RUTGERS
New Jersey Agricultural
Experiment Station

Draft

Impervious Cover Assessment
for
Monroe Township, Middlesex County, New Jersey

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

February 2, 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

Monroe Township Impervious Cover Analysis

Located in Middlesex County in central New Jersey, Monroe Township covers approximately 42.2 square miles. Figures 3 and 4 illustrate that Monroe Township is dominated by urban land uses. A total of 39.0% of the municipality's land use is classified as urban. Of the urban land in Monroe Township, low density residential is the dominant land use followed by medium density and rural residential (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 Monroe 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 Monroe Township. Based upon the 2007 NJDEP land use/land cover data, approximately 11.7% of Monroe Township has impervious cover. This level of impervious cover suggests that the streams in Monroe Township are likely impacted.

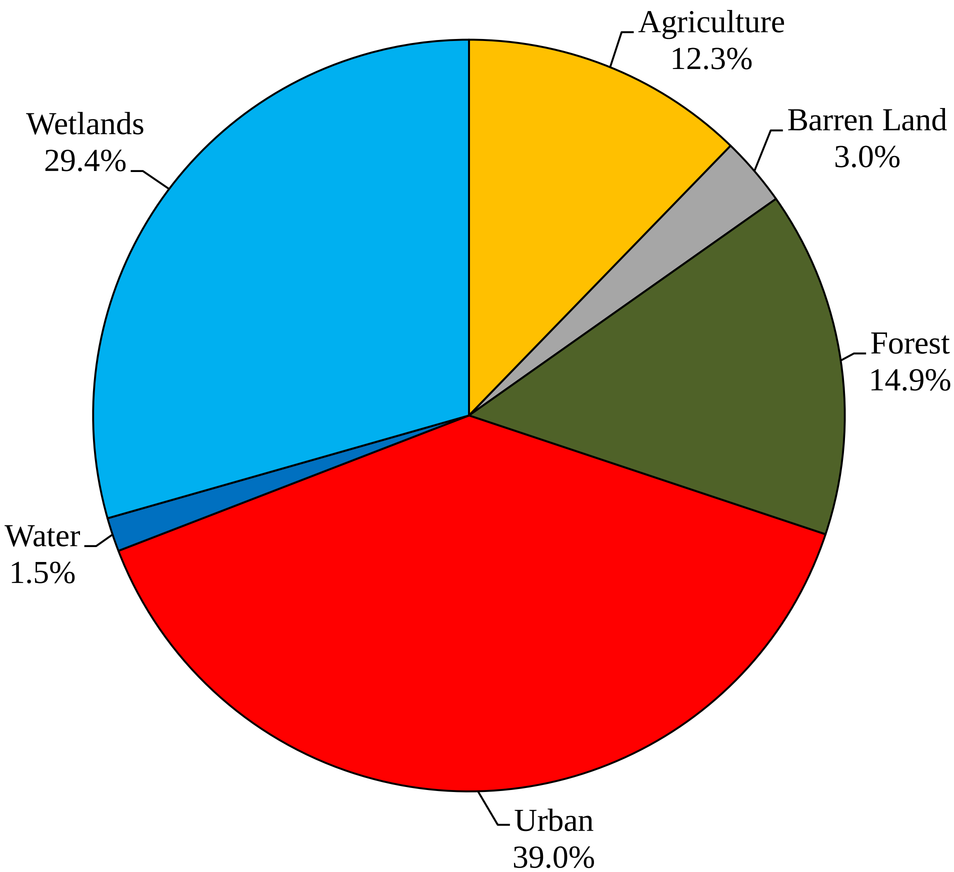


Figure 3: Pie chart illustrating the land use in Monroe Township

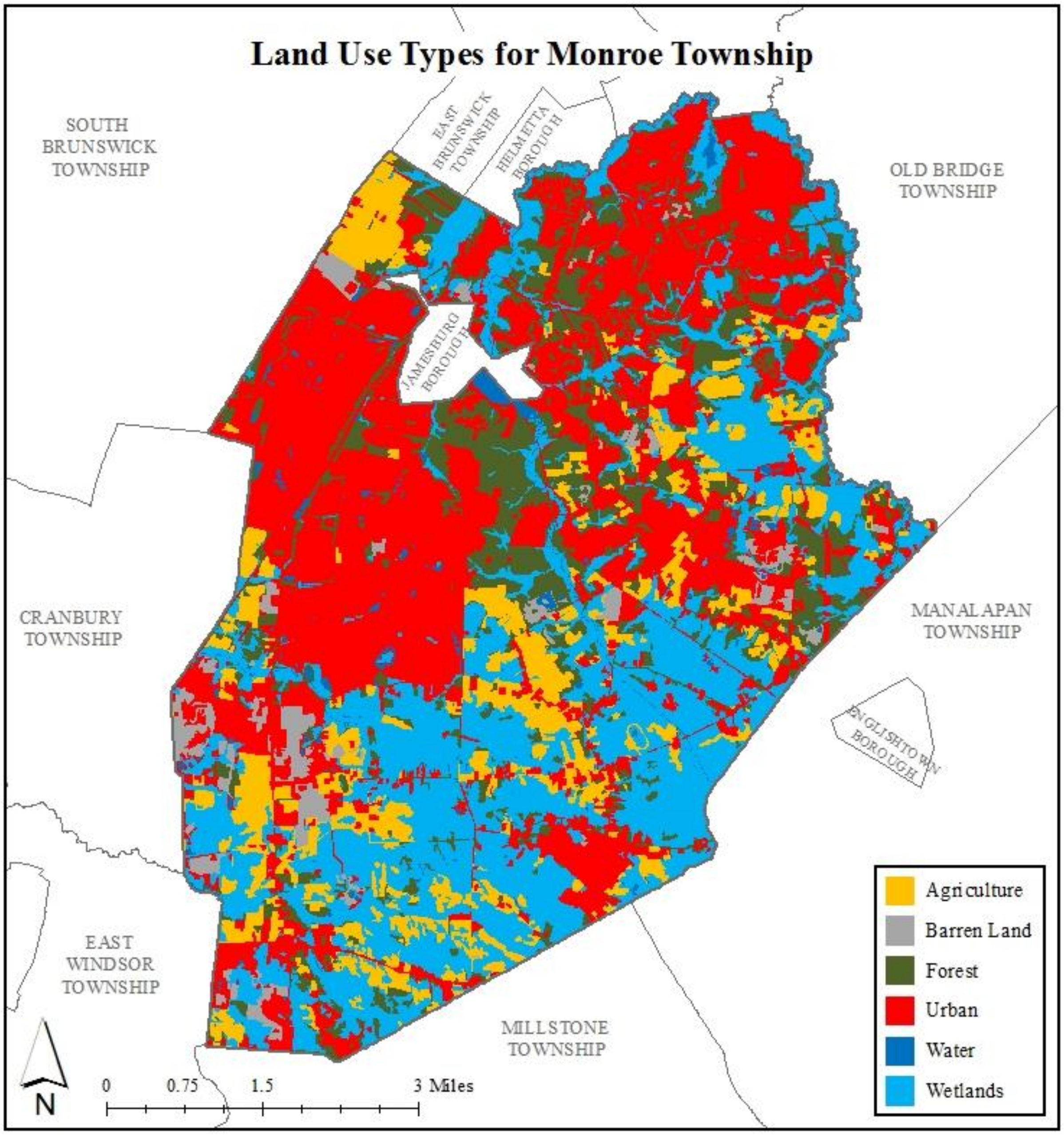


Figure 4: Map illustrating the land use in Monroe Township

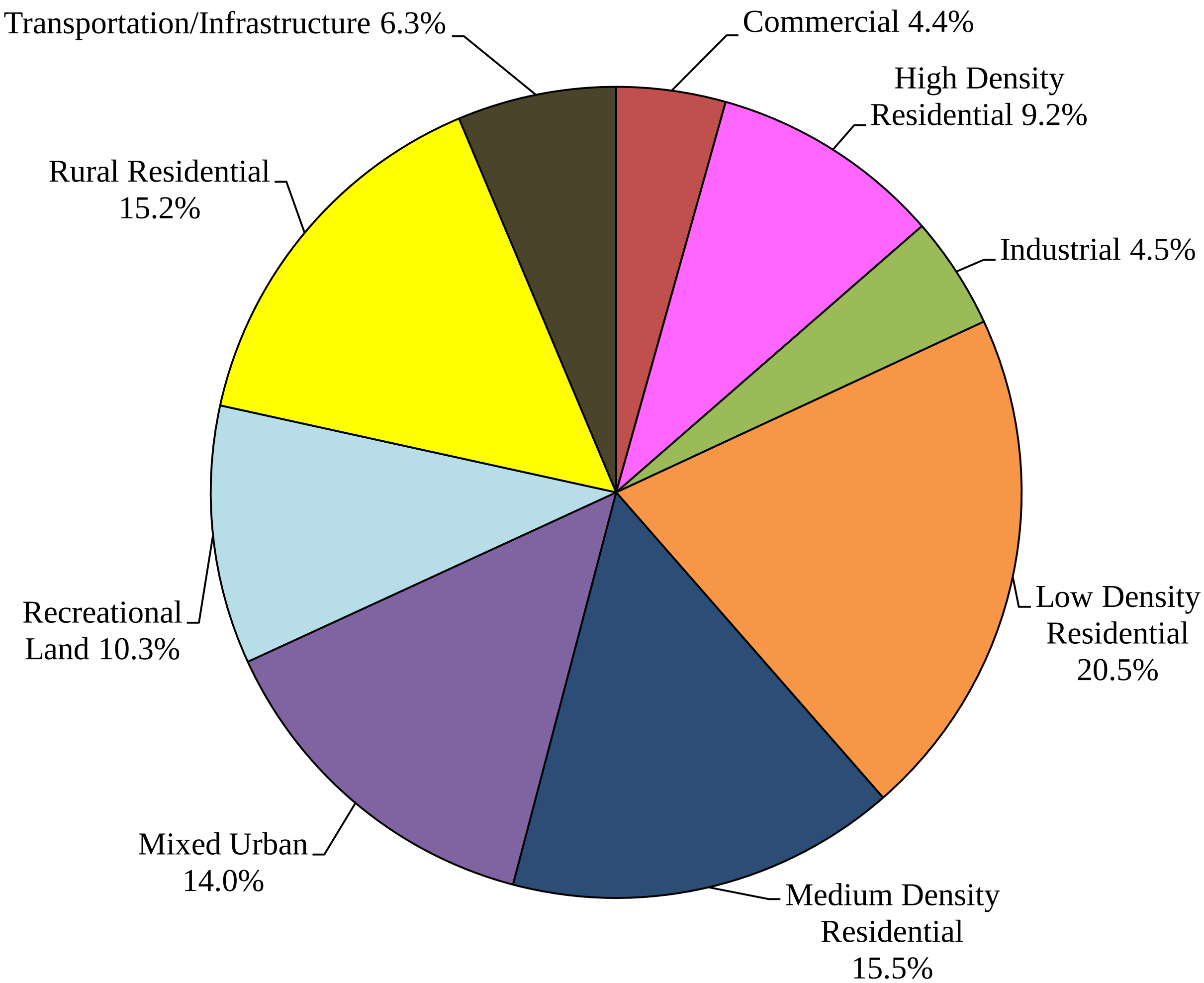


Figure 5: Pie chart illustrating the various types of urban land use in Monroe Township

