



# NYC Green Infrastructure

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2012 Annual Report



Michael R. Bloomberg  
Mayor  
Carter H. Strickland, Jr.  
Commissioner





Carter H. Strickland, Jr.  
Commissioner

Dear Friends:

DEP's mission is to protect public health and the environment by supplying clean drinking water, collecting and treating wastewater, and reducing air, noise, and hazardous substances pollution. Earlier this year we released the 2012 Progress Report which provided an overview of DEP's progress on the initiatives in Strategy 2011-2014, the ground breaking document that explains how DEP will achieve its goal to become the safest, most effective, cost-efficient, and transparent water utility in the nation over the next four years and beyond.

One of our goals is to "maximize the use of green infrastructure and other source controls to improve water quality," as more fully detailed in the landmark NYC Green Infrastructure Plan, a Sustainable Strategy for Clean Waterways. Released in 2010, the Plan laid the framework for cleaning waterways by building innovative, cost-effective green infrastructure to manage one inch of stormwater runoff from 10% of impervious surfaces in the combined sewer areas of the City by 2030. In March 2012, the City and the New York State Department of Environmental Conservation finalized a historic agreement that incorporates an iterative, adaptive management approach to sustainable stormwater management using green infrastructure.

Since the release of our first Annual Report in 2011 DEP has continued to make steady progress. This second, 2012 Annual Report documents the accomplishments of the past year, in which we:

- Fully staffed the Office of Green Infrastructure with Engineers and Project Managers;
- Awarded \$3.4 million through the Green Infrastructure Grant Program to design and construct green infrastructure on private property;
- Adopted Design Standards for the Right-of-way Bioswale and received approval from the New York City Public Design Commission;
- Worked with the Green Infrastructure Task Force to initiate Area-wide Contracts for the design and construction of green infrastructure in our City's streetscapes and on public property;
- Met all 2012 green infrastructure milestones of the Modified Consent Order including completing construction of the 26th Ward Neighborhood Demonstration Area Project in East New York; and
- Met with elected officials, community boards, local organizations, and notified over 25,000 New Yorkers that green infrastructure was coming to their neighborhoods.

This report provides specific details about these developments and more. In October 2012, Hurricane Sandy made landfall in the Northeast, bringing fierce winds and unprecedented tidal storm surge to New York City. As we join communities in the recovery effort, we recognize the important role green infrastructure plays in creating a resilient city that can not only manage its stormwater but recover more quickly from the impacts from climate change.

Sincerely,

Carter H. Strickland, Jr.  
Commissioner



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# Introduction

Blue Roof, 1201 Metropolitan Ave, a DEP storehouse

In 2012, the New York City Department of Environmental Protection (DEP) signed a groundbreaking agreement with the New York State Department of Environmental Conservation (DEC) to reduce combined sewer overflows (CSO) using a hybrid green and grey infrastructure approach. By the time of the signing, DEP had already established the Office of Green Infrastructure, worked with the interagency Green Infrastructure Task Force to develop standard designs, specifications, and siting procedures for Right-of-way Bioswales (“bioswales”), launched the Green Infrastructure Grant Program (“Grant Program”), adopted a new rule for stormwater management in new construction, and built first generation green roofs, blue roofs, bioswales, rain gardens, and other types of green infrastructure across the City’s combined sewer areas.

Despite all that has already been accomplished, the City is still in the early stages of achieving the goal set forth in the *NYC Green Infrastructure Plan, A Sustainable Strategy for Clean Waterways* (2010) (“Green Infrastructure Plan”): which is to manage one inch of runoff from 10% of impervious surfaces within combined sewer areas by 2030. Each year, DEP will report to DEC and the public on its progress toward this goal as well as interim milestones included in the CSO Order on Consent<sup>1</sup> (“Order”) between DEP and DEC and effective March 12, 2012. This annual report describes the institutional and organizational steps taken, creation of design standards, pilot and demonstration projects implemented for ongoing data collection, and approaches for citywide implementation developed over the past year.

<sup>1</sup> Order on Consent (CSO Order Modification to CO2-20000107-8) (DEC Case No. CO2-20110512-25)

Green infrastructure is included in the Order as baseline credit towards achieving waterbody-specific water quality standards consistent with the Federal CSO Policy and the water quality goals of the Clean Water Act (CWA). The Order requires a specific green infrastructure application rate—manage one inch of runoff from 10% of impervious surfaces in combined sewer areas citywide by 2030—but allows the City to develop waterbody-specific application rates as part of the development of Long Term Control Plans (LTCP) for New York City. Waterbody-specific application rates include varied percentages or targets for managing impervious areas in different combined sewer tributary areas. DEP will adjust these rates based on lessons learned during implementation, monitoring data collected from pilot projects and Neighborhood Demonstration Areas, and the development of green infrastructure performance metrics.

Over the next 20 years, DEP is planning for \$2.4 billion in public and private funding for targeted green infrastructure installations, as well as \$2.9 billion in cost-effective grey infrastructure upgrades to reduce CSOs. DEP expects to fulfill the interim milestones of the Order and manage one inch of runoff from 1.5% of impervious surfaces or commit more than \$192 million by 2015 largely by working with other City agencies to build green infrastructure in the right-of-way. The City’s comprehensive strategy for CSO control combines green infrastructure with cost-effective grey infrastructure and system optimization, and is a critical element of Mayor Bloomberg’s far-reaching environmental initiative, *PlaNYC 2030*, to ensure a cleaner and more accessible harbor that continues to benefit residents and visitors.

# 2012 Major Accomplishments

1

## Promulgated Stormwater Performance Standard

DEP's stormwater performance standard (or "stormwater rule") took effect in July 2012. By slowing the flow of stormwater to the sewers, the stormwater rule allows the City to manage stormwater runoff from new development and redevelopment more effectively and maximize, to the greatest extent possible, the capacity of the city's combined sewer systems.

2

## Signed Additional Agreements with Partner Agencies

In January 2012, building on its agreement establishing maintenance roles with the New York City Department of Parks and Recreation (DPR) and the New York City Department of Transportation (DOT), DEP finalized an agreement with the New York City Housing Authority (NYCHA). The agreement established a working relationship between DEP and NYCHA for a five year term. The agencies will amend the agreement as new projects are accepted and completed.

3

## Continued Outreach and Notification in Green Infrastructure Project Areas

In 2012, DEP expanded its outreach and notification strategies. DEP made presentations to inform communities of new green infrastructure projects within neighborhood and area-wide project areas, and coordinated with the New York City Department of Design and Construction (DDC) on construction project newsletters. DEP mailed over 25,000 postcards notifying the public of upcoming build-out of Right-of-way Bioswales and Stormwater Greenstreets in affected areas. DEP continues to participate in conferences and webinars, and hold outreach events. DEP also continues to make presentations upon request to elected officials, community boards, schools and universities, and other civic organizations.

4

## Conducted Green Infrastructure Program Environmental Review

In March 2012, the City published an Environmental Assessment Statement for the first five years of the Green Infrastructure Program. DEP, as lead agency, concluded there would be no foreseeable adverse impacts on the environment from constructing a large scale green infrastructure program, assuming a range of technologies to be constructed in concentrated throughout combined sewer areas of the city.

5

## Published Guidelines for the Design and Construction of Stormwater Management Systems

In conjunction with the implementation of the new stormwater performance standard, DEP published a companion document, *Guidelines for the Design and Construction of Stormwater Management Systems*, to assist New York City's development community and licensed professionals in the selection, planning, design, and construction of onsite source controls that comply with the new rule.

6

## Constructed Right-of-way Bioswales

In 2011 and 2012, DEP constructed 14 Right-of-way Bioswales in conjunction with ongoing DDC capital projects on 4th Avenue and Dean Street, Atlantic Avenue in Brooklyn, and on College Point Boulevard in Queens.

7

## Initiated Public Onsite Retrofit Projects

In 2012, DEP reviewed designs for five schoolyard sites with the Trust for Public Land and the School Construction Authority (SCA). DEP and SCA are also identifying other opportunities within Priority Areas for green infrastructure retrofits. DEP and SCA identified eight schools for the next fiscal year. Additionally, DEP is currently designing green infrastructure installations for a number of NYCHA facilities, including the Seth Low Houses and the Hope Gardens Houses in Brooklyn and the Edenwald Houses in the Bronx.

# 2012 Major Accomplishments

8

## Completed Construction of 26th Ward Neighborhood Demonstration Project

DEP completed the 26th Ward Green Infrastructure Demonstration Area Project (“Demonstration Area”) in December 2012, which included 29 Right-of-way Bioswales and two Greenstreets within a 23 acre tributary area. Additionally, DEP constructed Right-of-way Bioswales as part of the Hutchinson River Demonstration Area, which started in September 2012 and includes 22 Right-of-way Bioswales in a 24-acre tributary area. DEP is currently in the process of building 19 Right-of-way Bioswales in the 16-acre Newtown Creek Demonstration Project Area. Monitoring will be ongoing at all Demonstration Projects in order to study the benefits of green infrastructure application on a neighborhood scale.

9

## Initiated Area-wide Contracts

In 2012, DEP selected three consultants to design green infrastructure in Priority Combined Sewer Tributary Areas (“Priority Areas”) of the Gowanus Canal, Newtown Creek, and Flushing Bay waterbodies. These area-wide contracts have commenced, with construction expected to begin in the fall of 2013. DEP has also transferred funding for both design and construction to the New York City Economic Development Corporation (EDC), DDC, and DPR for area-wide contracts covering other Priority Areas in the Newtown Creek tributary areas, as well as Priority Areas within the Jamaica Bay, Bronx River, and Hutchinson River CSO tributary areas. In 2012, DPR began construction in Flushing Bay and Bronx River, and will complete those projects in 2013. DDC and EDC will begin design this year.

10

## Completed Green Infrastructure Standard Designs for Right-of-way Bioswales

In coordination with Green Infrastructure Task Force partners, DEP’s Office of Green Infrastructure developed design standards for various types of Right-of-way Bioswales to be used by engineers, architects, landscape architects and other city agencies while preparing contract plans. These standards, finalized in August 2012, will facilitate the design of green infrastructure practices in the right-of-way and specifically streamline the development of contract plans and drawings, and reduce the timeline and costs associated with design and approval processes. DOT, DPR, and DEP also developed a siting and review procedure for Right-of-way Bioswale and Greenstreet locations. This includes a desktop hydrologic analysis, followed by a site visit by all agencies to determine the feasibility of the Right-of-way Bioswale or Greenstreet in a specific location based on existing conditions such as spatial and pedestrian conflicts.

11

## Completed Second Cycle of Green Infrastructure Grant Program

In 2012, DEP awarded through the Green Infrastructure Grant Program \$3.4 million to eight proposals. Projects are spread across four boroughs, and included green roofs, rain gardens, porous pavement, and bioinfiltration. Since its introduction in 2011, approximately \$6.4 million has been awarded to 19 private property owners to build green infrastructure projects in the combined sewer areas of the city. DEP has expanded the Grant Program by announcing \$6 million for the 2013 cycle.

12

## Released NYC Green Infrastructure Plan: 2011 Preliminary Pilot Monitoring Results

Since 2009, DEP has been selecting appropriate sites, and designing and constructing green infrastructure pilots in various locations throughout the Bronx, Brooklyn, and Queens. These pilots informed the analysis in the NYC’s *Green Infrastructure Plan* and continue to shape future planning and design efforts. This inaugural report, published in 2012, summarizes initial monitoring results and preliminary observations made in 2011 for a number of individual source controls.



Brooklyn Navy Yard rooftop farm

# Institutionalizing Green Infrastructure

In addition to its financial commitment to implement green infrastructure, DEP achieved a number of important institutional milestones, including strengthening the agency's organizational structure and ensuring the staff and resources necessary to deliver the commitments laid out in the Order for green infrastructure. DEP focused its efforts on hiring additional staff members to support the Green Infrastructure Program<sup>1</sup>, establishing and sustaining partnerships with other City agencies and stakeholder groups, promoting citywide legislation, and conducting a programmatic environmental review.

## Multi-agency Green Infrastructure Task Force

The interagency Green Infrastructure Technical Task Force ("Task Force"), created to identify opportunities for green infrastructure implementation through existing and planned capital projects across the City's combined sewer area, continued to meet regularly in 2012. To further facilitate this coordination, DEP established a schedule of standing Task Force meetings with representatives of the Departments of Design and Construction (DDC), Parks and Recreation (DPR), and Transportation (DOT), and frequent meetings with the New York City Economic Development Corporation (EDC), and the Health and Hospitals Corporation (HHC). DEP has also met with the New York City Housing Authority (NYCHA), the New York City Departments of

Buildings (DOB), Cultural Affairs (DCA), Education (DOE), Sanitation (DSNY), and Housing Preservation and Development (HPD) on a semi-frequent basis. DEP also works closely with the New York City Corporation Counsel (Law Department) and New York City Office of Management and Budget (OMB) to implement the Green Infrastructure Program. DEP will publish a Task Force Newsletter annually to showcase work from the previous year. The 2012 edition highlights the overall accomplishments of the Green Infrastructure Program and the collaborative efforts among the involved City agencies. On a continual basis, Task Force members will evaluate and provide information to the DEP on current capital plans to identify opportunities to integrate green infrastructure into planned public projects.

