COLLEGE OF AGRICULTURE, HEALTH AND NATURAL RESOURCES

Center for Land Use Education & Research

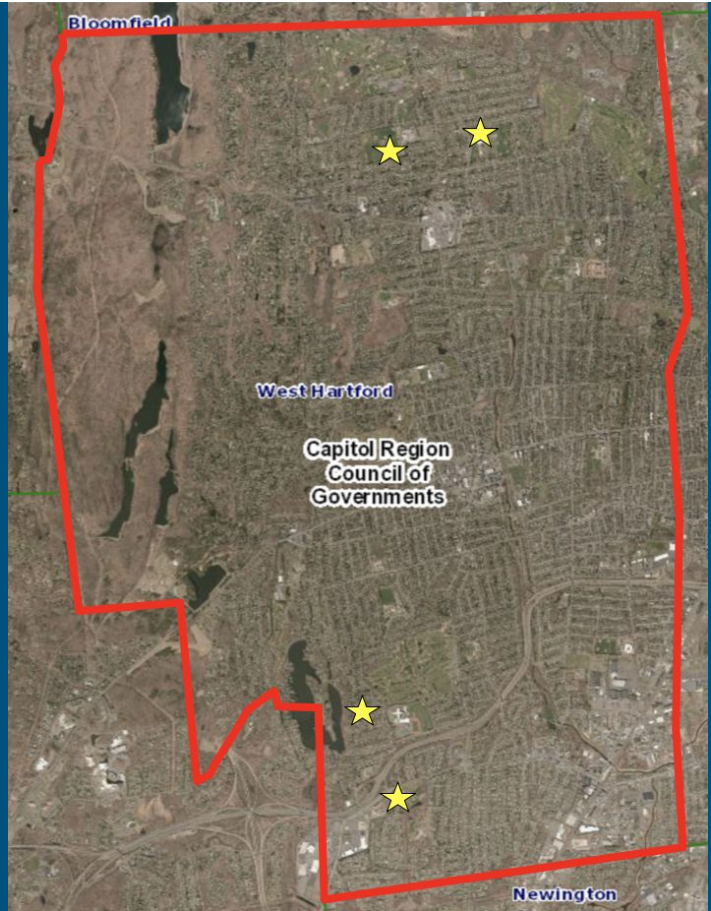
CLEAR

Low Impact Development Plan West Hartford, CT

Created by: Naomi Solares & Andrew Weitz - UConn Undergraduate Students, Environmental Sciences 2023

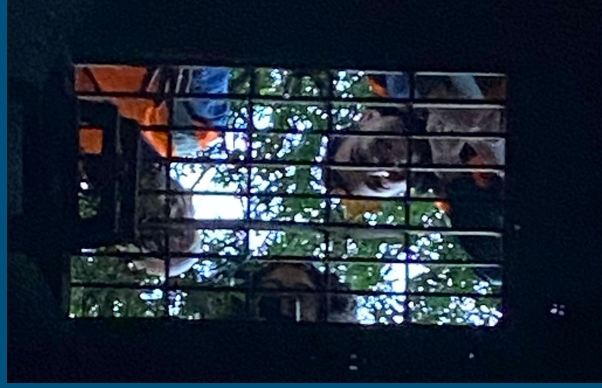
David Dickson, Michael Dietz, Mary Looney - UConn Center for Land Use Education and Research

UCONN



★ Site Locations

UConn Stormwater Corps



Who was involved in this project?

- Naomi Solares and Andrew Weitz- Undergraduate Environmental Science students
- UConn Extension faculty

What is the purpose of the stormwater corps?

- To help towns evaluate their stormwater management policies and suggest ways that LID/GSI can be more easily implemented
- Develop plans for LID/GSI practices that could be implemented to help West Hartford disconnect impervious surfaces
- To provide recommendations for improvements to land use regulations

GSI/LID Introduction

Impervious cover (IC) refers to any surface that is unable to infiltrate water such as concrete, asphalt, and heavily compacted ground.

The lack of infiltration leads to increased surface **runoff** which can introduce pollutants into local water bodies, increase sedimentation, erosion and flooding.

Increased runoff and localized flooding likely due to increased impervious cover.

Low Impact Development (LID) or **Green Stormwater Infrastructure (GSI)** helps reduce the amount of surface runoff by allowing water to infiltrate into the soil on site and mimicking natural infiltration.

On site infiltration prevents runoff, recharges groundwater and helps mitigate the adverse ecological effects of increased impervious cover.

Eutrophication due to increased surface runoff and increased nitrogen levels in water.

MS4 Permit Requirements

CT DEEP originally implemented regulations for the management of stormwater runoff in the form of the **Municipal Separate Storm Sewer Systems Permitting Program (MS4)** in 2004

- Permit focuses on **Directly Connected Impervious Area**, or any impervious surface which discharges stormwater directly into waters of the state, or to a municipal storm sewer system which eventually flows into waters of the state, such as lakes, streams, and the ocean
- Permit is designed to target **Nonpoint Source Pollution**, specifically pollution caused by the collection of pollutants as water flows over impervious surfaces.
- MS4 permit encourages the use of **Low Impact Development (LID)** through removal of LID barriers, encouraging LID priority during development and focusing on in situ water treatment.

Current DEEP MS4 Requirements - put into effect in 2017

- 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 area (DCIA) by 2022.
- Each year after that, they are required to disconnect 1%.

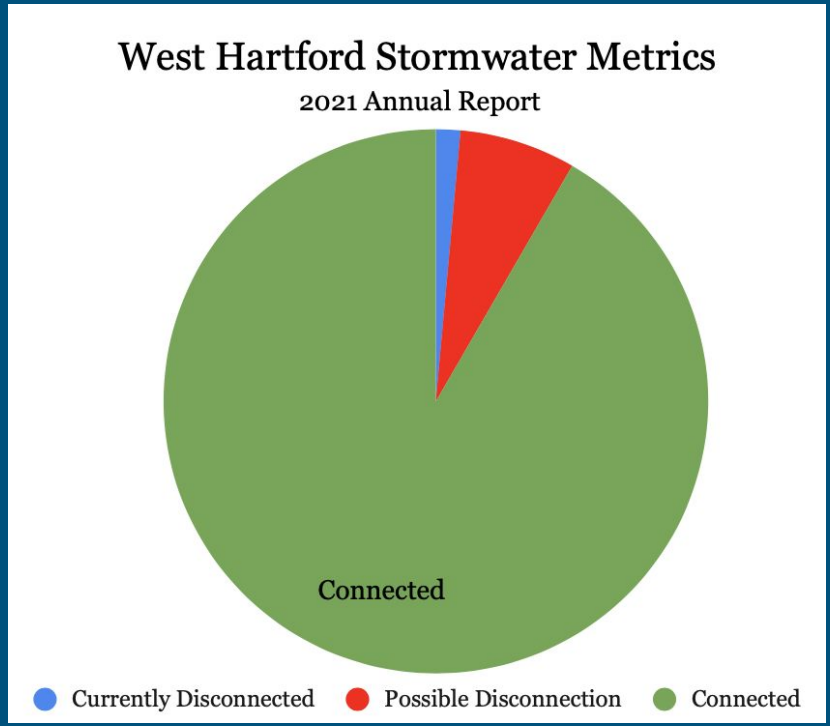
Green Stormwater Infrastructure in West Hartford

As of their 2021 Annual Report, West Hartford has disconnected 0.6 Acres of Directly Connected Impervious Surfaces out of a total of 2066 acres.

This equates to **0.03%** of the target **2%** goal.

If all of our suggested practices are implemented*, they would disconnect **124,303 square feet** or **2.85 acres**.