Water resources are typically managed on a watershed/subwatershed basis; therefore an impervious cover analysis was performed for each Raritan River subwatershed within Monroe Township (Table 1 and Figure 6). On a subwatershed basis, impervious cover ranges from 4.2% in the Millstone River subwatershed to 45.2% in the Shallow Brook 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 Monroe Township, Middlesex 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 (8.6 inches of rain). These runoff volumes are summarized in Table 2. A substantial amount of rainwater drains from impervious surfaces in Monroe Township. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Manalapan Brook subwatershed was harvested and purified, it could supply water to 363 homes for one year[1].

[1] Assuming 300 gallons per day per home

Table 1: Impervious cover analysis by subwatershed for Monroe Township

Subwatershed	Total Area		Land Use Area		Water Area		Impervious Cover		
	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(ac)	(mi^2)	(%)
Cedar Brook	853.7	1.33	830.3	1.30	23.4	0.04	365.8	0.57	44.1%
Cranbury Brook	6,156.6	9.62	6,072.7	9.49	83.9	0.13	855.0	1.34	14.1%
Devils Brook	61.6	0.10	60.2	0.09	1.40	0.00	16.3	0.03	27.1%
Manalapan Brook	11,207.9	17.5	11,024.2	17.2	183.7	0.29	1,169.2	1.83	10.6%
Matchaponix Brook	4,242.6	6.63	4,180.9	6.53	61.7	0.10	355.9	0.56	8.5%
Millstone River	3,942.3	6.16	3,915.0	6.12	27.2	0.04	166.1	0.26	4.2%
Rocky Brook	201.0	0.31	197.3	0.31	3.66	0.01	41.1	0.06	20.8%
Shallow Brook	323.4	0.51	315.8	0.49	7.64	0.01	142.7	0.22	45.2%
Total	26,989.1	42.2	26,596.4	41.6	392.7	0.61	3,112.0	4.86	11.7%

