CITY OF NEWBURGH
GREEN INFRASTRUCTURE FEASIBILITY REPORT

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EXECUTIVE SUMMARY

eDesign Dynamics (EDD), in partnership with Hudson River Sloop Clearwater (Clearwater) and the Quassaick Creek Watershed Alliance (QCWA), has completed a year-long, Green Infrastructure (GI) feasibility study under funding and guidance from the New England Interstate Water Pollution Control Commission (NEIWPCC) and the New York State Department of Environmental Conservation Hudson River Estuary Program (NYSDEC HREP or HREP). The purpose of the grant and the study was to provide educational outreach to community and municipal stakeholders regarding the feasibility and benefits of GI and generate fundable conceptual designs for specific GI interventions. EDD, Clearwater, and QCWA worked with the City of Newburgh to address local water quality concerns, the federal Clean Water Act, Combined Sewer Overflows (CSOs), natural hydrologic systems, and the potential role to be played by GI interventions for residents of Newburgh. GI interventions were developed in collaboration with stakeholders and are intended to complement the City's draft Long Term Control Plan (LTCP), regular and on-going road reconstruction work, and future land use planning. Of the many locations identified for possible GI, those with the highest potential to reduce CSOs and improve water quality in the Hudson or the Quassaick were chosen for further elaboration.

It is intended that this Report serve as a means to describe and promote a feasible set of Green Infrastructure possibilities for application in Newburgh, demonstrate how GI can complement the "grey" solutions recommended in the LTCP, and provide the background and materials needed to prepare the Green Innovation Grant Program (GIGP) application to the New York State Environmental Facilities Corporation (NYSEFC), as well as other potential sources for funding of design and construction. As part of the project's scope, the Team submitted a request for design and construction funding under the GIGP. That request was still pending at the time of this report completion.

GREEN INFRASTRUCTURE OBJECTIVES

Green Infrastructure (GI) is the set of stormwater management interventions that are designed to manage stormwater near the source or points of collection. GI systems typically imitate natural systems and replace many of the hydrological functions lost as land was developed and urbanized. Many older urban areas, Newburgh included, possess Combined Sewer Systems which convey sanitary wastewater and stormwater within the same set of pipes. These systems invariably surcharge during wet weather when system capacity is overwhelmed, resulting in severe compromises to water quality and ecological health. Where separate (non-sanitary) points of discharge do not exist, GI systems are intended to divert stormwater runoff away from the sewers toward alternative “green” structures that are sized and designed to be capable of receiving and managing runoff from the associated contributing area. GI practices provide a system of conveyance, capture, storage, treatment, and discharge, with components based on the same qualities that regulate natural conditions: utilizing soil, plants and sunlight to improve water quality prior to infiltration or release to surface waters. A host of secondary benefits accompanies the use of GI, including air quality improvements, habitat connectivity, groundwater recharge, reduction of urban heat island effect, and public recreation.

LONG TERM CONTROL PLAN (LTCP)

Newburgh’s most recent Combined Sewer Overflow Long Term Control Plan (CSO LTCP or LTCP) draft was issued in January 2013. The document outlines a viable course for meeting compliance with the United States Environmental Protection Agency’s (USEPA) CSO Control Policy. Currently, the City’s conveyance system and Water Pollution Control Plant (WPCP) manage approximately 74% of wet weather flows, while the remainder is released at 13 permitted CSOs (inclusive of the WPCP outfall), which discharge to the Hudson River. Annual CSO discharge is approximately 240 million gallons. The LTCP, prepared by engineering firms ARCADIS and Stantec, principally recommends repairs and improvements to the City’s conveyance system and increased treatment capacity at the WPCP. While Phase 1 of the five-phased proposed efforts recommends “institutional changes to promote green infrastructure,” this represents less than one percent of the total expected cost of fulfilling the LTCP. This GI feasibility effort is intended, in part, to expand the role that GI might play in abating Newburgh’s CSOs. At the time of this report, the LTCP had not been finalized as the City is in the process of negotiating the final elements of the plan with the New York State of Department of Environmental Conservation (NYSDEC or DEC), including a larger role for the use of GI.

GREEN INFRASTRUCTURE PRACTICES

The NYSEFC identifies eight types of GI Practices: permeable pavements, bioretention, green roofs and green walls, street trees and urban forestry programs, riparian buffers/floodplains/wetlands, downspout disconnection, stream daylighting, and stormwater harvesting/reuse. In addition to these eight practices, detention based systems can be used as a GI practice.

Permeable Pavement

Permeable pavement can refer to permeable concrete, permeable asphalt, and permeable pavers. They are most effective in sites where reducing existing pavement is not desirable, such as roads, sidewalks, and parking lots. Most permeable pavements have an infiltration rate higher than ten inches per hour, allowing water to permeate into a subsurface gravel reservoir or tanks and then infiltrate into the subgrade. Permeable pavement systems require periodic maintenance to reduce the buildup of fines within the pavement pores. This involves the use of a vacuum sweeper every one to three years, depending on local conditions. Permeable pavement systems are not recommended for use when runoff from adjacent areas is directed toward the system, as this will increase the potential for clogging. Permeable concrete systems have been known to be vulnerable to degradation from over application of road salt.

Bioretention

Bioretention is the basis for most GI design practices, configured and sized to meet a variety of applications. These systems utilize a planted filter layer typically installed over a highly porous gravel bed for storage and infiltrate to the soil below. Bioretention systems are typically fitted with forebays (to slow the flow and collect sediment and debris) and overflows (routed toward the sewers or an alternate point of discharge). The filter layer should be composed of approximately 18 inches of sandy soil planted with native, hardy, and salt-tolerant plant species selected for the specific conditions of the installation. Plants “discharge” the retained water by evapotranspiration and take up nutrients present in the contributing runoff. Other contaminants such as oils, organics, and bacteria are sequestered in the soil and decomposed by the active soil biota. Dissolved or suspended metals, commonly found in street or parking lot runoff, are also sequestered and held in the soil. These processes help to prevent the contamination of groundwater. Examples of bioretention practices include ROW bioswales, parking lot swales, enhanced tree pits, flow-through planters, and treatment wetlands.

Green Roofs and Green Walls

Green roofs include the full range of flat roof systems that support a year-round plant cover, planting media, and drainage system. The planting medium can range in thickness between three and more than 18 inches. Decisions about installing green roofs are largely contingent on cost and structure, as many existing roofs are not designed to carry the additional load from the soil and water. “Extensive” green roofs (typically three to four inches of planting medium) generally support hardy drought and flood tolerant sedums without the need for irrigation. “Intensive” systems can support a much larger range of plants including roof-top gardens, lawns and recreational areas. While green roofs are highly effective at reducing (or eliminating) stormwater discharges, reducing building energy costs for heating and cooling, and can extend the life of the roof itself to more than 75 years, they are not generally cost effective as a CSO control policy because of the limited area that each system manages.

Green walls are not well defined in their role as a form of green infrastructure as they have not yet come into common usage. A green wall can consist of a vine type cover, which adheres to the wall surface and draws moisture from roots in the ground. More sophisticated installations involve a hanging planting medium, sometimes installed behind screens over the wall surface; multiple plant types that add color, variety and sometimes pattern to the wall; and a drip irrigation system that keeps the medium continually moist. In order to manage stormwater, these systems would have to be installed in conjunction with a storage cistern and pumps. Little research has been performed to assess the potential for green walls to reduce stormwater discharges.

Street Trees/Urban Forestry

Street trees and urban forestry programs allow for improvement in water quality, as well as reduction in runoff by reducing impervious areas. Current research is making it increasingly clear that tree and plant canopies alone manage large volumes of stormwater through direct interception, and extensive tree root systems evapotranspire soil moisture and keep the soil permeable and biologically active. The ancillary benefits of increased tree cover in urban areas include: air quality improvements; reduction in urban heat island effect; carbon sequestration; recreation; habitat; soil stability; and wind break. Trees generally require minimal maintenance once established.

Contemporary tree pit designs can be configured to resemble bioretention systems and manage larger volumes of stormwater runoff. These designs include extensive subsurface storage components that allow runoff that enters the pit to quickly drain from the surface. These are highly efficient systems given their footprints on the ground, but require a higher degree of advanced planning and more elaborate installation than typical street tree plantings. Tree species selection should also consider the higher moisture content that these systems provide at the roots.

Riparian Buffers / Floodplains / Wetlands

Riparian buffers, floodplains, and wetlands are generally larger-scale interventions that either enhance existing natural conditions or replace natural functions lost during development. Riparian buffers protect streams from bank erosion, filter runoff, and provide enhanced habitat within the stream corridor. Floodplains provide places for streams to overflow during extreme rainfall events, and reduce stream velocity. Wetlands include a large range of systems, but typically refer to areas that sustain specially adapted plants and biota that rely on wet conditions and high nutrient levels. Wetland areas are extremely important in recharging groundwater and removing nutrients and sediments.

Downspout Disconnection

In combined sewer areas, roof leaders are often plumbed directly to a standpipe that connects with the sewer. As roof areas are quite large and impervious, disconnecting downspouts can remove a sizeable volume of water contribution to CSOs. Several practices are available for managing the discharge, including rain gardens, dry wells, rain barrels or, where native soils are sandy and permeable, direct discharge to lawn areas. Any extensive disconnection program should be accompanied by education and homeowner assistance in locating and configuring the new discharge.

Stream Daylighting

As communities developed along streams, poor water quality conditions and pressure to increase land availability inspired the culverting and burial of natural drainage ways. These piped systems often became part of the area's larger sewer system serving to receive and convey all sanitary wastes as well as stormwater. At some locations it is feasible to separate stormwater and sanitary discharges and to re-open or daylight the former stream. The advantage of this practice in combined sewer areas is that large volumes of stormwater runoff can be redirected toward daylighted streams without having to find space to manage the water within the landscape by means of infiltration and evapotranspiration. When done correctly, daylighting projects can restore a great deal of the natural functions lost during development, supporting enhanced riparian corridors, habitat, and recreation zones.

Stormwater Harvesting and Reuse

Reuse can be implemented to varying degrees, with the simplest form making water available for site irrigation. With the use of pumps and pipes, the stored rainwater can be lifted for use in site irrigation, non-potable cleaning needs, and even toilet flushing. Where the right combination of catchment (roof area), treatment (bioretention), storage (cistern), and reuse (toilets) are all located at a single site, stormwater has the potential to safely and efficiently replace potable water in non-potable applications.

Detention

In addition to the eight practices recognized by the NYSEFC, detention-based practices can also be used to reduce CSOs in combined sewer districts by detaining stormwater and slowly releasing it back into the combined sewer system after rainfall events, usually over 48 to 72 hours. For separate storm sewer systems, detention based practices can improve water quality by allowing for an extended detention period of 24 hours. Although detention systems are not as common as the previously listed practices, they offer many of the same benefits as other GI practices. Additionally, detention based systems allow for installation of GI in locations where infiltration is not feasible, either due to poorly drained soils or proximity to foundations, bedrock or groundwater.

GREEN INFRASTRUCTURE DESIGN GUIDELINES

Location, design, and construction guidelines for green infrastructure vary between regions and municipalities for reasons associated with climate, soils, topography, spatial constraints, and aesthetics. As Newburgh moves forward with establishing its conventions for GI systems, these parameters will be defined and refined to suit local conditions. Initial guidelines have been developed based on the Team's experience in other municipalities in the Northeast United States.

Sizing Criteria

Sizing of GI should be based on a volume associated with a standard rainfall event. It is recommended that GI practices in Newburgh be sized to accommodate the NYSDEC Water Quality Volume (WQv). NYSDEC defines the WQv as the volume of runoff resulting from the 90th percentile rainfall event, which for Newburgh is estimated to be 1.1 inches of rain. As per DEC:

$$WQv = [(P)(Rv)(A)] / 12, \text{ where:}$$
$$Rv = 0.05+0.009(I); I = \text{Percent Impervious Cover; minimum } Rv=0.02$$
$$P = 90^{th} \text{ percentile rainfall event in inches} = 1.1 \text{ inches}$$
$$A = \text{catchment area in acres}$$

Using the WQv to size GI allows for a significant reduction in runoff from entering the combined sewer system, with approximately 90% of rainfall events being completely managed and larger events (greater than 1.1 inches) being partially managed. The WQv also has the added benefit of allowing GI systems to treat stormwater in separate sewer systems, provided a 24-hour extended detention, as per DEC's guidelines. Note: the WQv is a target volume, and should not be used as the sole criteria in evaluating GI opportunities. GI systems are still effective when the WQv cannot be fully managed. Additionally, providing excess capacity beyond the WQv may not always be cost-effective, but can provide additional storage and opportunity to expand the contributing area. Finally, when designing GI practices that require excavation, a maximum depth of five feet below existing grade shall be used to avoid high construction costs associated with shoring.

Buried Utility Setbacks

As construction of GI systems generally involves excavation and occasional use of buried pipe, a setback from existing buried utilities is typically required. To determine the location of these utilities a survey shall be performed on site, as part of the initial feasibility analysis. In some cases the utility may possess an easement to allow for their own excavation and repair. Examples of subsurface infrastructure include gas, electric, cable, water, sewer, and telecom. A utility setback of three feet from the lateral extent of the utility is recommended, though in some cases, such as high-tension electrical lines, the setback can be as high as five feet. When developing its guidelines, Newburgh should establish a convention that meets with the approval from all relevant utility owners.

Foundation Setbacks

Where GI systems intend to promote infiltration (ie: unlined retention-type systems), a setback from existing building foundations or other subsurface utility vaults should be established in order to prevent intrusion, basement flooding and corrosion. These setbacks vary nationally from between five and twenty feet, though ten feet is becoming standard. In some dense urban areas, the setback can be reduced to five feet with the use of a vertical barrier lining the sides of the infiltration-based system to limit the lateral movement of water. This technique, however, has not yet been demonstrated to be effective. When the GI practice does not allow for infiltration (ie: pure detention systems with complete liners), setback from foundations should be based on structural concerns rather than risk of flooding.

Depth to Bedrock or Seasonally High Water Table

Most sets of guidelines require that infiltration-based GI remain a certain distance above bedrock and above the seasonally high water table. These conditions are determined using a geotechnical probe or drill rig under the guidance of a professional geologist or engineer. At the time of drilling, it is also common to perform an infiltration test on the in situ soils at the depth prescribed for the bottom of the GI. The NYSEFC specifies that GI must be installed at least three feet over bedrock and seasonally high water table.

Guidelines for GI in the Right-of-Way

When designing GI in the Right-of-Way (ROW) it is important to adhere to all local and state agency regulations (see *Regulatory Approval and Permits* below). In addition, minimum setbacks are recommended to allow for clear access of pedestrians and vehicles, and protection of existing structures. The most important consideration for designing GI in the ROW is allowing a five foot minimum clear path for pedestrian access on sidewalks. For high density neighborhoods the minimum clearance can be greater. Table 1 below lists suggested minimum distances for designing and constructing GI in the ROW.

Table 1: Suggested Setbacks for Green Infrastructure Practices located in the Right-of-Way

Recommended minimum distance/setback	From
Five feet	Existing structures and street furniture such as traffic signs, street lighting, fire hydrants, benches etc.
Five feet	Pedestrian ramps.
Five feet	Legal curb cuts/driveways.
Five feet	Property lines.
Three feet	Subsurface infrastructure including gas, electric, water, sewer, telecom, etc.
Drip line	Existing tree canopies.
Ten feet	Existing building foundations.

