RUTGERS
New Jersey Agricultural
Experiment Station

Draft

Impervious Cover Reduction Action Plan
for
Union Township, Hunterdon County, New Jersey

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

November 30, 2020

Highlands Council
New Jersey

ACKNOWLEDGEMENTS:

This document has been prepared by the Rutgers Cooperative Extension Water Resources Program, with funding and direction from the New Jersey Highlands Water Protection and Planning Council and the New Jersey Agricultural Experiment Station, to highlight green infrastructure opportunities within Union Township. We would like to thank the New Jersey Highlands Water Protection and Planning Council, the New Jersey Agricultural Experiment Station, and Union Township for their input and support in creating this document.

RUTGERS
New Jersey Agricultural Experiment Station

Highlands Council
New Jersey

Table of Contents

Introduction

Located in Hunterdon County, New Jersey, Union Township covers approximately 20.61 square miles. Figures 1 and 2 illustrate that Union Township is dominated by forest land use. A total of 24.4% of the municipality's land use is classified as urban. Of the urban land in Union Township, rural residential is the dominant land use (Figure 3).

The New Jersey Department of Environmental Protection's (NJDEP) 2015 land use/land cover geographical information system (GIS) data layer categorizes Union 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 Union Township. Based upon the 2015 NJDEP land use/land cover data, approximately 5.5% of Union Township has impervious cover. This level of impervious cover suggests that the streams in Union Township likely range from sensitive to impacted streams. [1]

Methodology

Union Township contains portions of eight subwatersheds (Figure 4). For this impervious cover reduction action plan, projects have been identified in three of these watersheds. Initially, aerial imagery was used to identify potential project sites that contain extensive impervious cover. Field visits were then conducted at each of these potential project sites to determine if a viable option exists to reduce impervious cover or to disconnect impervious surfaces from draining directly to the local waterway or storm sewer system. During the site visit, appropriate green infrastructure practices for the site were determined. Sites that already had stormwater management practices in place were not considered.

[1] Schuler, T.R., L. Fraley-McNeal, and K. Cappiella. 2009. Is Impervious Cover Still Important? Review of Recent Research. *Journal of Hydrologic Engineering* 14 (4): 309-315.