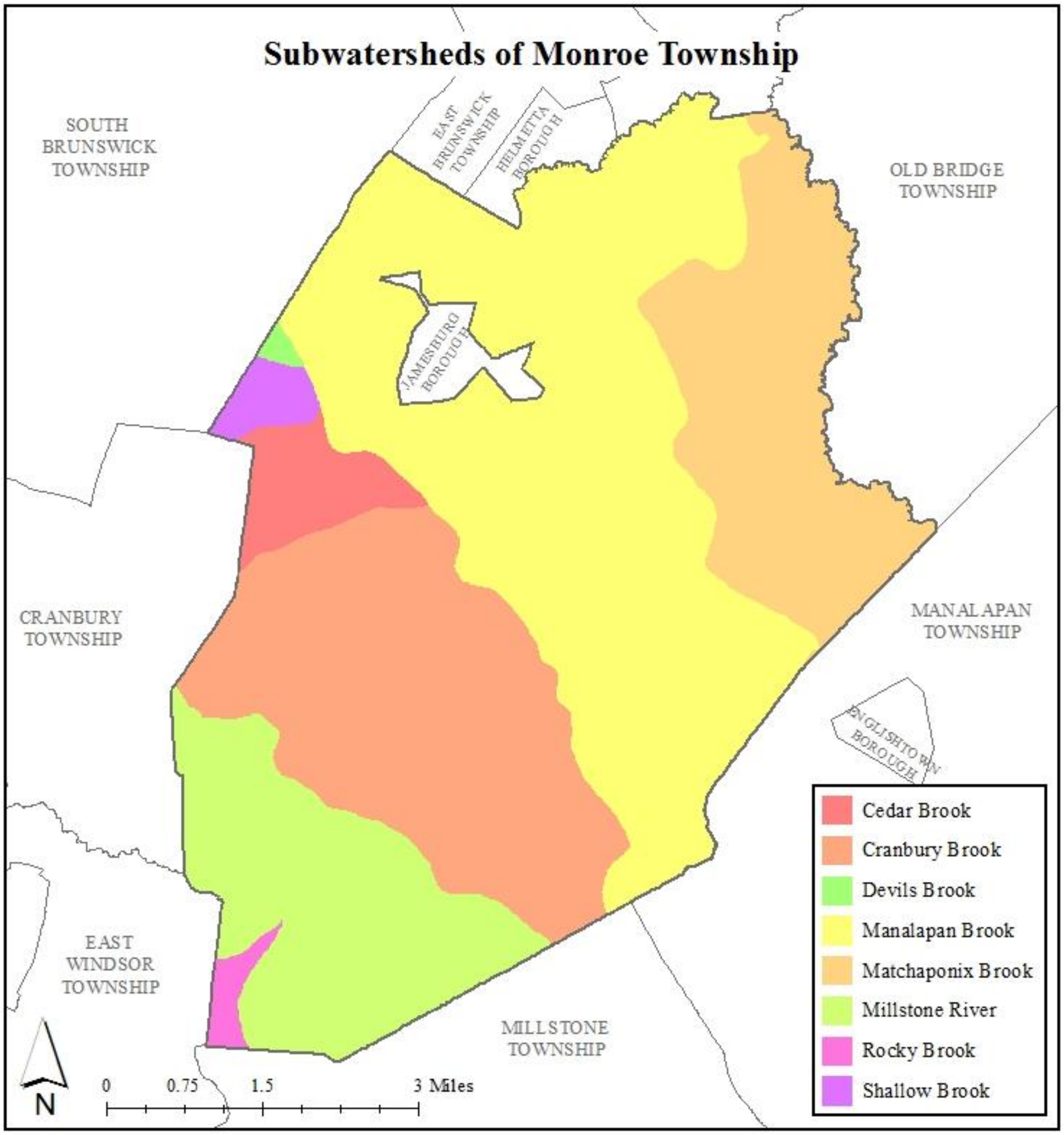


Figure 6: Map of the subwatersheds in Monroe Township

Table 2: Stormwater runoff volumes from impervious surfaces by subwatershed in Monroe 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 (8.6") (MGal)
Cedar Brook	12.4	437.0	32.8	50.7	85.4
Cranbury Brook	29.0	1,021.5	76.6	118.4	199.7
Devils Brook	0.6	19.5	1.5	2.3	3.8
Manalapan Brook	39.7	1,396.8	104.8	161.9	273.0
Matchaponix Brook	12.1	425.2	31.9	49.3	83.1
Millstone River	5.6	198.4	14.9	23.0	38.8
Rocky Brook	1.4	49.1	3.7	5.7	9.6
Shallow Brook	4.8	170.5	12.8	19.8	33.3
Total	105.6	3,717.9	278.8	430.9	726.7

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 Monroe 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 Monroe Township

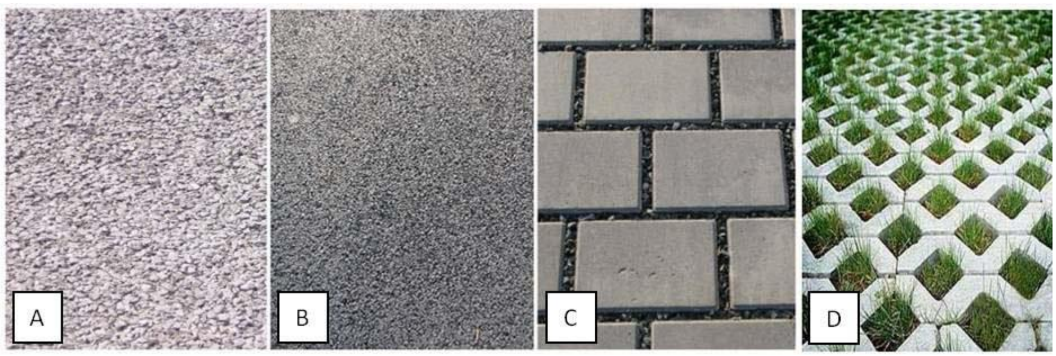
Subwatershed	Recommended Impervious Area Reduction (10%) (ac)	Annual Runoff Volume Reduction [2] (MGal)
Cedar Brook	36.6	41.5
Cranbury Brook	85.5	97.0
Devils Brook	1.6	1.9
Manalapan Brook	116.9	132.7
Matchaponix Brook	35.6	40.4
Millstone River	16.6	18.9
Rocky Brook	4.1	4.7
Shallow Brook	14.3	16.2
Total	311.2	353.2

[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.

<u>Pervious Pavement</u>

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.

<u>Impervious Cover Disconnection Practices</u>

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.

- <u>Simple Disconnection</u>: 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 Monroe 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 Monroe 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

Monroe 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

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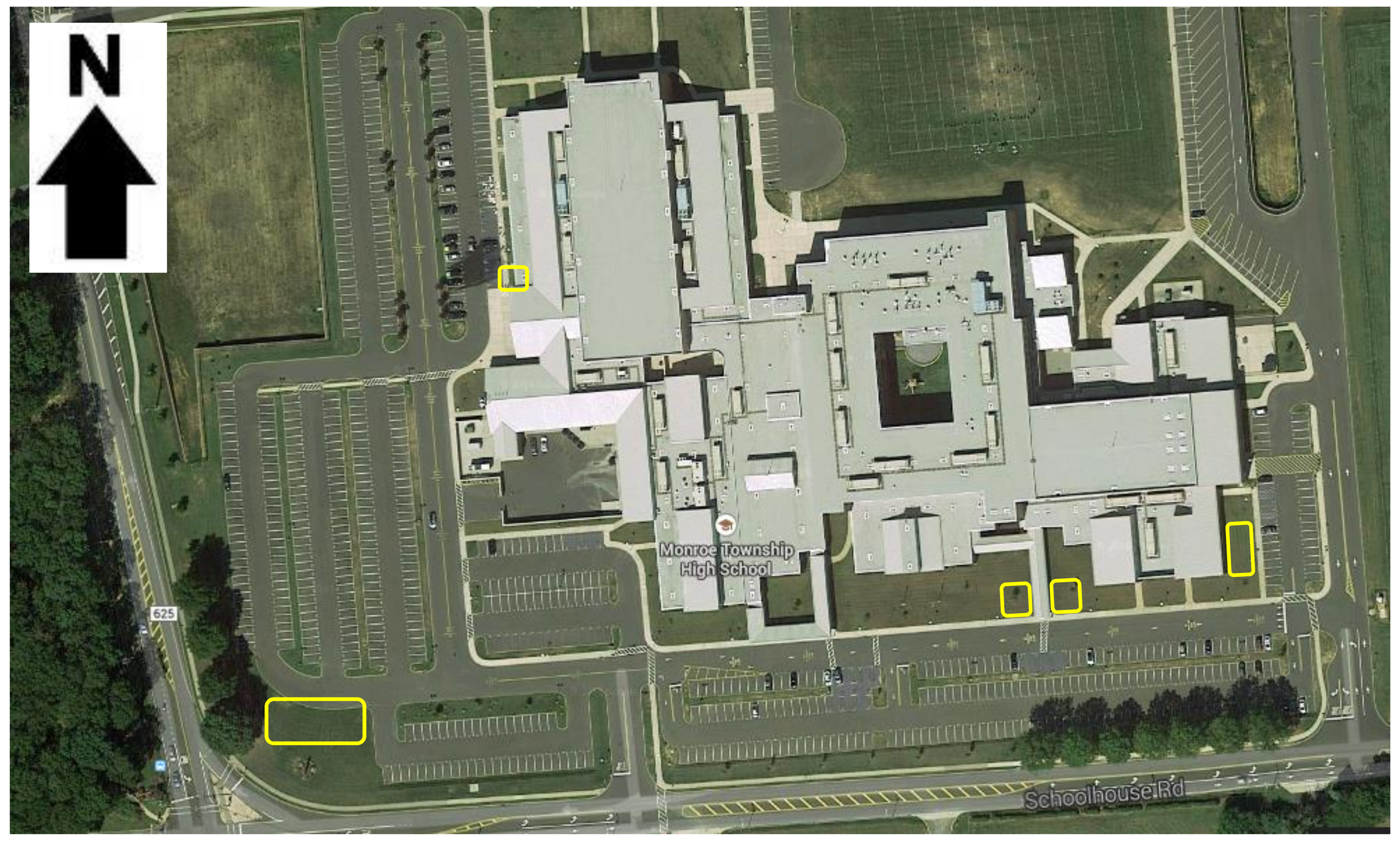
Appendix A

