RUTGERS
New Jersey Agricultural
Experiment Station

Draft

Impervious Cover Assessment
for
Readington Township, Hunterdon County, New Jersey

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

February 3, 2015

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

Readington Township Impervious Cover Analysis

Located in Hunterdon County in central New Jersey, Readington Township covers approximately 47.8 square miles. Figures 3 and 4 illustrate that Readington Township is dominated by urban land uses. Approximately 34.5% of the municipality's land use is classified as urban. Of the urban land in Readington Township, rural residential development 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 Readington 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 Readington Township. Based upon the 2007 NJDEP land use/land cover data, approximately 5.7% of Readington Township has impervious cover. This level of impervious cover suggests that the streams in Readington Township are likely sensitive streams.

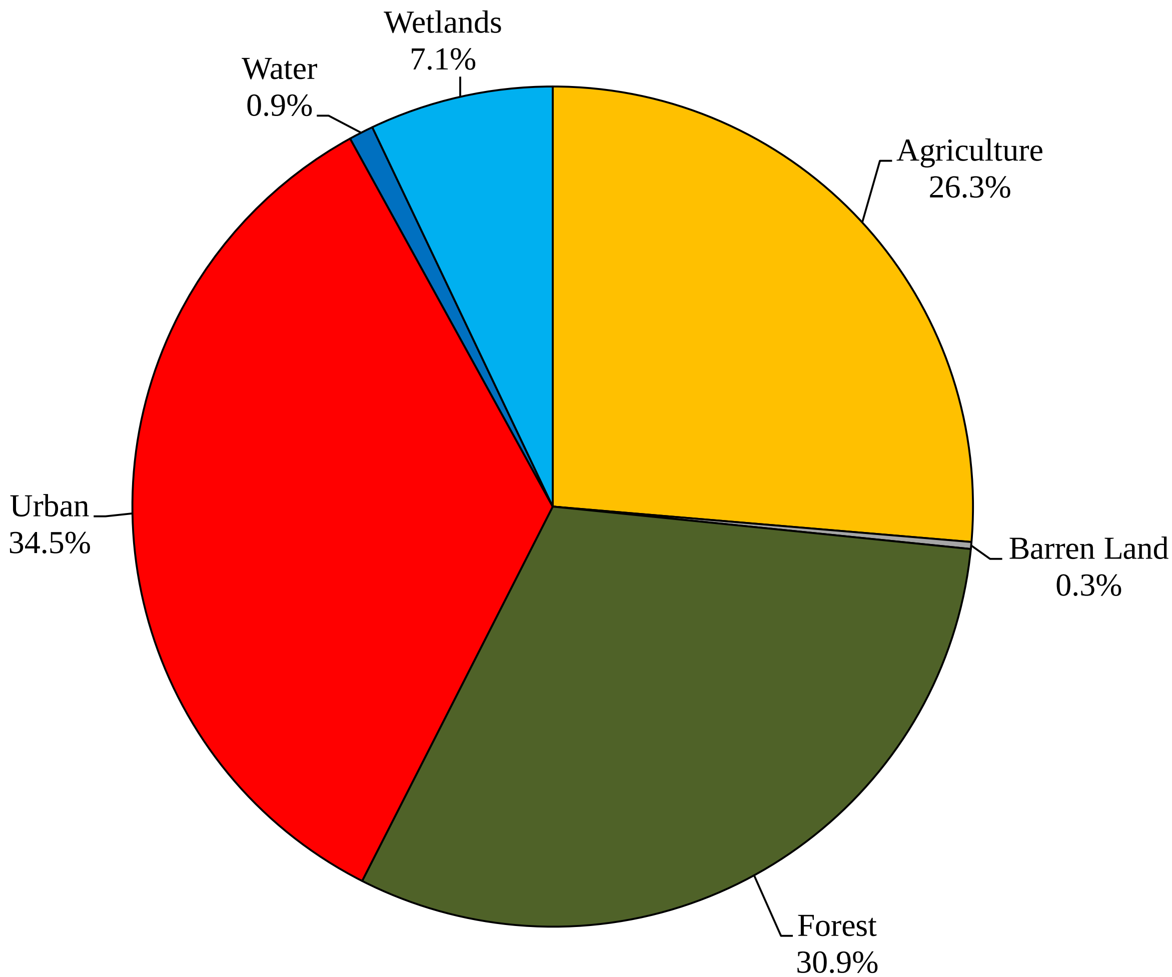


Figure 3: Pie chart illustrating the land use in Readington Township

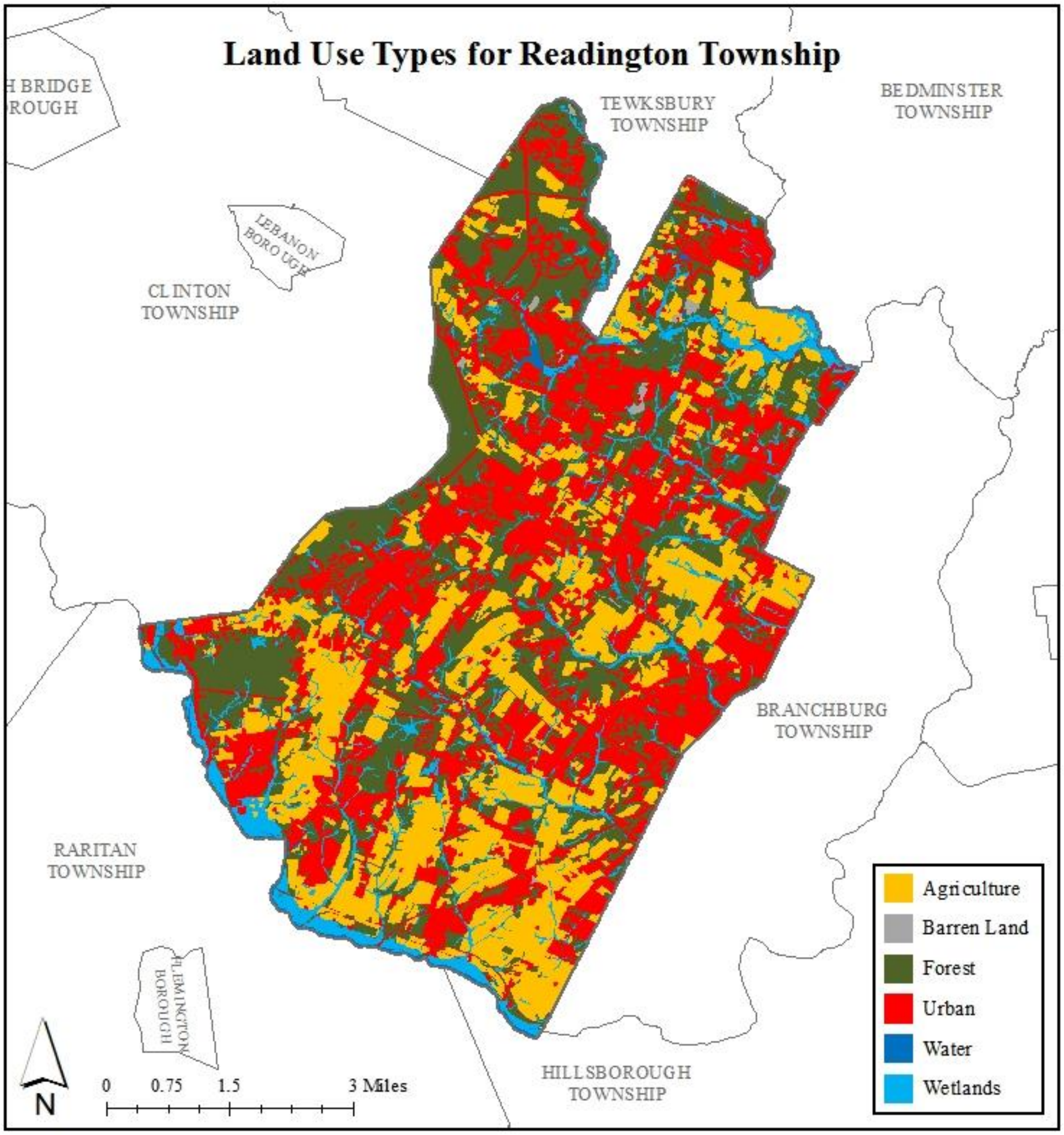


Figure 4: Map illustrating the land use in Readington Township

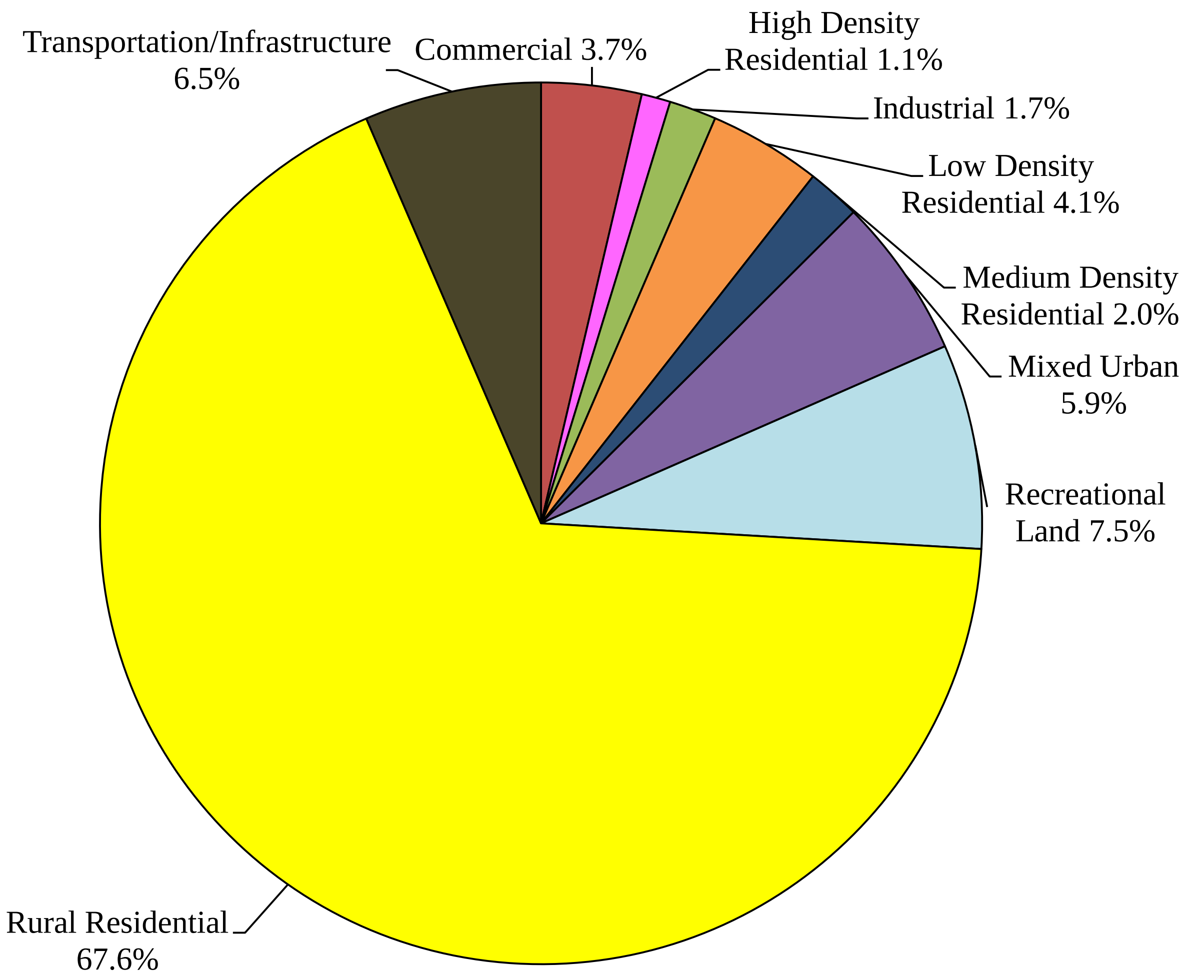


Figure 5: Pie chart illustrating the various types of urban land use in Readington Township

Water resources are typically managed on a watershed/subwatershed basis; therefore an impervious cover analysis was performed for each Raritan River subwatershed within Readington Township (Table 1 and Figure 6). On a subwatershed basis, impervious cover ranges from 3.6% in the Lamington River and the Prescott Brook/ Round Valley Reservoir subwatersheds to 9.1% in the Rockaway Creek 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 Readington Township, Hunterdon 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 (3.4 inches of rain), the 10-year design storm (5.0 inches of rain), and the 100-year design storm (8.0 inches of rain). These runoff volumes are summarized in Table 2. A substantial amount of rainwater drains from impervious surfaces in Readington Township. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Rockaway Creek subwatershed was harvested and purified, it could supply water to 125 homes for one year[1].

