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1 INTRODUCTION
Thousands of right-of-way bioswales will be constructed all over New York City over the next few years. By 2030, DEP plans to install about 8,000 bioswales across New York City.

Most passersby will recognize them as beautiful new curbside gardens or enhanced tree pits. However, these specially engineered gardens also serve as critical pieces of city infrastructure that manage stormwater and reduce the 27 billion gallons of combined sewage overflow that pollute NYC waterways each year.

The NYC Department of Environmental Protection (DEP) maintains bioswales. Similar to street trees and public parks, bioswales will require more support from a dedicated corps of volunteers to fill the gaps in the maintenance and care that is provided by the city. At this point, however, bioswales cannot be maintained by volunteers without a specific agreement with DEP.

This manual is a resource for anyone interested in how bioswales work. The bioswale maintenance section of this guide provides instruction on how to care for bioswales in the field. It is to be used in conjunction with a curriculum that was developed by Gowanus Canal Conservancy and Trees New York during a 3-year pilot course from 2015 through 2017. If you use or adapt these materials, please credit the Gowanus Canal Conservancy and Trees New York as the authors.

About the Authors:
The Gowanus Canal Conservancy is a community-based non-profit organization that serves as the environmental steward for the Gowanus Canal Watershed. We envision the evolution of an Open, Clean and Alive Gowanus Canal and Watershed with accessible, connective open space, clean water, soil and air; and vibrant ecological, business and cultural activity.

Trees New York was founded in 1976 as a volunteer response to New York City’s devastating cutbacks in forestry and tree-related community services. Trees New York has 40 years of experience in community tree planting, stewardship and education projects. Since its founding, Trees New York has trained over 12,500 Citizen Pruners and 8,000 youth in tree care and stewardship. Since 2005, Trees New York has planted over 5,000 trees in underserved communities throughout New York City.

This project is made possible by funding from the U.S. Forest Service and the National Fish & Wildlife Foundation.

Gowanus Canal Conservancy | Trees New York
Every year it rains more than the sewer system alone can handle.

NYC receives about 45-50 inches of rainfall and snowfall every year, an amount expected to increase though climate change in the coming years. In areas with permeable, soft, or porous surfaces like parks and beaches, rainwater is absorbed into the ground. Ground water can be accessed by plant roots or percolate down to the water table.

However, much of the land in NYC is covered with impermeable surfaces like concrete and asphalt that do not allow stormwater to pass through. Water “runs off” these surfaces into sewer drains or directly into waterways. Impermeable surfaces include rooftops, streets, and sidewalks, which make up about 72% of the city’s surface area. Rain that falls on impermeable surfaces carries litter and pollutants in its path to storm drains and into underground sewer pipes.

Most water in cities enters the sewer system via storm drains at each street intersection. In NYC these drains are part of 14 water catchment areas, each one carrying our sewage and stormwater to a water treatment plant.

Who keeps NYC water clean?

The NYC Department of Environmental Protection is primarily responsible for providing drinking water, and cleaning wastewater in NYC. The U.S. Environmental Protection Agency (EPA) and NYS Department of Environmental Conservation (DEC) both regulate water quality. For more information about how NYC manages drinking water, waste water and stormwater, see www.nyc.gov/dep.
URBAN WATERSHEDS = WATER + SEWERS

In order to grapple with the problem of rainwater management, it is helpful to understand the big picture about the water cycle and how cities fit into it.

Think about areas of land as watersheds. Watershed boundaries are created by ridge lines (high points in the land), which make a basin or bowl-shape. All water and snowmelt that falls in the basin either percolates into the ground or drains to the lowest point of the basin to a waterbody, such as a river, lake or stream. From there, water evaporates into the atmosphere, or, if it was absorbed into the ground, transpires through plant leaves, and eventually falls again as precipitation. This is the water cycle. Cities have watersheds too, but instead of getting absorbed into the ground most stormwater enters the sewer system.
WASTEWATER TREATMENT MAP

Wastewater Treatment Plants

Wastewater Catchment Treatment Areas:
- North River
- Wards Island
- Hunt’s Point
- Newtown Creek
- Tallmans Island
- Bowery Bay
- Red Hook
- Jamaika
- 26th Ward
- Coney Island
- Owls Head
- Rockaway
- Port Richmond
- Oakwood Beach

In NYC stormwater travels through 6,000 miles of underground pipes and gets pumped to one of the 14 water treatment plants in the city. At a treatment plant, the water gets “scrubbed” — of litter and pollutants left by oil, road salt, dog poop and other chemicals that washed off our streets. After the wastewater is cleaned, it is released into adjacent waterbodies.
COMBINED SEWER OVERFLOW

On any one day, NYC cleans 1.3 billion gallons of wastewater, including stormwater and sewage. At a certain point the sewer pipes reach capacity, and the excess sewage and stormwater discharges into NYC’s rivers, beaches and wetlands. This is called Combined Sewage Overflow (CSO).

CSO occurs because of the way the sewer system was constructed over 100 years ago. The same sewer pipes that are carrying stormwater also carry dirty wastewater (from toilets, sinks and drains) from NYC’s 8 million residents. Pipes that combine wastewater and stormwater is called a Combined Sewer System. This item was designed to prevent back ups of sewage in our streets and homes.

In New York City, 27 billion gallons of polluted runoff, and human and industrial waste enter NYC waterways each year from Combined Sewage Overflow (CSO). Nearly every waterway in NYC is polluted by CSOs, including the Hudson River, East River, and Jamaica Bay.

What seemed like the right engineering solution when the sewer system was constructed has grown into a significant water quality problem in NYC. Imagine the harmful impact that billions of gallons of polluted water has on our city’s water health, marine plants and animals, and recreation activities such as swimming, fishing and boating.

Combined Sewage Outfalls Points (CSO Points)

During storms, polluted water from combined sewers overflow at the 494 outfall points located along NYC waterways. You have probably seen these green signs at the city's beaches, rivers and creeks, which indicate a CSO Outfall.

CAUTION

Wet Weather Discharge Point
This outfall may discharge rainwater mixed with untreated sewage during or following rainfall and can contain bacteria that can cause illness.

