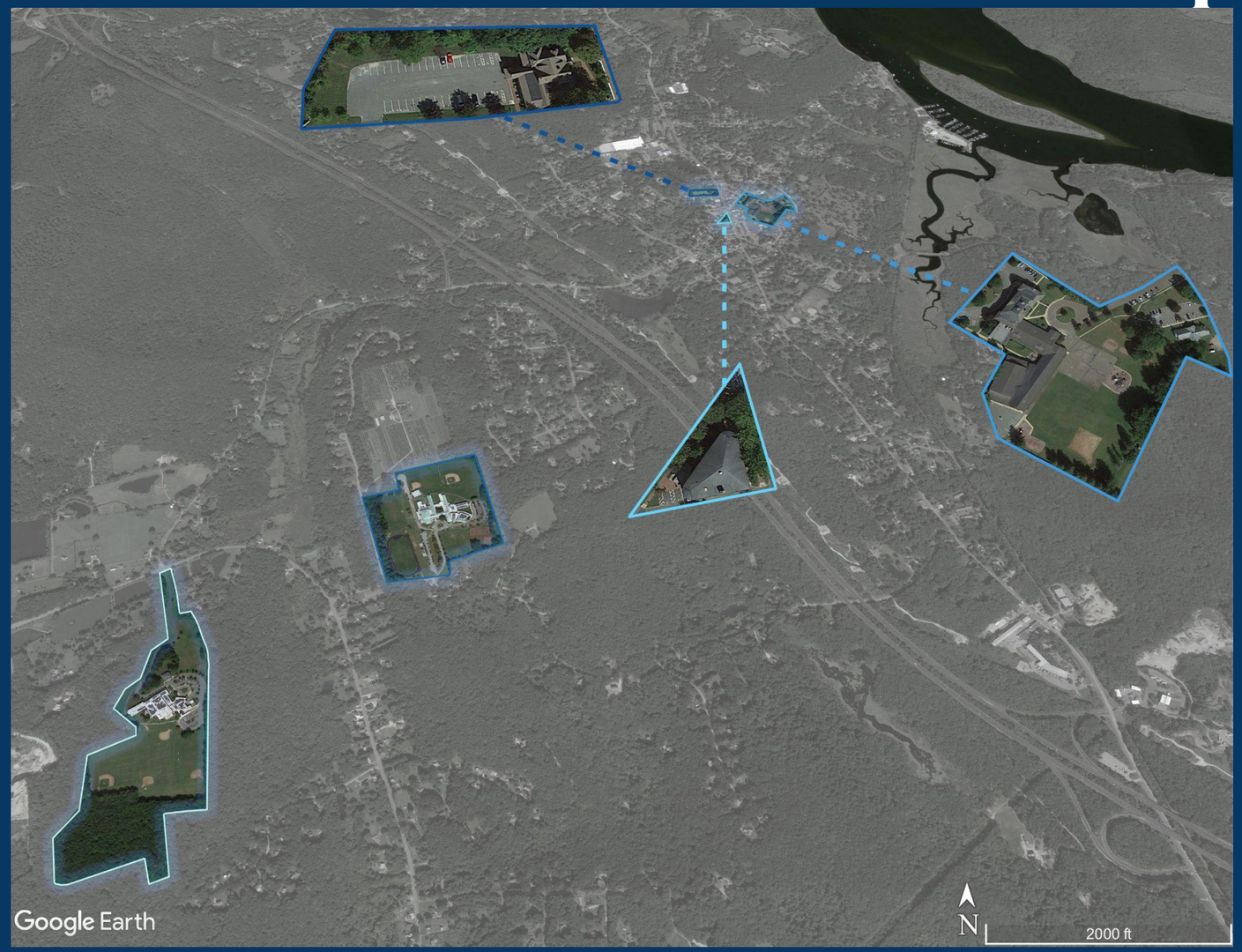
CLEAR

# Stormwater Runoff Reduction Plan - Deep River, CT

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# Summary

During the summer of 2021, a team of UConn students and Extension faculty performed an evaluation of potential stormwater enhancement opportunities in the Town of Deep River, CT. The process involved a desktop analysis and field visits to determine where potential green stormwater infrastructure installation opportunities existed on publicly owned land parcels. Calculations were performed to determine the potential stormwater and pollution benefits from each of the proposed installations. If all top five projects identified in the report are implemented, 79,232 sq ft of impervious cover will be disconnected from the stormwater drainage system, and 2,086,258 gallons of untreated stormwater, 21.67 lbs of nitrogen, and 2.76 lbs of phosphorus will be prevented from entering local water bodies annually.

# In This Report...

Included are recommendations for green stormwater infrastructure practices at five sites in the town of Deep River. Each site is introduced with an aerial photo from Google Maps displaying the recommended green infrastructure and a map displaying all impervious cover in the area. The following report includes the address and total impervious area to be disconnected from the stormwater system. Information about the nitrogen and phosphorus load reduction per year is included, as well as the size of the recommended installation, the gallons of runoff treated per year and its estimated cost. These estimations are calculated based on the drainage area, annual rainfall estimates specific to Connecticut, and literature export values. Sites that did not make the top five are also listed afterwards with some additional recommendations and notes.

# Impervious Surfaces & Runoff

The expansion of developed land in Connecticut has vastly increased the area of imperious cover around the state. This includes roads, rooftops, parking lots, and other development, leading to increased runoff into stormwater management systems. This not only disrupts the local water cycle, but increases the amount of pollutants in waterways and causes erosion and flooding. The implementation of green infrastructure disconnects stormwater from local management systems and allows it to naturally infiltrate into the ground. Installations such as rain gardens, green roofs, tree box filters, and pervious pavements benefit the local water cycle and offer great educational opportunities to the surrounding area, as well as offering a more aesthetic alternative to more traditional stormwater  management systems.

