Ulster County 2021 Climate Smart Communities Recertification Documentation

PE7 Action: Green Infrastructure

7 POINTS DOCUMENTED

Background: Ulster County continues to complete ongoing staff training and planning for green infrastructure and has also implemented several green infrastructure (GI) projects on County properties, which serve to effectively manage stormwater onsite. Benefits include reductions in impervious surface area, reductions in flooding and in runoff pollution during rain events, and the multitude of benefits associated with the beautiful native plantings in the gardens and bioretention areas including the aesthetics; the creation of pollinator habits; and enhanced and more accessible public spaces. These GI strategies also help to keep water from entering the municipal sewage system during rain events, resulting in less untreated wastewater being discharged via combined sewer overflows – CSOs – to local water bodies during storm events, which can occur in those urban areas with combined sewer systems.

Ulster County partnered with the Hudson Valley Regional Council via a NYSDEC-funded program to complete GI plans for several County-owned sites, and has since installed several of them: the small rain garden at Department of the Environment, the bioretention areas adjacent to the County of Building complex's parking lots, as well as other GI practices included at the SUNY ulster satellite campus including pervious parking lot pavement and a green wall. Summary information of these projects is included below, and full documentation is included for the Pearl Street rain garden and for the pervious pavement at Kingston Center of SUNY New Paltz.

- Pervious Pavement– STRIVE Project at Kingston Center of SUNY New Paltz**:** Pervious means "allowing water to pass through." Pervious pavement allows stormwater to pass through the surface, reducing flooding and runoff, capturing pollutants, and filtering water. At Kingston Center of SUNY Ulster (KCSU), 12,000 sq. ft. of porous asphalt was installed. Porous asphalt often looks just like regular blacktop …until it rains! The picture(*) included shows pervious and impervious pavement at KCSU. It is clear that water is pooling on the impervious pavement while pervious pavement allows water to infiltrate.

- Green Walls– STRIVE Project at Kingston Center of SUNY New Paltz**:** Green walls are walls that are made of living plants. Green walls absorb heat from the sun, naturally cooling buildings, clean the air, and absorb rain water. KCSU uses a green wall to conceal a maintenance area, creating a more visually pleasing campus. This green wall was planted with hardy perennials. On the northwestern wall, shade-loving heuchera is planted. The southwestern wall is planted with catmint, a native perennial that attracts pollinators, as well as a mix of drought-resistant, sun-loving sedum

- Rain Garden – UC Department of the Environment: Rain gardens are simple bioretention areas that collect and filter stormwater. They can be built in residential areas to collect water from roofs and gutters. Rain gardens enhance the landscape with native plants and provide habitat for wildlife. This rain garden at the Ulster County Department of the Environment serves as a demonstration site. The Department is housed in an older home with a small yard, similar to many other homes in Kingston.
    - Currently handles runoff from almost 1000 sq. ft. of roof, treating ~85 cubic feet of water; this can be expanded to include a larger drainage area
    - Approximately 300 sq. ft.

- Bioretention Areas – County Office Building Complex: Bioretention areas are depressed areas in the landscape that are designed to collect and filter stormwater. The trees, shrubs, and grasses planted in these areas must be able to survive both flooding and drought. Native perennials such as milkweed, mountain mint, coneflower, and beebalm are well suited for this and require minimal maintenance. This bioretention area is at the Ulster County Office Complex. It was designed to collect runoff from the adjacent parking lot and reduce flooding on Pearl Street.

Documentation:

- Ulster County Green Infrastructure hyperlinks:
  - Webpage: https://ulstercountyny.gov/environment/green-infrastructure
  - 17 Pearl Street Rain Garden Informational Brochure
  - Introduction to Rain Gardens Brochure
  - Recommended Plant List for Rain Gardens
- Complete a feasibility study for one or more priority location (2 points)
  - Project background: https://hudsonvalleyregionalcouncil.org/resources-publications/green-infrastructure-and-water-quality/
  - GI Conceptual Plan for County Office Building Complex
- Green infrastructure training (1 point)
  - The Department of the Environment's Environmental Resource Technician coordinates the MS4 stormwater program for Ulster County and completes several hours of training annually – the 2020 Training certificate is included (for 7 professional development hours).
- Implement green infrastructure projects (>5,000 cubic feet – 4 points)
  - Pervious Pavement– STRIVE Project at Kingston Center of SUNY New Paltz
    - Project Environmental Highlights summary document
    - As-Built Plans depicting porous asphalt parking lot area, porous pavers, bioretention basin (pond), live wall, and rain garden
    - GI Maintenance Requirements document
    - Water Quality Volume Calculations: Sums the 5,708 cubic feet of WQv capacity across all subcatchments
    - GI Maintenance Requirements document
    - Picture of pervious pavement and green wall
  - Rain Garden– UC Department of the Environment
    - Base Map: Includes calculations for the </= 274.5 cubic feet of WQv capacity across rain garden soils, gravels, and ponding areas
    - Planting list
    - Before & after pictures
  - Bioretention Areas – County Office Building Complex
    - Bioretention Area Dimension Plan
    - Bioretention Area Planting Plan
    - Before & after pictures

Green Infrastructure Training Course:

Completed by Benjamin Ganon
Environmental Resource Technician
Ulster County Department of the Environment

Green Infrastructure Training Course- The New York Stormwater Regional Training Centers (SW RTC) are a Statewide Partnership between Saratoga and Orange County Cornell Cooperative Extensions, the Central New York Regional Planning & Development Board, and the Stormwater Coalition of Monroe County & Monroe County SWCD. Our goal is to provide the best technical training to all stormwater professionals working in New York State.

1. Green Infrastructure; 01-23-2020 ~ 7.0 PDH available for this course.
Green Infrastructure (GI) practices have become the newest stormwater management tools. Even though it may still be considered an evolving technology, the benefits of GI over more conventional "hard" management techniques are well known. In particular, GI's ability to reduce runoff and provide climate change resilience has been firmly established. Many GI practices are now in place, and are performing with varying levels of success. Future design can benefit from some of the "lessons learned." This class will examine the design details, practical applications, and critical elements of the various GI practices that are necessary for long term performance. Proper plant selection, planting and care of the "green" elements of GI will be emphasized, as well as techniques for making GI practices "people friendly". Working with a specific site, participants will prepare a green infrastructure plan that incorporates appropriate structures, as well as complete a properly prepared planting plan. We will also review the important elements of planting installation and maintenance that can lead to the survival, long term performance, and community acceptance of projects.

EASTERN NEW YORK
STORMWATER REGIONAL TRAINING CENTER

THE PRACTICING INSTITUTE OF ENGINEERING

Cornell University
Cooperative Extension
Saratoga County

CERTIFICATE OF COMPLETION

This Certificate of 7.0 Professional Development Hours is given to

BENJAMIN GANON

In recognition of completing the course

PS20200004 - GREEN INFRASTRUCTURE

Thursday January 23rd, 2020 **at 50 West High Street, Ballston Spa, NY**

Signature/Instructor: John Dunkle PE, CPESC, CPMSM — 01/23/2020

Sig./Training Provider: Blue R. Neils CPESC, CPMSM — 01/23/2020

HUDSON VALLEY REGION
GREEN INFRASTRUCTURE
PLANNING 2010-2011

PROJECT AREA: Kingston

HUDSON VALLEY REGIONAL COUNCIL

3 Washington Center, Newburgh NY 12550 http://www.hudsonvalleyregionalcouncil

Google Earth 2011

GREEN INFRASTRUCTURE CONCEPT PLAN FOR ULSTER COUNTY DEPARTMENT OF THE ENVIRONMENT/COUNTY OFFICES PARKING LOT

Project type: Parking lot retrofits and small property demonstration projects **December 2011**
Proposed practices: 1- Rain garden 2- Stormwater planter
3- Permeable paving 4- Tree planting

RECOVERY.GOV

This project has been funded by the American Recovery and Reinvestment Act with support from the New York State Department of Environmental Conservation and New York State Economic Recovery and Reinvestment Cabinet. For more information, please visit: www.recovery.gov, www.dec.ny.gov or www.recovery.ny.gov.

NYWORKS

The following draft report describes a schematic landscape design proposal using green infrastructure practices for stormwater management. The illustrated plan and report are intended to give practical guidance for the owner, design professionals, contractors, and other interested parties to use in developing a final design. They are not intended to be used as final design and construction documents.

OVERVIEW

This conceptual masterplan was developed over the course of the Green Infrastructure Planning Project with the help of several individuals. From early on, Amanda LaValle, Coordinator of the Ulster County Department of the Environment (DOE) provided support for the project overall. She helped to identify potential sites in the city as well as the opportunities presented in this report for the Ulster County Offices parking lot and the DOE. Upon acquiring funding in 2011 for a rain garden at the department's offices at a converted residential property in uptown Kingston she invited the project outreach leaders to evaluate the whole property for retrofit opportunities. They sought professional support from Restaino Design Landscape Architects, PC for the final design of the rain garden. The firm designed it pro bono, and it was installed this summer. On another occasion, at a meeting to assess another County property, Amanda Lavalle and Brian Cunningham—Buildings and Grounds Administrative Manager for the Ulster County Department of Public Works—agreed that the parking lot for the County Offices that abut the DOE site could be another candidate for retrofits. DOE's Mandy Wolfson helped to identify several gi opportunities in the parking lot that were included in the concept plan presented here.

The DOE property includes small landscaped front and side yards. On the east is the driveway used for access to the parking lot located behind the building. The Ulster County Offices parking lot is heavily used and entirely paved. The set of practices on the concept plan on and around the DOE site would provide stormwater and other environmental benefits, and could be used as demonstration projects for public education and training. The building is an old home of a size and style that is fairly common to the area, and as such is especially useful for demonstration projects targeted to homeowners. In addition, pedestrians walk between the office building and Pearl Street through the parking lot and along a path through the DOE yard. Considering ways to improve pedestrian safety with green infrastructure was part of the rationale for the plans for permeable paving and planting shown in this portion of the lot. Green infrastructure practices on the plan include:

1- Rain garden in the front of the lawn area. (This practice has already been installed.)
2- Stormwater planter next to the rear entrance
3- Tree plantings in currently paved areas near Pearl Street
4- Permeable paving between the DOE pathway and the County Offices rear entrance

LOCATION AND OWNERSHIP

Ulster County owns the five contiguous lot shown in Figure 1

Ulster Co. Department of the Environment
17 Pearl Street
Tax ID 48.331-5-16

Ulster Co. Offices, 244 Fair Street
Tax ID 48.331-5-1

Parcels

EXISTING CONDITIONS

SURFACE COVER/CONTRIBUTING AREA

The majority of the properties combined (the County Offices, Department of the Environment and the parking lot) is devoted to parking, with approximately 90 percent impervious area and 10 percent lawn and landscaped.

SOILS AND TOPOGRAPHY

The DOE site is essentially flat, draining to Pearl Street. The County Offices parking lot is graded to drain to several inlets, and a portion of the south side drains to Pearl Street. The Web Soil Survey Report indicates RvA Riverhead fine sandy loam which is categorized as Hydrologic Soil Group B, a well-drained soil that would perform well in infiltration practices.[1]

SOLAR AND WIND EXPOSURE

The DOE side yard has good sun exposure for a range of plant choices. There is no shade in the parking lot.

VEGETATION

There is a small flowering tree in the yard that was considered in designing the garden. Most of the DOE yard is lawn.

Figure 1 *DOE Side yard (rain garden location)*

Figure 2 *UC parking lot area by DOE path*

Figure 3 *Parking lot (view towards gate)*

Figure 4 *DOE rear of building (stormwater planter location)*

Figure 5 *Edge of parking lot at Pearl Street*

Figure 6 *Parking lot and DOE building (view west)*

[1] Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed [7/30/2011].

