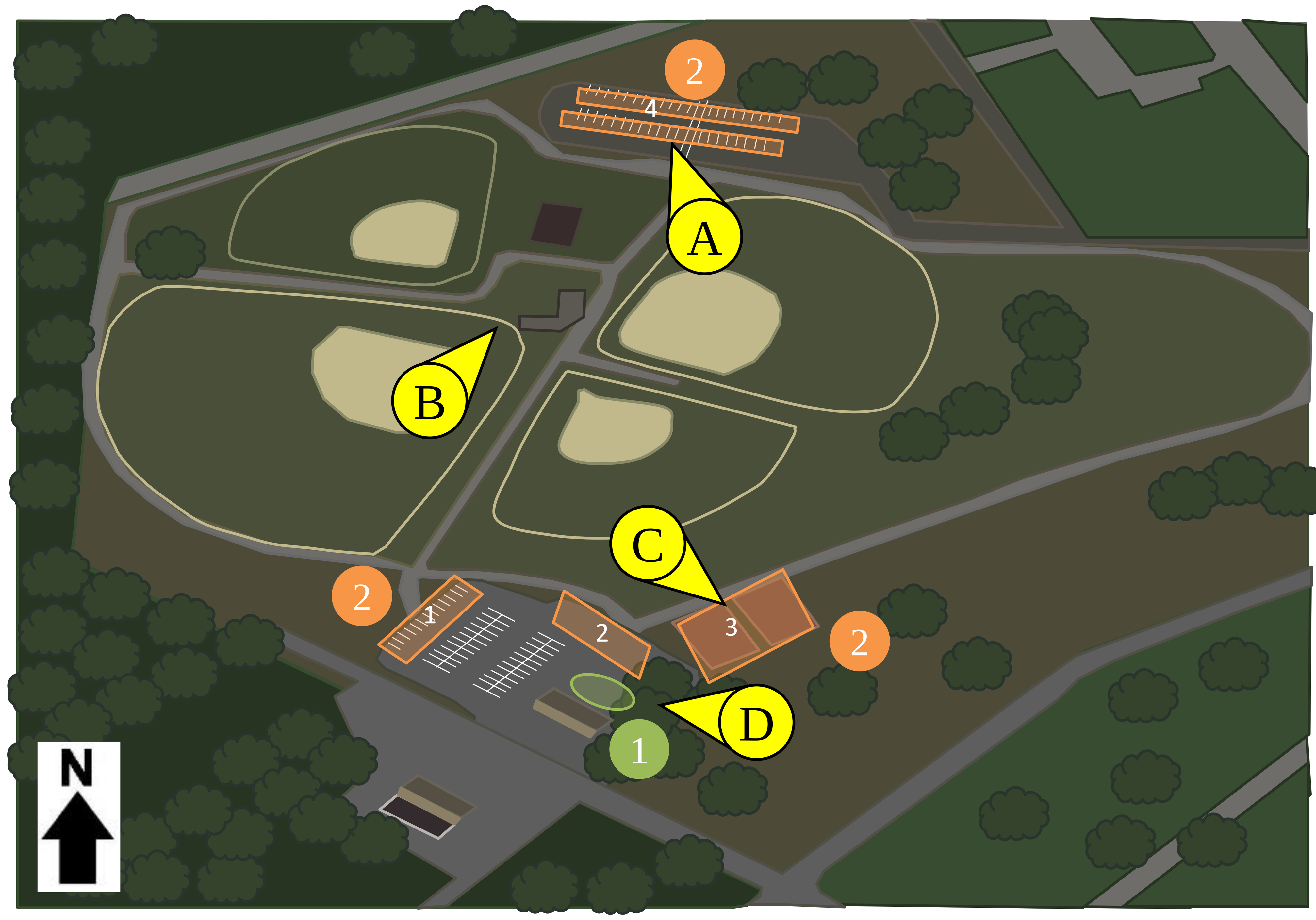
1 **BIORETENTION SYSTEMS:** Rain gardens will be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. A rain garden can be implemented behind the senior center to capture runoff from the rooftop.

2 **POROUS PAVEMENT:** Porous asphalt can be implemented to replace the existing impervious pavement in the the basketball courts and parking lot areas.