Soil Tests

When geotechnical borings are to be performed, it is advisable to perform waste classification testing of the in situ soil at elevations that would fall within the proposed GI. Since GI designs often require replacing existing soil with gravel and engineered soil, the cost of disposal of excavated soils should be considered in advance. In urban areas, legacy contamination may trigger costly disposal fees when certain constituents exceed safe concentrations. Environmental laboratories are equipped to perform a set of tests based on the local or state regulatory requirements for solid waste disposal. At least one composite sample taken from the proposed location should be tested well in advance of construction.

Infiltration Tests

A number of protocols are available for testing the infiltration capacity of undisturbed soils. In urban areas it is common to find a large quantity of fill material placed over the natural soil, making it difficult to assess the capacity at points below the surface. When geotechnical work is to be performed, it is common to require an infiltration test at the elevation of the bottom of the proposed GI. Infiltration can be measured using the standard protocol described in ASTM D6391-11. Alternatively, some municipalities recommend performing the test in an open pit. The City of Newburgh will need to select its preferred method, based on local costs and conditions, and establish a precise protocol and minimum infiltration rate for infiltration-based systems.

Regulatory Approval and Permits

As cities are increasingly promoting the use of GI in managing stormwater, they have established a submission and approvals process to assure that design and locations are consistent with the relevant regulations and codes. Common agencies and associated regulations and permits are listed in Table 2, as per the State Environmental Review Process (SERP) for NYSEFC funded GIGP projects. Additionally, the City of Newburgh will need to develop a protocol for approving GI practices. Such protocol can include:

- Design charrette for GI on public property;
- Design review (including, but not limited to, Schematic Drawings, Design Development Drawings, Construction Drawings, Stormwater Calculations, and Specifications) by all relevant Newburgh City Departments. It is recommended that all relevant Departments (such as Planning & Development, Water, Public Works, etc.) compile all desired regulations and have the City Engineer's office be responsible for all design reviews, in order to streamline the approvals process on the municipal level.
- Training and/or certification in Green Infrastructure practices for City Design review and Code enforcement professionals.

Table 2: Potential Regulatory Agencies, Source: New York State Environmental Facilities Corporation, State Environmental Review Process Requirements For Green Innovation Grant Program Projects.

Agency	**Potential Regulations/Approvals/Permits**
	Federal
United States Army Corps of Engineers (USCOE)	Permit for placement of dredged or fill material in waters of the US (stream crossings/wetlands).
United States Fish and Wildlife Service (USFWS)	Approval for constructions activities potentially affecting listed or proposed threatened or endangered species.
	New York State
New York State Department of Environmental Conservation (NYSDEC)	401 Water Quality certification for activities permitted by the federal government potentially affecting State water quality standards; General SPDES Permit and General Permit (GP-93-06) for storm water discharges from construction activities. Preparation of storm water pollution prevention plan (S\VPPP); Potable water supply components; Disturbances to streams and other waters.
New York State Office of Parks, Recreation and Historic Preservation (NYSOPRHP)	Activities affecting historic, architectural, archaeological, or cultural resources.
New York Department of Transportation (NYS DOT)	Work within State highway Right-of-Ways (ROWs).
Department of State (NYS DOS)	Activities affecting coastal zone management areas.
	City of Newburgh
City Engineer's Office	Consolidated review of all GI plans and designs.
Board of Education	Approval for GI work on public schools.
Department of Public Works	Approval for GI work on public parks.

TYPOLOGIES

During initial meetings with relevant stakeholders, including the City Engineer's office, and through the process of evaluating Newburgh's existing conditions, considering the City's combined and separate sewer areas, soil and topography, vacant and park lands, and public rights-of-way, the Team introduced five distinct GI typologies and the various land uses for which they could apply. This breakdown was intended as a means to direct and simplify the planning process and to draw stakeholders toward a cost-effective set of options for further consideration. The typologies consist of the following:

Strategic Separation

Strategic Separation involves the disconnection of stormwater sources (ie: roof drains and catch basins) from the existing combined sewer system (CSS) and toward an alternative form of conveyance, treatment, and discharge. "Green" separations will often involve the restoration or enhancement of surface hydrology and reconnection with natural systems. Even in urban areas where streams and wetlands have been culverted and filled to accommodate development, it is still often possible to identify discrete areas in close proximity to water features where separation can be performed effectively and efficiently. In Newburgh, where some parts of the City are served by separate sewer systems (SSS), stormwater from the combined areas can sometimes be conveyed toward separate areas, thus reducing the volume and frequency of CSO. The conventional or "grey" technique of separation is to construct new sanitary lines within the CSS and to direct the now dedicated storm lines toward points of discharge (often the former CSO point).

Open Spaces / Parks Adjacent to Large Impervious Surfaces

Where parks, green spaces, or otherwise undeveloped areas lie within the appropriate topography and within a short distance from a large, unmanaged impervious area, portions of these areas can be dedicated and converted to stormwater management. Retention/detention system, or "wet ponds" or "treatment wetlands" can be well integrated into public green spaces in a manner that provides attractive amenities, habitat niches, and significant reductions to wet weather discharges. Where feasible, these systems receive stormwater for infiltration and evapotranspiration, supporting a range of plant species chosen for hardiness and their ability to colonize a range of hydrological conditions. These retention systems are sometimes configured with a permanently wet zone where infiltration is prevented, thus allowing for a larger diversity of plants. Retention-only systems will commonly possess an overflow connection to the combined sewer or another point of discharge in order to limit flooding during extreme events.

Where soil conditions or proximity to building foundations precludes the method of imposing infiltration, detention systems can be utilized in the same manner but with a mechanism for slow release of the captured water back to the combined sewers. This reduces the volume and frequency of CSOs. Many storms will endure for a short time only, and detention systems can hold back the collected runoff until the treatment plant capacity has had the opportunity to converge with conveyance capacity. During longer storms, however, detention systems will overflow or slow-release while the surcharges (CSOs) are persisting.

Rights-of-Way

Curbside swales are common in rural areas and, along with neckdowns/bump-outs, are becoming increasingly popular in cities and towns where space can be located within the public right-of-way. Within urban areas, “bioswale” designs are significantly enhanced to receive larger volumes of runoff by using gravel beds and engineered soils, and plantings with hardy, salt-tolerant plants that require minimum maintenance. Tree pits are designed similarly, configured to receive street and sidewalk runoff that seeps into subsurface voids where the water is stored until it can be infiltrated or taken up by the plants. Permeable pavement over gravel reservoirs also has the potential to manage large volumes of stormwater runoff. Permeable pavement can be most cost effective when it is incorporated into the City’s ongoing roadwork reconstruction plans and when existing street cleaning allows for maintenance. Street cleaning would ideally utilize suction-based equipment to regularly remove sediment from permeable pavements.

When in situ soils are not sufficiently capable of infiltrating water, or when infiltration may compromise or interfere with existing structures, detention-based systems can be created with the use of impervious liners. These swales require a slow release mechanism to allow the detained runoff to discharge back to the sewers.

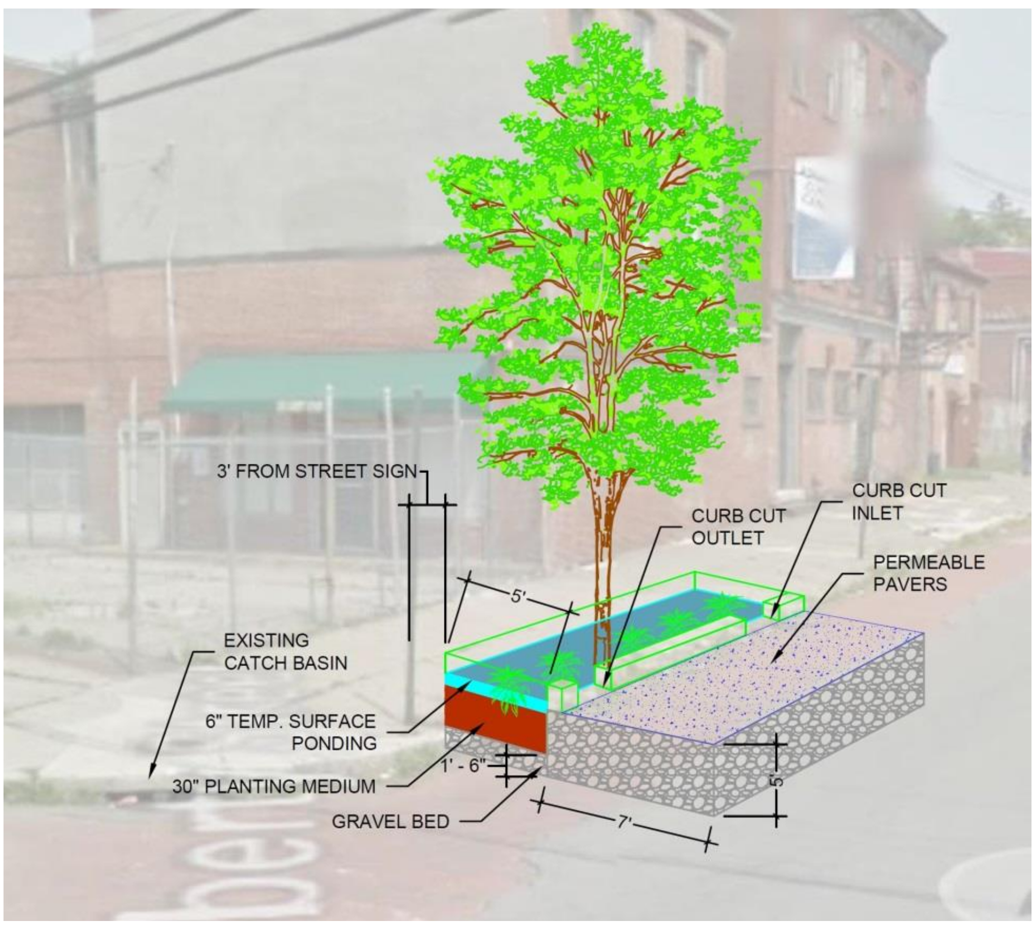


Figure 1: Rendering of right-of-way bioretention swale with permeable pavement over a gravel reservoir on Liberty Street in Newburgh, NY

Government Property

The key benefits to installing GI on public land include visibility, control over decision-making, promotion and education, and controlled access. Many cities nationally have begun the process of installing GI with high-profile demonstration projects on municipal grounds. These are also useful in training design, construction and maintenance personnel in new practices and paradigms. Green systems managing municipal parking lots, school playgrounds, or roof runoff from government owned buildings send a strong message to the public while also enhancing public spaces with new green amenities.

Within municipal properties or other parcels where access can be restricted and where maintenance is performed by personnel, it is possible to configure GI systems for various reuse scenarios such as site irrigation, toilet flushing, or some cleaning practices. Reuse systems are best configured to receive roof runoff diverted to barrels or cisterns. Secondary (non-potable) delivery systems convey the reuse water to points within the building, such as toilets and custodial sinks, or to irrigation points within the building grounds. Reuse requires a higher degree of initial investment, some mechanized parts (pumps and filters), and trained maintenance personnel. Benefits, beyond simple reductions in wet weather contributions to the City sewers, include education, "green" publicity, and potential rate reductions in building water and sewage costs.

Properties such as these can also benefit from use of retention/detention systems like those described above. These can also be elaborated to include some reuse to meet irrigation needs over the remaining property.

Private Property

A large number of options for green stormwater management at a variety of scales are available for use by enthusiastic property owners, depending on the availability of space, land use, and soil conditions. Where soils are sandy and the groundwater table is far from the surface, disconnecting downspouts for direct discharge to a rain garden or open lawn is generally sufficient to manage roof water. Small paved areas (i.e.: driveways and walkways) can be graded to direct discharge toward depressed planted areas. Larger, commercial lots can also replace existing, paved areas with permeable pavement, allowing large volumes of runoff to be stored in subsurface gravel reservoirs and then infiltrated into the existing subgrade.

When conditions are not suitable for promoting infiltration, more involved designs are needed to adequately control runoff sources. Retention/detention systems should be located down gradient and at least ten feet from building foundations to prevent intrusion. These systems can be configured to allow for overflow and/or slow release to the combined sewers, or can have secondary locations for discharge if space is available. Slow release can be configured for irrigation of garden plots or lawn, though may require the use of a pump. More sophisticated reuse scenarios can be implemented when the property owner is dedicated to oversight and maintenance.

The City of Newburgh can provide incentives for property owners to reduce their wet weather contributions to combined sewers, such as rate reductions on sewer bills. Other incentive programs include the reuse of stormwater or greywater, or use of water-saving appliances or fixtures, all reducing potable water demand. Each authority has its own unique set of requirements for receiving these incentives, but typically involves justification of an expected percent reduction in sewage volume or potable water demand.

POTENTIAL LOCATIONS

After the typologies were established, a list of suggested locations was created that fit into one of the five typologies. Numerous locations were initially evaluated through the use of satellite images, where large impervious surfaces were able to be located, and through Geographic Information Systems (GIS) data that was obtained from the Newburgh City Engineer's office. GIS data[1] allowed determining locations that were within combined sewer districts, ownership of locations, available area for construction of GI, and distance to separate storm sewers for conveying flow out of the combined sewer system. Following multiple meetings with stakeholders and the public, as well as follow-up site visits, some locations were removed while others were added. The result is a map (Figure 2) and corresponding table (Appendix A) of potential GI locations that can be installed in the City of Newburgh. The intent of this map is to act as a guideline for potential locations in Newburgh. Upon further investigation at specific sites, some locations might be deemed unsuitable for Green Infrastructure. Conversely, sites can be added where owners or neighborhoods express an interest in GI.

