RUTGERS
New Jersey Agricultural
Experiment Station

Impervious Cover Assessment for Town of Phillipsburg, Warren County, New Jersey

Prepared for the Town of Phillipsburg by the
Rutgers Cooperative Extension Water Resources Program

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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, and pesticides and other toxic substances. These pollutants are then able to enter waterways.

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

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

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

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

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

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

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

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

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

Phillipsburg Impervious Cover Analysis

Located in Warren County in northern New Jersey, the Town of Phillipsburg covers approximately 3.3 square miles east of the City of Easton, Pennsylvania. Figures 3 and 4 illustrate that Phillipsburg is dominated by urban land uses. A total of 77.9% of the municipality's land use is classified as urban. Of the urban land in Phillipsburg, high 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) 2007 land use/land cover geographical information system (GIS) data layer categorizes Phillipsburg 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 Phillipsburg. Based upon the 2007 NJDEP land use/land cover data, approximately 37.0% of Phillipsburg has impervious cover. This level of impervious cover suggests that the streams in Phillipsburg are non-supporting streams.

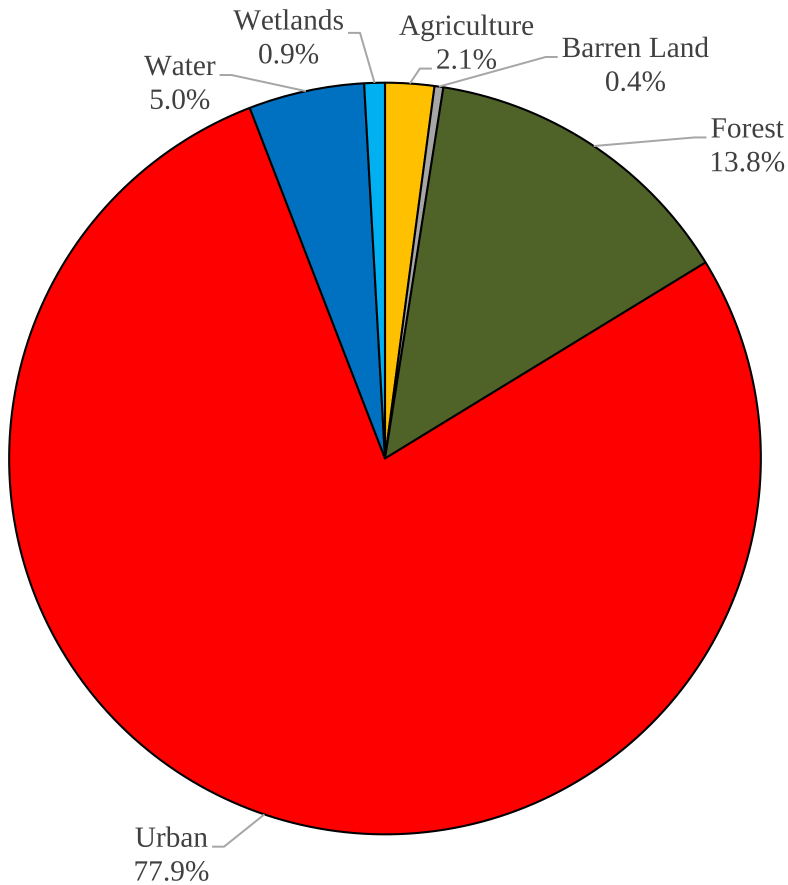


Figure 3: Pie chart illustrating the land use in Phillipsburg

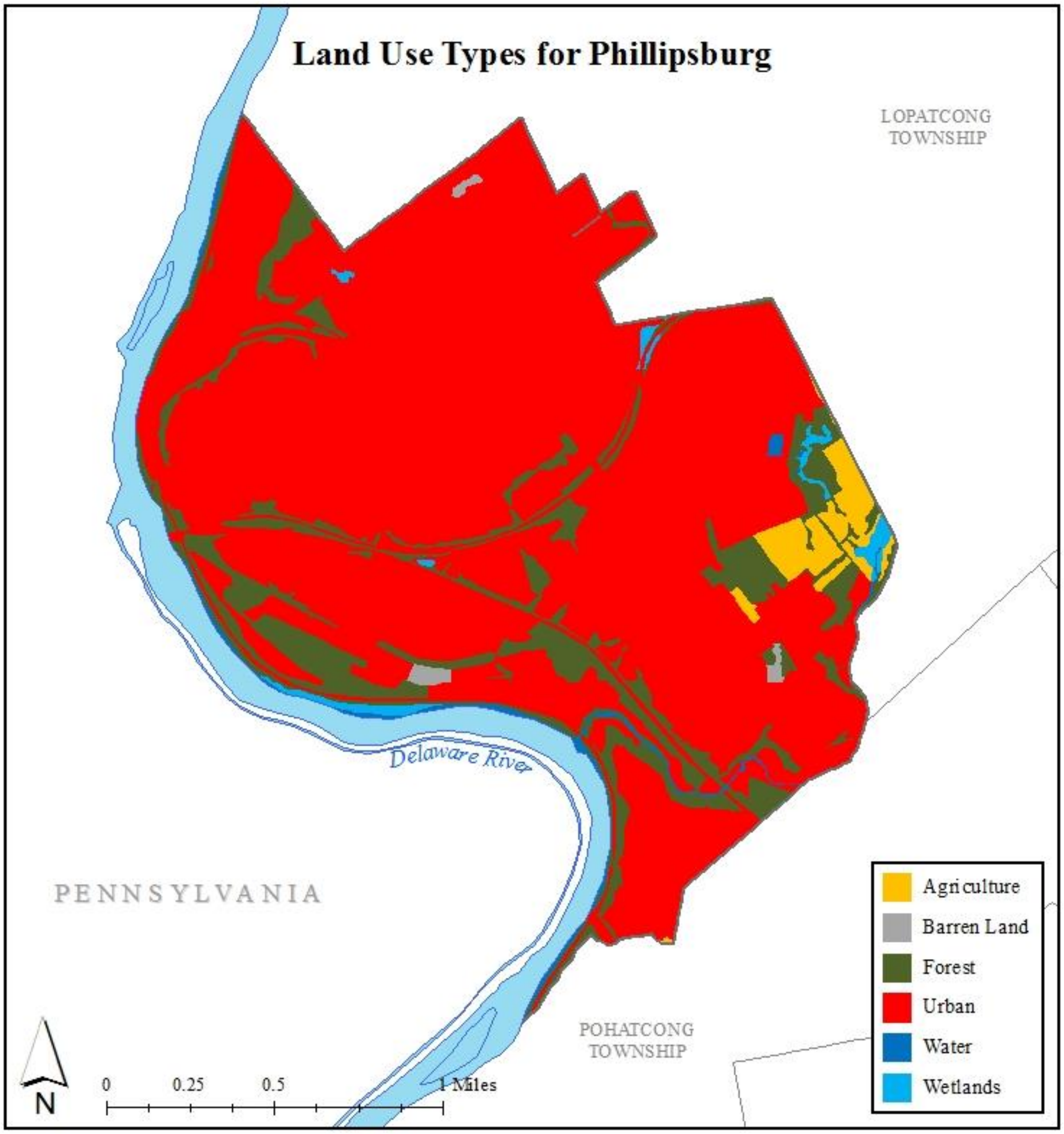


Figure 4: Map illustrating the land use in Phillipsburg

