Pilot BMP's for the Jamaica Bay Watershed Plan

An Hypothesis-Driven Testing Program for Restoring Hydrogeological and Ecological Function in the Jamaica Bay Watershed

- Streetside Green Infiltration Swales
- Enhanced Tree Pit Catchment
- Constructed Wetlands
- Green Roofs

prepared for: NYC DEP and the Jamaica Bay Watershed Study

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An Hypothesis-Driven Testing Program for Restoring Hydrogeological and Ecological Function in the Jamaica Bay Watershed Plan.

A unique estuary surrounded by a densely urbanized landscape, Jamaica Bay and its watershed is the major crossroads for airlines, roadways, rail, and thousands of migrating birds and fish in the New York City metropolitan region. Major transportation infrast--ructure including Kennedy Airport, the Long Island Expressway, Long Island Railroad and major subway lines occupy its shoreline, length and width. Industrial, commercial and residential structures make large portions of the land impermeable. Green corridors and bio-geographic corridors occupy the coastal zone and the vegetated and forested rise of the terminal moraine from the last glacier. This multi-use complexity must be central to any viable watershed restoration plan.

Jamaica Bay is a local resource for about a million people who live within a two-mile radius of the water's edge. The regional fishery for stripped bass, blue fish, wading and diving birds is one of the richest in diversity and productivity along the east coast. At inter-national scale, this estuary and its watershed are an irreplaceable resource, sustaining hundreds of species of Neotropical migrants along the Atlantic flyway.

Maintaining this natural resource has fallen to a consortium of agencies, organizations, and community and environmental interests, but amid this myriad of jurisdictions, one plan is needed to organize efforts. The City of New York may play a central role here, since much of the waterbody and its watershed lie within its jurisdiction. The agency that has assumed the express role of restoration is the New York City Department of Environmental Protection, presently engaged in planning and programming efforts set within the tight timeframe of the City Council Resolution. This proposal aims to offer a means by which this agency may leverage its interest and resources to provide an hypothesis driven and transparent approach to ecological restoration, stormwater capture, and cost-effective management of combined sewer discharge.

The ecological management practices proposed in what follows are designed to be readily constructible. The aim of the program outlined below is to get a number of hydrological and environmental modifications of City streets and infrastructure in place. In-the-ground management practices will strongly contribute, through monitoring and modeling, to the firmest available ground for a fully developed watershed plan for Jamaica Bay.

- Streetside Infiltration Swales
- Constructed Wetlands
- Enhanced Tree Pit Catchment
- Green Roofs

The structures presented in the following proposal show means by which it will be possible to increase stormwater capture, ecological productivity, biogeochemical pollutant removal, and biodiversity. These functions can become the fabric of GreenStreets. Greenways, greenroofs, and an infrastructure more closely coupled with ecology, and capable of supporting and sustaining human communities as well as the warblers, vireos, sparrows, kinglets and monarchs that have migrated through our region for the past five millennia.

Pilot Best Management Practices based on land use coupling.

Streetside Infiltration Swales 'GreenStreets for Stormwater Capture'.