PRELIMINARY ANALYSIS OF POTENTIAL SITES

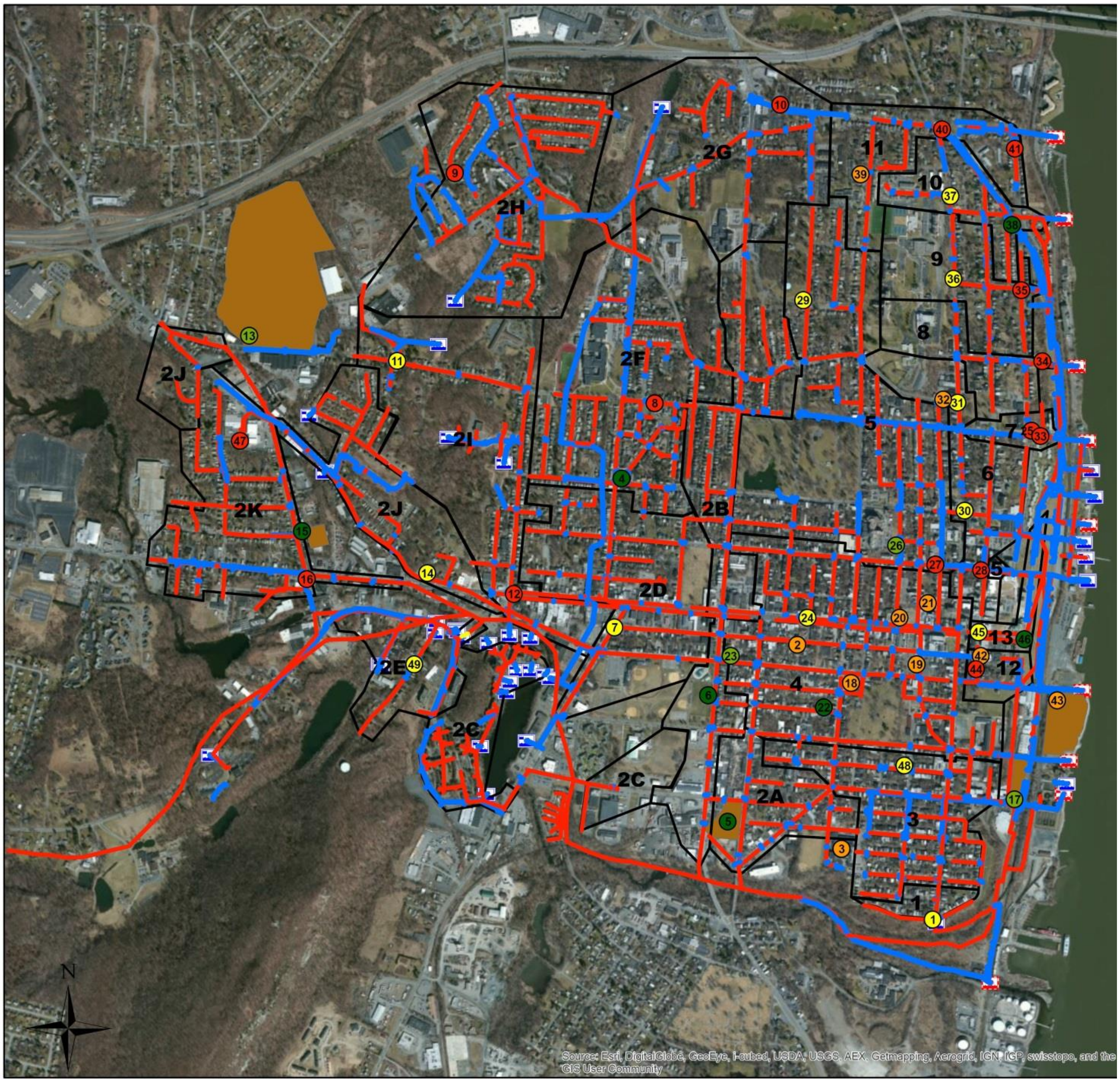
To demonstrate the potential of GI, one site from each typology was selected for further analysis. Conceptual plans and cursory cost estimates for each proposed site can be found in Appendix B.

1. *Strategic Separation: Montgomery Street and Clinton Street*
   a) Background

The strategic separation approach to CSO mitigation has the potential to divert large volumes of runoff, sometimes with relatively low implementation costs, and typically resulting in opportunities for habitat improvements. At some locations, stormwater flows can be strategically separated from within combined sewer areas before mixing with sanitary wastes and redirected toward alternative points of discharge. In most instances, candidate locations are near existing or historic streams or other bodies of water that possess the capacity to receive higher flows without complications. In many cases, the additional contributions can improve water quality in the receiving body through enhanced flushing, or extend the range and diversity of adjacent habitat. Because runoff, especially street runoff, carries sediment, metals, nutrients and pathogens, it is also necessary to pass the separated stream through "best management practices" (BMPs) which filter and treat the water before release to the environment. Green BMP designs highly resemble GI designs, and can themselves become attractive public amenities that enhance the urban environment.

[1] GIS data obtained from City Engineer's office. Before proceeding with any designs the location of separate and combined sewers will need to be confirmed in field.

Newbugh Potential GI Locations



Legend

Proposed GI
- GI on Government Property
- GI on Private Property
- Open Spaces / Parks Adjacent to Impervious Areas
- Right-of-Way GI
- Strategic Separation

Gravity Sewers
- Combined
- Storm
- Siphon
- Regulator Districts

Brownfield

Outfall
- COMBINED
- STORM

Figure 2: Map of Potential GI Locations for Newburgh; for a list of these locations, see Appendix A

b) Potential Site Application

The potential project (Figure 3) would divert runoff from approximately 45,000 square feet of Clinton and Montgomery Streets by rerouting three existing catch basins that are currently connected to the combined sewer system, toward a new subsurface pipe that conveys water to a tiered system of bioretention facilities supported by retaining walls. These innovative terraces would support attractive, salt tolerant native plant species within a sandy planting medium over a porous gravel base, managing at minimum 1.1 inches of runoff from the contributing impervious area, which is equal to the Water Quality Volume (WQv) as defined by the New York State Department of Environmental Conservation (NYSDEC). Runoff exceeding the WQv would overflow from the system terraces and conveyed further downhill to connect with a dedicated storm sewer line that eventually discharges through a storm outfall directly to the Hudson River.

This location was selected for Strategic Separation based on its visibility, replicability, property ownership, cost, and stakeholder interest. In this configuration, runoff captured in street inlets is conveyed away from the combined sewers toward an adjacent hillside lot. Though steep slopes are not typically amenable to GI placement, this particular site offers an opportunity to implement an innovative use of terrace walls and planting beds to receive and treat flows before discharging to a separate storm sewer which subsequently discharges to the Hudson River. This concept was selected for use in the funding application to GIGP which was submitted to NYSEFC in June 2014.

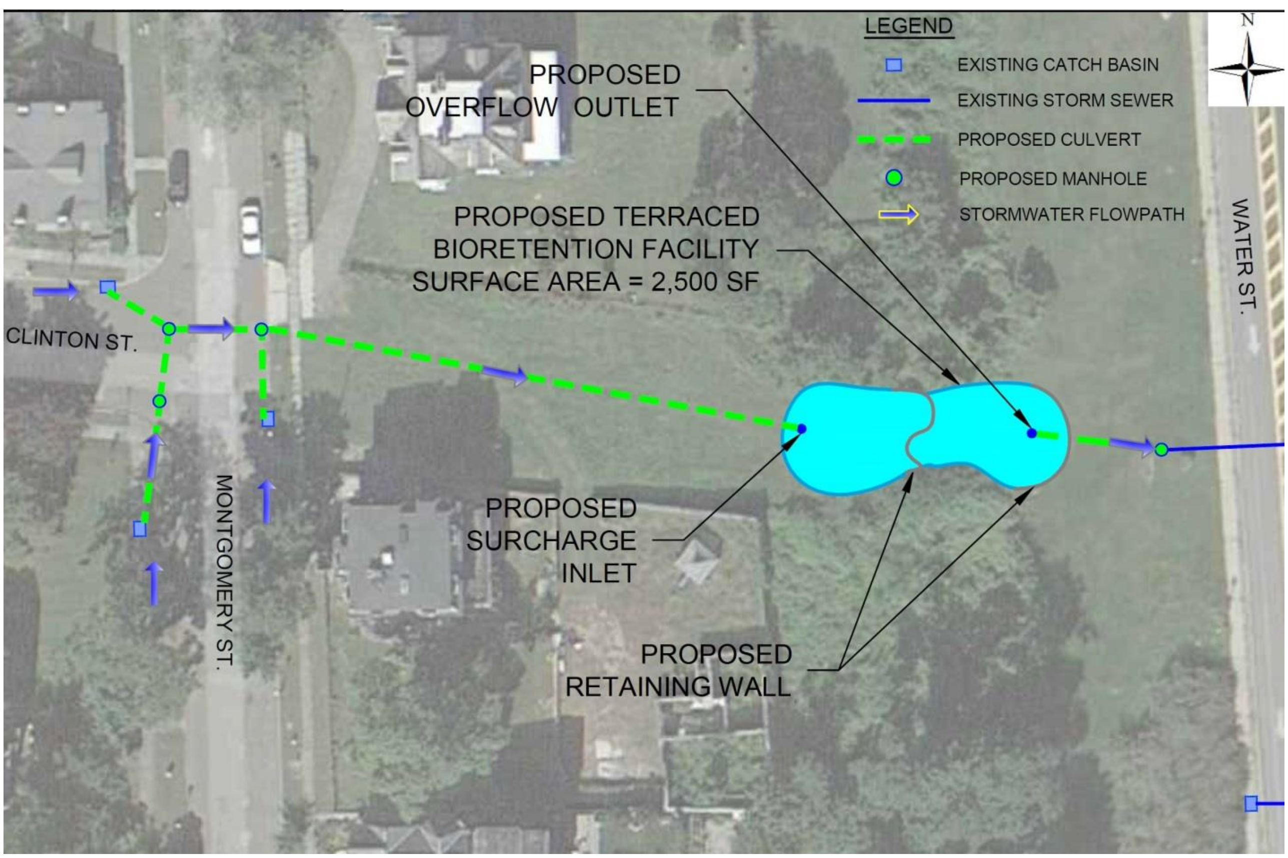


Figure 3: Proposed GI near Montgomery Street & Clinton Street, demonstrating an example of "Strategic Separation"

2. *Open Spaces / Parks Adjacent To Large Impervious Surfaces: Clinton Square*

a) Background

The typology of Open Spaces/Parks adjacent to large impervious surfaces applies when the potential to capture runoff from an expansive impervious area, such as streets, parking lots, large roofs, etc., exists in a location adjacent to a public park or under-utilized open space such as a vacant lot. Proper topographical conditions are needed to direct runoff toward the management area either by sheet flow or capture and conveyance. Space dedicated for the management area should be on the order of 10% of the catchment area if the WQv is to be met. In some cases it will be necessary to provide for overflow when the GI capacity is exceeded. In other cases it may be feasible to provide for overflow to occur at the points of capture, causing the conveyance system to back up and direct excess flows to the conventional system. When soil conditions preclude infiltration, some form of slow release may also be necessary.

b) Potential Site Application

The potential project would divert runoff from 3rd Street between Bush Avenue and Underhill Place into a bioretention facility in the park by installing a stormwater inlet directly upstream of the existing catch basin. The stormwater inlet would be designed similarly to the existing catch basin to facilitate maintenance, but would convey stormwater into the park via a culvert. A manhole would redirect stormwater into the bioretention facility through an inlet pipe. An overflow control would be placed into the manhole to redirect excess water to the catch basin downstream, thus preventing flooding in the park.

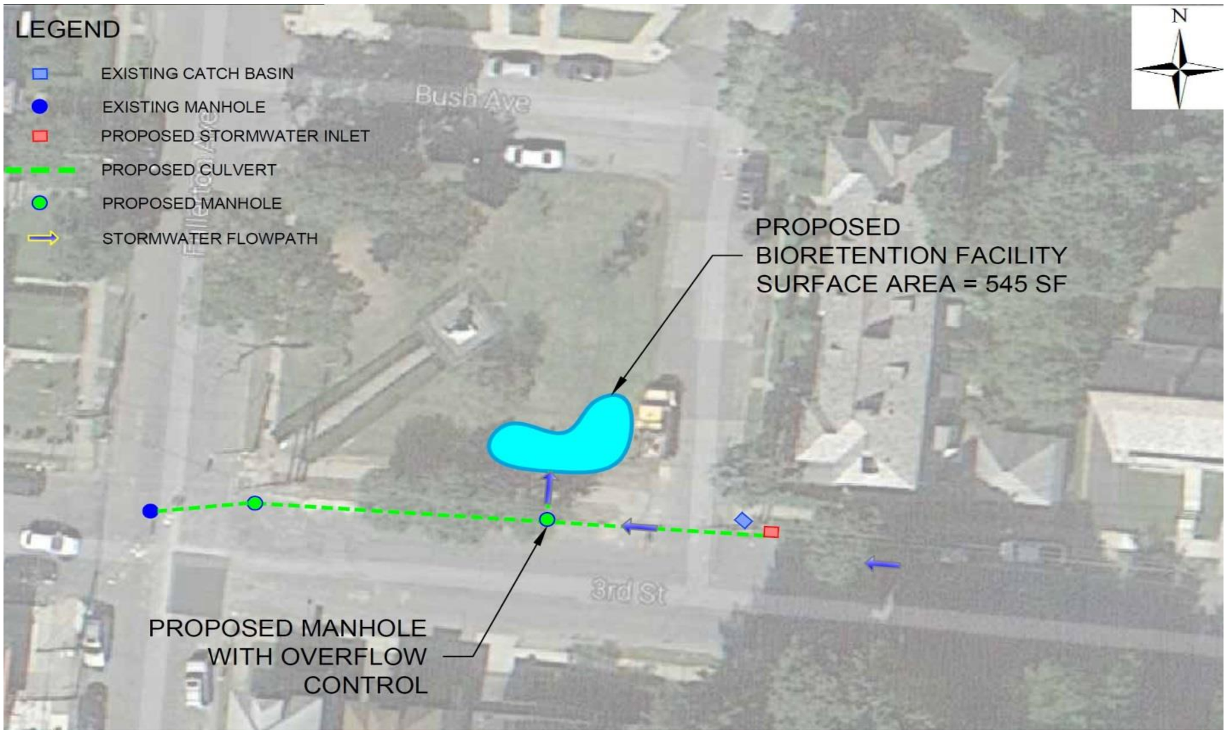


Figure 4: Proposed GI for Clinton Square, an example of managing water through GI in Open Spaces, adjacent to impervious areas.

The bioretention facility would enhance the existing park while also managing 872 cubic feet of water, or approximately 102% of the WQv associated with the upstream catchment area. The bioretention facility would be planted with attractive and hardy native plants that enhance the landscape, attract foraging birds, and provide educational and recreational opportunities for the public. Plants would be selected based on moisture and light regimes and soil type. As road salting is expected during winter months, proper soil drainage must be present to allow for adequate flushing in the spring. Salt-tolerant plants would survive better in these conditions.

3. *Right-of-Way: Broadway*

a) Background

The right-of-way (ROW) typology is a popular approach in dense urban areas that struggle to find suitable locations within the developed landscape for GI. Runoff into these systems tends to have particularly high sediment and contaminant levels, and may possess oils from leaking vehicles and metals from wearing tires. Most right-of-way systems attempt to divert runoff from the curb area before it reaches the conventional inlet, thus filling a depressed planting area located either within the sidewalk/curbside space or in a neckdown/bump-out. These systems must be excavated to a suitable depth to be backfilled with sorted gravel and a sandy planting bed. This assures that there will be sufficient void space to receive the runoff, and sufficient flow-through to promote infiltration.

