Seneca Bluffs Natural Habitat Park
Green Infrastructure Feasibility Study

APPLICANT | Erie County Department of Environment & Planning
95 Franklin St
Buffalo, NY 14202

PROJECT LOCATION | Seneca Bluffs Natural Habitat Park
1670 Seneca Street
Buffalo, NY 14210

PREPARED BY | Barton & Loguidice, DPC
11 Centre Park
Rochester, NY 14614

February 12, 2021

Green Innovation Grant Program **2021**

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II. Executive Summary

Erie County has identified a need for a Green Infrastructure (GI) Feasibility Study focused on the "front door" of Seneca Bluffs Natural Habitat Park, located in the City of Buffalo, NY. The project site comprises 0.7 acres of gravel parking, municipal streetscape, and entrance into the park, and is located adjacent to the Buffalo River. See **Figure 1** for site location. Green infrastructure improvements have the potential to transform this site into a high performance landscape system that improves stormwater management and contributes to environmental equity in the community.

The Buffalo River and Seneca Bluffs are critical assets to this project, and supporting the health and resiliency of these two natural resources is a priority for this project. The Buffalo River is an impaired waterbody and is classified as a 303(d) waterbody. It receives outflows from both combined sewer and municipal storm sewer systems. The GI practices proposed at this site will provide a multitude of benefits, including the reduction in quantity of stormwater entering the existing drainage systems, reduction in pollutant levels entering the systems, improvement of the quality of stormwater ultimately discharging into the Buffalo River, and will complement local ecological systems at Seneca Bluffs Natural Habitat Park. These are consistent with recommendations for natural space planning and preservation, environmentally sensitive areas, and stormwater and drainage included in Chapter 6 of the Niagara River Watershed Management Plan. As a secondary tier of benefits, green infrastructure improvements will also benefit multi-modal transportation along Seneca Street, increase awareness of the Park, build a recreational destination for the community that fits a range of user groups, and serve as educational infrastructure. GI practices proposed at the project site include:

- Bioretention
- Stormwater Harvest & Reuse
- Stormwater Street Trees
- Permeable Pavement
- Green Roof

The Seneca Bluffs Natural Habitat Park GI Project will connect to the Buffalo Niagara Waterkeeper Paddlecraft and Shoreline Enhancement Project that is funded and scheduled for construction in 2021. There is a unique opportunity for these two projects to work together to make an impact on both a local and citywide scale. This includes welcoming visitors to travel to the site and stay at the Seneca Bluffs Natural Habitat Park, encouraging use of the Park as a blue-green recreational node along the Buffalo River, and educating on the importance of stormwater management in Buffalo.

The GIGP project at Seneca Bluffs will help advance the relationship between green infrastructure and environmental justice in New York State. Median household income for the City of Buffalo in 2018 was $37,359, and the overall poverty rate was 30.3% (pre-COVID data). Seneca Bluffs is within walking distance of potential environmental justice areas mapped by NYSDEC, and is less than ½ mile from Southside Elementary School (Buffalo Public School #93).

Current national research indicates that green infrastructure practices can bring environmental, economic, and social benefits to the communities that need them the most. Integrating green infrastructure systems into public spaces that are highly visible and accessible creates a platform for advancing environmental equity. Green infrastructure projects like Seneca Bluffs can prioritize environmental justice communities facing disproportionate climate-risk and pollution burden. Seneca Bluffs will be a transformative project that utilizes green practices to provide multiple environmental, economic, and social benefits.

III. Project Objectives

Erie County is determined to provide a project that is context-sensitive and maximizes the performance of green infrastructure practices. With a close proximity to the Buffalo River, which is an impaired waterbody, and connection to the Seneca Bluffs Natural Habitat Park, the proposed green infrastructure system will prioritize the following objectives:

- Eliminate to the extent feasible the quantity of stormwater released from the project site entering the existing drainage and sewer systems, and further, entering the Buffalo River
- Provide measurable improvements to the quality of stormwater entering the Buffalo River, including the reduction of known pollutant sources, such as sediment
- Protect and preserve local habitats and ecology of the Park
- Ensure environmental sensitivity towards the Buffalo River ecology

In addition to the primary stormwater management objectives, the project will maximize secondary co-benefits of green infrastructure practices, including:

- Improved air quality
- Reduction of greenhouse gases
- Urban Heat Island mitigation
- Public Health and Social benefits
- Biodiversity and pollinator habitat
- Year-round visual quality

GI design will also focus on multi-modal connectivity between the Buffalo River, the Park, and the Streetscape to connect the community the environment and increase awareness of the Park's presence and welcome visitors into the Park.

IV. Existing Conditions

A. Current Land Use

The project area is part of the Seneca Bluffs Natural Habitat Park. The overall park is approximately 15 acres of riparian habitat located in a heavily urbanized area of the City of Buffalo. The park is owned and operated by Erie County Parks, Recreation and Forestry. Historically, the site had mixed-use, including farming. Currently the park is being preserved for its unique and critical habitat areas and is anticipated to become part of the Buffalo River Greenway Trail. The project area is limited to the front portion of the park, approximately 0.7 acres in size, that currently is comprised of a gravel parking area for the Park, municipal streetscape, and transition to the Park. Full topographic and boundary survey have been completed for this project site. See **Figure 2** for the Existing Conditions Graphic and **Attachment 1** for site photographs.

Existing Conditions

B. USDA Web Soil Survey Classifications

A review of the USDA Web Soil Survey was conducted for the project area. The park is comprised of three primary soil groups. The limited project area is comprised of only one. The following table provides information regarding the soils classification in the project area.

USDA Web Soil Survey Soil Classifications				
Symbol	**Name**	**Depth to Bedrock**	**Depth to Water Table**	**Hydrologic Soil Group**
Soils Within Project Area				
Uc	Udorthents, smoothened	>6'9"	4'6"	None Specified
Soils Surrounding Project Area				
Hm	Hamlin silt loam	>6'9"	4'6"	B
Fu	Fluvaquents & Udifluvents, frequently flooded	>6'9"	6"	A/D

C. Other Site Constraints

Wetlands

A review of the National Wetlands Inventory (NWI) wetlands mapper did not indicate the presence of wetlands within the project area. The Buffalo River, located immediately north of the project area and bounding a large portion of the park, is shown as a riverine system. The Buffalo River is classified by NYSDEC as a Class C waterbody, and is listed by NYSDEC as an impaired waterbody and 303(d) for PCBs from contaminated sediment.

Floodplains

The project area is depicted on FEMA Flood Insurance Rate Map (FIRM) 36029C0327H, effective June 7, 2019. The Buffalo River, immediately north of the project site is detailed as Zone AE, with a delineated floodway. According to the Flood Insurance Study, immediately upstream of the Seneca Street bridge, the Base Flood Elevation is shown to be approximately 585.5 NAVD88. The design will seek to eliminate to the extent feasible any modifications within the 100-year floodplain. See Section VII for more information.

Site Contaminations & Brownfield Remediation

According to the NYSDEC Info Locator, no known permits, registrations, or environmental cleanup/ monitoring programs are located within the project area. A Petroleum Bulk Storage facility is registered for the auto service station across the street from the project area.

Historic Significance

A review of the Cultural Resource Information System (CRIS) indicates that two Phase I Cultural Resource Investigations were conducted at the project site, including one focusing along the Jordan Place access and along the Buffalo River for the Seneca Bluffs Habitat Restoration Project, and a second focusing between Jordan Place and Avon Place, and extending back to the Buffalo River for a previously proposed DePaul Buffalo Housing Project. It appears that a former structure (presumed to be the location of a former Deco Restaurant) located within the project area was determined to be Not Eligible – Demolished during these investigations. The project area is located within an archaeologically sensitive area. Refer to Section VII for a discussion of how this will be addressed.

Threatened and Endangered Species

A review of the NYS Environmental Resource Mapper (ERM) did not indicate the presence of any species of concern or critical habitat. A review of the USFWS IPaC system indicated the potential for the Northern Long-eared Bat to be present. This will be addressed during design, but is not anticipated to impact the project as no tree removal is proposed and NYSDEC Environmental Resource Mapper indicates an absence of protected species shading.

Utilities

All of the utilities near the park run along Seneca Street and Avon Place. On Seneca Street, utilities are located within the right-of-way below the sidewalk. Utilities in this area include gas, underground electric, an above ground light pole, a combined sanitary sewer, and a separate storm drain system. On Avon Place, an additional gas line and oil line run on the northwester side of the street and the eastern edge of the park boundary.

In the project area, the sanitary collection system is known to be a combined system owned by the Buffalo Sewer Authority. The 24" brick combined sewer along Seneca Street outfalls into the Buffalo River at CSO No. 050 (SPDES Permit: NY0028410), just upstream of the Seneca Street bridge. A separate 12" PVC storm system was also identified along Seneca Street that outfalls just upstream of the Seneca Street Bridge. The design of the project will consider grading and flow paths to eliminate to the extent feasible the quantity of stormwater entering the existing drainage system. Additionally, GI practices will be design to maximize stormwater capture and reuse to further reduce potential stormwater entering the existing drainage system.

Other

As indicated previously, there are historic reports of a building located at the project site with the potential for the foundation to remain.