[1] Assuming 300 gallons per day per home

Table 1: Impervious cover analysis by subwatershed for Readington Township

Subwatershed	Total Area		Land Use Area		Water Area		Impervious Cover		
	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(%)
Chambers Brook	4,017.8	6.28	4,002.6	6.25	15.2	0.02	314.5	0.49	7.9%
Holland Brook	6,015.7	9.40	5,992.0	9.36	23.7	0.04	328.4	0.51	5.5%
Lamington River	3,057.7	4.78	2,997.5	4.68	60.2	0.09	106.5	0.17	3.6%
Pleasant Run	5,298.1	8.28	5,269.6	8.23	28.5	0.04	230.7	0.36	4.4%
Prescott Brook/ Round Valley Reservoir	541.6	0.85	536.2	0.84	5.35	0.01	19.3	0.03	3.6%
Raritan River South Branch	7,171.0	11.2	7,077.8	11.1	93.2	0.15	330.5	0.52	4.7%
Rockaway Creek	4,510.3	7.05	4,447.6	6.95	62.7	0.10	403.1	0.63	9.1%
Total	30,612.2	47.8	30,323.2	47.4	288.9	0.45	1,733.0	2.71	5.7%

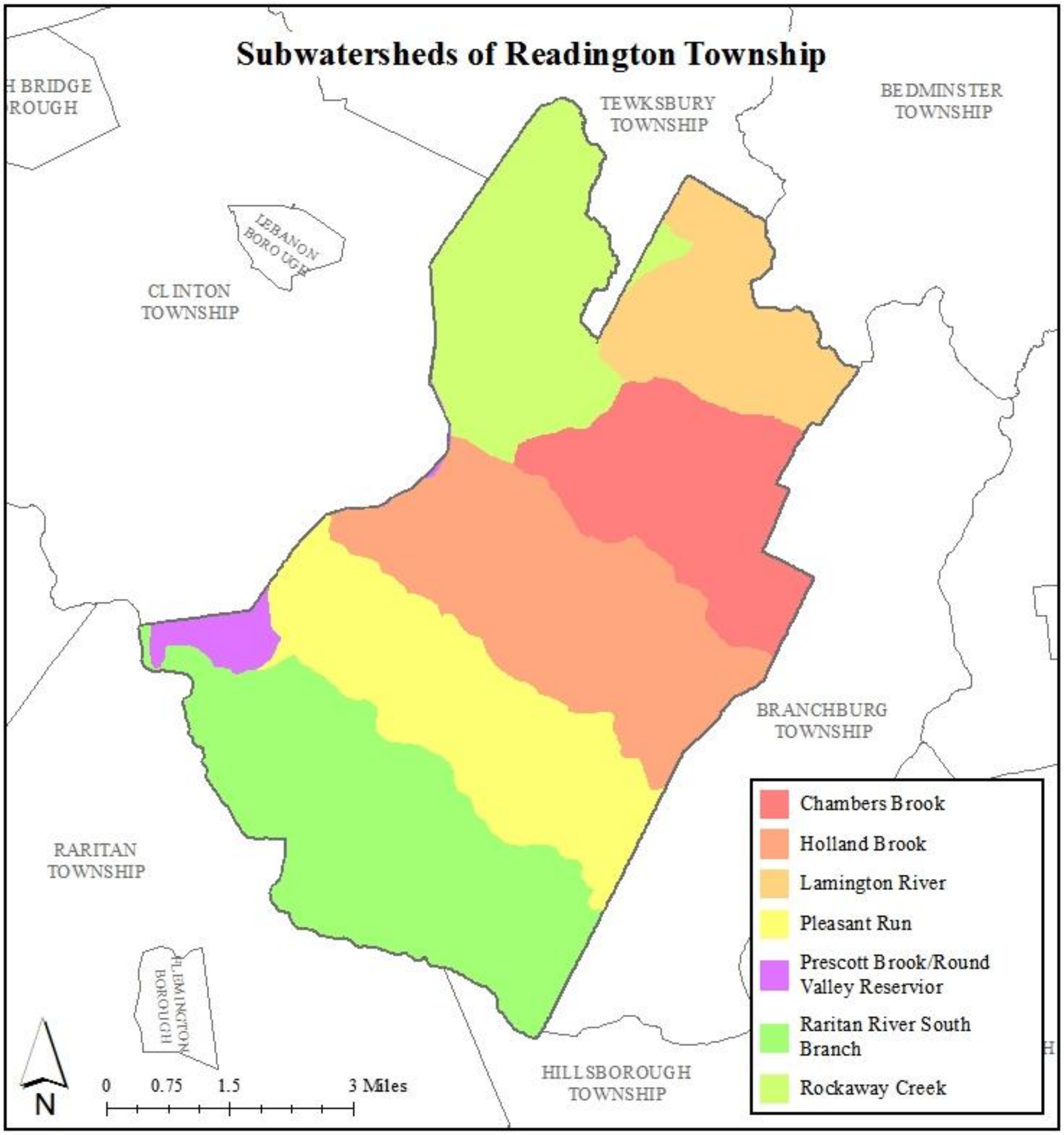


Figure 6: Map of the subwatersheds in Readington Township

Table 2: Stormwater runoff volumes from impervious surfaces by subwatershed in Readington 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 (3.4") (MGal)	Total Runoff Volume for the 10-Year Design Storm (5.0") (MGal)	Total Runoff Volume for the 100-Year Design Storm (8.0") (MGal)
Chambers Brook	10.7	375.7	29.0	42.7	68.3
Holland Brook	11.1	392.4	30.3	44.6	71.3
Lamington River	3.6	127.2	9.8	14.5	23.1
Pleasant Run	7.8	275.7	21.3	31.3	50.1
Prescott Brook Round Valley Reservoir	0.7	23.1	1.8	2.6	4.2
Raritan River South Branch	11.2	394.8	30.5	44.9	71.8
Rockaway Creek	13.7	481.6	37.2	54.7	87.6
Total	58.8	2,070.4	160.0	235.3	376.4

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 Readington 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 (3.4 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 Readington Township

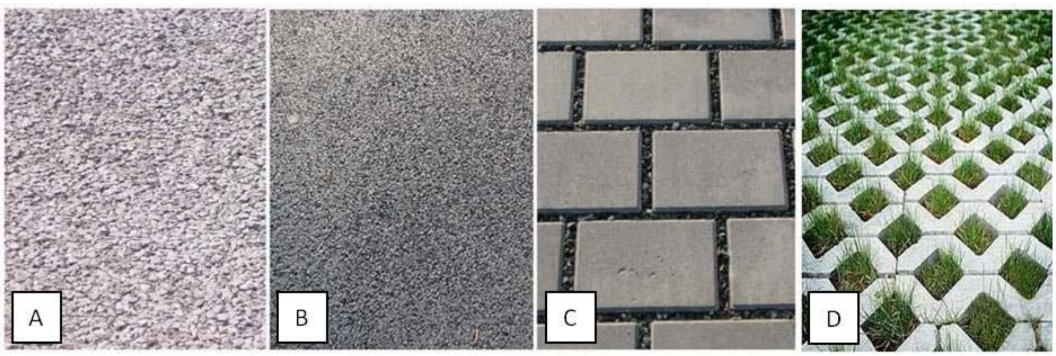
Subwatershed	**Recommended Impervious Area Reduction (10%) (ac)**	**Annual Runoff Volume Reduction [2] (MGal)**
Chambers Brook	31.5	35.7
Holland Brook	32.8	37.3
Lamington River	10.7	12.1
Pleasant Run	23.1	26.2
Prescott Brook/ Round Valley Reservoir	1.9	2.2
Raritan River South Branch	33.1	37.5
Rockaway Creek	40.3	45.8
Total	173.4	196.8