A

B

SITE PLAN:



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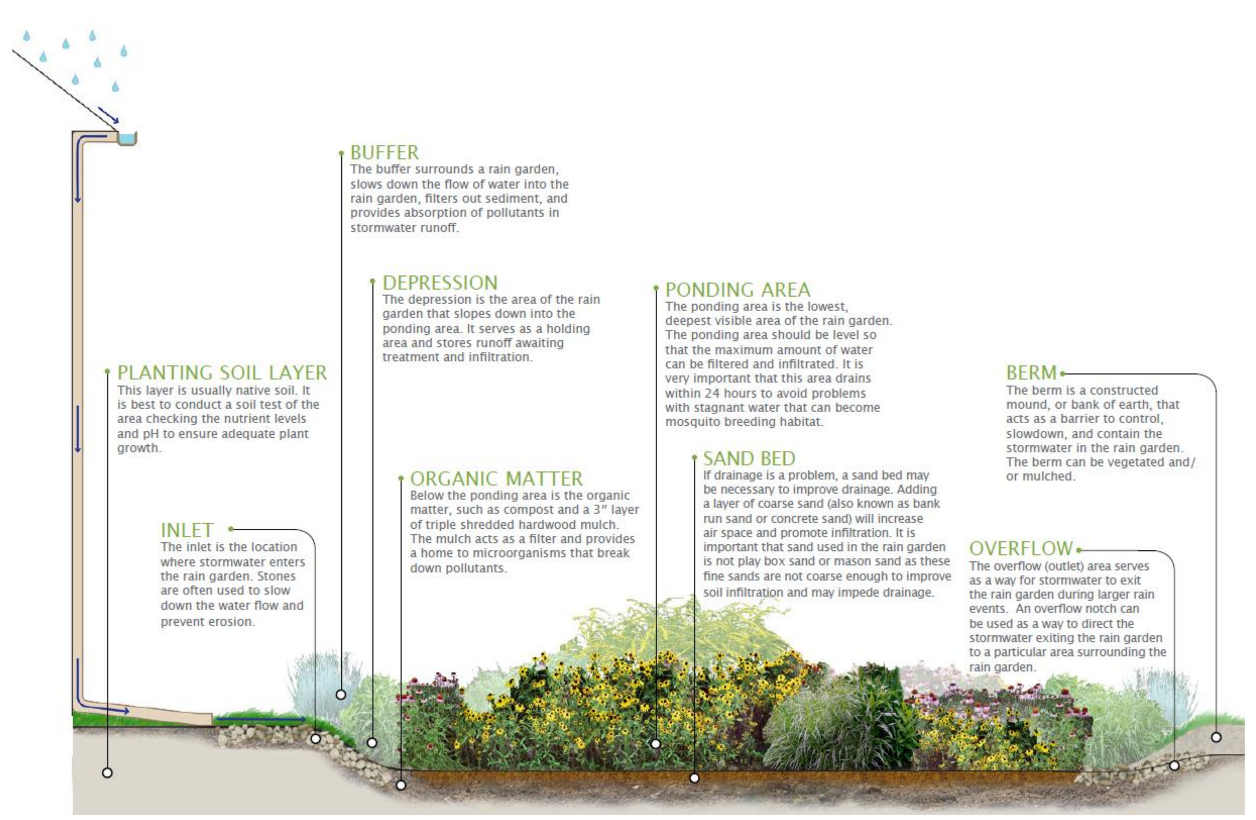
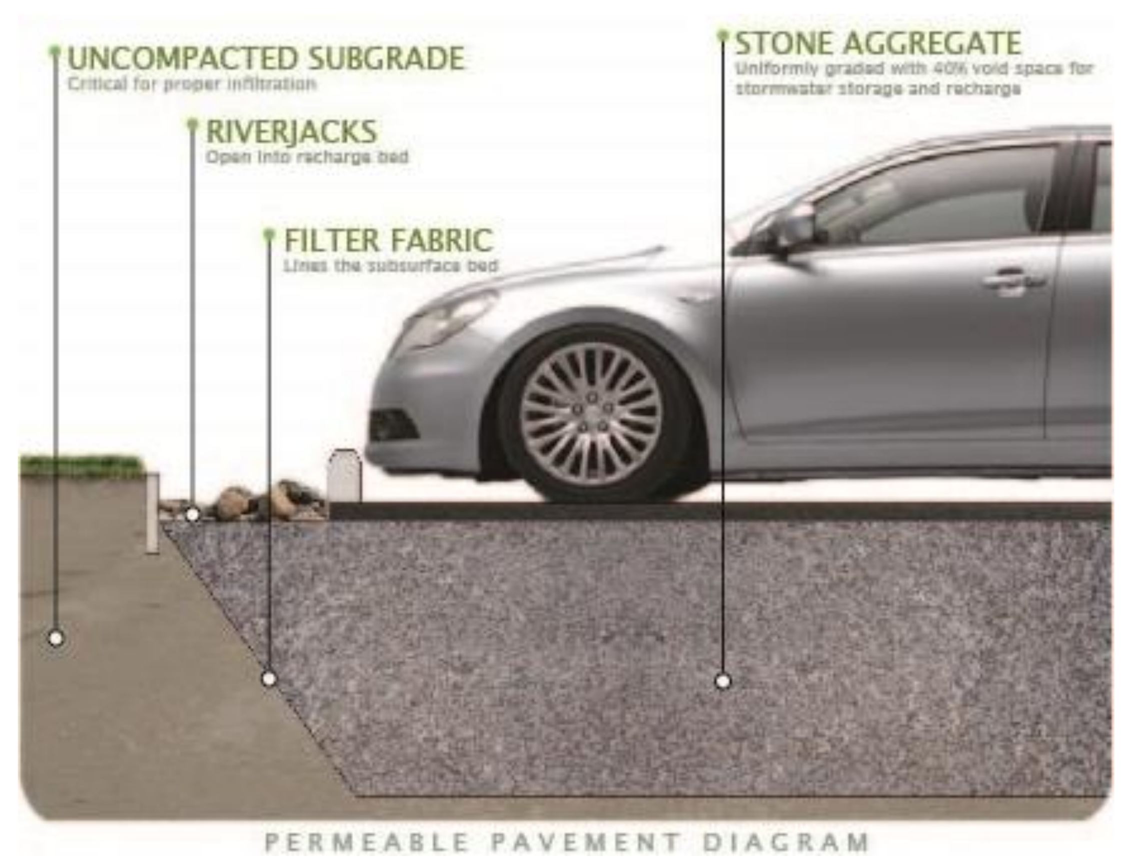
1 **BIORETENTION SYSTEM**



