

# Plainfield Runoff Reduction Recommendations

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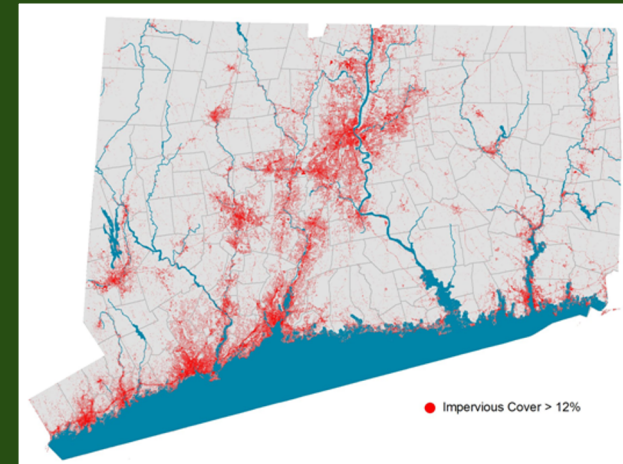
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# Impervious Surfaces & Runoff

- Increase in urban development leads to increase in *impervious cover*
  - *Impervious cover*- any surface which prevents the natural infiltration of stormwater into soil
    - *Ecological impact*- Runoff collects pollutants as it flows across impervious cover where it gains volume and velocity leading to erosion, sedimentation, and increased flooding.
      - Increased runoff enters city sewer systems where it is discharged into water bodies having adverse ecological consequences
- *Green Stormwater Infrastructure (GSI)* disconnects stormwater runoff from city sewer systems allowing for infiltration into the ground

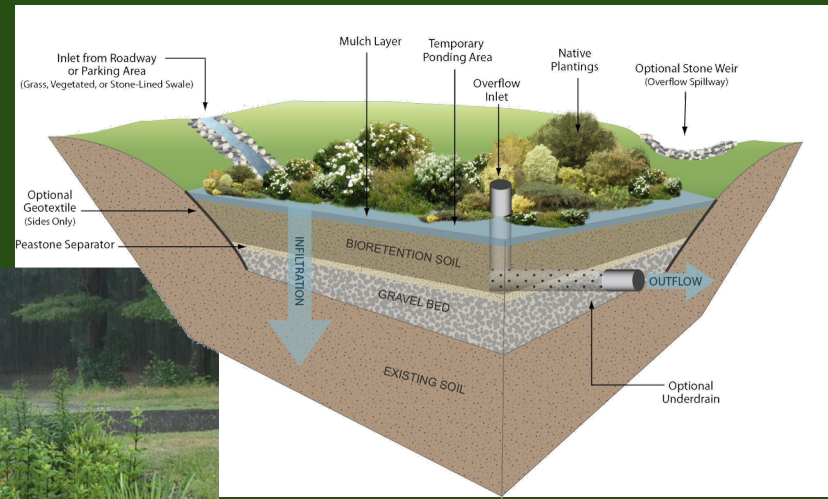


# MS4 Requirements- Municipal Separate Storm Sewer Systems Permitting Program

- 2004- DEEP recognizes need for regulation of stormwater runoff
  - *Nonpoint Source Pollution*: stormwater runs across impervious surfaces, collecting pollutants as it flows into storm drains.
  - Permitting program encourages use of *Low Impact Development* practices to mitigate pollution in waterways. These practices are designed to maintain or recreate *pre-development hydrology*, with an emphasis on *treatment of stormwater onsite*
- 2016- DEEP issues additional MS4 requirements
  - As part of the development of stormwater management plans, along with subsequent monitoring and reporting, municipalities are required to *disconnect 2% of directly connected impervious cover*.
  - *Directly connected impervious cover* is any impervious surface which conducts stormwater into the city storm sewer system, and which eventually flows into lakes, streams, and the ocean.

# Rain Gardens and Bioretention

- Shallow depression which collects runoff from impervious cover
- Facilitates infiltration of runoff while filtering out pollutants and recharging groundwater
- Supports wildlife by providing food and shelter



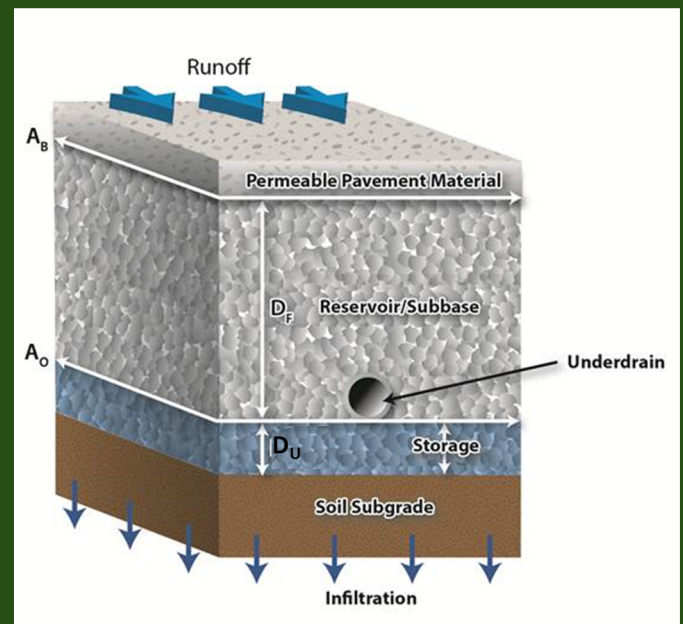
# Bioswale

- Shallow depression to capture, treat, and infiltrate water
- Similar to a rain garden, but with a long and narrow shape
- Located alongside parking lots and roads