This would add **0.137%** towards their 2% goal



Possible disconnection assumes complete and correct implementation of suggested practices

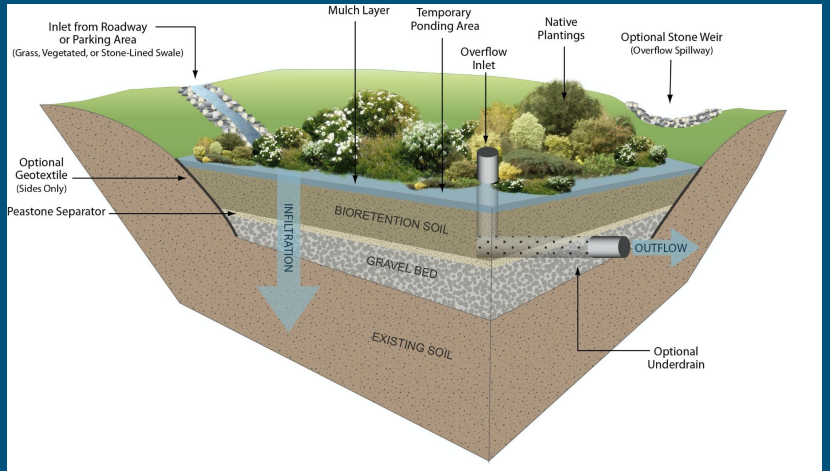
Rain Garden and Bioretention

Rain Garden

- Rain gardens consist of a depression at least 6 inches deep which may include native plants, grass, or stone designed to collect and infiltrate runoff
- Allows for infiltration while filtering out pollutants in the runoff
- Helps recharge groundwater and can be used as shelter and food by local wildlife

Bioretention

- Same principles as a rain garden but usually include special media, underdrains and overflow structures
- Usually to a larger scale



Rain Garden and Bioretention Maintenance

Initial Maintenance:

- Check soil infiltration before implementing project
- Water plants as necessary to help establish them
- Monthly inspection for weeds and invasives
- Check for erosion problems

Once the practice is established, the general maintenance includes

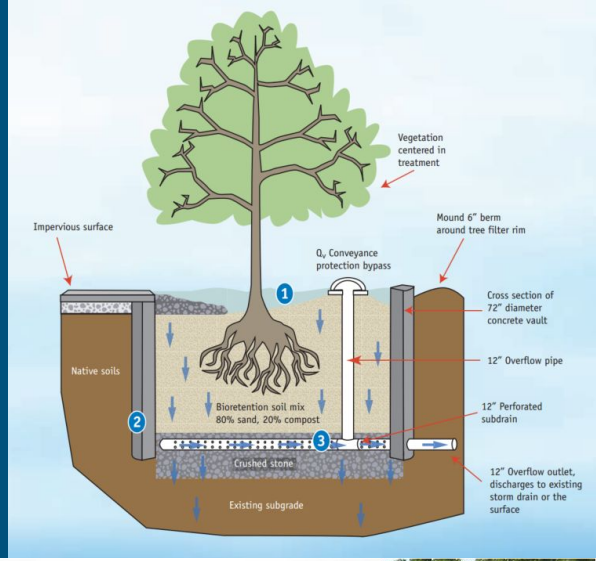
- Checking for invasives and weeds at least once a year, does not need to be monthly anymore
- For aesthetics - changing and maintaining plant shape and size
- Remulching annually if desired being careful not to over mulch
    - Over mulching will compromise the storage capacity of the garden

Fully installed rain garden with gravel path

Fully installed rain garden in use, demonstrates ponding of water.

Tree Box Filters

- Prefabricated bioretention in a box
  - Precast box filled with infiltration media and soil
  - The majority of the runoff will be absorbed by the tree
  - Includes overflow structures/ underdrains to allow for excess water to percolate into the ground
- Can infiltrate a lot of water without using a lot of above ground space
  - Can vary in size but they are preferable for tight spaces
- Maintenance:
  - Check tree health regularly
  - Check surface for debris to maintain infiltration capacity

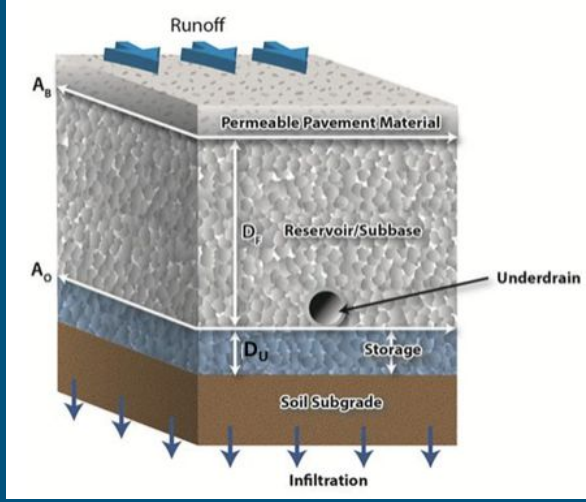


Rain Barrels and Rainwater Harvesting

- Runoff from downspouts is collected by connecting downspouts to rain barrels or cisterns
  - The size of the collection units will vary depending on the amount of runoff
- Water collected is often used for watering gardens, livestock, fire safety, domestic use, and long term storage
- The actual quantity of runoff disconnect varies depending on the manner and frequency of use
  - General formula for estimating disconnection is available

- Maintenance:
  - Use collected water regularly to allow for collection next rainfall event
  - Check gutters for debris to maintain maximum flow
  - Drain rain barrel in the winter to prevent freezing

Permeable/Pervious Pavement



- Pavement that allows for water to infiltrate into the ground by passing through the surface
  - Can also treat runoff from surrounding areas (up to a limit)
- Different Types:
  - Pervious concrete - durable in high traffic areas, cost competitive
  - Pervious asphalt - same installation as traditional asphalt, durable in high traffic areas
  - Pervious pavers - plastic and interlocking concrete, good for low traffic areas
- Various types allow for flexibility in different sites based on topography, use and cost

Maintenance:

- Maintenance of pervious systems is heavily dependent on weather conditions and the type of system implemented
  - Minimal salt required during the winter
  - No sand because it will clog the practice and reduce permeability
- Require pressure washing and vacuum sweeping to dislodge debris from pores to ensure proper infiltration

Practice Calculations

Sizing Measurements:

- **Drainage Area**: the size of the watershed estimated to drain into the practice. Delineated during site visits and the footage was measured using geospatial tools in CTEco and google maps.
- **Practice Sizing:** Practices were sized to infiltrate the volume of runoff generated by a 1” rainfall event based on the size of their drainage area.

Performance Measurements:

- **Nutrient Reductions**: nitrogen and phosphorus reductions were calculated using accepted nutrient export coefficients*.
- **Annual Gallons Treated**: Volume of runoff treated is based on the size of the drainage area for each practice and on CT’s average annual rainfall (4ft)

Site Evaluations & Selection

Initial Evaluation

- Town evaluation to identify attractive locations based on town ownership and community use
- Find sites that can use
- Geospatial evaluation using aerial imagery based on topography, amount of impervious cover, ongoing construction
    - Imagery from ArcGIS, CTEco, and Google Maps

On Site Evaluation

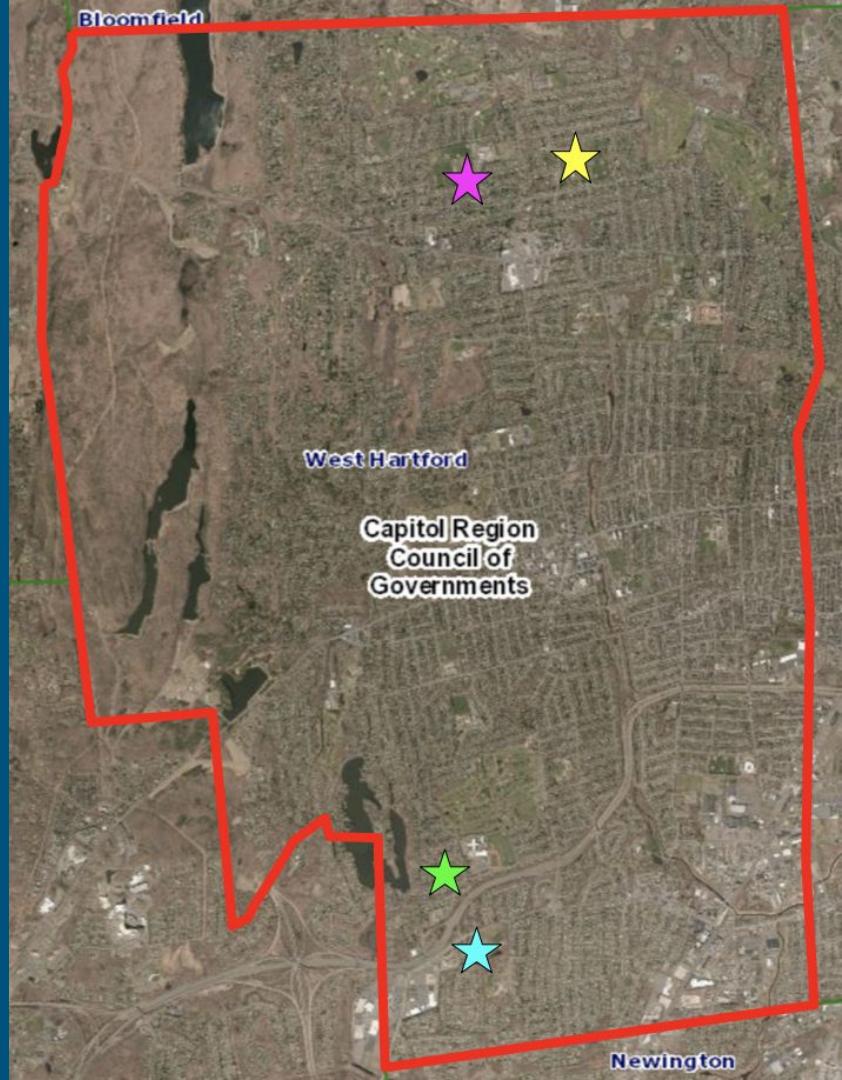
- Identify the location of storm drains, downspouts, nearby water bodies, existing GSI practices, possible obstructions
- Determine potential of the land based on slope, direction of runoff flow, format of current built environment
- Assess actual potential based educational resources, practice visibility and accessibility to the community