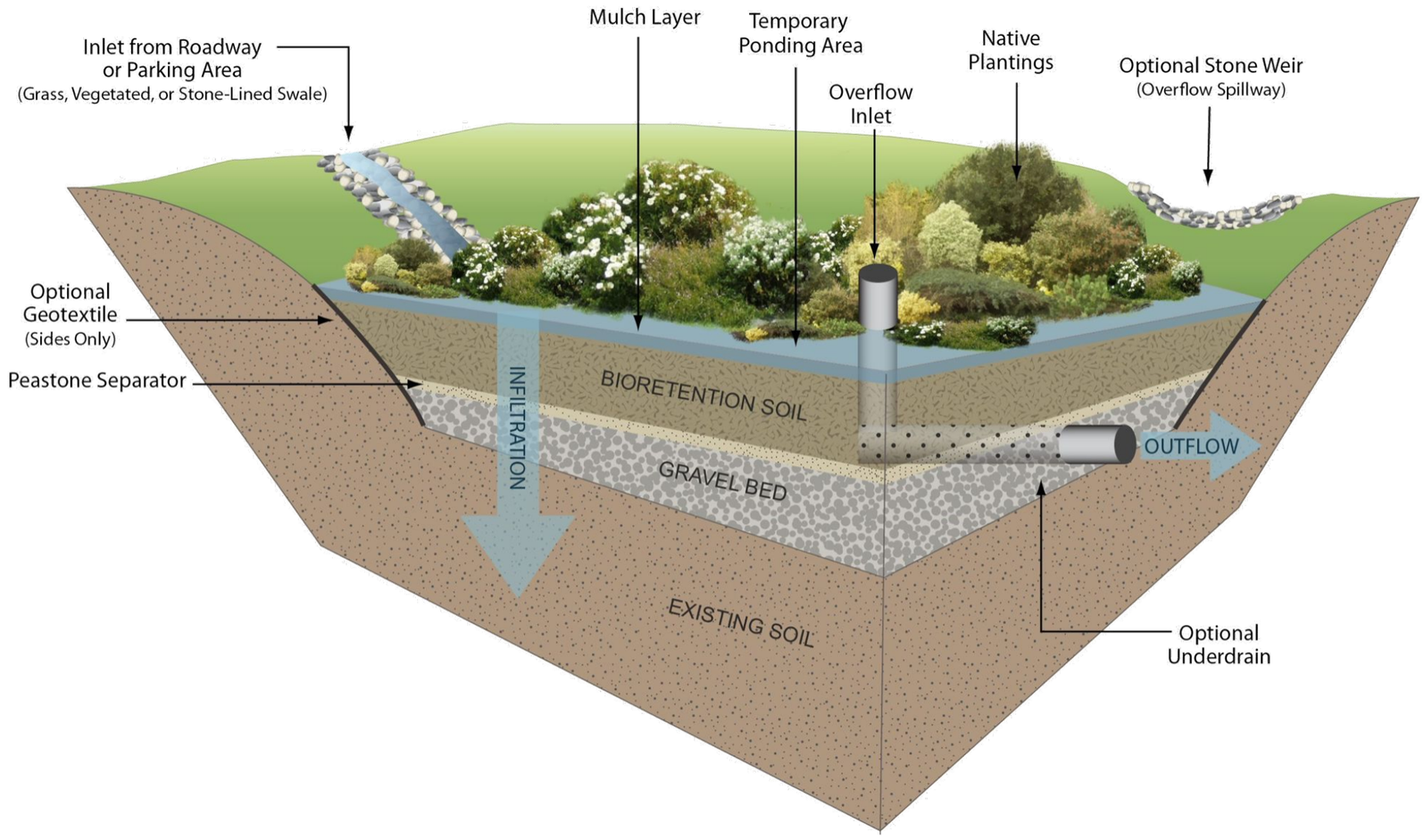
# MS4 Requirements- Municipal Separate Storm Sewer Systems Permitting Program

- 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 sewer system, and which eventually flows into lakes, streams, and the ocean.