If you see a discharge during dry weather:
• Please call 311 - Refer to CSO Outfall NMCB-010
• For more information visit www.nyc.gov
• Or contact the New York State Department of Environmental Conservation Division of Water Resources Office
47-45 21st St, Long Island City NY 11101
718-560-4800
• New York State Wet Weather Discharge point
• SPDES Permit # NY 3028201

CSO sign at outfall
COMBINED SEWAGE OVERFLOW

1. **Residential and industrial sewage:**
   On a daily basis, wastewater flows into the sewage system to local water reclamation plants for treatment.

2. **Treatment plant:**
   After sewage has been treated, it’s released into our rivers and waterways.

3. **Stormwater:**
   During heavy rain events, the sewage system is overloaded.

4. **Sewage overflow:**
   Combined Sewer Overflow is triggered when more stormwater runs off streets and other impermeable surfaces than the sewer system can handle.

**Dry Day conditions:**
Sewage is directed to the local treatment plant and clean water is released.
NYC CSO-SHED MAP

In NYC there are three types of sewer systems that carry rain water and wastewater (wastewater from toilet and sink drains):

**Combined Sewer Areas:** Sewage and stormwater runoff from streets are carried in the same pipe system to a wastewater treatment plant. Excess untreated water, or combined sewage overflows into waterbodies during rain storms. About 60% of NYC sewers are combined.

**Separated Sewer Areas:** Two sewer pipes convey stormwater and sewage separately. Stormwater is released into local water bodies, while sewage travels to a wastewater treatment plant. Stormwater runoff does not get cleaned, but sewage stays out of waterbodies.

**Unsewered Areas:** There are no sewer pipes to carry stormwater. It is absorbed into the ground or runs off directly into water bodies. Sanitary sewage travels to the water treatment plant in sewer pipes.

**Combined Sewage Overflow Outfall Points**
What’s in CSOs?

1. Contaminants from street runoff: oil, road salt, animal feces, litter, fertilizers, petroleum, hydrocarbons, and other toxic metals.

2. Contaminants from wastewater: cooking oils, human feces, detergents, pharmaceuticals, dyes, bleach, and anything else poured down residential, commercial or industrial drains.

What’s the impact of CSOs?

Contaminants can cause excess nutrient levels and decreased oxygen in waterbodies, both of which worsen marine habitat conditions. They can create cloudy or turbid water, which blocks sunlight needed for marine plant photosynthesis. Polluted sediment can build up on the bottom of stream and river floors, which decreases habitat.

Some affected waterways are wetlands and salt marshes that are home to diverse populations of wildlife and plants. Others are industrial, such as the Gowanus Canal and Newtown Creek, which, on top of CSOs, have significant levels of historical pollution from factories that dumped waste over 100 years ago. Even polluted waterways are used for recreation by the public — but better water quality would allow people to use waterways more for swimming, fishing and boating.
PRIORITY WATERWAYS IN NYC

New York City has identified waterways in violation of the Clean Water Act.

The CSO-sheds, or drainage areas, feeding into these eight waterways are critical areas where we need to absorb storm water before it enters the sewer system and causes sewage overflow. The largest CSO shed in NYC is the Newtown Creek CSO-shed. The Newtown Creek Wastewater Treatment Plant cleans water from over 1,000,000 people and 25 square miles across neighborhoods in Brooklyn, Queens and Manhattan.
NYC Priority CSO-Shed Map

Resources for learning more about CSO-sheds:
✓ Open Sewer Atlas NYC: openseweratlas.tumblr.com
✓ Printable Maps of some NYC CSO-sheds
  http://openseweratlas.tumblr.com/resources
✓ “A Citizen’s Guide to the Sewershed”
Reducing CSOs in these waterways will:

- Reduce ‘floatables’ - litter and debris from streets, drains and toilets.

- Reduce noxious odors that occur during CSOs.

- Reduce suspended sediment in the water, allowing more sunlight to pass through for photosynthesis.

- Improve plant and animal biodiversity by reducing harmful nutrients and increasing oxygen levels in the water.

- Create healthier conditions for recreational activities.
Solving the CSO problem

The next time you walk around your neighborhood, look for high points in the land to see which way rain water flows and the amount of impermeable surface area. What do you observe that may contribute to sewage overflow? A lot of litter on the streets that may clog storm drains? Oil? Dog poop? Road salt? How much water runs off hard surfaces, and how much do gardens, planters or tree pits absorb? What about your own household? What kind of toxins might be going down your drains? How much water do you use when it is raining through activities like flushing the toilet, washing dishes, taking a shower, or doing laundry? Think about how you can reduce the amount of sewage overflow from your own CSO-shed.

Personal water use worksheet

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>ESTIMATED AMOUNT OF WATER USED (GAL)</th>
<th># OF TIMES PER DAY YOU DO THIS ACTIVITY</th>
<th>TOTAL WATER USED PER ACTIVITY (GAL)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Washing face or hands</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking a shower</td>
<td>50</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Taking a bath</td>
<td>40</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brushing teeth (water running)</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brushing teeth (water turned off)</td>
<td>0.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flushing the toilet (older model toilet)*</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flushing the toilet (low flow toilet)*</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooking a meal</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Washing dishes by hand</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running a dishwasher</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Doing a load of laundry**</td>
<td>30</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

TOTAL DAILY WATER USE (GAL):

\[ \times 365 = \text{TOTAL YEARLY WATER USE (GAL)} \]
3 WHAT IS GREEN INFRASTRUCTURE?

FEDERAL: 1972 - Clean Water Act

STATE: 2005 - Consent Order to NYC to improve Water Quality
2011 - Modifications to Consent Order to include Green Infrastructure

CITY: 2010 - Green Infrastructure Plan, 2013 - 17 Long Term Control Plans
Reducing CSOs and achieving better water quality will take a major public investment in updating our city infrastructure.

The NYC Department of Environmental Protection (DEP) is working to reduce CSOs through the NYC Green Infrastructure Plan, laying out a system of green and grey infrastructure to better manage stormwater within the Priority CSO-sheds. The plan consists of various techniques described on the following pages, to be installed in priority CSO-sheds between now and 2030. Thousands of projects will take place on public and private land, including streets, parks, playgrounds, public housing, libraries and parking lots.