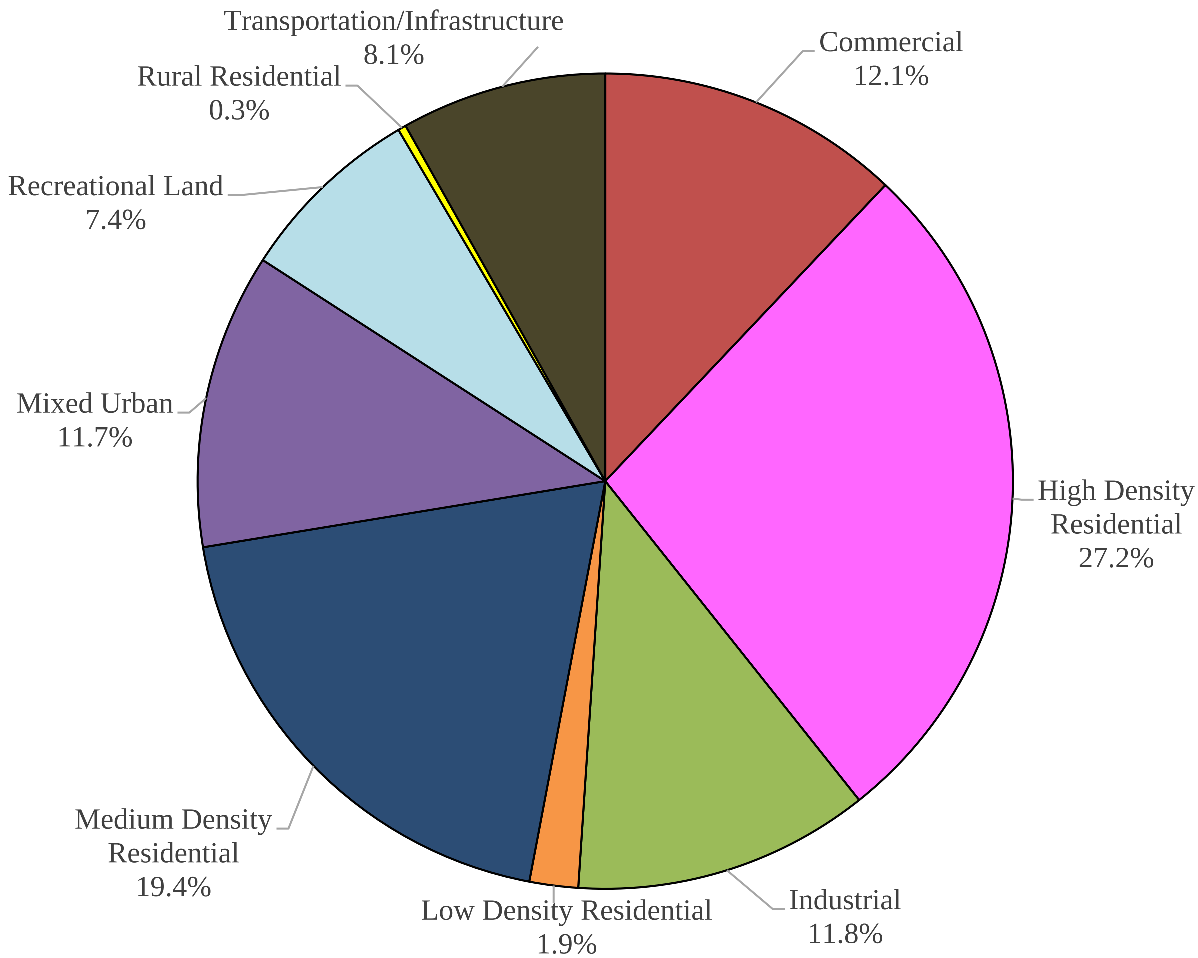


Figure 5: Pie chart illustrating the various types of urban land use in Phillipsburg

Water resources are typically managed on a watershed/subwatershed basis; therefore an impervious cover analysis was performed for each watershed within Phillipsburg (Table 1 and Figure 6). On a subwatershed basis, impervious cover ranges from 44.5% in the Upper Delaware River (UDRV) tributary subwatershed to 34.5% in the Lopatcong Creek subwatershed. Evaluating impervious cover on a subwatershed basis allows the municipality to focus impervious cover reduction or disconnection efforts in 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 Phillipsburg, Warren County) associated with impervious surfaces were calculated for the following storms: the New Jersey water quality design storm of 1.25 inches of rain, an annual rainfall of 44 inches, the 2-year design storm (3.3 inches of rain), the 10-year design storm (4.9 inches of rain), and the 100-year design storm (7.8 inches of rain). These runoff volumes are summarized in Table 2. A substantial amount of rainwater drains from impervious surfaces in Phillipsburg. For example, if the stormwater runoff from one water quality storm (1.25 inches of rain) in the Upper Delaware River Valley (UDRV) tributary subwatershed was harvested and purified, it could supply water to 8,153 homes for a year[1].

[1] Assuming 300 gallons per day per home

Table 1: Impervious cover analysis by subwatershed for Phillipsburg

Subwatershed	**Total Area**		**Land Use Area**		**Water Area**		**Impervious Cover**		
	(ac)	**(mi^2)**	**(ac)**	**(mi^2)**	**(ac)**	**(mi^2)**	**(ac)**	**(mi^2)**	**(%)**
Upper Delaware River Valley (UDRV) Tributary	509.0	0.80	480.0	0.80	29.1	0.05	213.2	0.30	44.5%
Lopatcong Creek	1,617.0	2.50	1,541.0	2.40	76.4	0.12	534.1	0.80	34.5%
Total	2,126.0	3.30	2,021.0	3.20	105.5	0.17	747.3	1.10	37.0%

