Environmental Protection

Green Infrastructure

Managing Stormwater in NYC

A Teacher's Guide and Classroom Resource

Contents

About DEP

The NYC Department of Environmental Protection (DEP)

DEP protects public health and the environment by supplying clean drinking water, collecting and treating wastewater, and reducing air, noise, and hazardous materials pollution.

Quick facts about DEP:

- Distributes more than 1 billion gallons of clean drinking water each day
- Collects wastewater through a vast underground network of pipes, regulators, and pumping stations
- Treats the 1.3 billion gallons of wastewater that New Yorkers produce each day

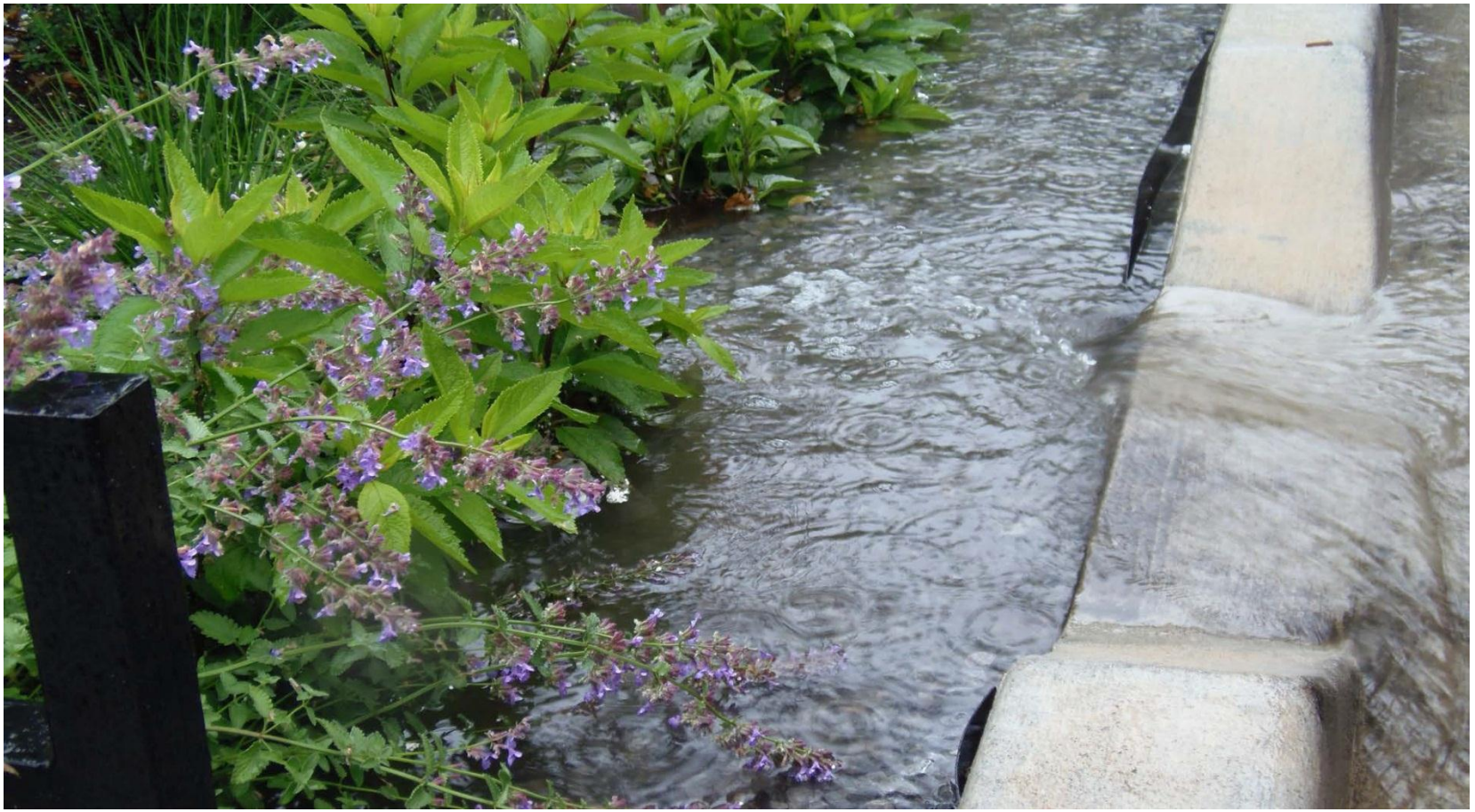
For more information, visit www.nyc.gov/dep.