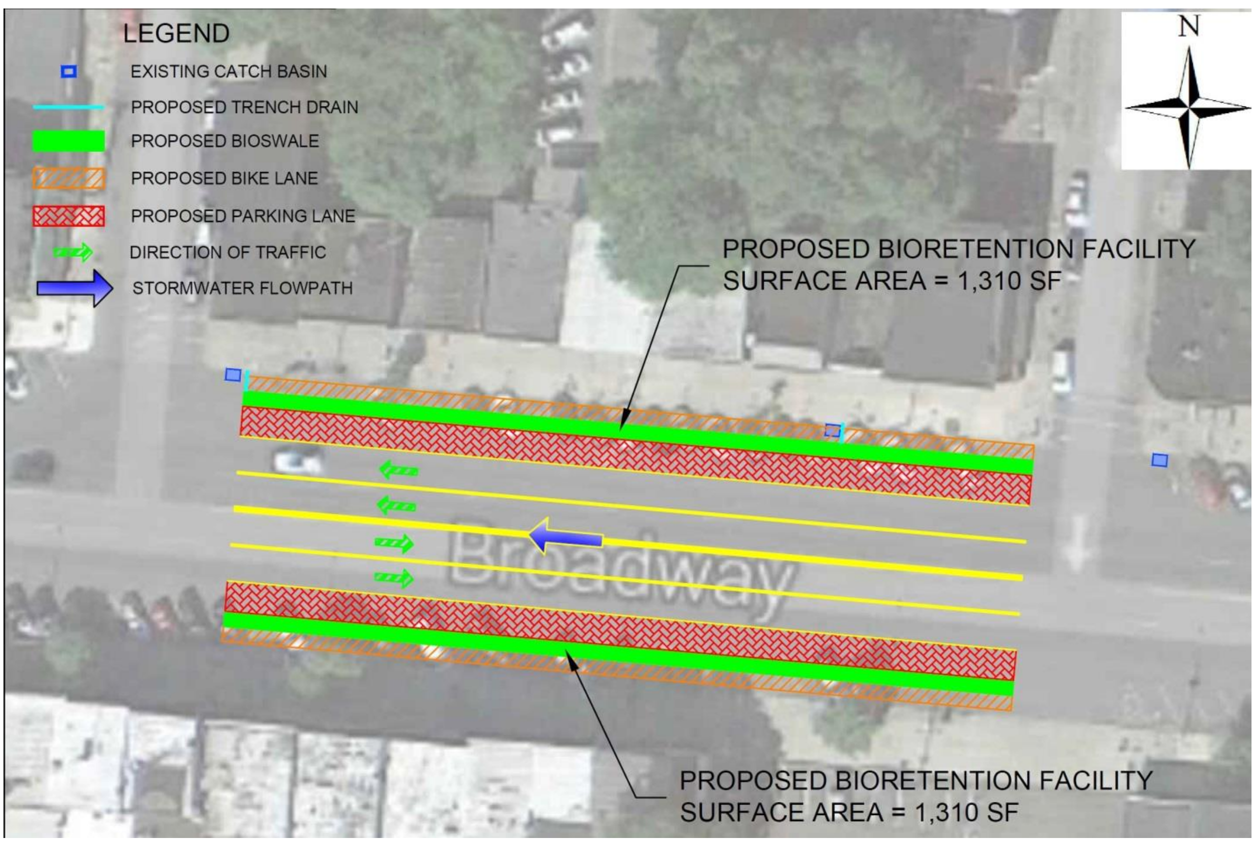


Figure 5: Proposed ROW GI for a section of Broadway in Newburgh, NY

b) Potential Site Application

To demonstrate the use of ROW GI, the Team describes an example of how GI could be incorporated into future roadwork. Although the location of this project is on Broadway between Carpenter Avenue and Lutheran Street, the GI practice could work anywhere along Broadway as the City of Newburgh begins to redesign the street, by removing angled parking spaces. The project would manage stormwater in a bioretention facility that runs along the entire length of the street. The bioretention facility could also act as a safety buffer between a proposed bicycle lane and vehicular traffic, while also enhancing the newly designed road. The bioretention facility could be installed on both sides of the street to treat runoff from a catchment area of approximately 63,000 square feet, with an estimated WQv of 5,472 cubic feet. In addition to a potential bioretention facility, permeable asphalt could be used for the re-designed parking spaces, with a subsurface gravel reservoir allowing for increased storage volume. Permeable asphalt can be beneficial should a geotechnical analysis reveal that excavating to a full five feet is not feasible. Native plants chosen must be hardy and salt-tolerant. Maintenance is typically devoted to plant care and trash removal.

4. *Government Property: Washington Street School & Ann Street Parking Lot*

a) Background

In some special conditions it may be feasible to employ a more ambitious stormwater management and reuse scheme, one that requires trained personnel and jurisdiction over several system components. Such systems can be placed on public and private lots.

a) Potential Site Applications

A potential project at the Washington Street School would be a highly visible example of GI on public land-- not only enhancing the school but also offering valuable educational opportunities for students. Stormwater could be diverted from rooftops into storage containers for reuse purposes. Permeable surfaces could replace existing asphalt in the playground, allowing stormwater to be managed in a subsurface gravel bed, while providing an added amenity for students.

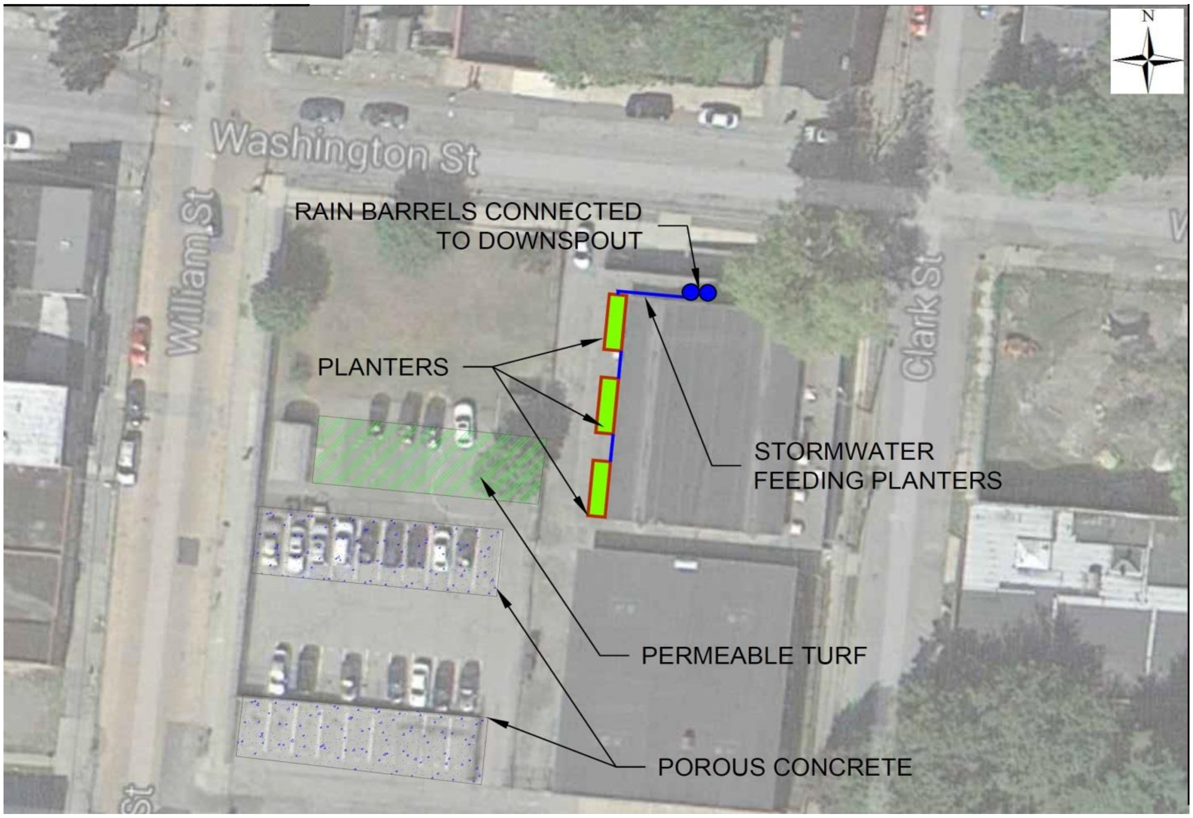


Figure 6: Proposed GI for Washington Street School

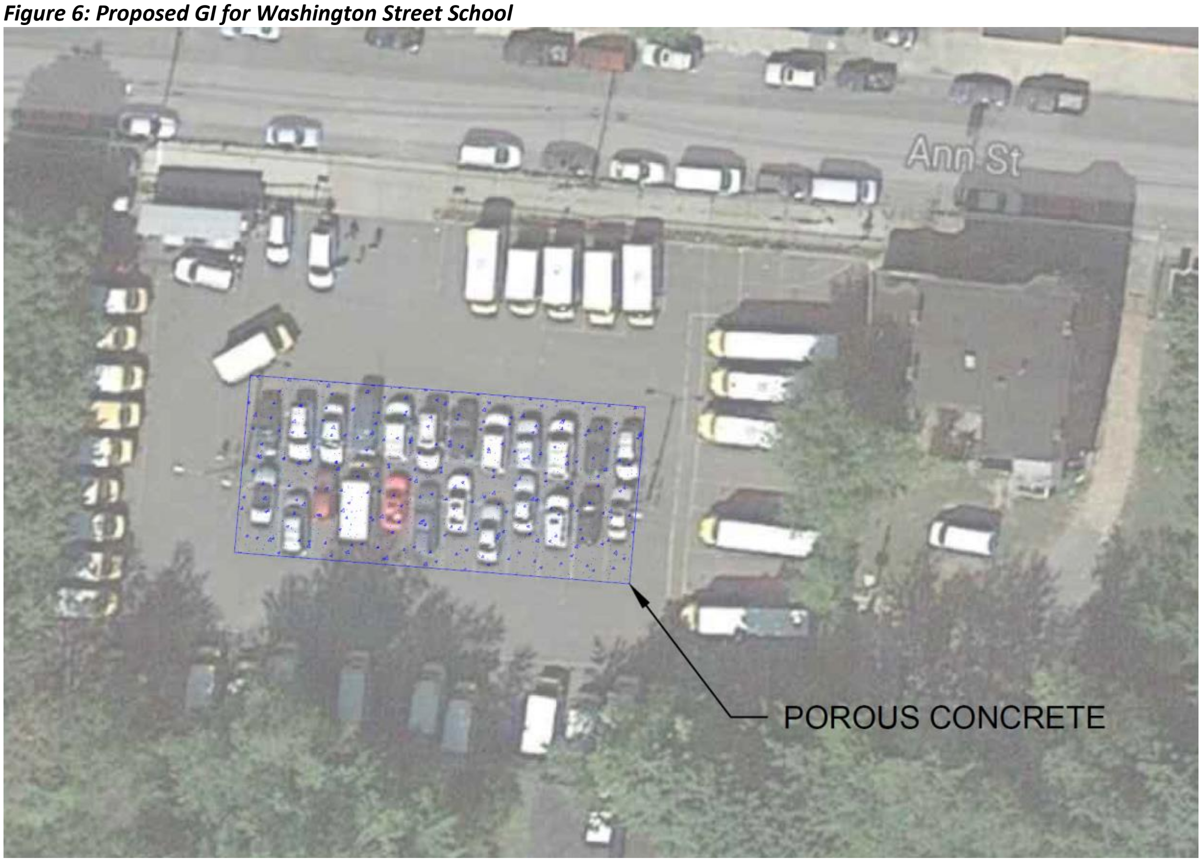


Figure 7: Proposed Permeable Concrete for the Ann Street Parking Lot

Impermeable asphalt on parking lots could also be converted to permeable surfaces. The existing lots contribute runoff directly into the Newburgh combined sewer system. Replacing these parking lots with permeable surfaces during regularly scheduled maintenance would allow for existing public maintenance funds to be redirected towards GI. In the case of the Ann Street Parking Lot (Figure 7), permeable concrete with an area of approximately 5,000 square feet over a two foot deep gravel reservoir can manage 140% of the WQv over a catchment area of 34,000 square feet. This practice could be highly replicable throughout Newburgh's municipal parking lots.

5. *Private Property*

While no specific locations have been identified within this effort for private property management of stormwater, a large number of opportunities exist throughout the City the Newburgh, particularly at the individual parcel level. These types of interventions generally require some initial investment by the property owner along with a degree of familiarity and willingness to perform maintenance. The relative ease with which rain garden-type systems can be installed depends highly on the individual property, available space, and soil conditions. Some regions possess soils that are sufficiently sandy to allow for the direct discharge of roof drains to the lawn with no consequences, rutting, flooding, or muddiness. Where soils are less receptive to infiltration, receiving depressions located at least ten feet from the building foundation can be dug and planted with a variety of native wetland plants. In areas on steep slopes or with clay soils that are resistant to infiltration, detention systems like rain barrels can be effective at managing small volumes. Other design configurations such as planter boxes can be employed at multi-unit residential buildings. These planters would resemble lined bioretention systems and, when designed and sized appropriately, can demonstrate a significant reduction in wet weather contributions to the combined sewers.

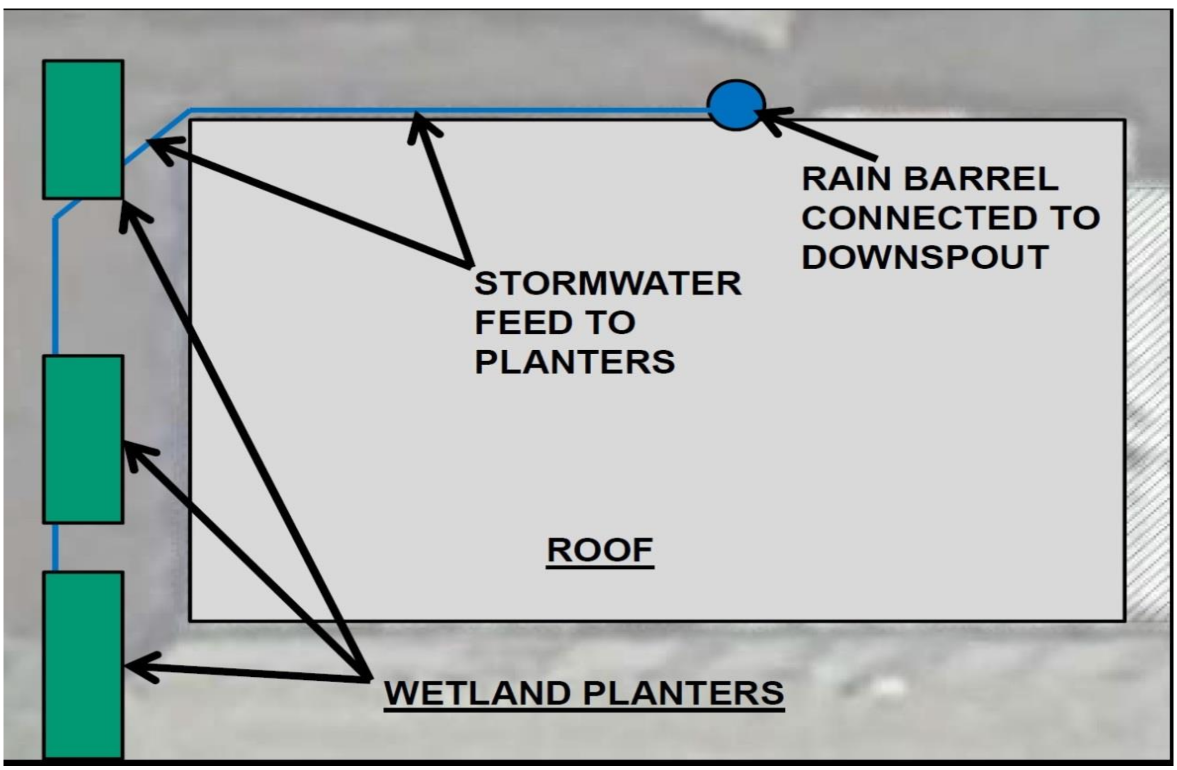


Figure 8: Schematic Design of detention based GI using downspout disconnection on a private lot.

POST CONSTRUCTION MONITORING

GI strategies address flood mitigation and enhance stormwater quality in a highly distributed manner, interrupting the runoff and conveyance of stormwater toward conventional systems and detaining it or managing it locally. Because these interventions are generally small in scale, the effect of a single management practice is not felt at the city-wide level. Quantifying the collective water quality or water volume benefits of GI systems can be challenging. Within the design process, performance expectations are modeled mathematically using measured parameters such as system geometry, soil infiltration rates, and local precipitation patterns. To confirm these predictions, post-construction monitoring (PCM) should be incorporated into GI practices.

The goal of PCM is to characterize the water budget and determine the efficacy of various GI practices. Results obtained from PCM will allow the City to assess performance, refine design and construction standards, and determine spatial implementation of future GI practices. More importantly, PCM will allow the City to demonstrate that GI is a cost-effective approach in increasing wet weather capacity to the WPCP and reducing CSOs.