Practice Introduction

We identified 4 different locations for possible practices in the town of West Hartford and are suggesting a total of 11 practices:

- William H. Hall High School - 5 practices
- King Philip Middle School - 1 practice
- Frederick U. Conard High School - 3 practices
- Wolcott Park - 2 practices

Combined, all of the suggested practices would disconnect **124,303 square feet** or **2.85 acres**.



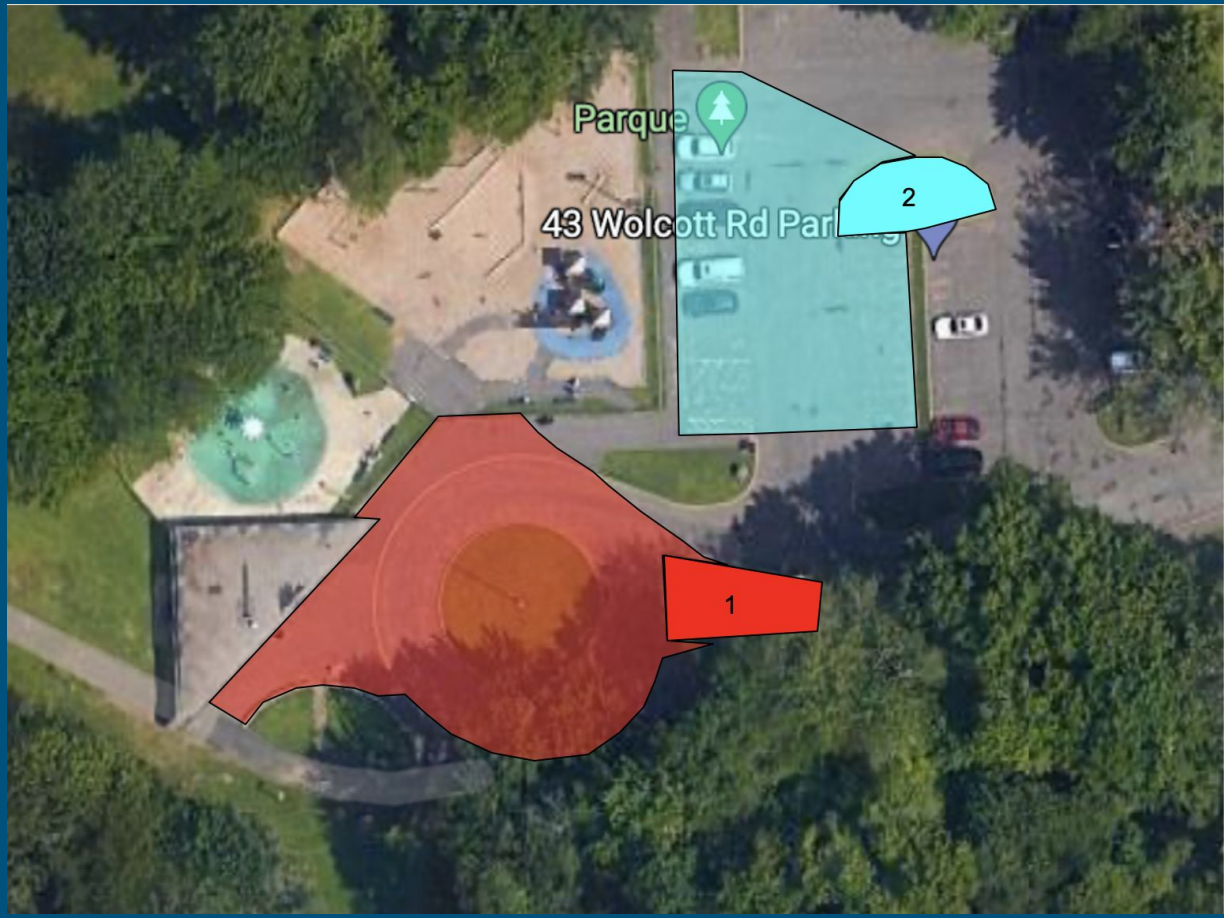
Wolcott Park

At this site, we identified 2 potential locations and decided that the best practices to include would be 2 bioretention areas.

Practice 1 would disconnect the entirety of the roundabout near the entrance of the park.

Practice 2 would disconnect a portion of the parking lot next to the playground of the park.

If both practices are implemented, they would disconnect a total of **11,370 square feet**.



Wolcott Park - Bioretention 1

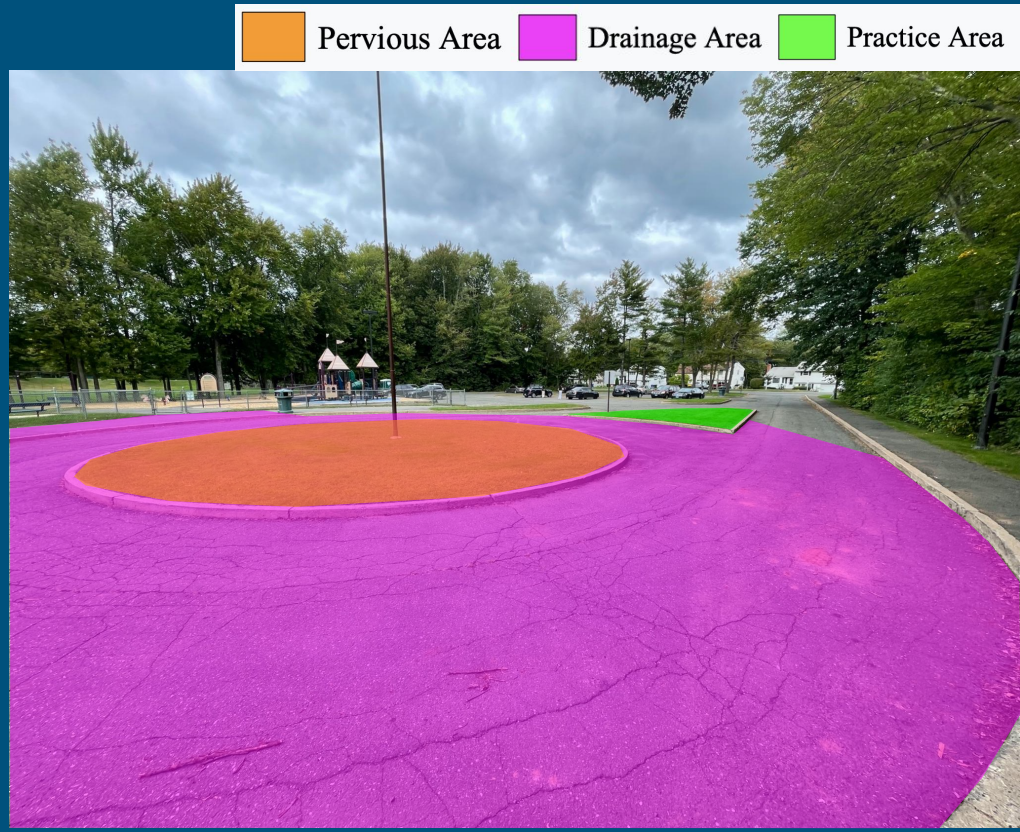
Suggested Practice: Bioretention Area

Benefits

- Proximity to school and neighborhood creates educational opportunities to educate public about GSI and stormwater
- Proximity to waterbody makes this location higher priority - might help reduce eutrophication at nearby pond