D. Subsurface Investigations

Subsurface investigations were conducted at the site by NW Contracting in January 2021. These investigations included 3 soil borings and infiltration tests within the project area. The boring logs and infiltration testing results are included in **Attachment 2**. Key elements from the investigations indicate:

- Bedrock was not located within any of the borings taken. Borings were taken to a depth of 12'. Each of the borings found subsurface materials of silt and silty-sand.
- Evidence of ground water was not observed within any of the borings taken within the project area. The infiltration rates were as follows:
    - B1/IW-1: 0.84 in/hr
    - B2/IW-2: 2.76 in/hr
    - B3/IW-3: 2.04 in/hr
    - Average: 1.88 in/hr (used for water quality volume calculations)
- The infiltration rates exceed the 0.5 in/hr parent soil infiltration rate required for green infrastructure practices by the NYS Stormwater Management Design Manual.

V. Project Description

The implementation of green infrastructure at Seneca Bluffs Natural Habitat Park will provide for stormwater infiltration, bioretention, biofiltration, stormwater intercept, evapotranspiration, and stormwater harvest and reuse. The practices are linked together to allow overflow from one GI practice to the next. Stormwater can receive multiple levels of treatment before discharging into the Buffalo River.

To connect the community to this demonstration of green infrastructure design, educational infrastructure will illustrate the efficacy of these systems working together to achieve the highest water quality benefits. The placement of each practice will also aid in circulation within the parking lot for school buses, personal vehicles, bicycles, and pedestrian, improve and define the appearance of the Park, and provide benefits to the ecosystems at Seneca Bluffs Natural Habitat Park. See **Figure 3** for the Conceptual Site Plan.

A. Recommended GI Practices

Bioretention:

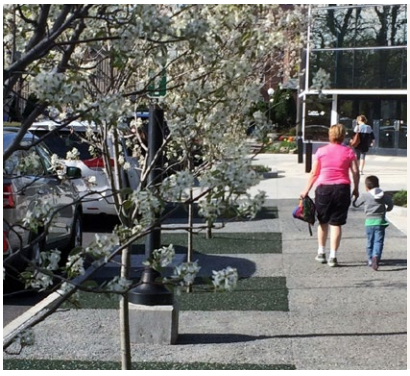
6,500 SF of bioretention areas are strategically located to capture and allow infiltration and treatment of stormwater flowing from the parking lot, Seneca Street, and Avon Place before they enter the combined stormwater outflow system. These include infiltration islands in the parking area and two larger areas. Adjacent to the parking lot, these areas will be curbed, with drop curbs placed and oriented according to the flow patterns along the parking lot. Along the street, curb inlet chases will be located to channel runoff from the street into bioretention areas.

Bioretention areas will be planted with a diverse set of native species, and a total of 12 trees, providing a range of benefits including year round interest, habitat creation, and pollinator capabilities. The diversity of species selected will increase the resiliency of these populations for years to come, increasing pest and disease resistance. Criteria for selecting these species and designing these areas will include low maintenance considerations, such as incorporation of herbaceous species that can tolerate snow storage, and relationship to local ecological systems at Seneca Bluffs Natural Habitat Park.

Permeable Pavements:

The concrete sidewalk along Seneca Street will be reconstructed and widened with the placement of 2,190 SF of permeable interlocking concrete pavers (PICP). PICP will allow infiltration of stormwater through the spaces between pavers into a base course of CU Structural Soil. This change in material from standard concrete to PICP will reduce impervious surface, improve pedestrian mobility, and enhance the appearance of the Park along Seneca Street.

The multi-use pathways around the parking lot will consist of 5,350 SF of flexi-pave pavement, which has proven to be a reliable permeable pavement material and is ADA compliant. Flexi-pave is composed of recycled vehicle tires and removes up to 90% of soluble phosphates and nitrates. The appearance of the pathway will incorporate both naturalized colors and the Buffalo Blueway colors with a distinctive design unique to the Park.



Stormwater Street Trees:

Street trees will be placed along the drive aisle leading into Seneca Bluffs Natural Habitat Park. This 370 SF band of trees will define the edge of the parking area and provide additional path width between tree surrounds. The street tree system will include planting three trees in CU structural soil that provide water quality improvements through infiltration and evapotranspiration. On the surface, the trees will be surrounded by a flexi-pave material. Under drains in an underlying storage layer will carry excess, filtered flow into the existing drainage system.

Selection criteria for tree species will include hardy native species as recommended by NYSDEC for GI installations, salt tolerance, and resistance to pests and disease.

Stormwater Harvesting & Reuse:

Three (3) 220 SF picnic shelters will be pitched to direct rainwater into 900 SF total of rain gardens populated with indigenous wetland species. The associated rain gardens proposed for Seneca Bluffs will reference native plant communities along the Buffalo River corridor.

The 160 SF bicycle shelter and half of the larger group pavilion (330 SF) will be pitched to direct rainwater into rain barrels. These will slowly release water into an adjacent, central rain garden area, and during overflow will directly discharge into adjacent rain gardens. This stormwater interception reduces velocity of water entering the rain garden, and allows storage of rain water to be used to water the rain gardens and other bioretention areas during droughts.

The diversity of these shelters will serve community user groups, with the large pavilion functioning as an outdoor classroom and group event space, while the individual picnic pavilions will provide spaces for families and smaller groups to gather. These spaces have proven to be valuable during the challenges of the pandemic.

Green Roof:

The other half of the larger group pavilion (330 SF) will be covered in a semi-intensive green roof with 8" depth soil media. The green roof will not only offer a unique aesthetic to vehicles and pedestrians along Seneca Street or entering the park, but also provide stormwater benefits and additional pollinator habitat. Surcharge from the green roof will be collected in rain barrels.

Educational Infrastructure:

Following the NYSEFC signage guidance, three interpretive signs will be incorporated into the site plan to illustrate the diversity of approaches to GI design at the project site and educate visitors on the significance of the green infrastructure practices as an interconnected system.

A. GI Practice Sizing and Water Quality Volume (WQv) Calculations

Potential Water Quality Treatment Volumes were computed by J. M. Davidson based on the anticipated catchment areas for each stormwater treatment device/area within the project area. The anticipated catchment areas are depicted on **Figure 3**. Water Quality Volumes were computed in accordance with the NYS Stormwater Management Design Manual, utilizing 1.0" of rainfall for the Buffalo region. Green infrastructure devices will be designed to treat the full WQv for their respective catchment area. The table below shows the anticipated treatment volumes. Calculation worksheets can be found in **Attachment 3**.

$$WQv = \frac{P \times R_v \times A}{12} \qquad R_v = 0.05 + 0.009(I)$$

Catchment No.	Location	Drainage Area (sf)	Drainage Area (ac)	I (%)	Rv	WQv (ac-ft)
1	Harvest & Reuse, Bicycle Shelter	352	0.008	50	0.50	0.0003
2	Harvest & Reuse Large Pavilion	535	0.012	60	0.59	0.0006
3	Green Roof	326	0.007	100	0.95	0.0006
4	Permeable Pavement Sidewalk (NW)	1320	0.030	100	0.95	0.0024
5	Permeable Pavement Sidewalk (NE)	2670	0.061	100	0.95	0.0049
6	Rain Garden/Harvest Re-Use Picnic Pavilions (3)	1312	0.030	50	0.50	0.0013
7	Bioretention (SE)	11869	0.272	86	0.82	0.0187
8	Permeable Paver Sidewalk	2205	0.051	100	0.95	0.0040
9	Bioretention (S)	13482	0.310	71	0.69	0.0177
10	Stormwater Street Trees	2040	0.047	100	0.95	0.0037
11	Bioretention (W)	1910	0.044	82	0.79	0.0029
12	Bioretention Island (W)	850	0.020	65	0.64	0.0010
13	Bioretention Island (E)	542	0.012	28	0.30	0.0003

Total Potential Water Quality Volume Treatable	**ac-ft**	**0.0585**
	cf	**2546**

VI. Project Schedule

The following anticipated project schedule considers coordination, design, review, deliverables, and construction tasks and periods. A key assumption of the schedule is that grant award notifications will be completed by May 2021.

Grant Awarded	**June 2021**
Grant Agreement Executed	August 2021
RFP for Design	August 2021
Selected Firm	February 2022
Preliminary Design	Begin March 2022
Permit Agency and Sponsor Review	May 2022
Reviews Completed	June 2022
Final Design	Begin End of June 2022
Final Design & Reviews Completed	September 2022
Bidding, Letting, Award	October 2022 to November 2022
Construction Begins	March 2023
Construction Ends	**August 2023**

VII. Regulatory Approval & Permits

The proposed project will not impact any regulated waterbodies or wetlands.
The project is within the New York State Coastal Zone, as mapped by the New York State Department of State (NYSDOS). The City of Buffalo has an approved Local Waterfront Revitalization Program (LWRP), which includes the project area. Access to the project area will be through two improved connections off New York State Route 16, locally known as Seneca Street. Based on the current conceptual site plan, the following permits/reviews are anticipated to be required for the project:

- A State Coastal Consistency Review will need to be completed for this state-funded project. A Coastal Assessment Form is required to be completed to assist involved state agencies in determining consistency of their actions with coastal policies and the City of Buffalo's LWRP. Formal review by the NYSDOS is not anticipated to be needed.
- A letter of consistency from the City of Buffalo certifying the project's consistency with the LWRP.
- New York State Department of Transportation (NYSDOT) Highway Work Permit for Non-Utility Work (PERM 33) is required for any work within a state route right-of-way.
- A Building Permit is needed from the City of Buffalo to cover installation of the proposed large group pavilion and three picnic shelters.
- State Pollutant Discharge Elimination System (SPDES) General Permit (GP) for Stormwater Discharges from Construction Activity (GP-0-20-001) will not be required since the proposed project involves soil disturbance and excavation of less than 1 acre of land.
- Species records and regulations may need to be re-confirmed for the Northern Long-eared Bat once the project commences to ensure the determination that no further review, coordination, or permit still remains valid.