PCM should include a climate station measuring precipitation, wind speed and direction, relative humidity, air temperature, and net radiation; water quality sampling locations equipped with ISCO samplers and YSI sondes; piezometers, wells, flumes, and weirs fitted with calibrated pressure transducers; soil sensors that record volumetric moisture content, soil temperature, and electrical conductivity; and weighing lysimeters consisting of low profile scales sensitive enough to record water lost during one day of evapotranspiration.

DECISION/FEASIBILITY MATRIX

The following decision/feasibility matrix was created to assist stakeholders and the public in better understanding stormwater management options.

GI Design	Typology	Advantages	Disadvantages (Including Difficulty To Implement)	Approx. Cost Per Gallon Managed[1]
Permeable Pavement	ROW, Government Property, Private Property	No loss of paved area.	Maintenance, clogging, salt damage.	$8/gal
Bioretention	Strategic Separation, Open Spaces, ROW, Government Property, Private Property	Habitat improvements. Groundwater recharge.	Maintenance (plant care and litter removal), tripping hazard, spatial limitations.	$13/gal
Green Roofs/ Green Walls	Government Property, Private Property	Building energy reductions, increased roof longevity, decreased urban heat island effect.	Cost, existing roof structure may be insufficient.	$22/gal
Stormwater Street Trees	Open Spaces, ROW	Street beautification, limited footprint, decreased urban heat island effect.	Extensive excavations.	$6/gal
Riparian Buffers/ Floodplains/ Wetlands	Government Property, Open Spaces	Recreate natural conditions – multiple benefits.	Large land areas, precludes further development.	$7/gal
Downspout Disconnect	Government Property, Private Property	Typically inexpensive and highly tangible. Can represent large impervious areas.	Internally located downspouts may be difficult to disconnect. Points of discharge within or near the property must be available to receive roof runoff without promoting poor conditions.	$0.50-1.50/gal

[1] Only includes construction costs and based on average of costs aggregated from EDD's GI projects.

GI Design	Typology	Advantages	Disadvantages (Including Difficulty To Implement)	Approx. Cost Per Gallon Managed[1]
Stream Daylighting	Open Spaces	Potential for high volume, recreate natural conditions, habitat opportunities.	Continuity required, spatial constraints, access/safety.	$5-50/gal
ROW retention system	ROW	Street greening. Traffic calming and pedestrian safety. Utilizes ROW areas. Habitat improvements. Groundwater recharge.	Conflicts with land use and subsurface utilities. Public maintenance requirements.	$10-15/gal
Detention systems	Strategic Separation, Open Spaces, ROW, Government Property, Private Property	Reduces downstream flooding by regulating discharge to waterways. Habitat improvements. Recreation. Source for irrigation water/reuse.	Does not reduce volume discharges to treatment plant. Maintenance requirements.	$5/gal
Stormwater Harvesting and Reuse	Government Property, Private Property	Educational, reduces water/sewer bills.	Treatment standards, unclear regulatory oversight, potential health risk.	$3/gal

INTERMUNICIPAL COORDINATION FOR SEWERS AND PROTECTION OF DRINKING WATER

In coordinating its GI feasibility work, EDD was requested by stakeholders to bring attention to the existing status of the City's sewer infrastructure and the quality of the reservoirs and outline a scope for future evaluation of sewer and drinking water reservoir infrastructure.

Sewers

The City of Newburgh's WPCP is shared between the City of Newburgh and the Town of Newburgh. The existing sewer maps have been found to contain some errors. Coordination between the City and Town would allow both municipalities to assess methods to improve existing infrastructure. Such methods include:

- Performing a survey of the sewer districts to determine if what has been built over the years conforms to what is documented.
- Assessing the physical condition of storm and waste lines throughout the sewer district. Older sections of the system may have deteriorated; and may admit surface and ground water, taking up unnecessary capacity.
- Weighing the capacity of the WPCP against the potential build out of both municipalities based on their zoning and comprehensive plans to determine realistic limits to future growth.

Updating the City's sewer data would also allow for the potential locations of GI proposed in this report to be refined.

Drinking Water

The City of Newburgh's two drinking water reservoirs, Washington Lake and Brown's Pond are located outside the City's municipal boundaries. Washington Lake lies in both the Towns of Newburgh and New Windsor. Brown's Pond, also known as Silverstream Reservoir, lies wholly in the Town of New Windsor. Opportunities to protect these two drinking water sources are:

- Work with both neighboring Towns to develop a drinking water overlay zone that would identify areas that would be inappropriate for intensive development.
- Explore the potential to incorporate a GI practice, such as a fore-bay or constructed wetland, at the mouth of Murphy's Ditch, a supplemental source of water that diverts Patton Brook into Washington Lake on the north shore.
- Explore using GI practices to intercept storm water at locations along route 300 before it enters Washington Lake. An existing swale may be enhanced to become a designed bioswale, specifically designed to take up street runoff.
- Explore modifying the Silver Stream diversion channel, to slow water entering Washington Lake from the south. Opportunities may exist to modify the channel using GI practices such as check dams, broadening the channel width in places and appropriate aquatics plantings specified to uptake road runoff contaminants.

CONCLUSION

Green Infrastructure has the potential to benefit the City of Newburgh as it develops strategies for meeting the water quality requirements of the USEPA and NYSDEC. The scope of this work was intended specifically to engage diverse stakeholders in the process of siting, designing, and evaluating the potential of GI systems to become integrated within City infrastructure and within the fabric of communities. Green Infrastructure benefits extend well beyond their function to manage stormwater runoff and abate combined sewer overflows. Throughout the country, GI investments have been demonstrated to contribute noticeably to civic pride, educational opportunities, stewardship, and public engagement. Because GI systems are frequently implemented on publicly-owned properties, all residents have a stake and ownership in their success. Additionally, because GI systems are highly distributed throughout the catchment area, all communities directly benefit from the public investment. Installation and maintenance of most GI systems are consistent with the skills and resources of small to medium-scale construction and landscaping firms. Policies that support the strategically planned substitution of conventional “grey” solutions to CSO abatement with “green” solutions also promote local job growth, enhancement of public spaces, habitat improvements, air quality improvements and public awareness.

This document itself should be used as an educational tool for municipal decision-makers and residents to become familiar with the processes behind making good GI siting and design decisions. Policies or regulations needed to guide these decisions are described here in the context of Newburgh’s specific set of needs and resources. The demonstration or pilot projects described here were generated through community involvement and intended to provide diverse, visible, and viable examples of the role GI can play within the urban and natural landscape. As these pilot structures are implemented and more funding opportunities are identified, this document should assist the City and its residents in making the suite of decisions necessary to take full advantage of GI opportunities to become in compliance with state and federal requirements to reduce or eliminate combined sewage discharges.

APPENDIX A

LIST OF POTENTIAL GREEN INFRASTRUCTURE LOCATIONS

ID	LOCATION	DESCRIPTION	OWNERSHIP	TYPOLOGY	REGULATOR DISTRICT[1]	Potential GI Options
1	Bay View Terr. & Liberty St.	Street Intersection	ROW	Right-of-Way GI	1*	Capture runoff and treat in bioretention facility, prior to discharging into Quassaick Creek.
2	227 Ann St	Parking Lot	City of Newburgh	GI on Government Property	4	Permeable pavement, bioretention facility.
3	South Middle School	School	Board of Education	GI on Government Property	2A*	Permeable pavement, bioretention facility; potentially redirect stormwater to adjacent field in separate sewer system
4	Clinton Square	Park	City of Newburgh	Open Spaces / Parks Adjacent to Impervious Areas	2F*	Potentially redirect stormwater from upstream street to Clinton Square in a bioretention facility.
5	210 Mill Street	Brownfield Site	City of Newburgh	Open Spaces / Parks Adjacent to Impervious Areas	2A	GI would be integrated with site assessment; potential for retention or detention.
6	401 Washington Street	Park/ Recreation Center	City of Newburgh	Open Spaces / Parks Adjacent to Impervious Areas	2B*	Potential to redirect stormwater from street into eastern section of Park; some existing CB[2]s are already on Park Side.
7	Ann St & Lake St	Street Intersection	ROW	Right-of-Way GI	2D*	Runoff downstream appears to drain to SS[3]; placing ROW GI here could allow for treating runoff and potential overflow to SS.
8	South St between Robinson Ave & West St.	Street	ROW	Strategic Separation	2F*	Potentially connect large portion of street to existing separate sewer nearby.
9	Sherman Dr. & Pleasant Pl	Street Intersection	ROW	Strategic Separation	2H*	There appears to be only one CB that connects to the CS[4]; replacing this with a connection to a SS could potentially separate entire regulator district.
10	North Plank St & Carpenter Ave	Street	ROW	Strategic Separation	2G*	Potential to expand storm sewer and connect to existing SS outfall nearby; potentially create new SS on Robinson Ave to connect with existing SS.

[1] Asterisk indicates site is in a Combined Sewer System (CSS) near a Storm Sewer (SS)
[2] CB = Catch Basin
[3] SS = Storm Sewer
[4] CS = Combined Sewer

ID	LOCATION	DESCRIPTION	OWNERSHIP	TYPOLOGY	REGULATOR DISTRICT[1]	Potential GI Options
11	South St between Shipp St & West	Street	ROW	Right-of-Way GI	2I*	Potential for ROW GI with overflows to SS nearby.
12	Broadway & West St	Street Intersection	ROW	Strategic Separation	2I*	Potential for ROW GI with overflows to SS nearby.
13	Dupont Ave & Thompson St	Brownfields Site	Private	GI on Private Property	2J*	Redirect stormwater from 2J West to Dupont Brownfield Site.
14	Dupont Ave & Broadway	Street Intersection	ROW	Right-of-Way GI	2J*	ROW GI at downstream edge of Dupont.
15	86 Wisner Street	Brownfield Site	City of Newburgh	Open Spaces / Parks Adjacent to Impervious Areas	2K*	Potentially redirect stormwater from Maple St & Wisner St to Brownfields Site.
16	Broadway & Wisner	Street Intersection	ROW	Strategic Separation	2K*	Large SS runs along Broadway, before connecting to CS. A new SS can be constructed to connect existing SS to existing storm outfall downstream.
17	4 Renwick Street	Brownfield Site	Private / Central Hudson	GI on Private Property	3*	Separate sewer beneath Renwick connects to combined system; potentially intercept sewer system before connection to CS and treat in a bioretention facility on Brownfields Site (or even WWTP).
18	Washington Street School	School	Board of Education	GI on Government Property	4	Bioretention Facility to manage runoff from parking lot and roofs.
19	111 Ann St	Parking Lot	City of Newburgh	GI on Government Property	4	Permeable pavement, bioretention facility.
20	Broadway & Johnston Street	Vacant Lots	City of Newburgh	GI on Government Property	4	GI Potential on Vacant Lots owned by City of Newburgh. If lots are for sale, potential incentives for buyers to pay for GI could be offered.
21	25 Chambers Street	Parking Lot	City of Newburgh	GI on Government Property	4	Permeable pavement, bioretention facility.
22	10 Hasbrouck Street	Park	City of Newburgh	Open Spaces / Parks Adjacent to Impervious Areas	4	Potential for bioretention facility to collect runoff from street.
23	301 Ann Street	Church	Church	GI on Private Property	4	GI to treat runoff from parking lot.
24	Broadway	Street	ROW	Right-of-Way GI	4	ROW bioretention facilities; Greenstreets; Storm Trees; Great potential for runoff capture during redesign of Broadway.

ID	LOCATION	DESCRIPTION	OWNERSHIP	TYPOLOGY	REGULATOR DISTRICT[1]	Potential GI Options
25	Montgomery St & South St	Vacant Lot	City of Newburgh	Strategic Separation	7	SS under South St connects to CSS[1]. Potential to intercept connection and treat stormwater in Vacant Lot or potentially create tiered bioretention facilities along South St. medians.
26	St. Luke's Hospital	Hospital	Private	GI on Private Property	5	Bioretention Facility to manage runoff from parking lot and roofs.
27	Chambers St & First St	Street Intersection	ROW	Strategic Separation	5	Storm sewer on Chambers & First discharges to existing stormwater outfall; potential to redirect upstream flow into SS.
28	Grand & First Street	Street Intersection	ROW	Strategic Separation	6	Redirect upstream flow into SS.
29	Carpenter & Marne Ave	Street Intersection	ROW	Right-of-Way GI	5	Long stretch of Carpenter Ave; potential for large capture through ROW GI.
30	Liberty St & Third St	Street Intersection	ROW	Right-of-Way GI	6*	Storm sewer connecting both sides of street allows for GI on one corner to treat both sides of street. Potential for construction of SS to connect with existing SS on Liberty St & Grand St.
31	Liberty St & Gidney Ave	Street Intersection	ROW	Right-of-Way GI	6	ROW GI.
32	14 Gidney Ave	Public Basketball Courts	City of Newburgh	GI on Government Property	6	Permeable pavement.
33	South St between Montgomery St & Water St	Street	ROW	Strategic Separation	7	Potential SS could connect existing SS that abruptly ends on Montgomery St and resumes on Water St.
34	Clinton St & Montgomery St	Government Parcel	City of Newburgh	Strategic Separation	8	Intercept existing SS to convey stormwater to a bioretention swale or facility with overflows back into an existing SS. Combination of GI on public property and strategic separation.
35	Broad St & Montgomery St	Street	ROW	Strategic Separation	9	Potential for small SS to connect to existing SS.