General Notes:

- Check soil infiltration before implementing project to ensure proper infiltration capacity
- Since the garden is 9”, installing a 1 foot fence could help discourage pedestrians and reduce accidents

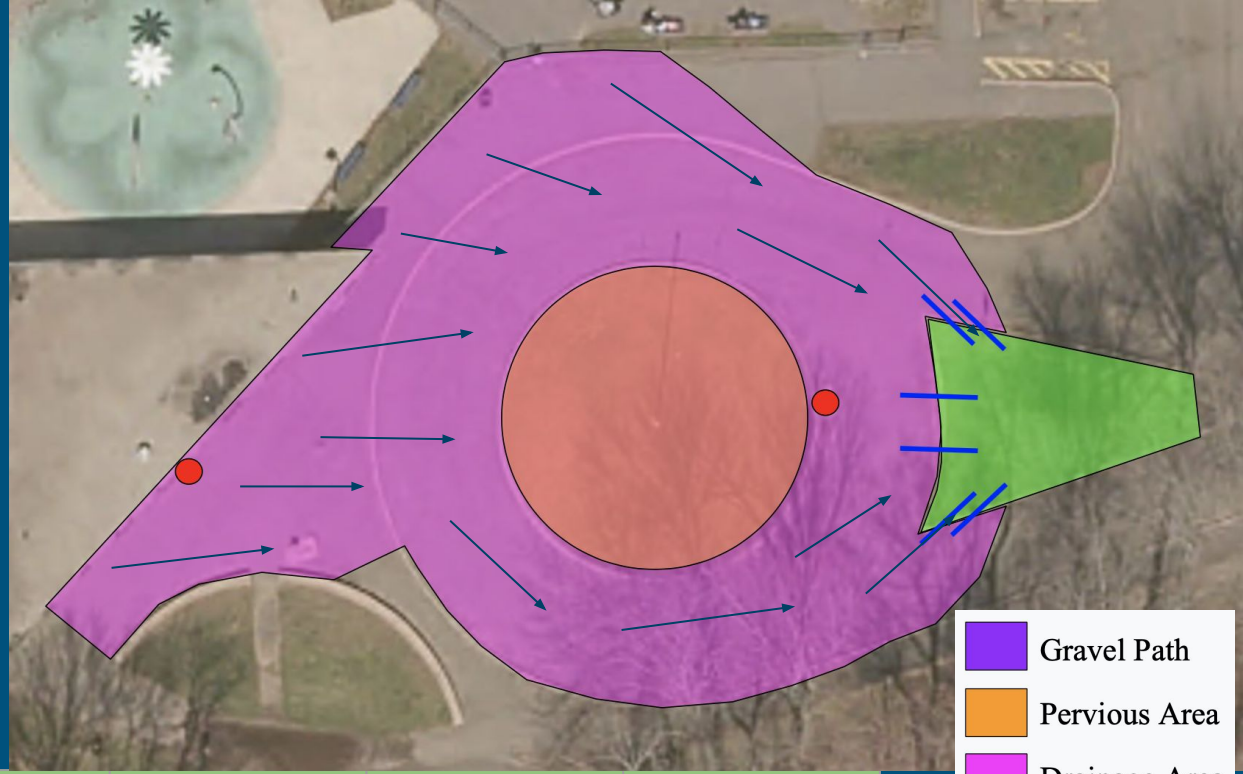


Wolcott Park Ground Image - roundabout to be disconnected by Bioretention 1

Wolcott Park - Bioretention 1

Maintenance:

- Check for erosion problems since the practice is on a slight hill
- Once established - check for invasives and weeds and re-mulch annually



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) - 9" depth
6,065	Bioretention	24,260	1.66	0.2105	674

Wolcott Park - Bioretention 2

Suggested Practice: Bioretention Area

Benefits

- The parking lot might be redone soon which would be a good opportunity to install GSI
- Proximity to school and neighborhood creates educational opportunities to educate public about GSI and stormwater
- Location within the parking lot helps to partially disconnect large impervious area

Wolcott Park Ground Image - Parking lot to be partially treated by bioretention 2

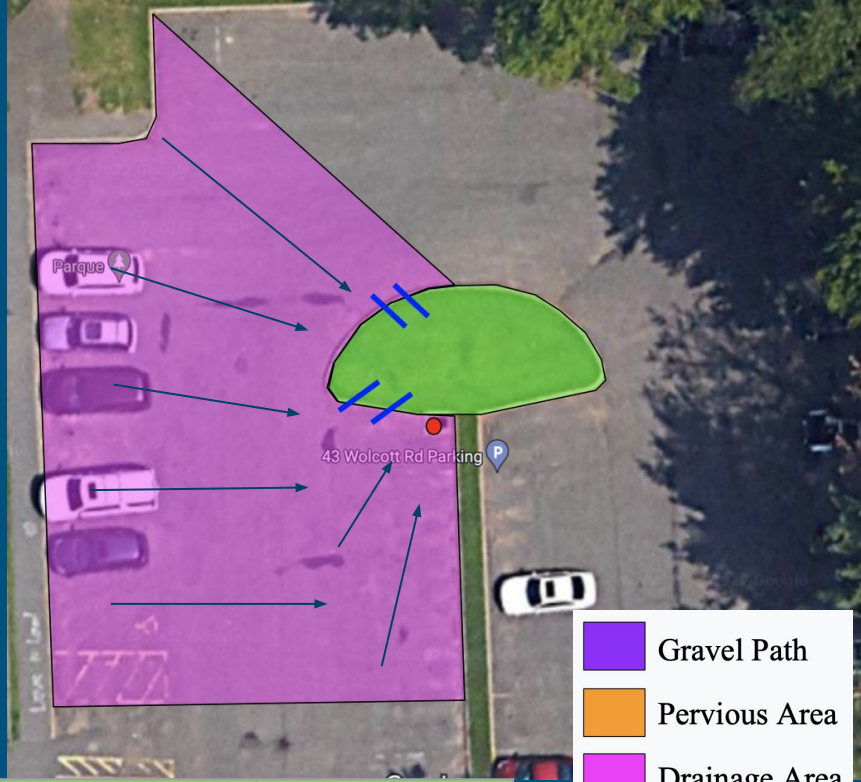
Wolcott Park - Bioretention 2

Maintenance:

- Check for invasives and weeds and re-mulch annually

General Notes:

- Snow being placed in the garden during the winter would require the use of appropriate plants
- Check soil infiltration before implementing project to ensure proper infiltration capacity



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) - 9" depth
5,305	Bioretention	139,697	1.45	0.18	589

Conard High School

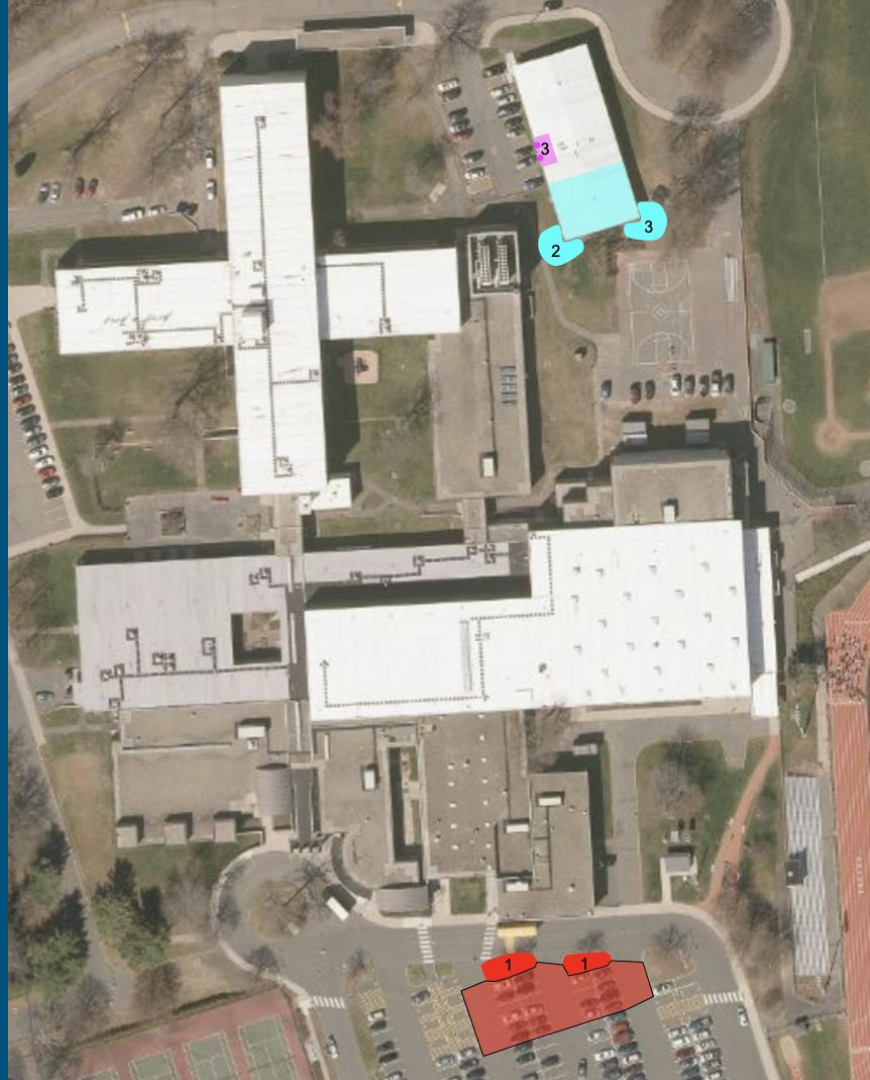
For this site, we identified 3 potential locations with a total of 6 practices.