2 **POROUS PAVEMENT**



Senior Center & Luke Avenue Sports Complex
Green Infrastructure Information Sheet

Location: 235 Pine Avenue Berlin Township, NJ 08091	**Municipality:** Camden County **Subwatershed:** Lower Delaware
Green Infrastructure Description: bioretention system (rain garden) porous pavement	**Targeted Pollutants:** total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes TSS removal potential: yes stormwater peak reduction potential: yes	**Stormwater Captured and Treated Per Year:** rain garden: 68,790 gal. porous pavement #1: 593,270 gal. porous pavement #2: 232,940 gal. porous pavement #3: 292,450 gal. porous pavement #4: 798,075 gal.

Existing Conditions and Issues:
While a majority of the site is sports fields, there are many places where pooling water and visible damage to pavement can be seen, notably in the parking lots and basketball courts. The senior center building has two connected downspouts behind it adjacent to a grassed area.

Proposed Solution(s):
Porous pavement can be implemented in both the north and south parking lot area to capture runoff from the parking lots. The basketball courts could also be redone with porous pavement. A rain garden can be implemented behind the senior center.

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. This bioretention system would provide additional benefits such as aesthetic appeal and wildlife habitat.

Porous pavement allows stormwater to penetrate 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
grants from foundations
home and school associations

Partners/Stakeholders:
Township of Berlin
students and parents

local community groups (Boy Scouts, Girl Scouts, etc.)
Rutgers Cooperative Extension

Estimated Cost:
The rain gardens would be 660 square feet in size. At $5 per foot, the estimated cost of the rain gardens is $3,300. The sections of porous pavements would be 4,066 sq.ft, 2,368 sq.ft, 11,224 sq.ft, and 7,700 sq.ft. With a 2-foot stone layer, they would cost $101,650, $59,200, $280,600, and $192,500 respectively. The total cost of the project is thus approximately $637,250.