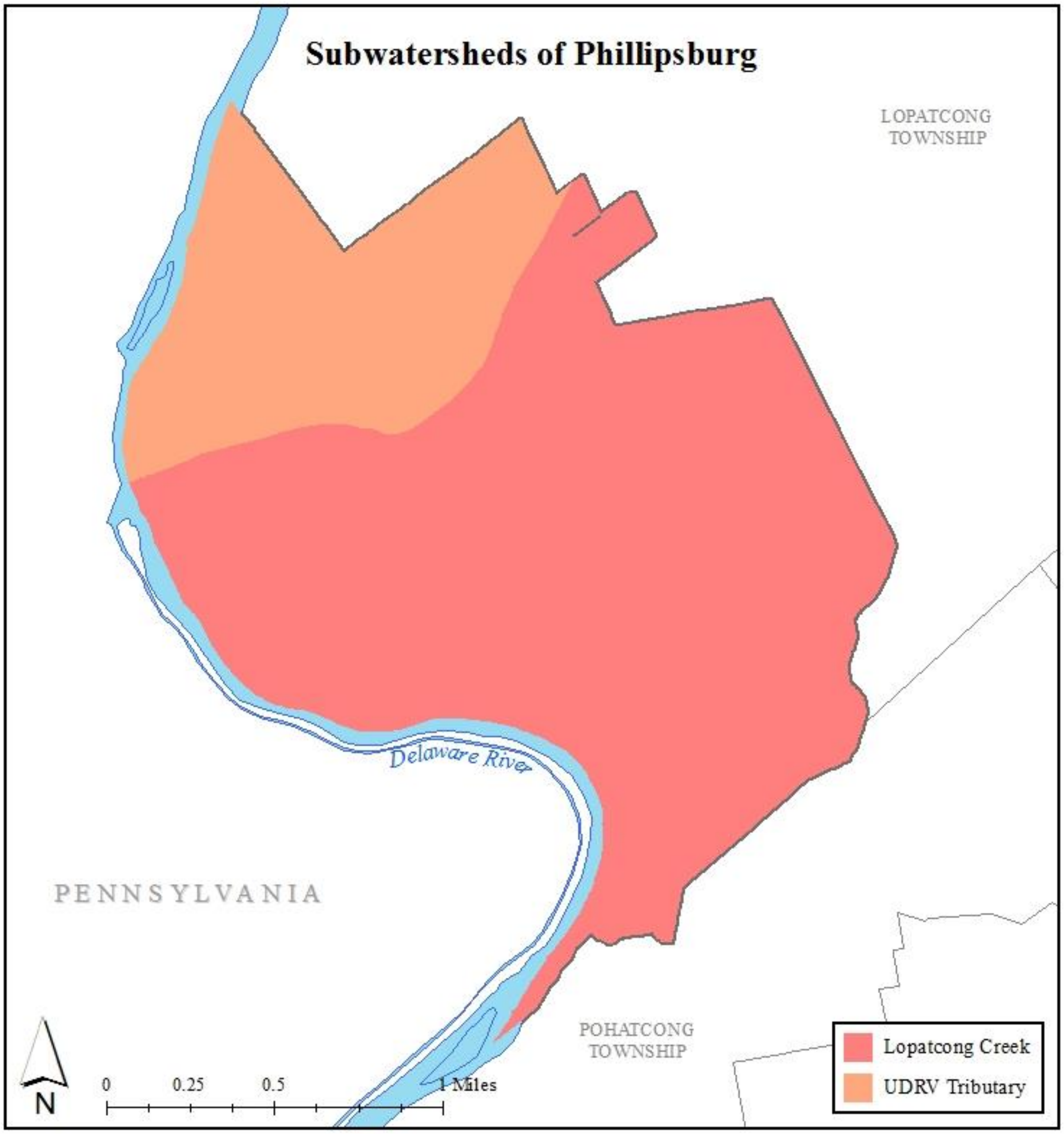


Figure 6: Map of the subwatersheds in Phillipsburg

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

Subwatershed	**Total Runoff Volume for the 1.25" NJ Water Quality Storm (MGal)**	**Total Runoff Volume for the NJ Annual Rainfall of 44"(MGal)**	**Total Runoff Volume for the 2-Year Design Storm (3.3") (MGal)**	**Total Runoff Volume for the 10-Year Design Storm (4.9") (MGal)**	**Total Runoff Volume for the 100-Year Design Storm (7.8") (MGal)**
Upper Delaware River (UDRV) Tributary	7.2	254.7	19.1	28.4	45.2
Lopatcong Creek	18.1	638.1	47.9	71.1	113.1
Total	25.3	892.8	67.0	99.5	158.3

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 Phillipsburg. 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 Phillipsburg

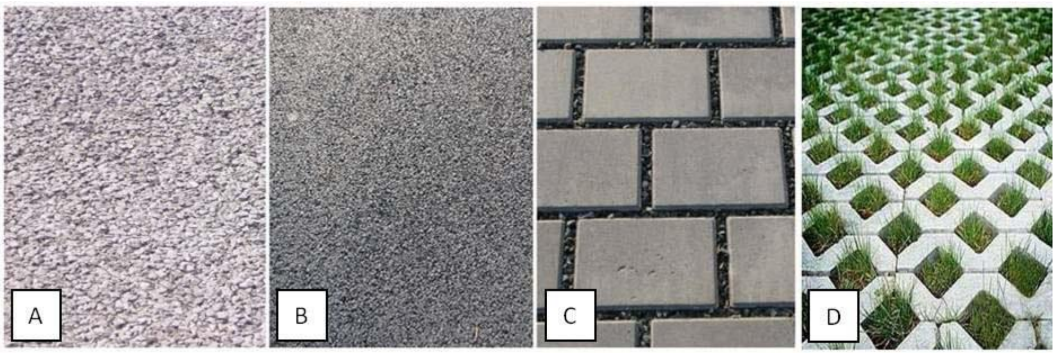
Subwatershed	Recommended Impervious Area Reduction (10%) (ac)	Annual Runoff Volume Reduction [2] (MGal)
Upper Delaware River (UDRV) Tributary	21.3	24.2
Lopatcong Creek	53.4	60.6
Total	74.7	84.8

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

Pervious Pavement

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

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



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

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

Impervious Cover Disconnection Practices

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

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

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

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

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

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

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

Examples of Opportunities in Phillipsburg

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 Phillipsburg, 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

Phillipsburg 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

Town of Phillipsburg
Impervious Cover Assessment
Andover-Morris Elementary School, 712 South Main Street

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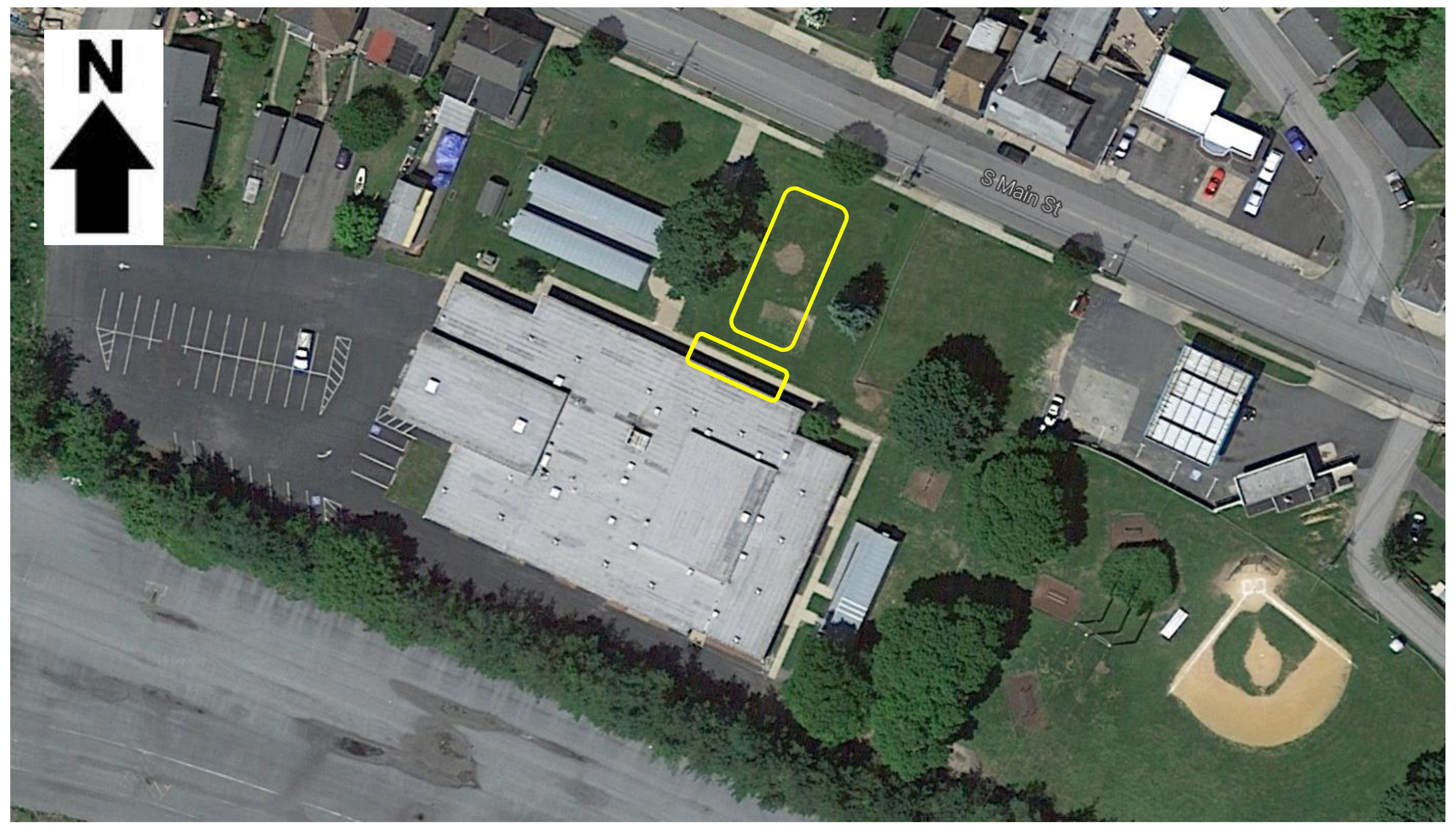
New Jersey Agricultural Experiment Station