Examples of Impervious Cover Reduction Action Plan Projects

Concept Plans and Detailed Green Infrastructure Information Sheets

Monroe Township
Impervious Cover Assessment
Monroe Township High School, 200 Schoolhouse Road

PROJECT LOCATION:



SITE PHOTOS:

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SITE PLAN:

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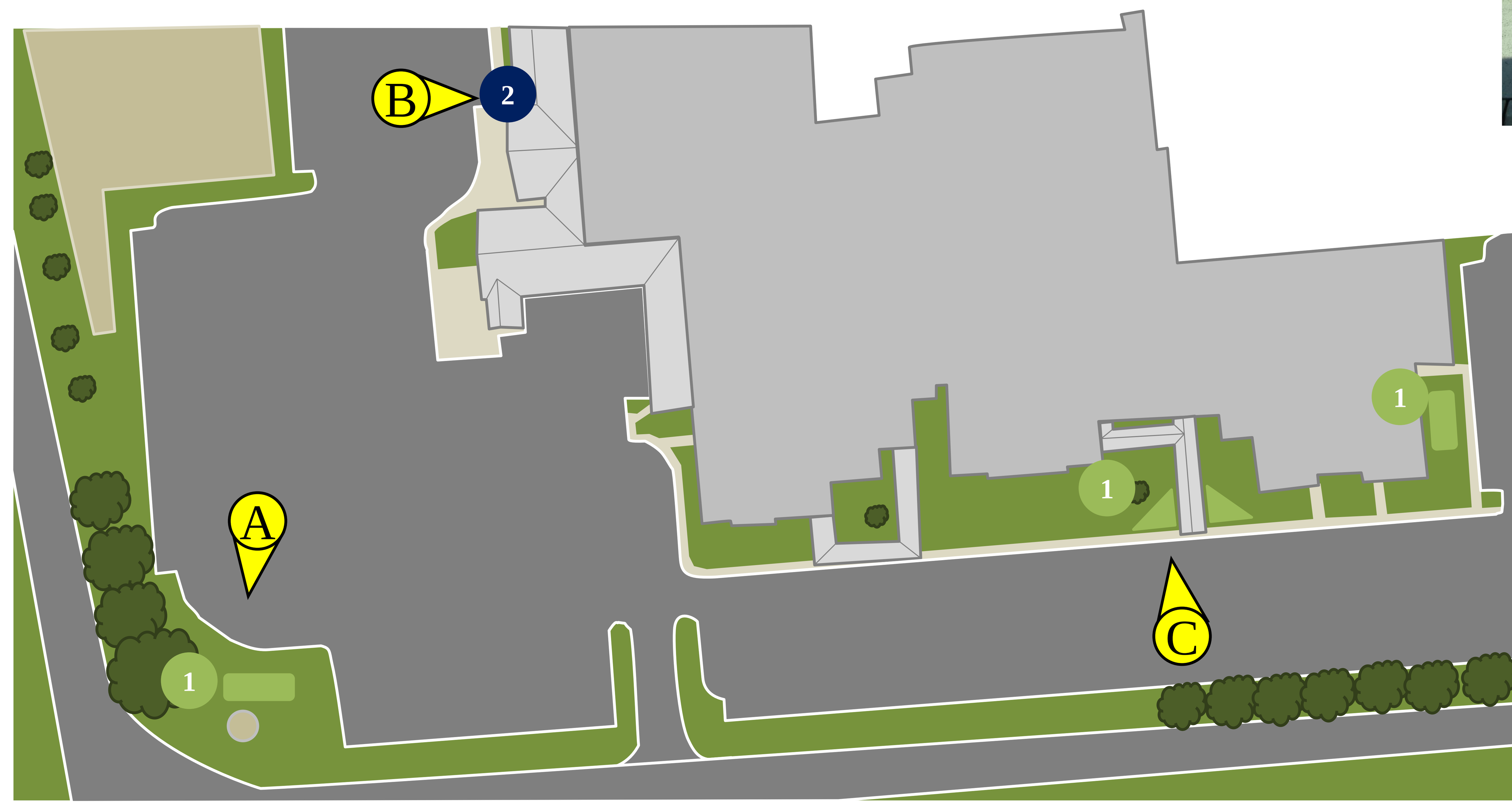
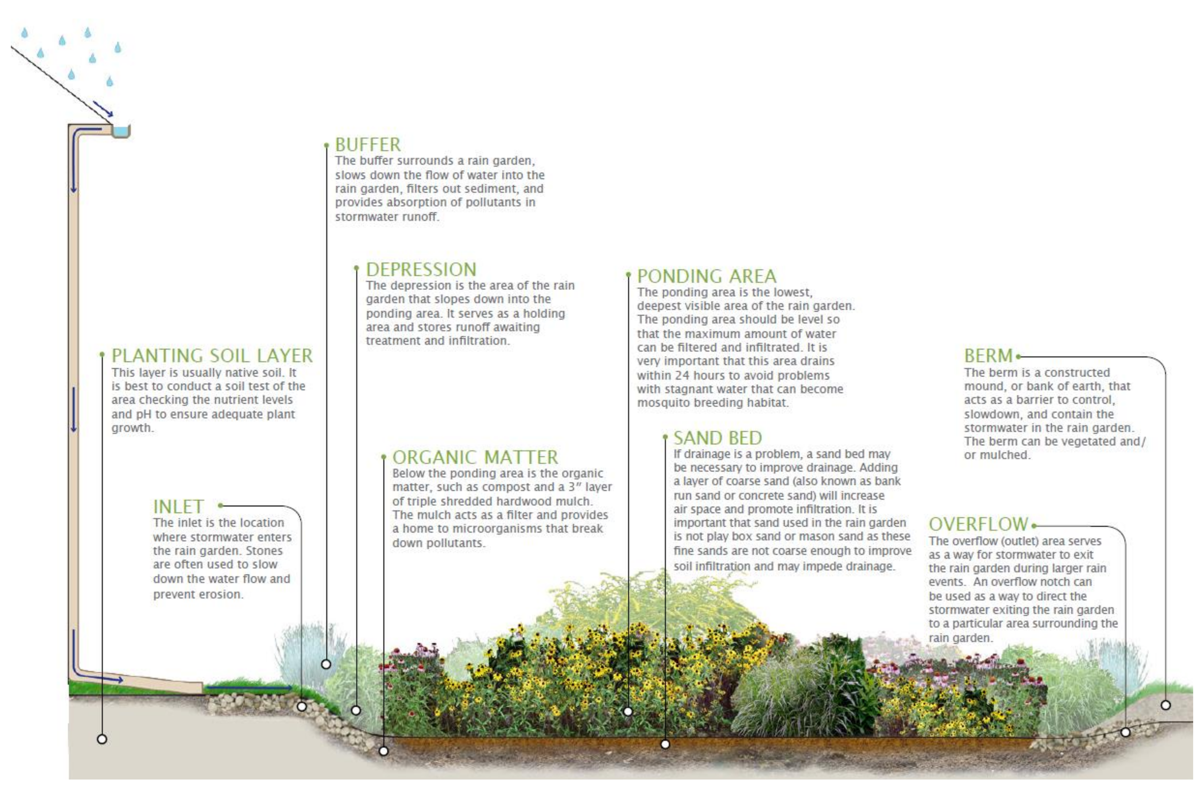