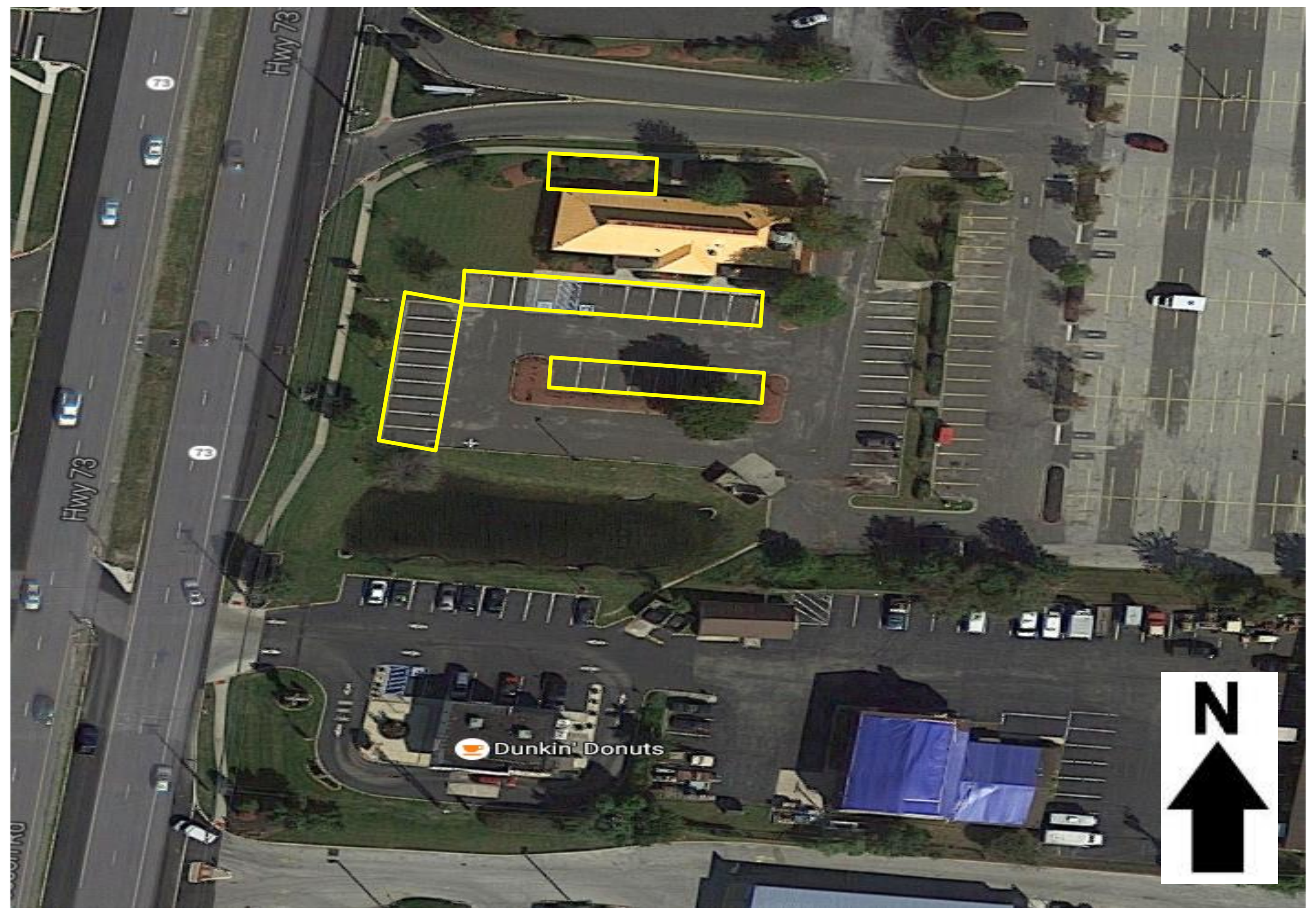
Berlin Township
Impervious Cover Assessment
AtlantiCare Urgent Care Center, 255 NJ-73