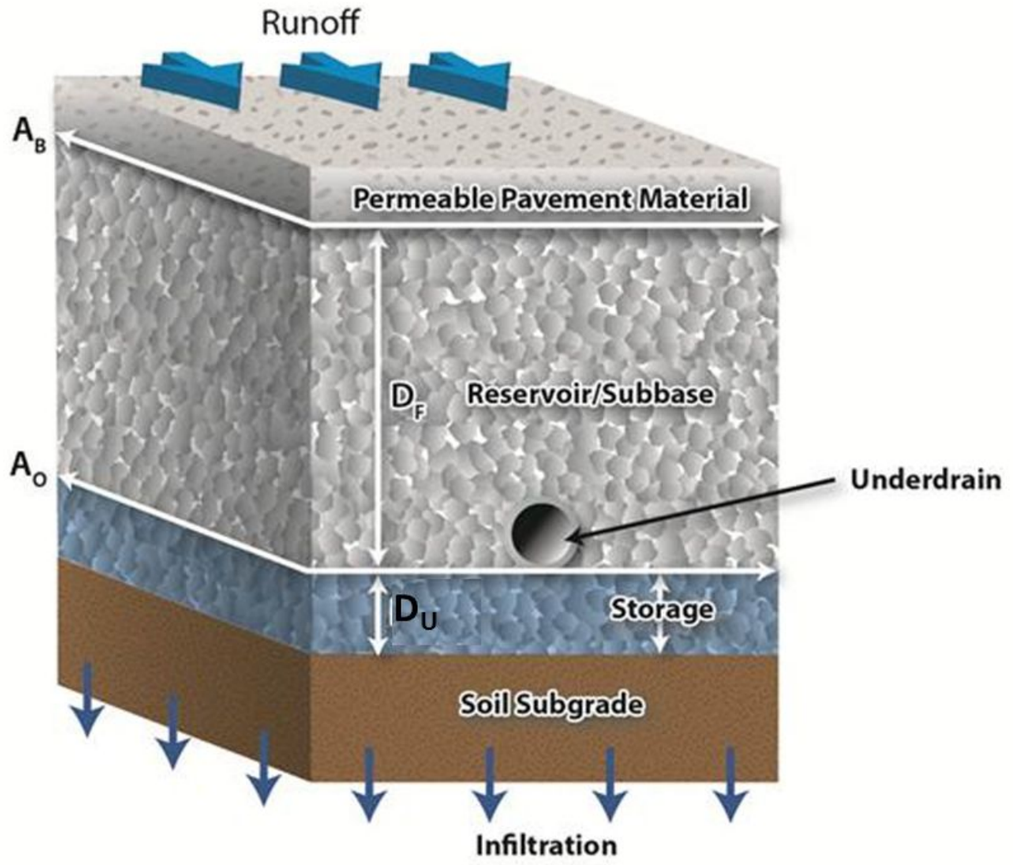
# Rain Gardens and Bioretention

Rain gardens are a green infrastructure installation that capture stormwater from impervious surfaces or disconnected gutters. This practice allows the runoff to infiltrate into the soil and recharge groundwater. Rain gardens consist of a depression at least 6 inches deep which may include native plants, grass, or stone. The practice might involve curb cuts or gravel material as a buffer for erosion depending on the individual site. Rain gardens add to the aesthetic appeal and the biodiversity of urban areas.



# Pervious Paving

Pervious paving is an alternative to traditional asphalt or concrete that allows for the infiltration of water. Ideal locations for pervious pavement are relatively flat areas that take on a fair amount of water from surrounding impervious surfaces during storm events. Pervious asphalt needs to be replaced less often than traditional asphalt and is less susceptible to seasonal expansion and contraction which reduces the occurrence of frost heaves and cracking. Pervious pavements are also fairly costly and require maintenance such as pressure washing and vacuum sweeping to dislodge debris in the pores of the pavement. Without proper maintenance the stormwater is unable to infiltrate and the green infrastructure is ineffective. Pervious pavement requires less snow maintenance than its counterpart. A variety of pavement types are available such as pervious asphalt, concrete, and a variety of permeable pavers.

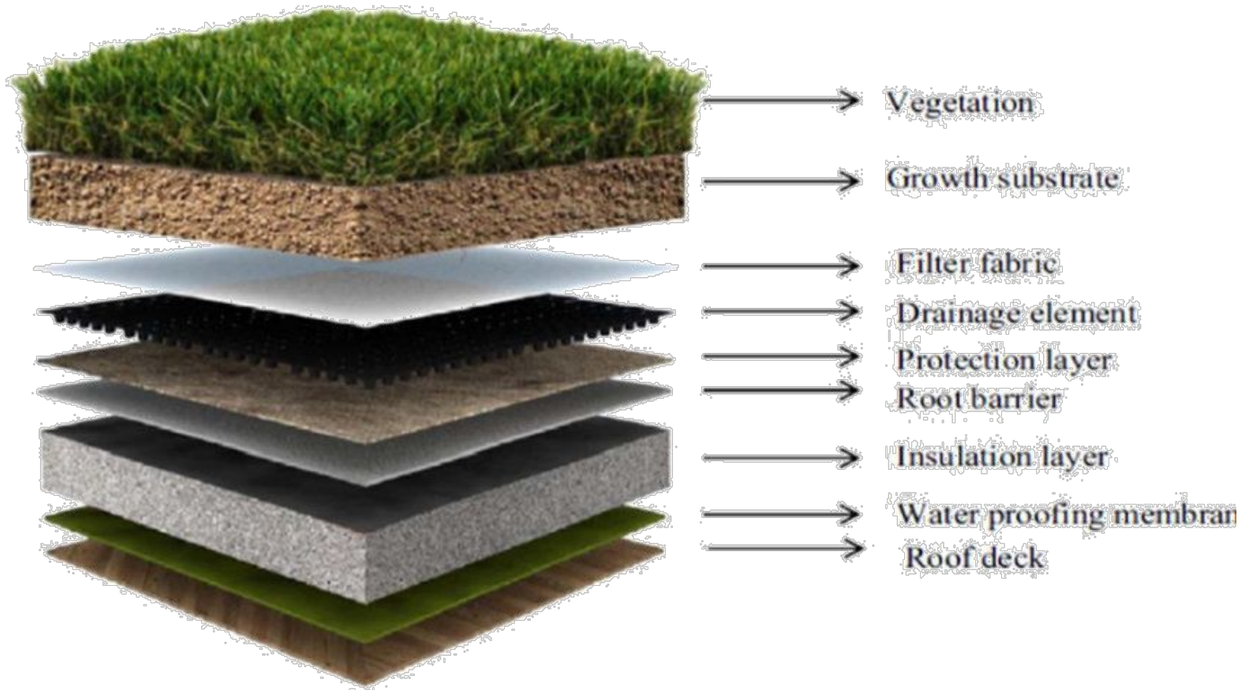


# Tree Box Filters

Tree box filters are an aesthetically pleasing green infrastructure practice that filter runoff. Stormwater enters the installation through a grate, then infiltrates through the soil and root system, filtering out pollutants. Depending on the amount of stormwater present near the practice, an underdrain may be required to prevent flooding.