According to DEP, green infrastructure techniques “use or mimic natural systems to manage urban stormwater runoff.” Types of green and grey infrastructure that are part of the plan include: rain gardens, bioswales, permeable pavement, underground tanks, permeable athletic turf, green roofs, blue roofs and rain barrels. These techniques keep stormwater out of the sewer system or slow the rate at which it enters the system, both of which reduce combined sewage overflows. DEP calculates that collectively these strategies will reduce CSO volumes from 27 billion gallons a year to approximately 17.9 billion gallons a year.

DEP expects to invest more than 1 billion dollars to construct green and grey infrastructure across the five boroughs. The costs for these projects are covered by the public water rates that water users pay in NYC.

WHERE DID THE NYC GREEN INFRASTRUCTURE PLAN COME FROM?

In 2005 the New York State Department of Environmental Conservation (DEC) ordered NYC to decrease the amount of CSOs released into waterbodies with low water quality, through regulations coming from the 1972 Federal Clean Water Act. In 2011 DEC ordered NYC to use Green Infrastructure (GI) as a strategy to reduce CSOs.

Read more about DEP’s Green Infrastructure Plan:
ROOFTOP STORMWATER MANAGEMENT

The techniques on these pages reduce CSOs through **detention** or **retention**.

**Detention:** Rain Barrels, Blue Roofs, and Cisterns store water temporarily during storms, and slowly release it after the storm. This water is then used to irrigate, allowed to percolate into the soil, or is directed into sewers when there is room in the system.

**Retention:** Bioswales, Rain Gardens, Blue Belts and areas with Permeable Paving retain water on a more permanent basis. Rainfall is absorbed into soil or gravel layers, taken in through plant roots, or percolates into ground water, never entering the sewer system.

1. **Rain Barrel:** Rain Barrels are containers that collect water, often from a roof gutter, and hold it to be used when weather is dry.

2. **Green Roof:** Green Roofs are rooftop gardens that collect rain, to be absorbed by plant roots. They can also cool buildings by reflecting UV radiation, reduce air and noise pollution, and provide habitat for insects and birds.

3. **Blue Roof:** Blue Roofs collect rain on rooftops to gradually release to the sewer system or to evaporate.
GROUND LEVEL STORMWATER MANAGEMENT

4 Rain Garden:
Rain Gardens are sunken planted areas that collect rain and runoff, to be absorbed by plant roots or to percolate into groundwater. They can also provide shade, reduce air and noise pollution, and provide habitat for insects and birds.

5 Permeable Pavers:
Permeable Pavers are pavers with tiny holes that water can percolate through.

6 Rain Cistern:
Rain Cisterns are large underground tanks that hold water, to be used when weather is dry.

7 Bioswale:
Bioswales are curbside rain gardens that collect rain and runoff from the street, to be absorbed by plant roots or to percolate into groundwater. They can also provide shade, reduce air and noise pollution, and provide habitat for insects and birds.

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GREY INFRASTRUCTURE UPGRADES

As part of the GI plan, NYC will also construct upgrades to Grey Infrastructure. Grey infrastructure describes pipe and sewer techniques, and other traditional practices for stormwater management and wastewater treatment.

Improvements include:

High Level Storm Sewers
These large pipes capture stormwater rainfall before it enters the combined sewer pipes. This water is then diverted directly into the waterways through permitted outlets, reducing the volume of flows that pass through the treatment plants and the combined sewer system.
Separated Sewers

Sewage and stormwater runoff are channeled in separate sewer systems: sewage is carried to wastewater treatment plants while stormwater is channeled directly to local streams, rivers, and bays.

CSO Storage Facility

These enormous tanks are installed near a CSO outlet to temporarily hold the material instead of releasing it. Once the storm passes, and there is room in the sewer system and the wastewater treatment plants, the material is pumped back into the system.
4 BIOSWALES: HOW DO THEY WORK?
STREET DRAINAGE

Roads are built to drain. Every impermeable road has at least a slight slope along its length and width, to move water to a drain or a permeable surface.

In NYC, the high point (crown) of the road is down the center. A catch basin covered with a sewer grate is at the low point, generally next to the curb. Stormwater runs along the curb to the catch basin. In a combined sewer system, the catch basin connects to the sewage system, and brings this water to the treatment plant.

A bioswale intercepts stormwater before it reaches the catch basin. The typical DEP 20'x5' bioswale can hold roughly 2,250 gal of stormwater during a storm. Any additional stormwater is let back into the sewer system.

Numerous bioswales across a watershed can keep a significant amount of stormwater out of the combined sewage system, which helps to reduce the sewage from overflowing into our waterways.
BIOSWALE COMPONENTS

A bioswale is like a machine. Every piece needs to function for the system to capture and filter stormwater. There are four basic parts to a bioswale “machine“:

1. Protection and Interpretation:
   - Tree Guards and signage protect the bioswale and educate the passerby.

2. Organic Components:
   - Plants absorb stormwater through roots, while the remaining water percolates through soil.

3. Impermeable Hardscape:
   - Concrete forms the bones of the bioswale and directs stormwater into retention areas.

4. Permeable Hardscape:
   - Stone Layers detain stormwater in pores between particles, while geotextile fabric filters sediment from stormwater.
Protection and Signage:
Tree Guards and Signage improve the long-term performance of bioswales by educating passerby.

Interpretive Signs
explain the purpose of bioswales.

3 Sided Guards
protect bioswales from trampling, while letting stormwater run off the sidewalks into bioswale.
Organic Components:

Plants absorb stormwater through their roots, the remaining water percolates through soil.

A typical street tree intercepts 197 gallons of rainwater annually.

Bioswale soil is specifically engineered with a high sand content to hold a lot of water. The soil is distributed with a low space point at the center of the swale, which allows water to pause and infiltrate.

Plants absorb water through their roots, and release it into the air through transpiration. Bioswales include a range of plants that can handle varying dry and wet conditions. See page 35 for plants used in DEP bioswales.
Impermeable Hardscape:

Concrete forms the bones of the bioswale and directs stormwater into retention areas.