PROJECT LOCATION:



A

B

C

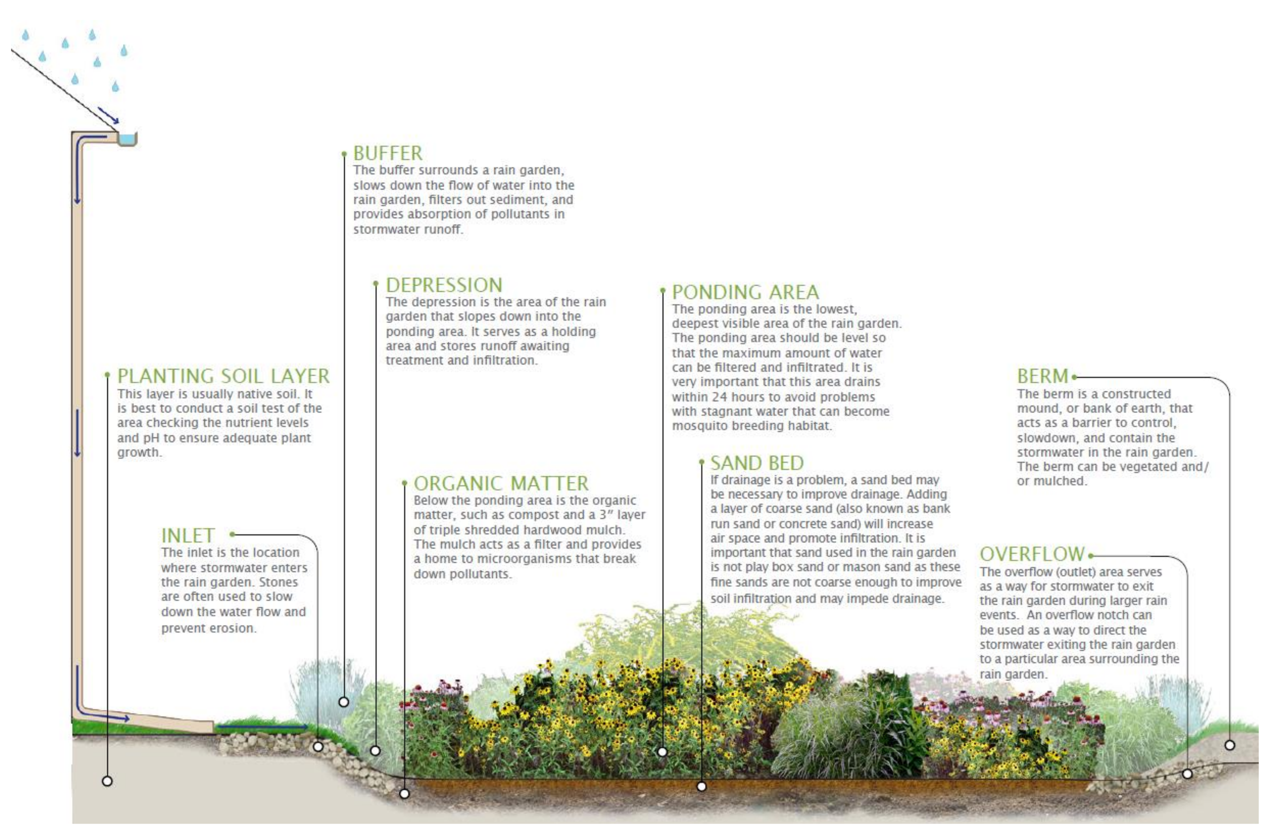
SITE PLAN:

1 **BIORETENTION SYSTEM:** A bioretention system could be installed in the large lawn in front of the school. The two patches of exposed earth have gravel and several pipes that would need to be removed. A bioretention system will reduce runoff and allow stormwater infiltration, decreasing the amount of contaminants that reaches the catch basins.

2 **TRENCH DRAIN:** Trench drains could be installed to allow the roof runoff to drain under the sidewalks into the bioretention system.

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

1 BIORETENTION SYSTEM



2 TRENCH DRAIN

3 EDUCATIONAL PROGRAM

Location: 712 South Main Street Phillipsburg, NJ 08865	**Municipality:** Town of Phillipsburg **Subwatershed:** Lopatcong Creek
Green Infrastructure Description: bioretention system trench drain	**Targeted Pollutants:** total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes stormwater peak reduction potential: yes total suspended solids removal potential: yes	**Stormwater Captured and Treated Per Year:** bioretention system: 174,571 gal.

Existing Conditions and Issues:
At the front of the building the ground dips down after the sidewalk into a large turf grass area. This turfgrass area has soil erosion and contains gravel and metal. At the building's north face, there are a few connected downspouts with a sidewalk between them and the turf grass area.

Proposed Solution(s):
At the front of the building, a bioretention system could be constructed if the existing gravel and metal were removed. The downspouts could be disconnected, and a trench drain could be installed to allow stormwater to flow under the sidewalk and into the bioretention system. The bioretention system will capture stormwater from the roof.

Anticipated Benefits:
If these bioretention systems are designed to capture and infiltrate stormwater runoff from the 2-year design storm (3.3 inches of rain over 24 hours), these systems will prevent approximately 95% of the TN, TP and TSS from flowing directly into local waterways. A bioretention system would also provide ancillary benefits such as enhanced wildlife habitat and aesthetic appeal. Rutgers Cooperative Extension could additionally present the *Stormwater Management in Your Schoolyard* program to students and include them in bioretention system planting efforts to enhance the program. This may also be used as a demonstration project for the Phillipsburg Department of Public Works staff to launch educational programming. The disconnected downspouts will allow stormwater to infiltrate into the ground naturally, promoting groundwater recharge, rather than being sent straight into the stormwater management systems. Trench drains allow stormwater runoff to cross over into the vegetated areas and bioretention systems rather than flow directly into storm drains.

Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs

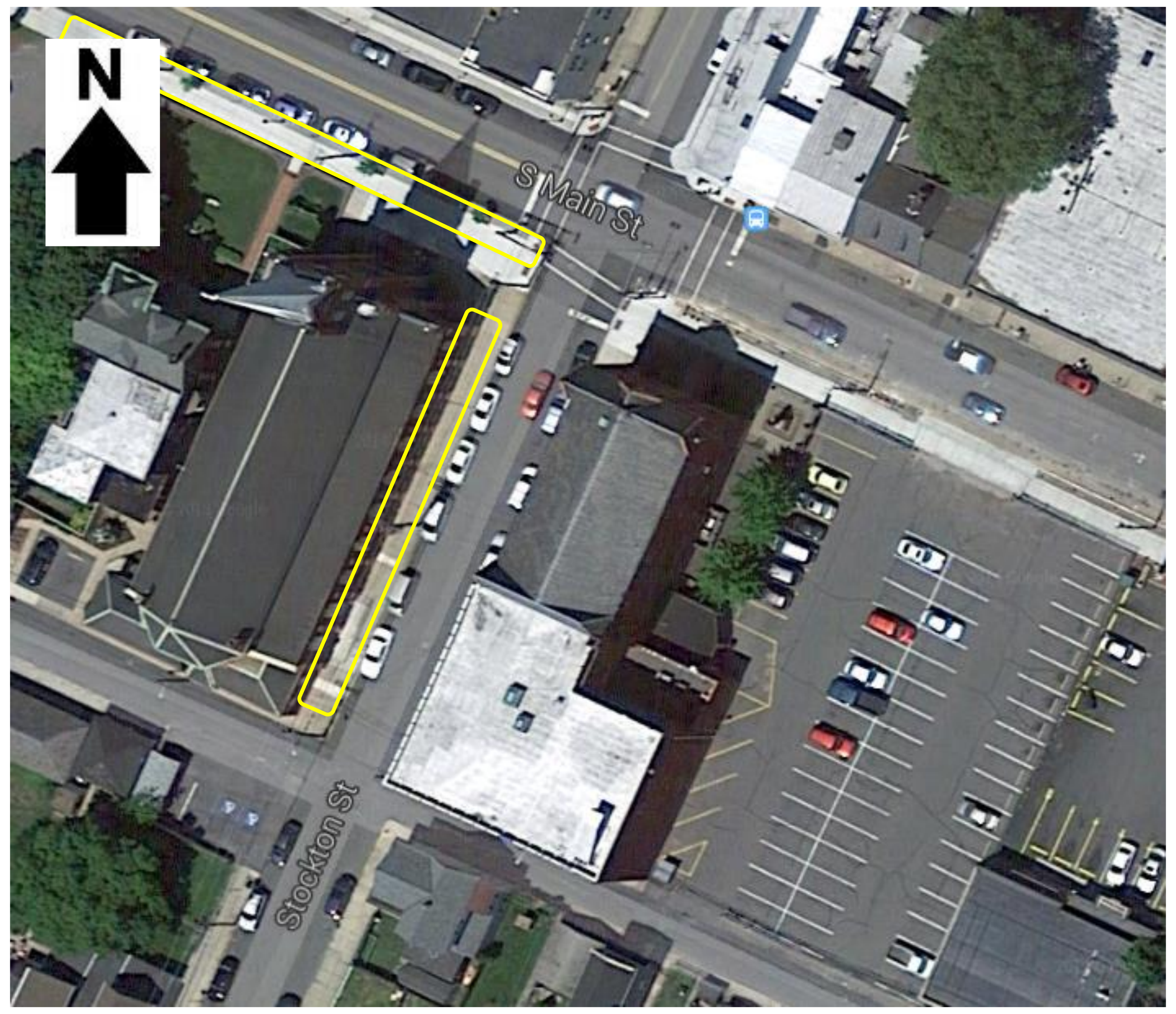
Partners/Stakeholders:
Town of Phillipsburg
Andover-Morris Elementary School
Rutgers Cooperative Extension

Estimated Cost:
The bioretention system would need to be approximately 1,680 square feet. At $5 per foot, the estimated cost of the rain garden is $8,400. The estimated cost for simple disconnection of downspouts is $250.

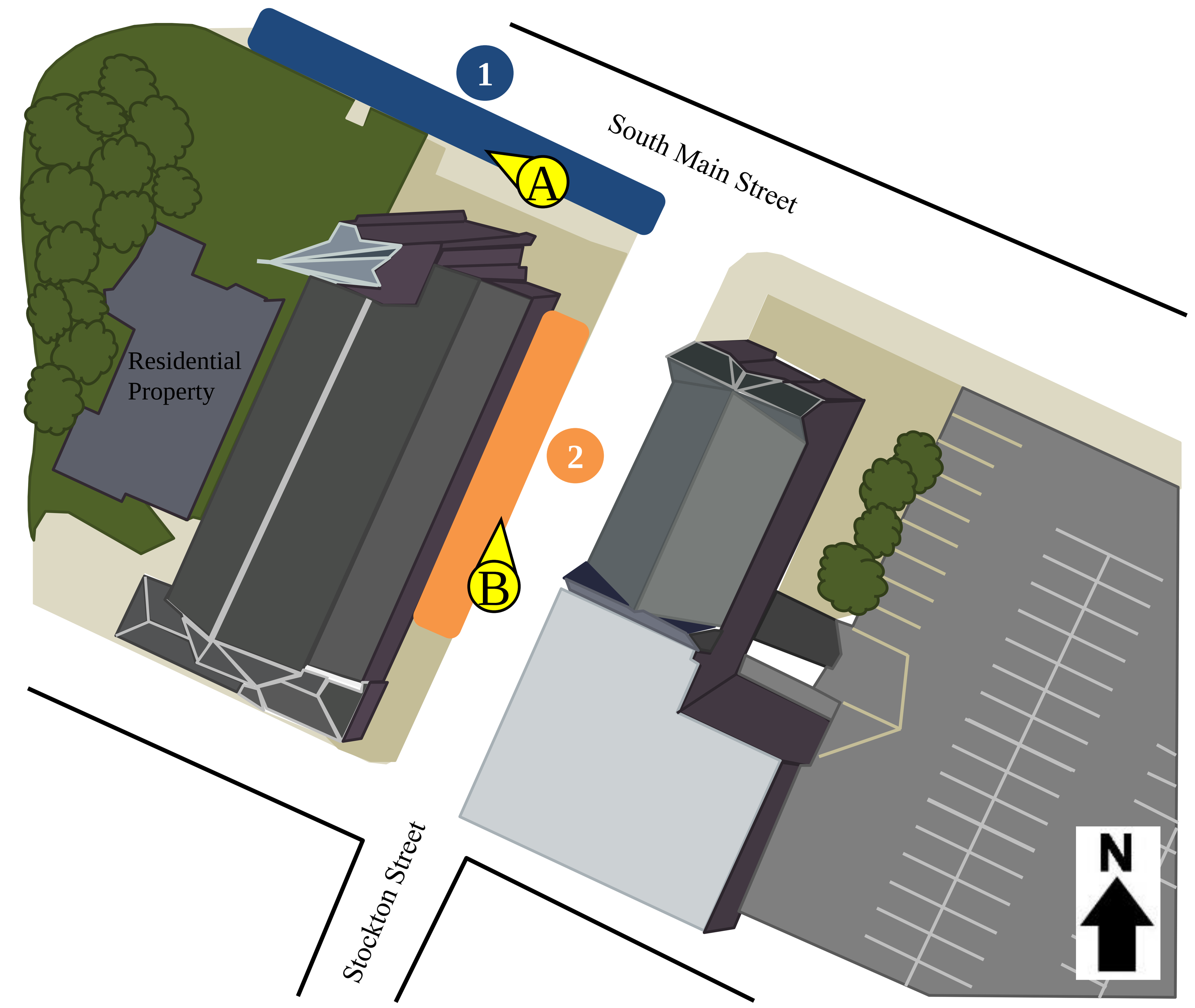
The total cost of this project would be $8,650.