1 **BIORETENTION SYSTEMS:** Rain gardens can be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. This site has areas where downspouts can be disconnected and rain gardens implemented. Curb cuts should be made in the parking lot area to allow the flow of runoff into the bioretention systems proposed.

2 **DOWNSPOUT PLANTER BOX:** Planter boxes reduce runoff and allow water to slowly infiltrate while being treated for pollutants.

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

1 BIORETENTION SYSTEM



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2 DOWNSPOUT PLANTER BOX

EDUCATIONAL PROGRAM

Monroe Township High School
Green Infrastructure Information Sheet

Location: 200 Schoolhouse Road Monroe Township, NJ 08831	**Municipality:** Monroe Township **Subwatershed:** Manalapan Brook
Green Infrastructure Description: bioretention system (rain garden) downspout planter boxes	**Targeted Pollutants:** total nitrogen (TN), total phosphorous (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: 250,131 gal. bioretention system # 2: 15,633 gal. bioretention system # 3: 15,633 gal. bioretention system # 4: 57,322 gal. downspout planter box: 1,400 gal.

Existing Conditions and Issues:
There are impervious surfaces at this site that contribute to the site's stormwater runoff volumes and nonpoint source pollution. The parking lots are in good condition, but at the southeast end, there is an area where water flows down the lot toward a large grass area near Schoolhouse Road. There are connected downspouts at the borders of the school building. These downspouts have coverings, which may limit their accessibility. There are several detention basins at the northeast and northwest corners of the site.

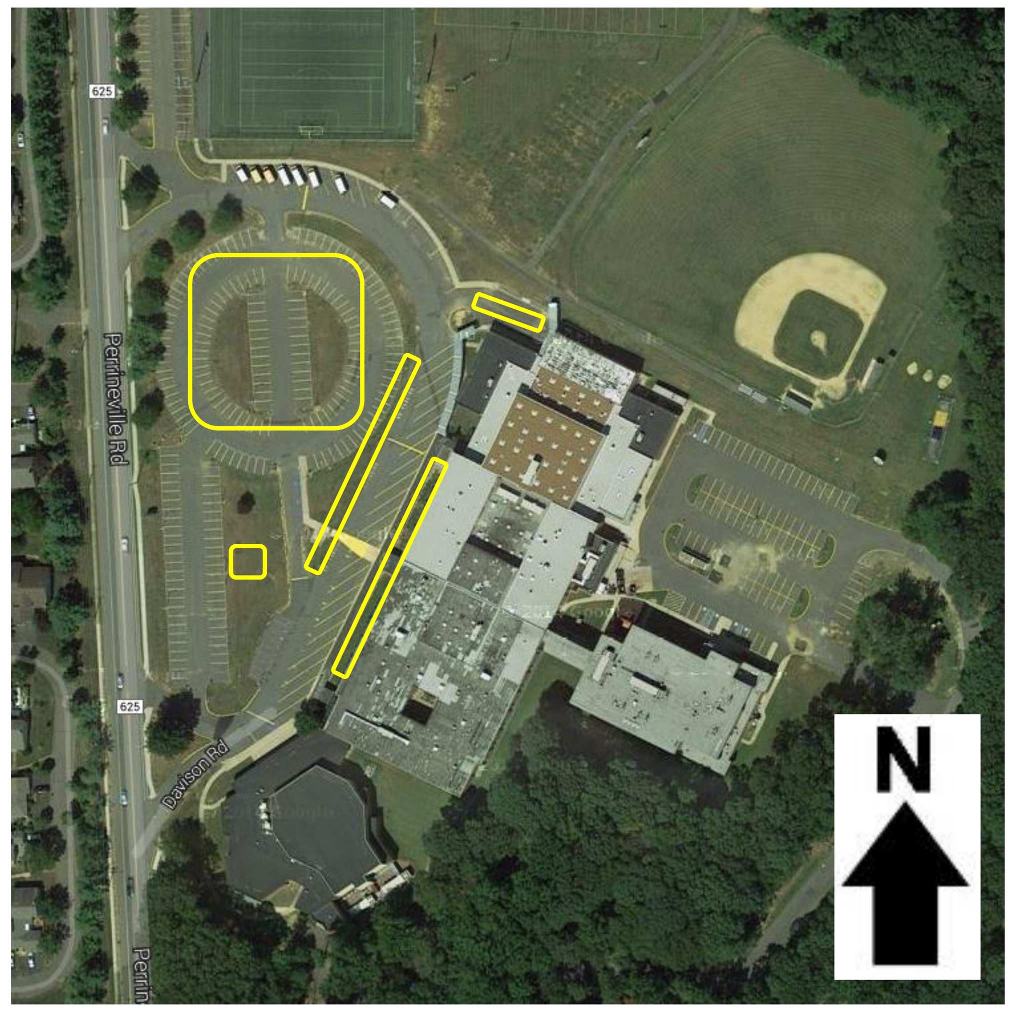
Proposed Solution(s):
A bioretention system (#1) could be installed at the southwestern corner of the school property to treat stormwater runoff from the driveway and parking area nearby. This system would receive runoff via curb cuts. A downspout adjacent to the western entrance to the school could be routed to a downspout planter box placed in the grass nearby. A bioretention system could be placed on each side of the covered walkway at the southern entrance to the school. Bioretention systems #2 and #3 would receive stormwater from the walkways nearby downspouts. Bioretention system #4 could be installed at the southeastern corner of the school building to treat a portion of the building's roof runoff.

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. Curb cuts allow stormwater runoff to flow into the vegetated areas and bioretention systems rather than flow into catch basins. 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 Monroe Township Public Works staff to launch educational programming. The downspout planter box will take in runoff from a downspout and achieve reductions in TN, TP, and TSS similar to the bioretention systems.
Possible Funding Sources: mitigation funds from local developers NJDEP grant programs Monroe Township local social and community groups
Partners/Stakeholders: Monroe Township Monroe Township High School local community groups students and parents Rutgers Cooperative Extension
Estimated Cost: Bioretention system #1 would need to be approximately 2,400 square feet. At $5 per square foot, the estimated cost of the system is $12,000. Bioretention system #2 would need to be approximately 150 square feet. At $5 per square foot, the estimated cost of the system is $750. Bioretention system #3 would need to be approximately 150 square feet. At $5 per square foot, the estimated cost of the system is $750. Bioretention system #4 would need to be approximately 550 square feet. At $5 per square foot, the estimated cost of the system is $2,750. The downspout planter box would cost $300. The total cost of the project will be approximately $16,550.