A curb cut inlet lets water into the bioswale. It is a cut in the curb at street level, slightly sloping towards the bioswale.

A header curb separates the bioswale from the sidewalk and the street. It holds water and soil in the bioswale.

A curb cut outlet lets excess water out of the bioswale. It is a cut in the curb at street level, slightly sloping towards the street.
Permeable Hardscape:

**Stone Layers** detain stormwater in pores between particles, while **Geotextile Fabric** filters sediment from stormwater.

1. **Geotextile fabric** is a specially designed fabric that is wrapped around stone layers. It keeps sediment from clogging stone layers, maintaining the stone layer’s water-holding capacity.

2. **Stone Layers** containing gravel or small stones detain stormwater in air pockets between the stones, before the water percolates into the soil or is absorbed by plant roots. Specific types of stone layers vary among bioswales, depending on the infiltration capacity of the ground below.
BENEFITS OF BIOSWALES

Across the watershed, bioswales can make a big difference in diverting stormwater from the sewer system, and reducing the frequency and severity of flooding. In addition, bioswales can provide multiple co-benefits:

**Reduced Temperatures and Energy Use:** Bioswale plants absorb carbon dioxide (CO2), a heat trapping gas, thereby reducing ambient temperatures. Annually, a newly planted bioswale tree intercepts 30 lbs of CO2, and that amount grows to 110 pounds over a three-year span (Trees New York). This helps reduce the urban heat island effect, lowering the need for air conditioner usage and reducing overall electricity usage. (Center for Neighborhood Technology 2010)

**Enhanced Habitat:** Bioswale plants provide additional habitat for pollinators such as birds, butterflies, bees, and other beneficial insects.

**Increased Property Values:** Property values in urban spaces increase an average of 3.5% when green infrastructure is built. (Center for Neighborhood Technology 2010)

**Improved Streetscape Aesthetics:** Bioswales can improve quality of life through street beautification, decreased noise pollution, improved air quality, and increased outdoor recreation.

**Green Jobs:** Engineers, landscape architects, scientists, and horticulturists are needed to design, build, maintain and monitor bioswales throughout their lifetime.
SITING A BIOSWALE

How does DEP decide where to put bioswales? Areas where CSOs are in violation of the Clean Water Act. The volume targeted of rainwater to capture in each sewer catchment area is calculated according to the surface area and a typical rainfall.

Based on the joint DEP and DOT guidelines, locations are selected. The guidelines not only focus on the priorities to achieve Clean Water Act goals, but also urban factors like distances to door ways, transportation routes, trees, driveways, property lines, and foundation lines. Once the potential sites are selected, infiltration tests are completed with a drill rig and sites without sufficient infiltration are ruled out. Then surveys are done for the remaining sites to determine if there are utilities that eliminate more sites. Finally, the remaining sites are built.

CONSTRUCTING A BIOSWALE

Source: DEP

Contractor paints the length and width of the sidewalk.

Sidewalk and curb are removed. Material is excavated to 5' depth.

Bioswale is backfilled with stone and wrapped in geotextile fabric.

Utility lines are fitted with a protective sleeve.

A new curb is installed with an inlet and outlet.

Soil is installed and graded with a low point in the center.

A steel tree guard is installed.

Plants and trees are installed.
PLANT PALETTES

DEP and the Department of Parks and Recreation have worked together to develop a suite of planting plans for bioswales. The shrubs and perennials included in these plans have been tested for longevity, tolerance of very dry or very wet conditions, and aesthetic performance on the streetscape. There are 8 different plant palettes, for varying light, moisture and traffic conditions. See Appendices for Plant Keys.

Especially Wet
Rows with less than 30% stormwater runoff managed.

Especially Dry
Rows with less than 15% stormwater runoff managed.

Pennisetum alopecuroides ‘Hameln’  Fountain Grass
Panicum virgatum ‘shenandoah’  Switch grass
Acorus calamus ‘Variegatus’  Sweetflag
Hemerocallis ‘Lady Florence’  Daylily

Brunnera macrophylla ‘Jack Frost’  Siberian bugloss
Alchemilla mollis  Lady’s mantle
Iris versicolor  Blue flag
Panicum virgatum ‘shenandoah’  Switch grass
Acorus calamus ‘Variegatus’  Sweetflag
Hemerocallis ‘Lady Florence’  Daylily
Residential Plans with low volume circulation.

- **lex glabra “Shamrock”** - Inkberry
- **Rosa ‘Radrazz’** - Knock Out Shrub Rose
- **Coreopsis ‘Redshift’** - Tickseed
- **Nepeta x faassenii ‘Walker’s Low’** - Catmint
- **Liriope spicata** - Lily turf
- **Liriope muscari ‘Monroe White’** - Lily turf
- **Acorus calamus ‘Variegatus’** - Sweetflag
- **Rudbeckia subtomentosa ‘Henry Eilers’** - Sweet Coneflower
- **Echinacea purpurea ‘Kim’s Knee-High’** - Purple Coneflower
- **Cotula anfoxia ‘Hummingbird’** - Sweet Pepperbush
- **Acanthus mollis** - Swamp Rose
Especially Shady
Rows with partly sunny or shady light conditions:

Urban/Commercial and Industrial Plans
with higher volume circulation:

* Ilex glabra 'Shamrock'
  * Inkberry

* Clethra alnifolia 'Hummingbird'
  * Sweet Pepperbush

* Carex 'Ice Dance'
  * Sedge

* Hakonechloa macra 'All Gold'
  * Japanese Forest Grass

* Astilbe 'Deutschland'
  * Astilbe

* Astilbe chinensis 'Vision in Red'
  * Chinese astilbe

* Ajuga reptans 'Catlin's Giant'
  * Bugleweed

* Rosa palustris
  * Swamp Rose

* Hibiscus moscheutos 'Luna Pink'
  * Hardy Hibiscus

* Rudbeckia subtomentosa 'Henry Eilers'
  * Sweet Coneflower

* Pennisetum alopecuroides 'Little Bunny'
  * Fountain Grass

* Carex 'Ice Dance'
  * Sedge
Residential Plans

with higher volume circulation.