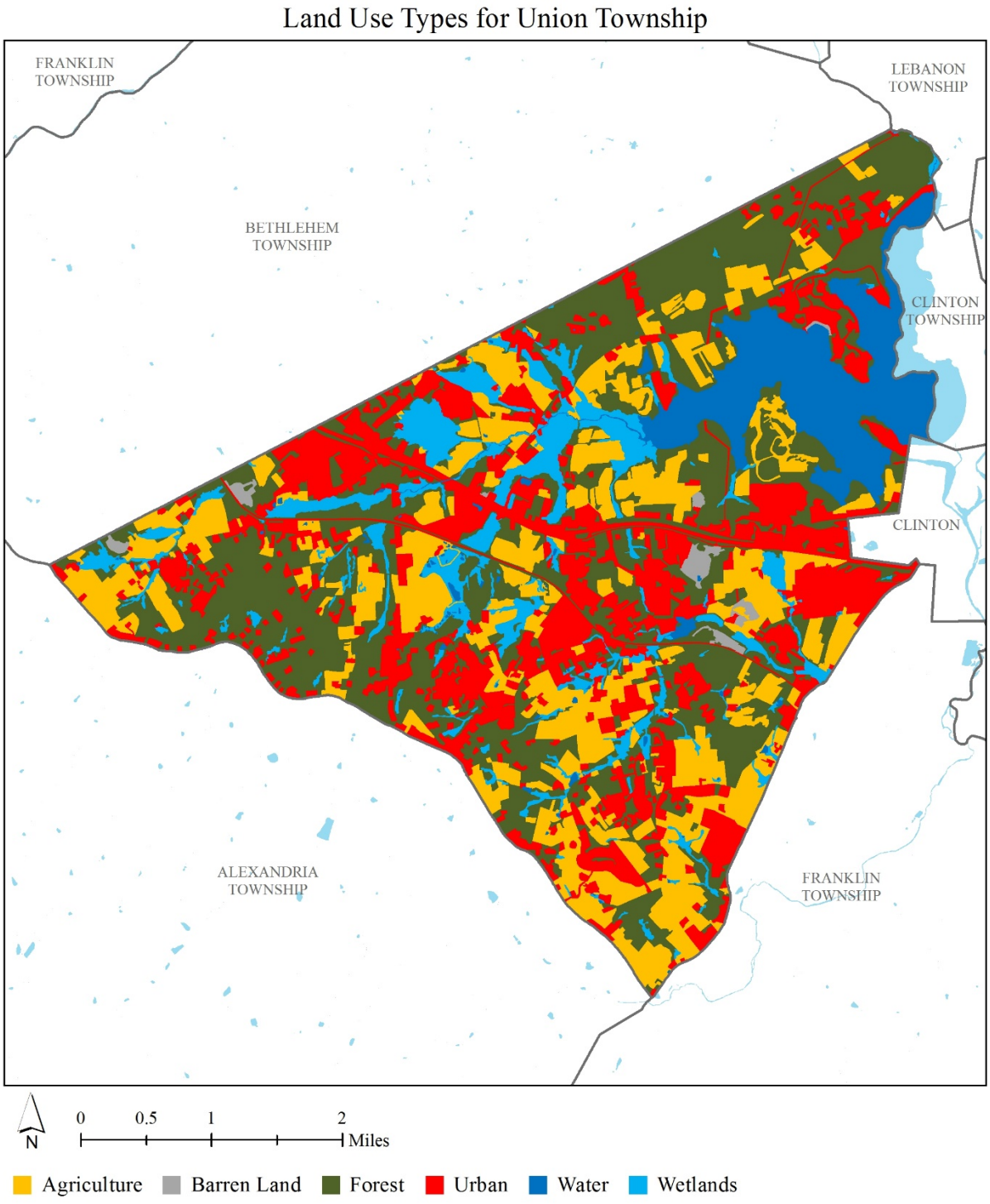


Figure 1: Map illustrating the land use in Union Township

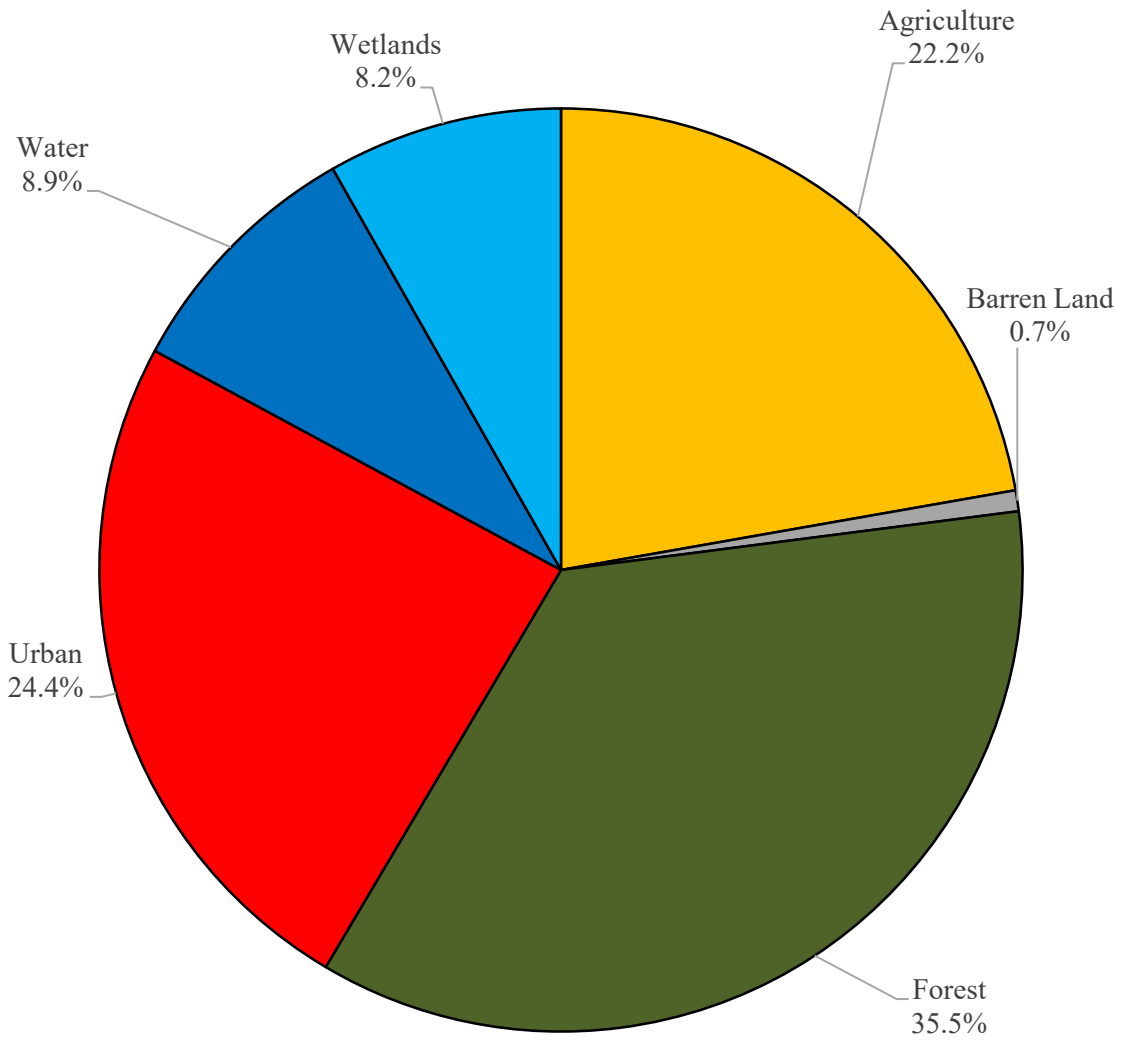


Figure 2: Pie chart illustrating the land use in Union Township

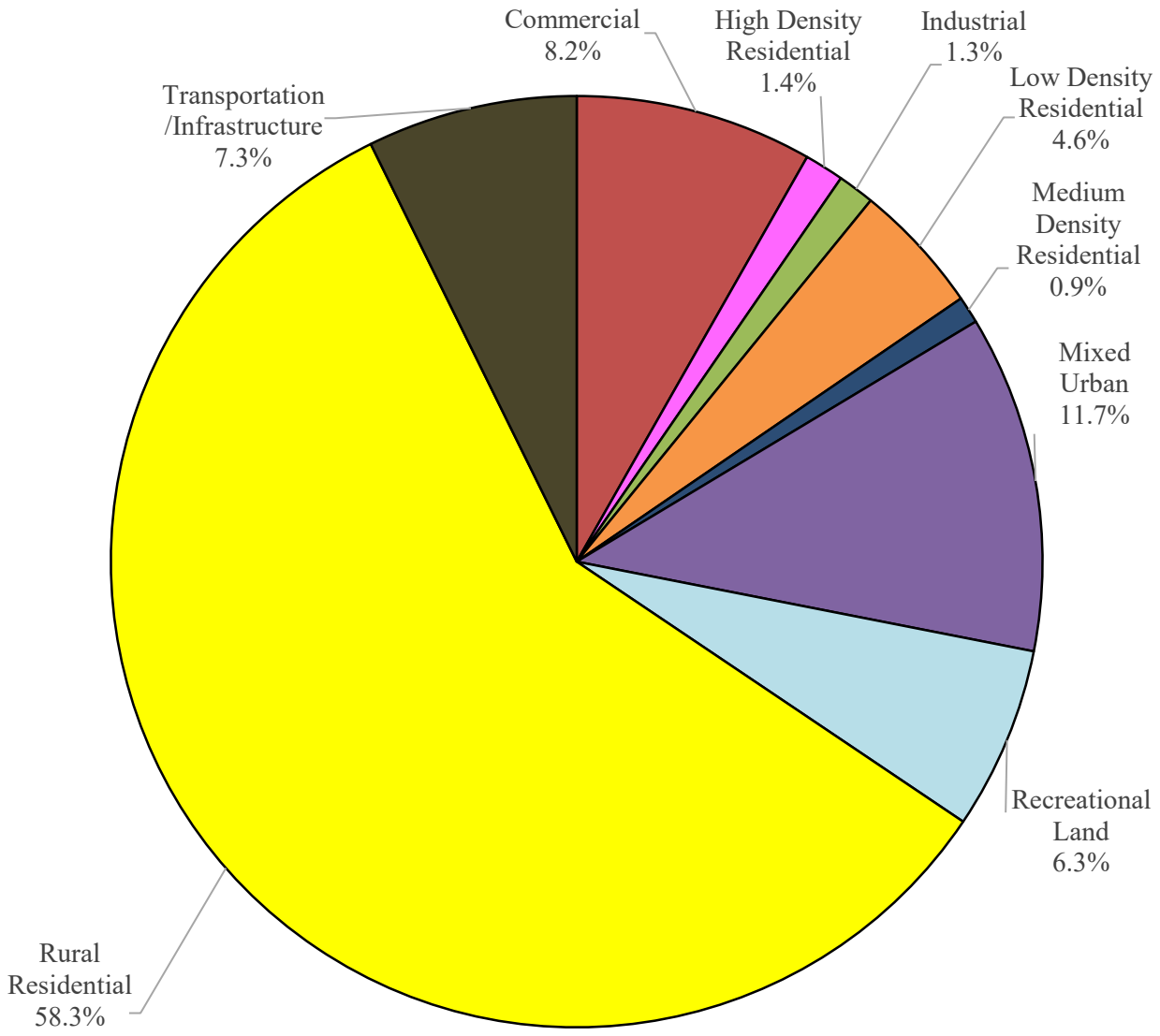


Figure 3: Pie chart illustrating the various types of urban land use in Union Township

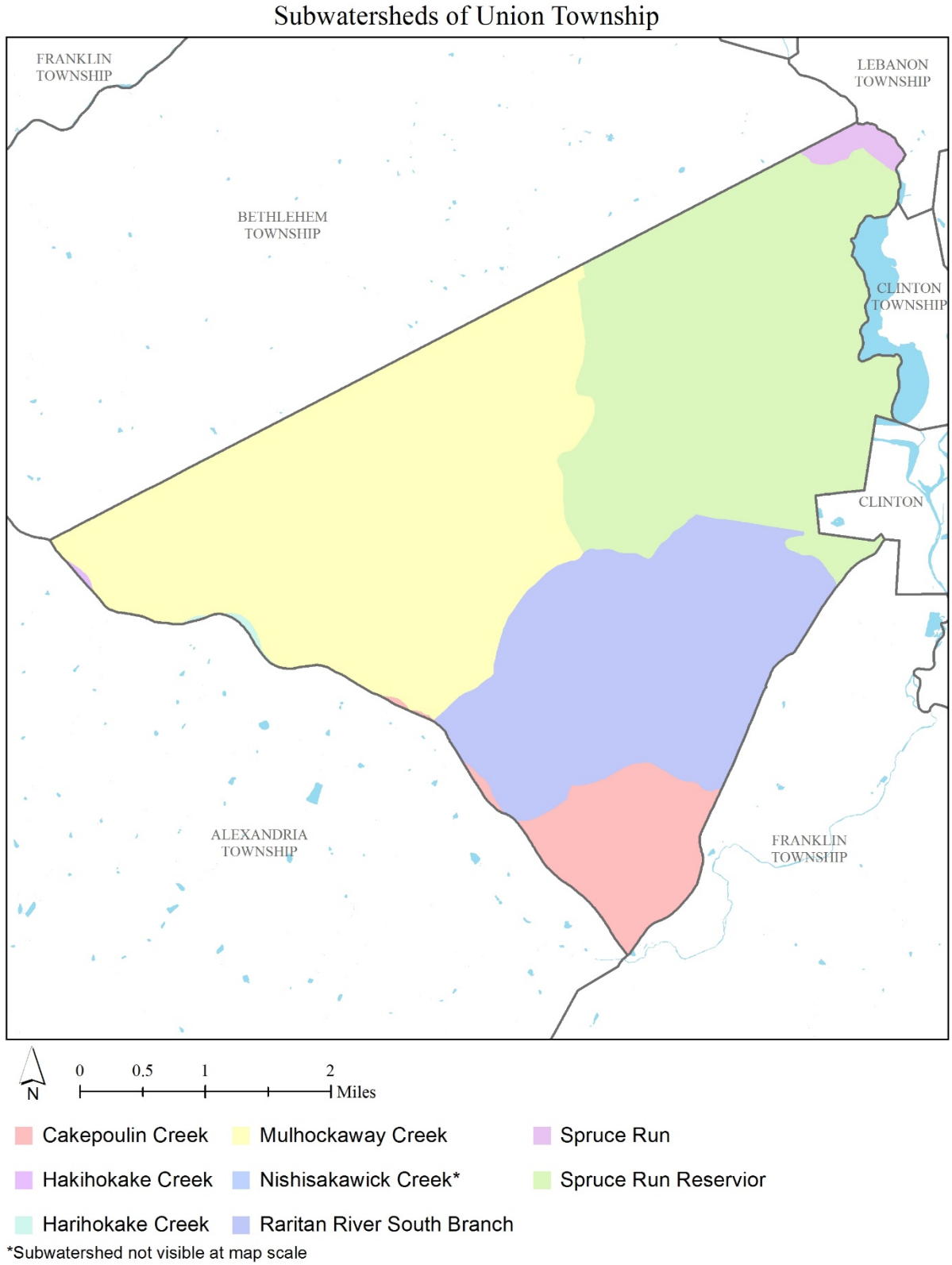


Figure 4: Map of the subwatersheds in Union Township

For each potential project site, specific aerial loading coefficients for commercial land use were used to determine the annual runoff loads for total phosphorus (TP), total nitrogen (TN), and total suspended solids (TSS) from impervious surfaces (Table 1). These are the same aerial loading coefficients that NJDEP uses in developing total maximum daily loads (TMDLs) for impaired waterways of the state. The percentage of impervious cover for each site was extracted from the 2015 NJDEP land use/land cover database. For impervious areas, runoff volumes were determined for the water quality design storm (1.25 inches of rain over two-hours) and for the annual rainfall total of 44 inches.

Preliminary soil assessments were conducted for each potential project site identified in Union Township using the United States Department of Agriculture Natural Resources Conservation Service Web Soil Survey, which utilizes regional and statewide soil data to predict soil types in an area. Several key soil parameters were examined (e.g., natural drainage class, saturated hydraulic conductivity of the most limiting soil layer (K_{sat}), depth to water table, and hydrologic soil group) to evaluate the suitability of each site's soil for green infrastructure practices. In cases where multiple soil types were encountered, the key soil parameters were examined for each soil type expected at a site.

For each potential project site, drainage areas were determined for each of the green infrastructure practices proposed at the site. These green infrastructure practices were designed to manage the 2-year design storm, enabling these practices to capture 95% of the annual rainfall. Runoff volumes were calculated for each proposed green infrastructure practice. The reduction in TSS loading was calculated for each drainage area for each proposed green infrastructure practice using the aerial loading coefficients in Table 1. The maximum volume reduction in stormwater runoff for each green infrastructure practice for a storm was determined by calculating the volume of runoff captured from the 2-year design storm. For each green infrastructure practice, peak discharge reduction potential was determined through hydrologic modeling in HydroCAD. For each green infrastructure practice, a cost estimate is provided. These costs are based upon the square footage of the green infrastructure practice and the real cost of green infrastructure practice implementation in New Jersey.

Table 1: Aerial Loading Coefficients[2]

Land Cover	TP load (lbs/acre/yr)	TN load (lbs/acre/yr)	TSS load (lbs/acre/yr)
High, Medium Density Residential	1.4	15	140
Low Density, Rural Residential	0.6	5	100
Commercial	2.1	22	200
Industrial	1.5	16	200
Urban, Mixed Urban, Other Urban	1.0	10	120
Agriculture	1.3	10	300
Forest, Water, Wetlands	0.1	3	40
Barrenland/Transitional Area	0.5	5	60

[2] New Jersey Department of Environmental Protection (NJDEP), Stormwater Best Management Practice Manual, 2004.

Green Infrastructure Practices

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 principle, 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 practices 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[3]. A wide range of green infrastructure practices have been evaluated for the potential project sites in Union Township. Each practice is discussed below.

Disconnected downspouts

This is often referred to as simple disconnection. A downspout is simply disconnected, prevented from draining directly to the roadway or storm sewer system, and directed to discharge water to a pervious area (i.e., lawn).

Pervious pavements

There are several types of permeable pavement systems including porous asphalt, pervious concrete, permeable pavers, and grass pavers. These surfaces are hard and support vehicle traffic but also allow water to infiltrate through the surface. They have an underlying stone layer to store stormwater runoff and allow it to slowly seep into the ground.