Town of Phillipsburg
Impervious Cover Assessment
St. Philip & St. James Church, 430 South Main Street

PROJECT LOCATION:



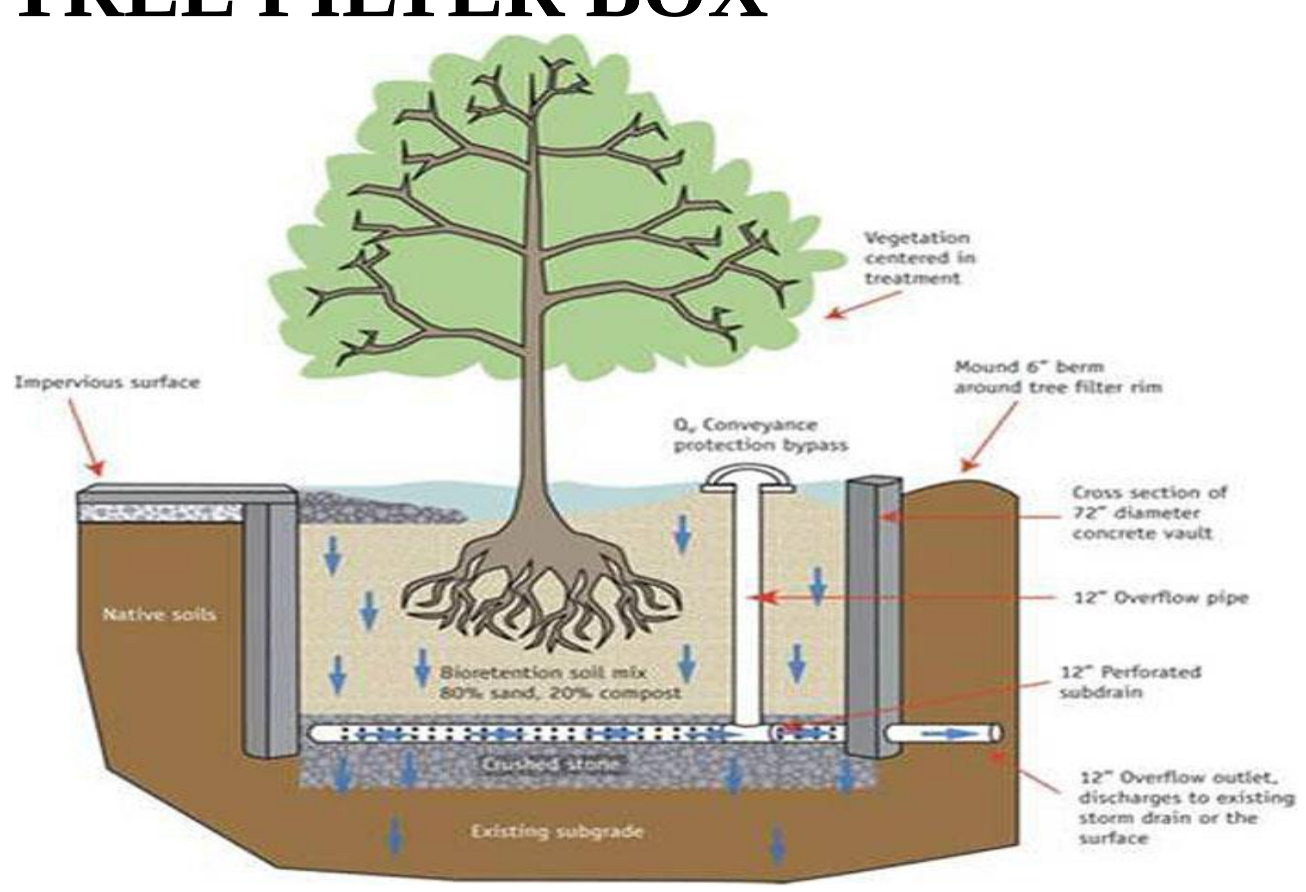
SITE PLAN:



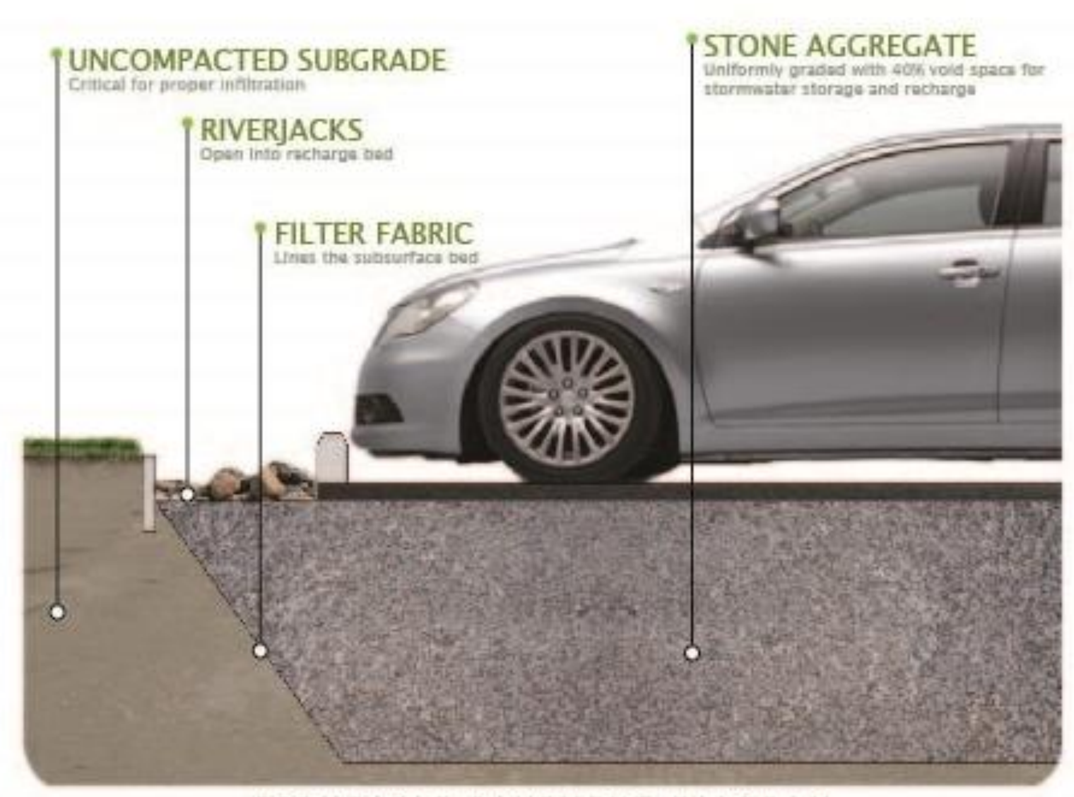
1 **TREE FILTER BOX:** A tree filter box could be installed along the sidewalk in the front of the church to catch and treat the first flush of stormwater prior to discharge into the stormwater system.