At location 1, the suggested 2 tree box filters would disconnect a portion of the parking lot at the front of the school.

At location 2, the suggested rain gardens would disconnect ⅓ of the rooftop of the Reach Program building.

At location 3, 2 rain barrels would collect the runoff from 200 square feet of the Reach Program Building.

In total these practices would disconnect a total of **12,091 square feet.**



Conard High School - Location 1

Suggested Practice: 6x12 Tree Box Filters (2x)
Benefits:

- High visibility at the front of the school
- Close proximity to the Green Energy Community Lab adds a resource for students interested in environmental sciences
- Stumps in the parking lot islands signal recently lost trees - this would restore the trees with added stormwater function

General Notes:

- Check soil infiltration before implementing project
- Potential utilities underground (parking lot lights shown in image)
- Might be a great opportunity to use curbless islands instead of curb cuts. It would allow more runoff to enter the tree boxes

Conard High School Ground Images - grassed areas that can become tree box filters and help disconnect portion of the parking lot

Conard High School - Location 1

The suggested 65 square feet of practice are the amount of box filter footage needed to treat this area of the parking lot.

The “actual size” refers to the highlighted green areas, where the filters would be located. The tree boxes would not take up the entire island.

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)	Actual Practice Size
7,585	Tree Box Filters	199,737	2.07	0.26	65.9	144

Conard High School - Location 2

Suggested Practice: 2 rain gardens outside of the REACH Program Building

Benefits:

- Aesthetic benefit of gardens
- Gardens can also attract pollinators that will benefit the student gardens
- Educational opportunity for students and the general public due to its proximity to the sports fields
- Gardens combined would disconnect ⅓ of the building's roof

Conard High School Ground Image, Reach Program Building - rain garden number one

Conard High School - Location 2

General Notes:

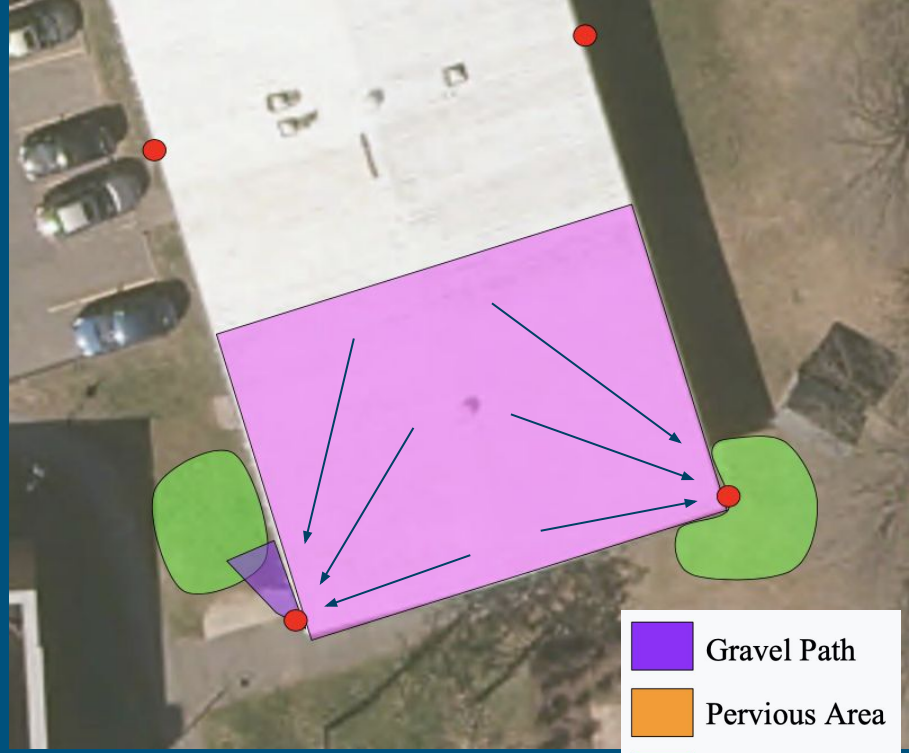
- The garden on this side will have to be between 3 different walking paths (the exit to the building, the main sidewalk and one not shown).
- Imaging shows that there is enough room for the practice to be the correct size without impacting the walkways.

Conard High School Ground Image, Reach Program Building - rain garden number two

Conard High School - Location 2

General Notes:

- Check soil infiltration before implementing project to ensure proper infiltration capacity
- Consideration has to be given to any possible utilities surrounding the building
- Garden should be placed in locations that will not inhibit regular lawn maintenance



Values in the table represent both rain gardens combined

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) - 6" depth
4,294	Rain Gardens	86,741	0.90	0.11	549

Conard High School - Location 3

Suggested Practice: Two 60 gallon rain barrels outside of the REACH Program Building

Benefits:

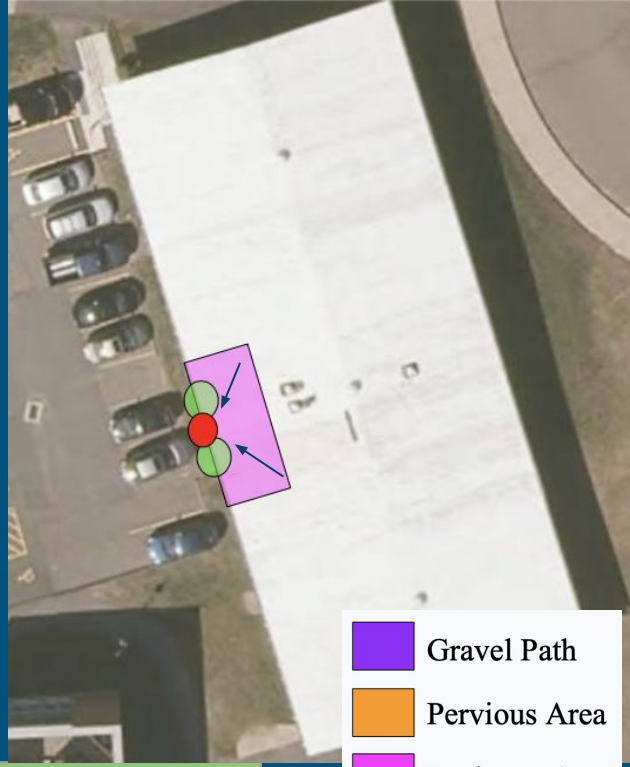
- Ability to add more if you would like to treat more area, allows for flexibility based on use
- Educational opportunity for introducing students to rainwater harvesting. There were raised garden beds in the area that the barrels could be used to water
- Due to the symmetry of the building, there are two possible locations on either side of the building that could accommodate rain barrels

Conard High School Ground Image - Reach Program Building Side View

Conard High School - Location 3

Maintenance:

- Making sure the rainwater in the barrels is in use in order to maximize the amount of runoff collected
- Regular gutter maintenance to maintain waterflow
- Draining and disconnecting barrels in the winter is recommended to avoid freezing



Area treated by barrels (sq. ft)	Suggested green infrastructure	Annual gallons treated	Annual nitrogen reduction (lb N/yr)	Annual phosphorus reduction (lb P/yr)
212	Rain Barrels	6,344	0.06	0.01

William H. Hall High School

For this site, we identified 3 potential locations with 5 potential practices.