[1] CSS = Combined Sewer System

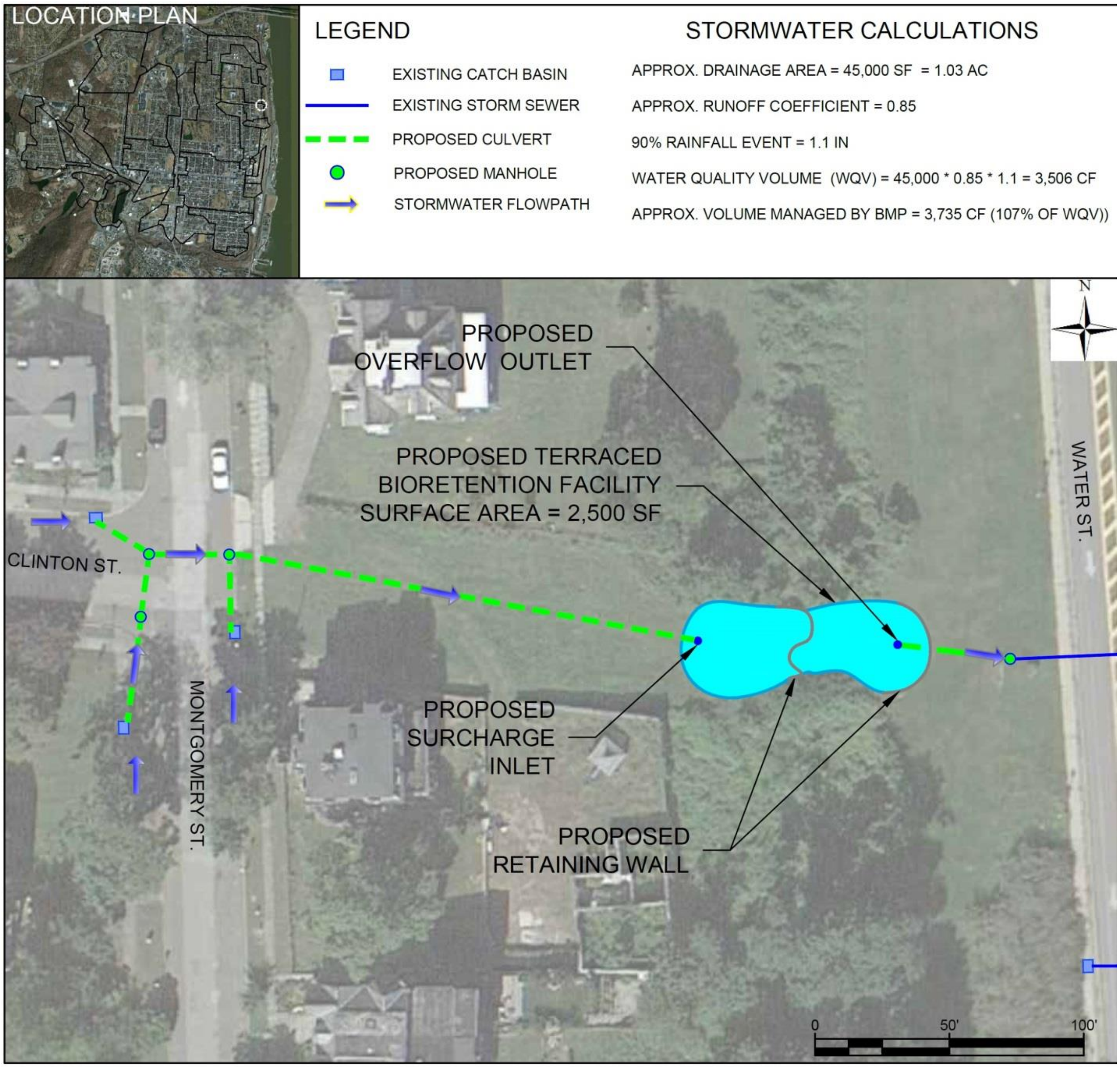
ID	LOCATION	DESCRIPTION	OWNERSHIP	TYPOLOGY	REGULATOR DISTRICT[1]	Potential GI Options
36	Liberty St between Nicoll St & Broad St	Street	ROW	Right-of-Way GI	9	ROW GI along Liberty Street, potential permeable pavers and bioswales.
37	Carobene St & Liberty St	Street	ROW	Right-of-Way GI	10	Existing SS infrastructure facilitates management of stormwater in ROW GI at bottom of hill.
38	38 Forsythe Street	Forsythe Pl Triangle	City of Newburgh	Open Spaces / Parks Adjacent to Impervious Areas	10*	Park at downstream edge of street can capture stormwater in bioretention facility; potential to overflow into SS system.
39	379 Powell Ave	Private Property	Chadwick Gardens Assoc.	GI on Government Property	11	GI to treat runoff from parking lot; potentially roofs; approach owner/management corporation.
40	Leroy Pl & Liberty St	Street Intersection	ROW	Strategic Separation	11	A small SS could potentially connect a large portion of the CS system into the SS system.
41	Montgomery St & Park Pl	Street	ROW	Strategic Separation	11	Potentially place SS beneath Montgomery Street to collect all runoff and divert to existing SS that runs beneath Park Pl.
42	55 Broadway	Fire Station	City of Newburgh	GI on Government Property	12	GI to treat runoff from west side parking lot (east side drains to SS).
43	83 Broadway	Brownfield Site	City of Newburgh	GI on Government Property	12	Potential for large constructed wetland to: 1) treat runoff that enters CSS on Water Street; 2) treat runoff from parking lot north of site (currently seems to discharge directly to Hudson); 3) convey and treat storm runoff.
44	Grand St between Ann St & Washington St	Street	ROW	Strategic Separation	12	Existing SS connects to CS; potential SS beneath this street could connect Ann St SS to Washington St SS alleviating a large volume of runoff from the CSS.
45	Broadway & Grand St	Street Intersection	ROW	Right-of-Way GI	13	Potential for ROW GI at downstream edge of angled parking spots.

ID	LOCATION	DESCRIPTION	OWNERSHIP	TYPOLOGY	REGULATOR DISTRICT[1]	Potential GI Options
46	Broadway & Washington Pl	Park	City of Newburgh	Open Spaces / Parks Adjacent to Impervious Areas	13*	Capture runoff from Broadway and treat in tiered bioretention facility inside Downing Vaux Park. Potential for Overflow into SS located downstream in Water Street.
47	Fowler & Favoriti Ave	Street Intersection	ROW	Strategic Separation	2K*	SS connects to combined; can potentially be connected to SS running along Dupont instead.
48	Various Locations	Street	ROW	Right-of-Way GI	3	Potential for ROW GI throughout Regulator District 3.
49	Ellis Ave	Street	ROW	Right-of-Way GI	2E	SS connects to combined sewer on Ellis Ave; Potential to connect to SS downstream or place GI to treat only portion of street that drains to CSS.

APPENDIX B

CONCEPTUAL PLANS AND CURSORY COST ESTIMATES

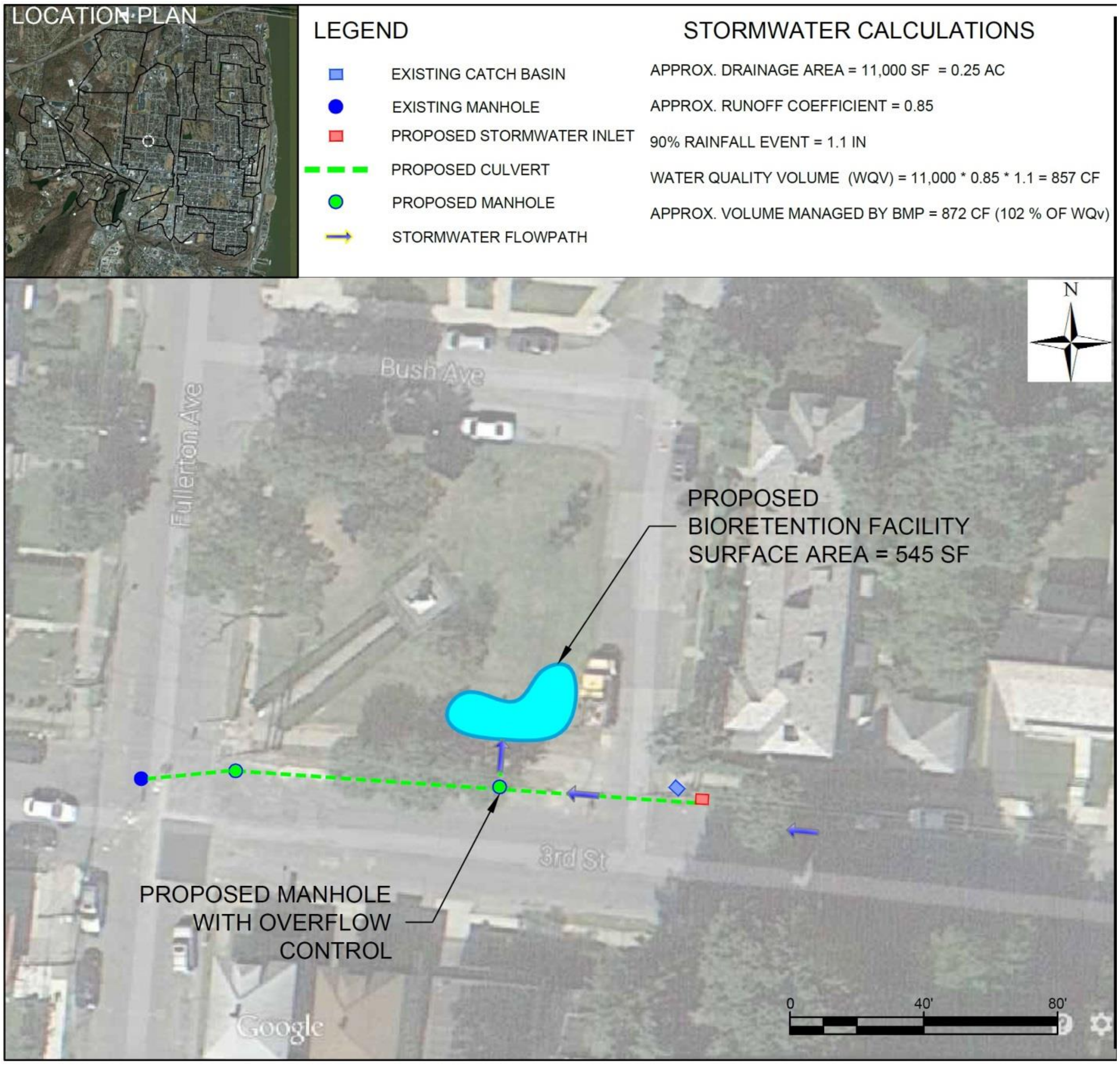
STRATEGIC SEPARATION: MONTGOMERY STREET AND CLINTON STREET
CONCEPTUAL PLAN



STRATEGIC SEPARATION: MONTGOMERY STREET AND CLINTON STREET
CURSORY COST ESTIMATE

Item	Unit	Unit Cost	Qty	Total Cost
Temporary Fencing	LF	$12.00	500	$6,000
Silt Fence	LF	$15.00	200	$3,000
Excavation And Removals	CY	$100.00	454	$45,370
Saw Cut Pavement	LF	$12.00	300	$3,600
Asphalt and Sidewalk Restoration	SY	$50.00	85	$4,250
Gravel - 12" Depth	CY	$100.00	93	$9,259
Engineered Soil - 24" Depth	CY	$100.00	185	$18,519
Geotextile	SY	$5.00	556	$2,778
2" Plugs (With 2 Year Guarantee)	EA	$6.00	2,500	$15,000
Waterfowl Barrier	SY	$20.00	278	$5,556
Surcharge Inlet	LS	$5,000.00	1	$5,000
Overflow Outlet	LS	$5,000.00	1	$5,000
Retaining Wall	LF	$300.00	100	$30,000
Traffic Protection	LS	$15,000.00	1	$15,000
Culvert / Storm Sewers	LF	$350	350	$122,500
Manholes	EA	$5,000	5	$25,000
Construction Administration	LS	$50,000	1	$50,000
Mobilization	%	6		$18,950
			CONSTRUCTION SUBTOTAL	**$384,781**
			FEASIBILITY & ENGINEERING (25% OF CONSTRUCTION)	**$96,195**
			CONTINGENCY (30%)	**$144,293**
			TOTAL	**$625,270**

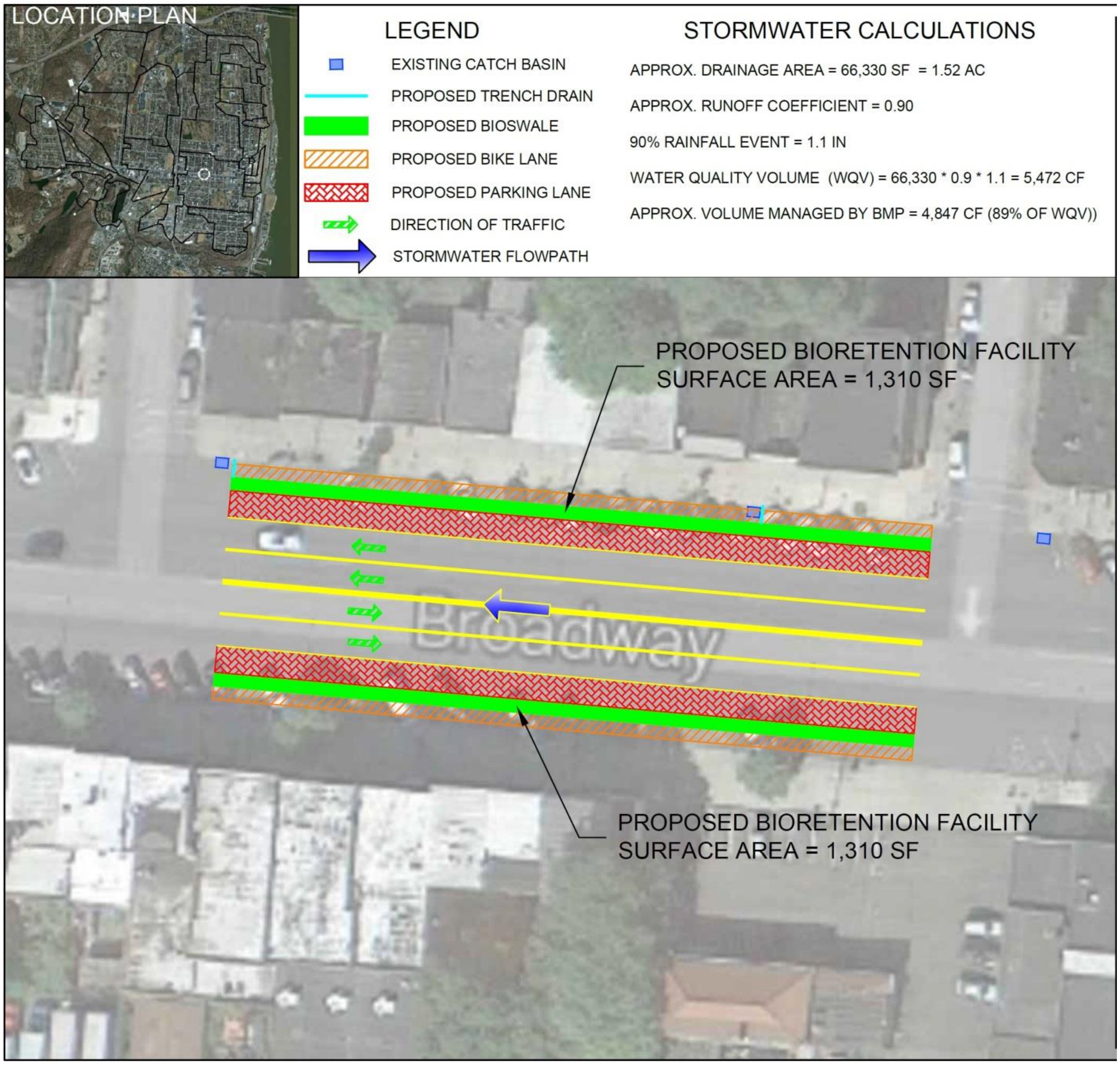
OPEN SPACES / PARKS ADJACENT TO LARGE IMPERVIOUS SURFACES: CLINTON SQUARE CONCEPTUAL PLAN



OPEN SPACES / PARKS ADJACENT TO LARGE IMPERVIOUS SURFACES: CLINTON SQUARE CURSORY COST ESTIMATE

Item	Unit	Unit Cost	Qty	Total Cost
Temporary Fencing	LF	$12.00	150	1,800
Silt Fence	LF	$15.00	100	1,500
Excavation And Removals	CY	$100.00	91	9,100
Saw Cut Pavement	LF	$12.00	358	4,296
Asphalt and Sidewalk Restoration	SY	$50.00	59	2,933
Gravel - 18" Depth	CY	$100.00	31	3,100
Engineered Soil - 30" Depth	CY	$100.00	50	5,000
Geotextile	SY	$5.00	138	690
2" Plugs (With 2 Year Guarantee)	EA	$6.00	545	3,270
Waterfowl Barrier	SY	$20.00	61	1,220
Surcharge Inlet	LS	$5,000.00	1	5,000
Overflow Control	LS	$2,000.00	1	2,000
Underdrain	LF	$20.00	90	1,800
Traffic Protection	LS	$15,000.00	1	15,000
Culvert / Storm Sewers	LF	$150	163	24,450
Stormwater Inlet	EA	$7,500	1	7,500
Manholes	EA	$5,000	2	10,000
Construction Administration	LS	$15,000	1	15,000
Mobilization	%	6		$6,820
			CONSTRUCTION SUBTOTAL	**120,479**
			FEASIBILITY & ENGINEERING (25% OF CONSTRUCTION)	**$30,120**
			CONTINGENCY (30%)	**$45,180**
			TOTAL	**$195,778**

