COLLEGE OF AGRICULTURE, HEALTH AND NATURAL RESOURCES
Center for Land Use Education & Research

CLEAR

Cromwell Runoff Reduction Recommendations

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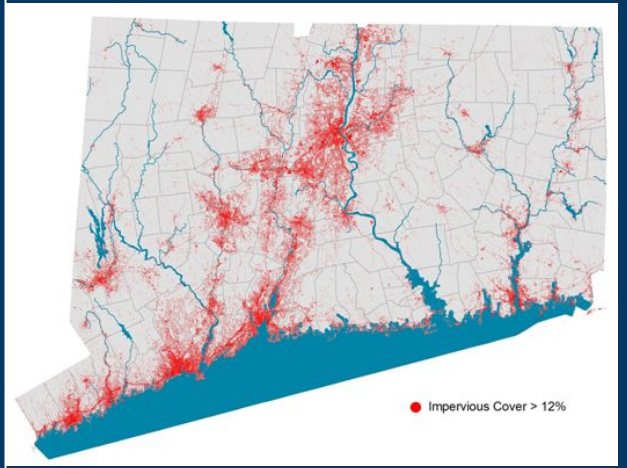
UCONN

Table of Contents

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



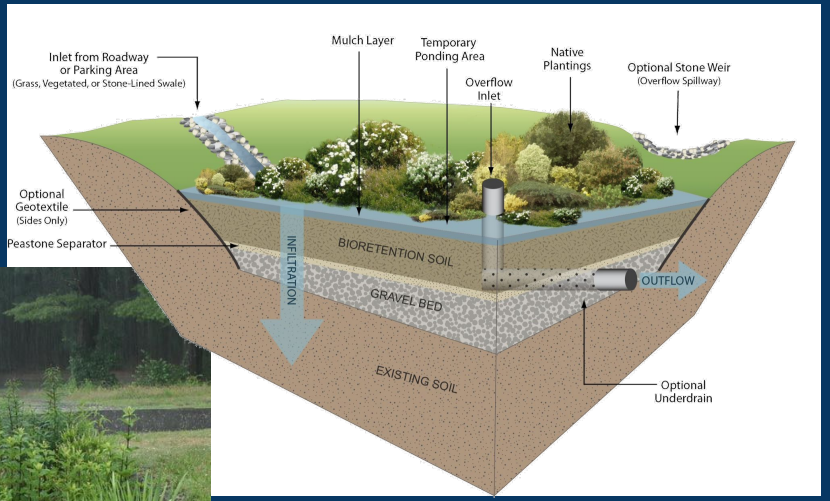
MS4 Requirements- Municipal Separate Storm Sewer Systems Permitting Program

- 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.

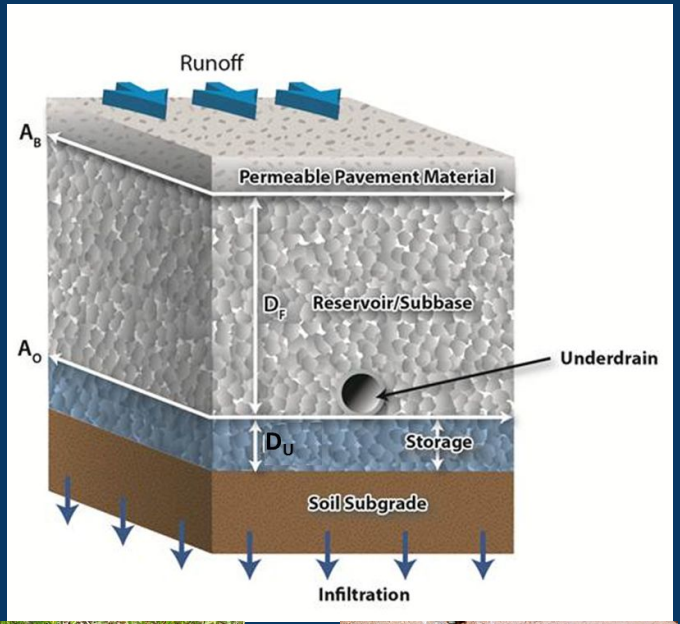
Rain Gardens and Bioretention

- 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



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^3
- Surrounded by pit filled with crushed stone
  - Depth: 7.67’
  - Percent voids of stone ≈40%
  - Can be sized to fit drainage area