At location 1, the suggested practices include a mix of rain gardens and permeable pavement that will treat the majority of the school parking lot.

At location 2, the suggested rain garden will treat a portion of the road next to the school parking lot.

At location 3, the suggested rain garden will treat a portion of the main school entrance.

In total, these practices would disconnect a total of **97,355 square feet.**

William H. Hall High School Parking Lot Summary

General notes:

- Largest impervious area out of all of our practices
- High visibility since location is between the school and the sports fields
- Good educational opportunity via signs

William H. Hall High School Parking Lot 1

Recommendation:

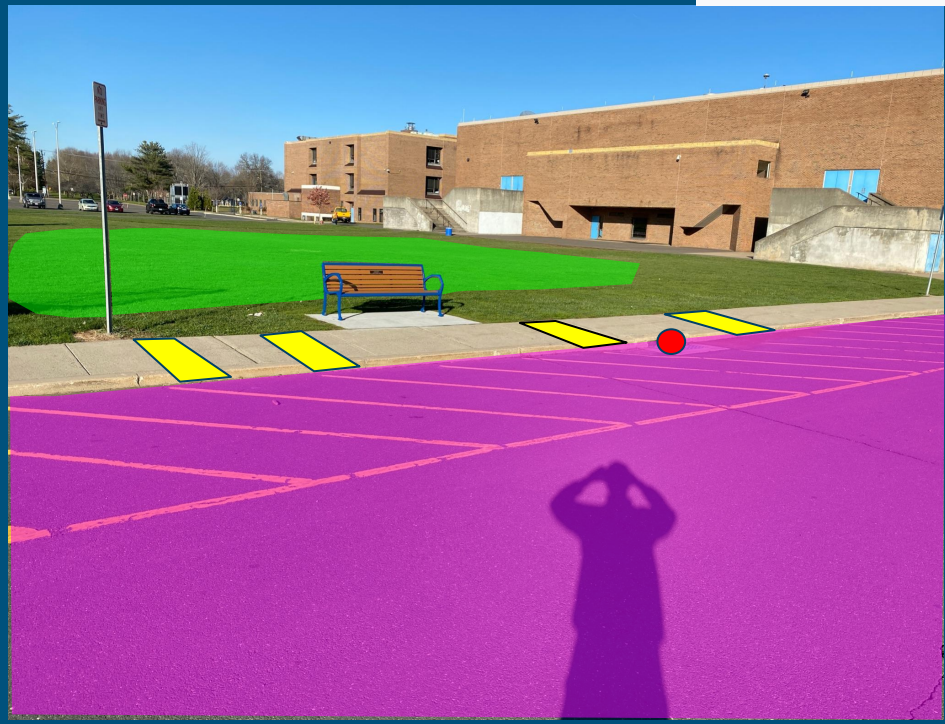
- 8,000 sq. ft. rain garden in the grass area next to the parking lot

Benefits:

- Largest opportunity available at almost 47,000 sq ft
- Educational opportunity since it goes between the school and fields
- Existing drain can be used as an overflow structure

General notes:

- Check soil infiltration before implementing project to ensure proper infiltration capacity
- Consideration has to be given to any possible utilities underground
- Would require trench drains to allow water to reach the practice without disturbing the sidewalk



William H. Hall High School Parking Lot 1

Maintenance:

- Re-mulch annually and check for invasives and weeds
- Regular cleaning of trench drains to maintain permeability is recommended. Should be cleaned out at least once a year

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) - 6" depth
47,000	Bioretention	1,237,657	12.85	1.63	8,000

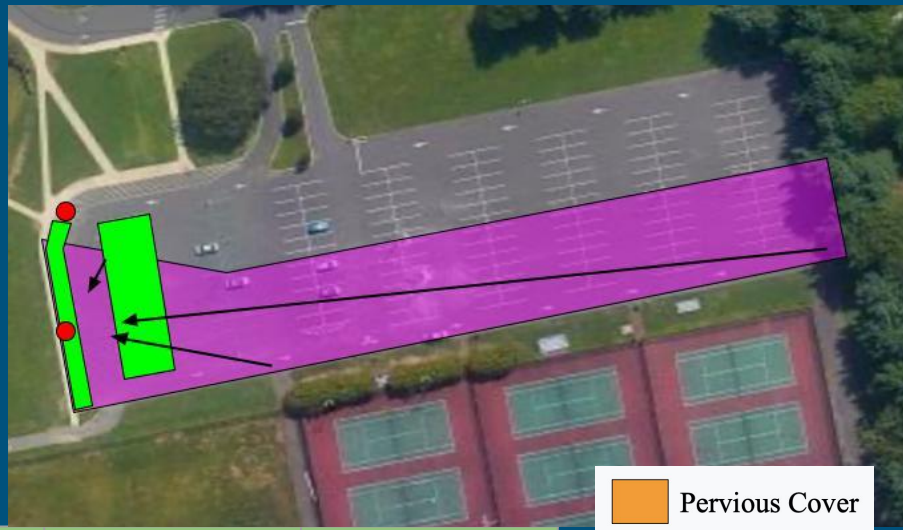
William H. Hall High School Parking Lot 1 Alternative

Benefits:

- A good way to show the town that permeable pavement can work
- Largest opportunity available at 47,000 sq.ft

Maintenance:

- Vacuum sweeper 2 times per year
- Leave driving lanes as regular asphalt
- Plowing snow to other end of the lot
- Applying salt increases the amount of vacuuming needed



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)
47,000	Permeable Pavement	1,237,657	N/A	N/A	8,000

William H. Hall High School Parking Lot 2

Suggested practice: Two Rain Gardens

- One rain garden in the square grass
- One rain garden in the triangle grass

Benefits:

- High visibility due to high foot traffic
- Will aid in a full disconnection of the parking lot

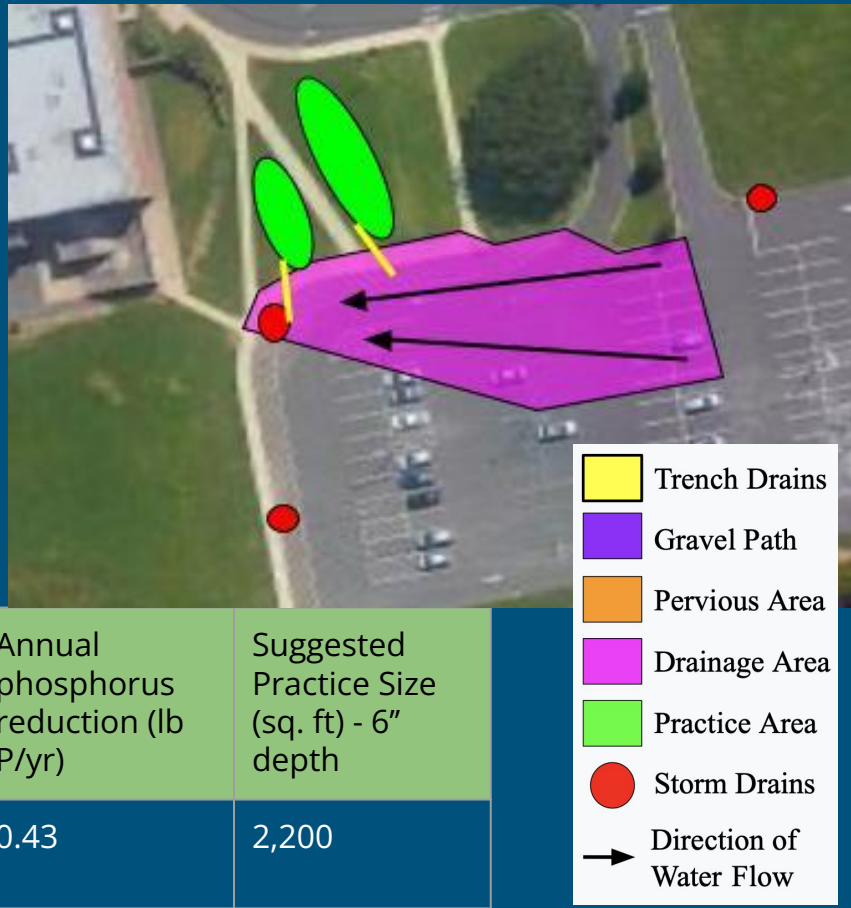
Maintenance:

- Re-mulch annually and check for invasives and weeds
- Regular cleaning of trench drains
- Check for underground utilities before digging