# Pervious Paving

- Allows for runoff to infiltrate into soil by passing directly through pavement surface
- Can be used to treat additional runoff from nearby impervious cover
- Can be implemented in a variety of light traffic areas
- Many cost effective options exist to suit site-specific needs



Gravel Grid Pavement



Permeable Interlocking  
Concrete Pavers

# Tree Box Filters

- Consist of a precast/cast in place concrete box filled with soil and filtration media
- Commonly used along sidewalks and roadways
- Runoff is contained within soil and consumed by tree, with overflow exiting the system via underdrain





# Dry Well

- Underground cylinder used to infiltrate stormwater
- 8' Diameter x 6' depth = 1900 gallons, or 254 ft<sup>3</sup>
- Surrounded by pit filled with crushed stone
  - Depth: 7.67'
  - Percent voids of stone  $\approx$ 40%
  - Can be sized to fit drainage area



# Site Selection & Approach

- **Preliminary Analysis-**

- Web-based search to identify potential GSI project locations to conduct site visits
  - Research using town databases: identifying property ownership, prominent locations, and potential educational and community outreach opportunities
  - Geospatial analysis using aerial imagery from ArcGIS, Google Maps
    - Topography, impervious cover maps, parcel maps, satellite imagery

- **On Location-**

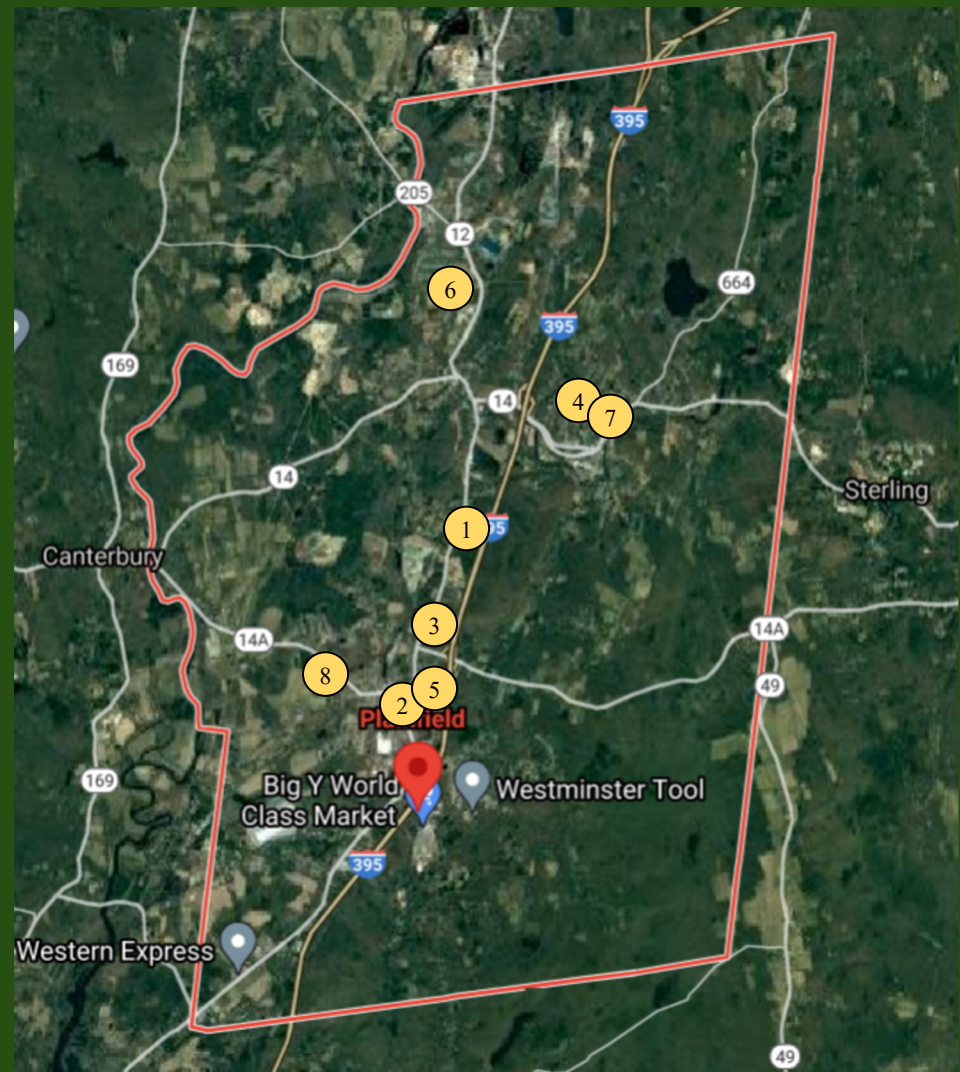
- Site specific recommendations selected based on suitability for GSI practices
  - Identify location of existing storm drains or downspouts and their proximity to potential GSI practice area
  - Assess slope of surrounding land, determine drainage areas for storm drains and direction of runoff flow
  - Locate above and below ground obstructions
  - Determine best locations for visibility of practice, educational value, and potential community involvement