[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 3.4 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 Readington 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 Readington Township, four 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

Readington 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

Readington Township
Impervious Cover Assessment
Holland Brook School, 52 Readington Road

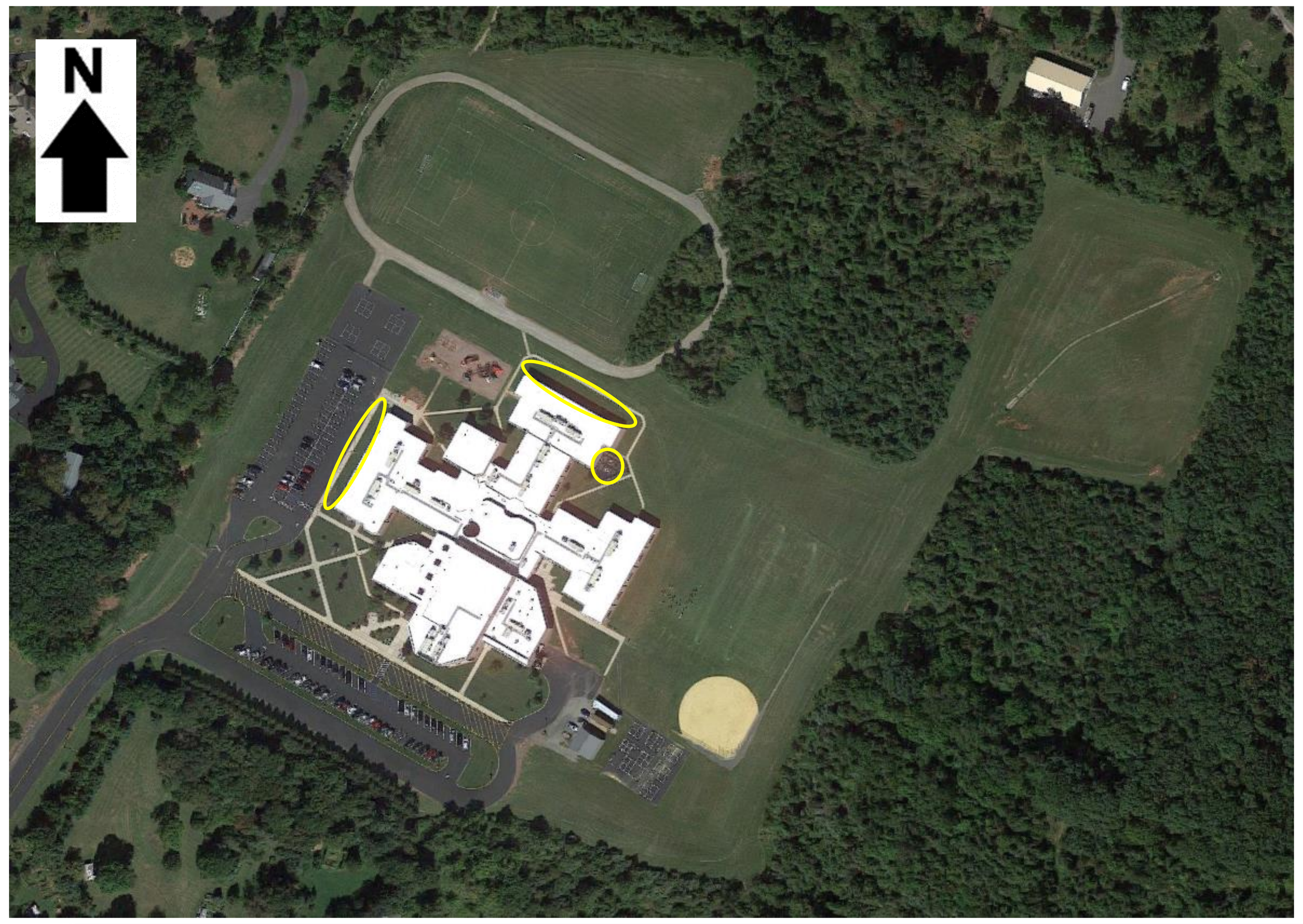
A

B

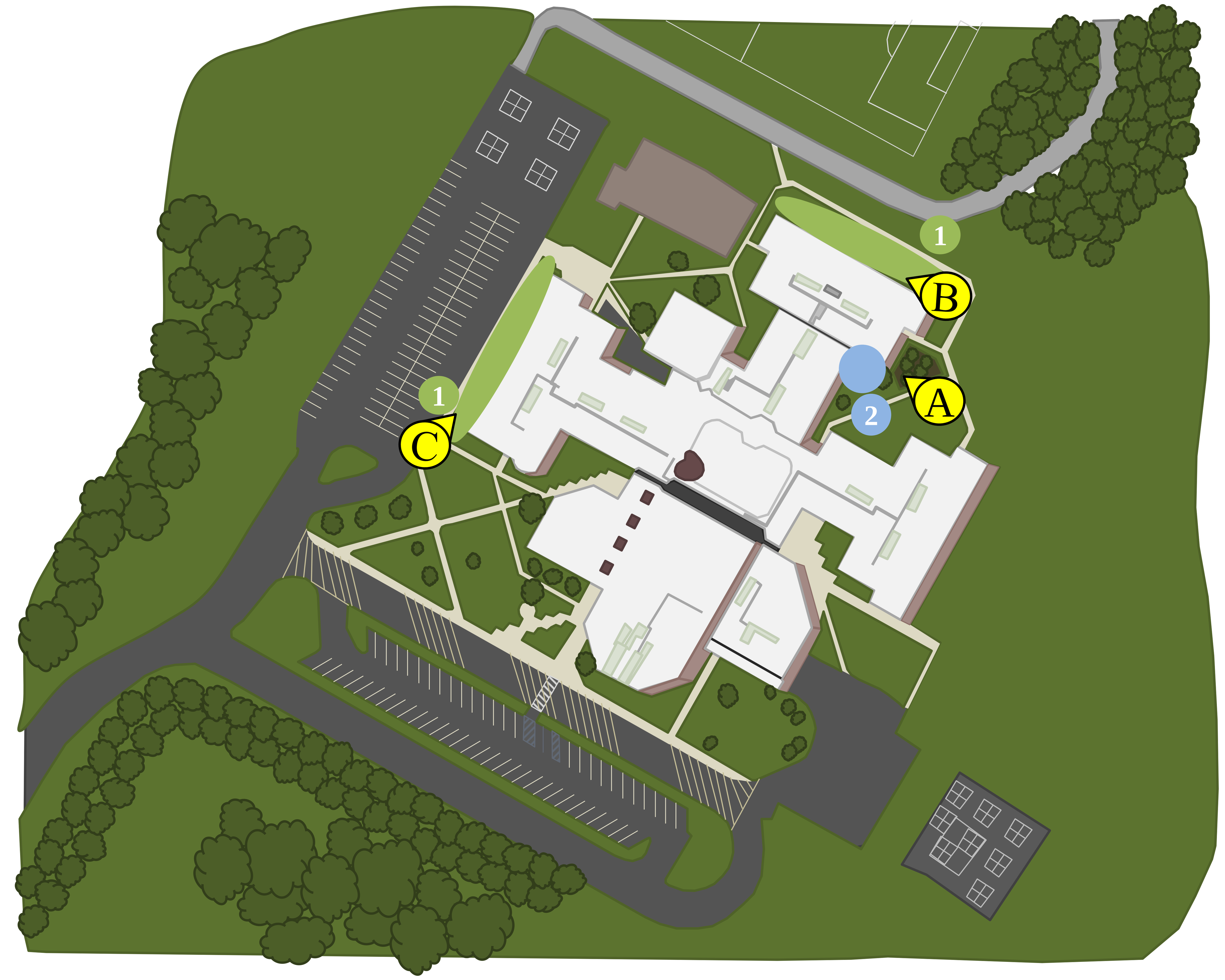
C

Rutgers New Jersey Agricultural Experiment Station

PROJECT LOCATION:



SITE PLAN:

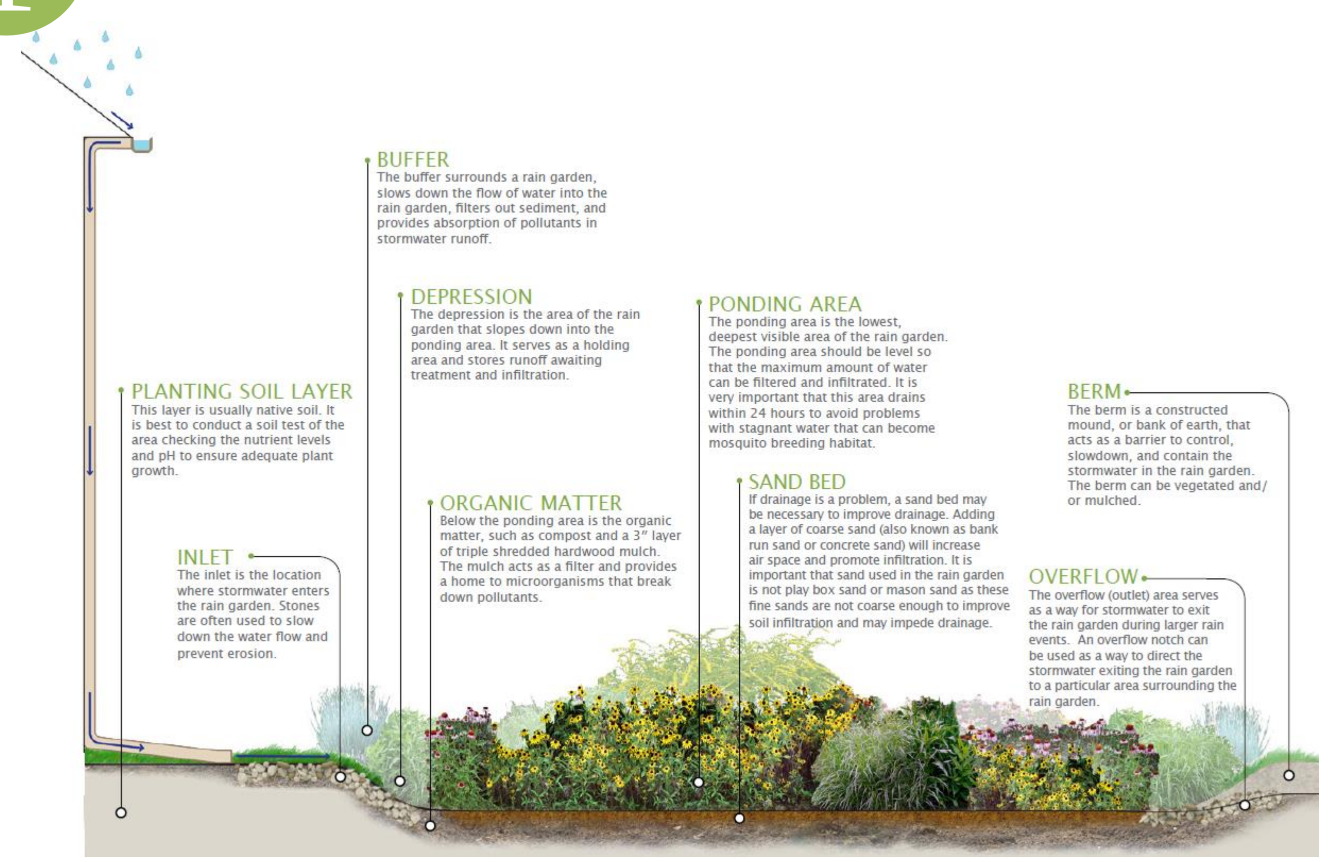


1 **BIORETENTION SYSTEM:** Bioretention systems could be installed along the sides of the school after disconnecting several downspouts. Bioretention systems will reduce runoff and allow stormwater infiltration, decreasing the amount of contaminants reaching catch basins.

2 **RAINWATER HARVESTING SYSTEM:** Rainwater could be harvested from the roof of the school and stored in a cistern. The water can be used to water the existing gardens.

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

1 BIORETENTION SYSTEM



2 RAINWATER HARVESTING SYSTEM

EDUCATIONAL PROGRAM

Holland Brook School
Green Infrastructure Information Sheet

Location: 52 Readington Road Whitehouse Station, NJ 08889	**Municipality:** Readington Township **Subwatershed:** Holland Brook and Chambers Brook
Green Infrastructure Description: bioretention systems (rain gardens) youth education program rainwater harvesting	**Targeted Pollutants:** total nitrogen (TN), total phosphorous (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:** disconnecting downspouts: 273,750 gal. rain garden #1: 143,799 gal. rain garden #2: 112,040 gal. cistern: 15,200 gal.

Existing Conditions and Issues:
On the western part of the school near the parking lot, there are four connected downspouts in a turf grass area that show signs of flooding and erosion. In the back of the school there are four connected downspouts in a turf grass area that slopes down near a trail. Around the corner from the last location, there is a garden with a connected downspout close by.

Proposed Solution(s):
On the northwest part of the school, the connected downspouts can be disconnected and redirected to flow to a bioretention system. The same procedure can be done to all four downspouts located on the northeast side of the school. In the area of the existing garden, the one connected downspout can be disconnected and redirected to cistern. The rainwater collected in the cistern can be used to water the existing garden.

Anticipated Benefits:
Since the bioretention systems would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.4 inches of rain over 24 hours), these systems are estimated to achieve a 95% pollutant load reduction for TN, TP, and TSS. This bioretention system would provide additional benefits such as aesthetic appeal and wildlife habitat. Rutgers Cooperative Extension could 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 Readington Township Department of Public Works staff to launch educational programming. A cistern can be used to harvest rainwater which can be used for watering plants or other purposes which reduce the use of potable water for non-drinking purposes. The cistern would reduce the pollutant loading by 90% during the periods it is operational (i.e., it would not be used in the winter when there is a chance of freezing). The simple disconnection also would reduce the pollutant loading by 90% since it will manage the water quality design storm of 1.25 inches of rain.

Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs
grants from foundations
home and school associations

Partners/Stakeholders:
Readington Township
students and parents
local community groups (Boy Scouts, Girl Scouts, etc.)
NY/NJ Baykeeper
Raritan Riverkeeper
Rutgers Cooperative Extension

Estimated Cost:
To disconnect all downspouts the area needed is about 2,310 square feet and cost about $2,250. Rain garden #1 would need to be approximately 1,380 square feet. At $5 per square foot, the estimated cost is $6,900. Rain garden #2 would need to be approximately 1,075 square feet. At $5 per square foot, the estimated cost is $5,375. The cistern would need to be approximately 1,000 gallons and would cost approximately $2,000. The total cost of the project would be approximately $16,525.

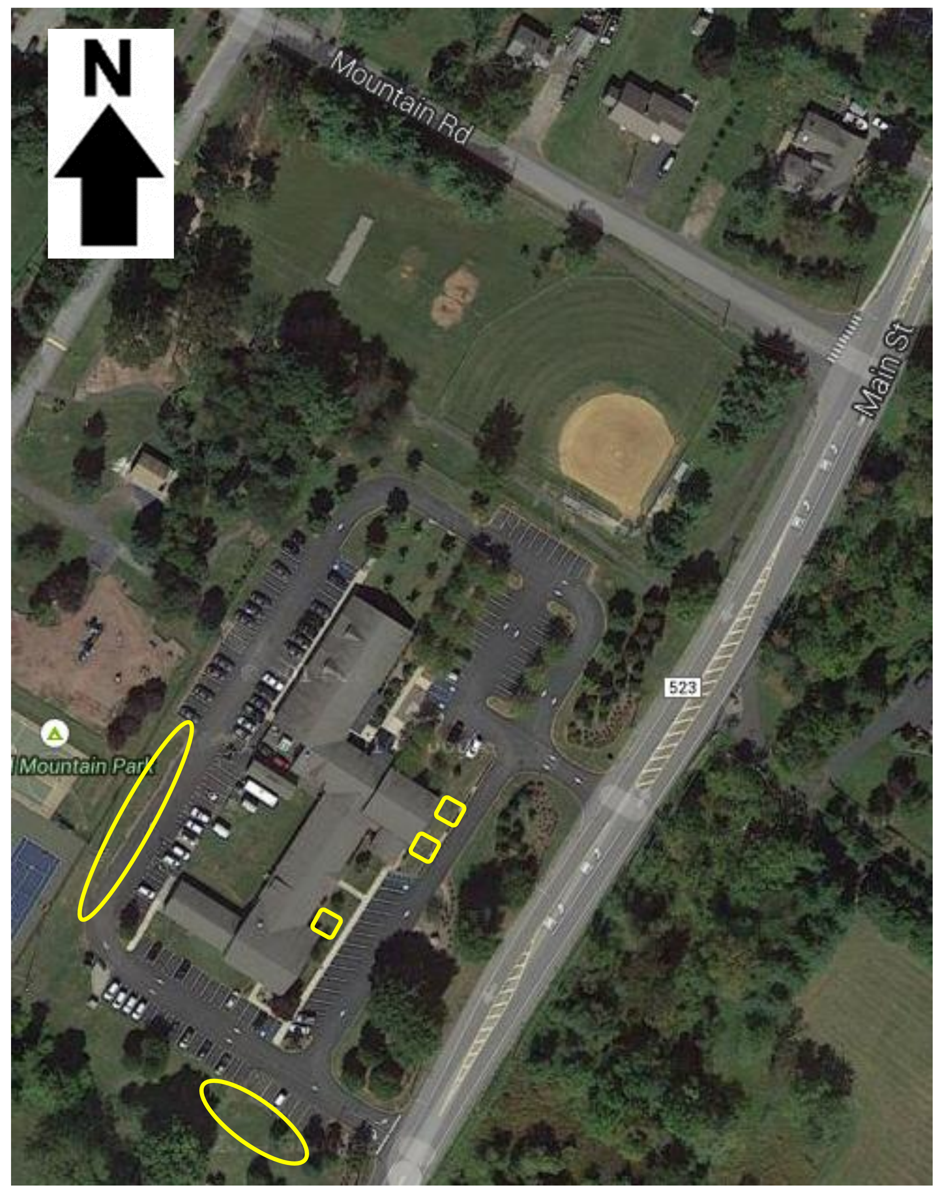
Readington Township
Impervious Cover Assessment