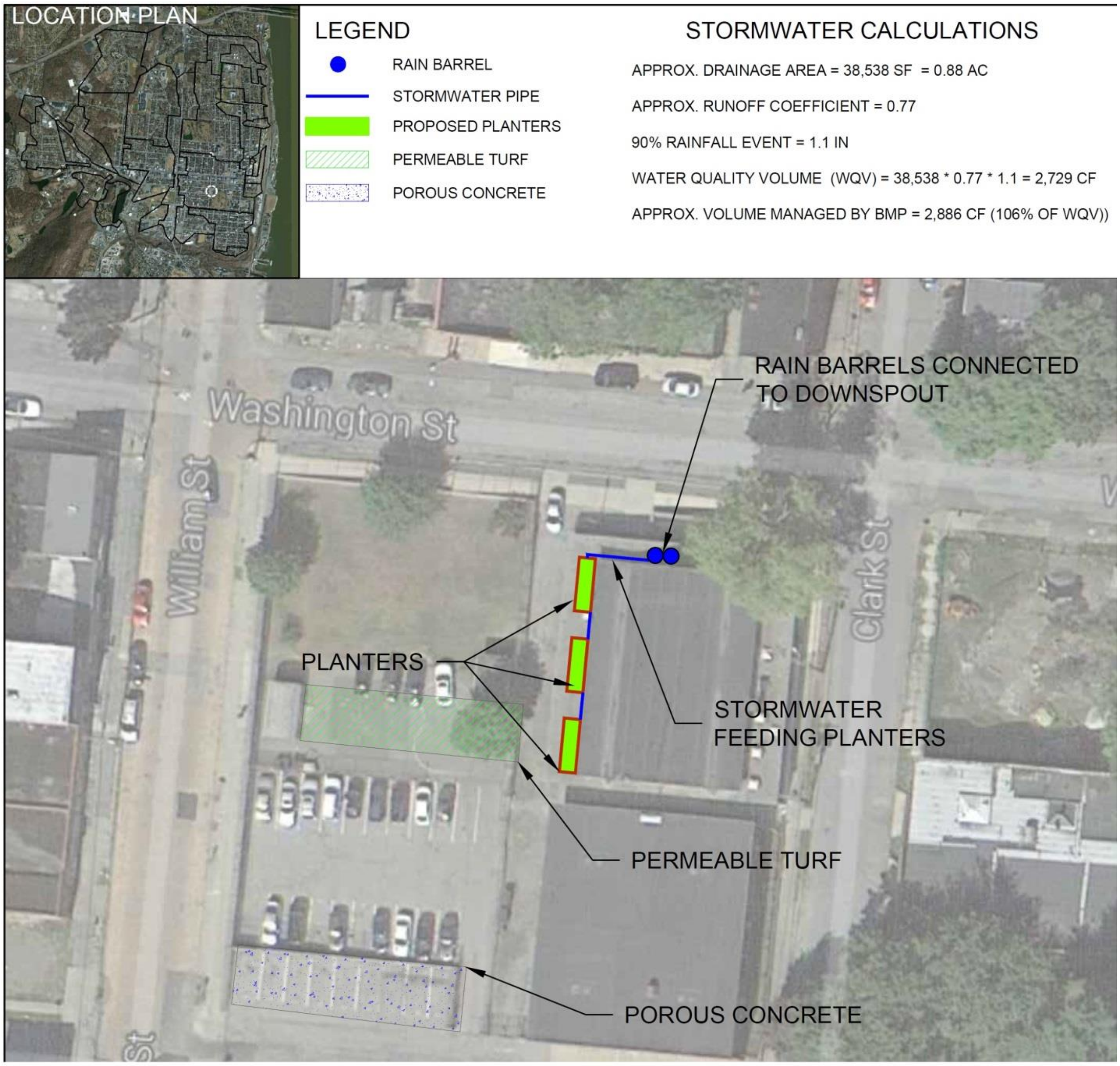
RIGHT-OF-WAY: BROADWAY
CONCEPTUAL PLAN



RIGHT-OF-WAY: BROADWAY
CURSORY COST ESTIMATE

Item	Unit	Unit Cost	Qty	Total Cost
Temporary Fencing	LF	$12.00	800	9,600
Silt Fence	LF	$15.00	1,060	15,900
Excavation And Removals	CY	$100.00	437	43,667
Saw Cut Pavement	LF	$12.00	700	8,400
*Asphalt and Sidewalk Restoration**	SY	$50.00	2,268	113,389
Gravel - 18" Depth	CY	$100.00	146	14,556
Engineered Soil - 30" Depth	CY	$100.00	243	24,259
Geotextile	SY	$5.00	671	3,353
2" Plugs (With 2 Year Guarantee)	EA	$6.00	2,620	15,720
Waterfowl Barrier	SY	$20.00	291	5,822
Surcharge Inlet	LS	$5,000.00	0	0
Overflow Control	LS	$2,000.00	0	0
Underdrain	LF	$20.00	520	10,400
Traffic Protection	LS	$30,000.00	1	30,000
Culvert / Storm Sewers	LF	$150	0	0
Trench Drain	LF	$50	14	700
Stormwater Inlet	EA	$7,500	2	15,000
Manholes	EA	$5,000	0	0
Construction Administration	LS	$15,000	1	45,000
Mobilization	%	6		$21,346
			CONSTRUCTION SUBTOTAL	**377,111**
			FEASIBILITY & ENGINEERING (25% OF CONSTRUCTION)	**$94,278**
			CONTINGENCY (30%)	**$141,417**
			TOTAL	**$612,806**

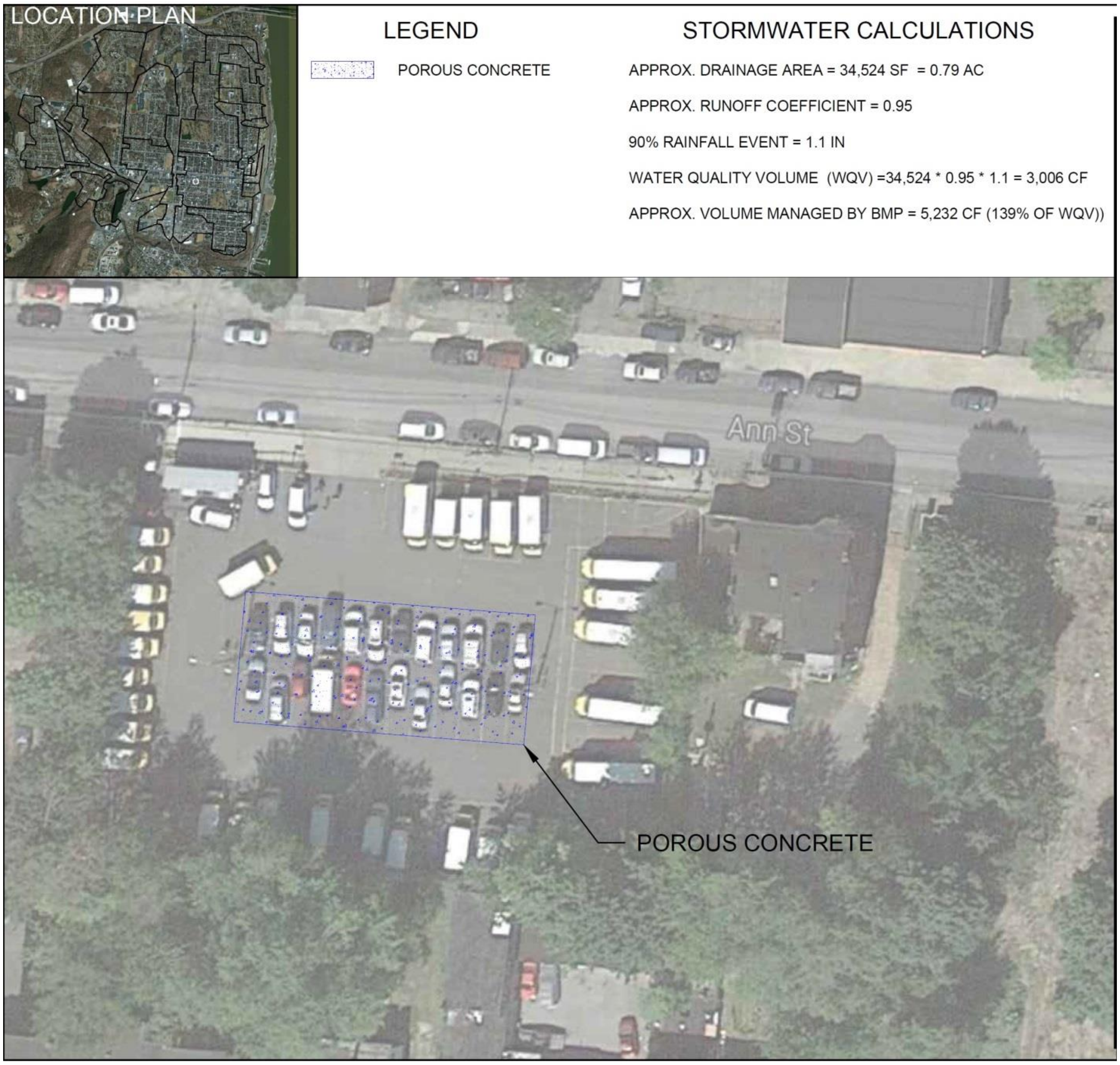
GOVERNMENT PROPERTY: WASHINGTON STREET SCHOOL
CONCEPTUAL PLAN



GOVERNMENT PROPERTY: WASHINGTON STREET SCHOOL
CURSORY COST ESTIMATE

Item	Unit	Unit Cost	Qty	Total Cost
Temporary Fencing	LF	$12.00	500	6,000
Silt Fence	LF	$15.00	0	0
Excavation And Removals	CY	$100.00	222	22,222
Saw Cut Pavement	LF	$12.00	400	4,800
Permeable Turf	SY	$113.33	222	25,185
Permeable Turf Curb	LF	$25.00	200	5,000
Porous Concrete	SY	$108.00	222	24,000
Gravel - 12" Depth (Planter)	CY	$100.00	236	23,556
Engineered Soil - 18" Depth	CY	$100.00	20	2,000
Geotextile	SY	$5.00	57	287
2" Plugs (With 2 Year Guarantee)	EA	$6.00	360	2,160
Waterfowl Barrier	SY	$20.00	0	0
Surcharge Inlet	LS	$5,000.00	0	0
Overflow Control	LS	$2,000.00	0	0
Underdrain	LF	$20.00	393	7,867
Planter Materials	LS	$1,500.00	3	4,500
Planter Plumbing and Cisterns	LS	$5,000.00	1	5,000
Traffic Protection	LS	$30,000.00	0	0
Culvert / Storm Sewers	LF	$150	0	0
Trench Drain	LF	$50	0	0
Stormwater Inlet	EA	$7,500	0	0
Manholes	EA	$5,000	0	0
Construction Administration	LS	$15,000	1	20,000
Mobilization	%	6		$9,155
			CONSTRUCTION SUBTOTAL	**161,731**
			FEASIBILITY & ENGINEERING (25% OF CONSTRUCTION)	**$40,433**
			CONTINGENCY (30%)	**$60,649**
			TOTAL	**$262,813**

GOVERNMENT PROPERTY: ANN STREET PARKING LOT
CONCEPTUAL PLAN



GOVERNMENT PROPERTY: ANN STREET PARKING LOT
CURSORY COST ESTIMATE

Item	Unit	Unit Cost	Qty	Total Cost
Temporary Fencing	LF	$12.00	500	$6,000
Excavation And Removals	CY	$100.00	388	$38,756
Saw Cut Pavement	LF	$12.00	313	$3,756
Porous Concrete	SY	$108.00	581	$62,784
Gravel - 24" Depth	CY	$100.00	388	$38,756
Geotextile	SY	$5.00	651	$3,254
Underdrain	LF	$20.00	106	$2,120
Traffic Protection	LS	$5,000.00	1	$5,000
Construction Administration	LS	$5,000	1	$5,000
Mobilization	%	6		$9,926
			CONSTRUCTION SUBTOTAL	**175,351**
			FEASIBILITY & ENGINEERING (25% OF CONSTRUCTION)	**$43,838**
			CONTINGENCY (30%)	**$65,757**
			TOTAL	**$284,946**

APPENDIX C

FEASIBILITY STUDY SUBMITTED TO

NYSEFC GREEN INNOVATION GRANT PROGRAM

NEWBURGH STREET-END GREEN STORMWATER MANAGEMENT SYSTEM

FEASIBILITY STUDY

JUNE 16, 2014

Prepared by:

Owner:
City of Newburgh
83 Broadway
Newburgh, NY 12550

Franco Andre Montalto, P.E.
eDesign Dynamics
338 West 39th Street, 10th Floor
New York, NY 10018

eDesign Dynamics

II. EXECUTIVE SUMMARY

The City of Newburgh (City) is partnering with eDesign Dynamics (EDD) to design, install, and monitor a street-end green stormwater management system that will divert stormwater runoff from 45,000 square feet of public right-of-way for management within a bioretention facility located in a publicly owned vacant lot in Newburgh, NY. EDD, with more than ten years of experience in designing and installing GI retrofits in urban areas, will lead the effort to implement an affordable and effective system at this location. This proposal seeks to build upon work already completed to further green infrastructure (GI) efforts in the City of Newburgh. eDesign Dynamics (EDD), with support from Hudson Sloop Clearwater (Clearwater) and the Quassaick Creek Watershed Alliance (QCWA), received a grant from the Hudson River Estuary Program to perform a GI planning assessment engaging stakeholders in the City of Newburgh and to establish a set of viable pilot sites for installation of GI. In order to advance the process begun with the planning assessment, the City of Newburgh is requesting GIGP funds to design and construct one of the conceptual GI designs, demonstrating and further assessing the advantages to green systems over “grey” solutions.

To confirm the feasibility of this location, EDD engineers visited the site on several occasions to perform soil inspections and to assess the conditions of existing and former building foundations. Soils inspected at a shallow depth were largely sandy loam with some signs of urban fill. EDD and the City of Newburgh are excited to demonstrate that this particular site offers an ideal opportunity to explore new options for use of GI where flat space is limited or unavailable. A goal of the project is to develop a replicable, innovative design that can be utilized in other areas within the City of Newburgh and beyond.

III. PROJECT OBJECTIVES

This proposal seeks to build upon work already completed to further green infrastructure (GI) efforts in the City of Newburgh. eDesign Dynamics (EDD), with support from Hudson Sloop Clearwater (Clearwater) and the Quassaick Creek Watershed Alliance (QCWA), received a grant from the Hudson River Estuary Program to perform a GI planning assessment engaging stakeholders in the City of Newburgh, NY, and to establish a set of viable pilot sites for installation of GI. As part of this process, the team used aerial photos and GIS mapping resources to identify possible sites with maximum potential benefit for removing stormwater from the City's combined sewers and reducing combined sewer overflows (CSOs) to the Hudson River. After several site visits and meetings with stakeholders, the team has identified a number of sites for priority intervention. The criteria for selecting these sites included: size of catchment area; public visibility; land ownership and use; soil conditions; slope; and light regime. Each site also possessed a possible point for discharge of overflows. Stakeholders were introduced to the issues behind CSOs, the range of conventional solutions to mitigating water quality concerns, and the role and benefits of GI systems. Community participants were enthusiastic in stakeholder meetings and there is wide support for the potential projects.