William H. Hall High School Parking Lot 2

General Notes:

- Check soil infiltration before implementing project
- Consideration must be given to possible utilities under the larger portion of grass. Visible lights indicate electrical wiring
- Trench drains would be needed to allow water to reach the practice without disturbing the sidewalk



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) - 6” depth
12,500	Bioretention	329,164	3.42	0.43	2,200

William H. Hall High School Parking Lot 3

Suggested Practice:

- One 3,800 sq. ft. rain garden
- Located on the side that is closer to the parking lot exit

Benefits:

- High car traffic and visibility because it is one of the main exits to the parking lot
- Would aid in disconnecting the entirety of the parking lot

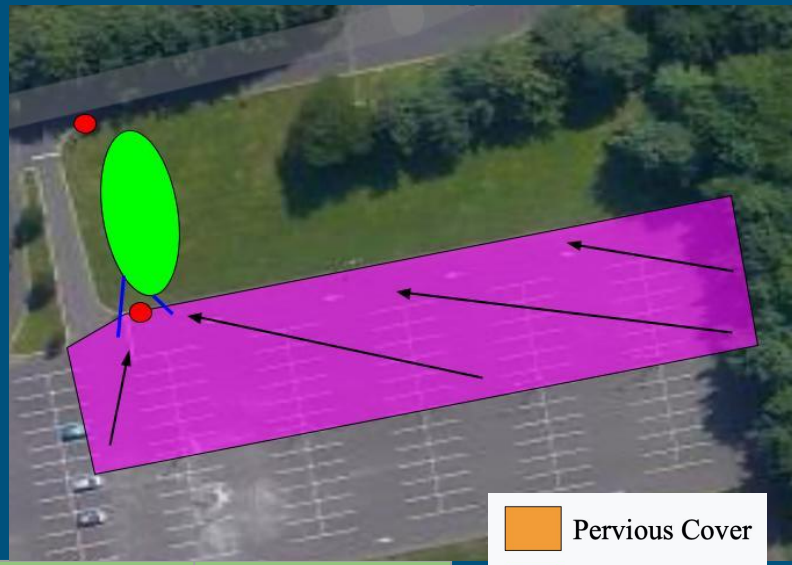
William H. Hall High School Parking Lot 3

Maintenance:

- Re-mulch annually and check for invasives and weeds

General Notes:

- Check soil infiltration before implementing project to ensure proper infiltration capacity

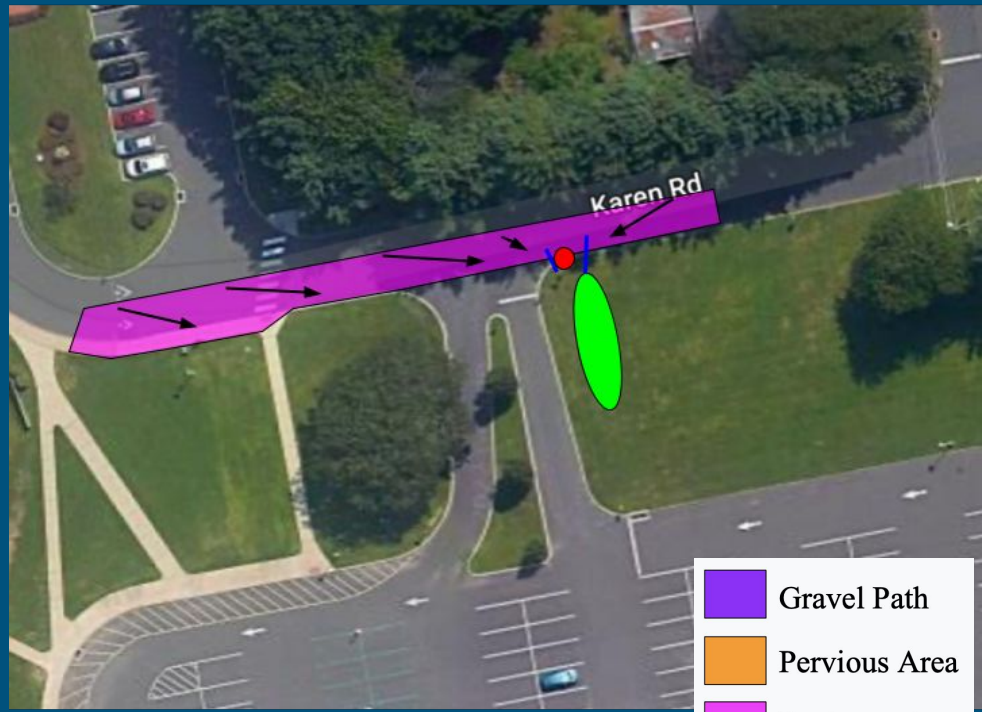


Drainage area (sq. ft)	Suggested green infrastructure	Annual gallons treated	Annual nitrogen reduction (lb N/yr)	Annual phosphorus reduction (lb P/yr)	Suggested Practice Size (sq. ft)
22,500	Bioretention	592,495	6.15	0.78	3,800

Karen Road

General Notes:

- This bioretention could be combined with practice 3 of the parking lot
- If combined, garden size required is 4,425 square feet
- Consideration must be given to any underground utilities



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)
3,690	Bioretention	97,169	1.01	0.13	625

William H. Hall Main Entrance

Suggested Practice:

- One 2,000 sq. ft. rain garden that surrounds the current garden
- The 2,000 sq. ft. must be in addition to the original garden

Benefits:

- A main entrance attraction
- Educational opportunity

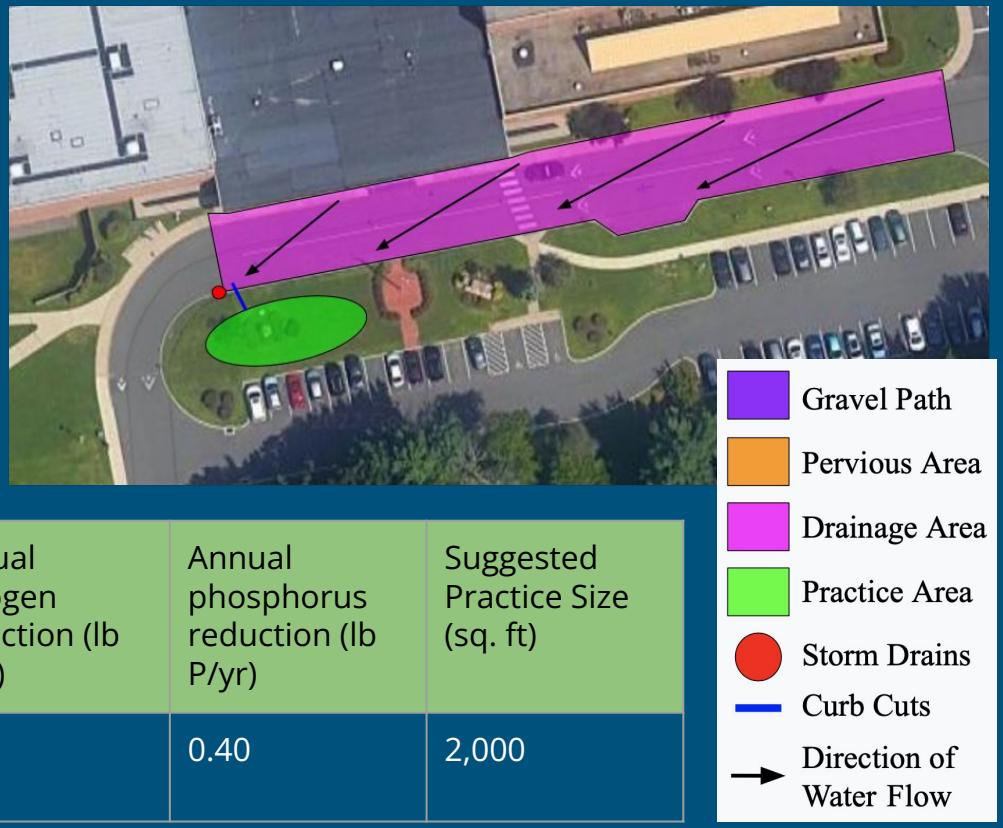
William H. Hall Main Entrance

Maintenance:

- Re-mulch annually and check for invasives and weeds

General Notes:

- Check soil infiltration before implementing project to ensure proper infiltration capacity
- Check for underground utilities



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)
11,665	Bioretention	307,176	3.19	0.40	2,000