The design intent is to avoid any impacts to mapped Federal Emergency Management Agency (FEMA) designated 100-year floodplain. In the event that the final project design results in the potential for impacts to regulated floodplains, all necessary floodplain permits and approvals will be obtained prior to the start of construction. This would include a Floodplain Development Permit (included under Article 31 Flood Damage Prevention) from the City of Buffalo.

In addition to the permit requirements summarized above, the following actions are anticipated:

- State Environmental Quality Review (SEQR), with Erie County assumed to be Lead Agency, as an Unlisted Action.
- Review of the project by the New York State Office of Parks, Recreation and Historic Preservation (OPRHP) in accordance with Section 14.09 of the New York State Historic Preservation Act of 1980. This will include review of the project by the State Historic Preservation Office (SHPO) for determination on the presence of cultural/historic resources and archaeological sensitive area.

VIII. Project Cost Estimate

We are requesting $1,380,270 for this grant, which is 90% of the estimated cost of construction for the proposed green infrastructure elements. The selected elements will offer the greatest reduction in stormwater runoff and best fit the project objectives. A detailed breakdown of this cost estimate is on the following page.

Funding Request Summary	
Total Project Cost	$1,533,630
90% Grant Funds	$1,380,270
10% Required Match	$153,360

ERIE COUNTY

SENECA BLUFFS NATURAL HABITAT PARK GI PARKING LOT FEASIBILITY STUDY

OPINION OF PROBABLE COST

ITEM	UNIT	QTY	COST/UNIT	Cost
SITE CONSTRUCTION & STABILIZATION				
EROSION & SEDIMENT CONTROL	LS	1	$ 2,500	$ 2,500
UNCLASSIFIED EXCAVATION & DISPOSAL	CY	2100	$ 35	$ 73,500
- STANDARD ASPHALT PAVING DRAINING TO GI (18 SPACES)				
STONE SUBBASE/STORAGE STONE 12"	CY	430	$ 50	$ 21,500
BINDER COURSE 4"	TON	290	$ 150	$ 43,540
TOP COURSE 2"	TON	150	$ 175	$ 26,250
DILUTED TACK COAT	GAL	120	$ 5	$ 600
GEOTEXTILE SEPARATION	SY	1300	$ 2	$ 2,600
GRANITE CURBING (INCLUDING DROP CURBS)	LF	1400	$ 50	$ 70,000
- STORMWATER HARVEST & REUSE AND GREEN ROOF APPLICATIONS				
STORWMATER HARVEST HARVEST PICNIC PAVILIONS	EA	3	$ 12,000	$ 36,000
STORWMATER HARVEST & GREEN ROOF GROUP PAVILION	EA	1	$ 30,000	$ 30,000
STORMWATER HARVEST BICYCLE SHELTER	EA	1	$ 8,000	$ 8,000
RAIN BARREL	EA	5	$ 500	$ 2,500
DOWNSPOUT/GUTTER SYSTEM	LF	50	$ 150	$ 7,500
- BIORETENTION AND STORMWATER STREET TREES				
BIORETENTION/RAIN GARDENS	SF	7400	$ 65	$ 481,000
DECIDUOUS TREES	EA	15	$ 625	$ 9,380
CU STRUCTURAL SOIL MIX	CY	130	$ 150	$ 19,500
- PERMEABLE PAVEMENT				
FLEXI-PAVE	SF	5350	$ 35	$ 187,250
PERMEABLE INTERLOCKING CONCRETE PAVERS	SY	240	$ 65	$ 15,600
GEOTEXTILE SEPARATION	SY	880	$ 2	$ 1,760
- GI DRAINAGE & UTILITIES				
CURB INLET CHASE	EA	6	$ 2,000	$ 12,000
DOMED INLET OVERFLOW STRUCTURES	EA	6	$ 1,500	$ 9,000
SELECT GRANULAR FILL	CY	160	$ 40	$ 6,400
CONNECTION TO EXISTING DRAINAGE FACILITIES	EA	1	$ 1,000	$ 1,000
REMOVE AND RELOCATE LIGHT POLE	EA	1	$ 3,000	$ 3,000
6" PERFORATED DRAINAGE PIPE	LF	700	$ 3	$ 2,100
- SIGNAGE				
INTERPRETIVE / EDUCATIONAL SIGNAGE	EA	3	$ 2,000	$ 6,000
- MONITORING				
MONITORING, MEASUREMENT, EDUCATION	LS	1	$ 10,000	$ 10,000
		CONSTRUCTION SUBTOTAL		**$ 1,072,480**
CONTRACT ITEMS				
SURVEY AND ENGINEERING (15%)	LS	NEC	$ 160,870	**$ 160,870**
CONSTRUCTION SUPPORT (5%)	LS	NEC	$ 53,620	**$ 53,620**
EQUIPMENT, MOBILIZATION (4%)	LS	NEC	$ 42,900	**$ 42,900**
LEGAL (1%)	LS	NEC	$ 10,720	**$ 10,720**
ADMINISTRATIVE FORCE ACCOUNT (1%)	LS	NEC	$ 10,720	**$ 10,720**
TECHNICAL FORCE ACCOUNT (2%)	LS	NEC	$ 21,450	**$ 21,450**
CONTINGENCY (15%)	LS	NEC	$ 160,870	**$ 160,870**
			TOTAL	**$ 1,533,630**

Prepared By: HCQ, B&L
Checked By: TMR, B&L

IX. Long-Term Operations & Maintenance

Low maintenance and long-term monitoring capabilities were considered in the proposed site design for the Seneca Bluffs GI Project to maximize the performance of the green infrastructure practices. The following maintenance activities are recommended:

Harvest & Reuse and Green Roof Pavilions Maintenance Requirements	
Activity	Recommended Frequency
Disconnect rain barrels in transition from fall to winter and reconnect rain barrels in the spring.	Bi-Annually
Remove debris, weeds, prune plants, and replenish green roof bi-annually and after initial 2-3 year establishment period.	Bi-Annually and after establishment (2-3 years after installation)
Monitor infiltration rates of green roof.	Monthly

Bioretention Maintenance Requirements	
Activity	Recommended Frequency
Inspect underdrain cleanout.	Bi-Annually
Verify filtering capacity of system (ponded water drains in 48 hours).	Bi-Annually
Prepare a plan for watering vegetation and trees, especially during dry periods.	As needed
Inspect and evaluate tree and vegetation health and check for invasive species.	Bi-Annually
Mulching of tree and vegetation areas.	Bi-Annually
Remove, replace and/or reseed dead or damaged plant material.	As needed
Remove silt/sediment buildup from filter bed.	When exceeds 1"
Remove weeds and prune and thin overgrown vegetation.	As needed

Permeable Pavement Maintenance Requirements	
Activity	Recommended Frequency
Inspect pavement for sediment and debris build-up and evidence of deterioration or spalling.	Annually
Inspect infiltration and dewatering.	Monthly
Inspect contributing area of the permeable pavement surface is free of sediment of debris and is stabilized.	As needed
Leaf blow or vacuum clean flexi-pave and permeable asphalt parking area to remove debris that prevent infiltration.	Bi-Annually
Power wash flexi-pave and permeable asphalt parking area to restore permeability.	Once every three years
Replace damaged and under-performing pavement areas.	As needed
Restore aggregate of permeable pavers system when gravel infill is not within ½ inch of the paver surface or immediately following vacuum cleaning.	As needed
Clear debris, litter, sediment, and other items from permeable pavements and inlet chases.	Bi-Annually

Stormwater Street Tree Maintenance Requirements	
Activity	Recommended Frequency
Inspect trees and soil to evaluate moistness of soil and tree health.	Every three months
Inspect trees for evidence of insect and disease damage.	Every three months
Inspect trees for damages or dead limbs.	Every three months
Water trees when soil is dry or it has not rained in a week.	Weekly for young trees (less than 3 years)
Add additional mulch.	Bi-Annually
Prune dead, diseased, broken, or crossing branches.	Annually
Remove and replace dead trees.	Annually

A. Post-Construction Monitoring

Post construction monitoring of green infrastructure practices at Seneca Bluffs can provide performance data to inform the design of future sustainability projects.

Monitoring activities at Seneca Bluffs may include:

- Inflow and outflow monitoring of bioretention areas
- Inflow rates to permeable pavements
- Outflow rates from green roof
- Soil property testing
- Infiltration measurements of bioretention, green roof, and permeable pavements
- Pollutant level sampling pre- and post-treatment

The Buffalo Niagara Waterkeeper is a stakeholder and supporter of the Seneca Bluffs GIGP project: **https://bnwaterkeeper.org.** Discussions are ongoing with the Waterkeeper regarding collaboration on post-construction monitoring of green infrastructure at Seneca Bluffs.

The Water Academy is an established partnership between the Waterkeeper and Erie Community College that focuses on watershed issues and potential solutions: **https://bnwaterkeeper.org/programs/wateracademy/.** Water Academy is a for-credit class that involves 40-50 students each year, and includes both classroom work and outdoor field sessions.

The green infrastructure systems and outdoor classroom facilities proposed at Seneca Bluffs will provide a living laboratory well-suited to Water Academy learning objectives. Water Academy will provide a workforce, resources, and academic support for ongoing performance monitoring of green infrastructure practices at Seneca Bluffs.

Figures

Seneca Bluffs Natural Habitat Park

GI Parking Lot Feasibility Study

Figure 1. Site Location

DESCRIPTION

The Seneca Bluffs Natural Habitat Park Green Infrastructure (GI) Project is located along Seneca Street in the City of Buffalo, NY. It is adjacent to the Buffalo Niagara Waterkeeper (BNW) Paddlecraft and Shoreline Enhancement Project, adjacent to the Buffalo River, within walking distance of potential Environmental Justice areas, and less than a half mile from Southside Elementary School.