## Sites and Practices were Selected Based On:

- Town-owned properties
- Education potentials
- Water quality & quantity impacts
- Impervious cover disconnection
- Available space
- Cost effectiveness
- Maintenance concerns
- Taking advantage of “re” projects
  - Replacing, repaving, restoring, redeveloping, etc

# Selected Sites

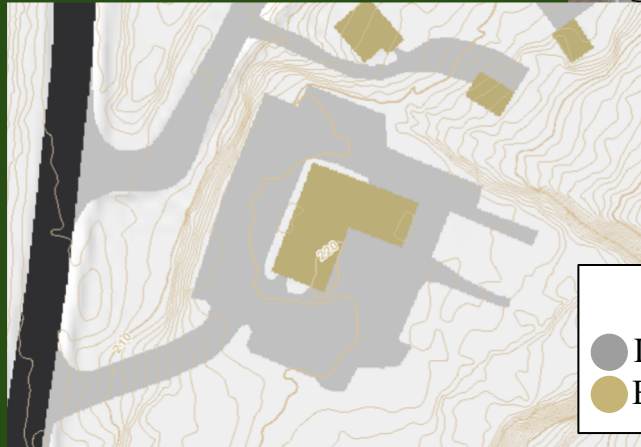
1. Police Station
2. Town Hall
3. Senior Center
4. Moosup Park
5. Plainfield Fire Co.
6. Shepherd Hill Elementary
7. Moosup Elementary
8. Plainfield Memorial High School



# 1. Police Station

The possible total disconnection for this site is about 2,352 sq ft

The possible disconnection method here is a rain garden



**KEY**

- Impervious pavement
- Buildings

High resolution impervious cover map, CT ECO

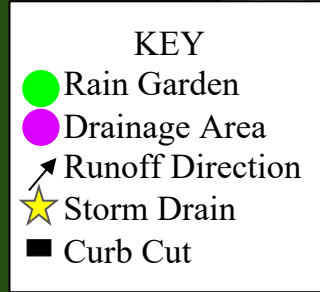
# 1. Police Station - Rain Garden

Pros:

- High visibility
- Provides aesthetic enhancement to entrance

Cons:

- Requires avoiding sign



Drainage Area (sq ft)	Suggested Green Infrastructure	Annual Gallons Treated	Annual Nitrogen reduction (lb N/yr)	Annual Phosphorus reduction (lb P/yr)	Suggested practice size (sq ft)	Cost
2,352	Rain Garden	61,934	0.64	0.082	384 @ 6 inches deep	\$3,100 - \$12,600