Ilex glabra ‘Shamrock’
Inkberry

Echinacea simulata
Glade purple conflower

Rudbeckia fulgida ‘Goldsturm’
Black-eyed Susan

Pennisetum alopecuroides ‘Hameln’
Fountain Grass

Chasmanthium latifolium
Northern Sea Oats

Panicum virgatum ‘Heavy Metal’
Switchgrass

Coreopsis ‘Redshift’
Tickseed

Nepeta ×faassenii ‘Walker’s Low’
Catmint

Hylotelephium ‘Vera Jameson’
Stonecrop

Hemerocallis ‘Scarlet Oak’
Daylily

Helictotrichon sempervirens
Blue oat grass

Chasmanthium latifolium
Northern Sea Oats

Panicum virgatum ‘Heavy Metal’
Switchgrass
5 PLANT IDENTIFICATION
Want to know more about perennials and weeds you might find in the bioswales?

**LEAF CONFIGURATIONS**

- **Leaflet**
- **Rachis**
- **Petiole**

- **Opposite**
- **Sub opposite**

- **Alternate**
- **Whorled**

**COMPOUND LEAVES**

- **Palmatisect**
- **Palmate**
- **Odd-pinnate**
- **Even-pinnate**
- **Trifoliate**
SIMPLE LEAVES

Entire

Lobed

Serrate

MONOCOT LEAVES

Grass
Sedge
Rush

A simple strategy to distinguish between the three different types of grassy plants, or monocots, is to look at the stem and leaf. Grasses have flat leaves, sedges have triangular leaves, and rushes have round leaves. This rhyme might help you remember: “Sedges have edges, rushes are round, and grasses are hollow from tip to the ground.”

On the following pages you’ll find a range of ID cards of common weeds, and typical perennials used, based on the list from the Department of Environmental Protection. Feel free to cut them out, and take them with you while working in the bioswales. For extra protection, sandwich a page of ID cards between two layers of contact paper, and then cut out the individual cards.

Bioswale plants
Common weeds
**BLACK MEDIC**
*Medicago lupulina*
- Leaves in whorls (groups) of 3 to 8, widest at base.
- Small yellow flowers, has 5 white petals.
- Flowers come from where the leaves join the trunk.

**CARPETWEED**
*Malva neglecta*
- Leaflets have smooth or finely notched edges.
- Stem for the entire leaflet usually longer.
- Lighter colored veins point forward.

**ASIATIC DAYFLOWER**
*Centaurea dealbata*
- Distinctive flowers with 2 blue petals above and 1 small white one below.
- Sheath around the stem where the leaf joins the stem.
- Likes shade

**BROAD LEAVED DUCKWORTH**
*Paspalum distichum*
- Brown flower head made up of lots of individual seeds with a small wing.
- Leaf margins often wavy, impressed.
- Leaf veins deeply impressed.
**Eastern Black Nightshade**

*Solium americanum*

- White or purple flowers
- Leaves have no or just a few teeth
- Fruit starts green then turns to red and plant is poisonous.
- Often grows low and spreading
- Deeply cut leaves

**Prostrate Knotweed**

*Polygonum pensylvanicum*

- Leaves have long, spreading leaflets
- Common at wood edges and to form clumps
- Leaves smell strong when crushed
- Common at wood edges and to form clumps

**Lambsquarters/Goosefoot**

*Chenopodium album*

- Shaped leaf base
- Light underside

**Mugwort**

*Artemisia rusticana*

- Leaves are lobed and toothed
- Common at wood edges and to form clumps
SOW THISTLE
- Base of the leaves clasps the stem.
- Yellow dandelion-like flowers.
- Leaves have lobes and teeth.
- Irregular toothed leaves:
  - Annual sowthistle (Sonchus arvensis)
  - Perennial sowthistle (Sonchus oleraceus)

2-6" | Regular toothed leaves:

THICK AND FISTY LEAVES
- Thick and fleshy leaves:
- Spotted redfish plant may be spreading or upright.
- Leaves may have a dark mark in the center.
- Sap may cause skin irritation.

PURSLANE
- Closely linear, pastures.

SPURGE
- Euphorbia mollis, tuberous, nectar.
By decreasing the amount of stormwater runoff that enters the sewage system, bioswales reduce CSO while providing multiple co-benefits. In order to function, bioswales need to be maintained both as a piece of infrastructure and as a living garden. The following section describes how to recognize and address problems that threaten the performance and lifespan of bioswales. Bioswales are currently under maintenance guarantee and maintained by DEP, which means that residents cannot maintain them without working through an organization that has a contract with DEP, like the Gowanus Canal Conservancy.

- Safety first!
- Ground rules
- Tools
- Checklist
- Litter and debris removal
- Sediment management
- Plant care

SAFETY FIRST!
Caring for NYC bioswales is usually a very safe activity. But, there are a few risks that should not be ignored, and can easily be mitigated.

Traffic Safety
Since bioswales are located along the curb of a street, remain aware of the vehicular and pedestrian traffic patterns around them. Keep yourself, tools and materials out of the street as much as possible. If possible, place traffic cones to block cars from the street adjacent to the bioswale. Remain aware of parked cars that may obscure you from drivers. Stay aware of bicycles that are much quieter than cars.

Tool Safety
Some gardening tools are sharp or potentially dangerous. When using long-handed tools, be careful of what is behind you. Don’t leave tools laying on the ground where a passerby could trip over them. When using cutting tools, wear safety glasses and work only as fast as you can safely do so.

Physical Health
Wear gloves and use tools like a shovel to scoop hazardous or unsanitary waste into a garbage bag. Avoid touching your face when working on a bioswale, and wash your hands well after you are done. If a sink is not available, use an alcohol based hand sanitizer.
GROUND RULES

Tread lightly
Bioswales only function if the soil can absorb water. Stepping inside the bioswale compacts the soil and reduces water infiltration. Stay off of the soil as much as possible while maintaining the bioswale.