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

Bioretention systems/rain gardens

These are landscaped features that are designed to capture, treat, and infiltrate stormwater runoff. These systems can easily be incorporated into existing landscapes, improving aesthetics and creating wildlife habitat while managing stormwater runoff. Bioretention systems also can be used in soils that do not quickly infiltrate by incorporating an underdrain into the system.

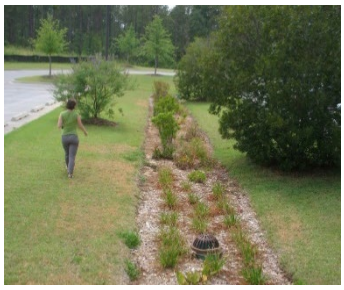
Downspout planter boxes

These are wooden boxes with plants installed at the base of a downspout that provide an opportunity to beneficially reuse rooftop runoff.

Rainwater harvesting systems (cistern or rain barrel)

These systems capture rainwater, mainly from rooftops, in cisterns or rain barrels. The water can then be used for watering gardens, washing vehicles, or for other non-potable uses.

Bioswale



Bioswales are landscape features that convey stormwater from one location to another while removing pollutants and providing water an opportunity to infiltrate.

Stormwater planters

Stormwater planters are vegetated structures that are built into the sidewalk to intercept stormwater runoff from the roadway or sidewalk. Many of these planters are designed to allow the water to infiltrate into the ground while others are designed simply to filter the water and convey it back into the stormwater sewer system.

Tree filter boxes

These are pre-manufactured concrete boxes that contain a special soil mix and are planted with a tree or shrub. They filter stormwater runoff but provide little storage capacity. They are typically designed to quickly filter stormwater and then discharge it to the local sewer system.

Potential Project Sites

Appendix A contains information on potential project sites where green infrastructure practices could be installed as well as information on existing site conditions. The recommended green infrastructure practices and the drainage area that the green infrastructure practices can treat are identified for each potential project site. For each practice, the recharge potential, TSS removal potential, maximum volume reduction potential per storm, the peak reduction potential, and estimated costs are provided. This information is also provided so that proposed development projects that cannot satisfy the New Jersey stormwater management requirements for major development can use one of the identified projects to offset a stormwater management deficit. [4]

[4] New Jersey Administrative Code, N.J.A.C. 7:8, Stormwater Management, Statutory Authority: N.J.S.A. 12:5-3, 13:1D-1 et seq., 13:9A-1 et seq., 13:19-1 et seq., 40:55D-93 to 99, 58:4-1 et seq., 58:10A-1 et seq., 58:11A-1 et seq. and 58:16A-50 et seq., *Date last amended: April 19, 2010*.

Conclusion

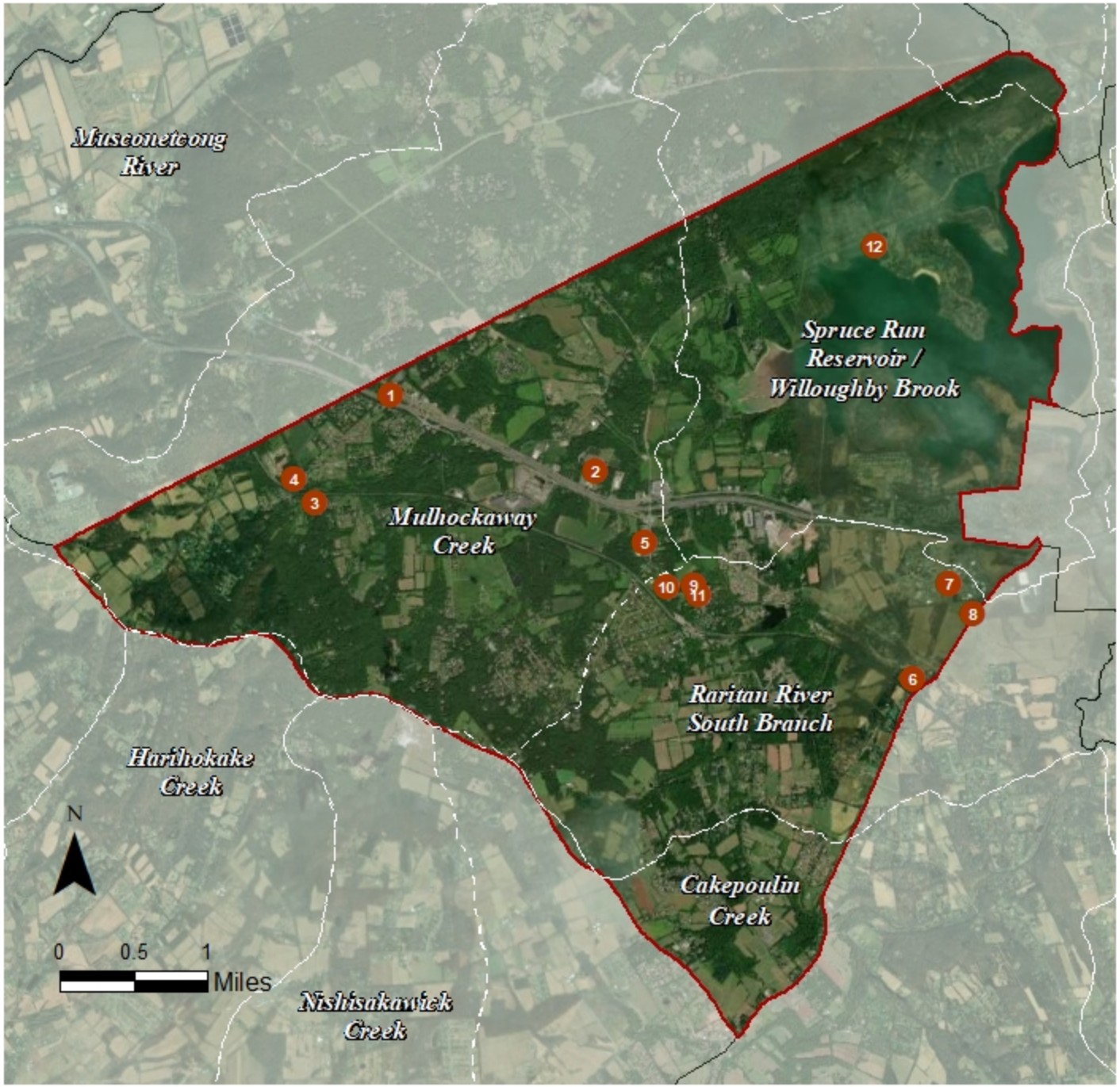
This impervious cover reduction action plan is meant to provide the municipality with a blueprint for implementing green infrastructure practices that will reduce the impact of stormwater runoff from impervious surfaces. These projects can be implemented by a wide variety of people such as boy scouts, girl scouts, school groups, faith-based groups, social groups, watershed groups, and other community groups.

Additionally, development projects that are in need of providing off-site compensation for stormwater impacts can use the projects in this plan as a starting point. The municipality can quickly convert this impervious cover reduction action plan into a stormwater mitigation plan and incorporate it into the municipal stormwater control ordinance.

Appendix A: Climate Resilient Green Infrastructure

a. Green Infrastructure Sites

UNION TOWNSHIP: GREEN INFRASTRUCTURE SITES



SITES WITHIN THE MULHOCKAWAY CREEK SUBWATERSHED

1. Community Affairs Department
2. Hunterdon Hills Playhouse
3. Pattenburg United Methodist Church
4. Pattenburg Volunteer Fire Company
5. Union Township Middle School

SITES WITHIN THE RARITAN RIVER SOUTH BRANCH SUBWATERSHED

6. Bethlehem Presbyterian Church
7. Hunterdon State School
8. Kingdom Hall Of Jehovah's Witnesses
9. St. Catherine of Siena Parish Center
10. Union Township Elementary School
11. Union Township Municipal Building

SITES WITHIN THE SPRUCE RUN RESERVOIR/WILLOUGHBY BROOK SUBWATERSHED

12. Spruce Run Recreation Area

b. Proposed Green Infrastructure Concepts

COMMUNITY AFFAIRS DEPARTMENT

Subwatershed: Mulhockaway Creek

Site Area: 73,100 sq. ft.

Address: 171 NJ-173 #101
Asbury, NJ 08802

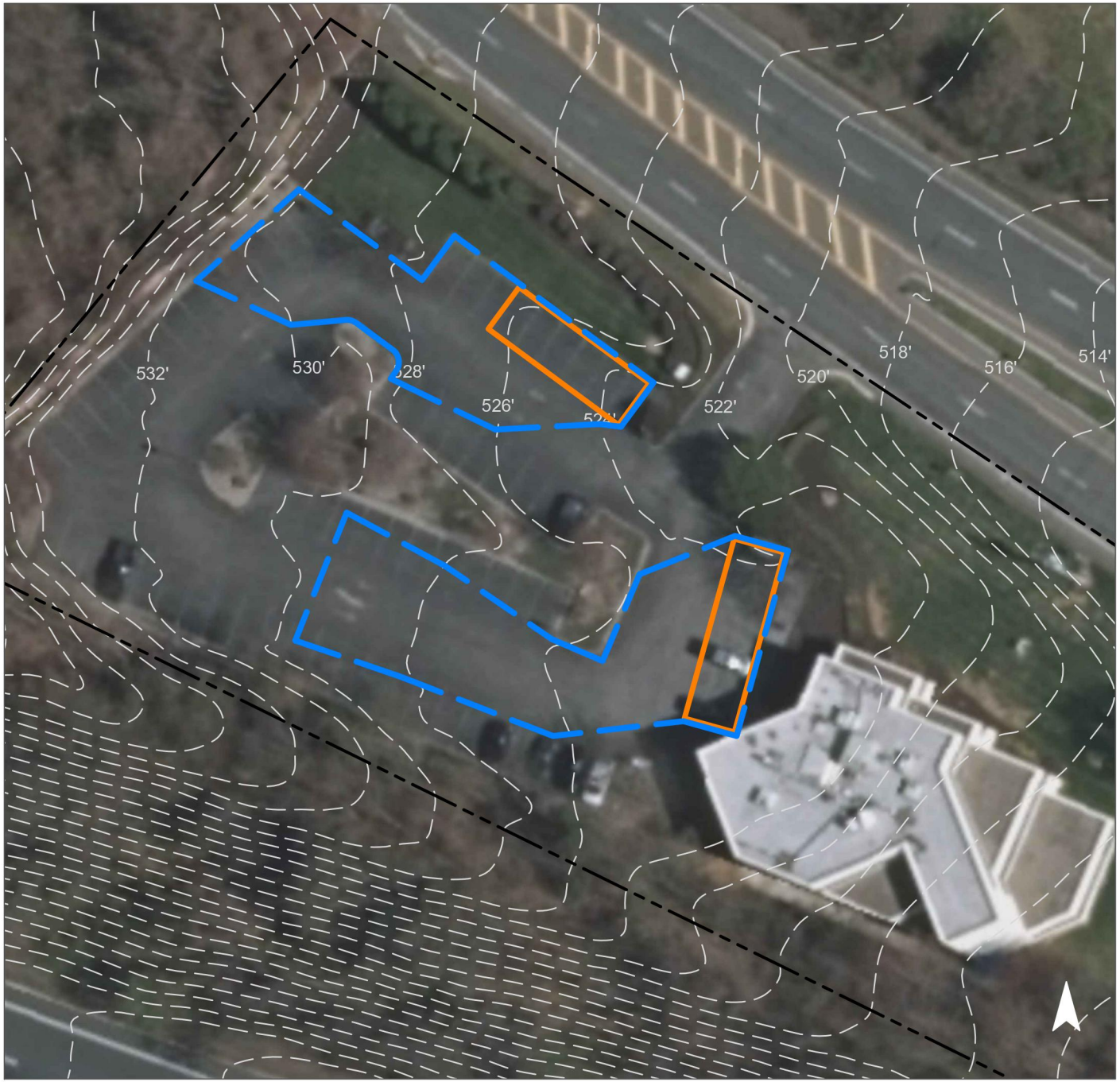
Block and Lot: Block 1.06, Lot 3

Parking spaces west of the building can be converted to pervious pavement to capture and infiltrate stormwater runoff from the road and parking lot. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs./yr.)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
42	30,680	1.5	15.5	140.9	0.024	0.84