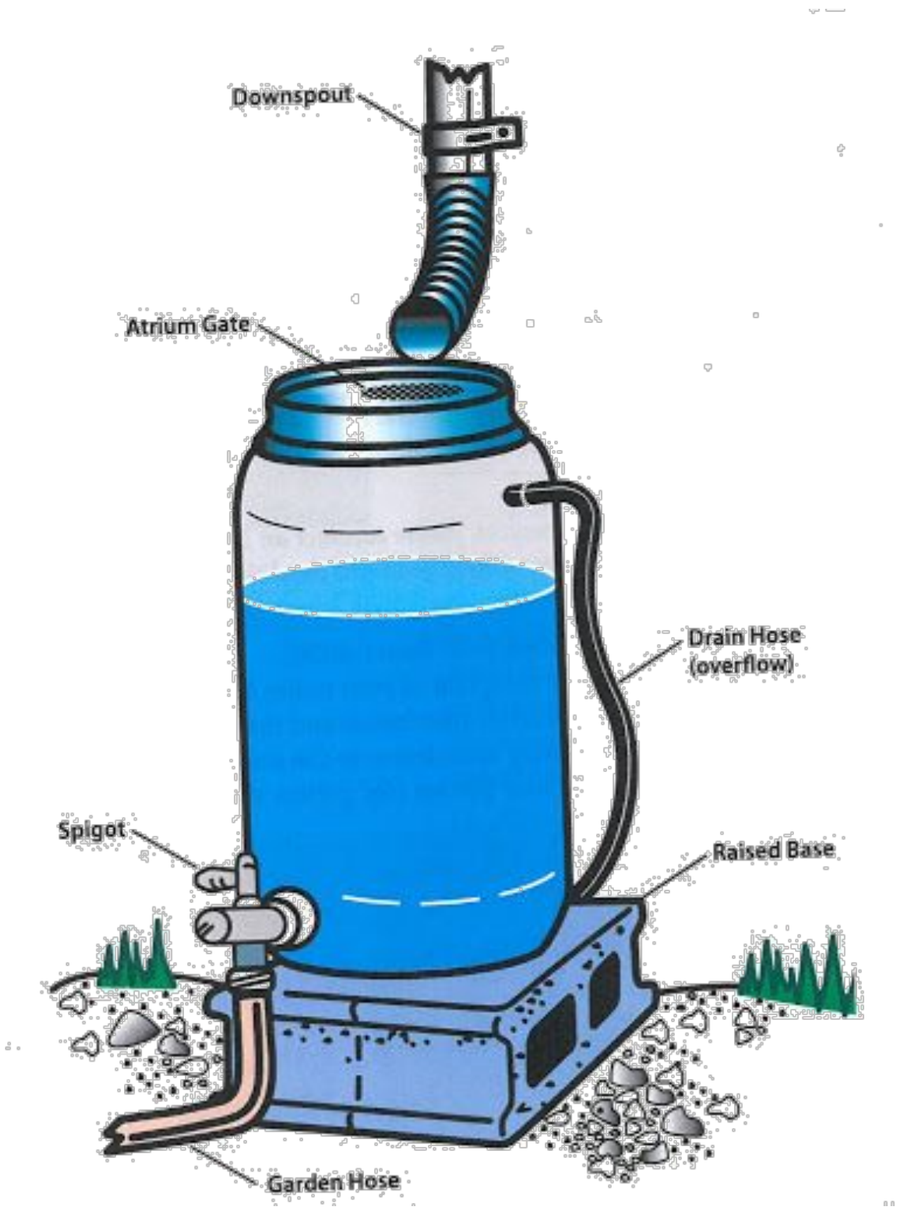
# Green Roofs

A green roof is a form of green infrastructure that allows runoff, that would otherwise enter an internal piping or gutter system, to infiltrate substrate directly. This installation disconnects about 50% of the stormwater that sheds off any given building. It is the most expensive practice, but offers great educational opportunities for nearby communities and adds to the aesthetic of any location. Green roof trays may be a more affordable option. The implementation of a green roof depends on the structural support of the roof and proper roof access.



# Rainwater Harvesting

Rainwater harvesting is the capture and reuse of water from gutters and downspouts which would otherwise end up in the municipal stormwater system. Roof runoff is fed into large cisterns which retain the water until it can be repurposed for garden watering, domestic use, fire protection, and a variety of other uses. Not only does this reduce runoff, but it also reduces stress on private wells and municipal water supplies. The required size of the rain barrel depends on the collection area and materials can range from PVC to steel. Based on the needs at the location, a filter can be installed to remove pollutants. Cisterns require minimal maintenance; however, may need to be moved in the winter months to prevent freezing.



# Explanation of Calculations

**Drainage Area:** The potential watershed area of each retrofit was estimated using topographic tools in Google Maps and confirmed during site visits.

**Rain Garden Size:** Rain garden area and depth is heavily dependent on the estimated drainage area and amount of rainfall expected. All rain gardens in this presentation are sized to handle a 1” rainstorm event as most storms are smaller than this and most pollutants are released in the first 1” of runoff. This information allows for the calculation of the volume of stormwater on a given drainage area. Rain gardens should be able to hold the same volume so the area and depth is altered accordingly. Rain gardens deeper than 12” are typically avoided for safety reasons so gravel layers may be added instead.

**Nutrient Reductions:** The nutrient reductions were determined using the estimated drainage area of the retrofit and nutrient export coefficients determined by Charles Frink in a paper discussing nutrient concentrations in CT by major type of land cover. In other words, the area of land treated and estimated concentrations of nutrients that runoff into that area gives the amount of nutrients that can be directed away from that watershed. Point source pollution were not taken into consideration in these calculations as it varies depending on site (i.e. fertilizers from farmland, animal feed, nearby industrial buildings, etc).

**Gallons Treated:** The volume of stormwater treated was determined with the assumption that CT experiences around 4’ of rain annually and the previously determine drainage area of each retrofit.

**Costs:** The cost range of each recommended green practice was estimated using literature, government websites/reports and installation manuals. Some prices may vary as examples are used of similar retrofits installed in the past and there subsequent cost. These prices were not determined by consulting contractors, but should fall somewhere in the presented range.