Readington Township Municipal Complex, 509 Route 523

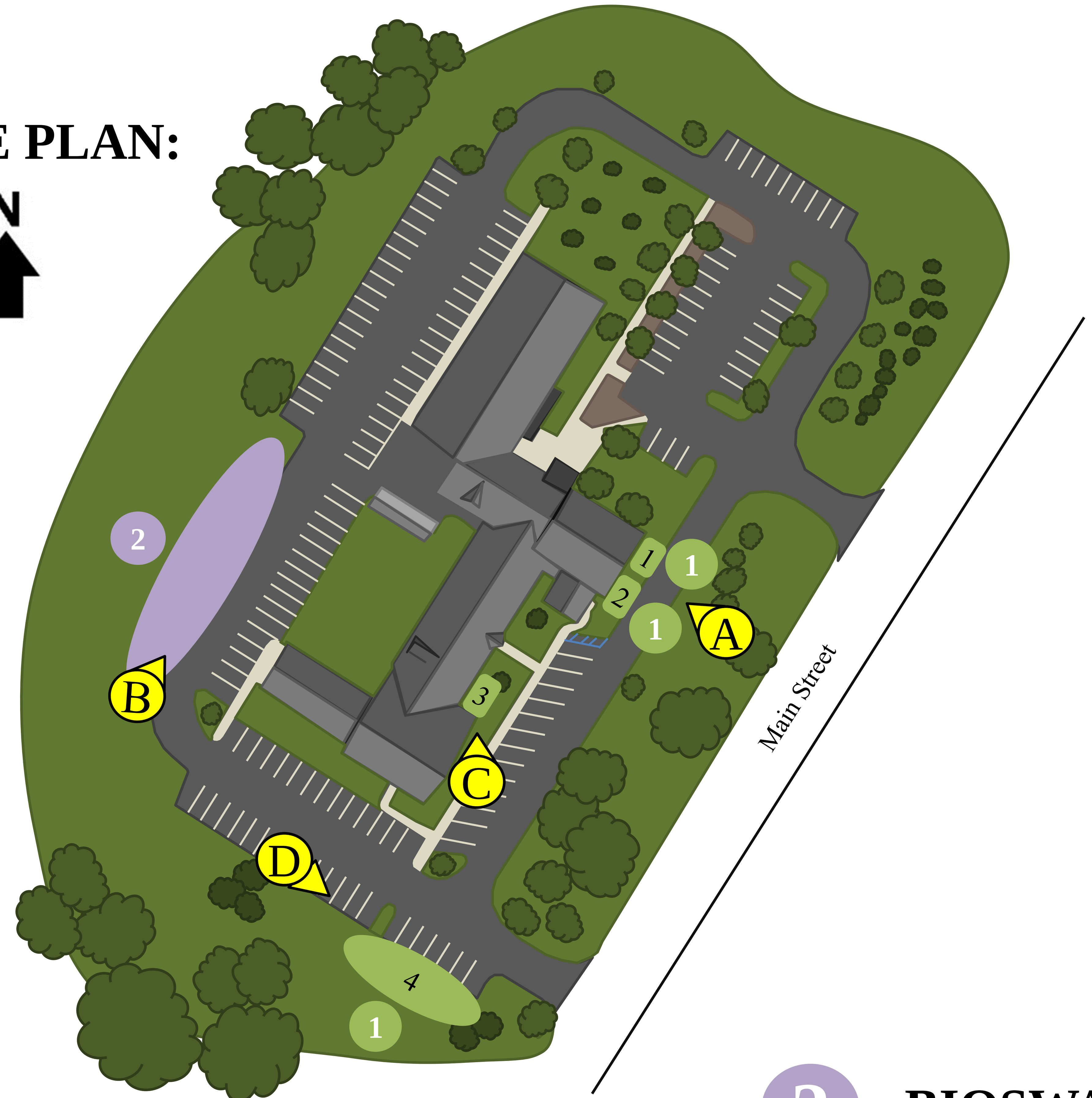
A

B

PROJECT LOCATION:



SITE PLAN:



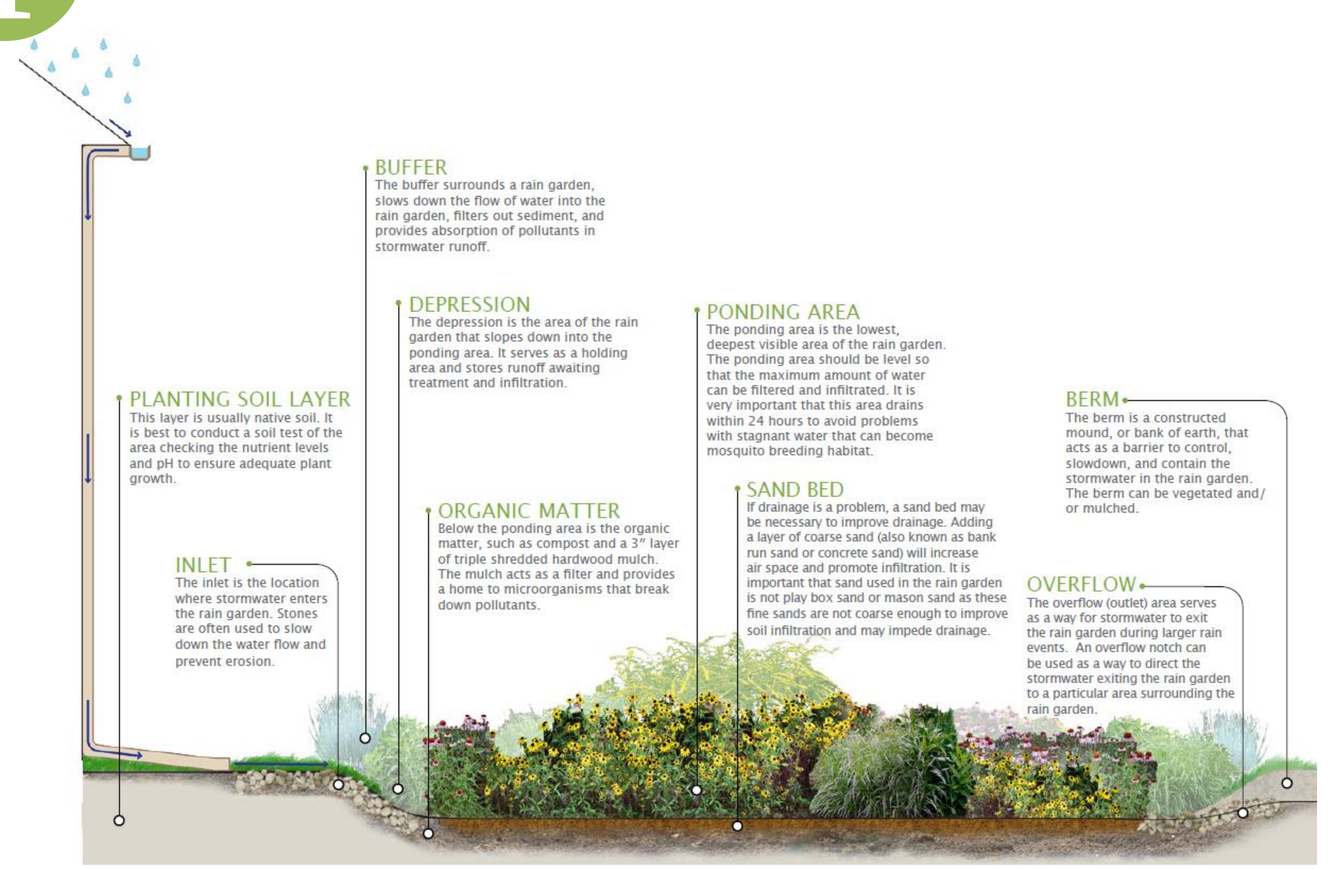
C

D

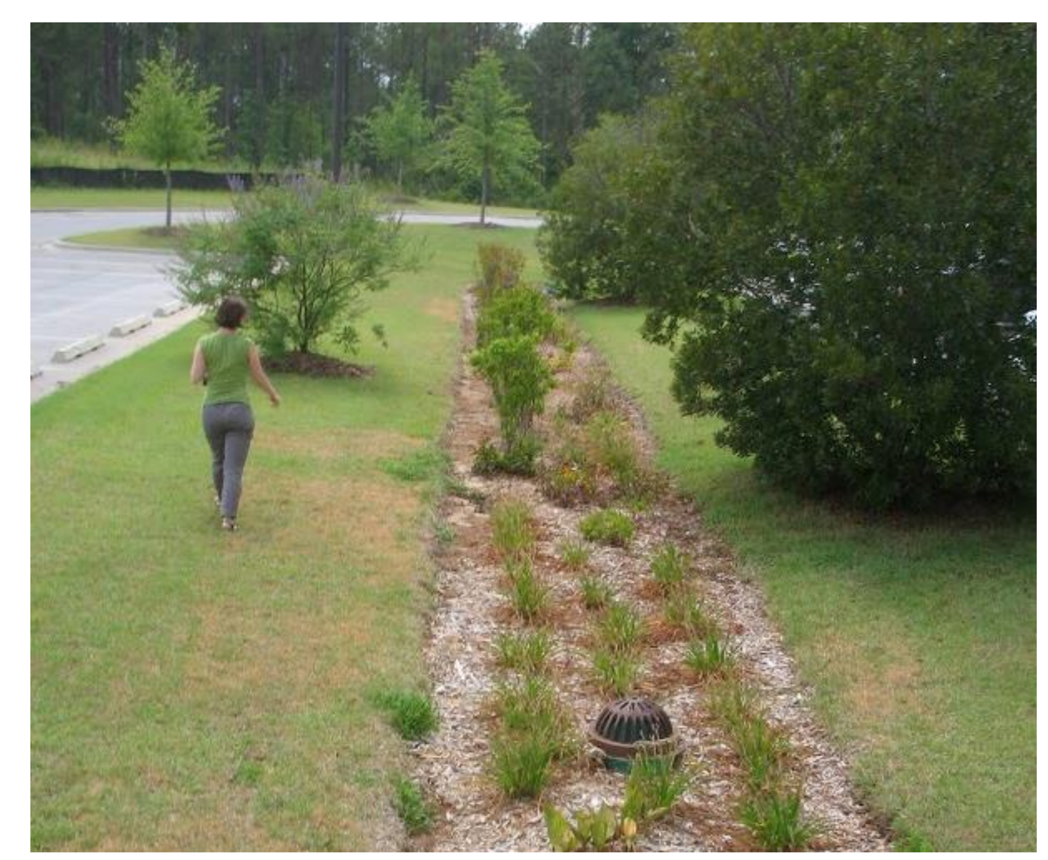
1 **BIORETENTION SYSTEM:** Bioretention systems could be installed along the eastern side of the building as well as in the lawn near the southern parking lot. Bioretention systems will reduce runoff and allow stormwater infiltration, decreasing the amount of contaminants reaching catch basins.

2 **BIOSWALE:** A bioswale is a vegetated system that can convey stormwater to the lawn behind the western parking lot while removing sediment and nutrients.