Educate
Many residents have no idea about the purpose of or how they can personally contribute to cleaner waterways in New York. When people ask what you are doing as you care for the bioswale, take the opportunity to educate others about how to reduce their water consumption and become local stewards.

TOOLS
Keep tools out of pedestrian paths while you are working.

Commonly used tools for bioswale maintenance, include:

Gloves, Trash Grabbers, Trash Bags, Recycling Bags, Rakes, Pruners and Brooms
CHECKLIST
A checklist may be useful to track work and problems observed.

BIOSWALE MAINTENANCE CHECKLIST
Date: 6/10/17

Name of Lead Steward: Ruth Nervig
# of Volunteers: 3

Location of Bioswale: 14th St + 4th Ave

1. Observe and note maintenance issues.
2. If equipped and confident, perform maintenance.
3. Note any specific issues to report. Submit checklist to Gowanus Canal Conservancy.
   info@gowanuscanalconservancy.org


Non-Organic Matter
- [x] Small Litter  [x] Removed 5 #s Litter
- [x] Large Litter or Debris  [x] Contacted DEP
- [ ] Curb or Tree Guard Damage  [ ] Contacted DEP

Organic Components
- [x] Weeds  [x] Removed 15 #s Weeds
- [ ] Sediment Buildup in Inlet/Outlet  [ ] Removed sediment
- [ ] Standing Water  [ ] Contacted DEP
- [ ] Erosion  [ ] Redistributed soil
- [ ] Drought Stress  [ ] Watered
- [ ] Flooding  [ ] Contacted DEP
- [x] Pests or Disease  [x] Removed pests (aphids - rubbed off)
- [ ] Dead or Damaged Plants [ ] Removed plants
- [x] Overgrown Plants  [x] Pruned plants
NON-ORGANIC MATERIALS

Bioswales are built to intercept stormwater runoff as it travels downhill, before it enters the sewer system. Therefore intercept a good deal of street litter, which makes the bioswale look messy, clog the inlets and outlets, and potentially impede plant growth. Bioswales can also become a dumping ground for large debris. The best to prevent this is to make the bioswale look like a well-kept garden so that people respect it.

Problem: Small Litter

Litter can block the inlet or outlet, which prevents proper bioswale function. Some bioswales have vertical pipes with slotted drain caps that are filled with stone to help with drainage. Keep these clear, as litter can block these and disrupt the drainage. Pay close attention to small pieces of paper, wrappers, cigarette butts, underneath foliage and at the base of plants. All of those tiny fragments of litter can impede plant growth, clog drains and make the bioswale look unkempt.

What to do: Remove litter

Tools: Grabber, Rake, Long Handled Cultivator or Gloves

When removing litter, be careful of sharp objects like broken glass. Try to step on the bed of the bioswale as little as possible, so you don’t compact the soil. If you are using a tool, make sure that it is not disturbing the plant roots and foliage. Look and feel at the base of long grasses and plants for small pieces of litter, as they often get trapped in foliage.
Problem: Large Litter or Debris
If you find large pieces of debris, like concrete, rocks, or household furniture, do not try to dispose of it yourself. Sometimes you can pick out the large items and place them on the sidewalk so they aren’t damaging the plants.

What to do: Report to DEP
If the litter is potentially hazardous or too heavy to handle, leave it where it is. If it is possible to pick up the debris, leave large objects on the sidewalk and call DEP.

Problem: Curb or tree guard damage
Make note of the state of the curb and iron tree guards near the bioswales. Take note of cracks in concrete or signs of vandalism or damage in tree guard.

What to do: Report to DEP
Notify your local stewardship and call DEP to let them know that there is a damaged curb or tree guard.
ORGANIC MATTER

Problem: Weeds

Weeds can resemble other plants in the bioswales in the early stages of their development. By learning to identify weeds, you can confidently remove them. Weeds should be removed as early as possible in the spring and summer, with continual weeding throughout summer and early fall. In summer and fall weeds release their seeds, giving rise to more weeds in the following season.

Strategies to identify weeds:
- Location: Nothing is ever planted right beside an edge or directly in the corner, so if something is growing there, it’s a weed!
- Foliage: Many weeds will grow right next to another plant, and can be easy to overlook. Look carefully notice slight differences in texture, color, or shape of plant foliage. Follow the leaf that looks out of place down to its roots to see if the roots look different than the surrounding roots. The weeds coming out of sidewalk cracks around the city. Chances are, you will find those same weeds in the bioswales.

What to do: Remove weeds

Tools: Gloves or hoe

Hoes let you work from outside the bioswale, so you don’t compact the soil, and are easiest to use when weeds are young and the soil is dry. Stand outside of the bioswale and place the blade of the hoe on the soil near the weeds. Pull the hoe towards yourself, putting pressure on the blade so that just the weeds and the top of the surface of soil are affected.

Alternatively, pull weeds by hand. Hand weeding is a better alternative when soil is damp or wet and roots are more established, and its a better method for getting to the roots. Grab as close to the soil as possible, and shake off any soil that climbs to the roots. It is much easier to pull weeds when the soil is wet, like after a rain storm.
SEDIMENT MANAGEMENT

☑ Problem: Sediment Buildup in Inlets and Outlets
Sediment, like gravel, sand, and construction debris, often collects at the inlet or outlet of bioswales. A buildup of sediment blocks or alters the flow of water into or out of the bioswale, resulting either in drought or flooding of the bioswale.

What to do: Remove Sediment
Tools: Rake, Broom
The sediment can usually be easily swept or scraped away. If there is a lot of sediment at the outlet, check the bioswale for erosion. Some bioswales contain a lot of stones because they allow water to run between them and down into the surrounding soil quickly. If stones are out of place, push them back into place on the curb side of the bioswale.

☑ Problem: Standing Water
Bioswales infiltrate and control the flow of rainwater runoff, but problems like compaction, clogged drains or outlets, and erosion can block that consistent flow.

What to do: Report to DEP
If you notice standing water for longer than 72 hours, call DEP to report it.

What to do: Clear debris from outlets
Tools: Gloves, broom, trash picker
Make sure that the inlets and outlets are swept clean and any large debris is removed.