## Agreements with City Agencies

DEP develops agreements with other City agencies to establish roles and responsibilities related to green infrastructure implementation and maintenance. In January 2012, DEP finalized an agreement with NYCHA. This agreement establishes a working relationship between the two agencies and will be amended as new sites and projects are adopted and completed. In this agreement, NYCHA has agreed to locate green infrastructure projects on NYCHA property and DEP has agreed to reimburse NYCHA for the additional maintenance costs for the projects.

<sup>1</sup> DEP's Green Infrastructure Program blends goals of the Green Infrastructure Plan with the requirements of the CSO Order on Consent.

## Capital Planning Coordination

In 2012, DEP continued to focus its efforts on institutionalizing the planning, design, construction and maintenance of green infrastructure in different bureaus throughout the agency as well as with other City agencies. In order to meet the Order milestone dates DEP developed an area-wide approach to green infrastructure implementation focused on Priority CSO Tributary Areas (“Priority Areas”). Priority Areas were chosen based on water quality of the receiving waterbody and the frequency and volume of overflow. DEP is now partnering with DDC, DPR, and EDC to implement green infrastructure Area-wide Contracts for the design of bioswales, Stormwater Greenstreets<sup>2</sup> (“Greenstreets”), and green infrastructure retrofits on public property. DEP initiated three Area-wide Contracts and is currently collecting field data to determine feasibility and design.

Throughout 2012, DEP assigned Priority Areas to partner agencies, who then solicited contracts for the design and construction of green infrastructure in those areas. DEP will continue to work closely with its partner agencies throughout design and construction under these contracts to meet the near-term Order milestones for green infrastructure and 2015 targets. DEP will also review and refine Priority Areas as it ensures green infrastructure implementation to achieve long-term Order milestones and 2030 targets.

<sup>2</sup> In 2010, the Greenstreets program became DPR’s Green Infrastructure Unit, realigning its focus in coordination with DEP to build bioswales and Greenstreets that can actively manage stormwater. Greenstreets, like bioswales, feature inlets, broken stone, engineered soil, and hardy plants to collect and absorb stormwater from the street and sidewalk. They are slightly larger than bioswales and are built in underutilized roadbed areas along the curb.

## DEP’s Office of Green Infrastructure

DEP leads green infrastructure implementation and coordination with other bureaus and City agencies and oversees area-wide green infrastructure design and construction. The Office of Green Infrastructure (OGI) began with six full time staff in January 2011 to implement the Green Infrastructure Program on behalf of DEP. In 2012, OGI increased to ten staff dedicated to the programmatic areas necessary for ongoing green infrastructure implementation and is currently in the process of hiring three additional engineers. Generally these programmatic areas include engineering design review, field investigations, hydraulic analysis, design and construction contract oversight, consultant/contractor contract management, Grant Program administration, interagency coordination, capital planning, maintenance program management, internal project tracking and data management, intra-agency and LTCP coordination, outreach and engagement, public meetings and presentations, and other related administrative tasks.

In addition, OGI collaborates with other DEP bureaus including the Bureau of Water and Sewer Operations and the Bureau of Environmental Planning and Analysis, which provide direct support to OGI primarily on design review, waterbody planning, and coordinating the monitoring of green infrastructure benefits. Figure 1 illustrates the variety of roles and responsibilities of DEP bureaus and collaborating agencies.

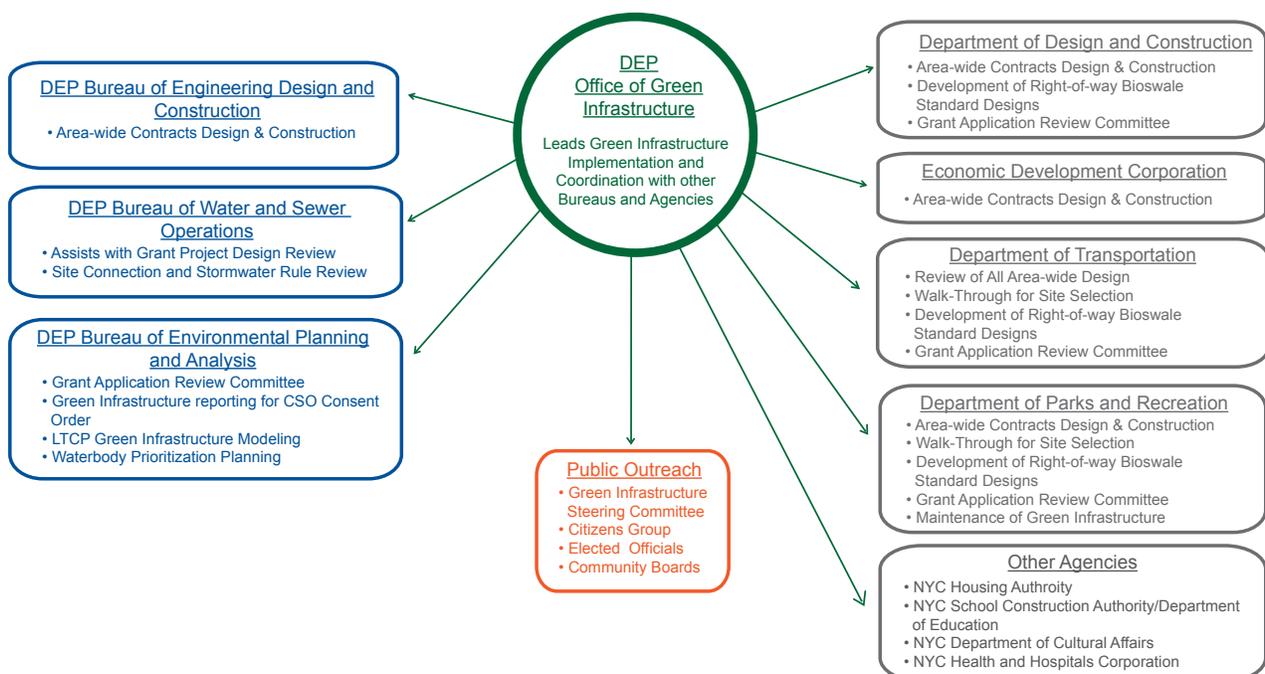


Figure 1: Office of Green Infrastructure organizational chart

## Outreach and Engagement

DEP continued to convene the Green Infrastructure Steering Committee in 2012 and engage the public in the ongoing implementation of the Green Infrastructure Program. The committee is comprised of a cross-section of stakeholders ranging from environmental justice and economic development organizations, to architecture, design, green jobs training organizations, and other experts in stormwater management. The Steering Committee meets quarterly and serves as a liaison between the Green Infrastructure Citizens Group and DEP in order to represent different stakeholder groups and interests. In 2012, the Steering Committee met quarterly and organized itself into three separate working groups: Green Jobs, Education and Engagement, and Technical Advice and Research. DEP works with each group to help foster greater stakeholder participation in the ongoing development of DEP's Green Infrastructure Program, raise awareness among the general public, and assist DEP in promoting green infrastructure practices across the construction industry.

In 2012, DEP expanded its outreach and notification strategies. DEP developed presentations to inform communities of new green infrastructure projects within neighborhood

and area-wide project areas, and coordinated with DDC on construction project newsletters. DEP mailed over 25,000 informational postcards notifying the public of upcoming build-out of bioswales and Greenstreets in affected areas. DEP led workshops at the *Grow Our Grassroots Summit*, organized by MillionTreesNYC and the Office of Long Term Planning and Sustainability (OLTPS); and *Green Infrastructure: Its Beauty and Function*, a conference sponsored by DEC's New York City ReLeaf Committee. In addition, DEP hosted a webinar for the U.S. Environmental Protection Agency (EPA) focusing on LTCP green infrastructure controls, and held a series of outreach events on DEP's new stormwater performance standard (see "Regulations, Rulemaking and other Developments" section). DEP continues to make presentations upon request to elected officials and their staff, community boards, schools and universities, and other civic organizations.

Finally, in the fall of 2012, as part of the Green Infrastructure Grant Program, DEP held three separate public workshops (in Brooklyn, Queens, and the Bronx) covering Grant Program criteria and application instructions. These meetings have served as a mechanism to educate the public about green infrastructure projects while providing guidance on developing thorough, cost-effective proposals for the Grant Program.

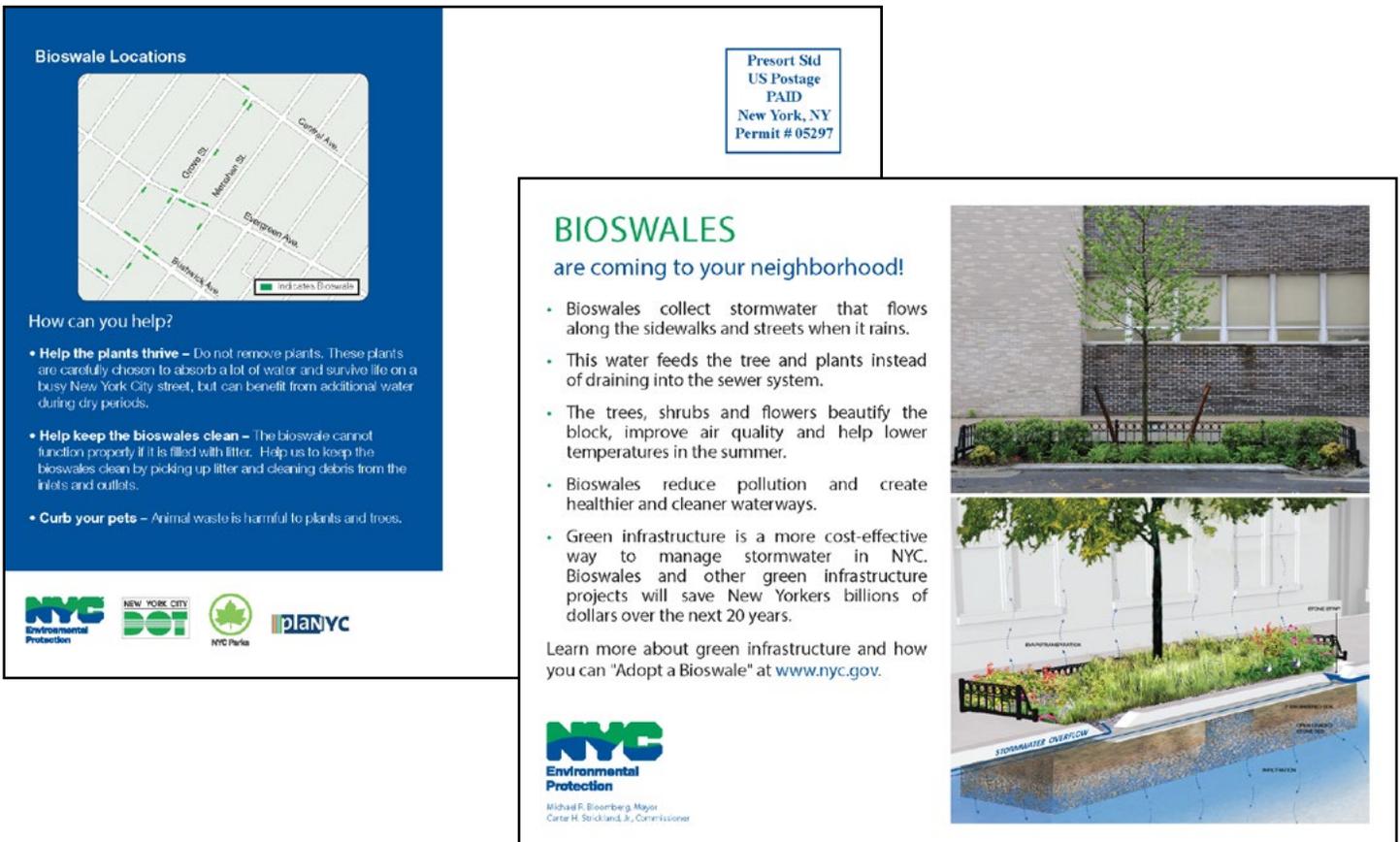


Figure 2: Construction notification postcards

## Regulations, Rulemaking, and other Developments

DEP promulgated the new stormwater performance standard (“stormwater rule”) in July 2012, as an amendment to the Rules of the City of New York after several years of development and analysis.<sup>3</sup> By slowing the flow of stormwater to the sewers, the stormwater rule allows the City to manage stormwater runoff from new development and redevelopment more effectively and to maximize the capacity of the City’s combined sewer systems to the extent possible. Any new house or site connections to the City’s combined sewer system must comply with a stricter stormwater release rate, effectively requiring greater onsite detention. The stormwater rule was a key component of *PlaNYC 2030* and the *Green Infrastructure Plan*, and is a green infrastructure strategy that DEP will continue to evaluate as part of its comprehensive approach to reduce CSOs using a combination of green and grey infrastructure.