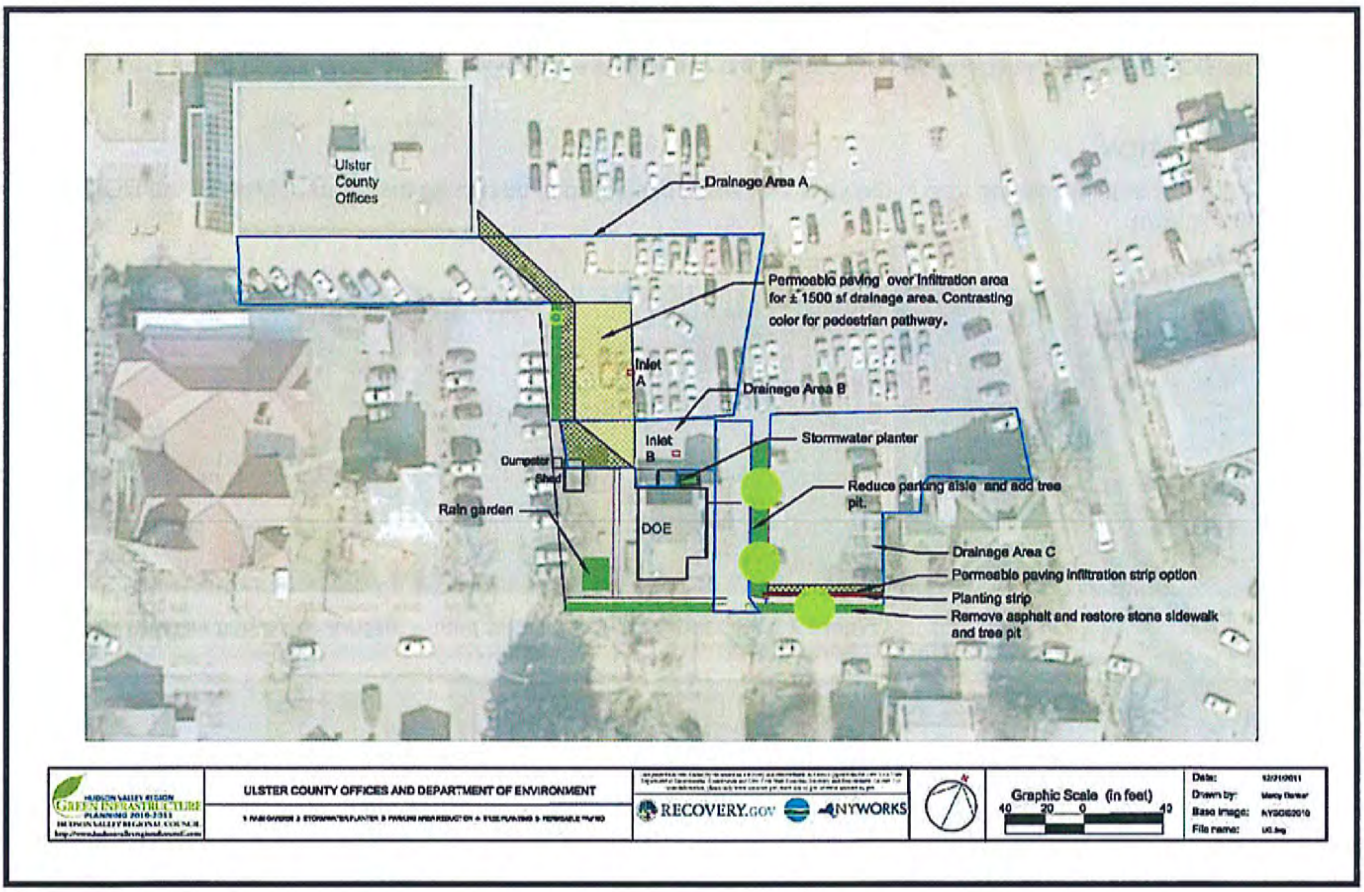


Figure 7 Green Infrastructure Concept Plan *(11x17 plan is included at the end of the report)*

THE CONCEPT PLANS IN BRIEF

Following is a brief discussion of the concept plan for each of the individual practices. The detailed discussion of design issues, materials, maintenance and costs is provided in the last section.

1- RAIN GARDEN

A rain garden was planned and installed this year with assistance from the GI project. It was designed by Barbara Restaino, Restaino Design, Landscape Architects, PC and installed by the Ulster County DPW. The garden handles runoff from a portion of the roof through two downspouts.

Figure 8 *Two downspouts connected to garden*

Figure 9 *Completed garden*

2 - STORMWATER PLANTER

Stormwater planters are like rain gardens in a box. The New York State Stormwater Management Design Manual (Design Manual) describes stormwater planters as "small landscaped stormwater treatment devices that can be placed above or below ground. They use soil infiltration and biogeochemical processes to decrease stormwater quantity and improve water quality, similar to rain gardens and green roofs" (page 5-97). For this location, a type known as an infiltration planter would be used, which would allow the runoff to flow through the planter, and discharge the overflow to the storm drain through a weep hole. The planter would be designed to enhance the appearance of the rear of the DOE building.

Figure 10 *Example of stormwater planter*
http://www.communitecture.net/communitecture/projects

Figure 11 *Sketch of proposed planter at rear of DOE*

3 - PERMEABLE PAVING

Permeable concrete pavers allow rain water to pass through the spaces between the units into a stone base and then infiltrate into the soil below. They are durable, low maintenance, and visually attractive. Light colored pavers have the added benefit of reducing urban heat island effect.

On the plan, cross hatching indicates permeable interlocking concrete pavers in the area between the DOE lot and the gate into the main part of the large lot. Contrasting paving could be used to create a crosswalk to alert drivers and pedestrians to be careful. Along the edge of the small portion of the parking lot along Pearl Street, a permeable paving strategy using the traditional stone sidewalk is proposed that would allow for storage and treatment of the runoff from the parking lot and create a supportive environment for planting on each side of the sidewalk.

Figure 12 *Permeable concrete interlocking pavers*

4 – TREE PLANTING

Tree plantings intercept rainfall in the canopy and release it through evapotranspiration. Street tree pits with good quality, uncompacted soil will infiltrate runoff, and tree roots and leaf litter enhance the soil conditions for infiltration. In addition to these stormwater management functions, trees can provide many other benefits including shading and cooling, buffering wind and noise, purifying air and beautification.

Two new tree pits are shown on the plan in areas that are currently paved. Reducing the parking aisle width in the small lot by the DOE and removing the remnants of an old driveway on Pearl Street would free up space for tree planting. Utilizing areas below the pavement as part of the tree pit design would provide the soil volume necessary for large canopy trees.

Figure 13 *Existing sidewalk on Pearl Street, view west*

Figure 14 *Proposed retrofit, with structural soil below restored sidewalk and planting areas on each side*

DESIGN, CONSTRUCTION, AND MAINTENANCE

The following section provides details about the specific design, materials, construction and maintenance considerations and the sizing calculations for each practice.

Green Infrastructure Sizing and Design

The green infrastructure practices included in these plans are among those considered acceptable for runoff reduction in the New York State Stormwater Management Design Manual 2010.The green infrastructure techniques include practices that:

- reduce calculated runoff from contributing areas
- capture the required water quality volume.

The **Water Quality Volume (denoted as the WQv**) is designed to improve water quality sizing to capture and treat 90% of the average annual stormwater runoff volume. For Kingston this 90% rainfall number is 1.1 inches. The WQv is directly related to the amount of impervious cover created at a site. The following equation can be used to determine the water quality storage volume WQv (in acre-feet of storage):

WQv = (P) (Rv)(A)/12
where:
WQv = water quality volume (in acre-feet)
P = 90% Rainfall Event Number
Rv = 0.05 + 0.009(I), where I is percent impervious cover
A = site area in acres (Contributing area)
A minimum Rv of 0.2 will be applied to regulated sites.

1- RAIN GARDEN

DESIGN

The rain garden was designed to align with the sidewalk and path in the DOE yard, to avoid tree roots and leave room for a picnic area. Pipes were connected to the garden from two downspouts.

MATERIALS

Plants
Native plants were selected that are adaptable to wet and dry conditions, easy to maintain, visually attractive, and attractive to wildlife. Friends of Forsyth Park and Cornell Cooperative Extension of Ulster County provided the plants, which were purchased from Catskill Native Nursery in Kerkonkson, and Victoria Gardens in Rosendale.

Soil amendments
The native, well drained soil was used and no amendments were added. The soil may be amended in the future to slow the infiltration rate.

Shredded hardwood mulch

Gravel 6" gravel base and gravel for outfall area

CONSTRUCTION STEPS

- Excavate to the depth required by the final design
- Backfill with layer of clean washed gravel
- Install underdrain if required
- Fill to required depth with amended garden soil
- Install plantings
- Apply mulch

MAINTENANCE CONSIDERATIONS

Rain gardens are intended to be relatively low maintenance. Weeding and watering are essential the first year, and can be minimized with the use of a weed free mulch layer. They should be treated as a component of the landscaping, with routine maintenance including the occasional replacement of plants, mulching, weeding and thinning to maintain the desired appearance.[2]

[2] Adapted from the Management Design Manual, page 5-84.

SIZING CALCULATIONS

RAIN GARDEN

Step 2: Calculate for drainage layer and soil media volume:

$V_{SM} = A_{RG} \times D_{SM} \times n_{SM}$

$V_{DL} = A_{RG} \times D_{DL} \times n_{DL}$

ARG = proposed rain garden surface area =	**300**	ft^2
DSM = depth soil media =	**12**	ft
DDL = depth drainage layer =	**0.5**	ft
nSM = porosity of soil media =	0.2	
nDL = porosity of drainage layer =	0.4	
VSM = volume of soil media = ARG * DSM * nSM	720	Ft^3
VDL = volume of gravel drainage layer = ARG * DDL * nDL	60	Ft^3
DP = ponding depth above surface =	**0.5**	ft
WQv less or equal to the soil volume + the gravel volume + the volume of the ponded water, which is ≤ VSM+VDL+(DP x ARG) ?	**930**	ft^2

2- STORMWATER PLANTER

DESIGN

The stormwater planter would be approximately 5' wide, 10' long and 3' high, so that it fits along the foundation of the house and aligns with the edge of the window. It would capture the runoff from the downspout at this location on splash rocks. The ponding depth would be 6", and the growing medium and drainage layer would be 30". The planter would have a weep hole that would drain runoff to the grass near and to the nearby inlet.

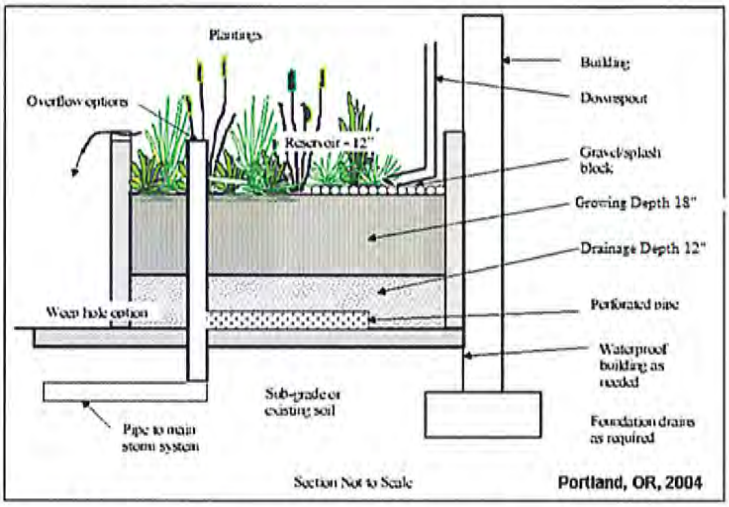


Figure 15 Typical stormwater planter design

MATERIALS FOR THE CONTAINER

Materials for construction of the planter would vary according to the final design. Materials suitable for planter wall construction include stone, concrete, brick, clay, plastic, wood,or other durable material. Treated wood may leach toxic chemicals and contaminate stormwater, and should not be used.

Plants Vegetation selected for stormwater planters should be relatively self-sustaining and adaptable. Native plant species are recommended, and fertilizer and pesticide use should be avoided whenever possible. (Design Manual page 5-105). Native plants that grow in wetland and upland areas recommended by the New York State Department of Environmental Conservation can be found in Appendix H of the Design Manual.

Soil The growing medium in stormwater planters consists of organic soil medium. According to the DEC Manual soils in the planter should allow an infiltration rate of 2 inches per hour and would meet the following specifications:

Growing media --a uniform mixture of 70% sand (100% passing the 1-inch sieve and 5% passing the No. 200 sieve) and 30% topsoil with an average of 5% organic material, such as compost or peat, free of stones, roots and woody debris and animal waste.

Drainage layer-- clean sand with 100% passing the 1-inch sieve and 5% passing the No. 200 sieve.

Other Materials
Washed gravel for the drainage layer should allow an infiltration rate of 5 inches per hour.
Filter fabric
Overflow device

MAINTENANCE

The planter should be treated as a component of the landscaping, with routine attention including the occasional replacement of plants, mulching, weeding and thinning to maintain the desired appearance. The planter would be small and the plantings would require relatively low maintenance. Weeding and watering are essential in the first year and can be minimized with the use of a weed free mulch layer.

A regular and thorough inspection regime should be established so that the planter functions well. Following construction, planters should be inspected after each storm event greater than 0.5 inches, and at least twice in the first six months. Subsequently, inspections should be conducted seasonally and after storm events equal to or greater than the 1-year storm event (Design Manual page 5-105).

SIZING COMPUTATIONS

The size of the roof drainage area is estimated to be around 500 feet. A stormwater planter with the dimensions described above would capture and treat slightly less than the WQv from a drainage area this size.