# 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 | $ 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.

# Site Selection & Approach

Before visiting sites, team members used various aerial imagery tools to view locations within each town to determine possible sites suitable for green infrastructure practices. This included using the statewide high-resolution impervious surface maps to get an overall feel for the site, following contour lines provided by ArcGIS to estimate drainage patterns, and examining images from Google Maps to locate possible disconnection sites

On location, site specific recommendations were selected based on suitability for implementation of green infrastructure practices. Whether or not a site was suitable depended on factors such as slope of surrounding land, land available for use, locations of existing storm drains, location of above ground and underground obstructions (large trees, pipes, utilities, etc.), and whether or not some form of green infrastructure practice was already in place.

Educational value, visibility, and volunteer opportunities were also considered when determining the most beneficial locations and practices.


1- Deep River Public Library
CT-9
CT-154
5- Deep River Town Hall
4- Deep River Elementary
2- Valley Regional HS
CT-80
3- Winthrop Middle School
Stormwater Retrofits
Deep River, CT
Google Earth
N
2000 ft

# Deep River Town Library

156 Main St
Deep River, CT

**Notes:**

-Prominent location in town center, great educational opportunity

-Large area of impervious cover drains directly into waterbody

-Great location for showcase GSI practice

**-Total Potential Disconnect:**
15,333 sq. ft.

IMPERVIOUS COVER

Runoff from parking lot drains directly into river. Treatment at this location is of great ecological importance. Existing educational signage presents opportunity to incorporate into potential GSI practice. Town Butterfly Corridor Project can be considered when choosing plants for rain garden. *Percolation test recommended due to high ground water.*

Main St

Village St

Possible disconnect of 15,333 sq. ft. of impervious cover with use of rain garden. Sedimentation may be an issue here; sediment traps along with regular emptying reccomended with implementation of rain garden.

# Deep River Public Library

150 Main St

Overflow to Pond

Drainage Area
15,333 sq. ft.

Curb Cut

Rain Garden Opportunity

**Suggested Practice**

**Rain Garden**

- 1,273 sq. ft. @ 1' depth

- $5,088 - $20,352

**403,711 gal. runoff treated per year**

15 P 30.974

**Phosphorus Reduction .53 lb/year**

7 N 14.007

**Nitrogen Reduction 4.19 lb/year**

# Valley Reg. High School

256 Kelsey Hill Rd
Deep River, CT

**Notes:**

-High profile location with large area of impervious cover

-Excellent educational opportunity

-GSI practices will help with erosion issues in parking lot

**-Total Potential Disconnect:**
23,913 sq. ft.

IMPERVIOUS COVER

Possible disconnect of 19,035 sq. ft. of impervious cover with use of tree box filters. Excellent location at entrance and athletic field parking, high visibility and great educational opportunity. GSI practice can help with erosion issues seen in parking lot; gravel swales recommended to conduct runoff to tree box filters.

Possible disconnect of 4,878 sq. ft. of impervious cover with use of rain garden. High traffic location, great visibility and educational opportunities.

Falls Landing Rd

Kelsey Hill Rd

# Valley Regional High School

## Entrance Lot


**Suggested Practice**

**Rain Garden**

- 808 sq. ft. @ 6” depth

- $3,232 - $12,928

**128,435 gal. runoff treated per year**

15 P 30.974

**Phosphorus Reduction .17 lb/year**

7 N 14.007

**Nitrogen Reduction 1.33 lb/year**

# Valley Regional High School

Kelsey Rd Lot

Drainage Area 1
10,890 sq. ft.

Drainage Area 2
8,145 sq. ft.