Monroe Township
Impervious Cover Assessment
Monroe Township Middle School, 1629 Perrineville Road

PROJECT LOCATION:



SITE PHOTOS:

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SITE PLAN:

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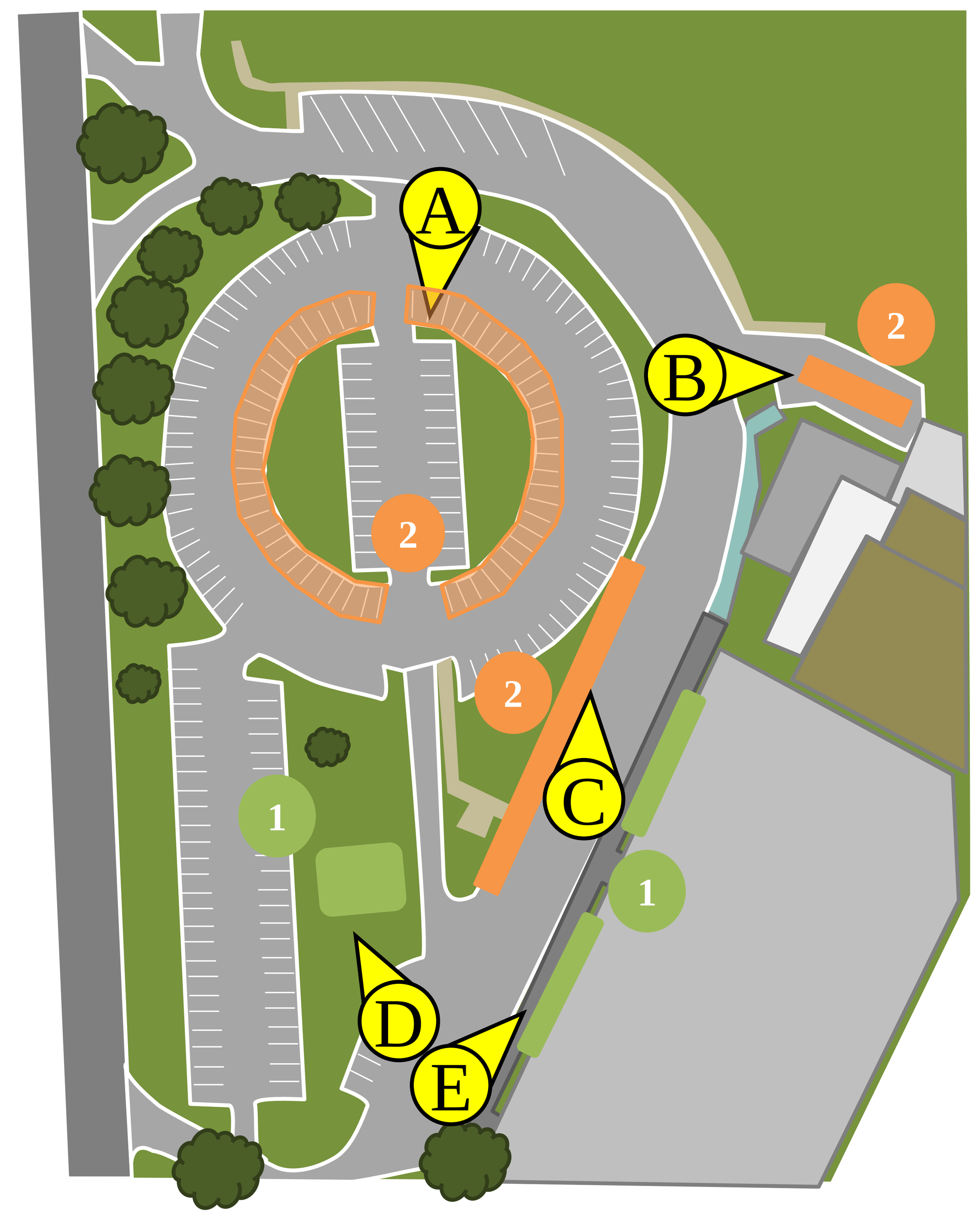

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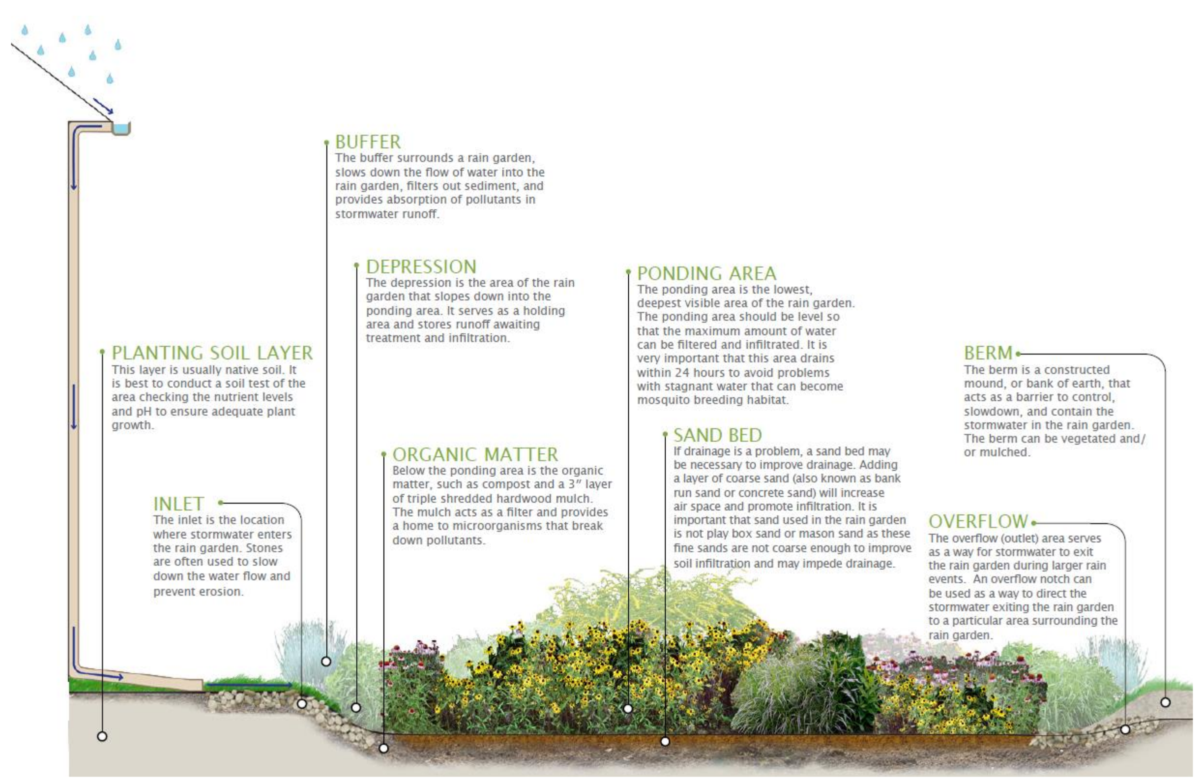
1 **BIORETENTION SYSTEMS:** Bioretention systems can be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. Bioretention systems can be placed along the front of the school and in a grass median.

2 **POROUS PAVEMENT:** Porous pavement promotes groundwater recharge and filters stormwater. This can be used on the circular parking area, main driveway, and delivery area to reduce flooding and erosion.