## 2. Town Hall

The possible total disconnection for this site is about 3,049 sq ft

The possible disconnection method here is a rain garden



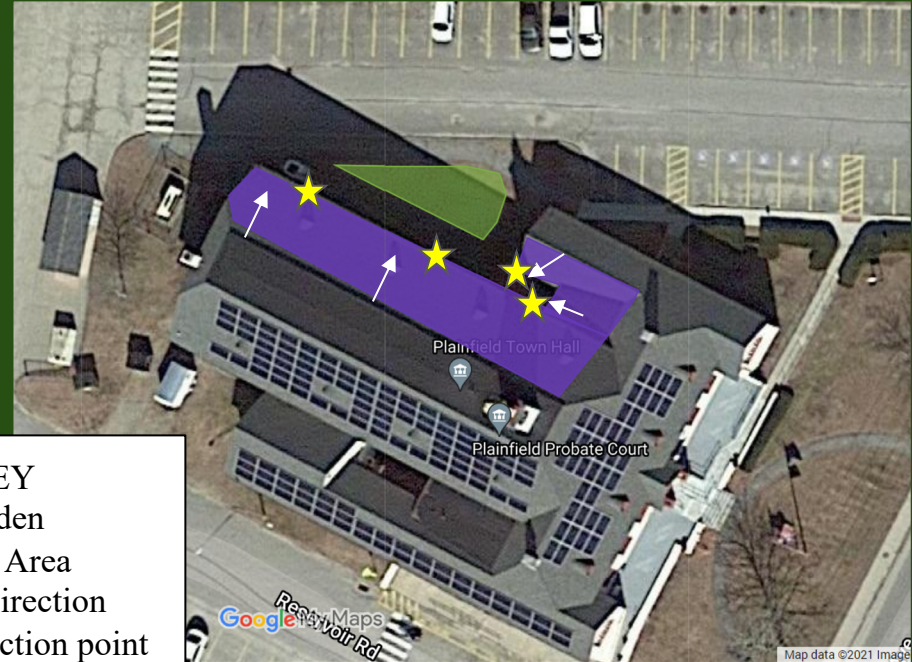
## 2. Town Hall - Rain Garden

### Pros:

- High visibility
- Plot has room for expansion

### Cons:

- Requires piping 10 feet away from building



**KEY**

- Rain Garden
- Drainage Area
- ↗ Runoff Direction
- ★ Disconnection point

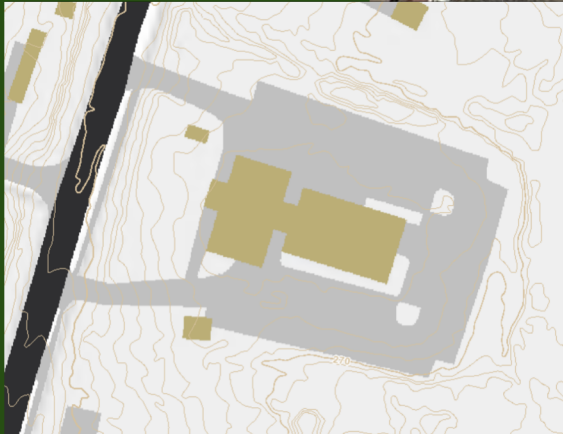
Drainage Area (sq ft)	Suggested Green Infrastructure	Annual Gallons Treated	Annual Nitrogen reduction (lb N/yr)	Annual Phosphorus reduction (lb P/yr)	Suggested practice size (sq ft)	Cost
3,049	Rain Garden	80,284	0.835	0.106	653 @ 6 inches deep	\$2,600 - \$10,500



### 3. Senior Center

The possible total disconnection for this site is about 4,138 sq ft

The possible disconnection methods here are rain gardens



# 3. Senior Center - Rain Gardens

Pros:

- High visibility
- Aesthetic benefits for seniors

Cons:

- Requires tree removal

**KEY**

- Rain Garden
- Drainage Area
- ↗ Runoff Direction
- ★ Disconnection point



Drainage Area (sq ft)	Suggested Green Infrastructure	Annual Gallons Treated	Annual Nitrogen reduction (lb N/yr)	Annual Phosphorus reduction (lb P/yr)	Suggested practice size (sq ft)	Cost
2,091	Rain Garden (North)	55,052	0.57	0.073	325 @ 6 inches deep	\$1,300 - \$5,200
2,047	Rain Garden (South)	53,905	0.56	0.071	348 @ 6 inches deep	\$1,400 - \$5,600
4,138	TOTAL	108,957	1.13	0.144	673	\$2,700 - \$10,800

## 4. Moosup Park

The possible total disconnection for this site is about 5,053 sq ft

The possible disconnection method here is a Bioswale



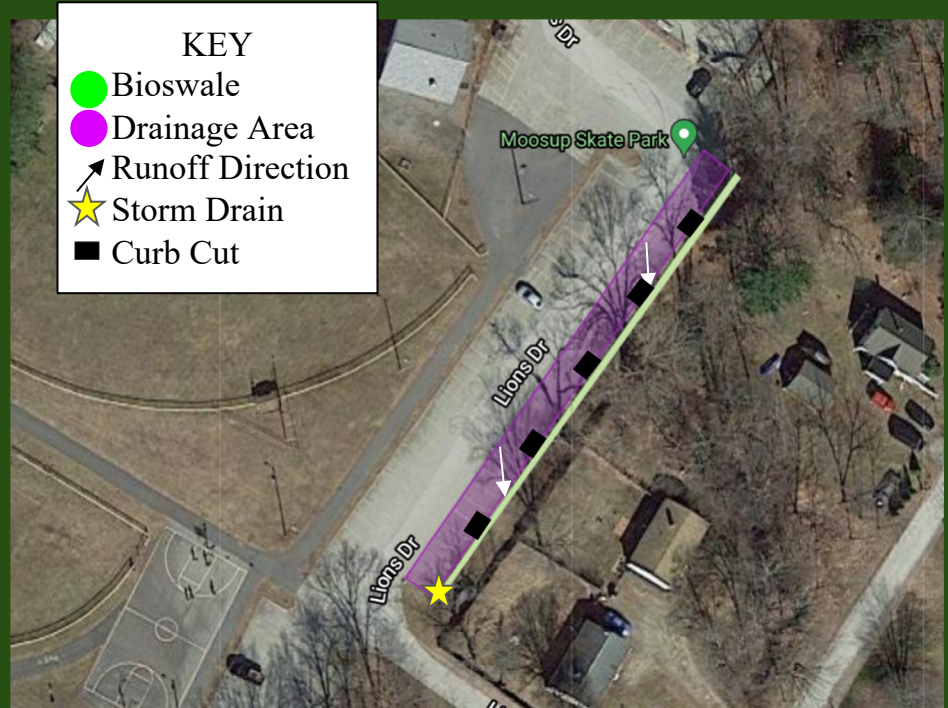
# 4. Moosup Park - Bioswale

## Pros:

- Large disconnection
- Prevents drain from clogging with leaf litter

## Cons:

- Lower visibility



Drainage Area (sq ft)	Suggested Green Infrastructure	Annual Gallons Treated	Annual Nitrogen reduction (lb N/yr)	Annual Phosphorus reduction (lb P/yr)	Suggested practice size ( sq ft)	Cost
5,053	Bioswale	133,042	1.38	0.176	274 ft long, 3 ft wide	\$1,200 - \$5,500