Tree Box Filter Opportunity

Storm Drain

**Suggested Practice**

**Tree Box Filters**

- North: 6'x6'
- South: 6'x4'
- $6,000 - $36,000

**501,183 gal. runoff treated per year**

15 P 30.974

**Phosphorus Reduction .66 lb/year**

7 N 14.007

**Nitrogen Reduction 5.21 lb/year**

# Winthrop Middle School

1 Winthrop Rd
Deep River, CT

**Notes:**

-Large areas of impervious cover with various, simple retrofits

-Excellent educational opportunity

-Potential for additional GSI practices along entrance road

**-Total Potential Disconnect:**
24,872 sq. ft.

IMPERVIOUS COVER

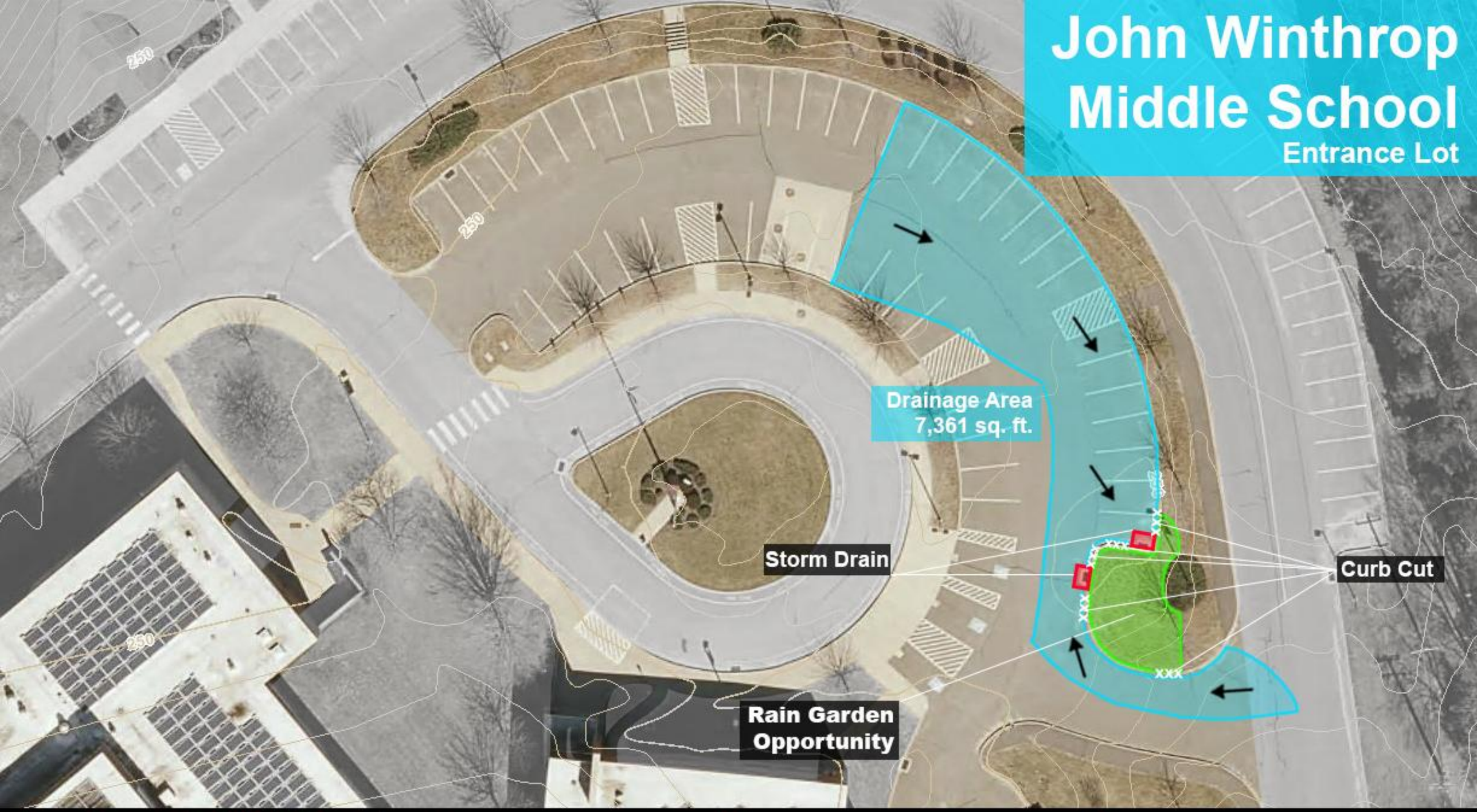
Possible disconnect of 7,361 sq. ft. of impervious cover with use of rain garden. Proximity to entrance provides excellent visibility and educational opportunities for students, faculty, and visitors.

Possible disconnect of 16,335 sq. ft. of impervious cover with swale retrofit. Existing conditions require little construction for implementation.

Possible disconnect of 1,176 sq. ft. of impervious cover with use of rain garden. Location has potential for highly aesthetic and engaging GSI practice. Consideration of existing tree roots is important during implementation.