Stormwater Planter	**Available Surface area**	**50**	**ft^2**
	Total Drainage Area	**500**	**Ft^2**
Step 1: Calculate Water Quality Volume (WQv)			
WQv = (P) (Rv) (A) / 12			
P = 90% rainfall number =		**1.1**	**inches**
Rv = 0.05+0.009 (I), if Rv < 20%, use Rv = 20%		**95%**	
I = percent impervious of area draining to planter =		**100%**	
% of Total area that drains to planter		**100%**	
A = Area draining to practice =		**500**	**Ft^2**
WQv =		**44**	**Ft^3**
Step 2: Calculate required surface area:			
Af = required surface area in sq ft = WQv*(df) / [k*(hf +df) (tf)]			
where:			
WQv =		**44**	**ft^3**
df = depth of soil medium =		**2.5**	**ft**
k = hydraulic conductivity =		**4**	**ft/day**
hf = Average height of water above planter bed =		**0.25**	**ft**
tf = filter time (days) =		**0.17**	**day**
Af = Required surface area for planter		**58**	**Ft^2**

3- PERMEABLE PAVING

DESIGN

Behind the DOE

Permeable pavers are proposed for the area between at the northwest corner of the DOE property and the parking gate. Small pavers in contrasting tones would delineate a pedestrian zone as part of a strategy to make this section of the lot safer and more attractive. The paving would capture and treat the WQv for the area shown as Drainage Area A on the plan and part of the smaller Drainage Area B.

Along Pearl Street

To capture the WQv from the adjacent parking area that drains to Pearl Street from the small lot by the DOE driveway a narrow permeable infiltration strip would be installed along a new planting bed. A patch of asphalt along the sidewalk would be removed, and the old stone sidewalk restored. The gravel base for the permeable paving infilstration strip and the native, well drained soils in the planting bed, below the sidewalk and in a new tree pit along the street would be designed as a stormwater practice to capture the WQv from Drainage Area C. The design of the combined planting and paving infiltration practice is described further in the tree planting discussion below.

TYPICAL CONSTRUCTION STEPS FOR PAVING

The gravel base layer for pervious paving must be protected from sedimentation during construction. The construction steps would follow specification developed by a qualified professional.
Typical construction steps are as follows:

- Excavate to proposed depth and level the bottom of infiltration bed.
- Place geotextile if required
- Place sub base and base aggregrates as required by final design
- Place setting bed aggregate
- Install edge restraint
- Place permeable interlocking pavers
- Place joint aggregate

MATERIALS

Typical manufacture's specifications for permeable interlocking concrete pavers require the following materials.

- Concrete pavers (permeable and conventional)
- Granular subbase
- Granular base
- Bedding and void opening aggregates
- Edge restraints
- Underdrain if required
- Geotextile fabric (optional)

MAINTENANCE CONSIDERATIONS

Two excellent fact sheets on permeable and porous paving are available from the NC State University Stormwater Engineering Group at http://www.bae.ncsu.edu/stormwater/pubs.htm: [3]

- *Research Update and Design Implications*
- *Maintaining Permeable Pavements*

[3] Urban Waterways, NC State University and A&T State University Cooperative Extension.2011.

The paving should be kept clean of debris. Vacuum sweep as needed. Upland and adjacent areas should be kept mowed and bare areas should be seeded.:

COST

According to the PaveDrain® website:
Depending on location and project size a conservative installed cost of the PaveDrain System is $10-11 per SF. This typically includes an installed 6 - 12" layer of clear stone (#3, #57 (TBD) and 1-inch of #8). The installation of the PaveDrain blocks or mats will be around $2.00- $2.50 per SF. The materials cost will be $5.00-$6.00/Sft. Delivery will add $0.50-$1.00 per SF depending on the distance to the jobsite. Color blocks adds ± $1 per SF.[4]

SIZING COMPUTATIONS FOR REAR PERMEABLE PAVING

As shown below, the permeable paving in the drainage area for Inlet A, would have a surface area of 2,700square feet, and 2,613 sf would be required to capture the WQv of 1,306 cubic feet, given a gravel base 15" inches deep and assumed porosity of .4 .

Total Drainage Area for Inlet A	**15000**	Ft^2
Available Surface Area	2700	Ft^2
Step 1: Calculate Water Quality Volume (WQv)		
WQv = (P) (Rv) (A) / 12		
P = 90% rainfall number =	**1.1**	**inches**
Rv = 0.05+0.009 (I), if Rv < 20%, use Rv = 20%	**95%**	
I = percent impervious of area draining to practice =	**100%**	
% of Total area that drains to practice	**100%**	
A = Area draining to practice =	**15000**	Ft^2
WQv =	**1306**	Ft^3
Step 2: Calculate required surface area for pavement:		
Ap = WQv / *n* x dt		
where *n* = assumed porosity	**0.4**	
dt =trench depth	**1.25**	**ft**
A_P=	**2613**	Ft^2

[4] http://www.pavedrain.com/faqs.php (accessed 11/9/2011).

4-TREE PLANTING

DESIGN FOR LARGE HEALTHY TREES AND STORMWATER MANAGEMENT

Tree planting along Pearl Street
Along Pearl Street a patch of asphalt would be removed and an open tree pit in the 4 feet wide grass strip would be created. The old stone sidewalk would be restored, and the native soil below the sidewalk would extend the rooting zone below the paving. This ample volume would support a large canopy tree.
As described in the previous section, this area would be designed as a component of a practice to capture the runoff from the adjacent parking lot. The practice could have an underdrain that connects to the storm sewer.

Tree pit along DOE entrance driveway with parking area reduction
A tree pit is proposed to separate the DOE entrance drive and the Pearl Street lot. The aisle in the parking area can be reduced by 6 feet, which would open up an area 6'x80' for tree planting --enough area for two small canopy trees, provided a careful tree selection and site preparation.

To optimize the site for stormwater management using trees, medium or large canopy trees would be the priority, and in that case, the area provided would need to be expanded below the paving to provide the conditions for long term healthy growth using structural soil or Silva Cells and permeable paving.

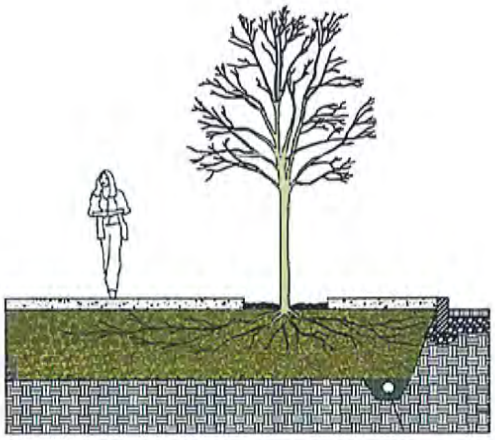


Figure 16 Structural soil below permeable paving
Copyright 2008 Casey Trees. Washington D.C.

Figure 17 Silva Cells below permeable paving
Copyright 2008. Casey Trees. Washington D.C.

Structural soil is formulated with angular gravel, a clay soil and a hydrogel (that prevents the soil and gravel from separating during mixing). It was developed at Cornell University and subsequently patented for quality control. Other brands are also.available. For information on structural soil see the Urban Horticulture Institute of Cornell University http://www.hort.cornell.edu/uhi/outreach/index.htm#soil.

Silva Cells are a modular system designeg support the paving and allow room for good quality soil below.

> Each Silva Cell is composed of a frame and a deck. The Silva Cell frame is 48" (1200 mm) long x 24" (600 mm) wide x 16" (400 mm) high. Frames can be stacked one, two, or three units high before they are topped with a deck to create a maximum amount of soil volume for tree root

growth and stormwater treatment. Silva Cells can be spread laterally as wide as necessary. Each unit is approximately 92% void space, making it easy to accommodate surrounding utilities.[5]

Soil assessment

Chemical, biological, drain, percolation, and infiltration tests should be conducted prior to the development of the final design. Site preparation would be based on soil conditions revealed in the assessment, including drainage, pH range, compaction levels, texture and other factors. For guidance on site assessment for tree planting see *Recommended Urban Trees: Site Assessment and Tree Selection for Stress Tolerance*. Urban Horticulture Institute, Cornell University, Ithaca, NY. .http://www.hort.cornell.edu/uhi/outreach/recurbtree/index.html

Soil Volume and Tree Size

The tree pit design and tree selection should reflect careful consideration of the available soil volume. Soil volume calculations should take into account a variety of specific factors including the soil type, whether the tree is growing in an open space or surrounded by paving, local climate conditions such as reflected heat and from cars, and other factors revealed in the complete site assessment. For the purpose of this plan, a good quality loam soil 3 feet deep is assumed, and healthy, large canopy trees are the goal. The chart below, developed by James Urban, shows that the soil volumes exceeding 1600 cubic feet would be required for trees with an ultimate crown projection over 1200 square feet, or about 40 feet in diameter. A general rule of thumb is a ratio of 2 CF of soil to 1 SF of mature crown spread. (Grabosky and others, 1999; Urban,1999). [6] Another factor to consider is the positive effect of extended pits for multiple trees -- when trees share soil, the volume of soil per tree is reduced.

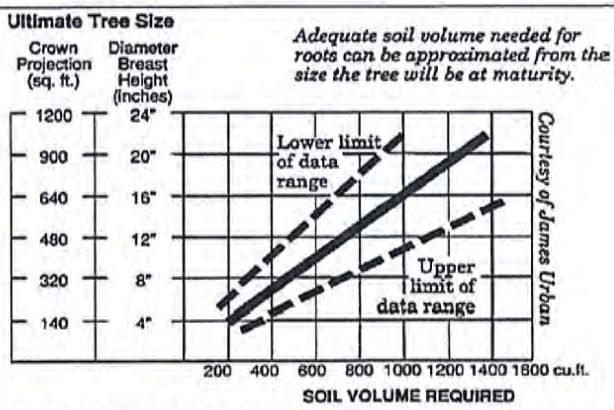


Figure 18 *The soil volume required for various size trees assumes a soil depth of 3 feet. (Source: James Urban) in Urban Watershed Forestry Manual - Part 3 page 26.)*

CONSTRUCTION STEPS

- Prepare tree pits according to the final design, including soil amendment and structural cell installation
- Plant trees according to approved specification prepared by a qualified design professional

[5] http://www.deeproot.com/products/silva-cell/silva-cell-overview.html Accessed 11/21/2011.
[6] In *Urban Watershed Forestry Manual Part 3: Urban Tree Planting Guide*, United States Department of Agriculture Forest Service Northeastern Area State and Private Forestry NA-TP-01-06,September 2006, page 26.

- Apply mulch
- Plant ground cover or turf as required

MATERIALS

- Soil and Soil Amendments: as required in final design
- Structural support for paved areas: Silva cells or structural soil
- Trees
- Mulch: Three inch layer in area at least 5 feet in diameter around the base of the tree (below the root flare).

MAINTENANCE CONSIDERATIONS

Well-prepared planting areas designed with appropriate plants and soils require routine maintenance. During the establishment period just after planting the new tree plantings would be watered using water bags and spot watering with a clear understanding of the requirements of the trees to avoid over- or under-watering. Instructions for watering and for monitoring for disease or damage and removing stakes are included in the Appendix. Ongoing maintenance would include occasional pruning and replacements, twice yearly clean up and yearly application of mulch.

COST INFORMATION

Silva Cells

The following information is provided by DeepRoot, the manufacturer fo Silva Cells:

Each Silva Cell installation is unique to existing site requirements. Costs will vary based on characteristics of the site, the quantity of Silva Cells required for the project, the tree size and stormwater treatment goals, and the design objectives. Remember that each frame is 48" (1200 mm) long x 24" (600 mm) wide x 16" (400 mm) high and holds about 10 ft^3 (.28 m^3) of soil.

According to bid tabulations from projects across North America, the Silva Cell system generally costs $14 - $18 per cubic foot installed (that estimate includes everything except the base course, the final paving and the tree itself.)

Structural Soil

According to Nina Bassuk of Cornell University's Urban Horticulture Institute (in CU Structural Soil: An Update after More than a Decade of Use in the Urban Environment, 2008), structural soil costs in the range of $35-42 per ton.

SIZING COMPUTATIONS FOR THE COMBINED PERMEABLE PAVING AND PLANTING ALONG PEARL STREET

The calculations shown here are based on the formula for permeable paving. The permeable paving strip at the end of the parking lot would be 4 feet wide have a gravel base approximately 12" deep. The rest of the area would be assumed to have a loamy sand soil 3' deep.