King Philip Middle School

Suggested Practice:

- 600 sq. ft. rain garden on the right side of the middle school sign

Benefits:

- Best visibility at the school because parents and children drive past it daily
- Good educational opportunity for the students and nearby neighborhood
- Can be a nice addition to the school sign

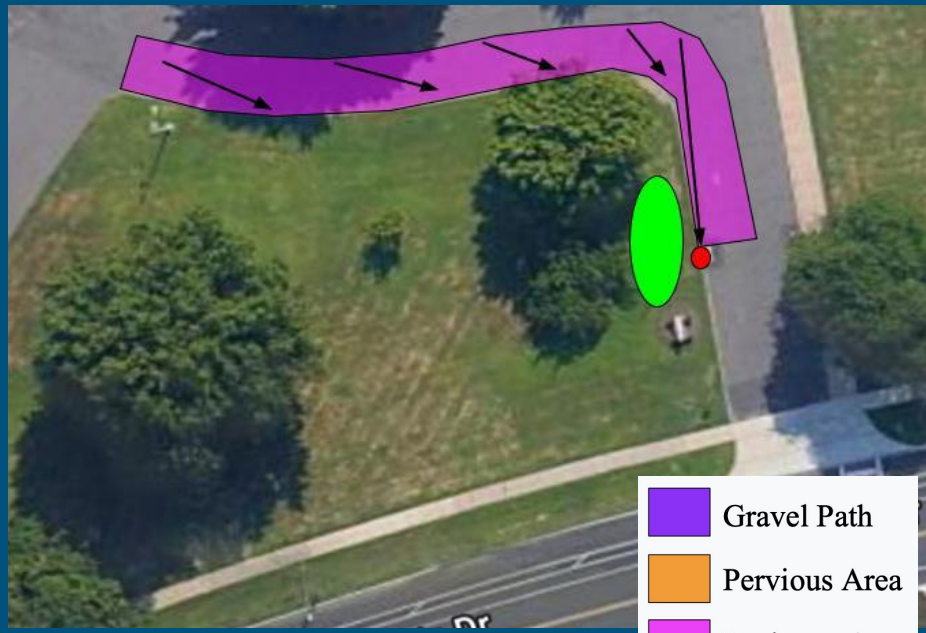
King Philip Middle School

Maintenance:

- Re-mulch annually and check for invasives and weeds

General Notes:

- Check soil infiltration before implementing project to ensure proper infiltration capacity



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)
3,487	Bioretention	91,824	0.95	0.12	600

Sites Not Chosen for Retrofits

Arapahoe Road Parking Lot*

The stormwater drains were located in the center of the parking lot and there was minimal green space. Any retrofit would've required total or partial reconstruction of the lot.

*The parking lot across from the post office, on the intersection of Arapahoe Rd and LaSalle Rd

Bugbee Elementary School Front Entrance

Due to the direction of the waterflow, it would have been impossible to use the grassed area in the roundabout to properly disconnect the road around it. The water mostly flowed away from the middle of the roundabout. Also, the storm drains in the parking lot were located in the middle of the lot, making it difficult to disconnect without a full retrofit.

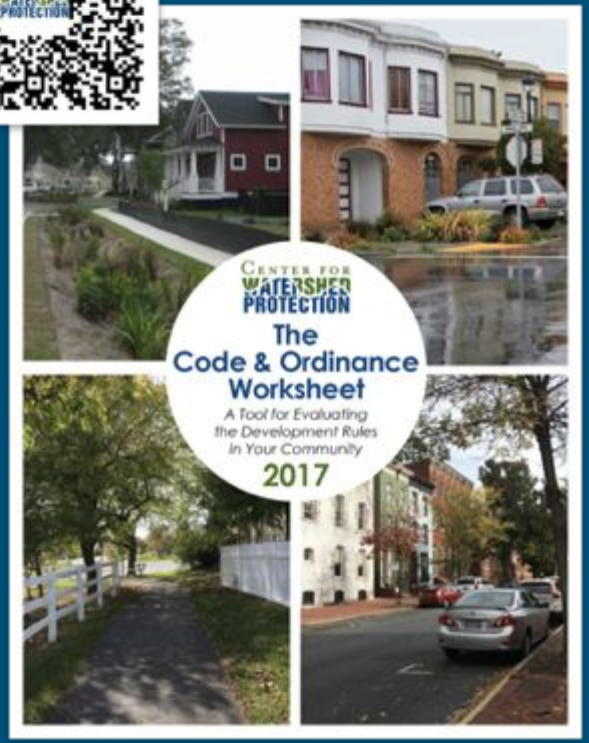
Final Figures

Site	Drainage area (sq. ft)	Suggested green infrastructure	Annual gallons treated	Annual nitrogen reduction (lb N/yr)	Annual phosphorus reduction (lb P/yr)	Practice Size (sq. ft)
Wolcott 1	6,065	Bioretention	24,260	1.66	0.2105	674
Wolcott 2	5,305	Bioretention	139,697	1.45	0.18	589
Connard 1	7,585	Tree box Filters	199,737	2.07	0.26	65.9
Conard 2	4,294	Rain Gardens	86,741	0.9	0.11	549
Conard 3	212	Rain Barrels	6,344	0.06	0.01	N/A
Hall 1	47,000	Bioretention	1,237,657	12.85	1.63	8,000
Hall 2	12,500	Bioretention	329,164	3.42	0.43	2,200
Hall 3	22,500	Bioretention	592,495	6.15	0.78	3,800
Karen Road	3,690	Bioretention	97,169	1.01	0.13	625
Hall 4 (Entrance)	11,665	Bioretention	307,176	3.19	0.4	2,000
King Philip 1	3,487	Bioretention	91,824	0.95	0.12	600
Totals	**124,303**		**3,112,264**	**33.71**	**4.2605**	**19,102.9**

Codes & Ordinances Review

Used Code and Ordinances Worksheet (COW)

- Developed by Center for Watershed Protection (CWP) with input from panel of national experts
- **94** recommended policies designed to:
  - Reduce impervious cover
  - Conserve open space
  - Prevent stormwater pollution
- 4 versions: ultra-urban, urban, suburban, rural
- Typical scores in the 30-40% range (always room for improvement)
- Helps to meet MS4 requirement to remove barriers to LID/GSI
- Documents reviewed:
  - Chapter A184 Subdivision Regulations
  - Chapter 177 Zoning Regulations
  - Inland Wetland and Watercourses Regulations



https://cwp.org/updated-code-ordinance-worksheet-improving-local-development-regulations/

Review of Codes and Ordinances

Strengths

- Cul De Sac, parking, and street requirements had LID dimensions that help lower the amount of impervious area.
- Clear requirements regarding open space - required to designate open space and identify an entity that is in charge of maintaining said open space.
- Requiring that a portion of runoff be treated on site is a great regulation to have. Sets the foundation for future requiring LID/GSI practices and helps preserve the local environment.

Areas to Improve

- Make the town beautiful and environmentally friendly by either encouraging or requiring LID practices in public projects such as new construction and parking lot renovations.
- Better protect your waterways by updating ordinances to require vegetated buffers around waterways that can absorb pollutants.
- Cul de sac ordinances could be improved if rain gardens were required in the middle instead of general landscaping.

Review of Codes and Ordinances

Conclusion

- The ordinances provide good fundamentals to build on and create opportunities for GSI to be encouraged and required in the future.
- There is work to be done in terms of open lot development and conservation of natural areas.
- Compiling all Low Impact Development regulations into one section would help with accessibility and clarity
- The final report will include the full account of the review.

Section of COW	Points Scored
Residential Streets and Parking Lots	12 out of 28 points
Lot Development	14 out of 45 points
Conservation of Natural Areas	9.5 out of 32 points
Runoff Reduction	6 out of 21 points
Final Score	**41.5 out of 126 points (33%)**

Contact & Partners

This project is part of UConn's E-Corps program. An effort, funded through a grant from the National Science Foundation, to provide students with real world, professional experience while addressing local capacity needs on environmental projects.

Contacts:
Naomi Solares, UConn Environmental Sciences, naomisolares26@gmail.com, 475-419-5496
Andrew Weitz, UConn Environmental Sciences, abweitz1@gmail.com, 203-249-5467
Mike Dietz, UConn CLEAR, michael.dietz.@uconn.edu, 860-486-2436
Dave Dickson, UConn CLEAR, david.dickson@uconn.edu, 860-345-4511

UCONN

CLEAR