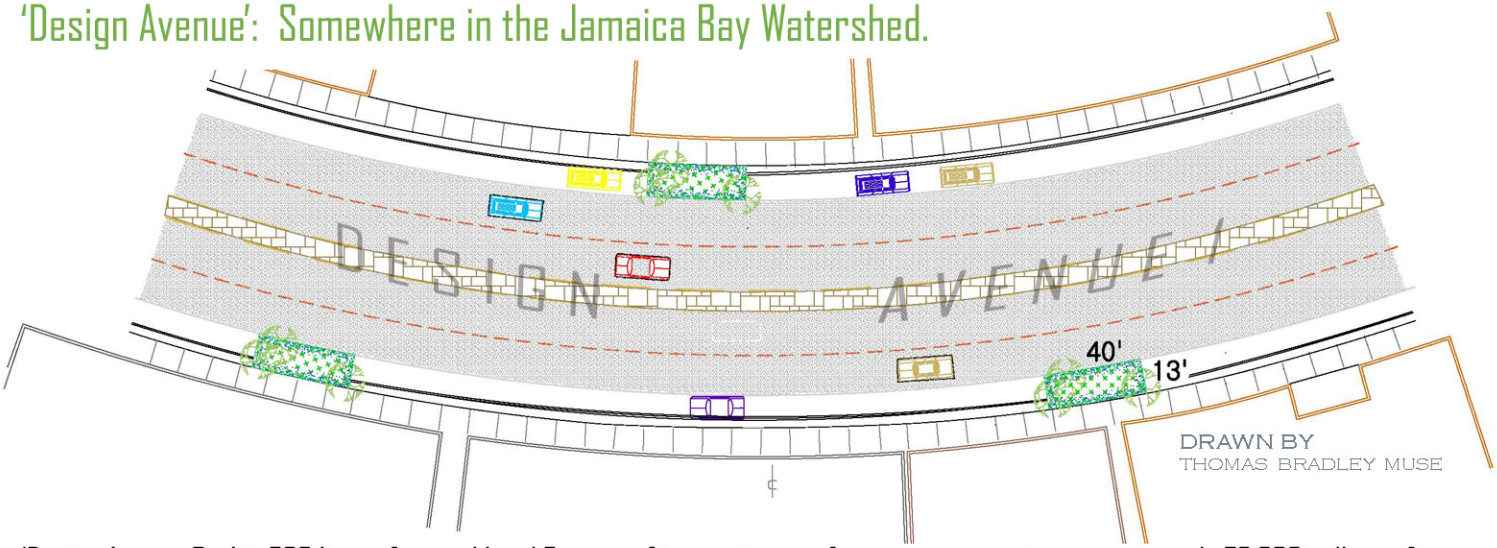
Curb-side Swales and Infiltration Zones. Many existing roadway designs allow for street-side planting which, in most cases, can be modified to capture stormwater runoff. This modification can by-pass the centralized combined sewer system, while supporting community amenities such as street trees and greenways.

More than 2000 conventional GreenStreets have been installed in the City of New York. Adding the value of storm water capture to these plantings is already underway. Plant survival rates increase when GreenStreets capture and harvest stormwater run-off.

On the other side of the country, Seattle's pilot Street Edge Alternatives project (SEA) (www.ci.seattle.wa.us) is a good example of street development designed to specifically reverse the hydrology of landscape adjacent to impervious zones. SEA Streets are designed to provide drainage patterns that more closely mimic natural systems. The city has reduced impervious surfaces replacing these, where possible, with detention ponds, retention swales and an enhanced soil column storage and infiltration. Two years of monitoring has shown that SEA Streets have reduced the total volume of stormwater leaving the street by 98% for a 2- year storm event. Puget Sound has benefitted greatly from reduced high density land use run-off.

Source: Seattle's SEA Program

'Design Avenue': Somewhere in the Jamaica Bay Watershed.



'Design Avenue One' is 500 linear feet and has 1.5 acres of impervious surface area generating approximately 73,300 gallons of storm-water run-off during 2 inches of rainfall in a 24 period (or an annual average of 1.6 million gallons).