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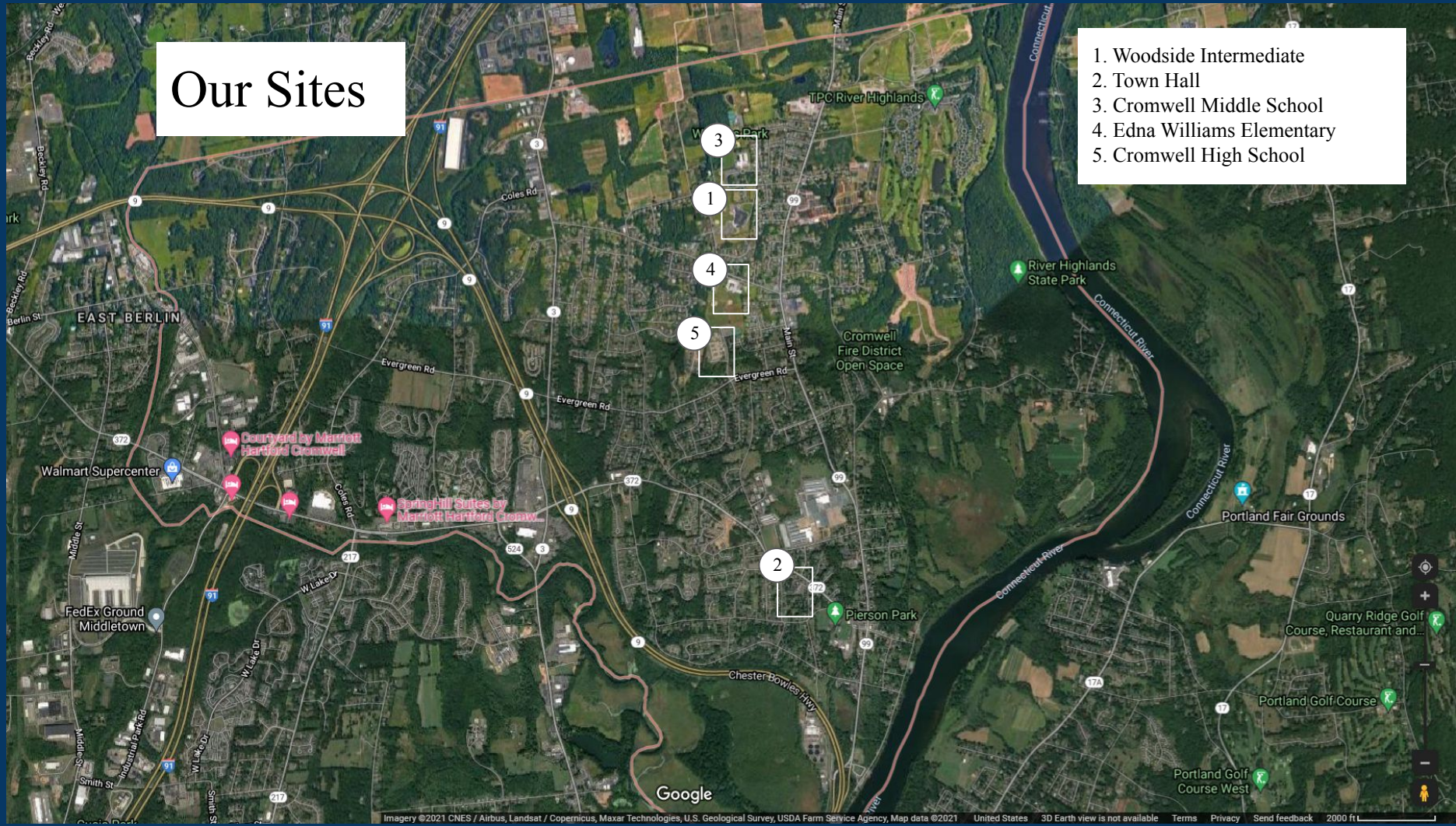
Our Sites


1. Woodside Intermediate
2. Town Hall
3. Cromwell Middle School
4. Edna Williams Elementary
5. Cromwell High School
1
2
3
4
5
TPC River Highlands
River Highlands State Park
Cromwell Fire District Open Space
Connecticut River
Portland Fair Grounds
Quarry Ridge Golf Course, Restaurant and...
Portland Golf Course
Portland Golf Course West
Pierson Park
EAST BERLIN
Walmart Supercenter
Courtyard by Marriott Hartford Cromwell
SpringHill Suites by Marriott Hartford Cromw...
FedEx Ground Middletown
Evergreen Rd
Coles Rd
Main St
Middle St
W Lake Dr
Chester Bowles Hwy
Industrial Park Rd
Smith St
Berlin St
Beckley Rd
Google