BNW Project

GI Project

February 12, 2021

Erie County, NY

Barton & Loguidice

Seneca Bluffs Natural Habitat Park

GI Parking Lot Feasibility Study

Figure 2. Existing Conditions Graphic

DESCRIPTION

There are several opportunities to improve the conditions at the parking lot entering Seneca Bluffs Natural Habitat Park. The following alternatives demonstrate approaches to the following key design components:

- **Multi-modal circulation**
- **Definition along the street**
- **Stormwater retention and infiltration**
- **Green space**
- **Recreational opportunities**
- **Connectivity to the street and the Park**

See Attachment 1 for site photographs.

Flow Arrow

Photo Location

Infiltration Test Location

0 15′ 30′ 60′

Graphic Scale (Feet)

February 12, 2021

Erie County, NY

Barton & Loguidice

JM Davidson Engineering, D.P.C.

Seneca Bluffs Natural Habitat Park

GI Parking Lot Feasibility Study

Figure 3. Conceptual Site Plan

Catchment Areas	
D-1	Harvest & Reuse, Bicycle Shelter
D-2	Harvest & Reuse Large Pavilion
D-3	Green Roof
D-4	Permeable Pavement Sidewalk (NW)
D-5	Permeable Pavement Sidewalk (NE)
D-6	Rain Garden/Harvest Re-Use Picnic Pavilions (3)
D-7	Bioretention
D-8	Permeable Paver Sidewalk
D-9	Bioretention (S)
D-10	Stormwater Street Trees
D-11	Bioretention (W)
D-12	Bioretention Island (W)
D-13	Bioretention Island (E)

Flow Arrow

JMDavidson Engineering, D.P.C.

DESCRIPTION

Alternative 2b is the preferred alternative, maximizing bioretention, best fitting recreational needs and visitor groups, and allowing adequate parking for visitors. The key features are listed below:

Standard Asphalt Pavement

1. **Standard asphalt pavement** in the parking lot will direct stormwater flow into bioretention areas. There will be 18 spaces, one designated bus parking area, and one accessible parking buffer for two accessible parking spaces. Two access points from Seneca Street will be provided.

Bioretention

2. **Bioretention areas** will capture stormwater runoff across the parking lot and include a diverse set of native herbaceous vegetation and trees. Bioretention to the east will screen the parking area from residencies along Avon Place.

Permeable Pavement

3. Existing concrete sidewalk will be replaced by **permeable interlocking concrete pavers**.

4. The proposed pathways will be composed of **flexi-pave** permeable pavement.

Stormwater Harvest & Reuse

5. **Three stormwater harvest & reuse picnic pavilions** are aligned with the existing playground and direct stormwater into adjacent **rain gardens.** Stepping stones are provided so that visitors can walk through and across.

6. **Half of a larger group pavilion for events and a bicycle shelter** will have roofs directing stormwater into rain barrels that slowly release into a shared **rain garden.**

Green Roof

7. **The other half of the large group pavilion will include a semi-intensive green roof** capturing and allowing for evapotranspiration of stormwater.

Stormwater Street Trees

8. **A band of stormwater street trees in CU structural soil with flexi-pave tree surrounds** will border the west side of the parking area**.**

9. **Connections to Shoreline Enhancements Project, by Buffalo Niagara Waterkeeper.**

10. **Three interpretive signs for green infrastructure practices.**

0 15′ 30′ 60′

Graphic Scale (Feet)

February 12, 2021

Erie County, NY

Barton & Loguidice

Seneca Bluffs Natural Habitat Park

GI Parking Lot Feasibility Study

Figure 4. Conceptual Perspective Rendering

February 12, 2021

Erie County, NY

Barton & Loguidice

Seneca Bluffs Natural Habitat Park

Green Infrastructure Feasibility Study

Attachment 1

Existing Site Photographs

Reference Figure 1 for photo locations.

Photo 1: From southeastern driveway entrance near Avon Place, looking northwest along Seneca Street. The existing gravel lot directly abuts the sidewalk along Seneca Street.

Photo 2: Looking west across existing gravel parking area towards northwestern driveway entrance near Seneca Street bridge over the Buffalo River.

Photo 3: Looking south across existing gravel parking area towards southeastern driveway entrance near Avon Place.

Photo 4: Looking northeast at continuation of Jordan Place access road into the main portion of the Seneca Bluffs Natural Habitat Park.

Photo 5: Looking southeast from near Buffalo River at gravel parking lot, northwestern driveway entrance, and sidewalk along Seneca Street.

Photo 6: Looking west along Seneca Street at utilities located beneath sidewalk. An existing gas line, 24" brick combined sewer,12" PVC separate storm drain system, and electrical lines all run underground along Seneca Street.

Attachment 2

Subsurface Investigation Figures

Job/Project: Seneca Bluffs GI Feasibility Study

IW: 1 Date: 01/20/2021

Time Hours:Minutes:Seconds	**Water Level** Top of Casing (ft)	**Water Level** Top of Casing (ft)	**Water Level** Top of Casing (ft)	**Water Level** Top of Casing (ft)
	Test #1	Test #2	Test #3	Test #4
***Add 1.5 gallons ~2.0' of Water**			***Add 1.0 gal. at start of Test #3**	
0:00:00	7.60	7.65	6.75	6.83
0:00:05	7.60	7.65	6.75	6.83
0:00:10	7.60	7.65	6.75	6.83
0:00:15	7.60	7.65	6.75	6.83
0:00:20	7.60	7.65	6.75	6.83
0:00:25	7.60	7.65	6.75	6.83
0:00:30	7.60	7.65	6.75	6.83
0:00:45	7.60	7.65	6.75	6.83
0:01:00	7.60	7.65	6.75	6.83
0:02:00	7.60	7.65	6.75	6.83
0:03:00	7.61	7.66	6.75	6.83
0:04:00	7.61	7.66	6.75	6.84
0:05:00	7.61	7.66	6.75	6.84
0:10:00	7.61	7.67	6.76	6.85
0:15:00	7.61	7.67	6.76	6.85
0:30:00	7.63	7.68	6.79	6.87
0:45:00	7.64	7.69	6.81	6.88
1:00:00	7.65	7.71	6.83	6.90
Drawdown/hr	0.05	0.06	0.08	0.07

Notes: Casing Height: 2.1' **Average infiltration rate (ft/hr)** 0.07

Pre soak water level on 1/19/21: 8.30' from top of casing

Water level on 1/20/12 at 8:00am: 9.20' from top of casing

The Infiltration Testing was performed in accordance with the New York State Management Design Manual Appendix D

Infiltration Testing was preformed by a Senior Geologist from Nature's Way Environmental

Job/Project: Seneca Bluffs GI Feasibility Study

IW: 2 Date: 01/20/2021

Time Hours:Minutes:Seconds	**Water Level** Top of Casing (ft)	**Water Level** Top of Casing (ft)	**Water Level** Top of Casing (ft)	**Water Level** Top of Casing (ft)
	Test #1	Test #2	Test #3	Test #4
***Add 1.5 gallons ~2.0' of Water**			***Add 1.0 gal. at start of Test #3**	
0:00:00	7.91	8.13	7.40	7.62
0:00:05	7.92	8.13	7.41	7.62
0:00:10	7.93	8.14	7.41	7.62
0:00:15	7.93	8.14	7.41	7.62
0:00:20	7.93	8.14	7.41	7.62
0:00:25	7.93	8.14	7.41	7.62
0:00:30	7.93	8.14	7.41	7.63
0:00:45	7.93	8.15	7.41	7.63
0:01:00	7.94	8.15	7.41	7.63
0:02:00	7.95	8.16	7.42	7.63
0:03:00	7.96	8.17	7.42	7.63
0:04:00	7.96	8.17	7.42	7.63
0:05:00	7.97	8.18	7.42	7.64
0:10:00	7.98	8.20	7.44	7.65
0:15:00	7.98	8.23	7.46	7.67
0:30:00	8.05	8.29	7.51	7.74
0:45:00	8.08	8.36	7.57	7.77
1:00:00	8.13	8.41	7.62	7.83
Drawdown/hr	0.22	0.28	0.22	0.21

Notes: Casing Height: 2.2' **Average infiltration rate (ft/hr)** 0.23

Pre soak water level on 1/19/21: 8.60' from top of casing

Water level on 1/20/21 at 8:00am: 10.0' from top of casing

The Infiltration Testing was performed in accordance with the New York State Management Design Manual Appendix D

Infiltration Testing was preformed by a Senior Geologist from Nature's Way Environmental

Job/Project: Seneca Bluffs GI Feasibility Study

IW: 3 Date: 01/20/2021

Time Hours:Minutes:Seconds	**Water Level** Top of Casing (ft)	**Water Level** Top of Casing (ft)	**Water Level** Top of Casing (ft)	**Water Level** Top of Casing (ft)
	Test #1	Test #2	Test #3	Test #4
***Add 1.5 gallons ~2.0' of Water**			***Add 1.0 gal. at start of Test #3**	
0:00:00	7.90	8.13	7.25	7.46
0:00:05	7.90	8.13	7.25	7.46
0:00:10	7.90	8.13	7.25	7.46
0:00:15	7.90	8.13	7.25	7.46
0:00:20	7.90	8.13	7.25	7.46
0:00:25	7.90	8.13	7.25	7.46
0:00:30	7.90	8.13	7.25	7.46
0:00:45	7.90	8.13	7.25	7.46
0:01:00	7.90	8.13	7.25	7.46
0:02:00	7.91	8.13	7.26	7.47
0:03:00	7.91	8.13	7.26	7.47
0:04:00	7.92	8.14	7.26	7.47
0:05:00	7.93	8.15	7.27	7.48
0:10:00	7.94	8.16	7.28	7.49
0:15:00	7.95	8.17	7.29	7.50
0:30:00	8.00	8.21	7.30	7.55
0:45:00	8.05	8.27	7.37	7.59
1:00:00	8.08	8.30	7.42	7.63
Drawdown/hr	0.18	0.17	0.17	0.17