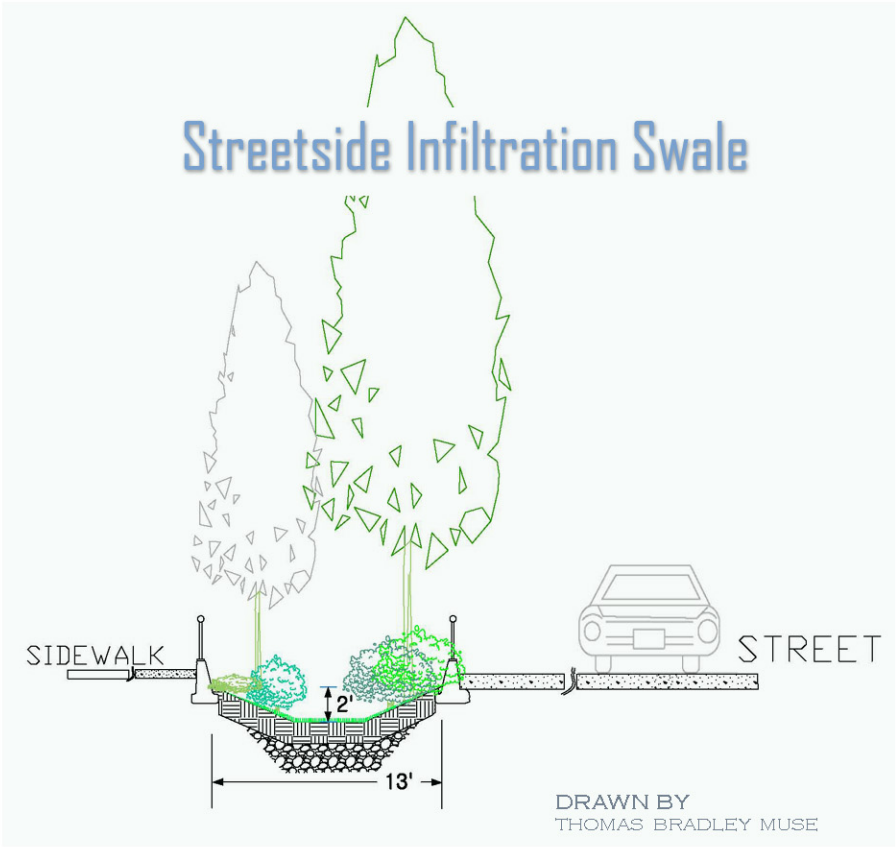
Pilot Best Management Practices based on land use coupling.

Three streetside infiltration swales will each be 13' wide by 40' long with a maximum depth of 2' 0" plus the desired curbing enclosure (see sample cross section below). Each swale has a volume capacity of 5200 gallons with an infiltration capacity of 19,368 gals. over 24 hours (based on 6" per hour infiltration rate).

This amounts to a total of 24,568 gallons over 24 hrs. for each unit and 73,704 gals. for 3 units combined. This should result, on a yearly basis, with the removal of approximately 1.65 million gallons from the combined sewer system (based on annual average rainfall of 45 inches).

Each swale on 'Design Avenue' will have an 3 square meter Rainstore3 cistern that will add 750 gals. of additional storage and act as a cistern for water harvesting. In the growing season sparse precipitation will be replaced with water drawn from storage by means of a solar powered DC pump and pressure compensated drip irrigation emitters servicing all plantings. Solar powered irrigation will be automated and controlled by a soil moisture meter. This system will compensate for up to a 7 week straight period of no precipitation.

To retrofit 3 BMP, streetside infiltration swales for 1.5 acres of impervious surface the capital cost is estimated at $ 120,000 or about $1.84 per sq. ft. of managed impervious watershed. This estimate assumes the existing conveyance of storm water towards storm drains can be coupled with new swale locations without the need to alter road bed elevations.



Greening streets with trees offers the opportunity to capture, store and infiltrate stormwater.

Enhanced Tree Pit Catchment

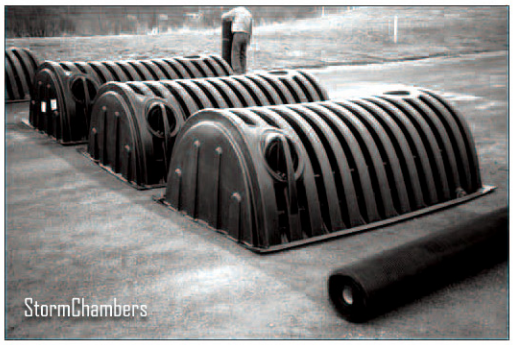
Rainstore3 ready for installation at El Jardin, NYC East Village park.

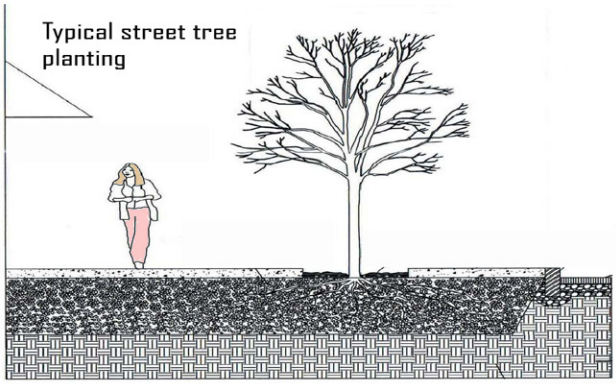
Rainstore3 (www.invisiblestructures.com)