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr.)	TSS Removal Potential (lbs./yr.)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Pervious pavement	0.298	50	22,540	0.85	2,105	$52,625

GREEN INFRASTRUCTURE RECOMMENDATIONS



Community Affairs Department

- pervious pavement
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 25' 50'

HUNTERDON HILLS PLAYHOUSE

Subwatershed: Mulhockaway Creek

Site Area: 3,565,970 sq. ft.

Address: 88 NJ-173
Hampton, NJ 08827

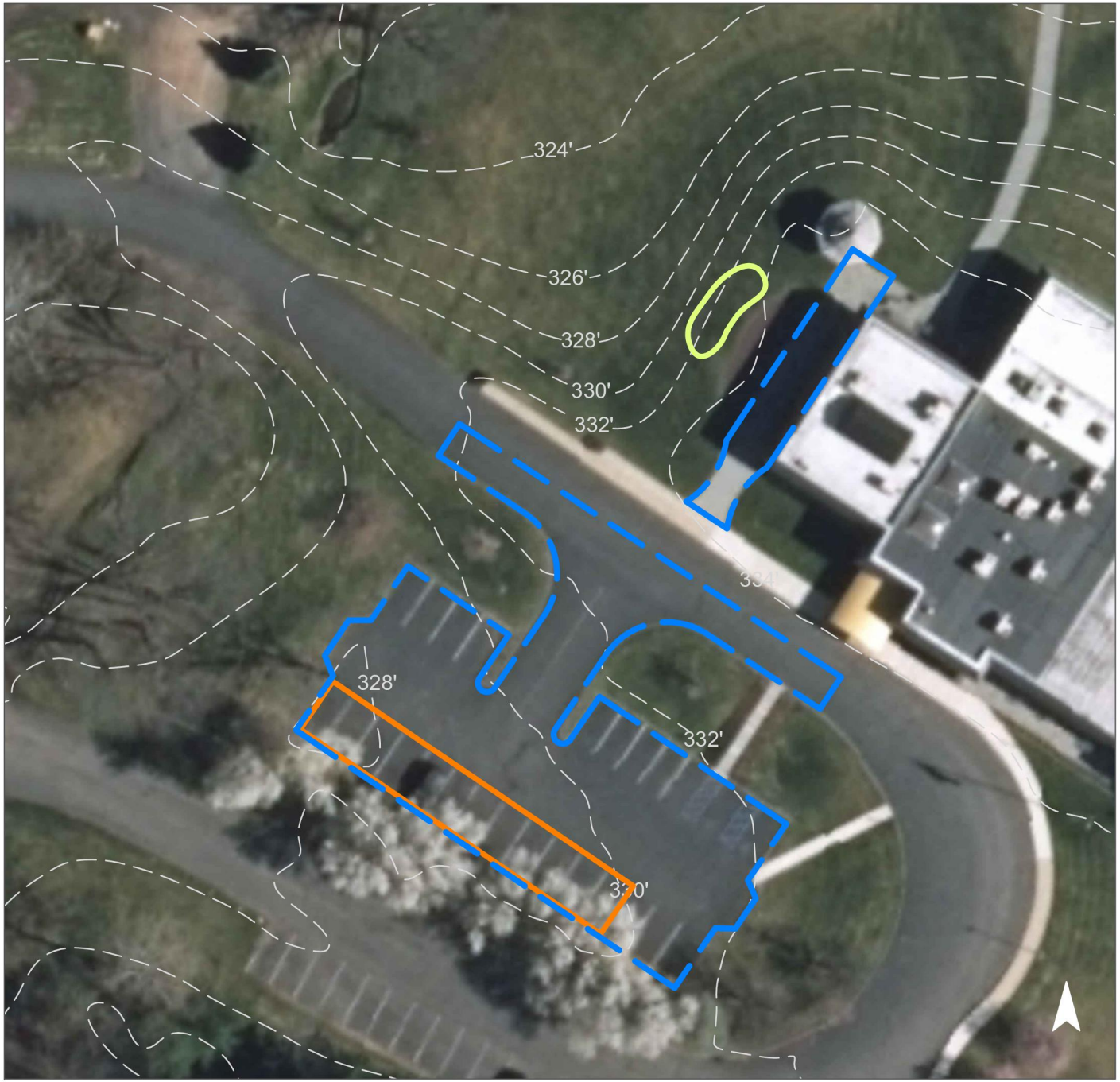
Block and Lot: Block 12, Lot 14

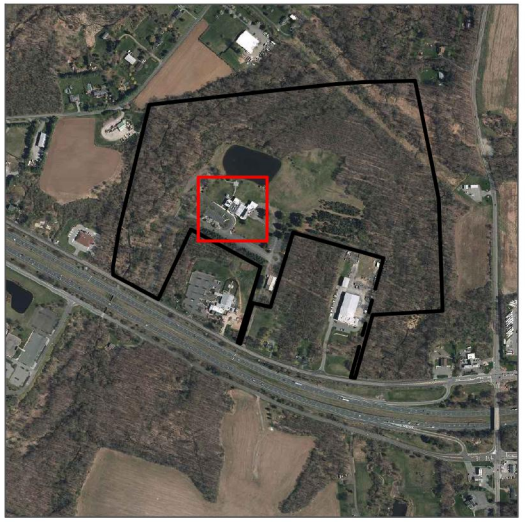
A rain garden can be installed west of the building to capture, treat, and infiltrate stormwater runoff from the surrounding pavement and patio. Parking spaces in the lot south of the patio can be converted to pervious pavement to capture and infiltrate stormwater runoff from the road and parking lot. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs./yr.)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
6	226,305	10.9	114.3	1,039.1	0.176	6.21

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr.)	TSS Removal Potential (lbs./yr.)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Bioretention system	0.039	7	2,960	0.11	375	$1,875
Pervious pavement	0.331	55	25,070	0.94	2,400	$60,000

GREEN INFRASTRUCTURE RECOMMENDATIONS





Hunterdon Hills Playhouse

- bioretention system
- pervious pavement
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 25' 50'

PATTENBURG UNITED METHODIST CHURCH

Subwatershed: Mulhockaway Creek

Site Area: 7,375 sq. ft.

Address: 587 Main Street
Asbury, NJ 08802

Block and Lot: Block 14.03, Lot 3

A rain garden can be installed at the east side of the building to capture, treat, and infiltrate stormwater runoff from the rooftop via the connected downspout. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs./yr.)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
20	1,475	0.1	0.7	6.8	0.001	0.04

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr.)	TSS Removal Potential (lbs./yr.)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Bioretention system	0.029	5	2,190	0.08	280	$1,400

GREEN INFRASTRUCTURE RECOMMENDATIONS

Pattenburg United Methodist Church

- bioretention system
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 15' 30'

PATTENBURG VOLUNTEER FIRE COMPANY

Subwatershed: Mulhockaway Creek

Site Area: 139,510 sq. ft.