Sediment in inlet
Problem: Erosion

When water travels through a garden with enough speed, erosion channels and depressions are dug into the surface of the soil. Erosion is a problem because it unevenly distributes water, so that some areas might have standing water and other areas get no water to sustain plant life. It can also remove soil from around plant roots and change the slope of the bioswale so that water does not reach the outlet. If your bioswale has vertical drains, erosion can wash soil into those and plug the drains.

What to do: Notify local stewardship agency and contact DEP

The only solution to erosion is regrading the soil. Before attempting to regrade, contact DEP or the local stewardship organization. If there is so much erosion that the roots of plants are becoming exposed or water is not flowing to all of the plants, contact DEP immediately.
Problem: Drought stress
If it’s not raining regularly, bioswale plants can dry out. This is particularly a problem when plants are young and their root systems are too small to store water. Look for wilted, brown, or dry edges on leaves to tell if a plant or tree is not receiving enough water.

What to do: Water
Tools: Permit, fire hydrant key and attaching hose, or water bucket
Ask a local stewardship or DEP if you can hook up a hose to a nearby fire hydrant. You must be trained in opening the hydrant, so if it is possible, bring buckets of water to drench the soil. Never water the leaves of the plant, only pour water directly on the soil where the plants’ roots need the water. Watering leaves rather than roots weighs down plants, which causes stems to break. It can also cause mildew.

Problem: Flooding
It is also possible for bioswale plants to get too much water - this is usually a sign that the bioswale isn’t draining properly, or that there’s more water going in than it was designed for.

What to do: Report to DEP
If the bioswale has been sitting with standing water for 72 hours after a rainstorm, call DEP.

Problem: Pests or disease
Bioswale plants are chosen for their hardiness in severe conditions, however, pests in large quantities can still cause serious damage. The note of discoloration, spots, dead or curling leaves. These could be indicators of either a fungus, disease or insects. If you notice any of signs of sickness, check the stems, leaves, and buds for insects. Small insects can deplete the plant of its water source and nutrients, resulting in death.
What to do: Treat the infestation

Tools: Pruners, Spray bottle with Soapy Water, or paper towel
If you notice an infestation, the best choices are to either prune the plant back below the infestation, wash the insects off of the plant, or use a liquid solution to coat the plant to prevent insects from eating. A simple liquid solution is 1/2 water and 1/2 liquid soap, or a diluted hot pepper spray. You can mix the solution in a spray bottle, and spray at least once a week. It is also good to wipe the bugs off of the individual leaves with a paper towel.

Problem: Dead or damaged plants

Despite the hardiness of plants chosen for bioswales, you will occasionally find dead plant material due to excessive litter, drought, pest infestations or disease. Before removing anything, make sure that it is really dead, and not simply dormant. On a woody plant or tree, test the flexibility of stems by bending gently, or scrape the stem with your fingernail to test for green growth beneath the exterior brown skin of the stem. If it is completely dry and brittle, then it is dead. Most of the plants in bioswales will turn brown and lose their leaves and blooms in the fall and may take longer to emerge in the spring.
What to do: Remove dead plant material and contact DEP

Tools: Gloves, trowel, pruners
Make sure that the plant is dead. If you can easily pull the roots of an established plant out of the ground, then it is dead. If the roots are still hanging on, then it may come back again, so simply prune the dead stems back to the ground and wait to see if it reemerges in the following growing season. If the plants do not reemerge, notify your local stewardship or call DEP so the spaces can be replanted. Follow the following pruning guide to make the right cuts when pruning.

Problem: Overgrown plants

Many of the plants in the bioswales can grow large and become a nuisance to foot or vehicular traffic surrounding the bioswale. They can also impede shorter or newer plants from growing.

What to do: Prune back large growth

Tools: Pruners
Follow instructions in the following pages to make the best cuts to promote healthy plant growth when pruning.
PLANT CARE

PRUNING GUIDE

Pruning keeps plants healthy and attractive by removing dead, damaged, or overgrown stalks, and promotes optimal growth patterns. For this focus on pruning that fixes or prevents damage, makes the plant healthier and stronger, and keeps the plant from becoming a problem.

Pruning tools
When pruning a perennial grass or flower, or a small shrub, hand pruners are the best tool. For a strong branch, switch to loppers or hand saw. The cut should be as clean and close to the main stern as possible, so use the best tool for the occasion.

• Hand pruners
Pruners are the most basic of pruning tools, and look like large scissors. There are 3 different kinds available: anvil, bypass, and snips. Bypass pruners are the only kind permitted for pruning NYC owned bioswales.

Bypass pruners

• Loppers
Loppers are like big hand pruners, with long handles that give you more leverage on what you are cutting. Loppers can also prune things that are just out of reach of hand pruners, and can prune thicker stems than hand pruners. Only bypass loppers are allowed to be used in bioswales.

Anvil pruners. Not permitted.

Pruning Trees
For bioswale, the focus is maintaining a healthy environment for the plants and trees to thrive, and that means that you will almost never need to prune a tree. Any major damage to large tree branches or trunks, call DEP for foresters to inspect and supervise the necessary removal. Smaller trees can be pruned by Citizen Pruners, who are volunteers trained and licensed by Trees New York to prune trees in New York City. For more information, contact Trees New York at 212-227-1887 or TreesNY.org.

Pruning Shrubs
The best way to reduce the risk of spreading disease in a plant is to make a clean cut and choose a good place for the cut. Prune back to a point where the plant’s defenses against disease are strongest, which is a bud, another branch, or the base of the plant.
Choosing what to prune on woody plants:

Control the size or replace poorly flowering stems by removing 1/4 to 1/3 of the largest, oldest stems out of the shrub, down to the ground. This will stimulate the growth of new stems from the shrub’s roots.

Prune:

- Dead and damaged branches to improve plant health, and keep the bioswales neat.

- Plant growth that is or will become a nuisance or danger to people.

- Root suckers to keep small trees and shrubs looking neat.

- Crossing stems or branches to prevent possible injury and disease in the plant.