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

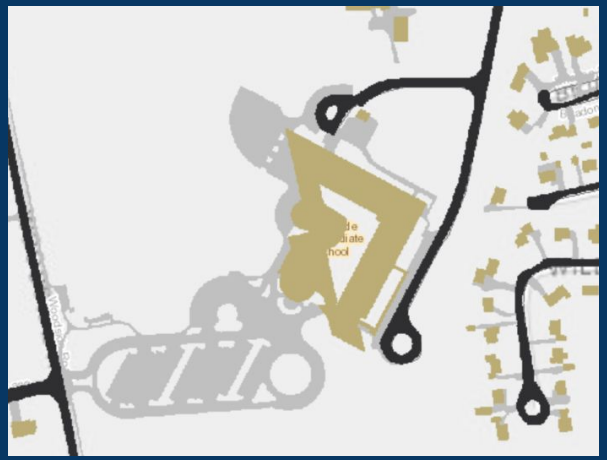
Sites and Practices Were Selected Based On:

- 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

Woodside Intermediate

This site has three really promising rain garden opportunities.

Possible total disconnection:
~ 39,028 square feet



West Parking Area #1

Pros:

- This would be a huge disconnection
- There is one drain this area drains to so disconnecting would be fairly easy

Cons:

- It's more expensive than other opportunities

There would be curb cuts on either side of the storm drain. Any overflow would be directed back into the drain as well.

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
22477	Rain Garden	591,890	6.15	0.78	3,746 @ 6 inches	$14,984- 59,936

Southwest Roundabout #2

Pros:

- This is a visible area with what seems like a lot of traffic.
- The drainage area is fairly large as well.

Cons:

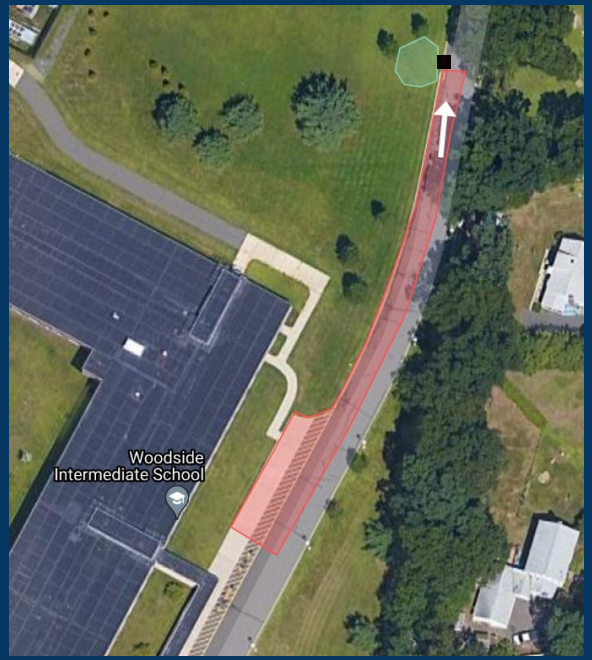
- The storm drain is located right where the sidewalk ends. This means the cut through the sidewalk/curb to get the behind the drain will require a little more innovation and work.

There would only have to be one cut on the right of the storm drain to allow water into the rain garden. We would recommend shortening the end of the sidewalk by 1 foot to allow a big enough space to allow water in.

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
10237	Rain Garden	269,546	2.80	0.36	1,024	$4,096-16,384

East Entrance Road #3

KEY
Rain Garden
Drainage Area



Pros:

- There is an overflow drain already in place
- This is the perfect area for a small rain garden

Cons:

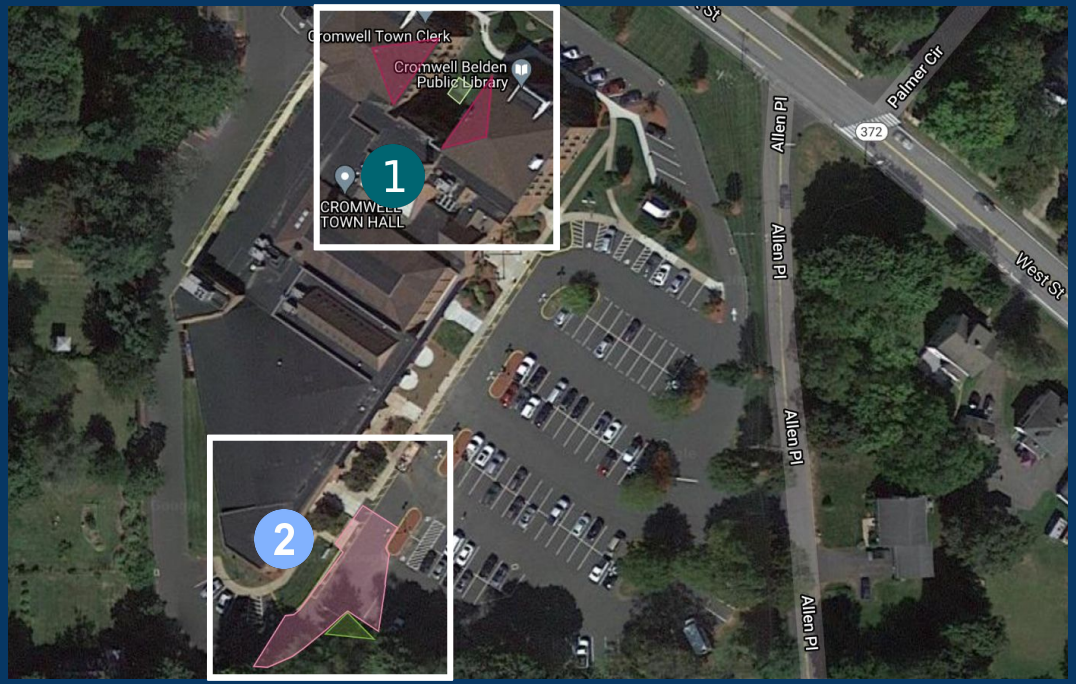
- This area is not as big as the other opportunities
- It may not be as visible depending on who uses the back entrance of the school

The curb cut for this drain would only have to be made on the south side of the storm drain because this drainage area flows downhill towards the 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
6316	Rain Garden	166,320	1.73	0.22	631 @ 10 inches	$2,524- 10,096

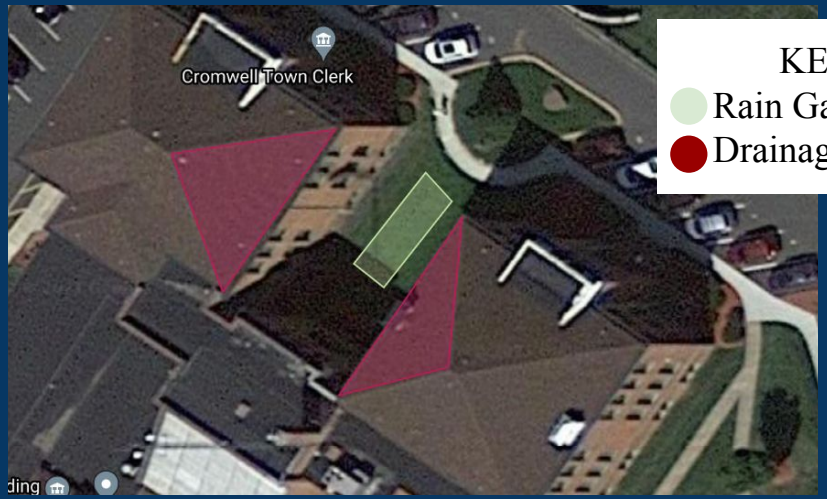
Town Hall

This building has two possible rain garden opportunities. There is not much green space on this site so disconnecting any of this would be beneficial for the area.



Possible total disconnection: ~5,574 square feet

Front Entrance Green #1



Pros:

- There is a nice green space for the rain garden which would add to the appeal
- It's in a fairly visible area
- Possible educational plus

Cons:

- There is a basement so we have to make sure the rain garden is far enough away from the building.

The best way to get water into the rain garden from the two drains on either side of the green space would be pipe the downspouts in. If we tried to create a rock channel or swale to direct the water we could have possible infiltration within ten feet of the building.

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
1612	Rain Garden	42,423	0.44	0.06	268 @ 6 inches	$1,072- 4,288

Southern Edge Parking #2

Pros:

- This site is very impervious and disconnecting even a small portion of the large parking lot would be beneficial

Cons:

- There is quite a bit of tree cover in the area so we would have to make sure we don't dig over tree roots
- There is not a lot of visibility in this area