Address: 512 Pattenburg Road
Asbury, NJ 08802

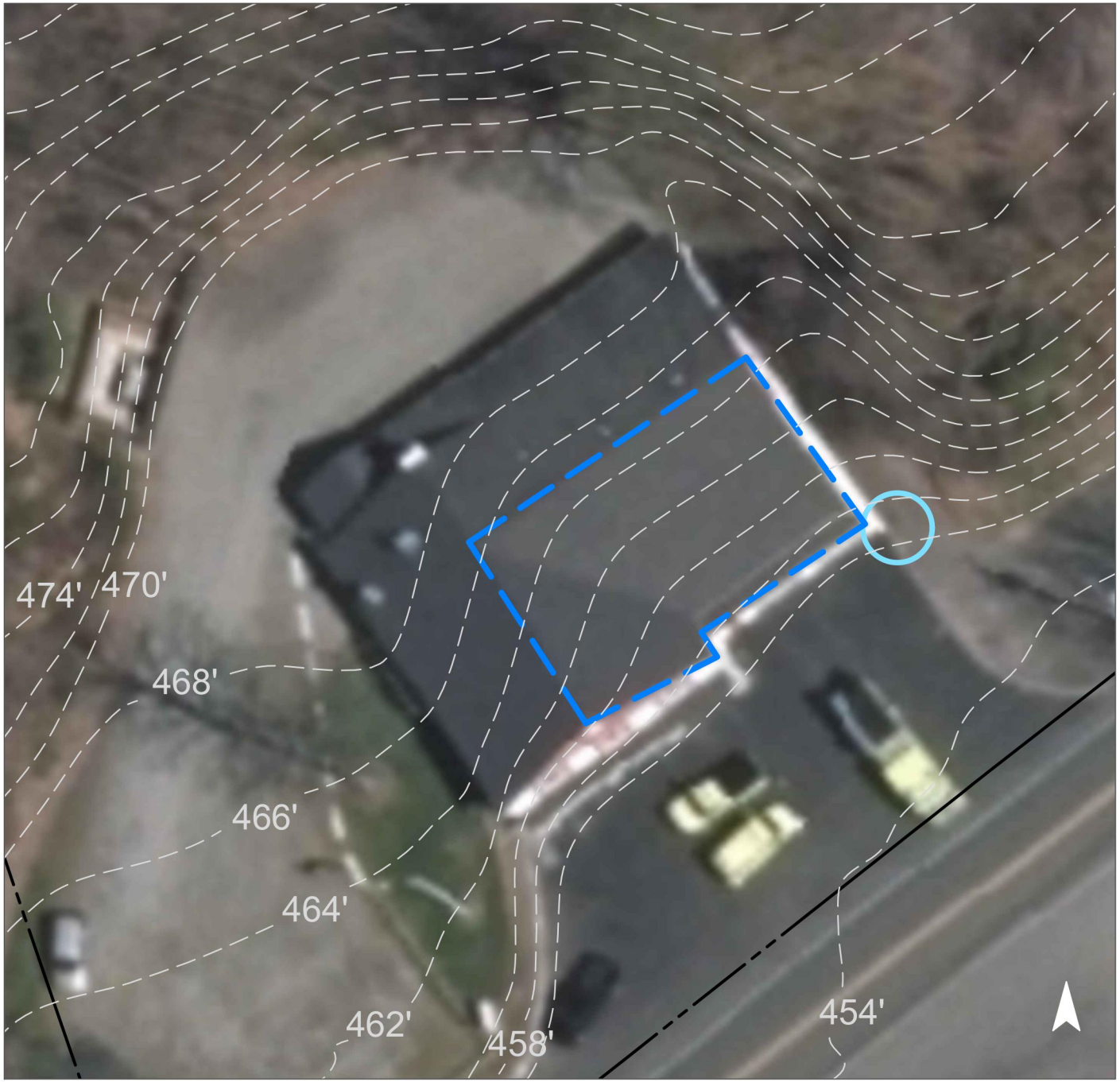
Block and Lot: Block 1.08, Lot 2

A cistern can be installed at the southeast downspout of the building to harvest rainwater from the roof. Captured rainwater can be used for non-potable uses such as washing vehicles. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs./yr.)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
13	17,900	0.9	9.0	82.2	0.014	0.49

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr.)	TSS Removal Potential (lbs./yr.)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Rainwater harvesting	0.072	12	2,500	0.10	2,500 (gal)	$5,000

GREEN INFRASTRUCTURE RECOMMENDATIONS



Pattenburg Volunteer Fire Company

- rainwater harvesting
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 15' 30'

UNION TOWNSHIP MIDDLE SCHOOL

Subwatershed: Mulhockaway Creek

Site Area: 573,935 sq. ft.

Address: 165 Perryville Road
Hampton, NJ 08827

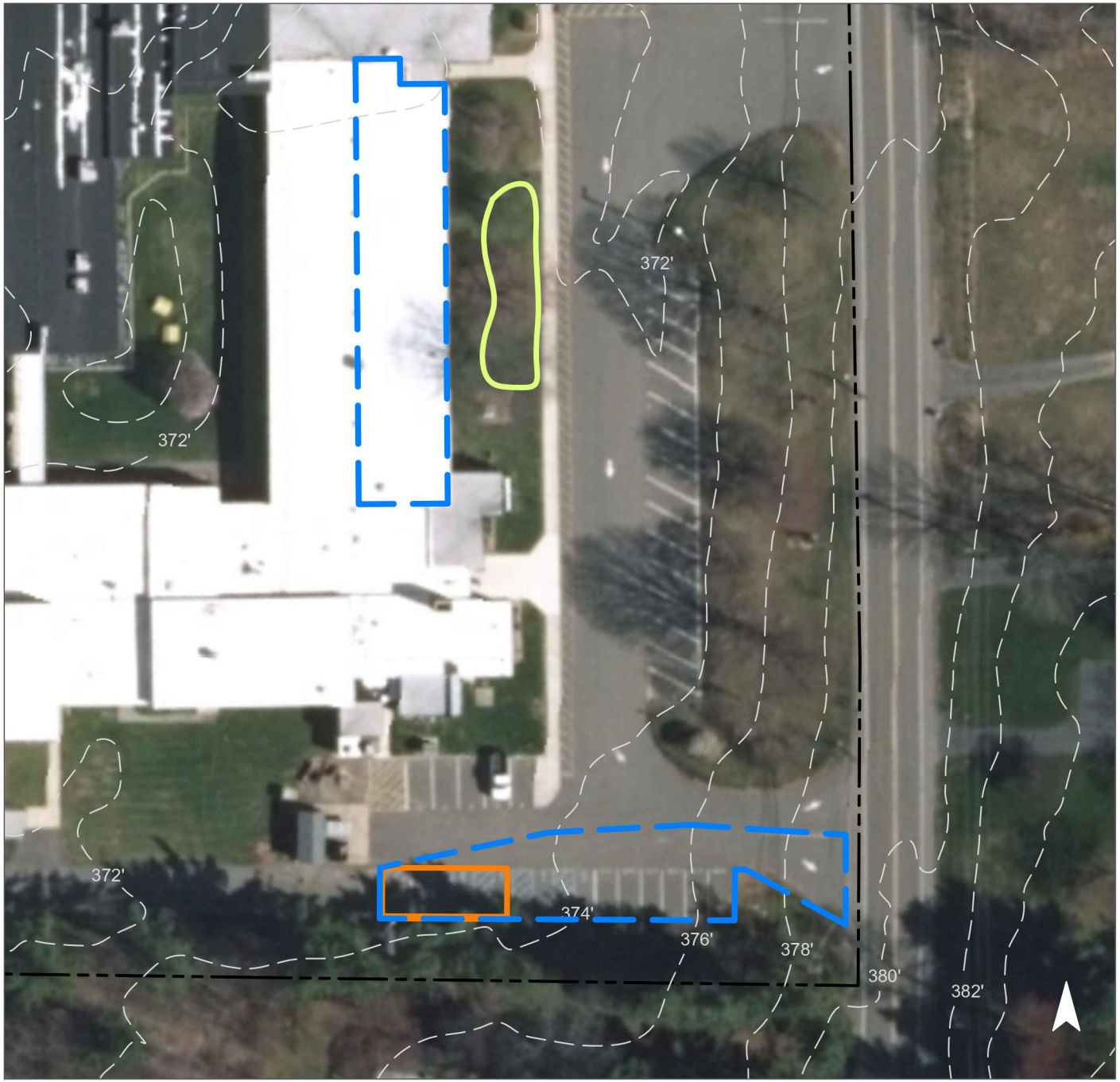
Block and Lot: Block 13, Lot 13

Parking spaces to the south of the school can be converted to pervious pavement to capture and infiltrate stormwater runoff from the street and parking lot. A rain garden can be installed to the east of the building to capture, treat, and infiltrate roof runoff. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs./yr.)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
23	130,620	6.3	66.0	599.7	0.102	3.58

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr.)	TSS Removal Potential (lbs./yr.)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Bioretention system	0.155	26	11,740	0.44	1,490	$7,450
Pervious pavement	0.144	24	10,900	0.41	1,000	$25,000

GREEN INFRASTRUCTURE RECOMMENDATIONS



Union Township Middle School

- bioretention system
- pervious pavement
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 25' 50'

BETHLEHEM PRESBYTERIAN CHURCH

Subwatershed: Raritan River South Branch

Site Area: 152,195 sq. ft.

Address: 2 Race Street
Pittstown, NJ 08867

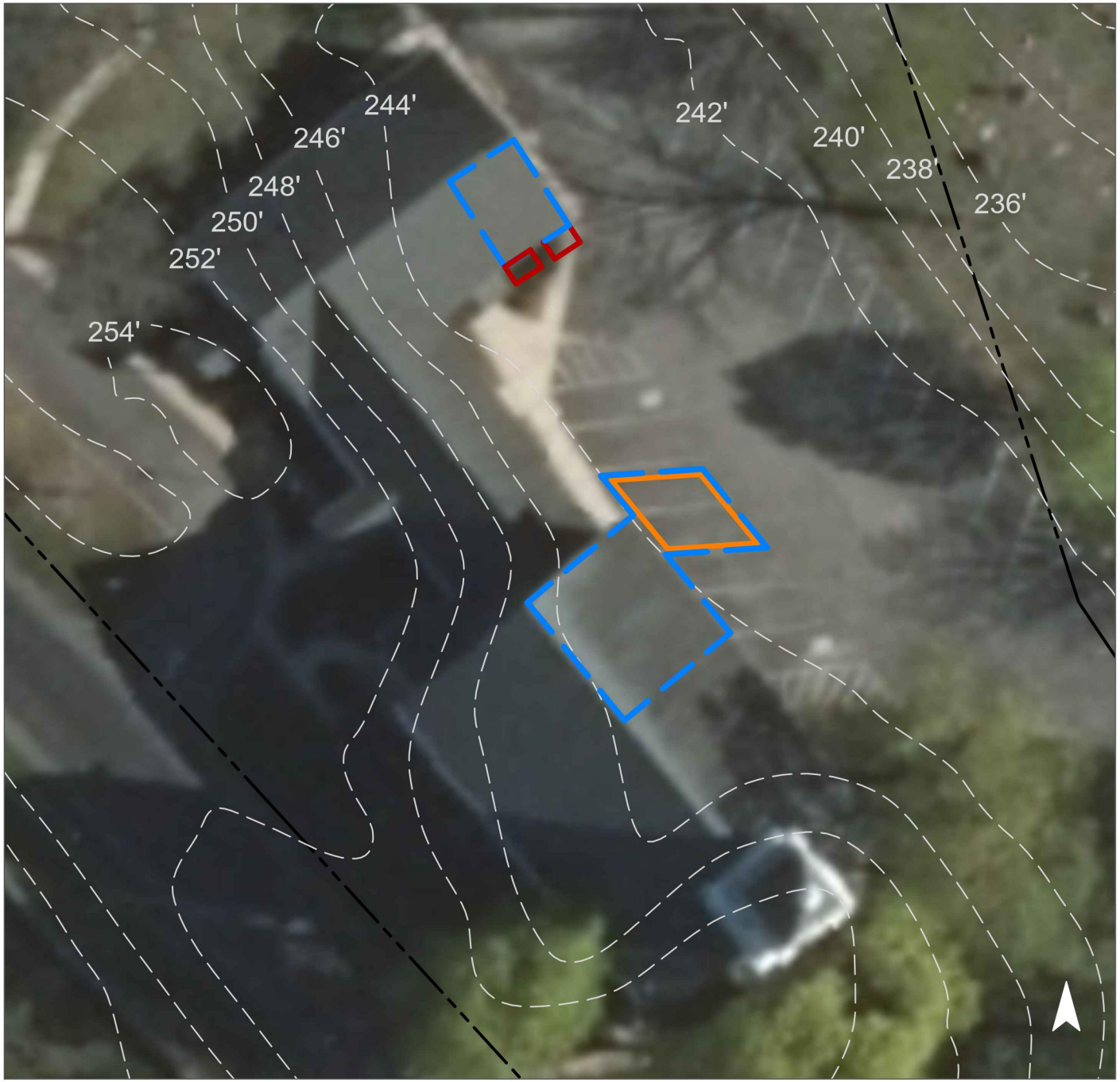
Block and Lot: Block 22, Lot 23

Downspout planter boxes can be constructed at the northeastern downspout. Pervious pavement can be installed along the eastern edge of the parking lot to capture, treat, and infiltrate stormwater runoff from the roof and parking lot. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs./yr.)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
35	53,805	2.6	27.2	247.0	0.042	1.48

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr.)	TSS Removal Potential (lbs./yr.)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Pervious pavement	0.030	5	2,240	0.08	325	$8,125
Planter boxes	n/a	1	n/a	n/a	2 (boxes)	$2,000

GREEN INFRASTRUCTURE RECOMMENDATIONS



Bethlehem Presbyterian Church

- pervious pavement
- planter box
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 15' 30'

HUNTERDON STATE SCHOOL

Subwatershed: Raritan River South Branch

Site Area: 13,557,120 sq. ft.