## 5. Plainfield Fire Co.

The possible total disconnection for this site is about 5,575 sq ft

The possible disconnection method here is a rain garden



# 5. Plainfield Fire Co. - Rain Garden

## Pros:

- A rain garden would add to the aesthetic of the area
- High visibility
- The rain garden would take in all of the drainage area

## Con:

- This is a smaller drainage area and the rain garden is a deeper size. If the rain garden is made to be a smaller depth it will not treat as much water.

**KEY**

- Rain Garden
- Drainage Area
- ↗ Runoff Direction
- ★ Storm Drain

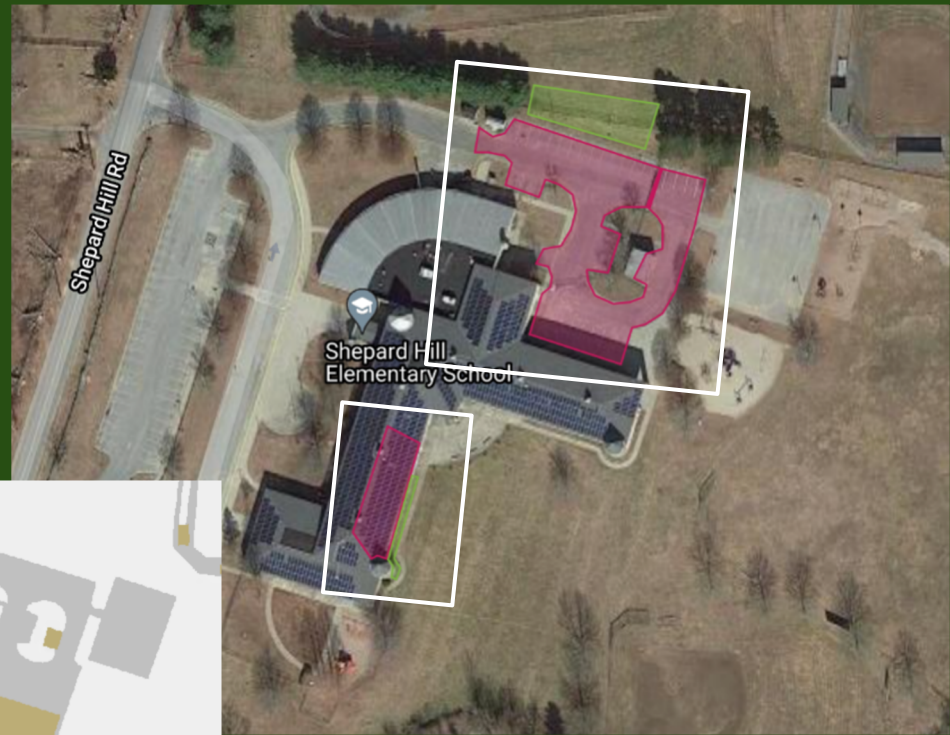
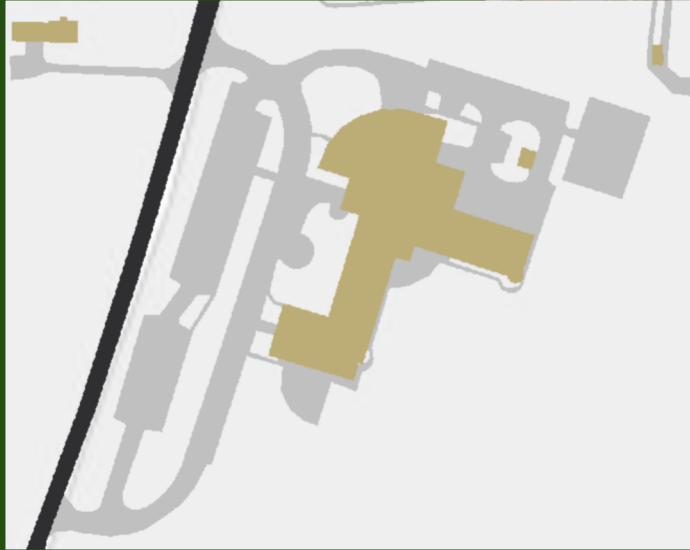