Total Drainage Area	**8400**	**Ft^2**
Available Surface Area or Designed Surface Area	**910**	**Ft^2**
Step 1: Calculate Water Quality Volume (WQv)		
WQv = (P) (Rv) (A) / 12		
P = 90% rainfall number =	**1.1**	**inches**
Rv = 0.05+0.009 (I), if Rv < 20%, use Rv = 20%	**95%**	
I = percent impervious of area draining to practice =	**100%**	
% of Total area that drains to practice	**100%**	
A = Area draining to practice =	**8400**	**Ft^2**
WQv =	**732**	**Ft^3**
Step 2: Calculate required surface area for pavement:		
Ap = WQ / *n* x dt		
where *n* = assumed porosity	**0.26**	
dt = structural soil reservoir depth	**3**	**ft**
A_p= Required surface area for paving	**938**	**Ft^2**

A WORD ON COSTS

Green infrastructure costs for retrofits are hard to state accurately. In new construction there is often considerably lower cost up front using and green infrastructure practices and planning versus conventional, big pipe systems. But where that "gray infrastructure" is already in place, assessing the value of adding a gi practice requires a fuller accounting. A recent report by the Center for Clean Air Policy states:

> *The value of green infrastructure actions is calculated by comparison to the cost of "hard" infrastructure alternatives, the value of avoided damages, or market preferences that enhance value (e.g. property value). Green infrastructure benefits generally can be divided into five categories of environmental protection:*
>
> *(1) Land-value,*
> *(2) Quality of life,*
> *(3) Public health,*
> *(4) Hazard mitigation, and*
> *(5) Regulatory compliance.*

The report sites, for example, New York City's 2010 Green Infrastructure Plan, "which aims to reduce the city's sewer management costs by $2.4 billion over 20 years. The plan estimates that every fully vegetated acre of green infrastructure would provide total annual benefits of $8,522 in reduced energy demand, $166 in reduced CO2 emissions, $1,044 in improved air quality, and $4,725 in increased property value. It estimates that the city can reduce CSO volumes by 2 billion gallons by 2030, using green practices at a total cost of $1.5 billion less than traditional methods.[1]

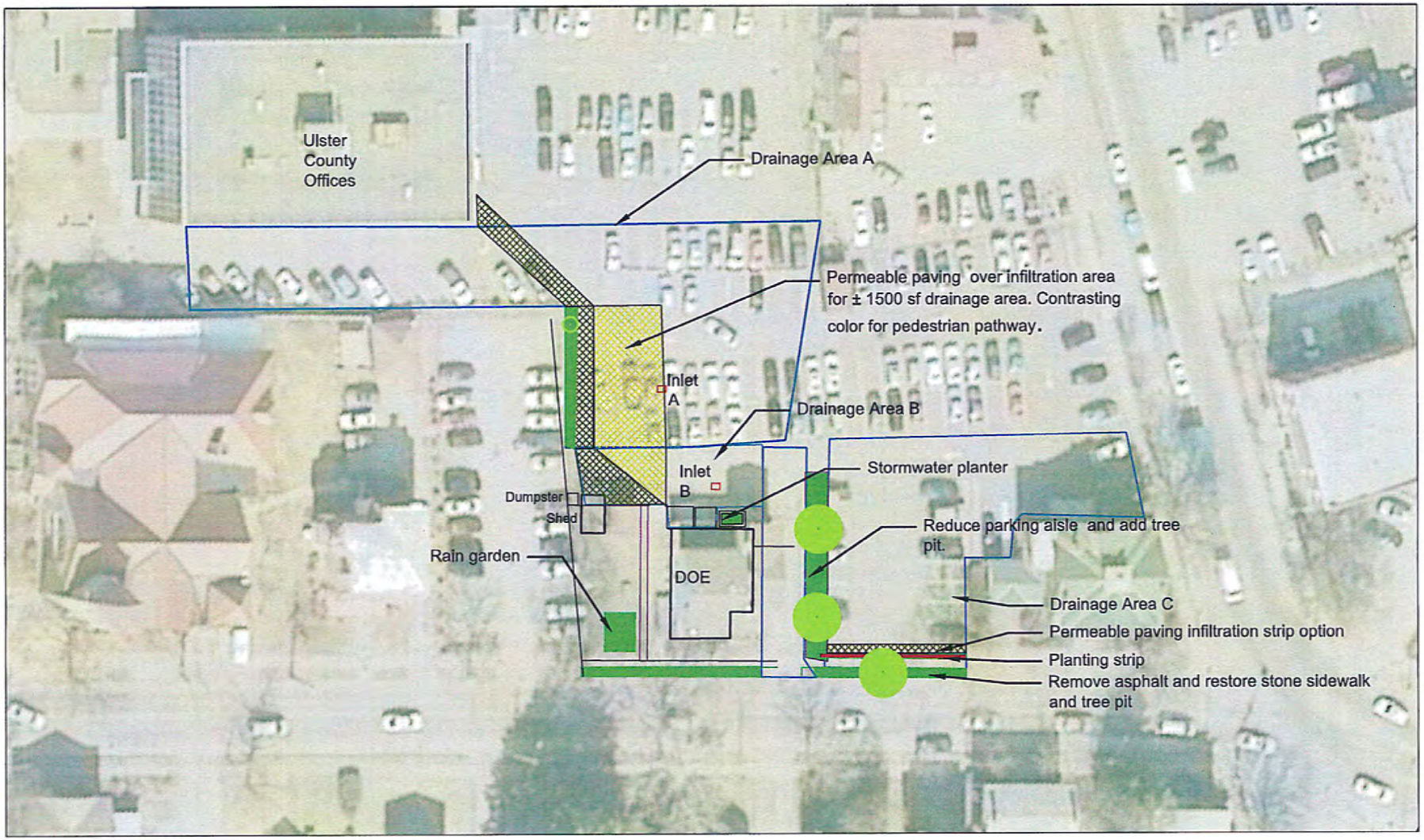
Cost Data

For installation, maintenance costs and lifespan data for the practices discussed here, the Cost Sheet developed by the Center for Neighborhood Technology (CNT) in collaboration with the *US EPA Office of Wetlands, Oceans, and Watersheds (OWOW), Assessment and Watershed Protection Division, Non-Point Source Branch,* provides useful information based on examples from various locations. It may be found at their website.
http://greenvalues.cnt.org/national/cost_detail.php

Another useful source of cost data can be found in the Center of Watershed Protection's *Urban Subwatershed Restoration Manual Series. Manual 3: Urban Stormwater Retrofit Practices*, pages E-1 though 14, includes a discussion of costs in terms of the amount of stormwater treated.
http://www.cwp.org/categoryblog/92-urban-subwatershed-restoration-manual-series.html

Concept Plan by Marcy Denker
Project Outreach by Victor-Pierre Melendez

[1] The Value of Green Infrastructure for Urban Climate Adaptation. Center for Clean Air Policy. Josh Foster, Ashley Lowe, Steve Winkelman. February 2011.



HUDSON VALLEY REGION
GREEN INFRASTRUCTURE
PLANNING 2010-2011
HUDSON VALLEY REGIONAL COUNCIL
http://www.hudsonvalleyregionalcouncil.com/

ULSTER COUNTY OFFICES AND DEPARTMENT OF ENVIRONMENT

1- RAIN GARDEN 2- STORMWATER PLANTER 3- PARKING AREA REDUCTION 4- TREE PLANTING 5- PERMEABLE PAVING

This project has been funded by the American Recovery and Reinvestment Act with support from the New York State Department of Environmental Conservation and New York State Economic Recovery and Reinvestment Cabinet. For more information, please visit www.recovery.gov, www.dec.ny.gov or www.nyworks.ny.gov.

RECOVERY.GOV NYWORKS

N

Graphic Scale (in feet)
40 20 0 40

Date: 12/21/2011
Drawn by: Marcy Denker
Base Image: NYSGIS2010
File name: UC.dwg

SUSTAINABLE
ULSTER COUNTY
— COUNTY EXECUTIVE MICHAEL P. HEIN —
GREENER BY DESIGN

Kingston Center of SUNY Ulster, S.T.R.I.V.E. Project
Environmental Highlights

By reusing an existing building in the community, improving its energy efficiency, and better managing stormwater, the STRIVE project has transformed a closed formed elementary school to a state of the art educational facility and model of green design.

Site Location - Reuse of the site takes advantage of the urban location and optimizes smart growth principles. Students can easily walk to the site from other locations in the City of Kingston. Sidewalks have been extended or upgraded, bicycle racks were installed to encourage cycling, and a walkway to Kingston High School was installed. The site was redesigned specifically with bus and transit connections in mind. In addition, an **electric vehicle charging station** was also installed to help promote greener transportation options.

Building Reuse - Reuse of this historic structure included minimizing demolition and other alterations which would have disturbed its historic character. This approach also greatly reduced the need for new material and maximized the reuse of the existing materials. Potentially hazardous materials, including lead and asbestos, were removed from the structure through a meticulous abatement process.

Energy Efficiency-By both improving the efficiency of building equipment, and increasing the ability to conserve energy when not needed, the redesign of the building remarkably reduces the overall energy demand of the facility and increased occupant comfort in the facility.

- **Lighting**- Existing lighting was replaced with high efficiency lighting. New lighting includes LED interior lighting and LED parking lot lighting as well as other LED exterior lighting. Occupancy sensors were installed, ensuring that lights are turned off in spaces which aren't being used.

- **HVAC** equipment- Energy efficient cooling equipment and fans were installed. Additionally, the flexibility to independently cool classrooms allows for space which may not be utilized in the summer months to not be cooled, saving additional energy.

- **Windows**- Existing single pane windows were replaced with energy efficient thermopane windows improving energy efficiency as well as allowing better use of daylight throughout the building further reducing the lighting demand.

Domestic Water- Low-flow fixtures were installed including dual flush toilets to reduce domestic water consumption. Water fountains include bottle filling stations to encourage the use of reusable water bottles.

SUSTAINABLE
ULSTER COUNTY
COUNTY EXECUTIVE MICHAEL P. HEIN
GREENER BY DESIGN

SUNY Extension Center at Kingston, S.T.R.I.V.E. Project
Environmental Highlights Continued

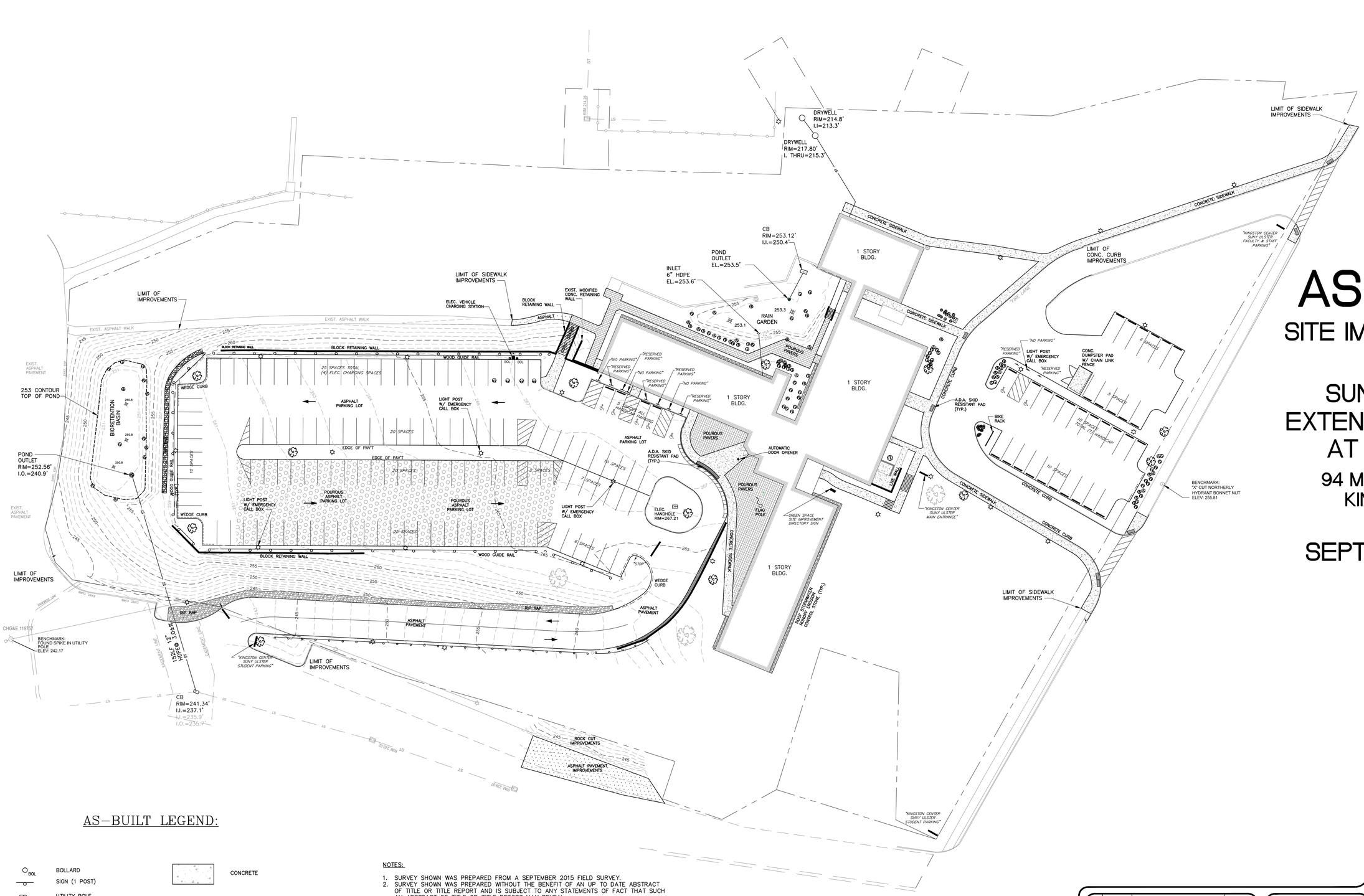
Stormwater- Significant site improvements, funded by a **$439,000 grant** from the NYS Environmental Facilities Corporation Green Innovation Grant Program, were made to dramatically change the way stormwater is managed on the site. To the maximum extent practicable, stormwater is treated on site. Infiltration to the ground is promoted and stormwater entering the municipal storm system is minimized through a suite of green infrastructure design techniques including the following measures.