Address: 40 Pittstown Road
Clinton, NJ 08809

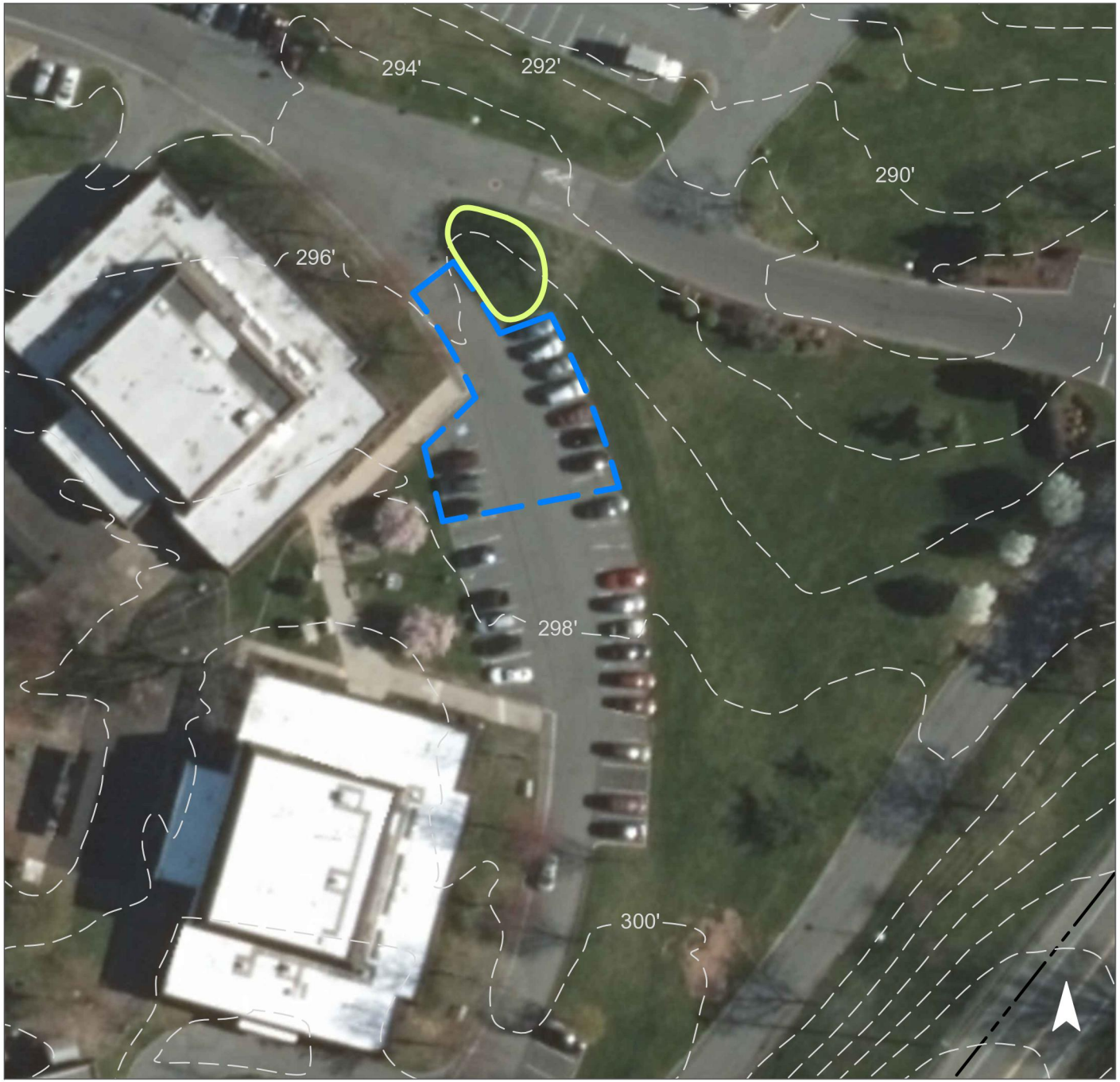
Block and Lot: Block 22, Lot 18

A rain garden can be installed in the north of the eastern parking lot to capture, treat, and infiltrate stormwater runoff from the parking lot before reaching the nearby storm drain. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs./yr.)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
22	3,048,490	147.0	1,539.6	13,996.7	2.375	83.61

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs./yr.)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Bioretention system	0.188	20	8,940	0.34	1,135	$5,675

GREEN INFRASTRUCTURE RECOMMENDATIONS



Hunterdon State School

- bioretention system
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 30' 60'

KINGDOM HALL OF JEHOVAH'S WITNESSES

Subwatershed: Raritan River South Branch

Site Area: 56,785 sq. ft.

Address: 54 Pittstown Road
Annandale, NJ 08801

Block and Lot: Block 22, Lot 46

A rain garden can be installed south of the building to capture, treat, and infiltrate rooftop stormwater runoff. A preliminary soil assessment suggests that the soils have suitable drainage characteristics for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs./yr.)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
65	36,880	1.8	18.6	169.83	0.029	1.01

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr.)	TSS Removal Potential (lbs./yr.)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Bioretention system	0.021	3	1,580	0.06	200	$1,000

GREEN INFRASTRUCTURE RECOMMENDATIONS

Kingdom Hall of Jehovah's Witnesses

- bioretention system
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 15' 30'

ST. CATHERINE OF SIENA PARISH CENTER

Subwatershed: Raritan River South Branch

Site Area: 303,310 sq. ft.

Address: 142 Perryville Road
Hampton, NJ 08827

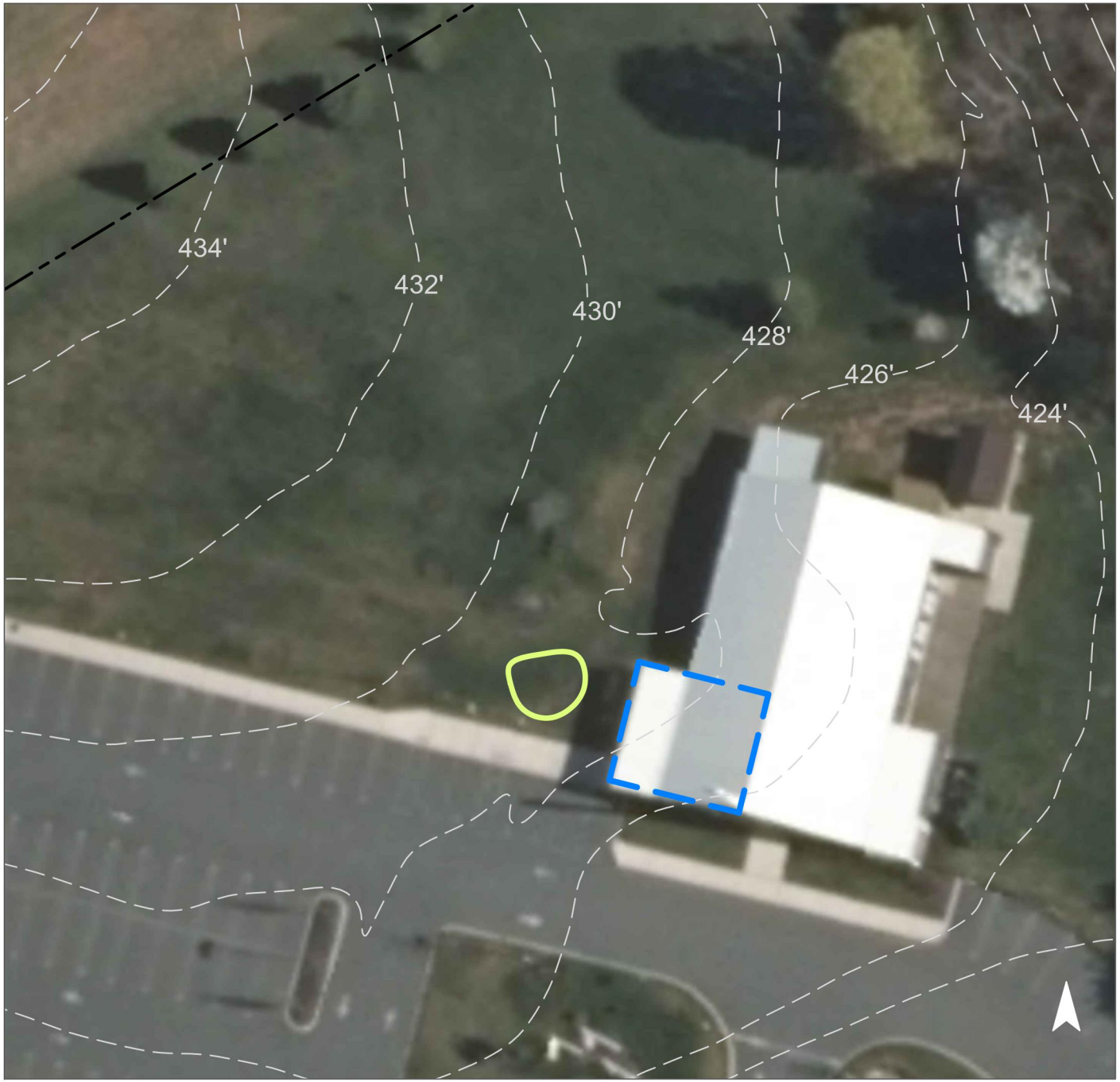
Block and Lot: Block 22, Lot 34.02

A rain garden can be installed west of the building to capture, treat, and infiltrate stormwater runoff from the roof. The nearby downspout could be disconnected to capture rooftop runoff into the rain garden. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs./yr.)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
21	62,795	3.0	31.7	288.3	0.049	1.72

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr.)	TSS Removal Potential (lbs./yr.)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Bioretention system	0.029	5	2,210	0.08	280	$1,400

GREEN INFRASTRUCTURE RECOMMENDATIONS



St. Catherine of Siena Parish Center

- bioretention system
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 20' 40'

UNION TOWNSHIP ELEMENTARY SCHOOL

Subwatershed: Raritan River South Branch

Site Area: 1,064,360 sq. ft.