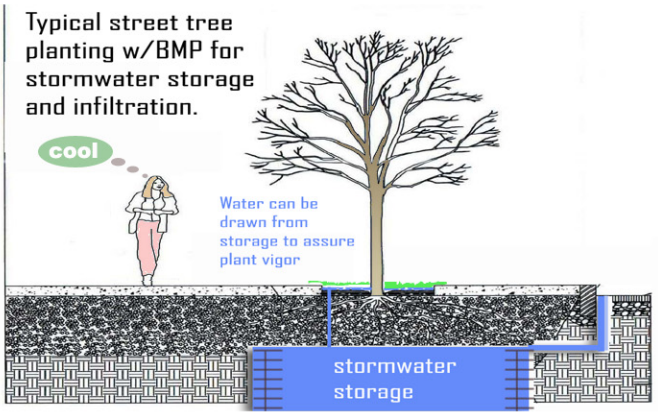
This plastic structure is used to store stormwater underground. Made from injection molded plastic, a single panel contains 36 vertical columns and exceeds H-20 loading, allowing the construction of driving areas or parking lots. Built- in compression fittings allow units to be easily stacked to a variety of depths up to 8'4". The Rainstore3 modular system is more efficient at storing water than pipes or vaults because of it's 94% void space, and is less expensive than concrete structures.

StormChambers (www.hydrologicsolutions.com)

This plastic vault provides a low cost, high water quantity and quality BMP. Open bottoms allow for stormwater infiltration and groundwater recharge, mimicking pre-development conditions, thus meeting low impact development standards when coupled with plantings in a watershed plan.







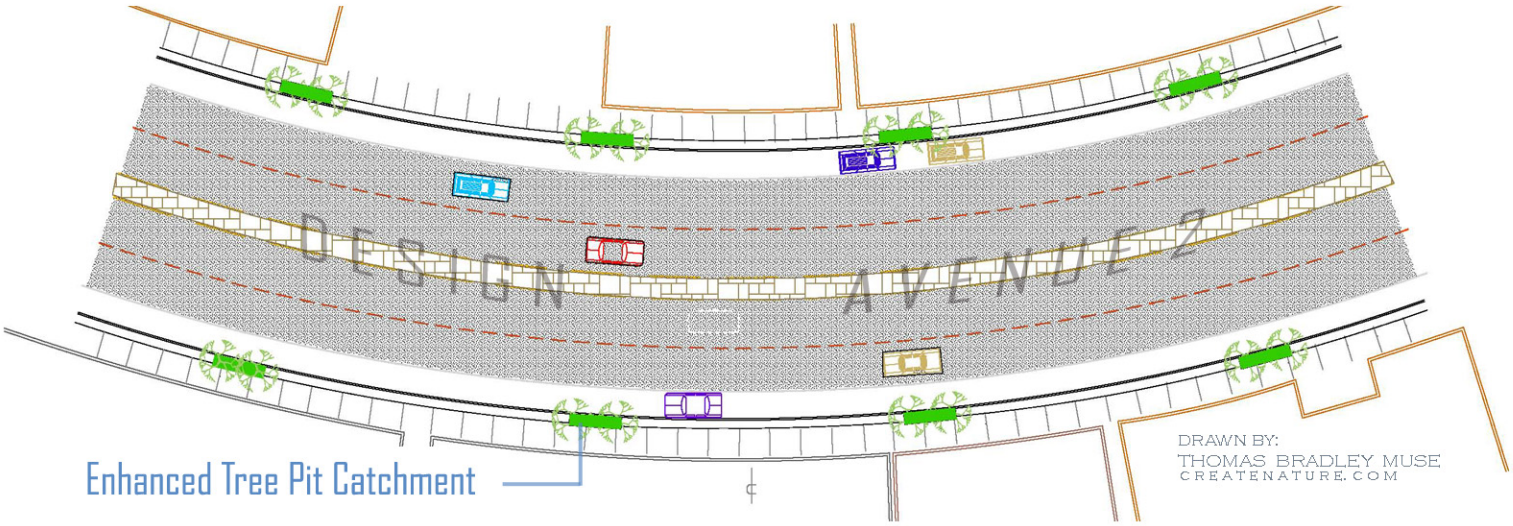
DRAWN BY:
THOMAS BRADLEY MUSE

CREATENATURE.COM

Greening streets with trees offers the opportunity to capture, store and infiltrate stormwater.