The stormwater rule applies to new development or the alteration of an existing development in combined sewer areas of the City. For a new development, the stormwater release rate<sup>4</sup> will be the greater of 0.25 cubic feet per second (cfs) or 10% of the drainage plan allowable flow<sup>5</sup>. If the allowable flow is less than 0.25 cfs, then the stormwater release rate shall be equal to the allowable flow. For alterations, the stormwater release rate for the altered area will be directly proportional to the ratio of the altered area to the total site area, and no new points of discharge are permitted.<sup>6</sup>

DEP’s stormwater rule effectively implemented several proposals of the New York City Green Codes Task Force, a citywide effort led by the U.S. Green Buildings Council to “green” the City’s rules and regulations. Specifically these proposals include; reduce stormwater runoff from new developments, send rainwater to waterways, encourage innovative stormwater practices, and maintain site-based stormwater detention systems.

In conjunction with the implementation of the new stormwater rule, DEP published a companion document, *Guidelines for the Design and Construction of Stormwater Management Systems*, to assist New York City’s development community and licensed professionals in the selection, planning, design, and construction of onsite source controls that comply with the stormwater rule. The guidelines were

<sup>3</sup> See Chapter 31 of Title 15 of the Rules of the City of New York Governing House/Site Connections to the Sewer System. (New York City, N.Y., Rules, Tit. 15, § 31)

<sup>4</sup> New York City, N.Y., Rules, Tit. 15, § 31-01(b)

<sup>5</sup> Allowable flow is defined as the storm flow from developments based on existing sewer design criteria that can be released into an existing storm or combined sewer.

<sup>6</sup> New York City, N.Y., Rules, Tit. 15, § 31-03(a)(2)

developed in consultation with DOB, and feature guidance on siting, design, and construction considerations for various stormwater control systems, as well as operation and maintenance recommendations. Likewise, DEP went through an extensive peer review process that incorporated input from representatives of multiple City agencies, members of design, engineering, real estate communities, and leaders in sustainability.

DEP continued implementation of the Parking Lot Stormwater Pilot Program first initiated in 2011, and billed 364 parking lot accounts for a total of \$188,000 during 2012. DEP instituted a stormwater charge of \$0.05 per square foot for stand-alone parking lots which applies to existing and new parking lots that do not receive or pay for water service but discharge stormwater to City sewers. The charge generates revenue for important stormwater-related expenditures. In 2012, DEP used updated data to identify additional stand-alone parking lots not charged in 2011, and will begin billing these additional accounts in 2013. The charge is anticipated to increase each year as DEP’s stormwater related expenditures increase.

Throughout 2012, DEP worked with OLTPS, DOB, OMB and the Department of Finance (DOF), as well as environmental advocates and green roof designers to modify and extend the New York City Green Roof Tax Abatement past the March 2013 expiration date. Since the tax abatement became effective in 2008, approximately two acres of green roof have been installed. Five individual property owners have received the abatement, totaling approximately \$260,000. DEP met with stakeholders and agency partners to identify ways to improve response to the program, increase the number of green roofs in the City, and support the transformation of the local market for green roof materials and labor.

## Environmental Review

On March 8, 2012, DEP published an Environmental Assessment Statement for the first five years of the Green Infrastructure Program. Although individual projects are unlikely to trigger an environmental review, each project site is intended to function together as part of a larger stormwater management program. DEP, as lead agency, concluded there would be no foreseeable adverse impacts on the environment from constructing a large scale Green Infrastructure Program, assuming a range of technologies to be constructed in concentrated areas throughout combined sewer areas of the City. DEP published the Negative Declaration May 23 and finalized it on June 22, 2012. Documents pertaining to the environmental review are on DEP’s website: [nyc.gov/dep](http://nyc.gov/dep).



Right-of-way Bioswale, Dean St. & 4th Ave., Brooklyn

# Green Infrastructure Design Standards

In coordination with Task Force partners, DEP has developed design standards for various types of bioswales to be used by engineers, architects, landscape architects, and other city agencies while preparing contract plans. These standards will facilitate the design of green infrastructure practices in the right-of-way and specifically streamline the development of contract plans and drawings, and reduce the timeline and costs associated with design and approval processes. Finalized on August 16, 2012, the standards are posted on DEP's website. Currently, there are three standard designs including a 10'x5', 15'x5' and 20'x5' bioswale, each with unique plant specifications and variations to include stormwater inlets and/or stone columns. DEP is developing additional green infrastructure standards in order to address a range of site conditions common throughout the Area-wide Contract locations.

In February 2012, DEP joined DDC, DOT, and DPR in presenting the bioswale designs to the NYC Public Design Commission. With support from professional design partners the designs received the commission's final approval on March 12, 2012.

In 2011 and 2012, DEP constructed 14 bioswales in conjunction with ongoing DDC capital projects on 4th Avenue

and Dean Street and Atlantic Avenue in Brooklyn, and on College Point Boulevard in Queens. DEP also completed the 26th Ward/Jamaica Bay Demonstration Area in December 2012, which included 29 bioswales and two Greenstreets.

Beyond the design standards, DOT, DPR, and DEP also developed a siting and review procedure for bioswale and Greenstreets locations. This includes a desktop hydrologic analysis, followed by a site visit by all agencies to determine the feasibility of the bioswale or Greenstreet in that specific location based on existing conditions such as spatial and pedestrian conflicts. The right-of-way green infrastructure projects respect the established street zones and will be placed in the "Furnishing Zone" of the sidewalk, similar to street trees.

DEP has standardized survey and geotechnical procedures specifically required for bioswale and Greenstreets sites to ensure that each site does not conflict with utilities and will infiltrate as designed. Due to the various complications that can arise during construction as well as unknown subsurface conditions, these procedures are necessary in order to avoid utility conflicts, and areas with adverse soil conditions and high groundwater tables.

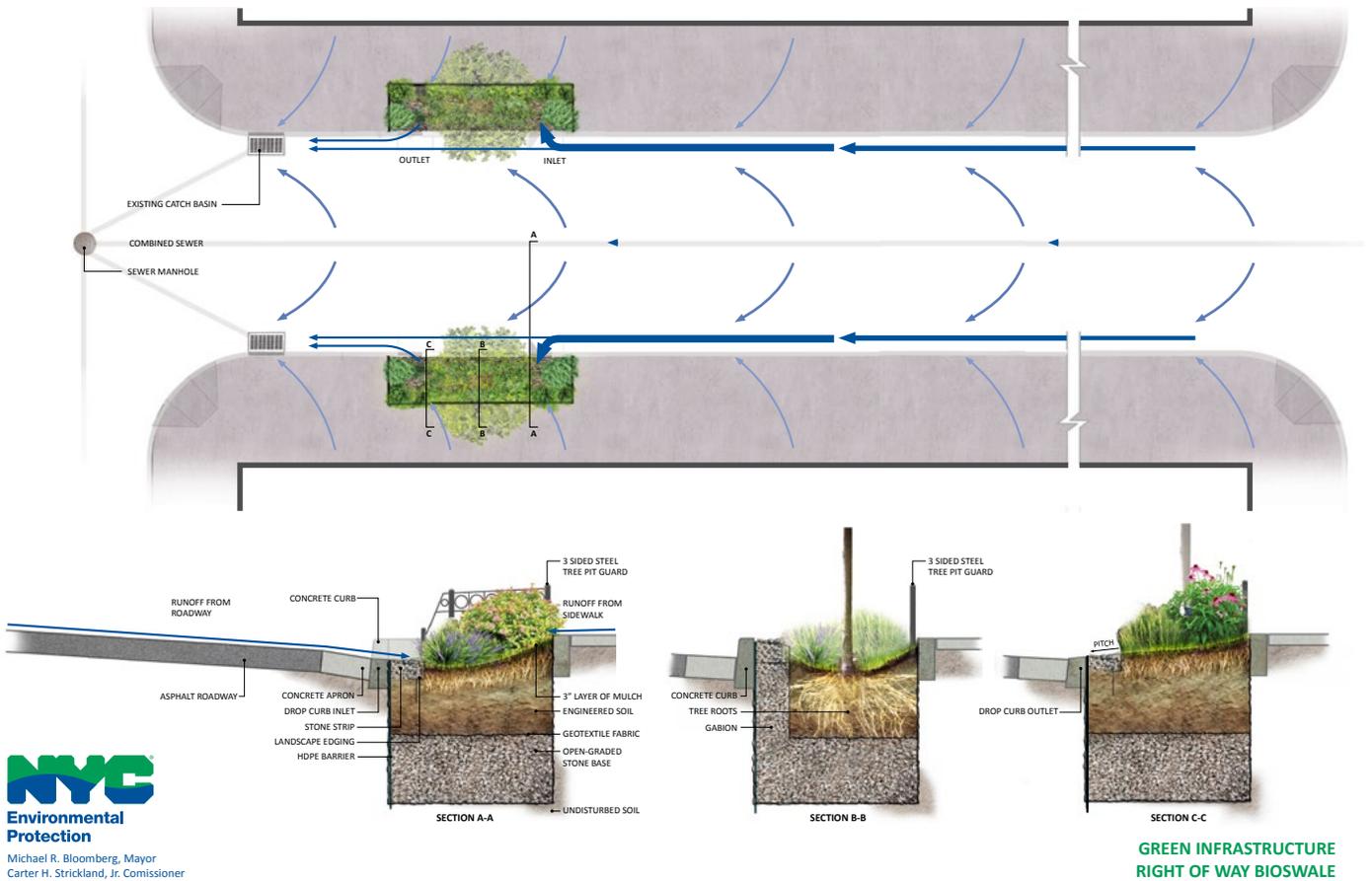


Figure 3: Illustrations showing Right-of-way Bioswale design and functions



# Demonstration & Pilot Projects

Right-of-way Bioswale monitoring equipment, Junius St. and East New York Ave., Brooklyn

The Green Infrastructure Program applies an adaptive management approach based on pilot monitoring results and information collected and assessed for demonstration projects. In particular, this information will be used to develop a green infrastructure performance metrics report required by the Order to relate the benefits of combined sewer overflow reduction to the amount of constructed green infrastructure.

## Neighborhood Demonstration Area Projects

The Order contains design, construction, and monitoring milestones for three Neighborhood Demonstration Area Projects (“Demonstration Projects”). DEP is currently in the process of building and monitoring green infrastructure within a total of 63 acres of tributary area in the Newtown Creek, Hutchinson River<sup>1</sup> and Jamaica Bay CSO tributary areas to study the benefits of green infrastructure application on a neighborhood scale. The development of these Demonstration Projects will culminate in the submission of a post-construction monitoring report in August 2014, and

<sup>1</sup> The original location of this Neighborhood Demonstration Area project was in the Bronx River CSO tributary area. However, in the course of conducting soil borings in the area as part of the green infrastructure design process, DEP found that the Demonstration Area is predominantly underlain with shallow bedrock that is unfavorable for the design and construction of bioswales. Per a modification request submitted by DEP to DEC on March 30, 2012, the location was moved to the Hutchinson River CSO tributary area, where more favorable soil conditions were identified for a neighborhood area connected to a common combined sewer.

will be incorporated into the 2016 performance metrics report. Monitoring for all three Demonstration Projects started in the fall of 2011 and continued throughout 2012.

Construction of bioswales as part of the Hutchinson River Green Infrastructure Demonstration Area Project (Demonstration Area 1) started in September 2012. Demonstration Area 1 includes 22 bioswales that will be installed within a 24-acre tributary area and will cost approximately \$371,000 to construct. DPR’s Green Infrastructure Unit completed the design for Demonstration Area 1. In December 2012, DEP completed the Jamaica Bay Green Infrastructure Demonstration Project in the 26th Ward Tributary Area (Demonstration Area 2). The project includes 29 bioswales and two Greenstreets within a 23-acre tributary area. Demonstration Area 2 cost approximately \$887,000 to design and construct. Finally, the Newtown Creek Green Infrastructure Demonstration Project (Demonstration Area 3) includes 19 bioswales within a 16-acre tributary area. Demonstration Area 3 will cost approximately \$690,000 to design and construct.