1 BIORETENTION SYSTEM



2 BIOSWALE



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Location: 509 Route 523 Readington, NJ 08889	**Municipality:** Readington Township **Subwatershed:** Chambers Brook
Green Infrastructure Description: bioretention systems (rain gardens) bioswales disconnecting downspouts	**Targeted Pollutants in Surface Runoff:** total nitrogen (TN), total phosphorous (TP), and total suspended solids (TSS)
Mitigation Opportunities: recharge potential: yes stormwater peak reduction potential: yes TSS removal potential: yes	**Stormwater Captured and Treated Per Year:** bioretention system # 1: 28,700 gal. bioretention system # 2: 26,100 gal. bioretention system # 3: 51,100 gal. bioretention system # 4: 28,700 gal. bioswale # 1: 78,200 gal.

Existing Conditions and Issues:
This site contains several impervious surfaces including paved walkways, driveways, a municipal complex building (complete with roofing and downspout systems), and parking areas. These impervious surfaces are directly connected to a storm sewer system. There are two directly connected downspouts near a light pole at the walkway for the visitor lot. The most eastern part of the municipal complex building has three directly connected downspouts, one on the northern face and two in the southeast corner of the structure. The entrance to the south wing of the complex building has at least two directly connected downspouts. Runoff passes directly over spaces fifteen through nineteen of the southernmost parking area into the storm sewer while eroding the nearby grassy area. A steep hill leads southeast from the tennis and basketball courts into the rear parking area. Runoff from the hill and the rear parking lot is channeled by a ditch along the edge of the pavement. The ditch is graded to the southwest where runoff flows into a storm sewer.

Proposed Solution(s):
The downspouts connected to the municipal complex building can be disconnected and routed to bioretention systems or the current vegetated areas. Bioretention systems #1 and #2 could be installed along the northern and southern areas, respectively, of the easternmost area of the building; and bioretention system #3 could be installed near the front walkway of the southern wing of the building. Bioretention system #4 is recommended for the turf grass area adjacent to parking space fifteen through nineteen in the southern parking area to curb erosion. A bioswale is proposed to intercept runoff from the rear parking lot and the nearby basketball and tennis courts.

Anticipated Benefits:
Since the bioretention systems would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.4 inches of rain over 24 hours), these systems are estimated to achieve a 95%

pollutant load reduction for TN, TP, and TSS. The bioswale would reduce TN by 30%, TP by 60%, and TSS by 90%. These systems would also provide ancillary benefits, such as enhancing the site's wildlife habitat and aesthetic appeal.

Possible Funding Sources:
NJDEP grant programs
Readington Township
Garden Beautiful Charity
local social and community groups

Partners/Stakeholders:
Readington Township
local community groups (Boy Scouts, Girl Scouts, etc.)
residents and park-goers
Rutgers Cooperative Extension

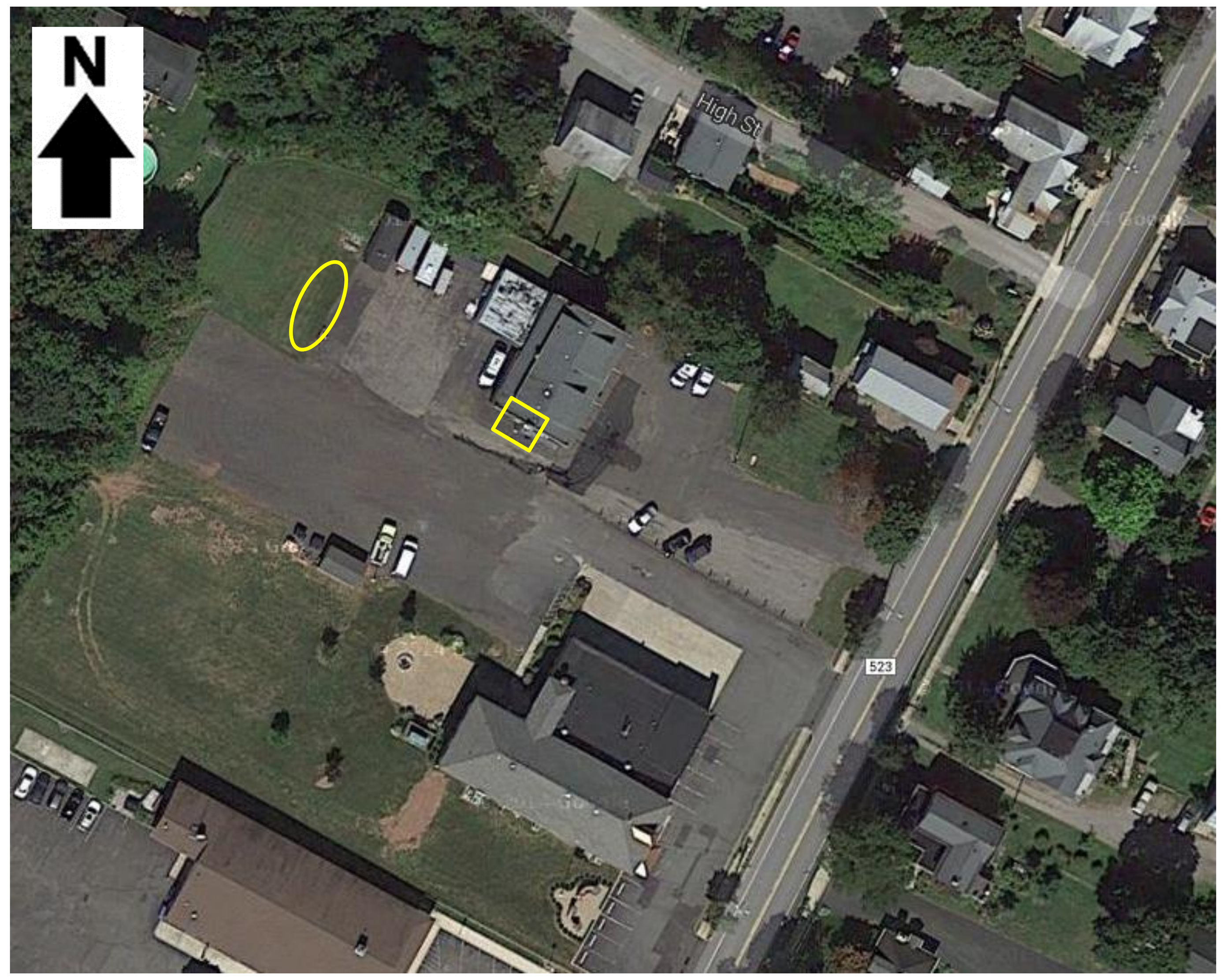
Estimated Cost:
Bioretention system #1 would need to be approximately 280 square feet. One downspout would be disconnected and routed to this system adding an additional $250 to the cost. Bioretention system #2 would be approximately 250 square feet. Two downspouts would be disconnected and routed to this system adding an additional $500 to the cost. Bioretention system #3 would need to be approximately 490 square feet. Two downspouts would be disconnected and routed to this system adding an additional $500 to its cost. Bioretention system #4 would need to be approximately 280 square feet. At $5 per square foot, the estimated cost of each bioretention system is $1,650, $1,750, $2,950, and $1,400, respectively. The total estimated cost of the bioretention systems is $9,000. The bioswale would need to be approximately 750 square feet. At $5 per square foot, the estimate cost of the bioswale is $3,750. The total cost of the project will thus be approximately $12,750.

Readington Township
Impervious Cover Assessment
Whitehouse Fire Company, 271 Main Street

A

B

PROJECT LOCATION:



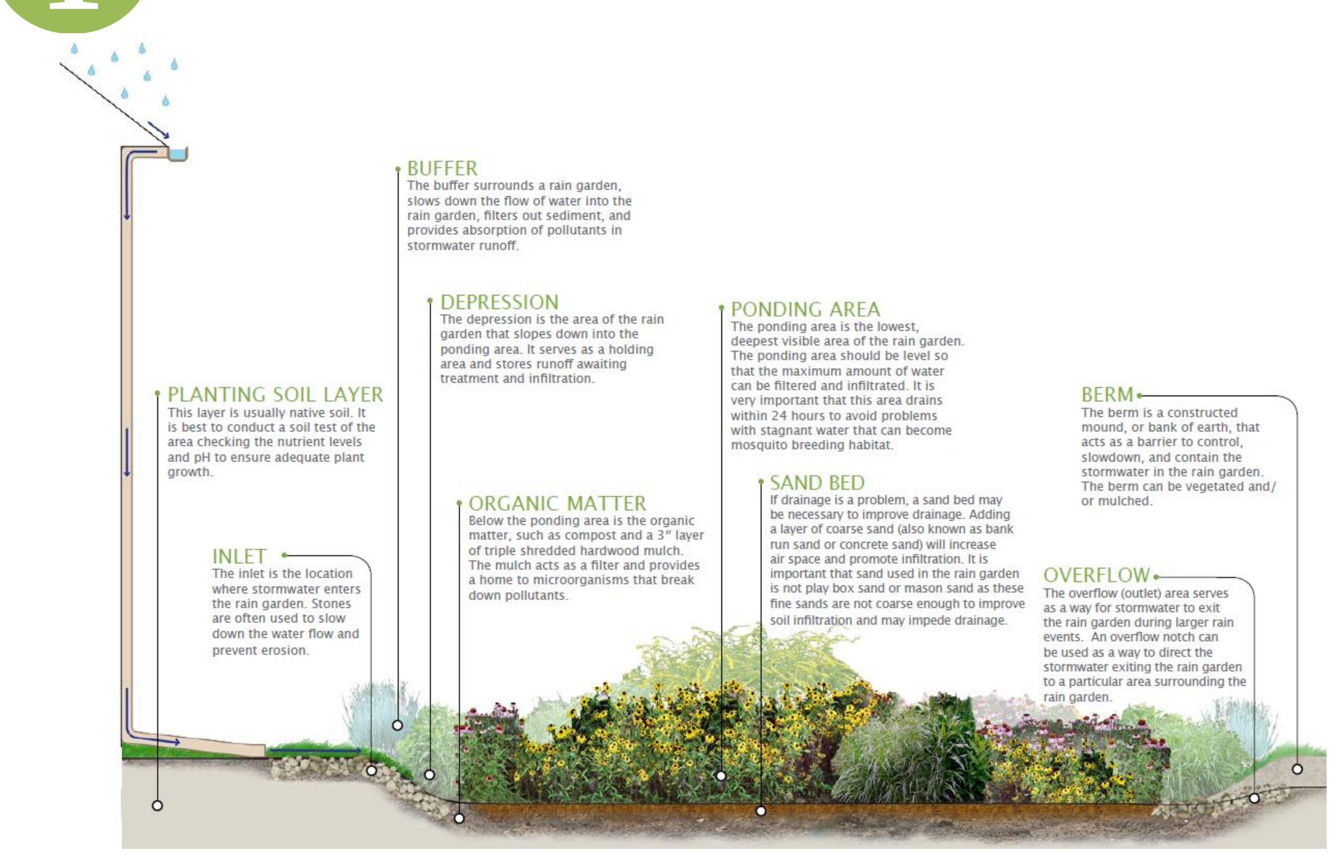
SITE PLAN:

N

1 **BIORETENTION SYSTEM:** A bioretention system could be installed in the grass area towards the back of the parking lot to manage stormwater runoff from the parking lot**.** A bioretention system will reduce runoff and allow stormwater infiltration, decreasing the amount of contaminants reaching catch basins.

2 **RAINWATER HARVESTING SYSTEM:** Rainwater could be harvested from the roof of the building and stored in cisterns. The water could be used to wash the vehicles.

1 BIORETENTION SYSTEM



2 RAINWATER HARVESTING SYSTEM

Location: 271 Main Street Whitehouse Station, NJ 08889	**Municipality:** Readington Township **Subwatershed:** Rockaway Creek
Green Infrastructure Description: rainwater harvesting system (cistern) bioretention system	**Targeted Pollutants in Surface Runoff:** total nitrogen (TN), total phosphorous (TP), and total suspended solids (TSS)
Mitigation Opportunities: recharge potential: yes stormwater peak reduction potential: yes TSS removal potential: yes	**Stormwater Captured and Treated Per Year:** rainwater harvesting system: 40,600 gal. bioretention system: 52,100 gal.

Existing Conditions and Issues:
This site contains several impervious surfaces including paved driveways, parking areas, and a garage and central building (complete with roofing and downspout systems). There are downspouts routed to the bare pavement at all corners of the main building. Runoff flows from the paved surface of the parking lot onto grass behind the property. The southern half of the parking lot is mostly gravel, and there is ample space for motor vehicles. The parking lot at the rear of the building is made of gravel with areas that are eroded causing pooling. There is a grass lawn behind the parking lot that can be utilized to better manage stormwater runoff from the parking lot.

Proposed Solution(s):
A rainwater harvesting system could be placed on the southwest side of the building to collect water from the two buildings onsite. Rainwater would be routed to the rainwater harvesting system from disconnected downspouts on the southwest side of the building. Most of the stormwater runoff from the parking lot could effectively be managed with a bioretention system along the back of the parking lot. This bioretention system would capture, treat, and infiltrate the stormwater runoff, thereby reducing localized flooding and improving water quality.

Anticipated Benefits:
Since the rainwater harvesting system (a cistern) would be designed to capture the first 1.25 inches of rain, it would reduce the pollutant loading by 90% during the periods it is operational (i.e., it would not be used in the winter when there is chance of freezing). The rainwater harvested from the roofs of the buildings could be used for washing fire trucks and personal vehicles. The parking lot is large enough to hold car wash events for the local community. Since the bioretention system would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.4 inches of rain over 24 hours), the system is estimated to achieve a 95% pollutant load reduction for TN, TP, and TSS.

Possible Funding Sources: mitigation funds from local developers NJDEP grant programs Readington Township Hunterdon County local social and community groups
Partners/Stakeholders: Whitehouse Fire Company Readington Township local community groups (Boy Scouts, Girl Scouts, etc.) NJ Audubon Society Rutgers Cooperative Extension
Estimated Cost: The cistern would be 3,000 gallons and cost approximately $6,000 to purchase and install. The bioretention system will need to be approximately 500 square feet. At $5 per square foot, the estimated cost of the rain garden is $2,500. The total cost of the project will thus be approximately $8,500.