Address: 142 Perryville Road
Hampton, NJ 08827

Block and Lot: Block 21, Lot 7

A rain garden can be installed south of the gym building to capture, treat, and infiltrate stormwater runoff from the roof. The nearby downspouts can be disconnected into the rain garden. Parking spaces west of the gym can be converted to porous pavement to capture and infiltrate stormwater runoff from the parking lot. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs./yr.)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
20	207,645	10.0	104.9	953.8	0.162	5.70

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr.)	TSS Removal Potential (lbs./yr.)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Bioretention system	0.070	12	5,330	0.20	675	$3,375
Pervious pavement	0.321	54	24,320	0.91	2,200	$55,000

GREEN INFRASTRUCTURE RECOMMENDATIONS

Union Township Elementary School

- bioretention system
- pervious pavement
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 30' 60'

UNION TOWNSHIP MUNICIPAL BUILDING

Subwatershed: Raritan River South Branch

Site Area: 356,070 sq. ft.

Address: 140 Perryville Road
Hampton, NJ 08827

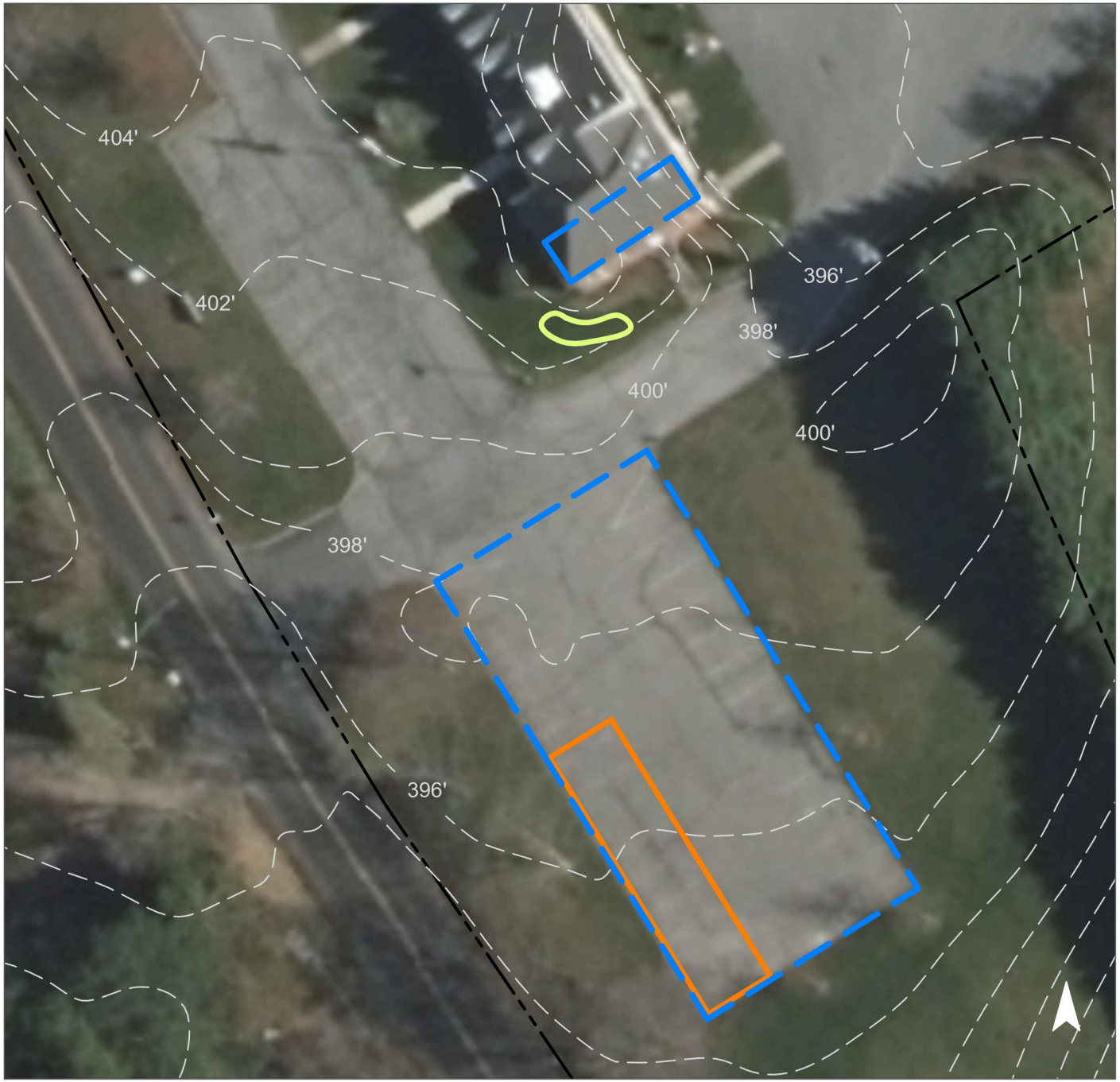
Block and Lot: Block 22, Lot 34.01

A rain garden can be installed south of the building to capture, treat, and infiltrate stormwater runoff from the roof. Parking spaces in the parking lot to the south can be converted to pervious pavement to capture and infiltrate stormwater runoff from the parking lot. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs./yr.)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
13	47,610	2.3	24.0	218.6	0.037	1.31

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr.)	TSS Removal Potential (lbs./yr.)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Bioretention system	0.013	2	990	0.04	125	$625
Pervious pavement	0.229	38	17,320	0.65	1,200	$30,000

GREEN INFRASTRUCTURE RECOMMENDATIONS



Union Township Municipal Building

- bioretention system
- pervious pavement
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 20' 40'

SPRUCE RUN RECREATION AREA

Subwatershed: Spruce Run Reservoir/ Willoughby Brook

Site Area: 86,413,070 sq. ft.

Address: 68 Van Syckles Road Clinton, NJ 08809

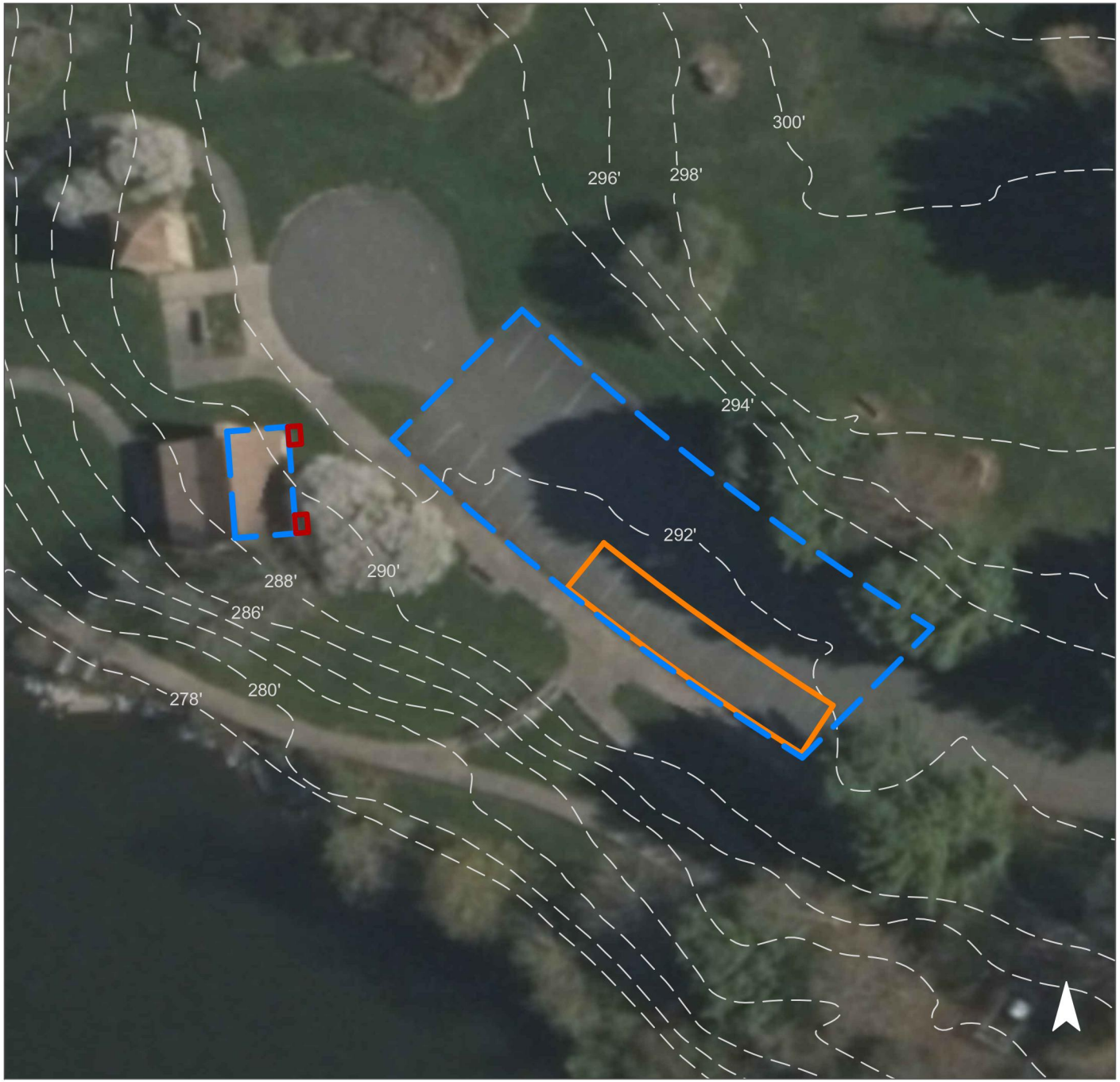
Block and Lot: Block 11, Lot 4

The southernmost parking spaces in the parking lot can be converted to pervious pavement to capture and infiltrate stormwater runoff from the parking lot. Downspout planter boxes can be constructed along the building to allow roof runoff to be captured and treated. A preliminary soil assessment suggests that more soil testing would be required before determining the soil's suitability for green infrastructure.