Drainage Area (sq ft)	Suggested Green Infrastructure	Annual Gallons Treated	Annual Nitrogen reduction (lb N/yr)	Annual Phosphorus reduction (lb P/yr)	Suggested practice size (sq ft)	Cost
5,575	Rain Garden	146,807	1.52	.19	465 @ 12"	\$1,860-7,440

## 6. Shepherd Hill Elementary

The possible total disconnection for this site is about 25,004 sq ft

The possible disconnection methods here are rain gardens

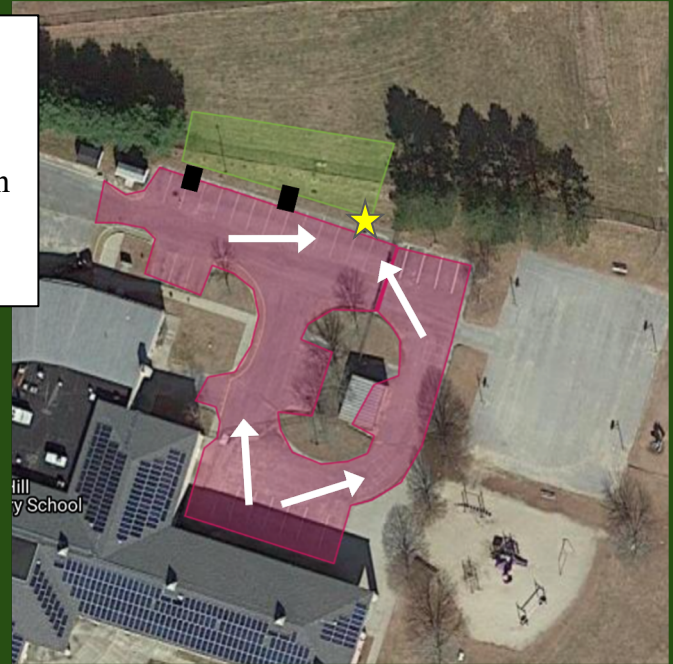


# Shepard Hill Elementary -

## Rain Garden #1

**KEY**

- Rain Garden
- Drainage Area
- ↗ Runoff Direction
- ★ Storm Drain
- Curb cuts



**Pros:**

- This is a very large drainage area
- There is already a small swale in the area which can be deepened and lengthed
- There is a lot of greenspace and more than enough room for a sizeable rain garden

**Cons:**

- There is a fence and some tree stumps which seem to be a barrier between the parking lot of the school and the sports fields. This could increase the cost because everything would need to be taken out.
- There is also a lamppost in this area that we have to be aware of when digging.

Drainage Area (sq ft)	Suggested Green Infrastructure	Annual Gallons Treated	Annual Nitrogen reduction (lb N/yr)	Annual Phosphorus reduction (lb P/yr)	Suggested practice size (sq ft)	Cost
20,909	Rain Garden	550,594	5.72	0.73	3,485 @ 6"	\$13,940-55,760



# 6. Shepard Hill Elementary

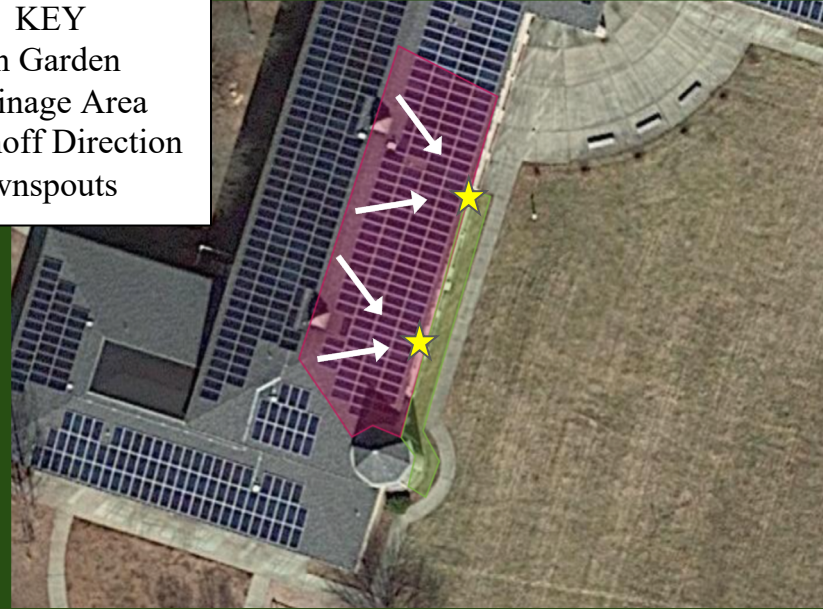
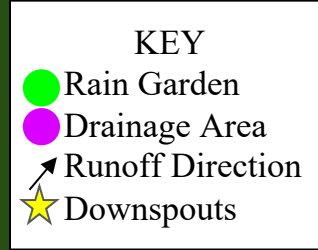
## - Rain Garden #2

### Pros:

- This area of the school seems very bare and a rain garden would help improve the aesthetics.
- Since it would be located in the back of the school, it would be an easy way to get the students involved in building the rain garden and/or just educating them more.