- **Permeable Pavement** is designed to convey rainfall through the pavement surface into an underlying reservoir where it can infiltrate, thereby reducing stormwater runoff from a site. This project includes an extensive permeable asphalt parking area as well as pervious pavers at the main entrance and in the rear courtyard.

- **Bioretention Systems** are shallow vegetated depressions often referred to by a variety of names, such as bioinfiltration areas, biofilters, rain gardens, bioswales, or recharge gardens. They are very effective at removing pollutants and reducing stormwater runoff. The water which collects on the surface, ponds and then is used by the vegetation in evapotranspiration and infiltrated into the soil. The use of native species results in a system that is resistant to insects, disease, pollution, and climatic stresses. This project includes multiple rain gardens including a large area in the courtyard as well as a bioretention area on the north end of the parking lot. All areas are extensively planted with native vegetation.

- **Green Walls** are typically vertical systems which consist of a modular container to hold growing media, the growing media itself, and vegetation. Vegetation can be rooted in the ground or in modular containers, growing blocks or growing mats located at various heights along the face of the structure. Green walls provide air quality and stormwater benefits and help to reduce energy use. This project includes a green wall which utilizes plants in modular containers.

- **Downspout Disconnection** is the removal of roof runoff from a direct connection to the combined or storm sewer. By redirecting the rain to a designated vegetated pervious area, runoff volume can be greatly reduced and water quality benefits can be achieved. When disconnecting a downspout, the runoff is directed to a vegetated and pervious area where plant and soil can filter and infiltrate the water. Multiple practices in this project treat roof water runoff which was previously directed to the storm sewer helping to significantly reduce the peak stormwater volumes running off the stie.



AS-BUILT

SITE IMPROVEMENTS

SUNY ULSTER EXTENSION CENTER AT KINGSTON

94 MARY'S AVENUE
KINGSTON, NY

SEPTEMBER 2015

0 30 60 Feet

AS-BUILT LEGEND:

- BOL — BOLLARD
- SIGN (1 POST)
- UTILITY POLE
- LIGHT POST
- FLAG POLE
- EHH — ELECTRIC HANDHOLE
- DECIDUOUS TREE PLANTING
- SHRUB/BUSH PLANTING
- CONCRETE
- POUROUS ASPHALT PAVEMENT
- POUROUS PAVERS

NOTES:

1. SURVEY SHOWN WAS PREPARED FROM A SEPTEMBER 2015 FIELD SURVEY.
2. SURVEY SHOWN WAS PREPARED WITHOUT THE BENEFIT OF AN UP TO DATE ABSTRACT OF TITLE OR TITLE REPORT AND IS SUBJECT TO ANY STATEMENTS OF FACT THAT SUCH AN ABSTRACT OF TITLE OR TITLE REPORT MAY REVEAL.
3. SURVEY SUBJECT TO ANY SUBSURFACE CONDITIONS THAT MAY EXIST, IF ANY.
4. PARCEL SUBJECT TO ANY SETBACKS, RESTRICTIONS, RIGHTS-OF-WAY (PUBLIC OR PRIVATE), EASEMENTS (PUBLIC OR PRIVATE), UTILITY EASEMENTS OF RECORD OR OTHERWISE THAT MAY AFFECT THE PREMISES SHOWN, IF ANY.
5. UNDERGROUND UTILITIES SHOWN HERON ARE APPROXIMATE AND BASED ON UTILITY EVIDENCE VISIBLE AT GROUND SURFACE AND ARE SUBJECT TO FIELD VERIFICATION BY EXCAVATION. UTILITIES SHOWN DO NOT IMPLY TO CONSTITUTE OR REPRESENT ALL UTILITIES UPON OR ADJACENT TO THE SURVEYED AREA. OTHER UTILITIES MAY EXIST, IF ANY.
6. NMB LAND SURVEYING PLLC PERFORMED NO BOUNDARY DETERMINATION FOR THE PURPOSES OF THIS SURVEY. PROPERTY LINES SHOWN ARE FOR REFERENCE ONLY.
7. VERTICAL DATUM AND BOUNDARY LINE PER MAP REFERENCE #1.

MAP REFERENCE:

1. MAP ENTITLED "SUNY ULSTER EXTENSION CENTER AT KINGSTON 94 MARY'S AVENUE KINGSTON, NY", SITE PLAN SHEET C110 AND GRADING AND DRAINAGE PLAN SHEET C120, DATED AUGUST 18, 2014 AND PREPARED BY MJ ENGINEERING AND LAND SURVEYING, P.C.

NMB
LAND SURVEYING
PLLC
20 TROY AVE, WYNANTSKILL NY, 12198
518-376-4630

NO.	DATE	REVISIONS DESCRIPTION	BY

NATHAN M. BURROWS L.S.
NEW YORK LIC. No. 50,724

SITE IMPROVEMENT
AS-BUILT PLAN

SUNY ULSTER EXTENSION CENTER AT KINGSTON
94 MARY'S AVENUE
CITY OF KINGSTON

COUNTY OF ULSTER — STATE OF NEW YORK

SURVEYED BY: NMB	CHECKED BY: NMB	DATE: OCTOBER 1, 2015
DRAWN BY: CC	JOB No. NB15-015	DWG No. AS-BUILT

SCALE: 1"=30' — SHEET 1 OF 1

6.0 MAINTENANCE REQUIREMENTS FOR PERMANENT PRACTICES

6.1 Bioretention Basin

The bioretention basin should be periodically monitored for sedimentation. Sediment removal should occur when it accumulates to a depth of more than six inches. In addition, the plants should be monitored for the first year.

6.2 Rain Gardens

The rain gardens should receive periodic maintenance to ensure the effective storage and conveyance of the required stormwater volume. Plants should be monitored for the first year. Sediment removal should occur when it accumulates to a depth of more than three inches. After the first year, two visits per year to inspect for nuisance species and safety inspections are required.

6.3 Porous Pavement/Pavers

Porous pavement is susceptible to clogging. The pavement should be checked to make sure it is clean of debris, dewaters between storms and clean of sediment monthly. Adjacent areas should be mowed and seeded as needed. In addition, vacuuming 3-4 times per year and annual surface inspections are recommended. Washing the pavement with a high pressure washer will also assist in preventing clogging. The pavement should receive periodic maintenance to ensure the effective storage and conveyance of the required stormwater volume. Sediment removal should occur when it accumulates to more than 25% of the original required WQv. Vegetation should be mowed, as required to maintain a grass height of 4 to 6 inches.

6.4 Green Wall

The green wall should be monitored for plant establishment and other functional concerns. The vegetation should be monitored particularly for the first two years. Irrigation and fertilization is typically most important during the first year of plant establishment. After the first year, two visits per year to inspect for nuisance species and safety inspections are required.

Appendix G

Calculations

Version 1.6 Total Water Quality Volume Calculation
Last Updated: 03/28/2014 WQv(acre-feet) = [(P)(Rv)(A)] /12

Is this project subject to Chapter 10 of the NYS Design Manual (i.e. WQv is equal to post-development 1 year runoff volume)?.....	No

Design Point:		
P=	1.10	*inch*

Manually enter P, Total Area and Impervious Cover.

Breakdown of Subcatchments

Catchment Number	Total Area *(Acres)*	Impervious Area *(Acres)*	Percent Impervious *%*	Rv	WQv *(ft^3)*	Description
1	0.54	0.35	66%	0.64	1,372	Infiltration Basin
2	0.56	0.56	100%	0.95	2,106	Porous Pavement
3	0.06	0.06	100%	0.95	219	Rain Garden
4	0.08	0.08	100%	0.95	296	Porous Pavement
5	0.06	0.06	100%	0.95	235	Porous Pavement
6	0.94	0.36	38%	0.39	1,480	Remaining disturbed areas
7						
8						
9						
10						
Subtotal (1-30)	2.23	1.46	66%	0.64	**5,708**	**Subtotal 1**
Total	2.23	1.46	66%	0.64	**5,708**	**Initial WQv**

Identify Runoff Reduction Techniques By Area

Technique	Total Contributing Area *(Acre)*	Contributing Impervious Area *(Acre)*	Notes
Conservation of Natural Areas	0.00	0.00	*minimum 10,000 sf*
Riparian Buffers	0.00	0.00	*maximum contributing length 75 feet to 150 feet*
Filter Strips	0.00	0.00	
Tree Planting	0.00	0.00	*Up to 100 sf directly connected impervious area may be subtracted per tree*
Total	**0.00**	**0.00**	

Recalculate WQv after application of Area Reduction Techniques

	Total Area *(Acres)*	Impervious Area *(Acres)*	Percent Impervious *%*	Runoff Coefficient Rv	WQv *(ft^3)*
"<<Initial WQv"	2.23	1.46	66%	0.64	5,708
Subtract Area	0.00	0.00			
WQv adjusted after Area Reductions	**2.23**	**1.46**	66%	0.64	5,708
Disconnection of Rooftops		0.00			
Adjusted WQv after Area Reduction and Rooftop Disconnect	2.23	1.46	66%	0.64	**5,708**

Total Water Quality Volume Calculation

WQv(acre-feet) = [(P)(Rv)(A)] /12

All Subcatchments						
Catchment	**Total Area** *(Acres)*	**Impervious Cover** *(Acres)*	**Percent Impervious** *%*	**Runoff Coefficient** *Rv*	**WQv** *(ft^3)*	**Description**
1	0.54	0.35	0.66	0.64	1371.71	Infiltration Basin
2	0.56	0.56	1.00	0.95	2,106	Porous Pavement
3	0.06	0.06	1.00	0.95	219.45	Rain Garden
4	0.08	0.08	1.00	0.95	296.08	Porous Pavement
5	0.06	0.06	1.00	0.95	235.13	Porous Pavement
6	0.94	0.36	0.38	0.39	1479.61	Remaining disturbed areas
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
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25						
26						
27						
28						
29						
30						

Runoff Reduction Volume and Treated volumes						
	Runoff Reduction Techiques/Standard SMPs		**Total Contributing Area**	**Total Contributing Impervious Area**	**WQv Reduced (RRv)**	**WQv Treated**
			(acres)	**(acres)**	**cf**	**cf**
Area/Volume Reduction	Conservation of Natural Areas	RR-1	0.00	0.00		
	Sheetflow to Riparian Buffers/Filter Strips	RR-2	0.00	0.00		
	Tree Planting/Tree Pit	RR-3	0.00	0.00		
	Disconnection of Rooftop Runoff	RR-4		0.00		
	Vegetated Swale	RR-5	0.00	0.00	0	
	Rain Garden	RR-6	0.06	0.06	219	
	Stormwater Planter	RR-7	0.00	0.00	0	
	Rain Barrel/Cistern	RR-8	0.00	0.00	0	
	Porous Pavement	RR-9	0.70	0.70	2637	
	Green Roof (Intensive & Extensive)	RR-10	0.00	0.00	0	
Standard SMPs w/RRv Capacity	Infiltration Trench	I-1	0.00	0.00	0	0
	Infiltration Basin	I-2	0.54	0.35	1372	0
	Dry Well	I-3	0.00	0.00	0	0
	Underground Infiltration System	I-4	0.00			
	Bioretention & Infiltration Bioretention	F-5	0.00	0.00	0	0
	Dry swale	O-1	0.00	0.00	0	0
Standard SMPs	Micropool Extended Detention (P-1)	P-1				
	Wet Pond (P-2)	P-2				
	Wet Extended Detention (P-3)	P-3				
	Multiple Pond system (P-4)	P-4				
	Pocket Pond (p-5)	P-5				
	Surface Sand filter (F-1)	F-1				
	Underground Sand filter (F-2)	F-2				
	Perimeter Sand Filter (F-3)	F-3				
	Organic Filter (F-4	F-4				
	Shallow Wetland (W-1)	W-1				
	Extended Detention Wetland (W-2	W-2				
	Pond/Wetland System (W-3)	W-3				
	Pocket Wetland (W-4)	W-4				
	Wet Swale (O-2)	O-2				
Totals by Area Reduction →			0.00	0.00	0	
Totals by Volume Reduction →			0.75	0.75	2856	
Totals by Standard SMP w/RRV →			0.54	0.35	1372	0
Totals by Standard SMP →			0.00	0.00		0
Totals (Area + Volume + all SMPs) →			1.29	1.10	4,228	0
	Impervious Cover √	error				

Minimum RRv

Enter the Soils Data for the site		
Soil Group	Acres	S
A	1.29	55%
B	0.00	40%
C	0.00	30%
D	**0.00**	20%
Total Area	1.288865932	

Calculate the Minimum RRv		
S =	**0.55**	
Impervious =	1.46	*acre*
Precipitation	1.1	*in*
Rv	0.95	
Minimum RRv	**3,055**	***ft3***
	0.07	af


SOPHIE C FINN SCHOOL


STOP
09.30.2015

Before Rain Garden

After Construction

Ulster County Department of the Environment
17 Pearl Street – PO Box 1800
Kingston, NY 12402
phone: (845) 338-7287 fax: (845) 338-7682
email: environment@co.ulster.ny.us
web: www.co.ulster.ny.us/environment

Michael P. Hein, County Executive

Demonstration Rain Garden

UC Department of the Environment
17 Pearl Street

What is a Rain Garden?