In order to advance the process, the City of Newburgh is requesting funds from the Green Innovation Grant Program (GIGP) to design and construct one of the conceptual GI designs, demonstrating and further assessing the advantages to green systems over "grey" solutions. The site selected for implementation lies on a parcel of publicly owned land on Water Street, near the corner of Montgomery and Clinton Streets in Newburgh, NY. The installation would involve diversion of runoff from approximately 45,000 square feet of impervious roadway and sidewalk to an innovative terraced bioretention system. The system will possess a series of contour retaining walls, or weirs, permitting the slow cascade of stormwater over terraced planting beds. Stormwater in excess of system capacity will be redirected to an existing storm sewer that discharges to a combined sewer outfall. The planting beds will be visible from Montgomery Street above, Water Street below, and by boaters on the Hudson River. The location and design were selected for the additional benefit of demonstrating the possibilities of establishing bioretention systems in niche areas with steep slopes which have been largely avoided due to erosion risks.

Post-construction monitoring (PCM) will also be implemented as part of this project. The goal of PCM will be to characterize the water budget and determine the efficacy of the proposed bioretention system. Bi-annual monitoring reports will be submitted to the City of Newburgh which will include basic information pertaining to quantity of stormwater influent and effluent, soil infiltration rates, and describe overall performance of the GI facility.

IV. EXISTING CONDITIONS

a. Project Location/Address (including nearest cross street)

The proposed project will be located on a vacant parcel on Water Street, adjacent to the corner of Montgomery and Clinton Streets in Newburgh, NY 12550.

b. Current Land Use

The site is currently a grassy, vacant lot owned by the City of Newburgh and is zoned as R-1: One-Family Residential.

c. USGS Soil Classification/Bedrock Depth

According to USGS Soil Classification, existing soils in this area are classified as Mardin gravelly silt loam (MdD). During a site visit conducted by EDD on May 17, 2014, a preliminary soil boring was performed using a soil auger. Soils were of a silt loam type with some gravel, which are suitable for infiltration practices. No bedrock was encountered during the preliminary soil boring, nor is any bedrock indicated according to the USGS Soil Classification. Further soil investigation will be conducted as part of the grant, before establishing a green infrastructure practice at the site.

d. Site Topography

The proposed site is located on a 15%-20% slope. Although such slopes have traditionally been deemed unfavorable for Green Infrastructure practices, the proposed design will use an innovative system of terraced bioretention facilities to manage stormwater runoff from the street.

e. Stormwater Flowpath (also consider adjacent sites)

Current stormwater upstream of the proposed site is collected via three catch basins located at the intersection of Montgomery and Clinton Streets, which are currently connected to combined sewers. Stormwater along the slope flows downslope towards Water Street, where it is collected via catch basins into the city's sewer system, which will serve as the overflow for the proposed design. Stormwater flowpaths are also indicated on the Conceptual Site Plan.

f. Depth To Water Table (Green Infrastructure Practice Dependent)

Depth to water table information at the proposed site is not available. Groundwater was not encountered with the soil auger investigation that was performed on May 17, 2014. Further geotechnical exploration will be performed as part of this grant. However, due to the large area available for constructing the proposed terraced bioretention facility, the depth of the proposed GI can be reduced if necessary to maintain a three foot vertical offset from any groundwater, while still managing the same volume of stormwater.

g. Nearest/Receiving Waterbody

The nearest waterbody is the Hudson River, located approximately 350 feet from the proposed site. Current stormwater at this location is captured in the City's combined sewer system, where it is released into the Hudson River either through the City's Water Pollution Control Plant effluent or as a Combined Sewer Overflow.

h. Other Site Considerations (Wetlands, Hotspots, Brownfield Remediation, etc.)

There are no other site considerations for the proposed location.

i. Boring Logs, Infiltration Tests, or other Subsurface Investigations, if applicable, may be required prior to Grant Agreement

Preliminary subsurface investigations took place by using a soil auger to analyze soils beneath the surface. The soils encountered were similar to those classified by the USGS. Further investigation will be required as part of the grant that will include soil classification, falling head permeability test, and a laboratory analysis to ensure existing soils are non-hazardous.

V. PROJECT DESCRIPTION

a. Recommended Green Infrastructure Practice (See *Technical Guidance for Green Infrastructure Projects* Table)

The proposed project will divert runoff from approximately 45,000 square feet of Clinton and Montgomery Streets by rerouting three existing catch basins, that are currently connected to the combined sewer system, toward a new subsurface pipe that conveys water to a tiered system of bioretention terraces supported by retaining walls. These innovative terraces will support attractive, salt tolerant native plant species within a sandy planting medium over a porous gravel base, managing at minimum 1.1 inches of runoff from the contributing impervious area, which is equal to the Water Quality Volume (WQv) as defined by the New York State Department of Environmental Conservation (DEC). Runoff exceeding the WQv will overflow from the system terraces and be directed back toward the City's sewers.

b. Feasibility Analysis of Selected Green Infrastructure Practice, including:

i. Drainage Area

The impervious drainage area servicing the proposed GI system is approximately 45,000 square feet collected from Clinton and Montgomery Streets. Additional runoff is expected from the lawn area west of the proposed terraces.

ii. Site Grading

Grading over the impervious catchment is relatively flat. The hillside proposed for the GI terraces possesses slopes ranging from 15% to 20%. The terraces themselves will be graded such that they are flat and supported by retaining walls.

iii. Stormwater Flowpath (also consider adjacent sites)

The catchment side of the proposed project will require construction of three new manholes and approximately 300 feet of new subsurface pipe. The drainage side will require one new manhole and approximately 50 feet of subsurface pipe. Existing catch basins on Clinton and Montgomery Streets will be rerouted toward these new fixtures.

iv. Design Considerations, including Green Infrastructure Practice Sizing & Water Quality Volume (WQv) Calculations (estimated)

The water quality volume (WQv) as defined by NYSDEC is approximately 3,506 cubic feet (stormwater calculations are shown on Conceptual Site Plan). The proposed bioretention system intends to manage 3,735 cubic feet, or 107% of the WQv. Pipe sizes will be determined by slope, length, and the peak flowrate required from the catchment area. An energy dissipater at the top of the terraced system will be designed to prevent damage or erosion. Retaining walls will act as weirs to allow overflow as the storage capacity of each terrace is reached. These walls will be designed and constructed with sufficient foundation and tie-back to prevent both settling and rotation. As the capacity of the entire system is exceeded, overflows will be directed toward an outlet structure that is plumbed back to the City's existing sewer system.

c. Feasible Alternative (to accommodate variables determined by site investigation)

The City and EDD see the proposed system as an innovation to standard green infrastructure practices. We are presenting this concept because of our belief that exploring the configuration such as this one could become an important addition to the palate of GI resources for use where flat areas are of limited availability or accessibility. Furthermore, there are a number of design advantages to utilizing slopes in this manner: The elevation changes allow us to convey water for a greater distance using smaller pipes and with minimal risk of sedimentation; and the energy allows for more efficient water quality improvements by providing hydraulic head to move water through filtration beds or other porous media. Flows from areas adjacent to steep slopes are not now easily managed by GI because of the reluctance to consider sloped installations. We look forward to the opportunity to develop this concept in partnership with NYSEFC.

In the event that the preliminary technical investigations at the site show conditions incompatible with the proposed design (i.e.: depth to bedrock; slope instability; construction access; conflict with existing subsurface utilities) or if NYSEFC decides to reject this option, we have identified an alternate location of similar scale for installation of GI within the City of Newburgh. This alternative would manage an impervious drainage area from approximately 11,000 square feet of right-of-way near the intersection of Fullerton Avenue and 3rd Street. This location would require construction of a new stormwater inlet (catch basin) directly upstream of the existing inlet, installation of approximately 170 feet of new buried pipe, and two new manhole structures. Captured runoff would be managed in a bioretention facility installed within the public parklet, and overflow would be directed back toward the City system. Slow subsurface discharges from the BMP would drain toward the parklet's interior and provide enhanced irrigation. This site is largely flat but with sufficient slope to meet the conveyance requirements of the proposed GI. A conceptual site plan of this alternative has also been included in the application.

VI. PROPOSED PROJECT SCHEDULE

TASK	START DATE	DURATION (WEEKS)	END DATE
Preliminary Design			
Hold project kickoff meeting with key partners and stakeholders	9/8/2014	1	9/15/2014
Site reconnaissance and review of existing technical information	9/15/2014	3	10/6/2014
Conduct site and drainage area assessment: Topographic Survey and Geotechnical Exploration	10/6/2014	4	11/3/2014
Conduct hydrologic and soil analysis, watershed model development	11/3/2014	2	11/17/2014
Develop preliminary design and monitoring plan	11/17/2014	2	12/1/2014
Review and comment period on schematic design	12/1/2014	2	12/15/2014
Design Development Drawings and Construction Documents			
Prepare 60% design development drawings, including site plan and details, and engineer's cost estimate	12/15/2014	3	1/5/2015
Review and comment period on 60% design by key stakeholders and regulatory agencies	1/5/2015	4	2/2/2015
Prepare 90% construction documents, including updated design development drawings, specifications, and updated engineer's cost estimate	2/2/2015	3	2/23/2015
Review and comment period on 90% construction documents by key stakeholders and regulatory agencies	2/23/2015	4	3/23/2015
Finalize construction documents, including 100% construction drawings, specifications, and bid documents	3/23/2015	4	4/20/2015
Construction and Construction Administration			
Submit bid documents	4/20/2015	4	5/18/2015
Review bids and select bidder	5/18/2015	3	6/8/2015
Apply and obtain all necessary permits and approvals	6/8/2015	6	7/20/2015
Construction of bioretention facility	7/20/2015	14	10/26/2015
Planting	10/19/2015	1	10/26/2015
Plant Maintenance and Guarantee Period	10/26/2015	104	10/26/2017

Post-Construction Monitoring

Conduct monitoring assessment	Spring 2016	156	Spring 2019

VII. ANTICIPATED REGULATORY APPROVAL AND PERMITS

The City of Newburgh will lead the permitting and approvals process for all local permit requirements. City of Newburgh and eDesign Dynamics will jointly prepare all application materials for State permitting requirements, meet with regulators as necessary, and follow up with design and/or application revisions in order to secure proper approvals. The Team anticipates that NYSDOT will require approval of designs and submission of a work permit application for construction within the right-of-way. NYSDEC will require submission and certification under the State Environmental Review Process (SERP) and the State Environmental Quality Review (SEQR). We also anticipate that, as project funder, NYSEFC will review and approve all designs. A General Permit for Stormwater Discharges from Construction Activity will not be required since the soil disturbance of the proposed site will be less than one acre.

VIII. PROJECT COST ESTIMATE

PROJECT ADMINISTRATION - City of Newburgh

Item	Personnel	Average Rate	Hours	Total Cost	Total In-Kind
Meetings	City Engineer's Office	$79	72	$5,684	$5,684
Design Development Review	City Engineer's Office	$79	60	$4,736	$4,736
Construction Documents Review	City Engineer's Office	$79	60	$4,736	$4,736
Contracting Approvals	City Engineer's Office	$79	60	$4,736	$4,736
Permitting Approvals	City Engineer's Office	$79	60	$4,736	$4,736
Procurement Oversight	City Engineer's Office	$79	60	$4,736	$4,736
Monitoring Assistance	City Engineer's Office	$79	40	$3,158	$3,158
			PROJECT ADMINISTRATION SUBTOTAL	**$32,523**	**$32,523**

ENGINEERING - eDesign Dynamics

Item	Personnel	Average Rate	Hours	Total Cost	Total In-Kind
Survey	Subcontractor/EDD Supervision	$10,000	LS	$10,000	-
Geotechnical Investigation (including soil classification, and falling head permeability test)	Subcontractor/EDD Supervision	$10,000	LS	$10,000	-
	Project Engineer	$115	24	$2,760	-
Meetings					
	Principal Engineer	$155	12	$1,860	-
	Sr. Engineering Hydrologist	$145	12	$1,740	-
	Project Engineer	$115	24	$2,760	-
	Engineer	$95	24	$2,280	-
Schematic Designs					
	Principal Engineer	$155	12	$1,860	-
	Sr. Engineering Hydrologist	$145	24	$3,480	-
	Project Engineer	$115	40	$4,600	-
	Engineer	$95	40	$3,800	-
Design Development Drawings					
	Principal Engineer	$155	12	$1,860	-
	Sr. Engineering Hydrologist	$145	24	$3,480	-
	Project Engineer	$115	60	$6,900	-
	Engineer	$95	80	$7,600	-
Construction Documents					
	Principal Engineer	$155	12	$1,860	-

	Sr. Engineering Hydrologist	$145	24	$3,480	-
	Project Engineer	$115	60	$6,900	-
	Engineer	$95	80	$7,600	-
Permitting and Approvals					
	Principal Engineer	$155	12	$1,860	-
	Sr. Engineering Hydrologist	$145	12	$1,740	-
	Project Engineer	$115	24	$2,760	-
	Engineer	$95	24	$2,280	-
			ENGINEERING SUBTOTAL	**$93,460**	**$ -**

CONSTRUCTION

Item	Unit	Unit Cost	Qty	Total Cost	Total In-Kind
Temporary Fencing	LF	$12.00	500	$6,000	-
Silt Fence	LF	$15.00	200	$3,000	-
Excavation And Removals	CY	$100.00	454	$45,370	-
Saw Cut Pavement	LF	$12.00	300	$3,600	-
Asphalt Restoration	SY	$50.00	85	$4,250	-
Gravel - 12" Depth	CY	$100.00	93	$9,259	-
Engineered Soil - 24" Depth	CY	$100.00	185	$18,519	-
Geotextile	SY	$5.00	556	$2,778	-
2" Plugs (With 2 Year Guarantee)	EA	$6.00	2,500	$15,000	-
Waterfowl Barrier	SY	$20.00	278	$5,556	-
Surcharge Inlet	LS	$5,000.00	1	$5,000	-
Overflow Outlet	LS	$5,000.00	1	$5,000	-
Retaining Wall	LF	$300.00	100	$30,000	-
Traffic Protection	LS	$15,000.00	1	$15,000	-
Culvert / Storm Sewers	LF	$350	350	$122,500	-
Manholes	EA	$5,000	5	$25,000	-
*Construction Administration Services by EDD**	LS	$25,000	1	$25,000	$10,000
*Construction Administration Services by City Of Newburgh**	LS	$25,000	1	$25,000	$25,000
*Mobilization***	%	6		$18,950	-
Contingency	%	30		$115,434	
			CONSTRUCTION SUBTOTAL	**$500,216**	**$35,000**

**Construction Administration (CA) services include procuring bid documents, reviewing and selecting bids, approving submittals, and construction management.*

***Mobilization percentage does not include CA services.*

POST-CONSTRUCTION MONITORING (THREE YEARS)

Item	Unit	Unit Cost	Qty	Total Cost	Total In-Kind
Monitoring Equipment	LS	$25,000.00	1	$25,000	
Equipment Installation	LS	$25,000.00	1	$25,000	$2,500
Equipment Servicing	YEAR	$5,000.00	3	$15,000	
Monitoring Oversight	YEAR	$2,000.00	3	$6,000	$600
Reporting	LS	$25,000.00	1	$25,000	$2,500
		POST-CONSTRUCTION MONITORING SUBTOTAL		**$96,000**	$5,600

PROJECT TOTAL	**$722,199**
10% MATCH	**$72,220**
IN-KIND SERVICES	**$73,123**
FUNDING REQUEST	**$649,979**