2 **POROUS PAVEMENT:** A strip of porous pavement could be installed along the northeast side of the building where several disconnected downspouts drain stormwater runoff from the roof. Porous pavement promotes groundwater recharge and filters stormwater.

1 TREE FILTER BOX



2 POROUS PAVEMENT



Location: 430 South Main Street Phillipsburg, NJ 08865	**Municipality:** Town of Phillipsburg **Subwatershed:** Lopatcong Creek
Green Infrastructure Description: tree filter box pervious pavement	**Targeted Pollutants:** total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes stormwater peak reduction potential: yes total suspended solids removal potential: yes	**Stormwater Captured and Treated Per Year:** tree filter box: 200,678 gal. pervious pavement: 152,736 gal.

Existing Conditions and Issues:
This site is located at the intersection of South Main Street and Stockton Street and focuses on the building on the west side of Stockton Street. On South Main Street, the sidewalk is very large with small tree pits. On Stockton Street, there are disconnected downspouts flowing onto the sidewalk with minor pooling.

Proposed Solution(s):
On the sidewalk of South Main Street, a tree filter box could be installed along the sidewalk to capture stormwater that would otherwise flow into the street. On the Stockton Street side, the sidewalk could be redone with pervious pavement to help prevent pooling and allow infiltration of stormwater.

Anticipated Benefits:
A tree filter box will absorb and treat stormwater runoff before flowing directly into stormwater sewer systems. They additionally provide aesthetic appeal to the local community and members of the congregation of St. Philip & St. James Church. Pervious pavement allows stormwater to penetrate through to soil layers which will promote groundwater recharge as well as intercept and filter stormwater runoff. Since it would be designed to capture, treat, and infiltrate the entire 2-year design storm (3.3 inches of rain over 24 hours), this system will be able to achieve a 95% pollutant load reduction for TN, TP, and TSS.

Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs

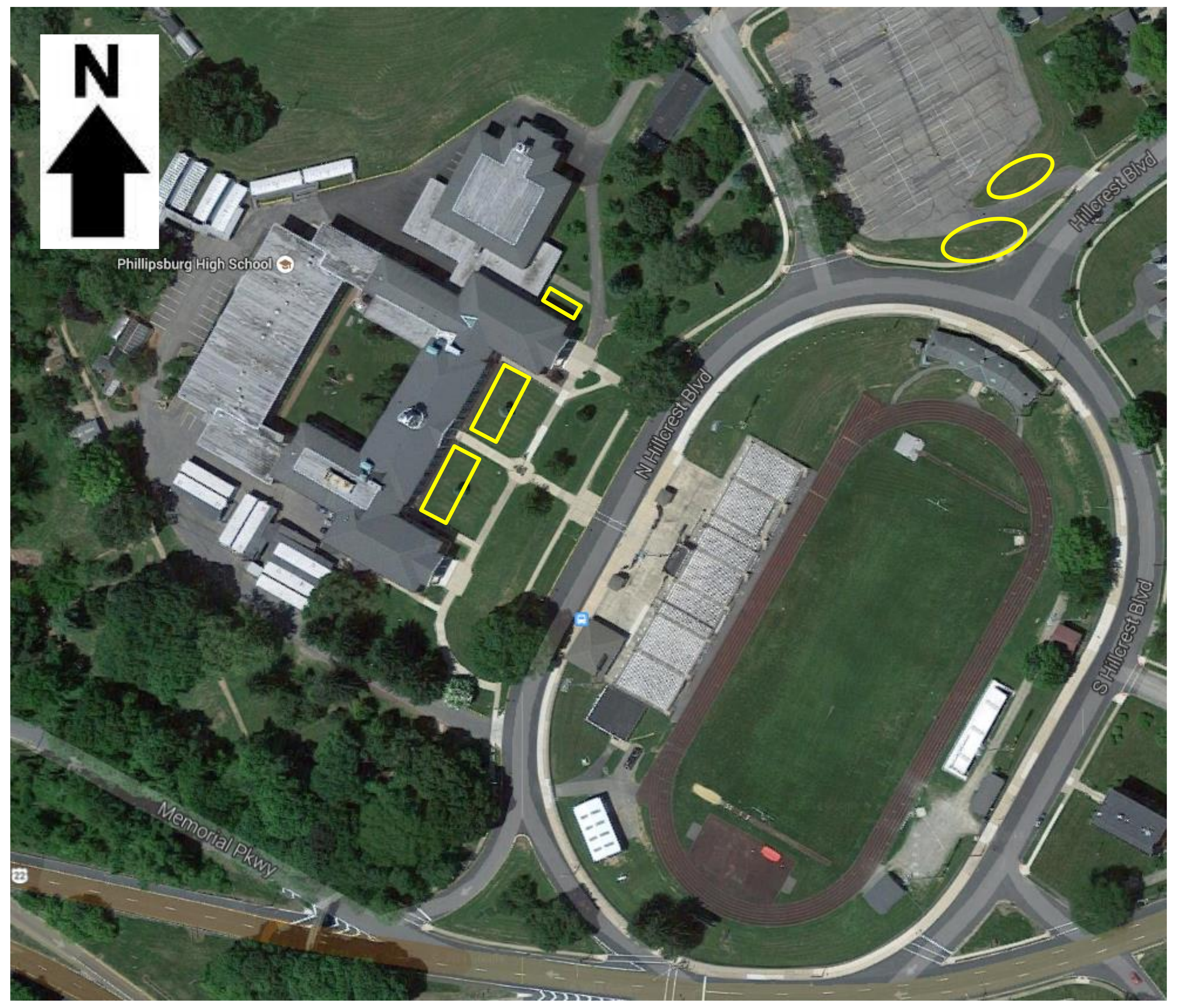
Partners/Stakeholders:
Town of Phillipsburg
St. Philip & St. James Church
Rutgers Cooperative Extension
church congregation

Estimated Cost:
The tree filter box will cost $7,500 each. Only one is necessary for the drainage area at this site. The pervious pavement would cover 2,100 square feet and have a 1-foot stone reservoir under the surface. At $20 per square foot, the cost of the porous pavement system would be $42,000.

The total cost of the project would be approximately $49,500.