Rain gardens are a stormwater management practice intended to manage and treat small volumes of stormwater runoff from impervious surfaces. Rain gardens are depressed garden beds filled with a variety of native perennials and shrubs that are both water and drought tolerant. They act as simplified versions of bioretention areas and are designed as a passive filter system.

How does a Rain Garden Work?

Rainwater is directed into the garden from residential roof drains, driveways, and other hard surfaces. Rain gardens slowly release runoff into the ground rather than allowing it to flow into the stormwater system. The runoff temporarily ponds in the garden and seeps into the soil over a day or two. The system consists of an inflow component, a shallow ponding area over a planted soil bed, mulch layer, gravel filter chamber, attractive shrubs, grasses, and flowers, and an overflow mechanism to convey larger rain events to the storm drain system.

Drain pipes coming from roof, entering garden area

Benefits of a Rain Garden

Rain gardens have many benefits when applied in urban settings. Most notably, rain gardens can help to:

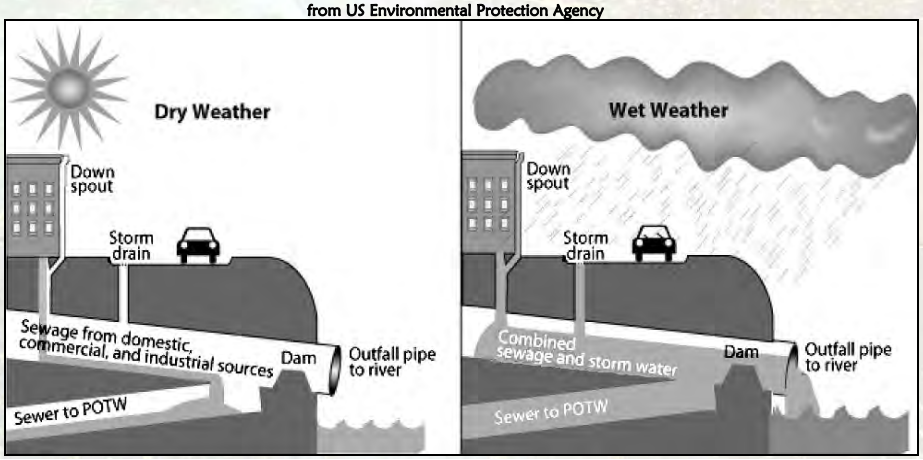
- Keep pollutants (solids, metals, nutrients, and hydrocarbons) from entering waterways
- Protect rivers and streams from erosion
- Recharge local groundwater resources
- Provide habitat for beneficial insects, birds, and other wildlife
- Enhance the landscape versus turfgrass or hard urban surfaces
- Promote watershed education and stewardship

Additional Benefits in Older, Urban Areas

A rain garden in an older city, such as Kingston, has an added benefit; it keeps water out of the municipal sanitary sewage system during a rain event. In many older cities, portions of their stormwater and sanitary sewer systems are combined- both stormwater and sanitary flows into the sewage treatment plant. This works well during fair weather. However, during moderate and larger storms the excess water overburdens the system causing sewage and stormwater to mix and overflow untreated into nearby water bodies. In Kingston, this means that untreated wastewater can be discharged to the Rondout Creek during storms. Raingardens help to keep water from entering the municipal sewage system and result in less untreated waste water being discharged to water bodies during storm events.

Combined Sewer Overflow (CSO)

from US Environmental Protection Agency



Specifics of Our Rain Garden

- Designed by Barbara Restaino, Restaino Design Landscape Architects, PC through the Hudson Valley Regional Council Green Infrastructure Planning Project 2010-2011 *
- Currently handles runoff from almost 1000 sq. ft. of roof, can be expanded to include greater drainage area
- Garden is approx. 300 sq. ft.
- Construction by Ulster County Department of Public Works
  - Area was dug down 24”; 6” gravel base was installed; 12” of native soil was put back in; roof downspouts were redirected into garden area; overflow drain pipes installed but not hooked up
- Plants were provided by Friends of Forsyth Park and Cornell Cooperative Extension of Ulster County

Plant List

Perennials

Blue milkweed	Helen's flower
Swamp milkweed	Blue flag iris
New England aster	Gayfeather
White wild indigo	Cardinal flower
Pink turtlehead	Eastern beebalm
Tickseed	Mountain mint
Purple coneflower	Sweet coneflower
Joe -pye weed	Dwarf ironweed

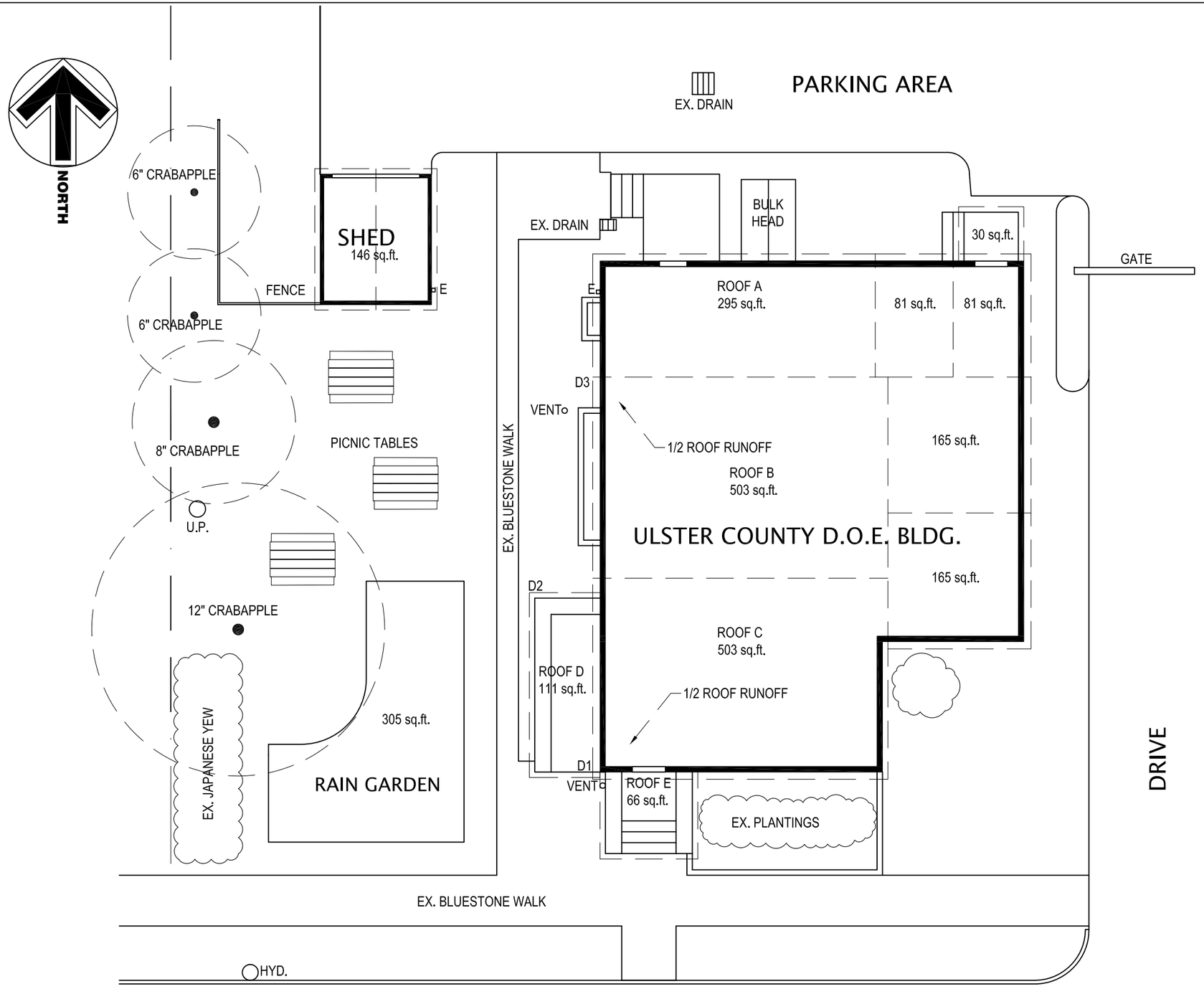
Shrubs and Grasses

New Jersey tea
Summersweet
Prairie dropseed

This garden is designed to serve as a demonstration site. The building, currently used as office space for the UC Department of the Environment, is actually an older home not atypical of Kingston. The area where the garden is located is used as an outdoor lunch site and is adjacent to a pedestrian walkway and the Ulster County Office Building. We hope this project creates interest in the many benefits of rain gardens to the community.

Please visit us at 17 Pearl Street if you have any questions or would like additional information.

* funded by the American Recovery and Reinvestment Act of 2009. Administered by NYS Department of Environmental Conservation



CALCULATIONS FOR RAIN GARDEN CAPACITY

$$WQ_V=\frac{(P)(R_V)(A)}{12}$$

WQv = Water Quality Volume [cubic feet]
P = 90% frequency rainfall event = 1.1 in
Rv is the volumetric runoff coefficient
Rv = 0.05+0.009 (I) = 0.05+0.009(100) = 0.95
I = Percentage impervious area draining to site = 100%
A = Area draining to practice (treatment area) = Roof A + (½ Roof B+C) + D + E = 975ft^2

$$WQ_V=\frac{(1.1)(.95)(975)}{12}= 84.9ft.^3$$

$WQ_V \leq V_{SM} + V_{DL} + (D_P \times A_{RG})$
$V_{SM} = A_{RG} \times D_{SM} \times n_{SM}$
$V_{DL} = A_{RG} \times D_{DL} \times n_{DL}$

where:
V_{SM} = volume of the soil media [cubic feet]
V_{DL} = volume of the gravel drainage layer [cubic feet]
A_{RG} = rain garden surface area [square feet]
D_{SM} = depth of the soil media, 1.0 to 1.5 [feet]
D_{DL} = depth of the drainage layer, 0.5 [feet]
D_P = depth of ponding above surface, maximum 0.5 feet [feet]
n_{SM} = porosity of the soil media (≥ 20%)
n_{DL} = porosity of the drainage layer (≥ 40%)

Vsm= (305 ft.^{2})(1ft)(.20)=61ft.^{3}
Vdl=(305 ft.^{2})(.5ft)(.40)= 61ft.^{3}
Dp=.5ft
Arg=305ft^2

$V_{SM} + V_{DL} + (D_P \times A_{RG})$ is 61ft.^{3}+61ft.^{3}+152.5ft^3=274.5 ft^3

$WQ_V \leq V_{SM} + V_{DL} + (D_P \times A_{RG})$

Volume of roof run-off of roofs A, B,C, D & E during 90% frequency rain event is 84.9ft^3
Volume of rain garden soils, gravel and ponding area is 274.5 ft^3
84.9ft.^{3} ≤274.5 ft^3

Rain garden capacity adequate for 90% frequency rainfall event

ULSTER COUNTY DEPT. OF THE ENVIRONMENT
17 PEARL STREET
KINGSTON, NEW YORK
RAIN GARDEN - BASE MAP
RESTAINO DESIGN
LANDSCAPE ARCHITECTS PC
(845) 985-0202
SCALE: 1"=10'-0"
DATE: 7/11/2011