Impervious Cover		Existing Loads from Impervious Cover (lbs./yr.)			Runoff Volume from Impervious Cover (Mgal)	
%	sq. ft.	TP	TN	TSS	For the 1.25" Water Quality Storm	For an Annual Rainfall of 44"
1	658,885	31.8	332.8	3,025.2	0.513	18.07

Recommended Green Infrastructure Practices	Recharge Potential (Mgal/yr.)	TSS Removal Potential (lbs./yr.)	Maximum Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cu. ft./second)	Estimated Size (sq. ft.)	Estimated Cost
Pervious pavement	0.264	44	19,980	0.75	1,875	$46,875
Planter boxes	n/a	2	n/a	n/a	2 (boxes)	$2,000

GREEN INFRASTRUCTURE RECOMMENDATIONS



Spruce Run Recreation Area

- pervious pavement
- planter box
- drainage area
- property line
- 2015 Aerial: NJOIT, OGIS

0 25' 50'

c. Summary of Existing Conditions

Summary of Existing Conditions

	Subwatershed/Site Name/Total Site Info/GI Practice	Area (ac)	Area (SF)	Block	Lot	I.C. %	I.C. Area (ac)	I.C. Area (SF)	Existing Annual Loads (Commercial) TP (lb/yr)	TN (lb/yr)	TSS (lb/yr)	Runoff Volumes from I.C. Water Quality Storm (1.25" over 2-hours) (cu.ft.)	Annual (cu.ft.)	Runoff Volumes from I.C. Water Quality Storm (1.25" over 2-hours) (Mgal)	Annual (Mgal)
	MULHOCKAWAY CREEK SITES	**100.09**	**4,359,890**				**9.34**	**406,980**	**19.6**	**205.5**	**1,868.6**	**42,394**	**1,492,260**	**0.317**	**11.16**
1	**Community Affairs Department**														
	Total Site Info	1.68	73,100	1.06	3	42	0.70	30,680	1.5	15.5	140.9	3,196	112,493	0.024	0.84
2	**Hunterdon Hills Playhouse**														
	Total Site Info	81.86	3,565,970	12	14	6	5.20	226,305	10.9	114.3	1,039.0	23,573	829,785	0.176	6.21
3	**Pattenburg United Methodist Church**														
	Total Site Info	0.17	7,375	14.03	3	20	0.03	1,475	0.1	0.7	6.8	154	5,408	0.001	0.04
4	**Pattenburg Volunteer Fire Company**														
	Total Site Info	3.20	139,510	1.08	2	13	0.41	17,900	0.9	9.0	82.2	1,865	65,633	0.014	0.49
5	**Union Township Middle School**														
	Total Site Info	13.18	573,935	13	13	23	3.00	130,620	6.3	66.0	599.7	13,606	478,940	0.102	3.58
	RARITAN RIVER SOUTH BRANCH SITES	**355.60**	**15,489,840**				**79.37**	**3,457,225**	**166.7**	**1,746.1**	**15,873.4**	**360,128**	**12,676,493**	**2.694**	**94.82**
6	**Bethlehem Presbyterian Church**														
	Total Site Info	3.49	152,195	22	23	35	1.24	53,805	2.6	27.2	247.0	5,605	197,285	0.042	1.48
7	**Hunterdon State School**														
	Total Site Info	311.23	13,557,120	22	18	22	69.98	3,048,490	147.0	1,539.6	13,996.7	317,551	11,177,797	2.375	83.61
8	**Kingdom Hall of Jehovah's Witnesses**														
	Total Site Info	1.30	56,785	22	46	65	0.85	36,880	1.8	18.6	169.3	3,842	135,228	0.029	1.01
9	**St. Catherine of Siena Parish Center**														
	Total Site Info	6.96	303,310	22	34.02	21	1.44	62,795	3.0	31.7	288.3	6,541	230,248	0.049	1.72
10	**Union Township Elementary School**														
	Total Site Info	24.43	1,064,360	21	7	20	4.77	207,645	10.0	104.9	953.4	21,630	761,365	0.162	5.70
11	**Union Township Municipal Building**														
	Total Site Info	8.17	356,070	22	34.01	13	1.09	47,610	2.3	24.0	218.6	4,959	174,570	0.037	1.31
	SPRUCE RUN RESERVIOR/ WILLOUGHBY BROOK	**1983.77**	**86,413,070**				**15.13**	**658,885**	**31.8**	**332.8**	**3,025.2**	**68,634**	**2,415,912**	**0.513**	**18.07**
12	**Spruce Run Recreation Area**														
	Total Site Info	1983.77	86,413,070	11	4	1	15.13	658,885	31.8	332.8	3,025.2	68,634	2,415,912	0.513	18.07

d. Summary of Proposed Green Infrastructure Practices

Summary of Proposed Green Infrastructure Practices

	Subwatershed/Site Name/Total Site Info/GI Practice	Potential Management Area Area (SF)	Potential Management Area Area (ac)	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Max Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cfs)	Size of BMP	Unit Cost ($/unit)	Unit	Total Cost ($)	I.C. Treated %
	MULHOCKAWAY CREEK SITES	**40,980**	**0.94**	**1.068**	**179**	**77,900**	**2.93**				**$153,350**	**0.1**
1	**Community Affairs Department**											
	Pervious pavement	11,420	0.26	0.298	50	22,540	0.85	2,105	$25	SF	$52,625	0.4
	Total Site Info	**11,420**	**0.26**	**0.298**	**50**	**22,540**	**0.85**				**$52,625**	**0.4**
2	**Hunterdon Hills Playhouse**											
	Bioretention system	1,500	0.03	0.039	7	2,960	0.11	375	$5	SF	$1,875	0.0
	Pervious pavement	12,700	0.29	0.331	55	25,070	0.94	2,400	$25	SF	$60,000	0.1
	Total Site Info	**14,200**	**0.33**	**0.370**	**62**	**28,030**	**1.05**				**$61,875**	**0.1**
3	**Pattenburg United Methodist Church**											
	Bioretention system	1,110	0.03	0.029	5	2,190	0.08	280	$5	SF	$1,400	0.8
	Total Site Info	**1,110**	**0.03**	**0.029**	**5**	**2,190**	**0.08**				**$1,400**	**0.8**
4	**Pattenburg Volunteer Fire Company**											
	Rainwater harvesting	2,780	0.06	0.072	12	2,500	0.1	2,500	$2	gal	$5,000	0.2
	Total Site Info	**2,780**	**0.06**	**0.072**	**12**	**2,500**	**0.1**				**$5,000**	**0.2**
5	**Union Township Middle School**											
	Bioretention system	5,950	0.14	0.155	26	11,740	0.44	1,490	$5	SF	$7,450	0.0
	Pervious pavement	5,520	0.13	0.144	24	10,900	0.41	1,000	$25	SF	$25,000	0.0
	Total Site Info	**11,470**	**0.26**	**0.299**	**50**	**22,640**	**0.85**				**$32,450**	**0.1**
	RARITAN RIVER SOUTH BRANCH SITES	**31,045**	**0.71**	**0.801**	**135**	**60,690**	**2.28**				**$99,075**	**0.0**
6	**Bethlehem Presbyterian Church**											
	Pervious pavement	1,135	0.03	0.030	5	2,240	0.08	325	$25	SF	$8,125	0.0
	Planter boxes	300	0.01	n/a	1	n/a	n/a	2	$1,000	box	$2,000	0.0
	Total Site Info	**300**	**0.01**	**0.000**	**1**	**0**	**0**				**$2,000**	**0.0**
7	**Hunterdon State School**											
	Bioretention system	4,530	0.10	0.118	20	8,940	0.34	1,135	$5	SF	$5,675	0.0
	Total Site Info	**4,530**	**0.10**	**0.118**	**20**	**8,940**	**0.34**				**$5,675**	**0.0**

Summary of Proposed Green Infrastructure Practices

	Subwatershed/Site Name/Total Site Info/GI Practice	Potential Management Area Area (SF)	Potential Management Area Area (ac)	Recharge Potential (Mgal/yr)	TSS Removal Potential (lbs/yr)	Max Volume Reduction Potential (gal/storm)	Peak Discharge Reduction Potential (cfs)	Size of BMP	Unit Cost ($/unit)	Unit	Total Cost ($)	I.C. Treated %
8	**Kingdom Hall of Jehovah's Witnesses**											
	Bioretention system	800	0.02	0.021	3	1,580	0.06	200	$5	SF	$1,000	0.0
	Total Site Info	**800**	**0.02**	**0.021**	**3**	**1,580**	**0.06**				**$1,000**	**0.0**
9	**St. Catherine of Siena Parish Center**											
	Bioretention system	1,120	0.03	0.029	5	2,210	0.08	280	$5	SF	$1,400	0.0
	Total Site Info	**1,120**	**0.03**	**0.029**	**5**	**2,210**	**0.08**				**$1,400**	**0.0**
10	**Union Township Elementary School**											
	Bioretention system	2,700	0.06	0.070	12	5,330	0.2	675	$5	SF	$3,375	0.0
	Pervious pavement	12,320	0.28	0.321	54	24,320	0.91	2,200	$25	SF	$55,000	0.1
	Total Site Info	**15,020**	**0.34**	**0.391**	**66**	**29,650**	**1.11**				**$58,375**	**0.1**
11	**Union Township Municipal Building**											
	Bioretention system	500	0.01	0.013	2	990	0.04	125	$5	SF	$625	0.0
	Pervious pavement	8,775	0.20	0.229	38	17,320	0.65	1,200	$25	SF	$30,000	0.2
	Total Site Info	**9,275**	**0.21**	**0.242**	**40**	**18,310**	**0.69**				**$30,625**	**0.2**
	SPRUCE RUN RESERVIOR/ WILLOUGHBY BROOK	**10,550**	**0.24**	**0.264**	**46**	**19,980**	**0.75**				**$48,875**	**0.0**
12	**Spruce Run Recreation Area**											
	Pervious pavement	10,120	0.23	0.264	44	19,980	0.75	1,875	$25	SF	$46,875	0.0
	Planter boxes	430	0.01	n/a	2	n/a	n/a	2	$1,000	box	$2,000	0.0
	Total Site Info	**10,550**	**0.24**	**0.264**	**46**	**19,980**	**0.75**				**$48,875**	**0.0**