RUTGERS
New Jersey Agricultural Experiment Station

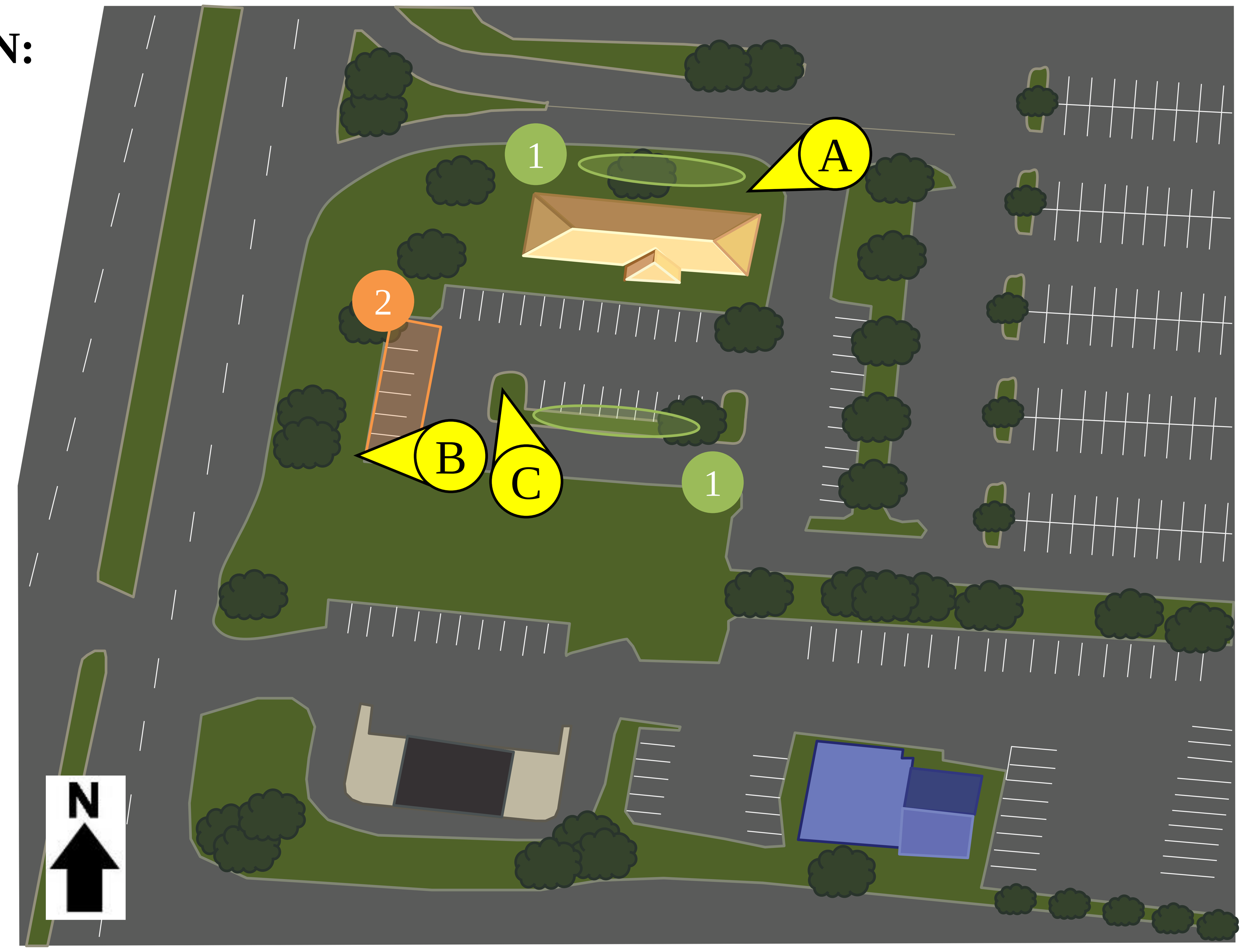
A

B

PROJECT LOCATION:



SITE PLAN:

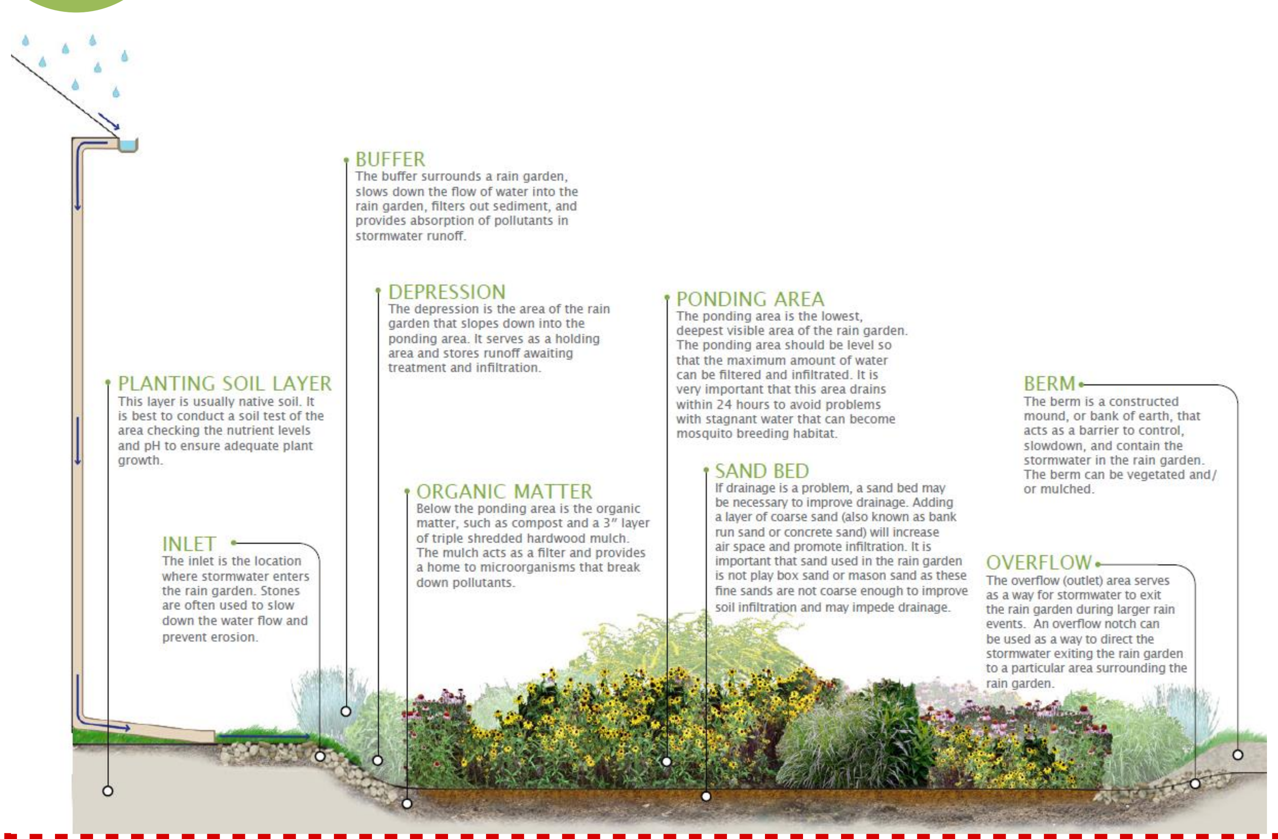


C

1 **BIORETENTION SYSTEMS:** Rain gardens will be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. Downspouts can be disconnected into a rain garden implemented at the northern face of the building. Curb cuts and a subsequent rain garden should be installed at the island in the middle of the parking lot to collect water from the nearby downspout.

2 **POROUS PAVEMENTS:** Porous pavement can be placed at the west end of the parking lot to capture runoff before reaching a nearby catch basin.

1 BIORETENTION SYSTEM



CURB CUT

2 POROUS PAVEMENT

Atlanticare Urgent Care Center

Green Infrastructure Information Sheet

Location:
255 NJ-73
Berlin, NJ 08091

Municipality:
Camden County

Subwatershed:
Great Egg Harbor River

Green Infrastructure Description:
bioretention system (rain garden)
porous pavement
curb cuts

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

Mitigation Opportunities:
recharge potential: yes
TSS removal potential: yes
stormwater peak reduction potential: yes

Stormwater Captured and Treated Per Year:
rain garden #1: 43,380 gal.
rain garden #2: 123,090 gal.
porous pavement: 213,650 gal.

Existing Conditions and Issues:
The parking area for AtlantiCare is eroded and cracking in certain areas. This shows pre-existing conditions of flooding and water damage. A grassed island is in the middle of the parking lot, and two catch basins are located along the west end of parking lot. The building has several downspouts located on the north side of the building adjacent to a sizeable grassed area.

Proposed Solution(s):
A rain garden can be implemented in the grassed area on the north side of the building by directing downspouts into it to capture rooftop runoff. Curb cuts could be used in the parking lot island to direct runoff into a rain garden that could be implemented in that area. Porous pavement can be placed in along the west end of the parking lot to capture runoff before reaching the catch basins.

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. This bioretention system would provide additional benefits such as aesthetic appeal and wildlife habitat.

Porous pavement allows stormwater to penetrate 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
grants from foundations
home and school associations

Partners/Stakeholders:
Berlin Township

local community groups (Boy Scouts, Girl Scouts, etc.) Rutgers Cooperative Extension
Estimated Cost: Rain garden #1 would be 420 square feet in size. At $5 per square foot, the estimated cost of the rain garden would be $2,100. Rain garden #2 would be 1,180 square feet in size. At $5 per square foot, the estimated cost of the rain garden would be $5,900. The porous pavement would be 1,678 square feet with a 2-foot stone layer. At $25 per square foot, the cost would be $41,950. The total cost of the project will thus be approximately $49,950.