Plant List

Botanical Name	Common Name	Quantity
	Perennials	
Amsonia X 'blue ice'	Blue milkweed	3
Asclepias incarnata	Swamp milkweed	6
Aster novae-angliae	New England aster	6
Baptisia alba	White wild indigo	3
Chelone lyonii	Pink turtlehead	5
Coreopsis verticillata 'zagreb'	Tickseed	5
Echinacea purpurea 'magnus'	Purple coneflower	4
Eupatorium dubium	Joe -pye weed	5
Helenium autumnale 'red jewel'	Helen's flower	5
Iris versicolor	Blue flag iris	6
Liatris spicata 'floristan white'	Gayfeather	3
Lobelia cardinalis	Cardinal flower	6
Monarda bradburiana	Eastern beebalm	4
Pycnanthemum muticum	Mountain mint	3
Rudbeckia subtomentosa	Sweet coneflower	3
Veronia lettermanii 'iron butteryfly'	Dwarf ironweed	5
	Shrubs and Grasses	
Ceanothus americanus	New Jersey tea	3
Clethre alnifolia 'sixteen candles'	Summersweet	3
Sporobolus heterolepsis	Prairie dropseed	8

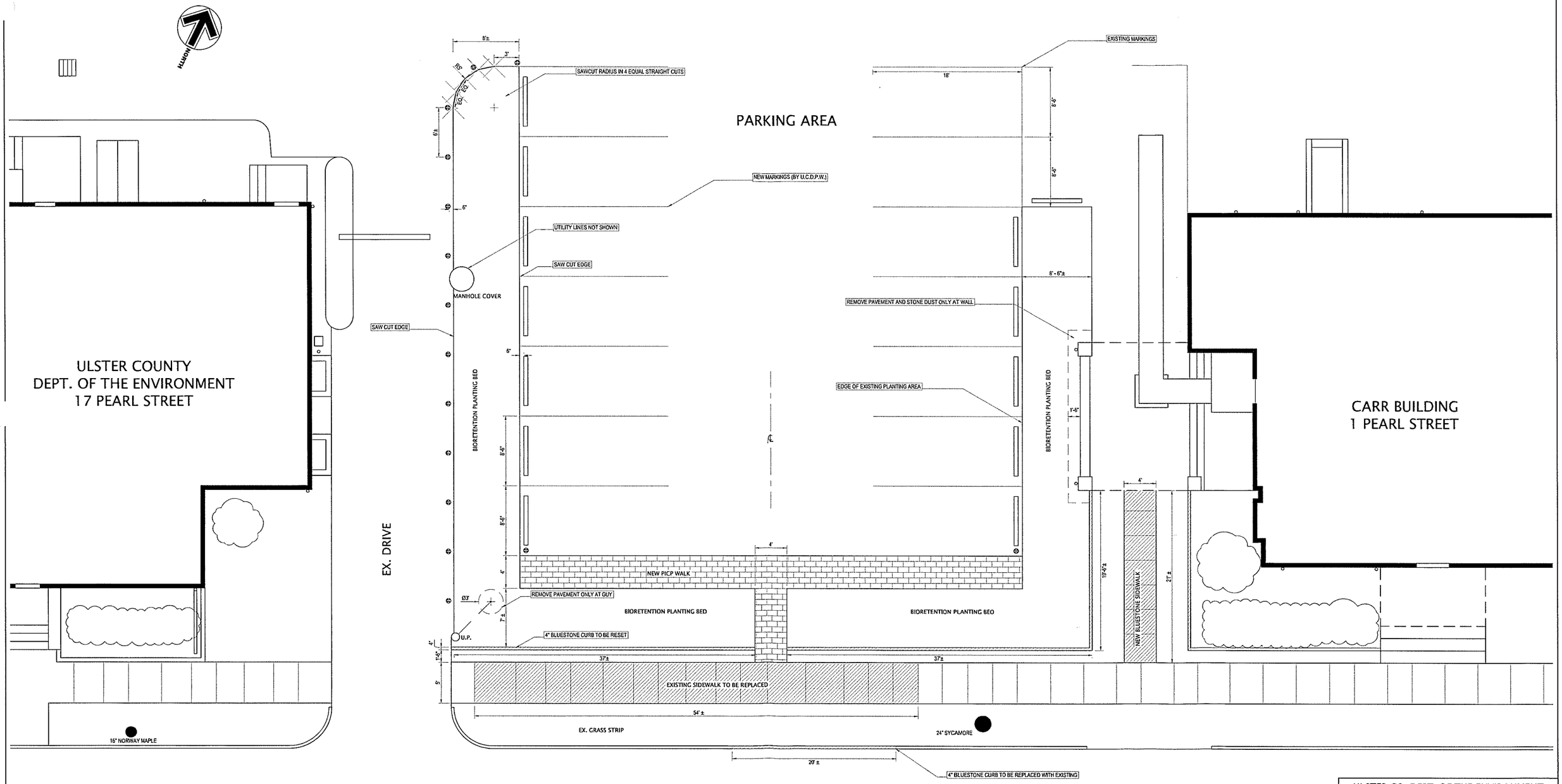

08.08.2011


CAUTION
08 . 10 . 2011


08.16.2011


09.29.2011


2019



NO EXCAVATION MAY BE MADE UNTIL ALL UNDERGROUND UTILITIES ARE LOCATED AND MARKED IN THE FIELD.
CALL DIGSAFE 811 2 TO 10 DAYS IN ADVANCE OF START DATE, NOT COUNTING DATE OF CALL.

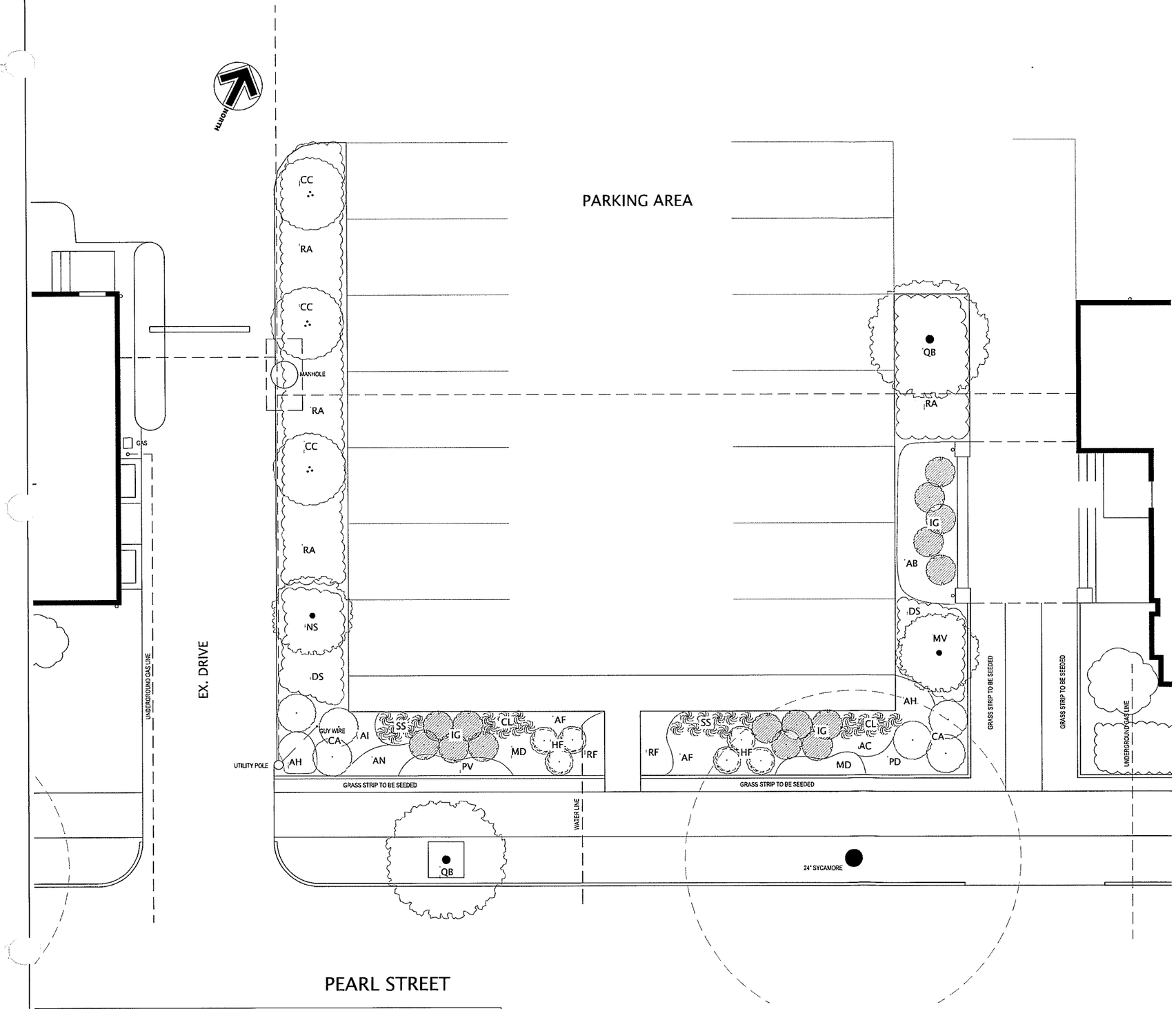
ULSTER CO. DEPT. OF THE ENVIRONMENT

KINGSTON, NEW YORK

BIORETENTION AREA DIMENSION PLAN

RESTAINO DESIGN
LANDSCAPE ARCHITECTURE, PC
P.O. BOX 778
GRAHAMSVILLE, NY 12740
TEL: 845-985-0202
bzr@restainodesign.com

DRAWN BY: DCM / BZR	REVISED: 9/6/2013	SCALE: 3/16"=1'-0"
DATE: 8/21/2013	NOTE REVISION DATE DISREGARD EARLIER COPIES	SHEET #: 3 OF 4



NO EXCAVATION MAY BE MADE UNTIL ALL UNDERGROUND UTILITIES ARE LOCATED AND MARKED IN THE FIELD.
CALL DIGSAFE 811 2 TO 10 DAYS IN ADVANCE OF START DATE, NOT COUNTING DATE OF CALL.

PLANT LIST

KEY	BOTANICAL NAME	COMMON NAME	#	SIZE
	PERENNIALS AND GRASSES			
AF	AGASTACHE FOENICULUM 'BLUE FORTUNE'	ANISE HYSSOP	10	1 GAL
AB	AMSONIA X 'BLUE ICE'	BLUE ICE AMSONIA	12	1 GAL
AH	AMSONIA HUBRICHTII	THREAD LEAF BLUESTAR	8	1 GAL
AI	ASCLEPIAS INCARNATA	SWAMP MILKWEED	6	1 GAL
AC	ASTER CORDIFOLIUS	BLUE WOOD ASTER	6	1 GAL
AN	ASTER NOVAE-ANGLIAE	NEW ENGLAND ASTER	6	1 GAL
CL	CHASMANTHIUM LATIFOLIA	NORTHERN SEA OATS	15	2 GAL
MD	MONARDA DIDYMA 'RASPBERRY WINE'	RASPBERRY WINE SCARLET BEEBALM	11	1 GAL
PD	PENSTEMON DIGITALIS 'HUSKERS RED'	HUSKERS RED PENSTEMON	8	1 GAL
PV	PHYSOSTEGIA VIRGINIANA 'MISS MANNERS'	MISS MANNERS OBEDIENT PLANT	9	1 GAL
RF	RUDBECKIA FULGIDA VAR. FULGIDA	BLACK-EYED SUSAN	12	1 GAL
SS	SCHIZACHYRIUM SCOPARIUM 'PRAIRIE BLUES'	PRAIRIE BLUES LITTLE BLUESTEM	16	2 GAL
	TREES AND SHRUBS			
CC	CERCIS CANADENSIS	AMERICAN REDBUD	3	1 - 1 ½" CAL, SINGLE STEM
CA	CLETHRA ALNIFOLIA 'RUBY SPICE'	RUBY SPICE SUMMERSWEET	6	5 GAL
DS	DIERVILLA SESSILIFOLIA	AMERICAN LOWBUSH HONEYSUCKLE	12	3 GAL
HF	HYPERICUM FRONDOSUM 'SUNBURST'	SUNBURST ST. JOHNSWORT	6	3 GAL
IG	ILEX GLABRA 'SHAMROCK'	SHAMROCK INKBERRY	15	3 GAL
MV	MAGNOLIA VIRGINIANA	SWEETBAY MAGNOLIA	1	7 - 8' CONTAINER
NS	NYSSA SYLVATICA	BLACK TUPELO	1	7 - 8' CONTAINER
QB	QUERCUS BICOLOR	SWAMP WHITE OAK	2	1 ½ - 2" CAL
RA	RHUS AROMATICA 'GRO-LO'	GRO-LO AROMATIC SUMAC	20	3 GAL

LAWN SEED MIX

FINE FESCUE SEED MIX:
- 20% HARD FESCUE
- 40% CHEWINGS FESCUE
- 40% CREEPING RED FESCUE

SEEDING RATE: 4 LBS. PER 1000 SQ. FT.