While DEP’s Pilot Monitoring Program provides performance data for individual green infrastructure installations, the Demonstration Projects will allow DEP to establish standardized methods for calculating and reporting derived CSO volume reductions and other benefits associated with multiple green infrastructure installations in a concentrated

area. DEP will assess CSO reductions achieved through multiple installations with common connections to the sewer system by collecting high-quality flow monitoring data at a point at which the combined sewers exit each of the Demonstration Areas. Monitoring activities consist of recording flow and depth using meters placed within the main outlet sewer as well as at several individual bioswale installations. Data acquisition will be continuous with measurements recorded at 15-minute intervals, and will be collected for a period of several months for pre-construction and a year for post-construction. In August 2014, DEP will report on the monitoring data in a Post Construction Monitoring Report. This information will enhance DEP's understanding of the benefits of green infrastructure relative to runoff control and CSO reduction. Additionally, DEP will extrapolate the results when calculating and modeling water quality and cost-benefit information on a waterbody basis.

### Pilot Monitoring Program

The Pilot Monitoring Program provides DEP opportunities to test different designs and monitoring techniques in order to determine the most cost-effective, adaptable, and efficient green infrastructure strategies for implementation citywide. Specifically, the program assesses the effectiveness of different source controls in various locations at reducing the volume and rate of stormwater runoff from the tributary area through measuring quantitative aspects like inflow and outflow rates. Monitoring efforts also include qualitative assessments of maintenance requirements, aesthetics, and community perception. DEP initiated site selection and design of 25 different pilot sites in 2009, and completed construction of each pilot site in less than one year. Water quality and quantity data collection began in 2010 and 2011. Monitoring results are currently used to estimate bioswale performance, and to validate modeling methods and parameters. DEP will publish the results of the 2012 Pilot Monitoring Report in 2013, and is expected to verify results published in the 2011 Pilot Monitoring Report, which DEP published in 2012.

The 2011 Pilot Monitoring Report is posted on DEP's website. Given the consistency in monitoring results reported for the first two years, DEP will scale back water quality and quantity monitoring for several pilots in 2013. DEP anticipates resuming in three to five years to determine if pilots are performing as originally designed. Besides measuring the direct stormwater capture and water quality benefits of the green infrastructure projects, DEP has also begun to develop protocols for monitoring the co-benefits of green infrastructure, such as carbon sequestration and urban heat island mitigation, and plans to begin its monitoring in 2013.



Figure 4: 26th Ward Demonstration Area, East New York, Brooklyn



# Green Infrastructure Planning

Green roof at Paerdegat Basin CSO Facility

As previously mentioned, the Order allows for the development of waterbody-specific green infrastructure application rates for 2030 as part of the development of LTCPs for 10 different waterbodies between 2012 and 2017. Baseline implementation rates with respect to green infrastructure must be included in each LTCP. Further, to begin area-wide implementation toward achieving the goals of the Order, DEP first had to identify combined sewer areas of the City to concentrate funding for design and construction contracts and in-house efforts. DEP employed a two-step planning process to identify target combined sewer areas for green infrastructure implementation: 1) waterbody prioritization and 2) tributary CSO drainage area prioritization. In addition, as LTCPs are developed and monitoring data continues to be collected, modeling will be used to confirm and identify additional Priority Areas in the future. Each of these processes is described in greater detail below.

## Waterbody Prioritization Approach

Waterbody-specific green infrastructure application rates were developed based on a review of current and expected water quality conditions and an overall prioritization of waterbodies. The results of this exercise were shared with and reviewed by DEC in 2012 as DEP initiated the development of the first LTCP for Alley Creek and Little Neck Bay in northeast Queens. DEP's waterbody prioritization process relied on existing information to provide

the best estimate for waterbody-specific application rates. DEP then used this approach to identify specific waterbodies for public and private green infrastructure investment, provide targeted areas for ongoing green infrastructure implementation, and optimize LTCP alternatives evaluations involving both grey and green infrastructure.

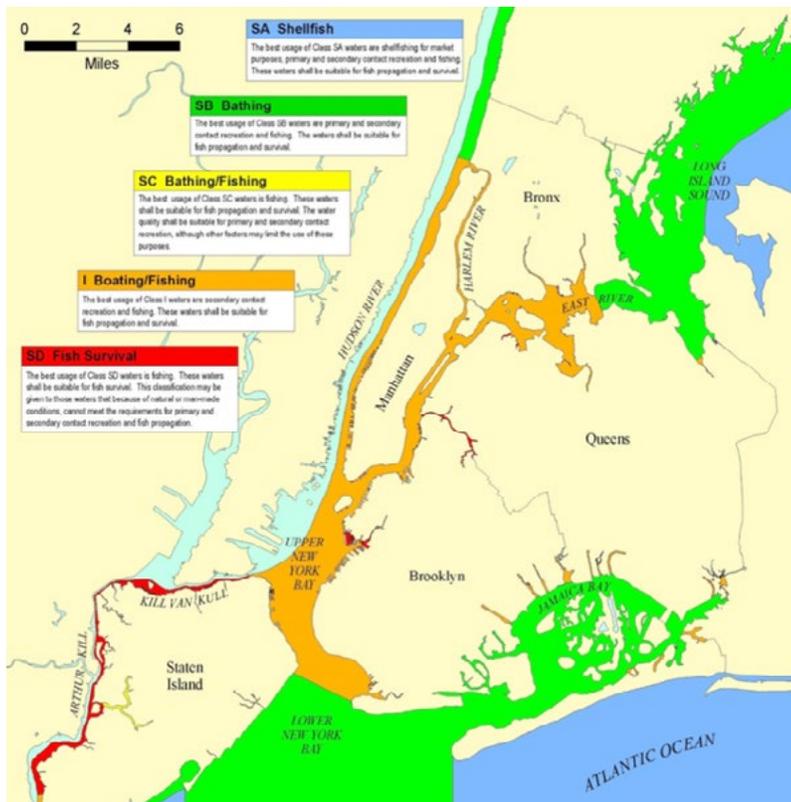


Figure 5: DEC water classifications used to prioritize waterbodies for green infrastructure implementation in corresponding CSO tributary areas

Order Requirements by 2030			
Waterbody	Combined Sewer Impervious Area (CSIA) Acreage	Application Rate Targets	
		Managed Acres	Percent of CSIA
<b>Initial Phases</b>			
Alley Creek	1,490	45	3%
Bronx River*	2,331	322	14%
Coney Island Creek	694	7	1%
Flushing Bay*	4,049	522	13%
Flushing Creek*	5,923	479	8%
Gowanus Canal*	1,387	162	12%
Hutchinson River*	1,128	158	14%
Jamaica Bay & CSO Tributaries*	7,891	675	9%
Newtown Creek*	4,524	593	13%
Westchester Creek	3,480	487	14%
<b>Total Waterbodies</b>	<b>32,897</b>	<b>3,450</b>	<b>10%</b>
<b>Future Phases</b>			
<b>CITYWIDE (Total Waterbodies + East River &amp; Open Waters + Paerdegat Basin)</b>	<b>78,749</b>	<b>7,875</b>	<b>10%</b>

Table 1: Waterbody specific application rates and opportunities for green infrastructure implementation

\* Priority Area

The following criteria were applied to compare and prioritize waterbodies in order to determine waterbody-specific green infrastructure application rates:

- Water quality standards
  - » Fecal coliform
  - » Total Coliform
  - » Dissolved Oxygen
- Baseline cost effective grey investments
  - » Planned/constructed grey investments
  - » Projected CSO volume reductions
  - » Remaining CSO volumes
  - » Total capital costs
- The ratio of separate stormwater discharges to CSO discharges;
- Additional planned CSO controls not captured in Watershed/Waterbody Facility Plans or Order (e.g., high level storm sewers);
- Preliminary waterbody sensitivity to green infrastructure in terms of cost per gallon of CSO reduced; and
- Additional considerations:
  - » Background water quality conditions
  - » Public concerns and demand for higher uses
  - » Eliminated or deferred CSO storage facilities

Table 1 provides a summary of 2030 green infrastructure implementation targets per the Order and for each water body based on the previously described Priority Areas. The combined sewer impervious area (CSIA) acreage for each waterbody illustrates portions of the citywide total. As LTCPs are developed, green infrastructure targets or application rates for specific waterbodies may be adjusted based on lessons learned during implementation and modeling of CSO and water quality conditions. Currently, DEP has identified greater application rates for waterbodies such as Bronx River, Flushing Bay, Gowanus Canal, Hutchinson River, Newtown Creek, and Westchester Creek based on the above DEP prioritization criteria.

DEP is targeting the right-of-way to achieve waterbody-specific application rates by aggressively designing and constructing bioswales and Greenstreets.

Application rates on public property is based DEP's ongoing coordination with other agencies including DPR, NYCHA, Metropolitan Transit Authority, DOT, DSNY, DOE, and the New York City Fire and Police Departments to identify on-site opportunities that will supplement green infrastructure implementation in the right-of-way.

Implementation of green infrastructure as part of new development or redevelopment in all waterbodies is based on compliance with DEP's stormwater performance standard made effective in July 2012. Grant program projects and other incentive programs will also be tracked and credited toward these private onsite application rates as well.

## Priority Area Approach

In order to meet the 1.5%, 4%, 7% and 10% citywide combined sewer tributary areas managed by green infrastructure application rates by 2015, 2020, 2025 and 2030 respectively, Priority Areas were identified based on discharges in receiving waterbodies from specific CSO outfalls. DEP looked closely at the annual CSO volume and frequency of CSO events at each outfall to target large volume and high frequency outfalls. In addition, DEP considered outfalls that may be affected by WWFPs or other system improvements in the future, outfalls in close proximity to existing and future public access locations, and tributary CSO drainage areas with potential site-specific limitations such as groundwater, bedrock, and soil types. This approach has provided DEP a platform for ongoing green infrastructure implementation and will provide DEP an opportunity to measure and evaluate the CSO benefits of area-wide green infrastructure implementation at the outfall level.

Once the Priority Areas are identified, DEP then initiates Area-wide Contracts and undertakes a series of additional steps to select potential, preliminary and final sites for bioswales, and proceed

with design. Due to standardized designs and efficiencies of scale, bioswales are the primary technologies for achieving overall targets and will manage runoff from 30% of right-of-way impervious surfaces within combined sewer tributary areas. To achieve overall targets, DEP identifies opportunities for collaboration with other agencies and develops onsite contracts to implement green infrastructure on other publicly owned properties. Additional information about Area-wide Contracts and Public Onsite Retrofit Projects is below under Citywide Implementation.