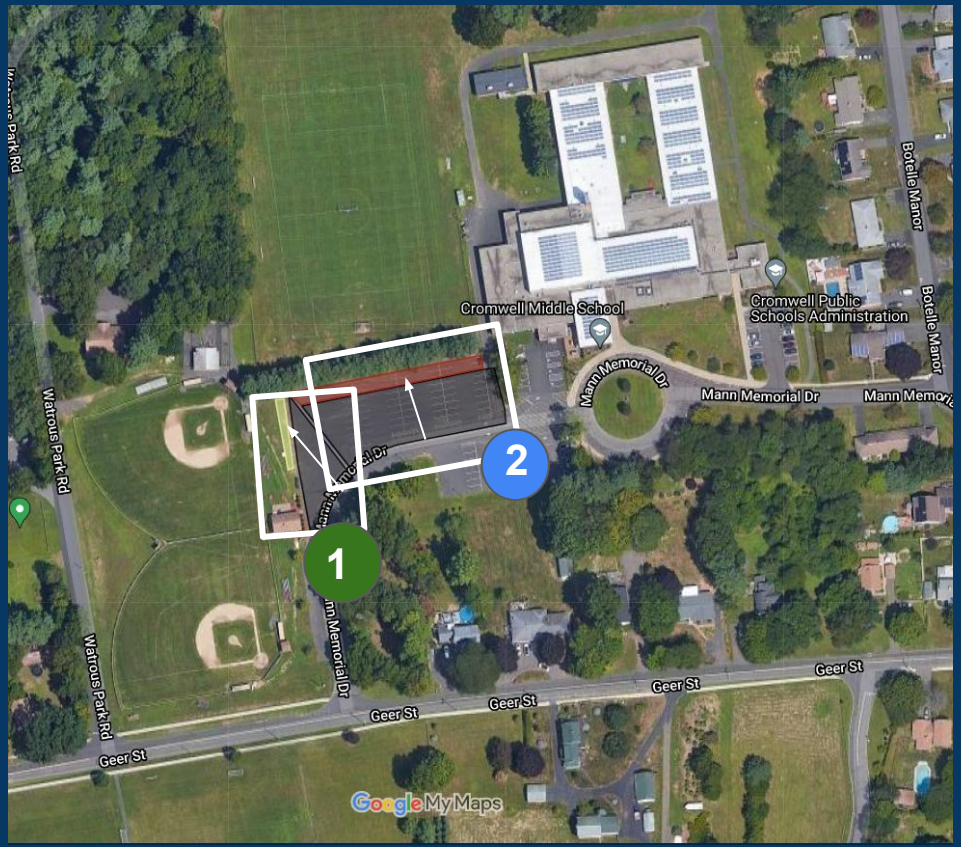
We can make a few curb cuts around where the grass area comes out into a semi-circle, this will allow us to take in water from both sides easier.

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
3964	Rain Garden	104,384	1.08	0.14	329 @ 12 inches	$1,320- 5,280

Cromwell Middle School

With renovations ahead, it's useful to keep GSI practices in mind.

Here there's potential for a rain garden and pervious pavement.



Baseball Fields - Raingarden #1

Pros:

- Beautifies green area that is already eroded from runoff
- High visibility from sports games

Cons:

- Treats a smaller drainage area

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
6,795	Rain Garden	**178,919**	**1.861**	**0.236**	1,176.12 at 6 inches deep	$4,700 - $18,800

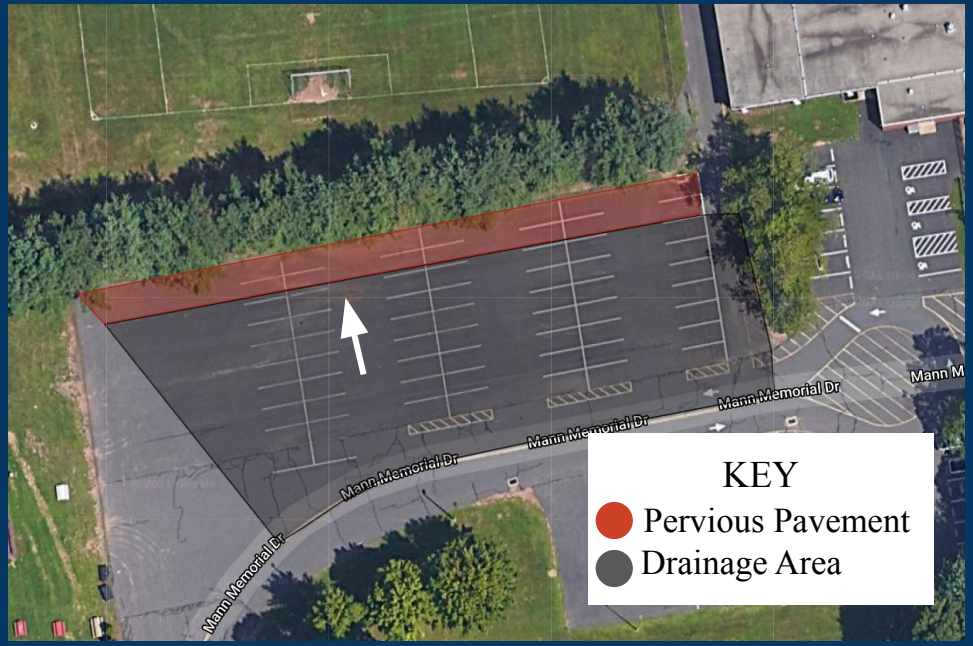
Southwestern Lot - Porous Asphalt #2

Pros:

- Treats a large area
- Doesn't require using green space
- Lasts longer than traditional asphalt

Cons:

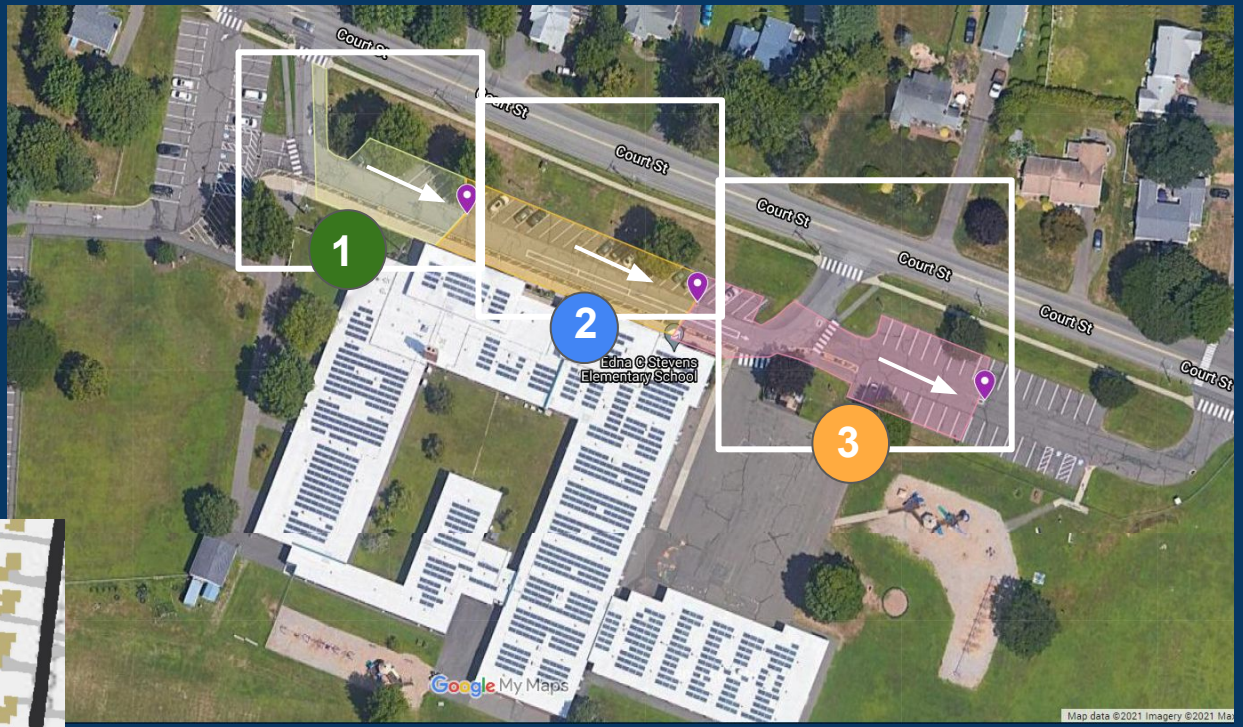
- More expensive than other options
- Requires periodic maintenance



Drainage Area	Suggested Green Infrastructure	Annual Gallons Treated	Annual Nitrogen reduction (lb N/yr)	Annual Phosphorus reduction (lb P/yr)	Suggested practice size (sq ft)	Cost
21,300	Porous Asphalt	560,843	5.834	0.740	4,225	$14,800 - $33,800

Edna Williams Elementary

This site has potential for 3 dry wells along the parking lot.