THE LANDSCAPE ARCHITECT SHALL APPROVE THE BIORETENTION SOIL MIX AND PLANTING BED LEVEL BEFORE INSTALLATION.THE LANDSCAPE ARCHITECT SHALL APPROVE PLACEMENT OF ALL PLANTS BEFORE INSTALLATION.

ALL NEW PLANTINGS ARE TO BE GUARANTEED BY THE CONTRACTOR FOR ONE FULL YEAR FROM THE TIME OF ACCEPTANCE OF THE PROJECT BY THE ULSTER COUNTY DEPARTMENT OF THE ENVIRONMENT AND THE ULSTER COUNTY DEPARTMENT OF PUBLIC WORKS. ANY PLANTS THAT DO NOT SHOW VIGOR OR HEALTH OR ARE DAMAGED SHALL BE REPLACED.

TURF GRASS SEEDED AREAS SHALL BE IN SATISFACTORY CONDITION AS DETERMINED BY THE ULSTER COUNTY DEPARTMENT OF THE ENVIRONMENT AND THE ULSTER COUNTY DEPARTMENT OF PUBLIC WORKS ONE YEAR FROM ACCEPTANCE.

ULSTER CO. DEPT. OF THE ENVIRONMENT

KINGSTON, NEW YORK

BIORETENTION AREA PLANTING PLAN

RESTAINO DESIGN
LANDSCAPE ARCHITECTURE, PC
P.O. BOX 778
GRAHAMSVILLE, NY 12740
TEL: 845-985-0202
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DATE: 8/21/2013	NOTE REVISION DATE DISREGARD EARLIER COPIES	SHEET #: 2 OF 4


ULSTER COUNTY
EMPLOYEE
PARKING
ONLY
09.18.2012


Bobcat

PE7 Action: Green Infrastructure

1 — 14 Points

A. Why is this action important?

Green infrastructure (GI), sometimes referred to as Low Impact Development or Better Site Design, uses natural processes to capture stormwater or rain through retention, infiltration, or evapotranspiration. While some GI measures support the reuse of water, (landscaping, for example), the main objective for GI is to decrease flooding and combined sewer overflows (CSO). With the increase of heavy precipitation events, separated storm sewers often cannot accommodate these larger runoff volumes. Implementing GI practices can help maintain the capacity of storm sewers and thereby save the local government significant financial resources that would be required to address inadequate flow capacities. Effective GI measures reduce sewer overflows and flooding, improve water quality, recharge aquifers, help improve air quality, increase biological sequestration of carbon, reduce urban heat island effects, restore habitat, help improve aesthetics, and create more community green space.

Green infrastructure practices may include the following:

- Green walls
- Green roofs
- Rainwater harvesting and reuse (rain barrels and cisterns)
- Downspout disconnection (redirecting roof runoff to a vegetated, pervious area, cistern or rain barrel)
- Bioretention systems with appropriate vegetation, such as bioinfiltration areas, rain/recharge gardens, vegetated swales, stormwater planters, and stormwater street tree plantings (engineered tree pits, tree boxes, or trenches)
- Permeable pavements
- Stream daylighting (i.e., exposing formerly culverted or buried streams)

Green infrastructure projects should be implemented in strategic locations to mitigate water quantity or quality impacts from existing and new development. A watershed approach should be used to assess the most strategic sites or strategies to manage stormwater using green infrastructure.

Municipalities should also consider equity and environmental justice issues when planning green infrastructure projects. For example, siting green infrastructure near economically disenfranchised neighborhoods could lead to a phenomenon known as “green gentrification” (see Greening in Place Toolkit in section G).

NY State Pollutant Discharge Elimination System (SPDES) permits may require sewer separation or stormwater outfall removal projects which may make GI projects an attractive, low-cost solution. The NYS Small Municipal Separate Storm Sewer System (MS4) General Permit requires regulated municipal entities provide adequate oversite and approval of standard stormwater management practices and green infrastructure practices constructed under the SPDES General Permit for Stormwater Discharges Associated with Construction Activity. These regulated construction activities may require implementation of green infrastructure and include sites which have a land disturbance greater than 1 acre and that necessitate a stormwater runoff reduction volume to be managed.

B. How to implement this action

To implement this Climate Smart Communities (CSC) action, communities should consider the following steps:

1) **Update or create a community-wide plan for green infrastructure** projects as a stand-alone plan or part of a CSO Long

Term Control Plan, Hazard Mitigation Plan, or other relevant planning document. This step may be combined with the feasibility study outlined below, depending on the size and scope of the community.

- Outline goals related to green infrastructure, which may include reducing sewer overflows/volume and combating flooding, heat stress and other climate and social risks.
- Identify existing and potential future developed sites that are viable for onsite stormwater management using green infrastructure. Assess all municipally owned or operated properties or facilities for opportunities to install green infrastructure projects.
- Consider and identify targeted locations for implementation based on physically-conducive locations but also equity and environmental justice issues like “green gentrification.” Sites could include the following:
    - Alleys and streets
    - Parking lots
    - Municipally-owned land
    - Residential and commercial properties
- Identify the most strategic locations for green infrastructure within the community to holistically manage stormwater based on watersheds and combined or separated sewersheds. Consider upstream sources of localized or riverine flooding. Consider existing site conditions, including land use, soil types and depth to water table and bedrock.
- Outline policy changes and/or incentives that will be needed to achieve your community’s green infrastructure strategy and goals. These could address zoning, pilot projects, rights-of-way, financial incentives like a stormwater fund, and more.
- Outline general operating and maintenance goals for existing and future GI. Individual GI projects will require their own unique operating and maintenance plan; some of the resources in Section G below can help with this. Consider providing green jobs by supporting community members to become certified to maintain, inspect and install green infrastructure through the National Green Infrastructure Certification Program. For example, see PUSH Buffalo’s PUSH Blue program.
- Outline training strategy for regular training for local government staff, code enforcement officers, engineers, planning board members, and zoning board members in planning, siting, implementing, and maintaining green infrastructure; some of the resources in Section G below can help inform the design of trainings. Trainings should be at least two hours and completed at least every two years for relevant staff.

2) **Complete green infrastructure training** on a regular basis (as described above).

3) **Conduct a feasibility study** community-wide or for priority projects identified in the plan.
- Identify and work with landowners where permission may be needed to implement projects in strategic locations that could reduce flooding or improve water quality. - Working with an engineer, landscape architect, or other qualified professional to complete a feasibility study for priority projects. Depending on project location, consult with the relevant entities, such as the New York State (NYS) Department of Transportation, County Department of Public Works, and other local fire departments/emergency services. The feasibility study should include the following:
- A description of existing conditions to ensure that GI will work in the proposed location, reviewing site conditions such as ground water, soil types, depth to bedrock - A project description and conceptual site plan, including an estimate of the water quality volume to be managed - A list of all permit requirements, including state, local, and NYS Environmental Quality Review Act (SEQR), if applicable - A long-term operations and maintenance plan that covers the entire useful life of the practice

Note: Detailed descriptions of the aspects that should be included in a feasibility study are available online from the following state agencies: NYS Environmental Finance Corporation (EFC): GIGP Required Documentation Guidance (PDF) and NYS Water Quality Improvement Project (WQIP) Program (PDF, see pages 17-24 and Appendix B) .

- Ensure that all aspects of selected strategy comply with NYS Department of Health regulations and building codes regarding rainwater harvesting and gray water recycling.
- Consider equity and environmental justice impacts of green infrastructure and avoid “green gentrification.”

4) **Implement green infrastructure projects** in targeted areas:

- Ensure compliance with all applicable codes, including the design criteria found in Chapters 5 and 6 of the NYS Stormwater Management Design Manual for green infrastructure practices.

- Inspect and maintain green infrastructure. Support a regular maintenance schedule (at least every two years) with proper equipment and adequate staffing.
- Provide green jobs by supporting community members to become certified through the National Green Infrastructure Certification Program. For this CSC action, demonstrate support for the National Green Infrastructure Certification Program (NGICP) by showing that NGICP-certified community members were used in implementing a project and/or by submitting maintenance plans that require the use of NGICP-certified community members for installation, inspection, and/or maintenance.

C. Timeframe, project costs, and resource needs

The timeframe to implement this measure depends on the number and scale of specific green infrastructure projects a community is looking to implement. In general, a community should be able to complete this action within one or two years. In many cases, additional funding or staffing resources may be needed to implement this action.

D. Which local governments implement this action? Which departments within the local government are most likely to have responsibility for this action?

This action is applicable to all types of local governments. The departments or people with the responsibility for leading the Municipal Separated Storm Sewer System (MS4) program, planning and zoning, engineering and building codes, the designated Floodplain Administrator, will most likely be responsible for this action. For this effort to be successful, cross-department involvement and support are recommended. Municipal committees, such as CSC task forces, conservation advisory councils, and environmental conservation committees and neighboring municipalities may also be involved. Soil and Water Conservation Districts, Watershed groups, regional groups and county agencies may be able to contribute valuable information and expertise.

E. How to obtain points for this action

Points for this action are tiered based on completion of the components described below. All must have occurred within ten years prior to the application date.

	POSSIBLE POINTS
Update or create a community-wide plan for green infrastructure	2
Implement one or more policy changes and/or incentives (e.g., zoning, rights-of-way, financial incentives)	4
Complete at least two hours of green infrastructure training for 50% or more of community's code enforcement officers, MS4 stormwater officers, engineers, and zoning and planning board members	1
Complete a feasibility study for green infrastructure for one or more priority locations	2
Implement a green infrastructure project. Points are based on the project's estimated amount of water treated or captured: Up to 4,999 cubic feet	2
5,000 cubic feet or more	4
Support the National Green Infrastructure Certification Program (NGICP) for community members to maintain, inspect and install green infrastructure projects	1

F. What to submit

This action has seven different tiers of points (as above); clearly describe the tiers for which the local government is applying.

For plans, policy changes, and/or feasibility studies, submit copies of them (or the web addresses where they can be found online).

If trainings were completed, submit the names and titles of the staff that attended and documentation describing the scope, date, and length of the training.

For NGICP support, show that NGICP-certified community members were used in implementing a project and/or submit maintenance plans that require the use of NGICP-certified community members for installation, inspection, and/or maintenance.

For implementation of green infrastructure projects, provide before and after photos, in addition to evidence of project design, a maintenance plan, and the estimated amount of water treated or captured.

All CSC action documentation is available for public viewing after an action is approved. Action submittals should not include any information or documents that are not intended to be viewed by the public.

G. Links to additional resources or examples

Green infrastructure and stormwater resources

- DEC What is Stormwater?
- DEC NYS Stormwater Management Design Manual
- DEC State Pollutant Discharge Elimination System (SPDES) Permit Program
- DEC Erosion and Sediment Control Training
- DEC Maintenance Guide for Stormwater Management practices (PDF)
- EFC Green Innovation Grant Program
- Georgetown Climate Center Green Infrastructure Toolkit
- University of New Hampshire Stormwater Center
- Low Impact Development Center
- US EPA: Storm Smart Cities - Integrating Green Infrastructure into Local Hazard Mitigation Plans
- US EPA Green Infrastructure
- US EPA National Menu of Stormwater Best Management Practices
- US EPA Low Impact Development Resources
- US EPA Operation and Maintenance Considerations for Green Infrastructure

Equity and training resources

- National Green Infrastructure Certification Program
- PUSH Buffalo PUSH Blue program
- Planning for Equity in Parks with Green Infrastructure
- Resource Guide for Planning, Designing and Implementing Green Infrastructure in Parks with spotlight on Equity
- ESRI Introduction to Green Infrastructure
- Lower Hudson Coalition of Conservation Districts' Reviewing Stormwater Management in Site Design: A Guide for Planning Board Members (PDF)
- Audubon Greening in Place Toolkit

Green infrastructure case studies

- Wetlands Watch Green Infrastructure Plan examples
- DEC Hudson River Estuary Program Green Infrastructure Examples for Stormwater Management in the Hudson Valley
- City of Newburgh Green Infrastructure Feasibility Report (PDF)
- "Rain Check" Buffalo Sewer Authority's Green Infrastructure Master Plan (PDF

- Buffalo, NY, Long Term Control Plan (PDF)
- Hoboken, NJ, Green Infrastructure Strategic Plan
- City of Rochester, NY, Green Infrastructure retrofit manual
- New York City, NY Green Infrastructure Plan

H. Recertification Requirements

The recertification requirements are the same as the initial certification requirements.