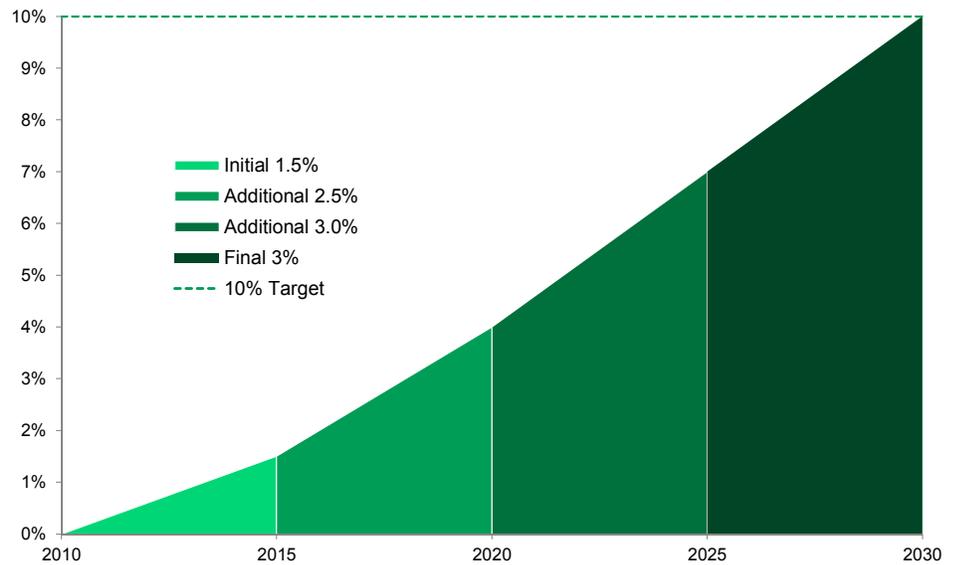
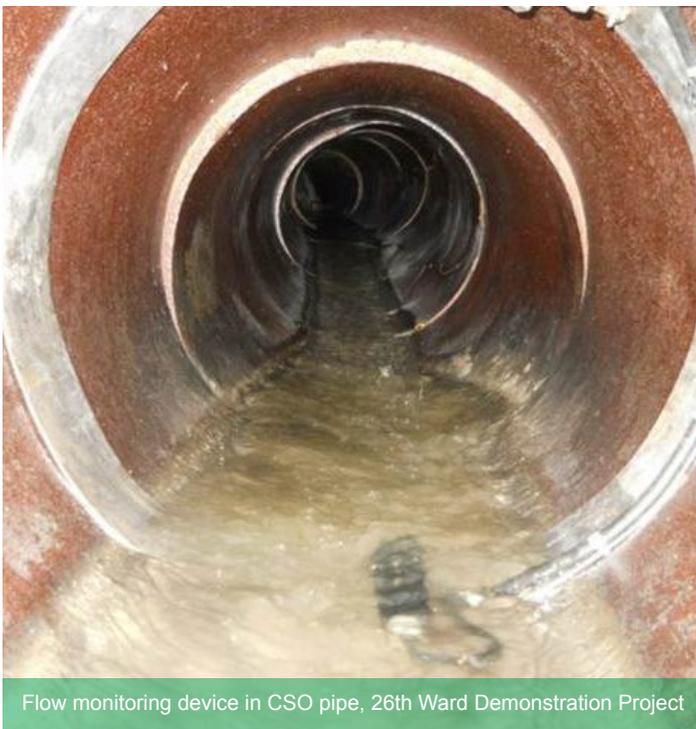
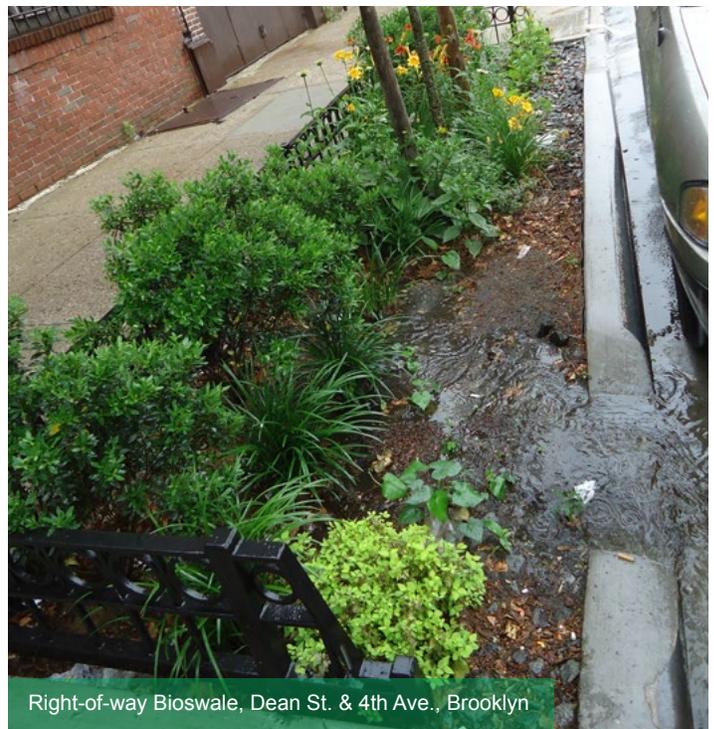


Figure 6: Green infrastructure application rates and milestone schedule



Flow monitoring device in CSO pipe, 26th Ward Demonstration Project



Right-of-way Bioswale, Dean St. & 4th Ave., Brooklyn

## Modeling

Green infrastructure implementation is incorporated into landside models using InfoWorks<sup>1</sup> modeling software and based on the extent of retention and detention practices in CSO tributary areas. Infoworks has been customized for well over a decade to account for the unique flow characteristics of New York City's sewer system. It uses information for 25,000 catchments, 7,500 pipes, 6,000 manholes, regulators, and other features, and predicts overland runoff routing in New York City's topography. InfoWorks expresses the extent of retention and detention in terms of a percent of impervious cover where one inch of stormwater is managed through different types of source controls such as bioswales, cisterns, and detention tanks on a CSO tributary area basis.

Individual source controls are aggregated in the model to collectively represent distributed green infrastructure throughout a neighborhood and also at the tributary area scale. The fundamental processes in these controls such as infiltration, storage, and orifice control for detention are still preserved, and DEP has developed scale-up methodologies to account for multiple retention and detention practices planned as part of the baseline credit for each CSO tributary area.

For example, the model replicates infiltration and storage in the bioswales based on the corresponding percent of retention and the number of bioswales needed to manage one inch of rainfall within this subcatchment.

Similarly, a detention system that constricts the outflow to 0.25 cubic feet per second per impervious acre or 10% of allowable flow is reflected in the models as a collective of decentralized systems at the neighborhood scale. Based on the number of new and redevelopment projects that will guide the percent of impervious area being managed by detention, DEP's drainage planning methodology is used to estimate the detention storage needed for each project. These neighborhood scale retention and detention systems are then aggregated within each CSO tributary area as "storage nodes" managing one inch of stormwater from impervious surfaces within specific CSO tributary areas in the model.

The total impervious area within a CSO tributary area is divided into a portion being controlled by retention, another portion by detention, and a third uncontrolled portion. These three portions contribute differing degrees of outflow to the sewer system during rainfall events based on the type of control, which is then routed through combined and interceptor sewers and regulators within the model as it would within the City's actual wastewater collections and treatment system. Combined sewer overflows that occur in individual regulators during certain rainfall events are thereby influenced by the application of retention and detention practices at the neighborhood and CSO tributary area scale. By comparing the CSO discharges and related pollutant loads for the scenarios with and without green infrastructure, the anticipated CSO benefits of green infrastructure implementation can be assessed on a waterbody basis.

CSO Watershed	LTCP Due Date
Alley Creek LTCP	June 2013
Coney Island LTCP	June 2014
Hutchinson River LTCP	September 2014
Flushing Creek LTCP	December 2014
Bronx River LTCP	June 2015
Gowanus Canal LTCP	June 2015
Jamaica Tributaries & Bay LTCP	June 2016
Westchester Creek LTCP	June 2016
Flushing Bay LTCP	June 2017
Newtown Creek LTCP	June 2017
Citywide LTCP	December 2017

Table 2: Long Term Control Plan Consent Order schedule

<sup>1</sup> The InfoWorks model is a commercially available product from Innovyze (<http://www.innovyze.com>). The model is used to analyze urban hydrology and hydraulics. The InfoWorks model is capable of using Geographic Information Systems (GIS) data, modeling continuous and event simulations, incorporating real time controls, modeling green and grey infrastructure, and performing water quality tracking within sewer systems.

# Current Phase to Meet 2015 Milestone

 Priority CSO Tributary Areas

Waterbody	Target Acres to be Managed by 2015
<b>Initial Phases</b>	
Bronx River	75
Flushing Bay	330
Flushing Creek	50
Gowanus Canal	40
Hutchinson River	55
Jamaica Bay & CSO Tribs	225
Newtown Creek	410
<b>Total Waterbodies</b>	<b>1185</b>

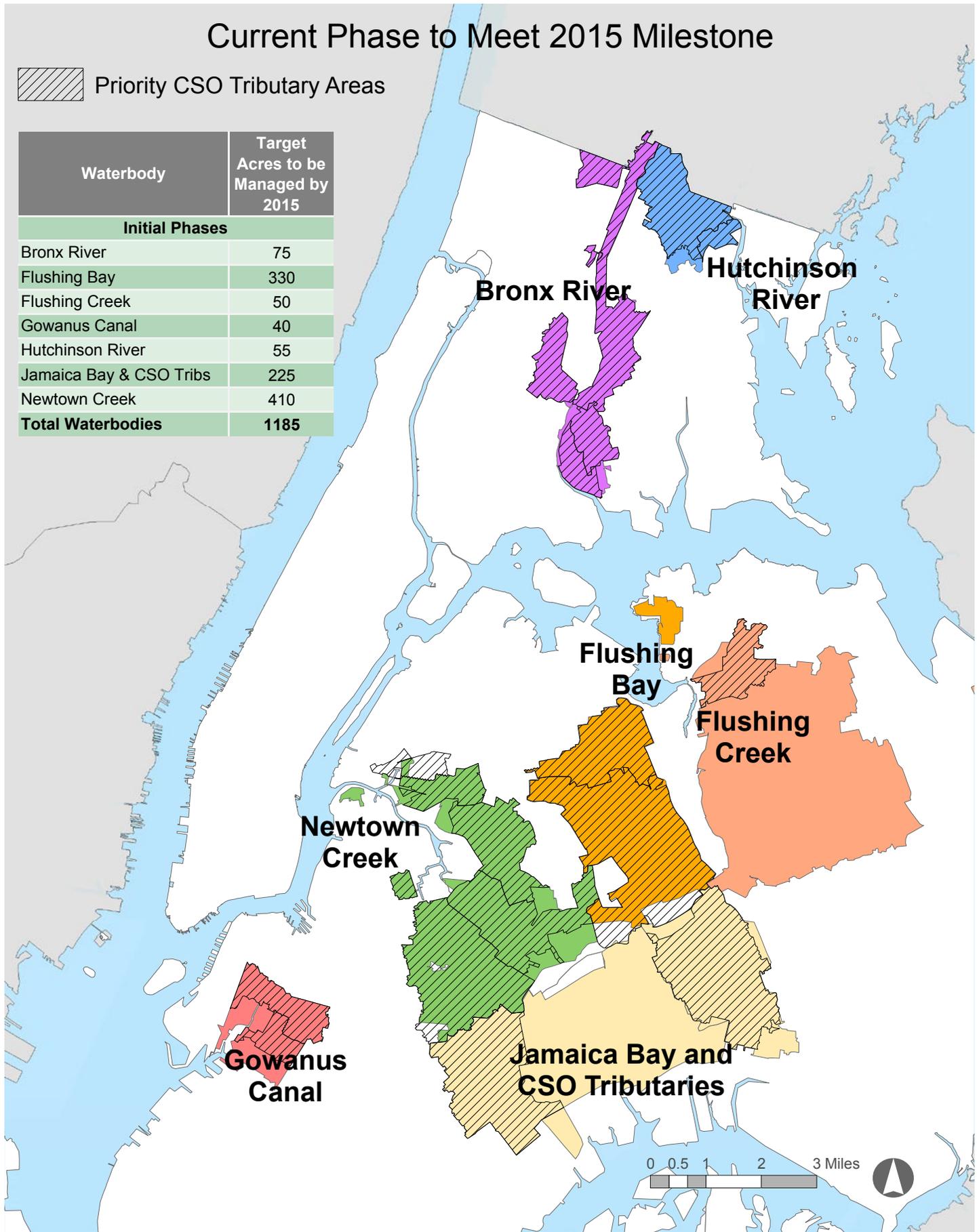


Figure 7: Greater green infrastructure application rates were identified for the above CSO tributary areas based on specific water quality criteria, ratios of separate stormwater and CSO discharges, and comparisons of existing and planned grey infrastructure investments



# Citywide Implementation

Rain garden at Bronx River House

## Area-wide Contracts

By far the largest part of the Green Infrastructure Program, DEP has dedicated a significant portion of funding and resources toward designing and constructing bioswales and Greenstreets on a tributary area-wide scale. As mentioned above, DEP is undertaking these projects along with its partner agencies, EDC, DDC, and DPR.

In 2012, DEP selected three consultants to design green infrastructure in Priority Areas of the Gowanus Canal, Newtown Creek, and Flushing Bay CSO tributary areas. These design contracts have commenced, with construction expected to begin in the fall of 2013.

DEP has transferred funding for design and construction to EDC, DDC, and DPR for Area-wide Contracts covering other Priority Areas in the Newtown Creek and Flushing Bay CSO tributary areas as well as Priority Areas within Jamaica Bay, Bronx River, and Hutchinson River CSO tributary areas. In 2012, DPR began actual construction in Flushing Bay and Bronx River, and will complete those projects in 2013. DDC and EDC will begin design this year.

As a first step in developing design and construction projects, DEP created the following specific site identification requirements for all right-of-way green infrastructure design services contracts, including those being managed by DEP's partner agencies.

**Potential** – Potential Bioswale and Greenstreets Locations are determined as follows:

1. Analyze the DEP GIS Sewer Map to find the gross tributary drainage area to existing downstream catch basins.
2. Take 30% of the gross tributary area which is determined to be the right-of-way impervious area.
3. Consultants will calculate the number of different types standard bioswales required to manage the one inch of stormwater runoff on the right-of-way impervious area for each catch basin.
4. The design team will locate as many different types of standard designs as possible to achieve this stormwater volume managed for each catch basin tributary area.

**Preliminary** – Once Potential Locations are identified, the design team shall complete the following steps to reclassify the sites as Preliminary:

1. Site walk-throughs with DEP, DPR, and DOT are required to confirm that existing conditions on the street and sidewalk will accommodate bioswales. For instance, sidewalk widths (DOT requires minimum pedestrian egress), driveways, and existing mature street trees.
2. Parks will specify tree species, tree guard, and planting scheme.
3. Parks will also note if a location would be a candidate for a Greenstreet.