# John Winthrop Middle School

## Entrance Lot




**Suggested Practice**

**Rain Garden**

- 815 sq. ft. @ 9” depth
- $3,260 - $13,040

**193,855 gal. runoff treated per year**

15 P 30.974

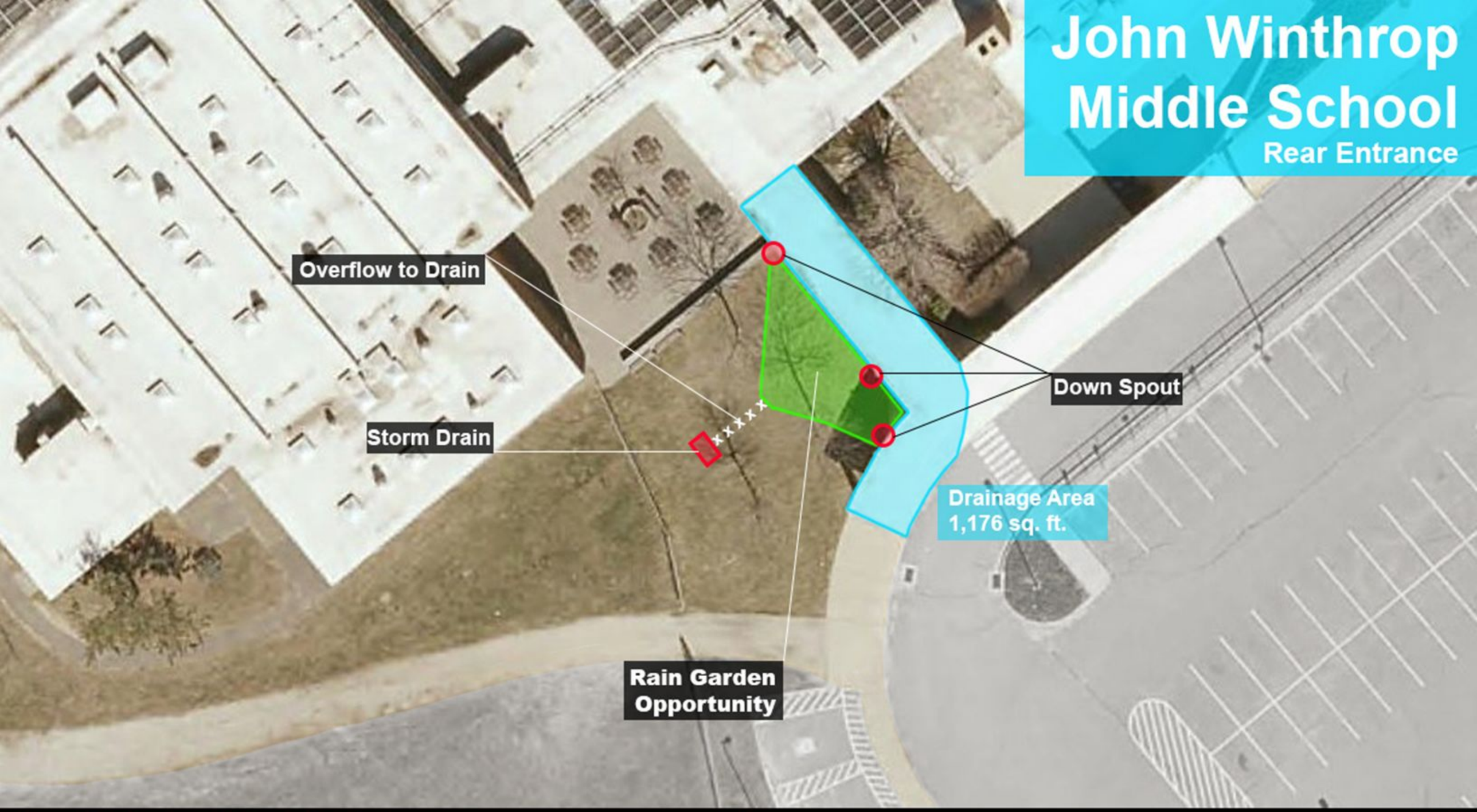
**Phosphorus Reduction .26 lb/year**

7 N 14.007

**Nitrogen Reduction 2.01 lb/year**

# John Winthrop Middle School

## Rear Entrance




**Suggested Practice**

**Rain Garden**

- 195 sq. ft. @ 6" depth

- $780 - $3,120

**30,917 gal. runoff treated per year**

15 P 30.974

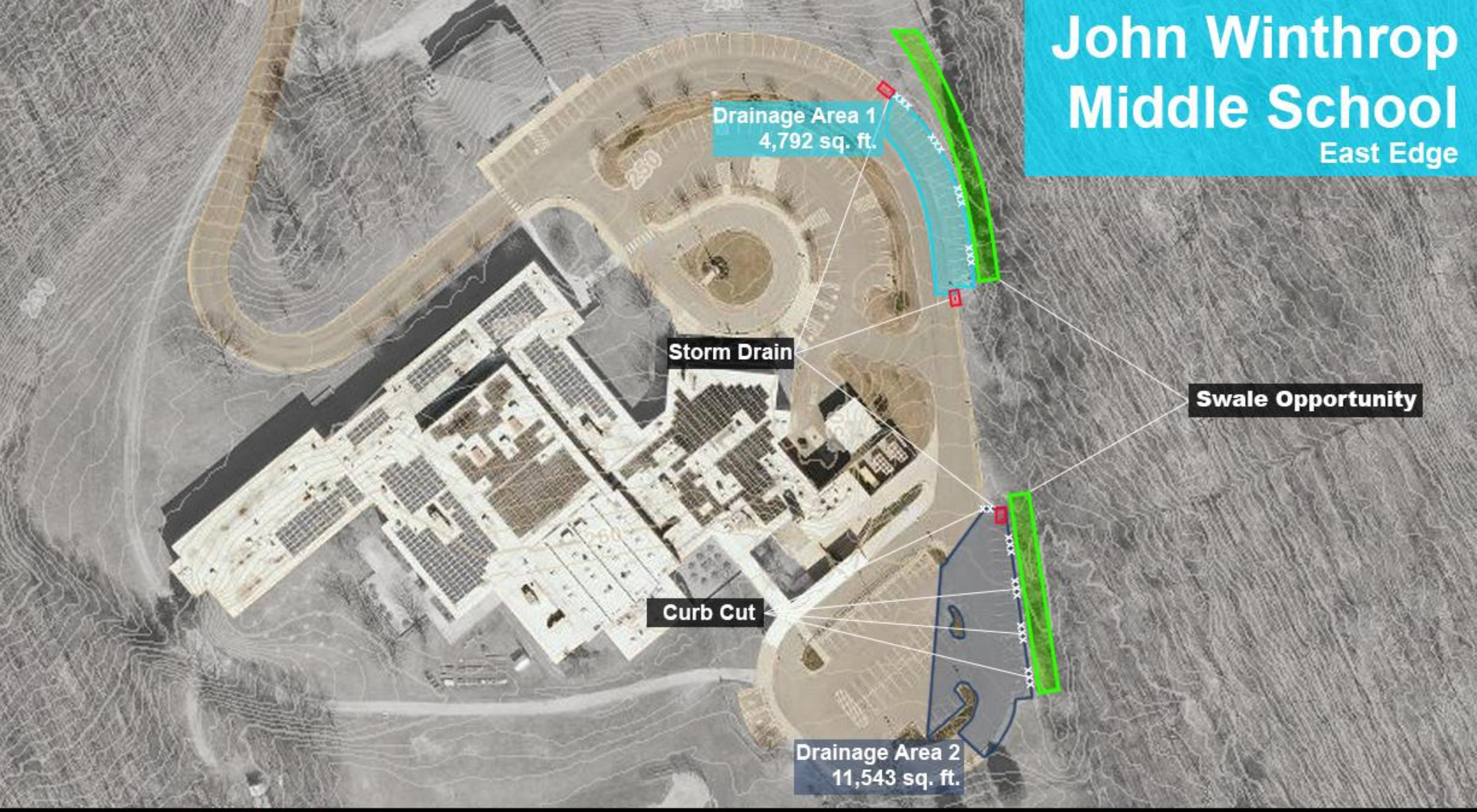
**Phosphorus Reduction .04 lb/year**

7 N 14.007

**Nitrogen Reduction .32 lb/year**

# John Winthrop Middle School

East Edge




**Suggested Practice**

**Grass Swale**

- N: 795 sq. ft. @ 6”
- S: 1,916 sq. ft. @ 6”
- $10,847 - $43,385

**430,152 gal. runoff treated per year**

15 P 30.974

**Phosphorus Reduction .57 lb/year**

7 N 14.007

**Nitrogen Reduction 4.47 lb/year**

# Deep River Elementary School

12 River St
Deep River, CT

**Notes:**

-High profile location, great visbility and educational opportunities

-Large area of impervious cover ideal for disconnect

-Low cost options may be implemented together

**-Total Potential Disconnect:**
14,156 sq. ft.

IMPERVIOUS COVER

Possible disconnect of 5,619 sq. ft. of impervious cover with use of rain garden. GSI practice in this location would add to the existing aesthetic of school entrance and provide excellent visibility and educational opportunities for students and the public.