Rainstore3 and/or StormChambers can be retrofitted to existing street tree plantings or installed at the time new tree pits are formed.

Design Avenue: Some where in the Jamaica Bay Watershed.



'Design Avenue Two' is 500 linear feet and has 1.5 acres of impervious surface area generating approximately 73,300 gallons of storm-water run-off during 2 inches of rainfall in a 24 period. Eight enhanced tree pits each 4' wide by 20' long, with 5 cubic meters of Rainstore3 installed under plantings and connected to existing storm drains. Each tree pit has a 1200 gal. capacity with a infiltration capacity of 7800 gals. over 24 hours (based on 6" per hour infiltration rate), for a total of 9000 over 24 hrs. for each unit and 72,000 gals. for 8 units combined. This works out to be approximately 1,620,000 gallons per year removed from the combined sewer system (based on annual average rainfall of 45 inches).

One rainstore unit on each side of the Design Avenue will have 3 square meters of Rainstore3 installed in an EPDM inner, and will act as a cistern for water harvesting. In the growing season sparse precipitation will be replaced with water drawn from storage by means of a solar powered DC pump and pressure compensated drip irrigation emitters servicing all plantings. Solar powered irrigation will be automated and controlled by a soil moisture meter. This system will compensate for up to a 10 week straight period of no precipitation.

To retrofit 8 BMP, enhanced tree pits for this 1.5 acres of impervious surface the capital cost is estimated at $ 180,000 or about $2.75 per sq. ft. of managed impervious watershed.

Greening streets with trees offers the opportunity to capture, store and infiltrate stormwater.