Notes: Casing Height: 2.3' **Average infiltration rate (ft/hr)** 0.17

Pre soak water level on 1/19/21: 8.20' from top of casing

Water level on 1/20/21 at 8:00am: 9.58' from top of casing

The Infiltration Testing was performed in accordance with the New York State Management Design Manual Appendix D

Infiltration Testing was preformed by a Senior Geologist from Nature's Way Environmental

NW CONTRACTING
3553 Crittenden Road
Alden, NY 14004
(716) 937- 6527
www.nwcontracting.com

HOLE NUMBER: B1/IW-1

DATE: 01/18/2021 ELEVATION:

PROJECT: Subsurface Investigation for the Seneca Bluffs Parking Lot GI Feasibility Study at 1670 Seneca St. Buffalo, NY

PREPARED FOR: Barton and Loguidice

BORING LOCATION:

SN	0/6	6/12	12/18	18/24	N	OVM	LITH	DESCRIPTION AND CLASSIFICATION	REC	INFILTRATION WELL	REMARKS	COMMENTS
1	18							Gravel fill 0.4	1.3'			NOTE: B1/IW-1 located at western side of parking lot, closest to river
		29			57			Moist, distinctly mottled, dark brown (SILT) fill with 10 to 15% gravel with red brick fragments, coal and glass, trace to little very fine size sand, compact becoming loose below 4.0'	1.5'	Soil backfill		
			28									
				15								Gravel fill to 0.4 feet over silty soil fill with trace gravel to 6.0 feet over silty slackwater sediment to 10.0 feet over water sorted and deposited sand with little to some silt to end of boring.
2	8											
		8			15							
			7						1.1'	4" Solid PVC riser pipe		
				7								
3	3											
		3			4							
			1									
				2				6.0				
4	1/12"							Extremely moist, gray (SILT) with trace very fine size sand, soft, weakly bedded	1.3'			
					<3					7.0 Bentonite seal		
			2									
				1								
5	WH								1.3'	8.0		
		1			2							
			1									
				1				10.0				
6	2							Wet, gray (SILTY-SAND) with very fine size sand, little to some silt, very loose, weakly bedded	1.5'			
		1			3							
			2									
				1				12.0				
								Boring completed at 12.0' bgs				

LOGGED BY: Dale M. Gramza, Drilling Manager PAGE 1 of 1

NW CONTRACTING
3553 Crittenden Road
Alden, NY 14004
(716) 937- 6527
www.nwcontracting.com

HOLE NUMBER: B2/IW-2

DATE: 01/18/2021 ELEVATION:

PROJECT: Subsurface Investigation for the Seneca Bluffs Parking Lot GI Feasibility Study at 1670 Seneca St. Buffalo, NY

PREPARED FOR: Barton and Loguidice

BORING LOCATION:

SN	0/6	6/12	12/18	18/24	N	OVM	LITH	DESCRIPTION AND CLASSIFICATION	REC	INFILTRATION WELL	REMARKS	COMMENTS
1	9							Moist, brown, very gravelly (SILTY-SAND) fill with 40 to 60% gravel and slag, very fine to coarse size sand, trace silt, dense in place	1.3'		Soil backfill	NOTE: B2/IW-2 located on east side of parking lot, furthest from river
		22			50							
			28									
				23				2.0				
2	3							Moist, gray becoming brown below 2.5' (SILT) with trace clay, loose, blocky soil structure	1.3'			
		2			5							
			3									
				5					1.5'		4" Solid PVC riser pipe	Sand and gravel fill with trace silt to 2.0 feet over silty slackwater sediment to 9.5 feet over water sorted and deposited sand with trace silt to end of boring.
3	2											
		2			5							
			3									
				4					1.5'			
4	2											
		2			5							
			3					7.0		7.0	Bentonite seal	
				3				Extremely moist, brown (SILT) with trace to little very fine size sand, very loose, weakly bedded				
5	1								1.4'			
		1			3							
			2									
				3				9.5		8.0		
6	2							Wet, brown (SILTY-SAND) with trace silt, very fine size sand, very loose, weakly bedded	1.5'			
		2			4							
			2									
				3				12.0				
								Boring completed at 12.0' bgs				

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CONTRACTING
3553 Crittenden Road
Alden, NY 14004
(716) 937- 6527
www.nwcontracting.com

HOLE NUMBER: B3/IW-3

DATE: 01/18/2021 ELEVATION:

PROJECT: Subsurface Investigation for the Seneca Bluffs Parking Lot GI Feasibility Study at 1670 Seneca St. Buffalo, NY

PREPARED FOR: Barton and Loguidice

BORING LOCATION:

SN	0/6	6/12	12/18	18/24	N	OVM	LITH	DESCRIPTION AND CLASSIFICATION	REC	INFILTRATION WELL	REMARKS	COMMENTS
1	11				51			Extremely moist, distinctly mottled, gravelly (SILTY-SAND) fill with 15 to 25% gravel, very fine to coarse size sand, very dense to loose	1.0'		Soil backfill	NOTE: B3/IW-3 located in parking lot between B1 and B2 near sidewalk
		29							1.2'			
			22									
				10								
2	6				9							
		5										
			4									
				5								
3	1				7			Moist, faintly mottled, brown (SILT) with trace clay, firm, blocky soil structure	1.4'		4" Solid PVC riser pipe	Sandy soil fill with little gravel to 3.0 feet over silty slackwater sediment to 10.5 feet over water sorted and deposited sand with some silt to end of boring.
		3										
			4									
				5								
4	2				5				1.6'			
		2										
			3									
				5								
5	1				3			Extremely moist, brown (SILT) with trace very fine size sand, very loose, weakly bedded	1.6'			
		1										
			2									
				2								
6	4				7				1.8'			
		4										
			3									
				3				Extremely moist, brown (SILTY-SAND) with very fine size sand, some silt, loose, weakly bedded				
								Boring completed at 12.0' bgs				

3.0 7.5 10.5 12.0

7.0 8.0 Bentonite seal

0 5 10 15 20

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Seneca Bluffs Natural Habitat Park

Green Infrastructure Feasibility Study

Attachment 3

WQv Calculations Runoff Reduction Worksheets

JM Davidson Engineering, D.P.C.

Version 1.8
Last Updated: 11/09/2015

Total Water Quality Volume Calculation
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:	1	
P=	1.00	*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						
2						
3	0.01	0.01	100%	0.95	24	Green Roof (Ext)
4	0.03	0.03	100%	0.95	103	Porous Pavement
5	0.06	0.06	100%	0.95	210	Porous Pavement
6						
7	0.27	0.23	86%	0.82	814	Bioretention
8	0.05	0.05	100%	0.95	176	Porous Pavement
9	0.31	0.22	71%	0.69	775	Bioretention
10	0.05	0.05	100%	0.95	162	Porous Pavement
Subtotal (1-30)	0.85	0.70			**2,450**	**Subtotal 1**
Total	0.85	0.70			**2,450**	**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"	0.85	0.70	82%	0.79	2,450
Subtract Area	0.00	0.00			
WQv adjusted after Area Reductions	**0.85**	**0.70**	82%	0.79	2,450
Disconnection of Rooftops		0.00			
Adjusted WQv after Area Reduction and Rooftop Disconnect	0.85	0.70	82%	0.79	**2,450**
WQv reduced by Area Reduction techniques					0

Total Water Quality Volume Calculation

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

Additional Subcatchments						
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Description**
11	0.04	0.04	82%	0.79	126	Bioretention
12	0.02	0.01	65%	0.64	46	Infiltration Bioretention
13	0.01	0.00	28%	0.30	13	Infiltration Bioretention
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						
26						
27						
28						
29						
30						
Subtotal	0.08	0.05	69%	0.67	**185**	**Subtotal**

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						
2						
3	0.01	0.01	1.00	0.95	24.14	Green Roof
4	0.03	0.03	1.00	0.95	103.46	Porous
5	0.06	0.06	1.00	0.95	210.36	Porous
6						
7	0.27	0.23	0.86	0.82	813.58	Bioretention
8	0.05	0.05	1.00	0.95	175.87	Porous
9	0.31	0.22	0.71	0.69	775.33	Bioretention
10	0.05	0.05	1.00	0.95	162.08	Porous
11	0.04	0.04	0.82	0.79	125.86	Bioretention
12	0.02	0.01	0.65	0.64	46.10	Infiltration
13	0.01	0.00	0.28	0.30	13.16	Infiltration
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
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	0.00	0.00	0	
	Stormwater Planter	RR-7	0.00	0.00	0	
	Rain Barrel/Cistern	RR-8	0.00	0.00	0	
	Porous Pavement	RR-9	0.19	0.19	652	
	Green Roof (Intensive & Extensive)	RR-10	0.01	0.01	24	
Standard SMPs w/RRv Capacity	Infiltration Trench	I-1	0.00	0.00	0	0
	Infiltration Basin	I-2	0.00	0.00	0	0
	Dry Well	I-3	0.00	0.00	0	0
	Underground Infiltration System	I-4				
	Bioretention & Infiltration Bioretention	F-5	0.66	0.51	1208	566
	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 →			0.20	0.20	676	
Totals by Standard SMP w/RRV →			0.66	0.51	1208	566
Totals by Standard SMP →			0.00	0.00		0
Totals (Area + Volume + all SMPs) →			0.85	0.70	1,884	566
	Impervious Cover √	okay				
	Total Area √	okay				