ROWB Types	Calculated CF Capacity	Calculated SF Managed
Type I	300	3,600
Type II	225	2,700
Type III	150	1,800
Type I - Enhanced	400	4,800
Type II - Enhanced	300	3,600

Table 3: Calculated Right-of-way Bioswale Capacity (cubic feet) and Square Feet Managed

**Final** – Once Preliminary Locations are identified, the Consultant shall complete the following steps to reclassify the sites as Final:

1. Conduct Soil boring and permeability test per DEP's Procedures Governing Limited Geotechnical Investigations to determine if the subsoil would be favorable for bioswales or Greenstreets to function.
2. Those sites remaining after the walk-through and geotechnical explorations will require a topographical survey per DEP's Procedure Governing Limited Survey.

After review and approval of final locations by DEP, the design team shall develop 60% plans, 90% plans and final contract plans and prepare complete construction bid packages and submit to DEP for final review and approval, and then proceed with bidding.

### Public Onsite Retrofit Projects

Each green infrastructure retrofit project must manage the one-inch rainfall volume from the impervious area tributary to the installation(s). This design criterion is based on the 90th percentile storm for the New York City area, which is approximately 1.2 inches. Therefore, projects designed using this criterion will perform at capacity for 90% of storms that fall in New York City. This cost-effective approach allows DEP to fund retrofits while also achieving both water quality and other sustainability goals such as reducing the urban heat island effect, providing greening and shade, and community improvements.

In 2012, DEP reviewed designs for five sites with the Trust for Public Land and the New York City School Construction Authority (SCA). DEP and SCA are also identifying other opportunities within Priority Areas for green infrastructure retrofits. Eight schools have been identified for the next fiscal year.

DEP and NYCHA signed an agreement in 2012 to build green infrastructure on NYCHA properties in DEP's Priority Areas. DEP is currently designing green infrastructure installations for the Seth Low Houses and the Hope Gardens Houses in Brooklyn, and the Edenwald Houses in the Bronx. DEP and NYCHA may also identify other opportunities within the Gowanus and Flushing Bay Priority Areas.

In 2012, DEP worked with the DCA and DDC on a parking lot project for the Flushing Town Hall, a non-profit cultural institution in Queens. The project consisted of installing additional bioinfiltration to the parking lot design and bioswales adjacent to the parking lot.

Also in 2012, DEP worked with the HHC and the Kings County Hospital Center to design a green roof for its East New York Diagnostic and Treatment Center building. DEP and HHC are working to identify additional opportunities for green roof projects at other City-owned hospital facilities.

### Green Infrastructure Maintenance

Throughout 2012, DPR and DEP proceeded on development of the Green Infrastructure Maintenance Program per the maintenance agreement signed in 2011 establishing the maintenance roles and responsibilities concerning green infrastructure installation in the right-of-way. In the agreement, DEP agreed to fund dedicated maintenance crews to maintain Greenstreets and bioswales through January 2016. The agreement established that the DPR crews would provide maintenance for the vegetated areas including the plants, trees, and landscaped areas; DOT will maintain to the extent practicable the existing grades during milling and resurfacing operations when working around green infrastructure sites; and DEP will continue to maintain catch basins and other existing roadway drainage elements.

Over the next several years, DEP will continue to hire staff for dedicated green infrastructure maintenance crews who will be working under DPR to maintain the bioswales and Greenstreets. DEP hired the first crew of five in Brooklyn, an additional crew in Queens to begin later this year and the Bronx crew in 2014. As the agencies approve final sites through the Area-wide Contracts, DEP will continuously evaluate the maintenance capacity of the existing crews and will add crews in each borough as needed. DPR also added three positions to support their in-house design capacity for green infrastructure projects in 2012.

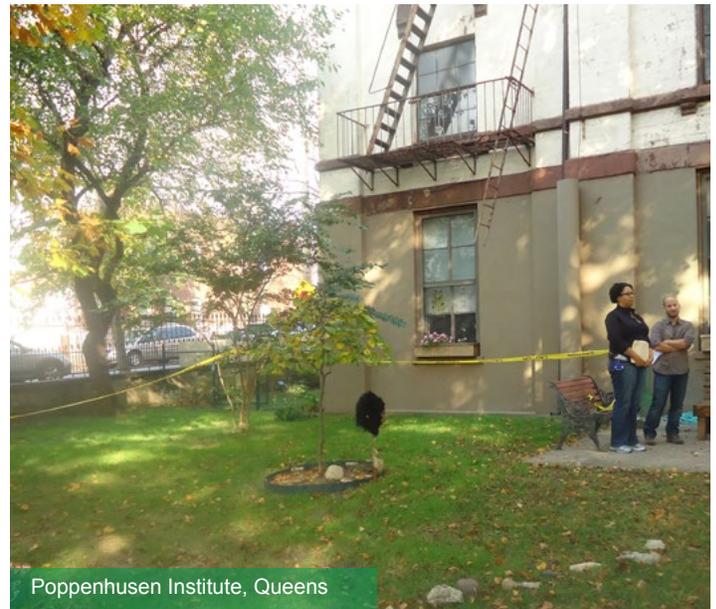
## Green Infrastructure Grant Program

The Green Infrastructure Grant Program has awarded approximately \$6.2 million to 18 private property owners to build green infrastructure projects in the combined sewer areas of New York City. Since its introduction in 2011, the Grant Program has sought to strengthen public-private partnerships and public engagement in regard to the design, construction and maintenance of green infrastructure.

For the 2011 grant cycle, DEP awarded \$3 million among 11 projects across four boroughs and three waterbodies. Projects included rooftop farms, permeable pavement, rain gardens, as well as green and blue roofs. Notably, the first completed Grant Program projects were the rooftop farm at Brooklyn Navy Yard and the rain garden-permeable pavement installation at Queens College, which were completed in summer 2012.

The Grant Program awarded over \$3 million to eight proposals for in the 2012 cycle. Projects are also spread across four boroughs, and include green roofs, rain gardens, porous pavement, and bioinfiltration. DEP hosts workshops throughout the City to equip applicants with the tools necessary to submit successful applications and works to improve the Grant Program each cycle by sending surveys to all applicants. DEP has expanded the Grant Program by announcing up to \$6 million available for the 2013 cycle.

The Order requires the extension of DEP's current Grant Program and a commitment to use a minimum of \$3 million of Environmental Benefits Program (EBP) funds<sup>1</sup> by 2015 to expand available grant funding for applicants. By the end of 2012, three grant projects were identified for EBP grant funds in the Bronx, Brooklyn, and Manhattan.



Poppenhusen Institute, Queens



Rooftop soil profile at Brooklyn Navy Yard



Commissioner Strickland speaking at the Queens College ribbon cutting ceremony

<sup>1</sup> This project was undertaken by DEP in connection with the settlement of an enforcement action taken by New York State and the New York State Department of Environmental Compliance for violations of New York State law and DEC regulations.

## Office of Green Infrastructure Program Costs

The Green Infrastructure Program has committed approximately \$23 million in capital funds to date and has budgeted over \$730 million to the Green Infrastructure Program over the next 10 years.

In the Order, DEP agreed to spend \$187 million on green infrastructure to show the agency's commitment toward mitigating CSOs using green practices. In addition, DEP set aside \$5 million as EBP funding, which equals the \$192 million commitment for green infrastructure by 2015. The Green Infrastructure Program will ramp up spending in the coming years to meet the commitments under the Order and will ultimately commit \$192 million by the end of 2015 (FY16).

Table 4 shows the FY12 and FY13 spending for the Green Infrastructure Program. The capital funding shown below are costs of design, construction management, and construction of green infrastructure program-wide for the last two fiscal years. This funding will support design, construction management, and construction for green infrastructure projects undertaken by DEP as well as agency partners, including the Area-wide Contracts with EDC, DDC, DPR and smaller projects with other agencies. Expense funding covers DEP's operational costs, such as maintenance of green infrastructure, as well as DEP's Rain Barrel Program.

While the program is still in its early stages, DEP is working to ensure that costs stay competitive and that economies of scale are realized for all contracts. Table 5 shows DEP's current estimated costs per bioswale. It should be noted that during the initial stages of Area-wide Contracts, DEP is conservatively requiring survey work and geotechnical investigations at most proposed green infrastructure locations. If needed, DEP will update these requirements

Average Costs for a Typical Right-of-way Bioswale	
Design	\$4,000
Surveys and Geotechnical	\$5,000
Construction	\$25,000
Construction Management (10% of Construction Costs)	\$2,500
<b>Total</b>	<b>\$36,500</b>

Table 5: Average costs for a typical Right-of-way Bioswale.

as well as design and construction practices to keep costs reasonable and to ensure that all green infrastructure projects will be functional over the long-term.

As previously described, the maintenance of right-of-way green infrastructure systems is currently governed by an interagency agreement between the DOT, DEP, and DPR, which established that green infrastructure will be maintained by dedicated DPR Green Infrastructure Maintenance Crews.

As final sites are approved through the Area-wide Contracts, DEP will continuously evaluate the maintenance capacity of the existing crews and will add crews per borough as needed. In order to estimate long term operations and maintenance costs, DEP and DPR are developing reasonable parameters as a basis including neighborhood context, vegetation establishment over time, streamlining tasks and frequencies, and accounting for site densities and clusters. These parameters will be analyzed regularly and revised as field experience increases.

DEP is also developing a state-of-the-art tracking and asset management system that will ensure all sites are maintained and functioning, and assist in the ongoing operations and maintenance (O&M) analyses. DPR and DEP are committed to on-going O&M evaluation to more accurately predict the costs and expenses of green infrastructure in the right-of-way going forward.

Program Summary	FY12	FY13	FY12 & FY13 Total
Capital	\$10,099,000	\$94,003,000	\$104,102,000
Expense	\$0	\$595,885	\$595,885
<b>TOTAL</b>	<b>\$10,099,000</b>	<b>\$94,598,885</b>	<b>\$104,697,885</b>

Capital Summary	FY12	FY13	FY12 & FY13 Total
Design	\$2,647,000	\$49,269,000	\$51,916,000
Construction/CM	\$7,452,000	\$44,734,000	\$52,186,000
<b>Total</b>	<b>\$10,099,000</b>	<b>\$94,003,000</b>	<b>\$104,102,000</b>

Expense Summary	FY12	FY13	FY12 & FY13 Total
DPR Green Infrastructure Maintenance Program	\$0	\$462,385	\$462,385
Rain Barrel Giveaway Program	\$0	\$133,500	\$133,500
<b>Total</b>	<b>\$0</b>	<b>\$595,885</b>	<b>\$595,885</b>

Table 4: Budgeted spending for FY12 and FY13.