### Cons:

- The patch of grass is a bit small. We have made the rain garden as shallow as possible but it is still fairly deep. We have to do this to allow it to exist in the space provided.



Drainage Area (sq ft)	Suggested Green Infrastructure	Annual Gallons Treated	Annual Nitrogen reduction (lb N/yr)	Annual Phosphorus reduction (lb P/yr)	Suggested practice size (sq ft)	Cost
4,095	Rain Garden	107,825	1.12	.14	512 @ 8"	\$2,048-8,192

# Moosup Elementary

The possible total disconnection for this site is about 7,971 sq ft

The possible disconnection method here is a rain garden



Moosup Elementary School

Google My Maps

# Moosup Elementary

## - Rain Garden

### Pros:

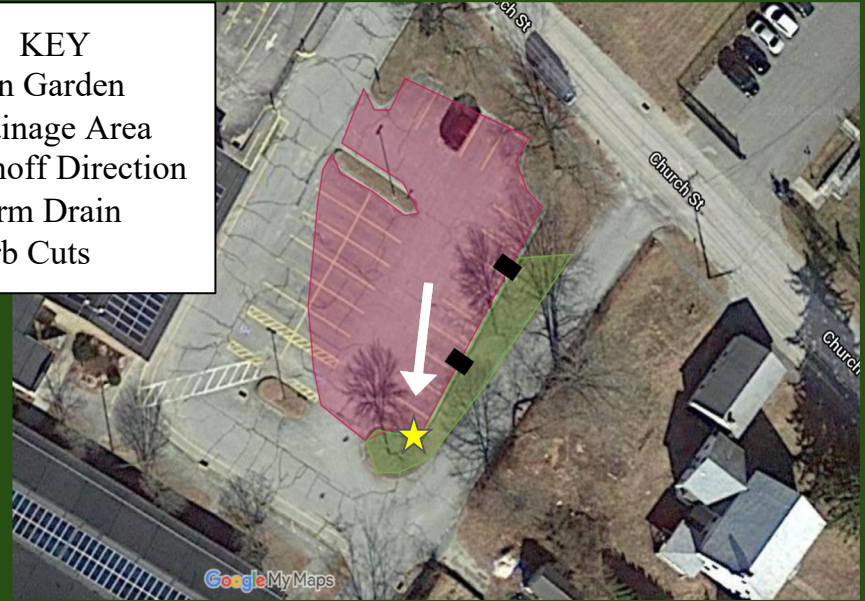
- This is a fairly large drainage area all draining to one drain
- We can make multiple curb cuts to infiltrate water
- Good visibility and educational opportunity

### Cons:

- We'd recommend tree removal for the two trees that are on the green space. We can replant them somewhere else on the property but we'd need a species of tree that works well in a rain garden

**KEY**

- Rain Garden
- Drainage Area
- ↘ Runoff Direction
- ★ Storm Drain
- Curb Cuts

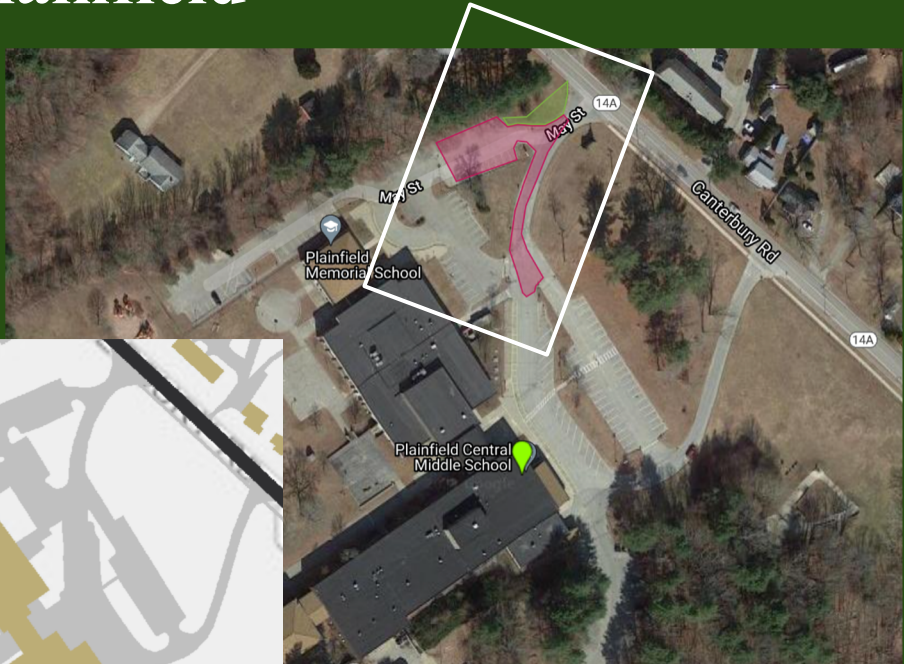


Drainage Area (sq ft)	Suggested Green Infrastructure	Annual Gallons Treated	Annual Nitrogen reduction (lb N/yr)	Annual Phosphorus reduction (lb P/yr)	Suggested practice size (sq ft)	Cost
7,971	Rain Garden	209,914	2.18	.28	1,329 @ 6"	\$5,316-21,264