Minimum RRv

Enter the Soils Data for the site		
Soil Group	Acres	S
A	0.07	55%
B		40%
C		30%
D		20%
Total Area	0.07	
Calculate the Minimum RRv		
S =	**0.55**	
Impervious =	0.70	*acre*
Precipitation	1	*in*
Rv	0.95	
Minimum RRv	**1,332**	***ft3***
	0.03	af

NOI QUESTIONS

#	NOI Question	Reported Value	
		cf	af
28	Total Water Quality Volume (WQv) Required	2450	*0.056*
30	Total RRV Provided	1884	*0.043*
31	Is RRv Provided ≥WQv Required?	No	
32	Minimum RRv	1332	*0.031*
32a	Is RRv Provided ≥ Minimum RRv Required?	Yes	
33a	Total WQv Treated	566	*0.013*
34	Sum of Volume Reduced & Treated	2450	*0.056*
34	Sum of Volume Reduced and Treated	2450	*0.056*
35	Is Sum RRv Provided and WQv Provided ≥WQv Required?	Yes	

Apply Peak Flow Attenuation			
36	Channel Protection	*Cpv*	
37	Overbank	*Qp*	
37	Extreme Flood Control	*Qf*	
	Are Quantity Control requirements met?		

Bioretention Worksheet

(For use on HSG C or D Soils with underdrains)

Af=WQv*(df)/[k*(hf+df)(tf)]

Af	Required Surface Area (ft2)
WQv	Water Quality Volume (ft3)
df	Depth of the Soil Medium (feet)
hf	Average height of water above the planter bed
tf	Volume Through the Filter Media (days)

k — The hydraulic conductivity [ft/day], can be varied depending on the properties of the soil media. Some reported conductivity values are: ***Sand*** - 3.5 ft/day (City of Austin 1988); ***Peat*** - 2.0 ft/day (Galli 1990); ***Leaf Compost*** - 8.7 ft/day (Claytor and Schueler, 1996); ***Bioretention Soil*** (0.5 ft/day (Claytor &

Design Point:	**1**

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
7	0.27	0.23	0.86	0.82	813.58	1.00	Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops			86%	0.82	814	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.						*ft^3*	

Soil Information			
Soil Group	D		
Soil Infiltration Rate	1.88	*in/hour*	*Design as an infiltration bioretention practice*
Using Underdrains?	Yes	*Okay*	

Calculate the Minimum Filter Area				
		Value	Units	Notes
WQv		814	*ft^3*	
Enter Depth of Soil Media	*df*	2.5	*ft*	*2.5-4 ft*
Enter Hydraulic Conductivity	*k*	0.5	*ft/day*	
Enter Average Height of Ponding	*hf*	0.5	*ft*	*6 inches max.*
Enter Filter Time	*tf*	2	*days*	
Required Filter Area	***Af***	**678**	***ft^2***	

Determine Actual Bio-Retention Area			
Filter Width	60	*ft*	
Filter Length	12	*ft*	
Filter Area	720	*ft^2*	
Actual Volume Provided	864	*ft^3*	

Determine Runoff Reduction				
Is the Bioretention contributing flow to another practice?		No	Select Practice	
RRv	346			
RRv applied	**346**	***ft^3***	***This is 40% of the storage provided or WQv whichever is less.***	
Volume Treated	468	*ft^3*	*This is the portion of the WQv that is not reduced in the practice.*	
Volume Directed	0	*ft^3*	This volume is directed another practice	
Sizing √	OK		*Check to be sure Area provided ≥ Af*	

Bioretention Worksheet

(For use on HSG C or D Soils with underdrains)

Af=WQv*(df)/[k*(hf+df)(tf)]

Af	Required Surface Area (ft2)
WQv	Water Quality Volume (ft3)
df	Depth of the Soil Medium (feet)
hf	Average height of water above the planter bed
tf	Volume Through the Filter Media (days)

k — The hydraulic conductivity [ft/day], can be varied depending on the properties of the soil media. Some reported conductivity values are: ***Sand*** - 3.5 ft/day (City of Austin 1988); ***Peat*** - 2.0 ft/day (Galli 1990); ***Leaf Compost*** - 8.7 ft/day (Claytor and Schueler, 1996); ***Bioretention Soil*** (0.5 ft/day (Claytor &

Design Point:	**1**

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
9	0.31	0.22	0.71	0.69	775.33	1.00	Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops			71%	0.69	775	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.						*ft^3*	

Soil Information			
Soil Group	D		
Soil Infiltration Rate	1.88	*in/hour*	*Design as an infiltration bioretention practice*
Using Underdrains?	Yes	*Okay*	

Calculate the Minimum Filter Area				
		Value	Units	Notes
WQv		775	*ft^3*	
Enter Depth of Soil Media	*df*	2.5	*ft*	*2.5-4 ft*
Enter Hydraulic Conductivity	*k*	0.5	*ft/day*	
Enter Average Height of Ponding	*hf*	0.5	*ft*	*6 inches max.*
Enter Filter Time	*tf*	2	*days*	
Required Filter Area	***Af***	**646**	***ft^2***	

Determine Actual Bio-Retention Area			
Filter Width	130	*ft*	
Filter Length	12	*ft*	
Filter Area	1560	*ft^2*	
Actual Volume Provided	1872	*ft^3*	

Determine Runoff Reduction				
Is the Bioretention contributing flow to another practice?		No	Select Practice	
RRv	749			
RRv applied	**749**	***ft^3***	***This is 40% of the storage provided or WQv whichever is less.***	
Volume Treated	27	*ft^3*	*This is the portion of the WQv that is not reduced in the practice.*	
Volume Directed	0	*ft^3*	This volume is directed another practice	
Sizing √	OK		*Check to be sure Area provided ≥ Af*	

Bioretention Worksheet

(For use on HSG C or D Soils with underdrains)

Af=WQv*(df)/[k*(hf+df)(tf)]

Af	Required Surface Area (ft2)
WQv	Water Quality Volume (ft3)
df	Depth of the Soil Medium (feet)
hf	Average height of water above the planter bed
tf	Volume Through the Filter Media (days)

k — The hydraulic conductivity [ft/day], can be varied depending on the properties of the soil media. Some reported conductivity values are: ***Sand*** - 3.5 ft/day (City of Austin 1988); ***Peat*** - 2.0 ft/day (Galli 1990); ***Leaf Compost*** - 8.7 ft/day (Claytor and Schueler, 1996); ***Bioretention Soil*** (0.5 ft/day (Claytor &

Design Point:	**1**

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
11	0.04	0.04	0.82	0.79	125.86	1.00	Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops			82%	0.79	126	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.						*ft^3*	

Soil Information			
Soil Group	D		
Soil Infiltration Rate	1.88	*in/hour*	*Design as an infiltration bioretention practice*
Using Underdrains?	Yes	*Okay*	

Calculate the Minimum Filter Area				
		Value	Units	Notes
WQv		126	*ft^3*	
Enter Depth of Soil Media	*df*	2.5	*ft*	*2.5-4 ft*
Enter Hydraulic Conductivity	*k*	0.5	*ft/day*	
Enter Average Height of Ponding	*hf*	0.5	*ft*	*6 inches max.*
Enter Filter Time	*tf*	2	*days*	
Required Filter Area	***Af***	**105**	***ft^2***	

Determine Actual Bio-Retention Area			
Filter Width	19	*ft*	
Filter Length	6	*ft*	
Filter Area	114	*ft^2*	
Actual Volume Provided	137	*ft^3*	

Determine Runoff Reduction				
Is the Bioretention contributing flow to another practice?		No	Select Practice	
RRv	55			
RRv applied	**55**	***ft^3***	***This is 40% of the storage provided or WQv whichever is less.***	
Volume Treated	71	*ft^3*	*This is the portion of the WQv that is not reduced in the practice.*	
Volume Directed	0	*ft^3*	This volume is directed another practice	
Sizing √	OK		*Check to be sure Area provided ≥ Af*	

Infiltrating Bioretention Worksheet

(For use on HSG A or B Soils without underdrains)

WQv ≤ VSM + VDL + (DP x ARG)

VSM = ARG x DSM x nSM

VDL (optional) = ARG x DDL x nDL

Design Point:	1

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
Enter Impervious Area Reduced by Disconnection of Rooftops						<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.						*ft^3*	

Infiltrating Bioretention Parameters				
Treatment Volume	WQv	0	*ft^3*	
Enter depth of soil Media	DSM		*ft*	*2.5 - 4 ft*
Enter depth of drainage	DDL		*ft*	*≥ 0.5 ft*
Enter ponding depth above surface	DP		*ft*	*≤ 0.5*
Enter porosity of Soil Media	nSM			*≥20%*
Enter porosity of Drainage	nDL			*≥ 40%*
Required Bioretention Area	ARG	0	*sf*	
Bioretention Area Provided			*ft2*	
Native Soil Infiltration Rate			*in/hr*	
Are you using underdrains?				
Total Volume Provided		0	*ft^3*	*Sum of storage Volume Provided in each layer*

Determine Runoff Reduction			
Runoff Reduction	**0**	***ft^3***	***This is 80% of storage volume provided or WQv whichever is less***
Volume Treated	0	*ft^3*	*This is the portion of the WQv that is not reduced in the practice*
Sizing √	*OK*		*Check to be sure Area provided ≥ Af*