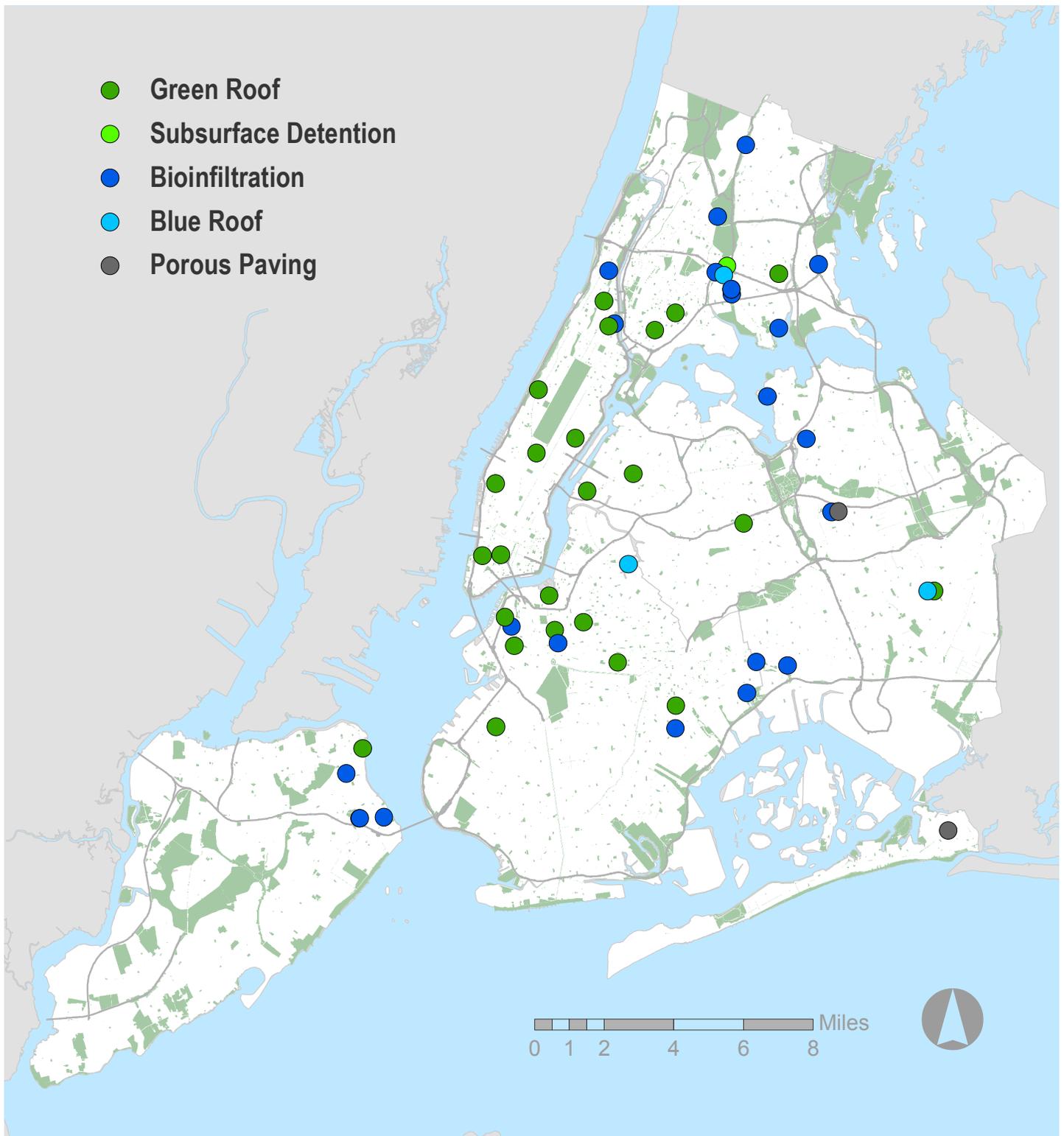


Figure 8: 2011 and 2012 built green infrastructure

Green Infrastructure Built and Designed as of April 30, 2013				
Waterbody	Acres Managed			Total Built and Designed Acres <sup>2</sup>
	2011 GI Built <sup>1</sup>	2012 GI Built <sup>1</sup>	2013 GI Designed <sup>2</sup>	
<b>Initial Phases</b>				
Bronx River	2.2	1.2	2.7	6.1
Flushing Bay	0.02	0.3	15.3	15.6
Flushing Creek		0.3		0.3
Gowanus Canal	0.6	0.5	0.7	1.8
Hutchinson River		1.8	14.8	16.6
Jamaica Bay & CSO Tributaries	3.8	5.1	1.9	10.8
Newtown Creek	0.5		5.3	5.8
Westchester Creek	0.06	0.1	0.6	0.8
<b>Total Waterbodies</b>	<b>7.2</b>	<b>9.3</b>	<b>41.3</b>	<b>57.7</b>
<b>Future Phases</b>				
<b>CITYWIDE (Total Waterbodies + East River &amp; Open Waters + Paerdegat Basin)</b>	<b>8.7</b>	<b>13.1</b>	<b>56.3</b>	<b>78.1</b>

Table 6: Built and Designed Green Infrastructure Implementation

1 Includes: change order projects, area-wide projects, pilots, demonstration projects, grants, onsite retrofits, green roof tax abatement, etc.

2 Based on completed designs (including grant projects) and public investments

## Built and Designed Green Infrastructure

Throughout 2011 and 2012, DEP has built and funded numerous green infrastructure projects throughout the City's combined sewer area, both onsite and in the right-of-way. In order to reach the citywide 10% goal, the agency has targeted projects in the Priority CSO Tributary Areas, or waterbodies, as defined under LTCP. Table 6 indicates the acreage necessary to meet this goal per waterbody, as well as the amount of impervious surface managed by green infrastructure to date and those planned for 2013.

The *built* columns for 2011 and 2012 show the area managed by completed green infrastructure projects in the right-of-way, including change order projects, Neighborhood Demonstration Areas, and public retrofits and Grant Program projects. The above table also includes the area managed by DEP's green infrastructure pilots as well as green roofs incentivized through the Green Roof Tax Abatement program and others built on private property. The *designed* 2013 projects have final design completed for construction to start in 2013. Those projects that are in various design stages at the date of this

report, including substantially completed designs, are not included in Table 6 but will be included in the next annual report. Additionally, the managed area included in the *designed* column for 2013 includes private properties affected by DEP's stormwater rule, which are tracked via permitted site connections through DEP's Bureau of Water and Sewer Operations.

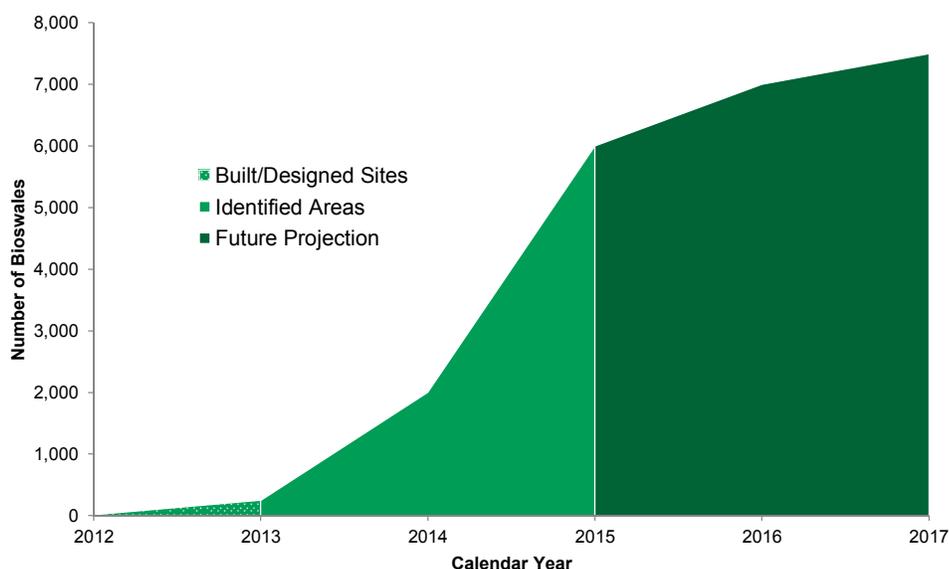


Figure 9: Right-of-way Bioswale construction targets.

In partnership with EDC, DDC, DPR, other agency partners, and on its own, DEP has initiated many area-wide green infrastructure projects in Priority CSO Tributary Areas. The final number of Right-of-way Bioswales to be constructed under these contracts is contingent upon meeting of OGI standards, specifications, and siting criteria



# Adaptive Management and Lessons Learned

Tree guard and native plants in a Right-of-way Bioswale

Since its inception in January 2011, DEP has progressed along the cost and learning curves associated with its Green Infrastructure Program. Reengineering stormwater management in New York City has posed serious challenges but has also led to significant opportunities and increasing gains. The decentralized and diverse nature of green infrastructure demands non-standard approaches to capital planning and streamlined processes to meet aggressive targets. As a result, DEP's program emphasizes the following strategies in the near term: Priority CSO Drainage Areas, area-wide design and construction, and pilot and demonstration project monitoring. As the implementation of Green Infrastructure Program progresses, DEP expects to take stock of lessons learned and modify the program accordingly to achieve cost-effective designs and installations, optimal performance over time, and overall water quality goals.

## Green Infrastructure Tracking

DEC has agreed to an adaptive management approach that allows DEP to propose alternative ways to meet its green infrastructure performance targets, and to account for any missed targets by changing its investment and design strategy to reflect current conditions. To establish the feedback loop necessary to adopt this approach, DEP has institutionalized tracking systems such as the Green Infrastructure Webmap, which has a public interface allowing people to search and enter green infrastructure projects online. DEP uses the Webmap to track a variety of onsite installations and encourages individual property owners installing green infrastructure on private property to add their information to the Webmap. DEP also updates the Webmap internally to

track other private projects as information is available, such as green roofs constructed by New York City Green Roof Tax Abatement recipients. DEP also tracks private properties affected by the stormwater performance standard at the time of site connection proposal certifications and issuance of a certificate of inspections once built. These private property owners must furnish proof of maintenance in the form of a certification by a licensed professional submitted to DEP every three years to comply with the performance standard. DEP will also track this information to ensure the performance of the retention and detention systems constructed in compliance with the performance standard over time.

DEP has developed an interim asset management system to track and monitor green infrastructure built in the right-of-way and as public retrofit and Grant Program projects throughout the City. DEP tracks all projects funded by the agency, including grant projects, bioswales, Greenstreets, and public retrofits through its asset management system and ultimately by the GIS-based Green Infrastructure Asset Management System currently under development. The asset management system will allow DEP to enter design, construction and maintenance information about each green infrastructure installation via Global Positioning System devices and map these projects via the Webmap application. DEP will review all tracking data annually to compare to estimated waterbody application rates presented in this annual report, and Pilot and Demonstration Project Monitoring data as collected. DEP will also compare tracked data to performance metrics to be developed based on future modeling in order to adjust the citywide implementation program as needed, and achieve the requirements of the Order.

# Case Studies

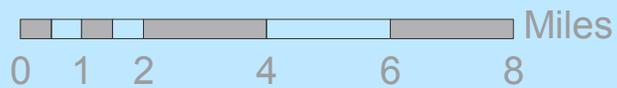
Brooklyn Navy Yard Rooftop Farm



Queens College Campus



26th Ward Demonstration Area



# Case Study: Brooklyn Navy Yard

The rooftop farm installation at the Brooklyn Navy Yard was the Grant Program's first and largest grant project completed to date. In June 2011, DEP awarded a \$592,730 grant to the Brooklyn Navy Yard to build a 43,000 square foot rooftop farm atop Building 3 in the Brooklyn Navy Yard. Construction began in May 2012 and was complete by August. The rooftop farm will prevent more than one million gallons of stormwater from entering the New York City sewer system each year and will help reduce CSOs to the East River.

The Brooklyn Navy Yard, formerly the largest shipbuilding facility in the U.S., is now home to a diverse array of businesses including movie studios, furniture manufacturers, ship repairers, architectural designers, electronics distributors and jewelers. Brooklyn Grange, who will manage the rooftop farm, is a commercial, urban farming business founded in 2010, and now has over two acres of rooftop under cultivation on two separate rooftops. The Navy Yard farm includes two flocks of egg-laying hens and a commercial apiary consisting of more than 30 bee hives.

The farm's 12-inch deep growing beds are comprised of a soil medium blended specifically for rooftop farming use. Brooklyn Grange expects an annual yield of 20,000 pounds of fresh produce. Crops include leafy greens, aromatic herbs, heirloom tomatoes and carrots. The farm is productive between April and November, and cover crops such as clover and vetch are planted in the winter to prevent soil erosion and replenish vital nutrients.

The farm will also provide several co-benefits to the Navy Yard itself, including increased ecological activity, local food production and job creation. Brooklyn Grange will also use the rooftop farm for community engagement by providing school groups, families and volunteers with opportunities to learn about the local food supply and participate in urban farming activities



Rooftop before farm installation



Rooftop farm after installation



Rooftop farm in production

# Case Study: Queens College

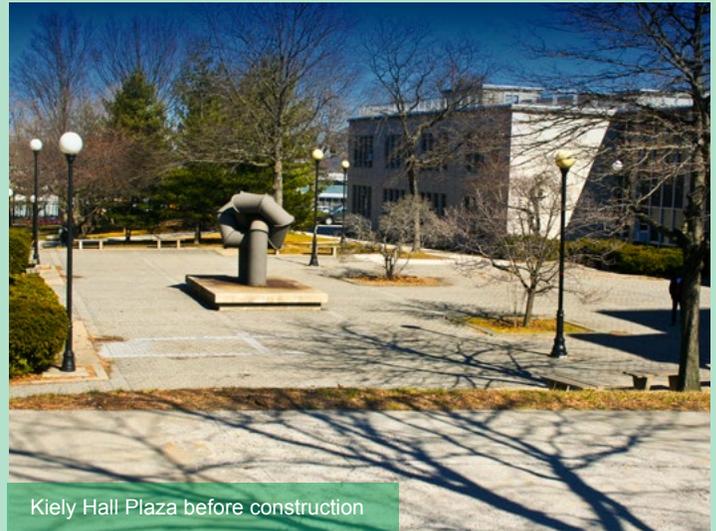
In October 2012, Queens College, a Green Infrastructure Grant Program grantee located in the Flushing Creek watershed, completed construction of three rain gardens and permeable paver projects on its campus. Construction lasted approximately 12 weeks and transformed three different plaza and public spaces into green infrastructure projects. In addition to DEP's \$386,000 award for the project, Queens College provided more than \$150,000 in matching funds. The newly installed permeable pavers, bioswales and rain gardens at Kiely Hall, Remsen Hall and the Rosenthal Library will manage stormwater runoff and keep an estimated 900,000 gallons of stormwater out of New York City's combined sewer system each year. The plazas also provide beautification and an educational opportunity for the campus community.