Possible disconnect of 4,922 sq. ft. of impervious cover with the use of rain garden. Simple and cost effective retrofit opportunity with existing curbed garden and connected downspouts.

Possible disconnect of 3,615 sq. ft. of impervious cover with the use of rain garden. Enclosed courtyard within school is an ideal location to engage with students and faculty with an aesthetically pleasing GSI practice. Connected downspouts provide a simple and cost effective retrofit opportunity.

# Deep River Elementary

River St Entrance

Drainage Area 1
2,875 sq. ft.

Rain Garden Opportunity

Storm Drain

Curb Cut

Drainage Area 2
2,744 sq. ft.

**Suggested Practice**

**Rain Garden**

- 932 sq. ft. @ 6” depth
- N: 477 sq. ft. S: 455 sq. ft.
- $3,732 - $14,928

**147,972 gal. runoff treated per year**

15 P 30.974

**Phosphorus Reduction .2 lb/year**

7 N 14.007

**Nitrogen Reduction 1.54 lb/year**

# Deep River Elementary
## Courtyard

Downspout

Rain Garden Opportunity

Drainage Area
3,615 sq. ft.

**Suggested Practice**
**Rain Garden**
- 600 sq. ft. @ 6" depth

- $2,400 - $9,600

95,194 gal. runoff treated per year

15 P 30.974

Phosphorus Reduction .13 lb/year

7 N 14.007

Nitrogen Reduction .99 lb/year

# Deep River Elementary

Rear


**Suggested Practice**

**Rain Garden**

- 817 sq. ft. @ 6” depth

- $3,268 - $13,072

**129,612 gal. runoff treated per year**

15 P 30.974

**Phosphorus Reduction .17 lb/year**

7 N 14.007

**Nitrogen Reduction 1.35 lb/year**

# Deep River Town Hall

174 Main St
Deep River, CT

**Notes:**

-High profile location, with excellent existing landscaping

-Excellent educational opportunity

-Simple and cost effective retrofit

**-Total Potential Disconnect:**
958 sq. ft.

IMPERVIOUS COVER

Potential disconnect of 958 sq. ft. of impervious cover with the use of rain garden. Large area of roof ideal for disconnect with downspouts conducting runoff into city sewer system.

Elm St

Main St

Veterans Memorial Ln

Practice will add to the aesthetics of the site, providing excellent visibility and educational opportunities for GSI within the town of Deep River.

# Deep River Town Hall

174 Main St


**Suggested Practice**

**Rain Garden**

- 159 sq. ft. @ 6” depth
- $636 - $2,544

**25,227 gal. runoff treated per year**

15 P 30.974

**Phosphorus Reduction .03 lb/year**

7 N 14.007

**Nitrogen Reduction .26 lb/year**

# Site Recommendation Figures

| | | Total Disconnection (sq. ft) | Phosphorus Nutrient Reduction (lb P/yr) | Nitrogen Nutrient Reductions (lb N/yr) | Gallons Treated per Year | Estimated Cost |
|---|---|---|---|---|---|---|
| Deep River Public Library | Rain Garden Opportunity | 15,333 | 0.53 | 4.19 | 403,711 | $5,088-20,352 |
| Valley Regional Highschool | Entrance Lot | 4,878 | 0.17 | 1.33 | 128,435 | $3,232-12,928 |
| | Kelsey Lot Road | 19,035 | 0.66 | 5.21 | 501,183 | $6,000-36,000 |
| | **Totals For All** | **23,913** | **0.83** | **6.54** | **629,618** | **$9,232-48,928** |
| Winthrop Middle School | Entrance Lot | 7,361 | 0.26 | 2.01 | 193,855 | $3,260-13,040 |
| | Rear Entrance | 1,176 | 0.04 | 0.32 | 30,917 | $780-3,120 |
| | East Edge | 16,335 | 0.57 | 4.47 | 430,152 | $10,847-43,385 |
| | **Total for all** | **24,872** | **0.87** | **6.80** | **654,924** | |
| Deep River Elementary | River St. Entrance | 5,619 | 0.20 | 1.54 | 147,972 | $3,732-14,928 |
| | Courtyard | 3,615 | 0.13 | 0.99 | 95,194 | $2,400-9,600 |
| | Rear | 4,922 | 0.17 | 1.35 | 129,612 | $3,268-13,072 |
| | **Total for all** | **14,156** | **0.50** | **3.88** | **372,778** | **$9,400-37,600** |
| Deep River Town Hall | West Entrance | 958 | 0.03 | 0.26 | 25,227 | $636-2,544 |

# Sites Not Chosen for Stormwater Retrofits

- Deep River Sewage Treatment Plant: While there were some options to expand the swale running along the east edge of the property, the sites lack of educational opportunities and visibility kept it from being included in the top five.
- Deep River Town Landing: This site had a significant amount of runoff from the connecting neighborhoods; however, the lack of green space and necessity of the parking areas prevented any viable retrofits.
- Deep River Parks & Rec: This location collected all runoff from the parking area in two catch basins which were situated in such a way to hinder disconnection.
- Fountain Hill Cemetery: This site had limited impervious area so it wasn't a priority when looking for disconnection.
- Plattwood Park: There was the possibility for a small rain garden in the corner of the parking area; however, the disconnection was limited and the condition of the lot hindered any suitable practices.
- Deep River Town Garage: This location was already disconnected and gave little opportunity for visibility or educational opportunity.

# Contact & Partners

This project was funded by a grant from the Long Island Sound Futures Fund of the National Fish and Wildlife Foundation. It is a partnership of the University of Connecticut Center for Land Use Education and Research (CLEAR) and Rutgers University Water Resource Program, and is adapted from a process developed by the latter.

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Dave Dickson, UConn CLEAR, david.dickson@uconn.edu, 860-345-5228

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