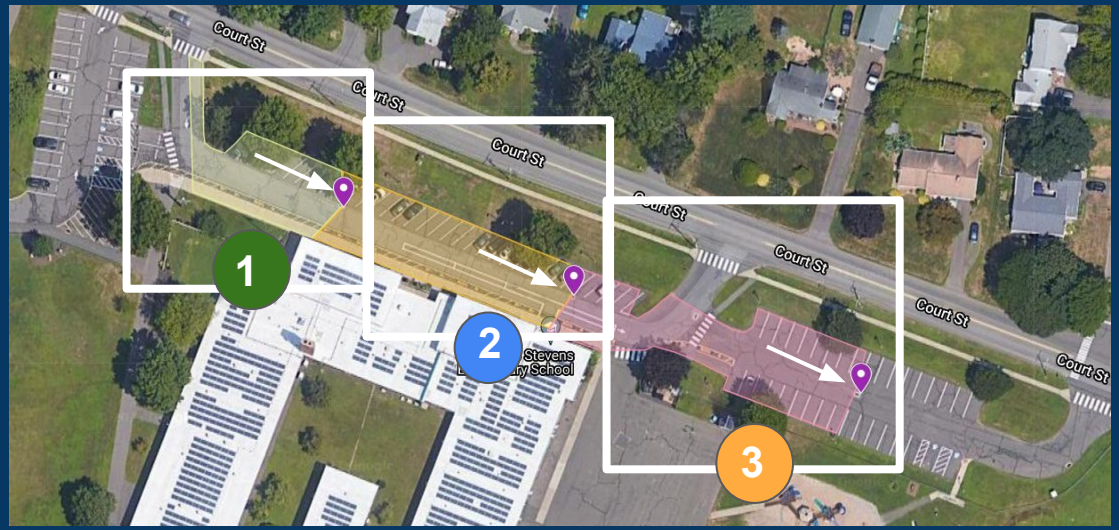
Dry Wells

Pros:

- Convenient for areas that drain towards center of road

Cons:

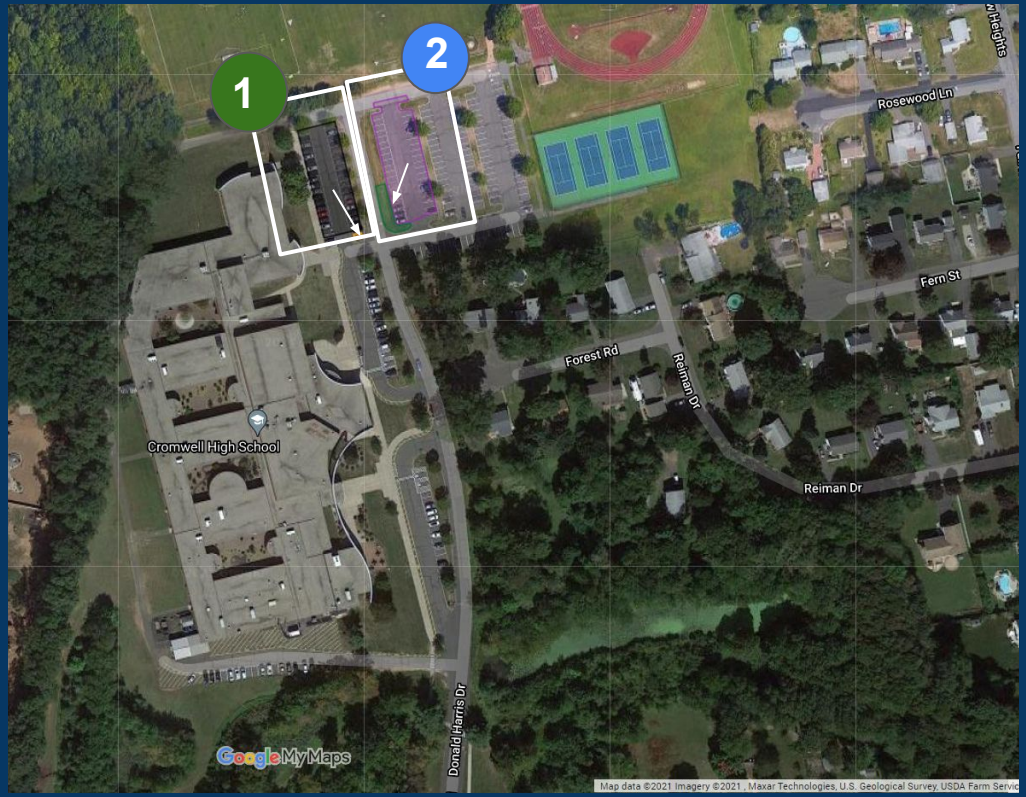
- Requires cutting into asphalt



Site/ Practice	Drainage area (ft²)	Annual Gallons Treated	Annual N Reductiton (lb N/yr)	Annual P Reduction (lb P/yr)	Drywell Volume (ft³)	Pit volume needed (with 40% stone porosity) (ft³)	Excavation area (ft²)	Cost
Drywell 1	6,185	162,862	1.694	0.215	254	650	10’ x 11’	Undetermined
Drywell 2	9,496	250,028	2.601	0.330	254	1,335	12’ x 15’	Undetermined
Drywell 3	11,194	294,758	3.066	0.389	254	1,690	15’ x 15’	Undetermined

Cromwell High School

There are two potential practices here: a tree box filter and rain garden.