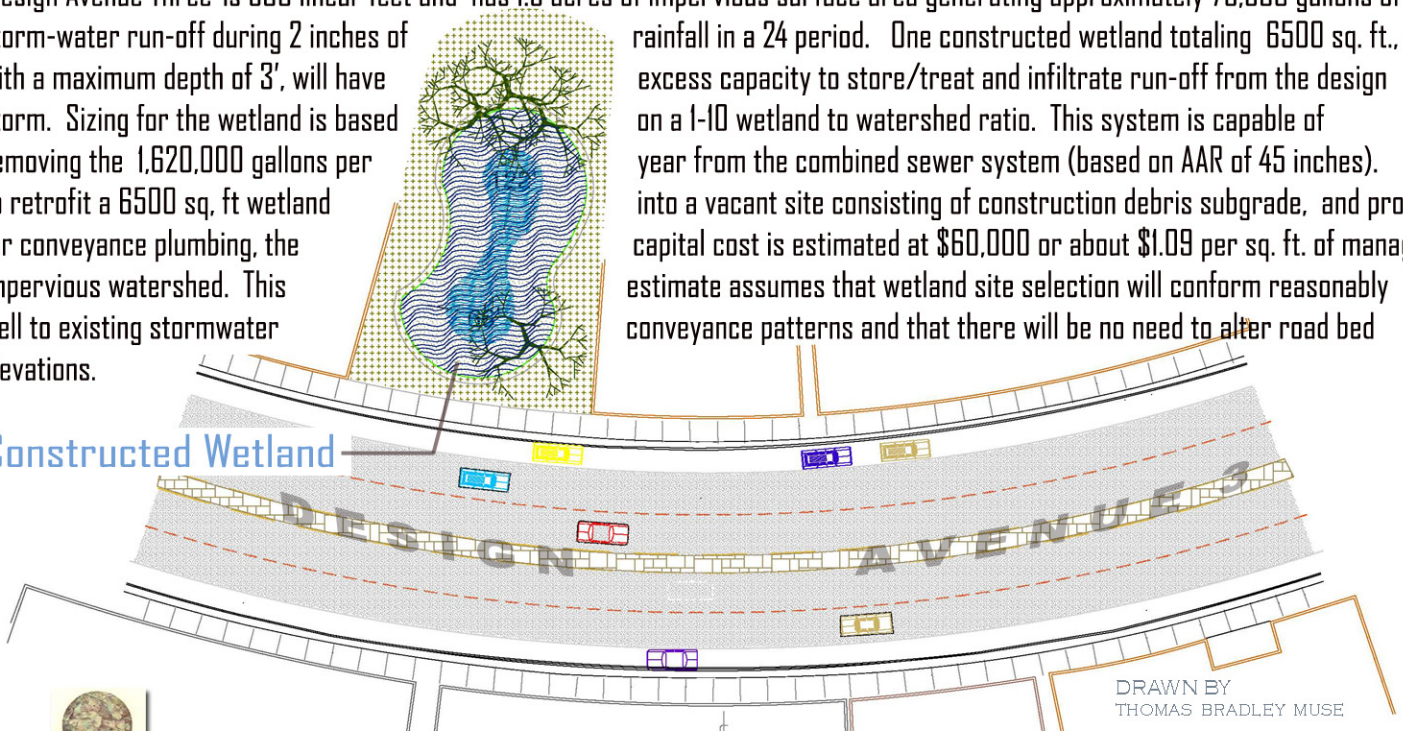
Constructed Wetlands

Sections of the Jamaica Bay Watershed serve as major nodes of transportation infrastructure. At the same time, large areas of Brownsville, East New York, and Jamaica, amongst others, are populated with long abandoned commercial and industrial properties and facilities. While the recent building boom in New York City has changed some of this, opportunities still exist for coupling stormwater capture with impervious surfaces.

Sample Project: Cozine and Crescent Avenue- Command Bus Depot Wetland/Infiltration Buffer.

Utilizing composted organic matter diverted from the waste stream of NYC, this project converted a sixth of an acre of vacant land in East New York into a native plant community and wetland catchment buffer capable of treating millions of gallons of stormwater runoff each year. The wetland is designed to move water, when full, into the surrounding porous soil buffer, providing a biogeo-chemical filter for hydrocarbons, metals, NOx, and other pollutants in parking lot runoff. Situated on top of fill over inter-tidal marsh, this project has thus turned the former construction staging area for the bus depot into urban GreenSpace and wetland habitat. This successful system is capable of producing measurable water quality improvements and increasing base-flow of bio-geochemically filtered groundwater into Jamaica Bay. Replicating similar projects between the terminal moraine and the estuary edge could decrease the volume and frequency of combined sewer discharge into Jamaica Bay by sustaining acres of vegetated landscape, greening some of the most industrialized sections of New York City in the process.

'Design Avenue Three' is 500 linear feet and has 1.5 acres of impervious surface area generating approximately 73,300 gallons of storm-water run-off during 2 inches of rainfall in a 24 period. One constructed wetland totaling 6500 sq. ft., and with a maximum depth of 3', will have excess capacity to store/treat and infiltrate run-off from the design storm. Sizing for the wetland is based on a 1-10 wetland to watershed ratio. This system is capable of removing the 1,620,000 gallons per year from the combined sewer system (based on AAR of 45 inches). To retrofit a 6500 sq. ft wetland into a vacant site consisting of construction debris subgrade, and provide for conveyance plumbing, the capital cost is estimated at $60,000 or about $1.09 per sq. ft. of managed impervious watershed. This estimate assumes that wetland site selection will conform reasonably well to existing stormwater conveyance patterns and that there will be no need to alter road bed elevations.

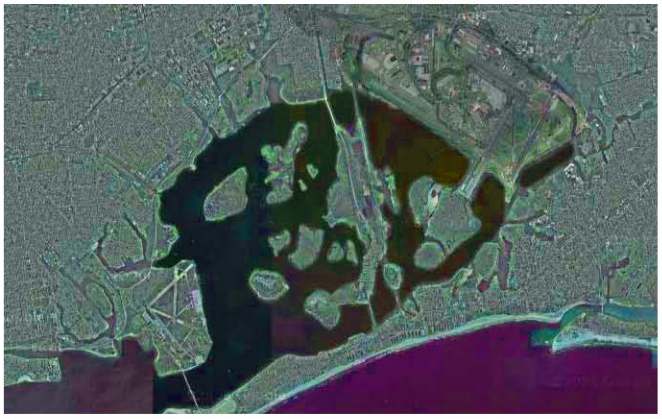


Constructed wetlands provide scenic wildlife habitats while storm water is treated and local aquifers are recharged.