Choosing where to cut:

- Prune to a bud to stimulate growth into another branch.
- Prune to a branch to stimulate growth in the same direction its already growing in.
- Don’t prune to a bud that points back to the center of the plant, because the new growth will cause crossing branches.
Pruning roses

Pruning a rose is similar to pruning any other shrub, with just a few small changes. For long and straight rose stems, with few or no branches, prune it back by half to just above a bud. This will encourage new branching from the buds nearest the cut, which will create new branches and of course flowers.

In early spring you can promote more branching by pruning 1/4 to 1/3 of the oldest stems to the ground. If you don’t prune it all the way to the ground, the remaining stem may grow new stems from dormant buds. Older rose stems have fewer flowers, so keeping the stems relatively young will result in a better display.

Pruning perennials

Pruning perennials is a little different than pruning trees, shrubs, and roses, but many of the principles still apply. Since most of our perennials have the showiest flowers in the bioswale, the goal is to keep them looking good and promote multiple blooms during the growing season. Pruning perennials also controls plant height, changes the time the plants flower and stimulates new growth if the plant is damaged.
Dead Heading
Once the flowers are pollinated, plants reduce their flowering to spend energy on producing seeds. Dead heading is simply cutting off a spent bloom so that rather than turning to seed, the plant grows another flower. It is also a technique to tidy up a plant when a spent bloom begins to look unattractive often in midsummer. To dead head, use hand pruners or snips to prune the flower back to the next flower stem or leaf. Or use shears for plants with many smaller flowers (like Coreopsis or Nepeta). Seeds are an important food source for wildlife during winter, so leave some flowers in the fall for them.

Pinching or Cutting Back
Stimulate new growth and more flowers by pinching or cutting off spent buds. Shorter, bushier plants are also stiffer, and less likely to flop over because of rain or storms. Pinch off just the flower buds at the tip of the stem, or cut back up to 1/2 of the stem. Cutting back in the spring is also used to manipulate flowering time, because the plant has to regrow those stems and flower buds. A 1-3 week delay in flowering can be expected. The more the plant is cut back, the longer the delay.

Renovation
Stimulate new growth from the base of the plant by cutting the stems at the base. It is not appropriate for every plant, so check a gardening book or website to know which plants will benefit. For example, Hemerocalas (daylily) leaves begin to slowly go yellow and die after the plant has flowered. At this point the plant can be renovated, which will encourage new foliage growth that will not die until the first frost.
Pruning Grasses

Pruning grasses is simpler than broadleaf perennials. Grasses are divided into two groups, depending on how they grow. Warm season grasses grow throughout the spring and summer, and die back in the winter. Cool season grasses grow during the cooler parts of spring, fall and in mild winters. Cool season grasses go dormant over the summer.

Warm season grasses should be pruned to 4-6 inches above the ground in mid-March. Cut around any bright green new growth at the base of the plant.

Cool season grasses just need to be cleaned up at the beginning of spring to remove dead, brown leaves. Run your hands through the grasses to pull out the dead leaves or carefully cut around the new growth to remove dead leaves. If the grass has been badly damaged, or is getting out of control, you can renovate it by pruning to 1/3 its height. Pruning lower than this can kill cool season grasses.

When pruning, wear long sleeves and gloves because the edges of leaves can be very sharp. To make pruning and clean up easier, grab a handful of grass and cut below it.

![Cool season grass before pruning](image1)
![Cool season grass after pruning](image2)
![Pruning warm season grasses](image3)
PLANT MAINTENANCE CALENDER

[Diagram of a circular calendar with months and maintenance tasks for trees, shrubs, perennials, and grasses, showing actions such as remove weeds, remove litter, remove deadfall, and critter watch for different months.]
January is NYC’s coldest month, and there is not much work for gardeners. Keep bioswale inlets and outlets clear of litter and snow so that any snow that melts can drain into the bioswale. Ask building staff to be careful not to get deicing salt into the bioswale.

February Keep bioswale inlets and outlets clear of litter and snow so that any snow that melts can drain into the bioswale. Ask building staff to be careful not to get deicing salt into the bioswale.

March: A warm March kicks off the spring, a cold one leaves us waiting. March is also a good time to prune shrubs. Keep an eye out for early weeds starting to grow, and remove them as necessary. Cool season (evergreen) grasses can be trimmed and cleaned of dead leaves. Warm season (“deciduous”) grasses should be pruned to 4-6 inches above the ground.

April is the start of stewardship season! It is a good time to prune shrubs. Perennial stems and warm season grasses left standing should be pruned, but be careful not to prune new growth. As people spend more time outside, litter may increase. Depending on weather conditions you may need to water as necessary.

May: If you need to prune perennials to control their size, mid-May is a good time. Prune them by 1/3 to reduce their height and the size of the flowers, and increase the number of flowers. Watering may be necessary, and weed as necessary.

June is the transition between spring and summer plant care in NYC. Pruning can be done as necessary for the dead and damaged plants. If the year is hot or the bioswale is newly planted, you may need to water. Keep removing litter as necessary and weeding.
July is the hottest month in NYC. As we reach the height of the summer, watering is the most important activity for newly planted plants. Cool season grasses will go dormant (turn brown) to help protect themselves from drought unless watered. Prune as necessary, and deadhead flowers to keep them blooming. If you want them to produce seeds, skip the dead-heading. Keep removing litter as necessary and weeding.

August is the second hottest month in NYC. Keep up with the watering if we are not getting rain, and prune as necessary. Keep removing litter as necessary and weeding.

September is part of the NYC growing season. Temperatures have started to fall, but watering may still be necessary. Perennials that were damaged can be pruned, and some new growth should occur if pruned. Keep removing litter as necessary and weeding.

October. Watering should only be necessary if there is a dry period (10 days of more without rain) or if the month is unusually warm. Prune as necessary and keep removing litter as necessary and weeding.

November. Perennials that are damaged can be pruned to an inch above the ground at the end of November. If possible, they should be left as they are important to wildlife for nesting material and as a food source if they have seeds. Warm season grasses can be pruned to a few inches above the ground after they turn light brown, but if possible keep them standing for wildlife. Keep removing litter as necessary and weeding.

December. Keep removing litter and weeding as necessary.