Infiltrating Bioretention Worksheet

(For use on HSG A or B Soils without underdrains)

WQv ≤ VSM + VDL + (DP x ARG)

VSM = ARG x DSM x nSM

VDL (optional) = ARG x DDL x nDL

Design Point:	1

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
12	0.02	0.01	0.65	0.64	46.10	1.00	Infiltration Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops			65%	0.64	46	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.						*ft^3*	

Infiltrating Bioretention Parameters				
Treatment Volume	WQv	46	*ft^3*	
Enter depth of soil Media	DSM	2.50	*ft*	*2.5 - 4 ft*
Enter depth of drainage	DDL	0.5	*ft*	*≥ 0.5 ft*
Enter ponding depth above	DP	0.5	*ft*	*≤ 0.5*
Enter porosity of Soil Media	nSM	0.20		*≥20%*
Enter porosity of Drainage	nDL	0.40		*≥ 40%*
Required Bioretention Area	ARG	38	*sf*	
Bioretention Area Provided		110	*ft2*	
Native Soil Infiltration Rate		1.88	*in/hr*	*Okay*
Are you using underdrains?		Yes		
Total Volume Provided		132	*ft^3*	*Sum of storage Volume Provided in each layer*

Determine Runoff Reduction			
Runoff Reduction	**46**	***ft^3***	***This is 80% of storage volume provided or WQv whichever is less***
Volume Treated	0	*ft^3*	*This is the portion of the WQv that is not reduced in the practice*
Sizing √	*OK*		*Check to be sure Area provided ≥ Af*

Infiltrating Bioretention Worksheet

(For use on HSG A or B Soils without underdrains)

WQv ≤ VSM + VDL + (DP x ARG)

VSM = ARG x DSM x nSM

VDL (optional) = ARG x DDL x nDL

Design Point:	1

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
13	0.01	0.00	0.28	0.30	13.16	1.00	Infiltration Bioretention
Enter Impervious Area Reduced by Disconnection of Rooftops			28%	0.30	13	<<WQv after adjusting for Disconnected Rooftops	
Enter the portion of the WQv that is not reduced for all practices routed to this practice.						*ft^3*	

Infiltrating Bioretention Parameters				
Treatment Volume	WQv	13	*ft^3*	
Enter depth of soil Media	DSM	2.50	*ft*	*2.5 - 4 ft*
Enter depth of drainage	DDL	0.5	*ft*	*≥ 0.5 ft*
Enter ponding depth above	DP	0.5	*ft*	*≤ 0.5*
Enter porosity of Soil Media	nSM	0.20		*≥20%*
Enter porosity of Drainage	nDL	0.40		*≥ 40%*
Required Bioretention Area	ARG	11	*sf*	
Bioretention Area Provided		130	*ft2*	
Native Soil Infiltration Rate		1.88	*in/hr*	*Okay*
Are you using underdrains?		Yes		
Total Volume Provided		156	*ft^3*	*Sum of storage Volume Provided in each layer*

Determine Runoff Reduction			
Runoff Reduction	**13**	***ft^3***	***This is 80% of storage volume provided or WQv whichever is less***
Volume Treated	0	*ft^3*	*This is the portion of the WQv that is not reduced in the practice*
Sizing √	*OK*		*Check to be sure Area provided ≥ Af*

Extensive Green Roof Worksheet

WQv ≤ VSM + VDL + (DP x AGR) VSM = AGR x DSM x nSM VDL = AGR x DDL x nDL

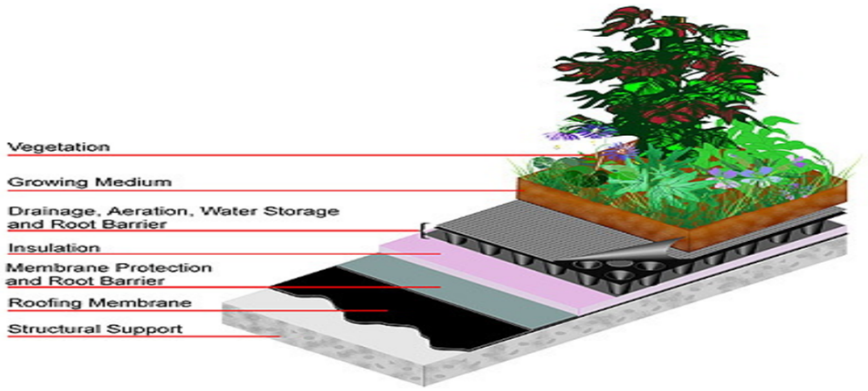
Design Point:	1

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
3	0.01	0.01	1.00	0.95	24.14	1.00	Green Roof (Ext)

Enter Parameters for Proposed Green Roof				
				Notes
Green Roof Surface Area	AGR	326	ft^2	
Depth of Soil Media	DSM	0.25	*ft*	*0.25-0.5*
Depth of Drainage Layer	DDL	0.17	*ft*	
Depth of Ponding Above Surface	DP	0.50	*ft*	
Porosity of the Soil Media	nSM	20%		*Max 20%*
Porosity of the Drainage Layer	nDL	25%		*Max 25%*

Calculations				
Volume Provided In Soil Media	VSM	16	ft^3	
Volume Provided In Drainage Layer	VDL	14	ft^3	
Volume in Ponding Layer		163	ft^3	
Storage Volume Provided in Green Roof		193	ft^3	

Runoff Reduction	**24**	**ft^3**	



Porous Pavement Worksheet

Ap = Vw / (n x dt)

Ap	Required porous pavement surface area	*ft2*
Vw	Design Volume	*ft3*
n	porosity of gravel bed/resevoir	*Assume .4 for gravel*
dt	depth of gravel bed/resevoir	

Design Point:	**1**

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
4	0.03	0.03	1.00	0.95	103.46	1.00	Porous Pavement

Enter Soil Infiltration Rate			
Soil Inflitration Rate	1.88	*in/hour*	

Calculate Required Surface Area				
Design Volume	Vw	103	*ft^3*	
Are underdrains being used?		Yes	-	Only Gravel Bed Depth below underdrain can be considered.
Porosity of Gravel Bed	*n*	0.40	-	
Gravel Bed Depth	dt	0.50	*ft*	Must be the depth below the underdrain.
Required Surface Area	Ap	517	*sf*	
Surface Area Provided		1,320	*sf*	*Dimensions of pavement can be provided here*
Storage Volume Provided		264	*ft^3*	

Determine the Runoff Reduction			
RRv	**103**	***ft^3***	

Porous Pavement Worksheet

Ap = Vw / (n x dt)

Ap	Required porous pavement surface area	*ft2*
Vw	Design Volume	*ft3*
n	porosity of gravel bed/resevoir	*Assume .4 for gravel*
dt	depth of gravel bed/resevoir	

Design Point:	**1**

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
5	0.06	0.06	1.00	0.95	210.36	1.00	Porous Pavement

Enter Soil Infiltration Rate			
Soil Inflitration Rate	1.88	*in/hour*	

Calculate Required Surface Area				
Design Volume	Vw	210	*ft^3*	
Are underdrains being used?		Yes	-	Only Gravel Bed Depth below underdrain can be considered.
Porosity of Gravel Bed	*n*	0.40	-	
Gravel Bed Depth	dt	0.50	*ft*	Must be the depth below the underdrain.
Required Surface Area	Ap	1,052	*sf*	
Surface Area Provided		2,670	*sf*	*Dimensions of pavement can be provided here*
Storage Volume Provided		534	*ft^3*	

Determine the Runoff Reduction			
RRv	**210**	***ft^3***	

Porous Pavement Worksheet

Ap = Vw / (n x dt)

Ap	Required porous pavement surface area	*ft2*	
Vw	Design Volume	*ft3*	
n	porosity of gravel bed/resevoir		*Assume .4 for gravel*
dt	depth of gravel bed/resevoir		

Design Point:	**1**

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
8	0.05	0.05	1.00	0.95	175.87	1.00	Porous Pavement

Enter Soil Infiltration Rate			
Soil Inflitration Rate	1.88	*in/hour*	

Calculate Required Surface Area				
Design Volume	Vw	176	*ft^3*	
Are underdrains being used?		Yes	-	Only Gravel Bed Depth below underdrain can be considered.
Porosity of Gravel Bed	*n*	0.40	-	
Gravel Bed Depth	dt	0.50	*ft*	Must be the depth below the underdrain.
Required Surface Area	Ap	879	*sf*	
Surface Area Provided		2,205	*sf*	*Dimensions of pavement can be provided here*
Storage Volume Provided		441	*ft^3*	

Determine the Runoff Reduction			
RRv	**176**	***ft^3***	

Porous Pavement Worksheet

Ap = Vw / (n x dt)

Ap	Required porous pavement surface area	*ft2*	
Vw	Design Volume	*ft3*	
n	porosity of gravel bed/resevoir		*Assume .4 for gravel*
dt	depth of gravel bed/resevoir		

Design Point:	**1**

Enter Site Data For Drainage Area to be Treated by Practice							
Catchment Number	**Total Area** *(Acres)*	**Impervious Area** *(Acres)*	**Percent Impervious** *%*	**Rv**	**WQv** *(ft^3)*	**Precipitation** *(in)*	**Description**
10	0.05	0.05	1.00	0.95	162.08	1.00	Porous Pavement