Constructed wetlands at work ...

Green Roofs

Green Roofs offer unique opportunities in high density infrastructure coverage zones which are common to the Jamaica Bay watershed.

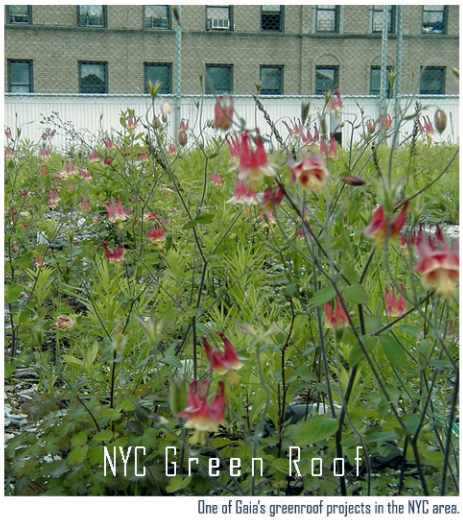


One of Gaia's greenroof projects in the NYC area.

The Gaia Institute is continuing its work in designing, constructing, modeling and monitoring greenroofs in the New York City metropolitan region and beyond. Ecological and economic benefits of greening rooftops have been investigated in various cities in the US, Europe and Asia, with widespread practices adopted in a number of places, notably Germany and the Pacific Northwest. Often the goals of these projects express the desire to protect waterways and estuaries. Greenroofs may provide the only means of addressing, in one stroke, combined sewer discharge, non-point pollution, and intensifying urban heat island impacts by increasing environmental quality and protecting human health in the process.

For this BMP we depart from 'Design Avenue' but use the same design storm (2" inches in 24 hrs.) and an equal size watershed. Applying the green roof application to 1.5 acres of existing roof area within the Jamaica Bay watershed will result in 100% stormwater storage and evapotranspiration loss. This works out to be approximately 1,620,000 gallons per year removed from the combined sewer system (based on annual average rainfall of 45 inches).

In some Jamaica Bay watershed areas the intensity of land us is such that Green Roofs offer the only opportunity to provide scenic wildlife habitats and BMP stormwater management.



One of Gaia's greenroof projects in the NYC area.

To apply the green roof BMP to 1.5 acres of impervious surface the capital cost is estimated at $ 1,960,000 or about $30.00 per sq. ft. of managed impervious watershed.

Monitoring and Reporting

Gaia Institute and its associates recommend a comprehensive 3 year monitoring and reporting program to accompany the proposed pilot BMPs. Fees for this work are estimated at $20,000 per year, per BMP. An estimated $72,000 will be required to install various monitoring devises on each BMP system. This amounts to an estimated total of $312,000 for a comprehensive 3 year program to establish each BMP's effectiveness, their individual strengths and weaknesses, and recommendations for design changes to improve each system where possible for future application.

Conclusion.

Precipitation capture can be approached either by centralizing its flows through stormwater infrastructure or using distributed naturalized landscapes to capture water closer to where it falls. Thus, water can either be conveyed off the land in pipes or captured in soils and wetlands. Centralization carries with it higher costs, so how much a stormwater strategy depends on centralization is likely to determine costs, as well as pollution removal capacities and the health and well being of urban ecological systems.

Once water enters a piped conveyance system, pollutant loads to receiving waters are maximized, since natural filtering of pollutants by soils, wetlands, and ground water systems are eliminated. As water is removed from the land, plant growth and ecological health is diminished proportionally, and the urban heat island effect is increased.

The watershed restoration program proposed here provides designs which divert quantities of water from storm sewers. Runoff is hereby directed to flow into swales, soils, wetlands, and groundwater. The quantity of water so partitioned into the landscape and subsurface environments thus becomes a resource for ecological communities on the land. By measuring and modeling the quantity of water which needs to be diverted from the combined sewer in sewersheds entering specific CSO regulators, this work aims to make it possible to diminish the volume and/or frequency of CSO discharge into Jamaica Bay,

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