Readington Township

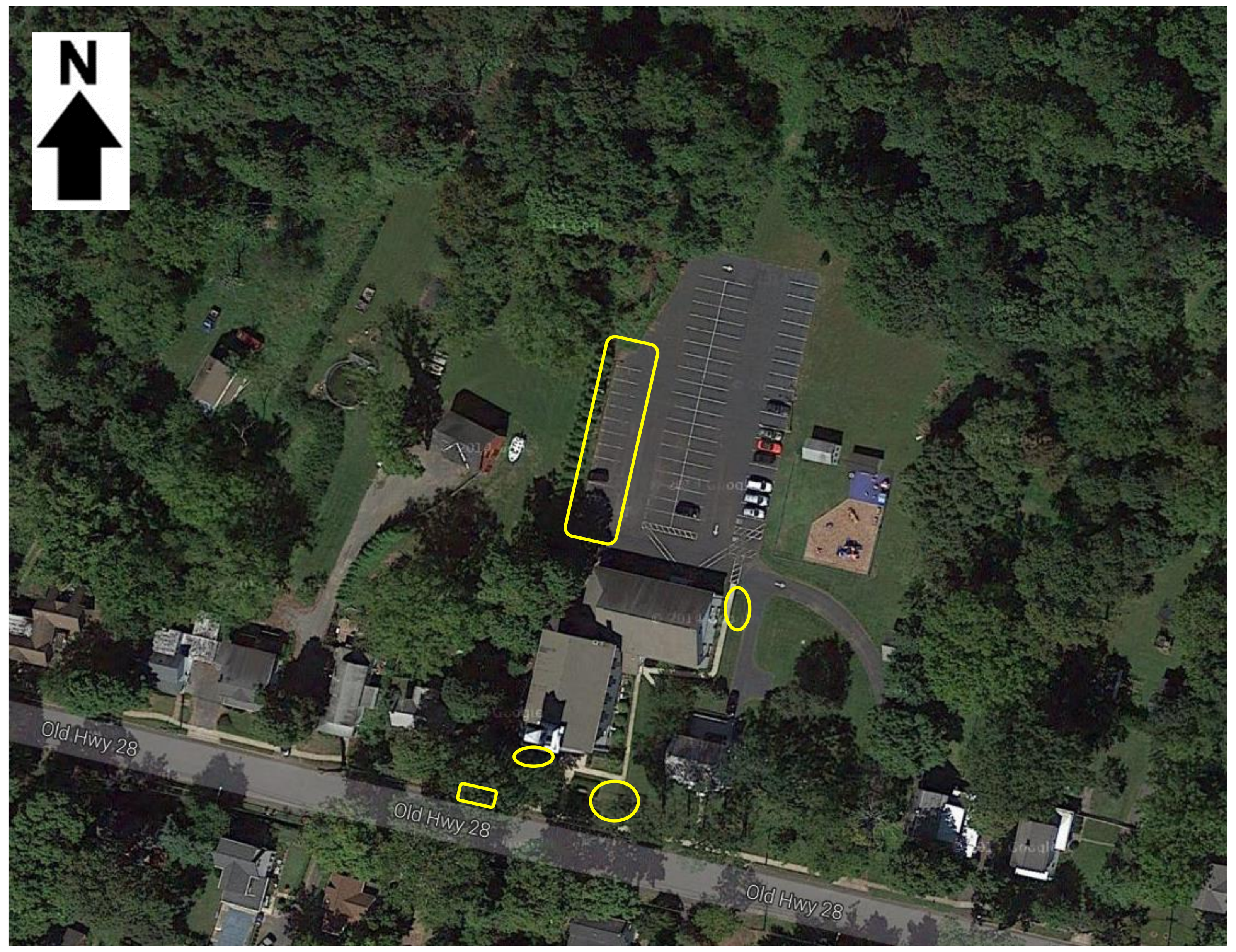
Impervious Cover Assessment

Whitehouse United Methodist Church, 73 Old Highway 28

A

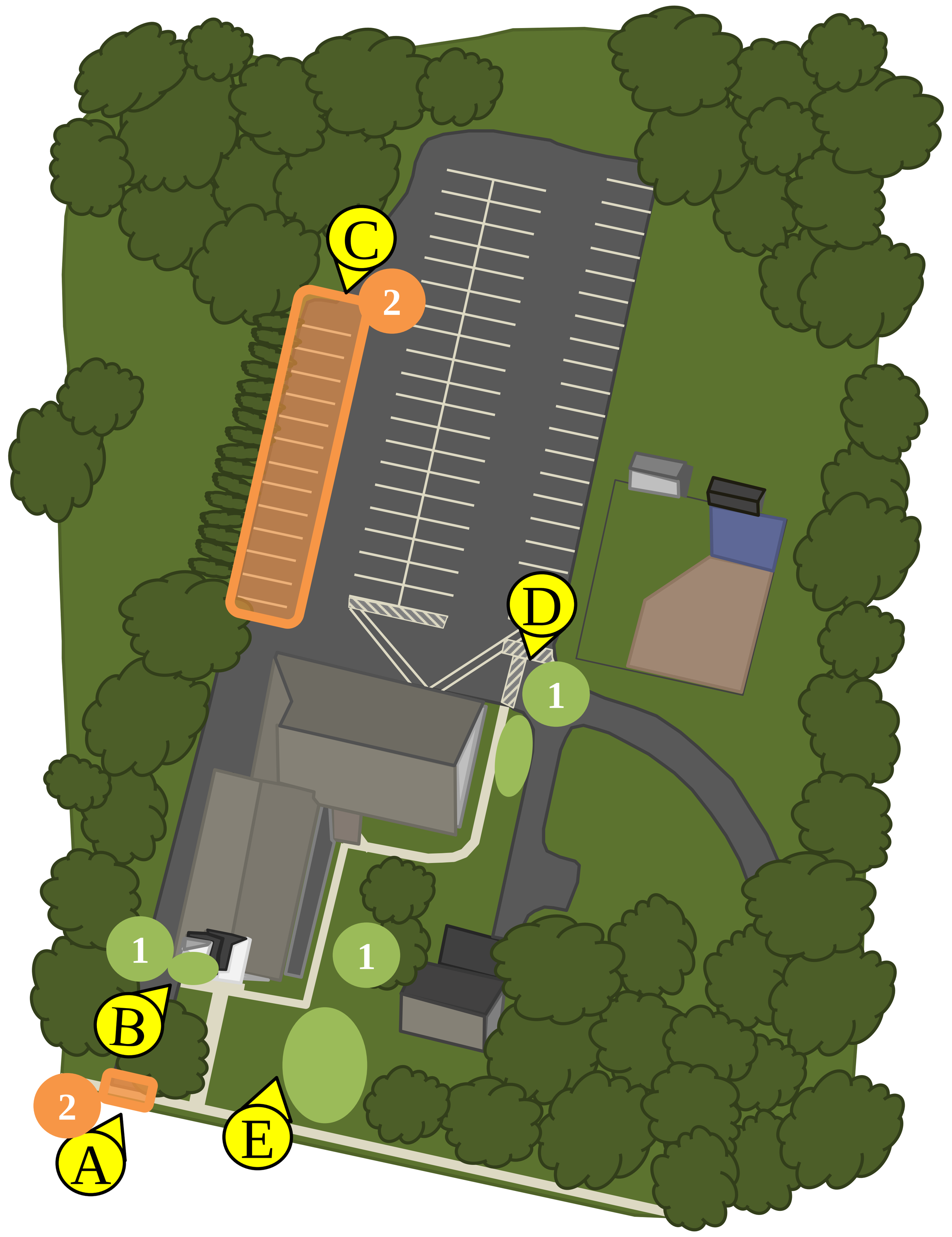
B

PROJECT LOCATION:



SITE PLAN:

N



C

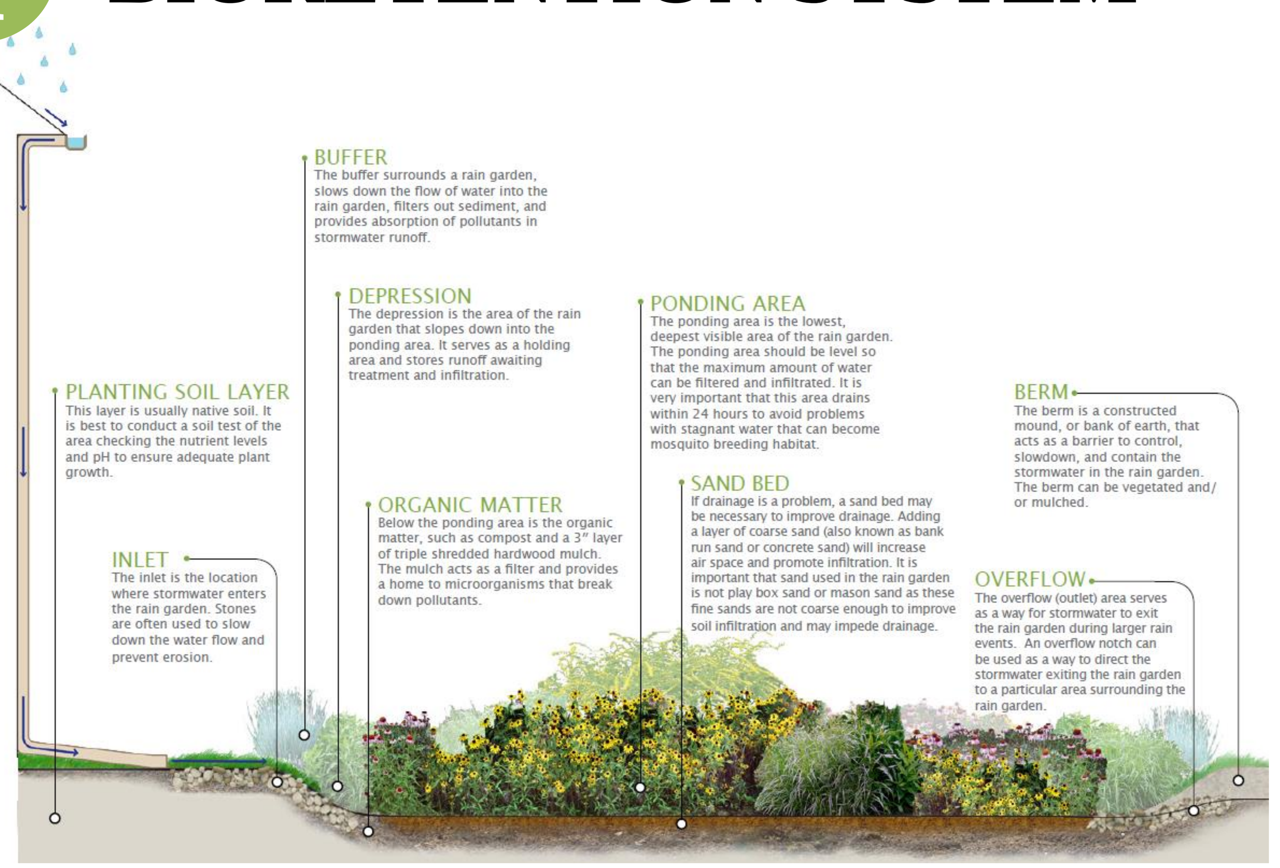
D

E

1 **BIORETENTION SYSTEM:** Bioretention systems could be installed near the entrance of the building to intercept runoff from downspouts. A bioretention system could also be installed near the eastern side of the rear building to capture runoff from a downspout. A bioretention system will reduce runoff and allow stormwater infiltration, decreasing the amount of contaminants reaching catch basins.

2 **POROUS PAVEMENT:** Porous pavement promotes groundwater recharge and filters stormwater.

1 BIORETENTION SYSTEM



2 POROUS PAVEMENT

Location: 73 Old Highway 28 Whitehouse Station, NJ 08889	**Municipality:** Readington Township **Subwatershed:** Lamington River
Green Infrastructure Description: bioretention systems (rain gardens) porous pavement areas disconnecting downspouts	**Targeted Pollutants in Surface Runoff:** total nitrogen (TN), total phosphorous (TP), and total suspended solids (TSS)
Mitigation Opportunities: recharge potential: yes stormwater peak reduction potential: yes TSS removal potential: yes	**Stormwater Captured and Treated Per Year:** bioretention system # 1: 15,600 gal. bioretention system # 2 109,400 gal. bioretention system # 3 34,700 gal. porous pavement area # 1: 15,000 gal. porous pavement area # 2: 422,100 gal.

Existing Conditions and Issues:

This site contains several impervious surfaces including paved walkways, driveways, a church and preschool (complete with roofing and downspout systems), and a parking area. These impervious surfaces are directly connected to a storm sewer system. The sidewalk at the entrance to the church is distressed and slopes into the street. On the left side at the front of the church there is a downspout that appears to be routed underground and into the street. On the eastern (right) side of the church there are four directly connected downspouts, which collect most of the rainwater from buildings' roofs. There also appears to be a grass swale adjacent to a pine tree channeling runoff from the grass directly into the street. The rear parking lot is in poor condition; there are many cracks and potholes. On the northeast corner of the preschool building there is a downspout directed toward the rear parking lot. Runoff from this area is eroding an area of grass near the rear exit from the complex.

Proposed Solution(s):

The downspouts connected to the church and preschool can be disconnected and routed to bioretention systems. Bioretention system #1 would be installed on the west side of the front of the building; bioretention system #2 would be installed in the grass area on the eastern side of the church; and bioretention system #3 would be installed in the grass area on the eastern side of the preschool building. Note that bioretention systems #2 and #3 may require downspout routing in the form of an overhanging trellis-gutter modification or sidewalk excavation. Porous pavement area #1 would be installed in place of the sidewalk at the driveway entrance to the church. Porous pavement area #2 is a retrofit of the western area of the rear parking lot, which is deteriorating.

Anticipated Benefits:

Since the bioretention systems would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.4 inches of rain over 24 hours), these systems are estimated to achieve a 95% pollutant load reduction for TN, TP, and TSS. A bioretention system would also provide ancillary benefits, such as enhancing the site's wildlife habitat and aesthetic appeal. 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
Readington Township
Garden Beautiful Charity
Whitehouse United Methodist Church
local community groups (Boy Scouts, Girl Scouts, etc.)

Partners/Stakeholders:
Readington Township
Whitehouse United Methodist Church
local community groups (Boy Scouts, Girl Scouts, etc.)
parishioners and nearby residents
Rutgers Cooperative Extension

Estimated Cost:
Bioretention system #1 would need to be approximately 150 square feet. One downspout would be disconnected and routed to this system adding an additional $250 to its cost. Bioretention system #2 would need to be approximately 1,050 square feet. Four downspouts would be disconnected and routed to this system adding an additional $1,000 to its cost. Bioretention system #3 would need to be approximately 330 square feet. One downspout would be routed to this system adding an additional $250 to its cost. At $5 per square foot, the estimated cost of each bioretention system is: $1,000, $6,250, and $1,900, respectively. The total estimated cost of the bioretention systems is $9,150. Porous pavement area #1 would cover 75 square feet and have a 3 feet stone reservoir under the surface. At $30 per square foot, the cost of the porous asphalt system would be $2,250. Porous pavement area #2 would cover 2,800 square feet and have a 2 feet stone reservoir under the surface. At $25 per square foot, the cost of the porous asphalt system would be $70,000. The total estimated cost of the porous pavement systems is $72,250. The total cost of the project would be approximately $81,400.