Enter Soil Infiltration Rate			
Soil Inflitration Rate	1.88	*in/hour*	

Calculate Required Surface Area				
Design Volume	Vw	162	*ft^3*	
Are underdrains being used?		No	-	
Porosity of Gravel Bed	*n*	0.25	-	
Gravel Bed Depth	dt	3.00	*ft*	
Required Surface Area	Ap	216	*sf*	
Surface Area Provided		350	*sf*	*Dimensions of pavement can be provided here*
Storage Volume Provided		263	*ft^3*	

Determine the Runoff Reduction			
RRv	**162**	***ft^3***	

Seneca Bluffs Green Infrastructure Design

Rain Barrel To Bioretention Treatment Train Calculations

Catchment 1

Rain Barrell Sizing

Total Area (sf)	Total Area (ac)	Impervious Area (sf)	% Impervious	RV	P (in)	WQv (ac-ft)	WQv (cf)
175	0.004	175	100%	0.95	1	0.000	13.85

Required Cistern Storage Volume	103.9	Gal	(WQv * 7.5)	
Number of Cisterns Proposed	2			
Volume per Unit	55	Gal		
Actual Cistern Storage Volume	110	Gal	14.71	cf
Water Use Plan?	Yes			

Rain Barrel Treats all WQv?	Yes	
RRv Provided:	13.85	cf
Remaining WQv to be Treated ?	0.00	cf

Catchment 2

Rain Barrell Sizing

Total Area (sf)	Total Area (ac)	Impervious Area (sf)	% Impervious	RV	P (in)	WQv (ac-ft)	WQv (cf)
213	0.005	213	100%	0.95	1	0.000	16.86

Required Cistern Storage Volume	126.5	Gal	(WQv * 7.5)	
Number of Cisterns Proposed	3			
Volume per Unit	55	Gal		
Actual Cistern Storage Volume	165	Gal	22.06	cf
Water Use Plan?	Yes			

Rain Barrel Treats all WQv?	Yes	
RRv Provided:	16.86	cf
Remaining WQv to be Treated ?	0.00	cf

Catchment 6

Rain Barrell Sizing

Total Area (sf)	Total Area (ac)	Impervious Area (sf)	% Impervious	RV	P (in)	WQv (ac-ft)	WQv (cf)
656	0.015	656	100%	0.95	1	0.001	51.93

Required Cistern Storage Volume	389.5	Gal	(WQv * 7.5)	
Number of Cisterns Proposed	3			
Volume per Unit	55	Gal		
Actual Cistern Storage Volume	165	Gal	22.06	cf
Water Use Plan?	Yes			

Rain Barrel Treats all WQv?	No	
RRv Provided:	22.06	cf
Remaining WQv to be Treated ?	29.87	cf

Bioretention Area Sizing for Remaining WQv

WQv Untreated	29.87	cf

Additional Drainage Area:

Drainage Area (sf)	Drainage Area (ac)	Impervious Area (sf)	% Impervious	RV	P (in)	WQv (ac-ft)	WQv (cf)
656	0.015	0	0%	0.05	1	0.000	2.73

Total WQv to be Treated By Downstream Bioretention:	32.61	cf

Calculate Filter Area Requried:

Depth of Soil Media:	2.5	ft
Hydraulic Conductivity:	0.5	ft/day
Ponding Depth:	0.5	ft
Filter Time:	2	day
Required Filter Area:	27.2	sf

Filter Area Provided:

Filter Lenth:	22	ft
Filter Width:	12	ft
Filter Area:	264.0	sf
Volume Provided:	660.0	cf
Filter Area OK?:	YES	

Max Volume Treated:	32.6	cf	
RRv Provided:	13.0	cf	40% of Volume Treated
WQv Treated:	19.6	cf	

Summary

ID	Impervious Area (ac)	Total WQv Required (ac-ft)	Total WQv Required (cf)	RRv Provided (cf)	WQv Provided (cf)	Total Treatment Provided (cf)	OK?
1	0.004	0.000	13.85	13.85		13.9	YES
2	0.005	0.000	16.86	16.86		16.9	YES
6	0.015	0.001	54.67	35.10	19.6	54.7	YES
Total	0.024	0.002	85.383	65.820	19.564	85.383	

RRv Requirements

No HSG data is available for site. Table compares RRv min. to all HSG cases.

HSG	S	RRv min. (ac-ft)	RRv min. (cf)	RRv Provided Exceeds Min?
A	0.55	0.001	45.5	YES
B	0.4	0.001	33.1	YES
C	0.3	0.001	24.8	YES
D	0.2	0.000	16.5	YES

Attachment 4

Letters of Support

BUFFALO
SEWER AUTHORITY

February 11, 2021

To whom it may concern,

On behalf of the Buffalo Sewer Authority, it is my pleasure to support the Erie County Department of Environment and Planning's Green Innovation Grant Program proposal to construct a green infrastructure parking area at Seneca Bluffs Natural Habitat Park, located in south Buffalo, New York.

The Buffalo Sewer Authority has a Long Term Control Plan which supports reducing combined sewer overflows (CSOs) to local waterways by implementing green infrastructure solutions. The green infrastructure technology implementation goal for the Buffalo River sewer shed is to control up to 20% of the approximately 319 acres of impervious surfaces. Erie County's parking lot improvement project at Seneca Bluffs supports the Buffalo Sewer Authority's Long Term Control Plan by reducing stormwater flow to the combined sewer system by modifying the vacant parking lot to store and infiltrate street runoff, installing pervious pavement, rain gardens, and street trees along public streets and parking lots.

In summary, the Buffalo Sewer Authority is pleased to support the Erie County Department of Environment and Planning's project proposal for constructing a green infrastructure parking area at the Seneca Bluffs Natural Habitat Park as it will protect the environment by reducing CSOs, address water quality in receiving streams, benefit the health of the Great Lakes basin, the Buffalo River, and the local community.

Sincerely,

Kevin Meindl
Green Infrastructure Program Manager

BUFFALO NIAGARA WATERKEEPER
PROTECT • RESTORE • CONNECT • INSPIRE

02-11-2021

To whom it may concern,

On behalf of Buffalo Niagara Waterkeeper, it is my pleasure to support the Erie County Department of Environment and Planning's Green Innovation Grant Program proposal to construct a green infrastructure parking area at Seneca Bluffs Natural Habitat Park.

Buffalo Niagara Waterkeeper serves as the Buffalo River Remedial Advisory Committee Coordinator. Under the Area of Concern (AOC) Program, Buffalo Niagara Waterkeeper, in partnership with Erie County Department of Environment and Planning and other private and public partners have restored habitat at thirteen sites along the Buffalo River, including Seneca Bluffs. Seneca Bluffs is located immediately upstream of the AOC boundary and used to suffer from extensive erosion and habitat loss. Restoration activities at the site have stabilized the shoreline and established native vegetation.

In close coordination with Erie County, Buffalo Niagara Waterkeeper is currently designing public access improvements in the interior of the park as part of New York State Governor Cuomo's Buffalo Billion II Initiative– known as the Buffalo Blueway Project. Seneca Bluffs was chosen as one of the Buffalo Blueway sites due to its unique habitat within a densely populated area in the City of Buffalo. The addition of a green infrastructure parking area will allow for stormwater capture as well as provide a welcoming, functional parking area with educational and stewardship opportunities for residents visiting the site.

In summary, Buffalo Niagara Waterkeeper is happy to support the Erie County Department of Environment and Planning's project proposal for constructing a green infrastructure parking area at the Seneca Bluffs Natural Habitat Park as we believe it will benefit the health of the Buffalo River AOC and the underserved local community as a whole.

Thank you in advance for your consideration of this proposal. Please contact me if you have any questions or require additional information on my support for this proposal.

Sincerely,

Katherine Winkler
Senior Program Manager

Buffalo Niagara WATERKEEPER
721 Main Street • Buffalo, NY 14203
E: Info@BNWaterkeeper.org

P: 716-852-7483
F: 716-885-0765
BNWaterkeeper.org

Erie County Soil & Water Conservation District
50 Commerce Way, East Aurora, New York 14052-2185
Phone: (716) 652-8480

January 27, 2021

Bonnie Lawrence
Erie County Dept. of Environment & Planning
95 Franklin St., Room 1085
Buffalo, NY 14202

Re: Seneca Bluffs Natural Habitat Park Green Infrastructure Project

Dear Ms. Lawrence,
It is my pleasure to write a letter of support for the New York State Green Innovation Grant, *Seneca Bluffs Natural Habitat Park Green Infrastructure Construction Project*, submitted by the Erie County Department of Environment and Planning and on behalf of Erie County Soil and Water Conservation District (District). The District is a partnership organization with a mission to improve, restore and protect local natural resources through a variety of different programs. Over the past year we have assisted with invasive species removal projects at Seneca Bluffs and plan to assist as available with future efforts. Habitat restoration and native planting included in the proposed project will provide necessary support for ensuring the long-lasting success of these efforts.

The District is committed to assist in reducing the impact of invasive species in our region and increasing capacity for management. In addition to improving invasive species management, The Seneca Bluffs Natural Habitat Park Green Infrastructure Construction Project will contribute to the overall health of the Buffalo River and falls in line with other restoration projects along the Buffalo River Area of Concern. The proposed installation of green infrastructure and restoration of urban wetland and forests will reduce large volumes of stormwater from entering the combined sewer system annually, provide valuable wildlife and pollinator habitat, revitalize the ecosystem, and enhance a community asset. The District is looking forward to continuing our work with the Erie County Department of Environment and Planning, as well as additional partners, to ensure the successful implementation of Seneca Bluffs Natural Habitat Park Green Infrastructure Construction Project. We ask you to support this project and would like to thank you for your consideration.

Sincerely,

Mark C. Gaston
District Field Manager