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

1 BIORETENTION SYSTEM



2 POROUS PAVEMENT

EDUCATIONAL PROGRAM

Location: 1629 Perrineville Road Monroe, NJ 08831	Municipality: Monroe Township Subwatershed: Manalapan Brook
Green Infrastructure Description: bioretention systems (rain gardens) porous pavement	**Targeted Pollutants:** total nitrogen (TN), total phosphorous (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: 88,588 gal. bioretention system #2: 119,855 gal. bioretention system #3: 125,066 gal. porous pavement #1: 689,424 gal. porous pavement #2: 242,210 gal. porous pavement #3: 72,955 gal.

Existing Conditions and Issues:
This site contains several impervious surfaces including driveways, walkways, parking areas, and a middle school. The site's impervious surfaces produce stormwater runoff during rain events. The front parking lot has a circular parking area with two semicircular grass islands. At the time of the site visit, eroded areas of grass and soil were identified at the northern and southern ends of these islands. Elevated and damaged catch basins were identified near these areas. The semicircular islands do have curbs along them, which has allowed them to flood in certain areas. There are directly connected downspouts and a covered walkway along the western (front) side of the school. A delivery area at the northern end of the school building was flooded and littered with debris and sediment at the time of the site visit. The grass along the Davison Road driveway was flooded at the time of the site visit.

Proposed Solution(s):
Porous pavement system #1 could be installed in the parking spaces around the grass islands in the front parking lot. Porous pavement system #2 could be installed in the center of the delivery area at the northern end of the school. Porous pavement #3 could be installed along the western edge of the main driveway (Davison Road) alongside the school building. Bioretention systems #1 and #2 could be installed along the western face of the school building. Both systems would have multiple downspouts routed to them. Bioretention system #3 would occupy a depressed, grass median between the southwestern parking area and the main driveway.

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. 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 Monroe Township Public Works staff to launch educational programming. Curb cuts allow stormwater runoff to flow into the vegetated areas and bioretention systems rather than flow into catch basins. Porous pavement allows stormwater to penetrate though to soil layers which will promote groundwater recharge as well as intercept and filter stormwater runoff. The porous pavement systems 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
Monroe Township
Monroe Township Middle School
local social and community groups

Partners/Stakeholders:
Monroe Township
Monroe Township Middle School
local community groups
students and parents
Rutgers Cooperative Extension

Estimated Cost:
Bioretention system #1 would need to be approximately 850 square feet. At $5 per square foot, the estimated cost of this system is $4,250. Bioretention system #2 would need to be approximately 1,150 square feet. At $5 per square foot, the estimated cost of this system is $5,750. Bioretention system #3 would need to be approximately 1,200 square feet. At $5 per square foot, the estimated cost of this system is $6,000. Porous pavement area #1 would cover approximately 9,450 square feet and have a 1 foot deep stone reservoir under the surface. At $20 per square foot, the cost of this system would be $189,000. Porous pavement area #2 would cover approximately 3,320 square feet and have a 1 foot deep stone reservoir under the surface. At $20 per square foot, the cost of this system would be $66,400. Porous pavement area #3 would cover approximately 1,000 square feet and have a 1 foot deep stone reservoir under the surface. At $20 per square foot, the cost of this system would be $20,000. The total cost of the project will be approximately $291,400.

Monroe Township
Impervious Cover Assessment

Monroe Township Senior Center, 12 Halsey Reed Road

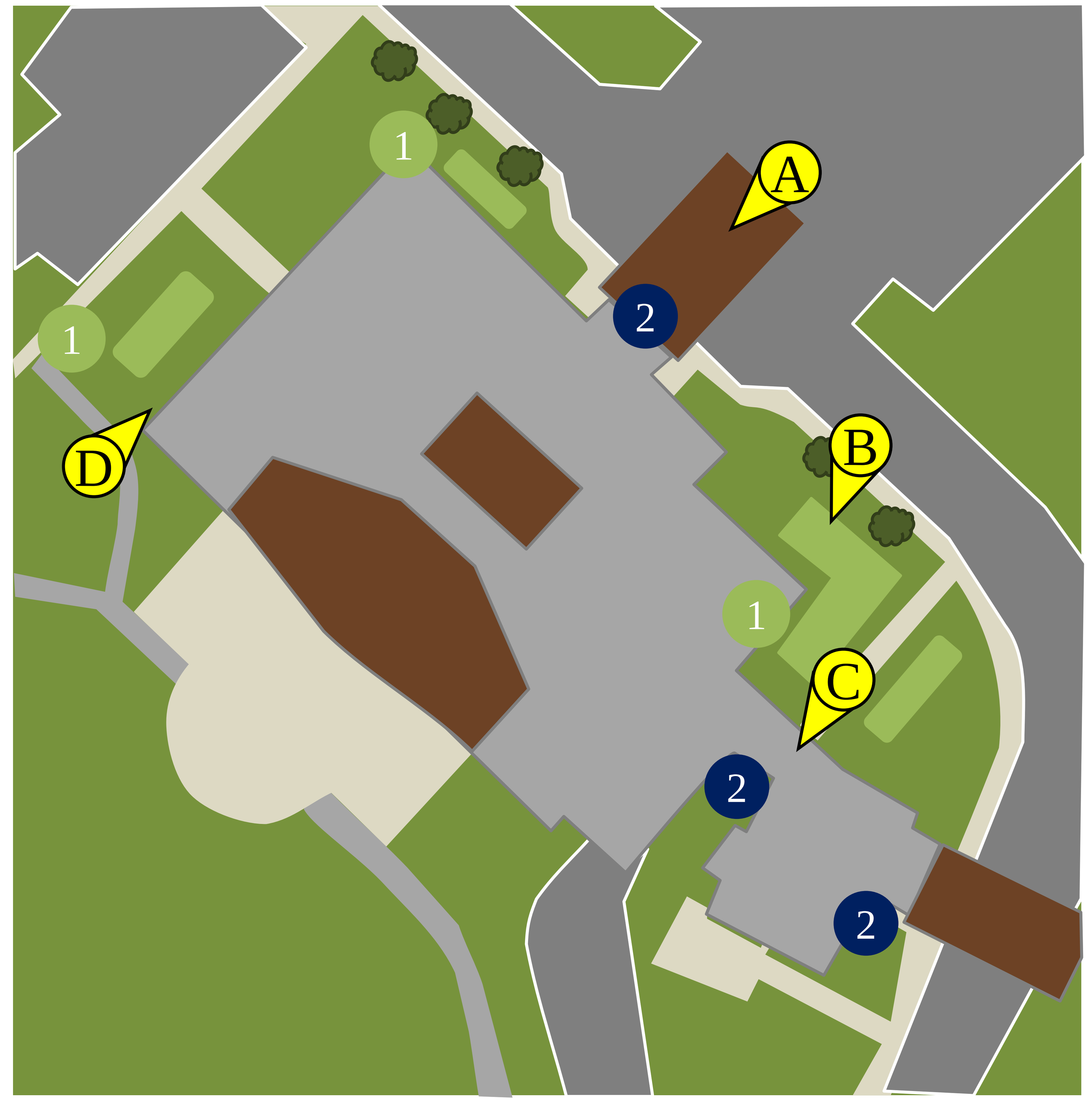
PROJECT LOCATION:

A

B

SITE PLAN:

N



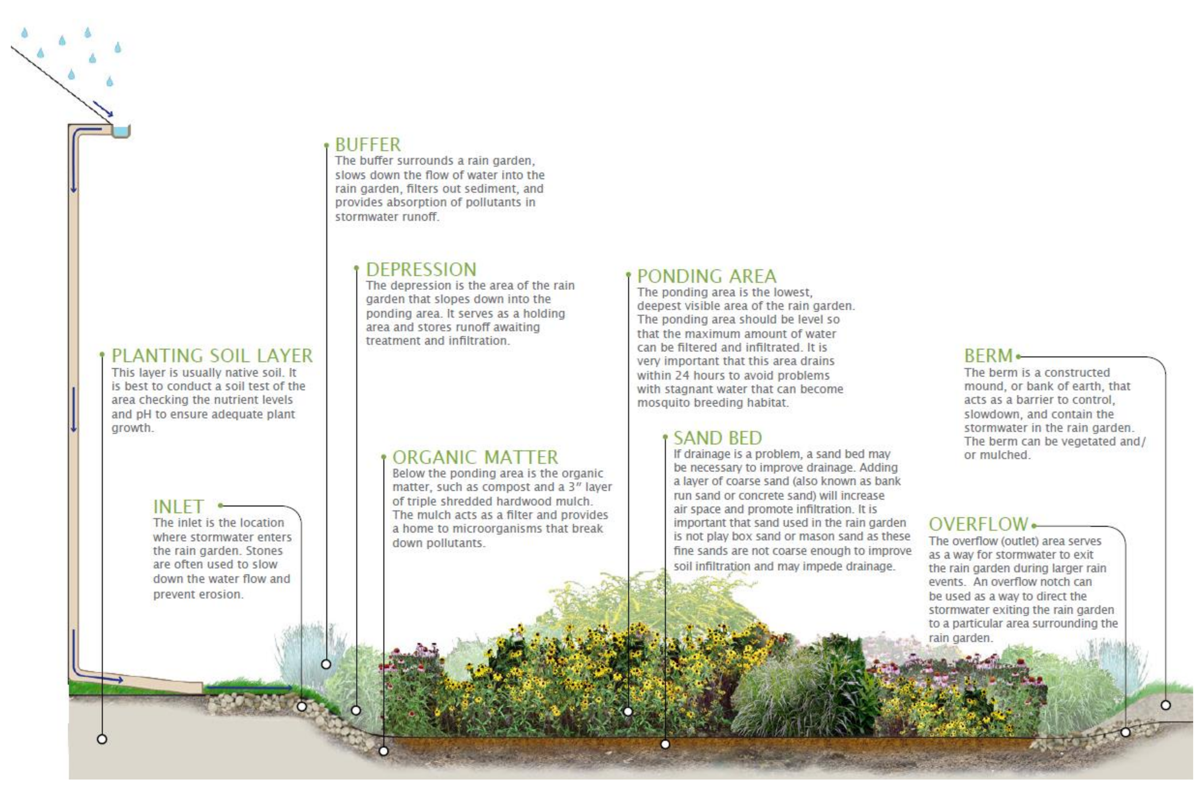
C

D

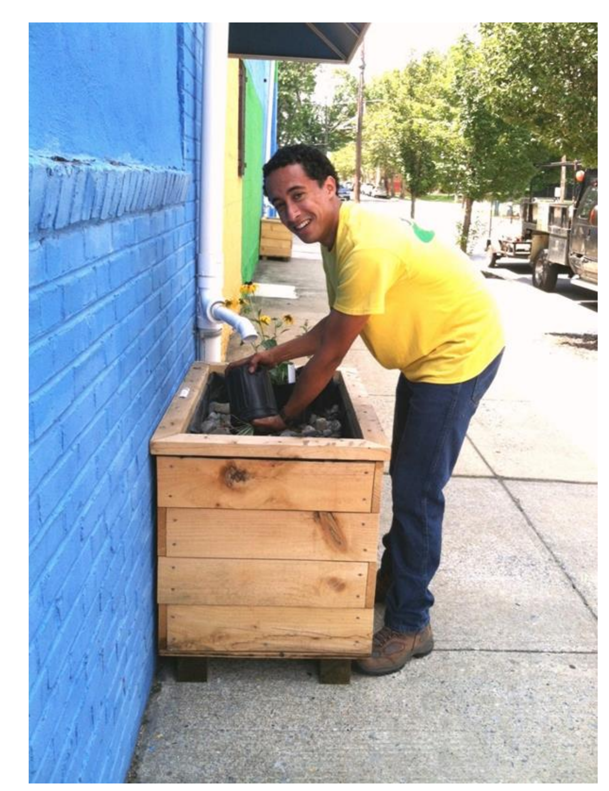
1 **BIORETENTION SYSTEMS:** Bioretention systems can be used to reduce sediment and nutrient loading to the local waterway and increase groundwater recharge. This site has multiple areas where downspouts can be disconnected and bioretention systems installed to capture roof runoff.

2 **DOWNSPOUT PLANTER BOX:** At least 15 downspout planter boxes could be installed in several areas to collect water from the building's downspouts. Downspout planter boxes reduce runoff and allow water to slowly infiltrate while being treated for pollutants.

1 BIORETENTION SYSTEM



2 DOWNSPOUT PLANTER BOX



Location: 12 Halsey Reed Road Monroe, NJ 08831	**Municipality:** Monroe Township **Subwatershed:** Millstone River
Green Infrastructure Description: bioretention systems (rain gardens) downspout planter boxes	**Targeted Pollutants:** total nitrogen (TN), total phosphorous (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: 72,955 gal. bioretention system #2: 31,266 gal. bioretention system #3: 125,066 gal. bioretention system #4: 31,266 gal. (each planter box: 1,400 gal.) fifteen downspout planter boxes: 21,000 gal.

Existing Conditions and Issues:
This site is located at the corner of Applegarth Road and Halsey Reed Road. This site appears to have been recently constructed. This site contains several impervious surfaces including driveways, parking areas, a shed, and the senior center. The site's impervious surfaces produce stormwater runoff during rain events. All of the senior center's downspouts are directly connected to a drainage system.

Proposed Solution(s):
Throughout the site there are many connected downspouts which can be disconnected and routed to downspout planter boxes or bioretention systems to capture the stormwater runoff from the roofs. Downspout planters could be installed in three locations of the senior center: the northeast entrance, the southwest patio area, and the southeast wing of the building. At least 15 downspout planter boxes could be placed around the senior center near these locations. At the western corner, multiple downspouts could be routed to bioretention system #1. At the northern corner, downspouts could be routed to bioretention system #2. Two bioretention systems (#3 and #4) could be similarly installed to the northeast of the building.

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. Downspout planter boxes will take in runoff from downspouts and achieve similar reductions in TN, TP, and TSS as the bioretention systems.

Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs
Monroe Township
Monroe Township Senior Center
local social and community groups

Partners/Stakeholders:
Monroe Township
Monroe Township Senior Center
local community groups
Rutgers Cooperative Extension

Estimated Cost:
Bioretention system #1 would need to be approximately 700 square feet. At $5 per square foot, the estimated cost of the system is $3,500. Bioretention system #2 would need to be approximately 300 square feet. At $5 per square foot, the estimated cost of the system is $1,500. Bioretention system #3 would need to be approximately 1,200 square feet. At $5 per square foot, the estimated cost of the system is $6,000. Bioretention system #4 would need to be approximately 300 square feet. At $5 per square foot, the estimated cost of the system is $1,500. The estimated cost of each downspout planter box is $300 for a total cost of $4,500 for fifteen. The total cost of the project will be approximately $17,000.