Town of Phillipsburg
Impervious Cover Assessment
Phillipsburg High School, 200 Hillcrest Boulevard

PROJECT LOCATION:



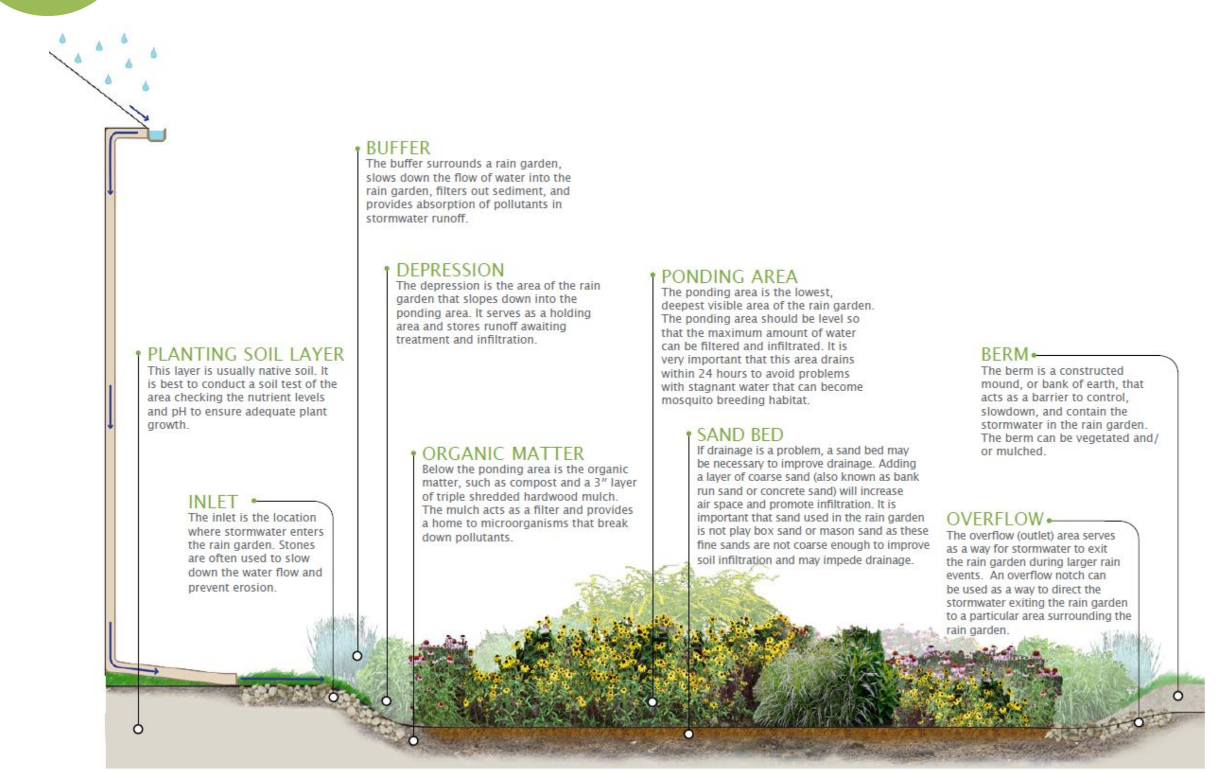
SITE PLAN:

1 **BIORETENTION SYSTEMS:** Bioretention systems could be installed in the turfgrass areas where downspouts can be disconnected on either side of the entrance as well as on the side of the school. A bioretention system will reduce runoff and allow stormwater infiltration, decreasing the amount of contaminants that reaches catch basins.

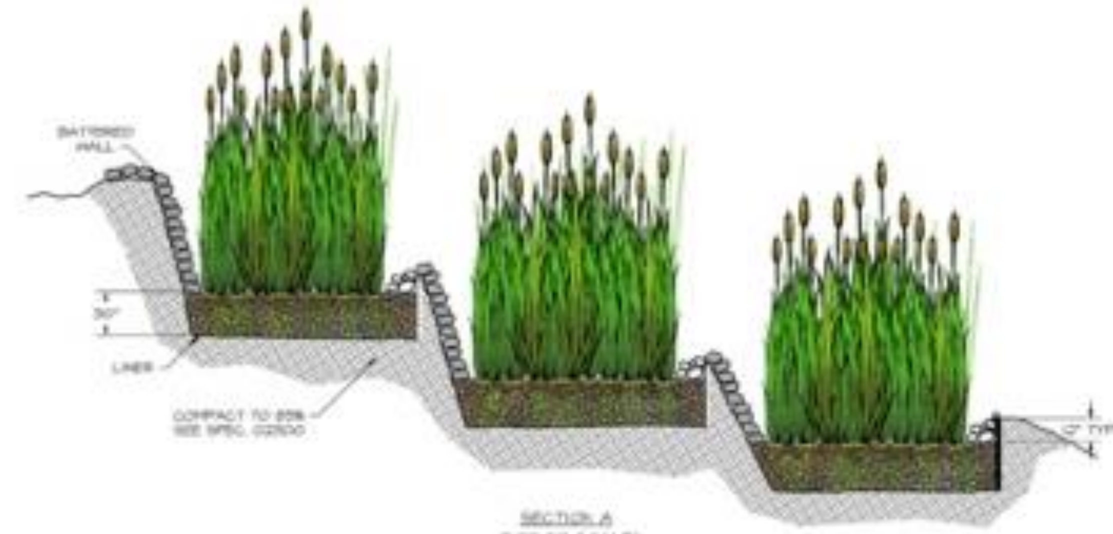
2 **TERRACED BIOSWALES:** A terraced bioswale could capture and convey stormwater from the parking lot to reduce flooding and decrease the amount of contaminants that reach catch basins by allowing for stormwater infiltration.

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

1 BIORETENTION SYSTEM



2 TERRACED BIOSWALES



3 EDUCATIONAL PROGRAM

Location: 200 Hillcrest Boulevard Phillipsburg, NJ 08865	**Municipality:** Town of Phillipsburg **Subwatershed:** Upper Delaware River Tributary
Green Infrastructure Description: terraced bioswales bioretention systems	**Targeted Pollutants:** total nitrogen (TN), total phosphorus (TP), and total suspended solids (TSS) in surface runoff
Mitigation Opportunities: recharge potential: yes stormwater peak reduction potential: yes TSS removal potential: yes	**Stormwater Captured and Treated Per Year:** terraced bioswale: 866,079 gal. bioretention system #1: 184,237 gal. bioretention system #2: 184,237 gal. bioretention system #3: 109,172 gal.

Existing Conditions and Issues:
This site is located along Hillcrest Boulevard and focuses on the parking lot area north of the track and in front of the school. At the southern end of the parking lot there is a steeply sloped turfgrass area with erosion. Along the front of the building there are two adjacent, symmetric turfgrass areas with several disconnected downspouts. Toward the building's northwest corner, there is a connected downspout with an adjacent turfgrass area.

Proposed Solution(s):
In the turfgrass area south of the parking lot, terraced bioswales could be implemented to help absorb runoff from the parking lot and reduce soil erosion. In the large turfgrass area in front of the school, two bioretention systems (bioretention systems #1 and #2) could be built. The nearby disconnected downspouts could be rerouted to flow into the bioretention systems. At the northeast corner of the building a downspout could be disconnected to flow into a bioretention system (bioretention system #3).

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

The terraced bioswales will aid in slowing down the water flowing down this hill as well as reduce soil erosion. The disconnected downspouts will allow stormwater to infiltrate into the ground naturally, promoting groundwater recharge, rather than being sent straight into the storm sewer.

Possible Funding Sources:
mitigation funds from local developers
NJDEP grant programs

Partners/Stakeholders:
Town of Phillipsburg
Phillipsburg High School
Rutgers Cooperative Extension

Estimated Cost:
The terraced bioswales would need to have a total area of approximately 14,130 square feet. At $5 per square feet the cost of the bioswales would be $70,650. Bioretention systems #1 and #2 would both need to be approximately 1,770 square feet each. At $5 per square feet the cost of bioretention systems #1 and #2 would be $17,700. Bioretention system #3 would need to be approximately 1,050 square feet. At $5 per square feet the cost of bioretention system #3 would be $5,250. The estimated cost for simple disconnection of downspouts is $250.

The total cost of this project would be approximately $93,850.