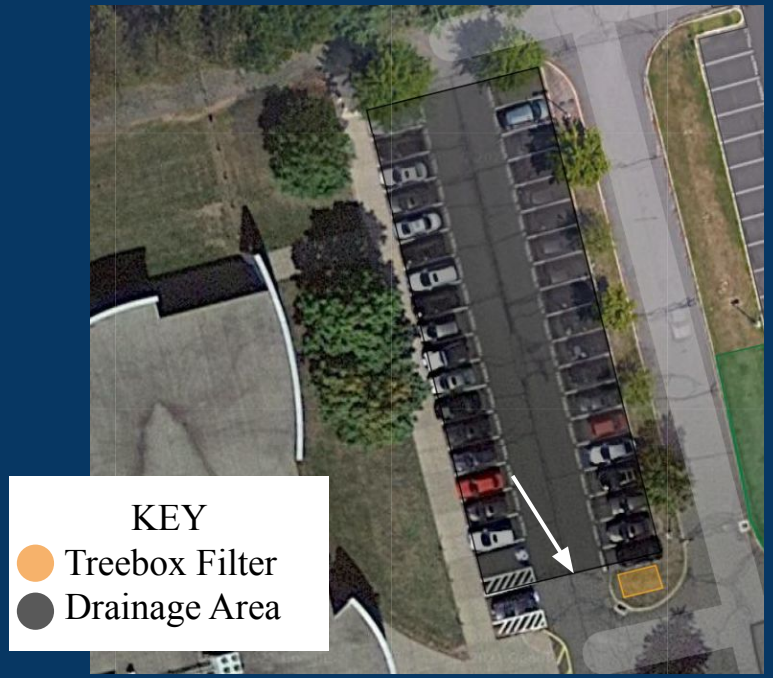
West Parking Lot - Treebox Filter #1

Pros:

- Treats a large amount of water in minimal space

Cons:

- More costly than other options



Drainage Area	Suggested Green Infrastructure	Annual Gallons Treated	Annual Nitrogen reduction (lb N/yr)	Annual Phosphorus reduction (lb P/yr)	Suggested practice size (sq ft)	Cost
10,367	Treebox Filter	272,966	2.839	0.360	Filtera 6 x 6 ft box	$3,000 - $18,000

East Parking - Raingarden #2

Pros:

- Beautifies parking area near entrance to the school
- High education potential

Cons:

- There's evidence of tree roots at this site that would need to be removed

Drainage Area	Suggested Green Infrastructure	Annual Gallons Treated	Annual Nitrogen reduction (lb N/yr)	Annual Phosphorus reduction (lb P/yr)	Suggested practice size (sq ft)	Cost
11,587	Rain Garden	**305,080**	**3.173**	**0.403**	1,600 at 7.5 inches deep	$6,400 - $25,600

Sites Not Chosen for Stormwater Retrofits

- Police Department, 5 West St
  - This site was not chosen because there was not enough green space surrounding the building
  - There were also no drains that bordered a green area making it very hard to try and catch the water in a practice
- Fire Marshall, 1 West St
  - This site was also not chosen for similar reasons to above.

A big recommendation we have for any new buildings or renovations would be to not put storm drains in the middle of impervious areas. Trying to retrofit for stormwater treatment becomes very hard when there is nowhere to infiltrate the water.

Total Costs

Location	Site	Practice	Disconnection Area (sq ft)	Cost Estimate
Woodside Intermediate	West Parking Area	Rain garden	22,477	$14,984- 59,936
	Southwest Roundabout	Rain garden	10,237	$4,096-16,384
	East Entrance Road	Rain garden	6,316	$2,524- 10,096
Town hall	Front Entrance Green	Rain garden	1,612	$1,072- 4,288
	Southern Edge Parking	Rain garden	3,964	$1,320- 5,280
Cromwell Middle School	Baseball Fields	Rain garden	6,795	$4,700 - $18,800
	Southwestern Parking	Pervious Asphalt	21,300	$14,800 - $33,800
Edna Williams Elementary	Western Parking	Drywell	6,185	Not provided
	Front Entrance Parking	Drywell	9,496	Not provided
	Eastern Parking	Drywell	11,194	Not provided
Cromwell High School	West Parking Area	Treebox Filter	10,367	$3,000 - $18,000
	East Parking Area	Rain garden	11,587	$6,400 - $25,600

Green Stormwater Infrastructure (GSI) Practice Unit Pricing Table

		Price Range			
Practice	**Unit**	**Low**	**High**	**Notes**	**References**
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	$ 1,500.00	$ 2,500.00	Not included: Cost of installation	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.

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