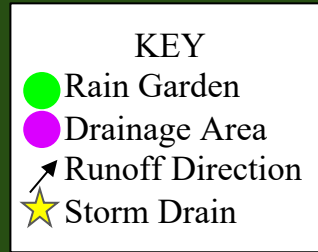
# Plainfield Memorial School/ Plainfield Central Middle School

The possible total disconnection for this site is about 11,671 sq ft

The possible disconnection method here is a rain garden



# Plainfield Memorial School/ Plainfield Central Middle School - Rain Garden



## Pros:

- This is a large area to disconnect
- Good visibility and great educational opportunity for the students

## Cons:

- We just have to be careful of the tree line in the back to make sure we don't dig through tree roots.

Drainage Area (sq ft)	Suggested Green Infrastructure	Annual Gallons Treated	Annual Nitrogen reduction (lb N/yr)	Annual Phosphorus reduction (lb P/yr)	Suggested practice size (sq ft)	Cost
11,671	Rain Garden	309,709	3.22	.41	1,960 @ 6"	\$7,840-31,360

# Total Costs

Location	Site/Practice	Disconnection Area (sq ft)	Cost Per Unit Area	Cost Estimate
Police Station	Rain Garden	2,352	4.00 - 16.00	\$3,136 - \$12,545
Town Hall	Rain Garden	3,049	4.00 - 16.00	\$2,614 - \$10,454
Senior Center	North Rain Garden	2,091	4.00 - 16.00	\$1,300 - \$5,200
	South Rain Garden	2,047	4.00 - 16.00	\$1,394 - \$5,576
Moosup Park	Bioswale	5,053	4.50 - 20.00	\$1,233 - \$5,480
Plainfield Fire Co.	Rain Garden	5,575	4.00 - 16.00	\$1,860-7,440
Shepard Hill Elementary	Rain Garden #1	20,909	4.00 - 16.00	\$13,940-55,760
	Rain Garden #2	4,095	4.00 - 16.00	\$2,048-8,192
Moosup Elementary	Rain Garden	7,971	4.00 - 16.00	\$5,316-21,264
Plainfield Memorial School/ Plainfield Central Middle School	Rain Garden	11,671	4.00 - 16.00	\$7,840-31,360
<b>Totals</b>		<b>64,813</b>		<b>\$40,681-163,271</b>

## Green Stormwater Infrastructure (GSI) Practice Unit Pricing Table

Practice	Unit	Price Range		Notes	References
		Low	High		
Rain Garden	SF	\$ 4.00	\$ 16.00	Price varies with underdrain and vegetation	Houdeshel, 2011
Bioretention	SF	\$ 5.00	\$ 30.00	Price greatly varies with structures, underdrains, bank stabilization and depth	Brennan, 2011; MassDEP, 2018
Vegetated Swale	LF	\$ 4.50	\$ 20.00	Not Included: Structures, bank stabilization, clearing/grubbing, curbs, underdrain	PDEP, 2006
Extensive Green Roof	SF	\$ 7.00	\$ 36.00	Not Included: Irrigation system, structural improvements, > 6" medium depth	PDEP, 2006; Peck and Kuhn, 2001; Manso, 2021, LID Center, 2005
Gravel Grid	SF	\$ 1.50	\$ 5.75	Includes the cost of installation	LID Center Website, 2007
Porous Asphalt	SF	\$ 3.50	\$ 8.00	Not included: Underdrain, >12" aggregate depth	LID Center, 2005
Porous Concrete	SF	\$ 5.00	\$ 13.50	Not included: Underdrain, >12" aggregate depth	LID Center, 2005
Permeable Pavers	SF	\$ 8.00	\$ 17.00	Not included: Underdrain, >12" aggregate depth	LID Center, 2005
Tree Box Filter	EA	\$ 7,000.00	\$ 18,000.00	Unit sizes and treatment volumes vary	PVPC, 2015; MassDEP, 2018
Rain Barrel/Cistern	EA	\$ 500.00	\$ 1,000.00	Additions can cause the rain barrel to be on the higher cost end	National Tank Outlet, 2021

These unit prices have been gathered from published literature, government websites/reports, and installation manuals. Unit prices have not been normalized to current market values. The cost ranges were selected to best represent recommendation typically made by the University of Connecticut Stormwater Corps course and are for informational purposes only. Prepared by Joshua Snarski, University of Connecticut, Department of Natural Resources and the Environment, 2021.

# CONTACT & PARTNERS

This project was completed by students enrolled in the Stormwater Corps course at the University of Connecticut as part of the University's E-Corps Program, funded by the National Science Foundation. For more information, visit the websites and contacts below.

## Stormwater Corps Contacts:

<https://nemo.uconn.edu>

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