The project's designers, RDA Landscape Architects, worked to transform the three highly-trafficked pedestrian areas on campus with sustainable green infrastructure technologies. The permeable pavers and bioretention system have a storage capacity of nearly 48,000 gallons of stormwater and are managing runoff from over 33,000 square feet of impervious area. The system has already improved site drainage on campus while providing additional green space.

The Rosenthal Library promenade is a primary campus entrance, linking a parking area with the campus quad. The project replaced 9,645 square feet of impervious area with permeable pavers, new concrete pavement, trees, bioswales, and rain gardens. In addition to adding green infrastructure, the landscape design intent was to enhance the experience of arriving at the campus.

Kiely Hall is the College's administration building. The 11,400 square foot impervious courtyard space is located just off the main campus quad. The College's aim was to transform the space from a pass-through corridor to a gathering place, using permeable pavers, new trees, and rain gardens.

Finally, Remsen Hall Forecourt was an existing 4,700 square foot impervious parking lot and loading area separating the Remsen Hall entrance from the main quad. To create this pedestrian-oriented space, existing asphalt and concrete were replaced with permeable pavers and along with rain gardens and bioswales.



Kiely Hall Plaza before construction



Kiely Hall Plaza during construction



Kiely Hall Plaza after construction

# Case Study: 26<sup>th</sup> Ward

In December 2012, DEP completed construction on the first of three Neighborhood Demonstration Projects in East New York, Brooklyn (“Demonstration Area 2”). Demonstration Area 2 is comprised of a 23-acre area of a mixed use neighborhood with approximately 2,300 residents, and is characterized by residential buildings, industrial, manufacturing, transportation, and utility facilities. DEP constructed twenty-nine bioswales and two Greenstreets over a six-month period beginning in August 2012.

The project is designed to manage one inch of rain on 2.63 acres of the right-of-way within the Demonstration Area, which equates to approximately 7,563 cubic feet of stormwater. DEP estimates that the project will prevent nearly four million gallons of stormwater on average from reaching the combined sewer system each year. Since October 2011, DEP has collected continuous data of normal and peak flow levels in the combined sewer pipe before it exits Demonstration Area 2. Post-construction monitoring of the green infrastructure installations at Demonstration Area 2 began in January 2013. In addition to the flow meters in the sewers, five of the bioswales have piezometers and moisture sensors installed in order to measure performance on the site level. These two monitoring approaches will help DEP determine the amount of stormwater being managed by each bioswale as well as their cumulative benefits that will be measured by the flow meters in the sewer pipe.

DEP worked closely with the contractor on the Demonstration Area projects to communicate the key functions of the bioswale and Greenstreet, which differ significantly from traditional planting practices in the landscape industry. For example, the soil level in a traditional street tree pit is even with the surrounding sidewalk; in contrast, the planting bed of a bioswale is several inches below the sidewalk to allow the collection of stormwater. During construction of the first Demonstration Area projects, DEP and the contractor together discovered bioswale construction methods that will serve to increase productivity in the upcoming larger bioswale construction contracts. In order to install the distributed right-of-way green infrastructure practices in an efficient manner, the 31 installations in Demonstration Area 2 were constructed in clusters. These clusters were identified by the proximity of each bioswale on a block, overall distribution in the area, and street parking regulations. In each cluster, the contractor started with pavement and sidewalk removal, followed by concrete work for the curbs and sidewalk. Excavation and backfill were then followed by tree planting, placement of the tree guard, and finishing with perennials and mulch.

In addition to providing performance monitoring data, Demonstration Area 2 will also allow DEP to demonstrate and study the operation and maintenance of right-of-way green infrastructure. DPR’s Greenstreets maintenance crews visit

each installation weekly, and perform routine and seasonal tasks year round to keep the bioswales and Greenstreets functioning as designed. Typical tasks include litter and leaf removal, weeding, and plant care.

In 2012, DEP completed designs for an onsite green infrastructure project at the New York City Housing Authority’s Seth Low Houses, which is also within Demonstration Area 2. The planned permeable pavement and subsurface detention system in the Seth Low development will also manage stormwater and supplement the overall volume managed by the right-of-way green infrastructure.

DEP will continue to conduct community outreach in the 26th Ward Demonstration Area. Office of Green Infrastructure staff has given multiple presentations to the Community Board, the City Council Member, and the East Brooklyn Business Improvement District. Over 1,500 postcards were sent to mailing addresses within the area to notify the community about the construction. DEP will host a stewardship workshop with MillionTreesNYC and NYCHA this spring to educate and train the community in environmental stewardship.



Right-of-way Bioswale construction, Junius St. and Liberty Ave., Brooklyn



Right-of-way Bioswale tree planting, Junius St and Glenmore Ave., Brooklyn

# 2013 Action Plan

Building on the progress made in 2012, DEP will implement the following programs and activities in 2013, in addition to ongoing outreach and program management for Area-wide Contracts, public retrofits, the Grant Program, and the designed projects in table 6.

**1** DEP will reinstate the Rain Barrel Giveaway Program and will make educational and informational materials available on the DEP website.

**2** DEP will create standard informational placards for the green infrastructure projects built in the right-of-way to educate and engage the public as well as to provide unique identification system for each site. This will provide multiple benefits as DEP builds its O&M Program.

**3** DEP will develop a Tracking and Asset Management System to track, manage, and maintain all of the Green Infrastructure Program's decentralized system of green infrastructure assets.

**4** DEP will continue a Research and Development Program to monitor the performance of built green infrastructure projects, and employ the data to adapt existing green infrastructure designs and modeling for CSO tributary areas.

**5** BioswaleCare, a stewardship program in partnership with MillionTreesNYC, will kick-off in March 2013 with workshops beginning shortly thereafter.

**6** DEP continues to explore opportunities to partner with other City agencies related to Hurricane Sandy recovery initiatives. Currently, DEP and DOT are jointly assessing locations to build out green infrastructure in City streets affected by the storm.

**7** DEP will to work with DOB, DOF and Law to modify the Rules of the City of New York to extend and enhance the Green Roof Tax Abatement.

**8** DEP will hire a Green Roof Technical Advisor to assist in the Green Roof Tax Abatement application process and educate prospective applicants.

**9** DEP will hire additional staff in 2013 to support broader implementation of the Green Infrastructure Program.

**10** DEP will continue to design and implement green infrastructure projects towards waterbody-specific application rates.

# Area-wide Contracts for Priority CSO Tributary Areas

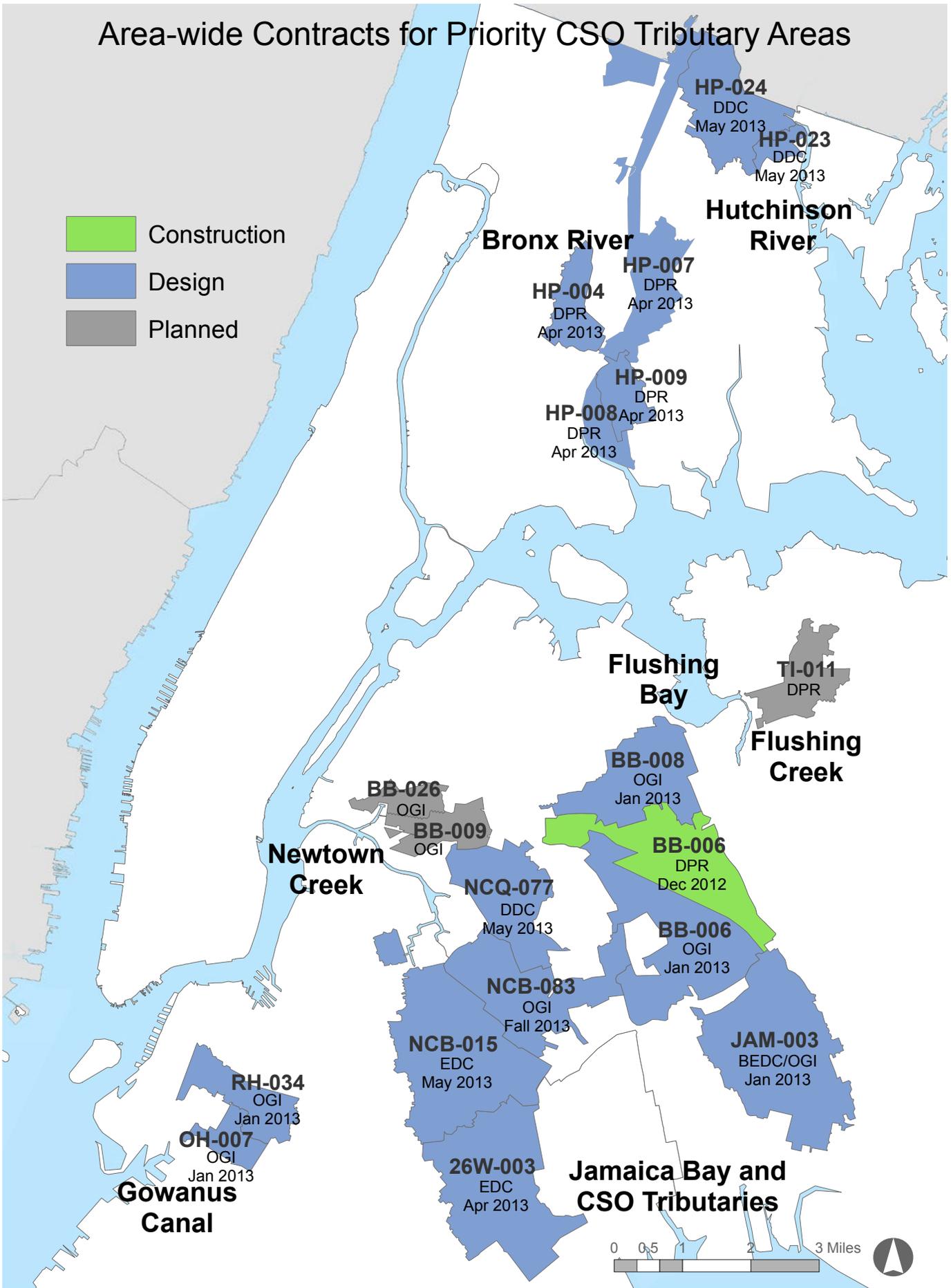


Figure 11: 2013 Area-wide Contracts, implementing agencies, and start dates.



# List of Acronyms

<b>Bioswale</b>	<b>Right-of-way Bioswale</b>
<b>CFS</b>	<b>Cubic Feet per Second</b>
<b>CSIA</b>	<b>Combined Sewer Impervious Area</b>
<b>CSO</b>	<b>Combined Sewer Overflow</b>
<b>CWA</b>	<b>Clean Water Act</b>
<b>DCA</b>	<b>New York City Department of Cultural Affairs</b>
<b>DDC</b>	<b>New York City Department of Design and Construction</b>
<b>DEC</b>	<b>New York State Department of Environmental Conservation</b>
<b>DEP</b>	<b>Department of Environmental Protection</b>
<b>DOB</b>	<b>New York City Department of Buildings</b>
<b>DOE</b>	<b>New York City Department of Education</b>
<b>DOF</b>	<b>New York City Department of Finance</b>
<b>DOT</b>	<b>New York City Department of Transit</b>
<b>DPR</b>	<b>New York City Department of Parks and Recreation</b>
<b>DSNY</b>	<b>New York City Department of Sanitation</b>
<b>EAS</b>	<b>Environmental Assessment Statement</b>
<b>EBP</b>	<b>Environmental Benefit Project</b>
<b>EDC</b>	<b>New York City Economic Development Corporation</b>
<b>EPA</b>	<b>U.S. Environmental Protection Agency</b>
<b>GIS</b>	<b>Geographical Information System</b>
<b>Greenstreets</b>	<b>Stormwater Greenstreets</b>
<b>HHC</b>	<b>New York City Health and Hospitals Corporation</b>
<b>HLSS</b>	<b>High Level Storm Sewers</b>
<b>HPD</b>	<b>New York City Department of Housing Preservation and Development</b>
<b>LTCP</b>	<b>Long Term Control Plan</b>
<b>NYCHA</b>	<b>New York City Housing Authority</b>
<b>O&amp;M</b>	<b>Operations and Maintenance</b>
<b>OGI</b>	<b>Office of Green Infrastructure</b>
<b>OLTPS</b>	<b>Office of Long Term Planning and Sustainability</b>
<b>OMB</b>	<b>Office of Management and Budget</b>
<b>Order</b>	<b>CSO Modified Consent Order</b>
<b>Priority Area</b>	<b>Priority CSO Tributary Area</b>
<b>ROW</b>	<b>Right-of-Way</b>
<b>SCA</b>	<b>New York City School Construction Authority</b>
<b>Task Force</b>	<b>Green Infrastructure Task Force</b>



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