View of the digester eggs at the Newtown Creek Wastewater Treatment Plant

Stormwater

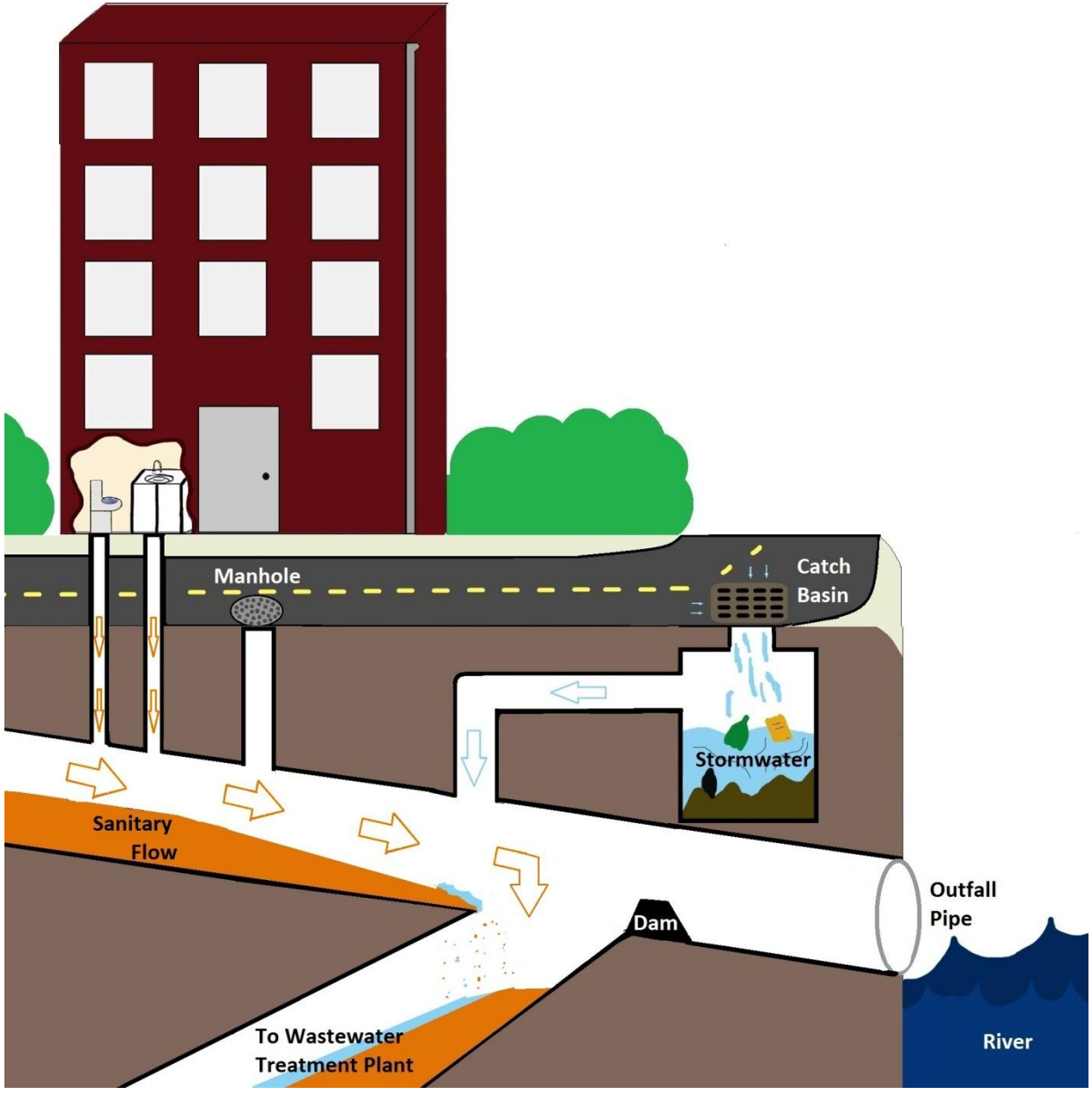
Stormwater is any water that originates from a precipitation event.

Stormwater runoff results from rain, snow, sleet, and other precipitation that lands on rooftops, parking lots, streets, sidewalks, and other impervious surfaces which run into our sewer system or local water bodies.

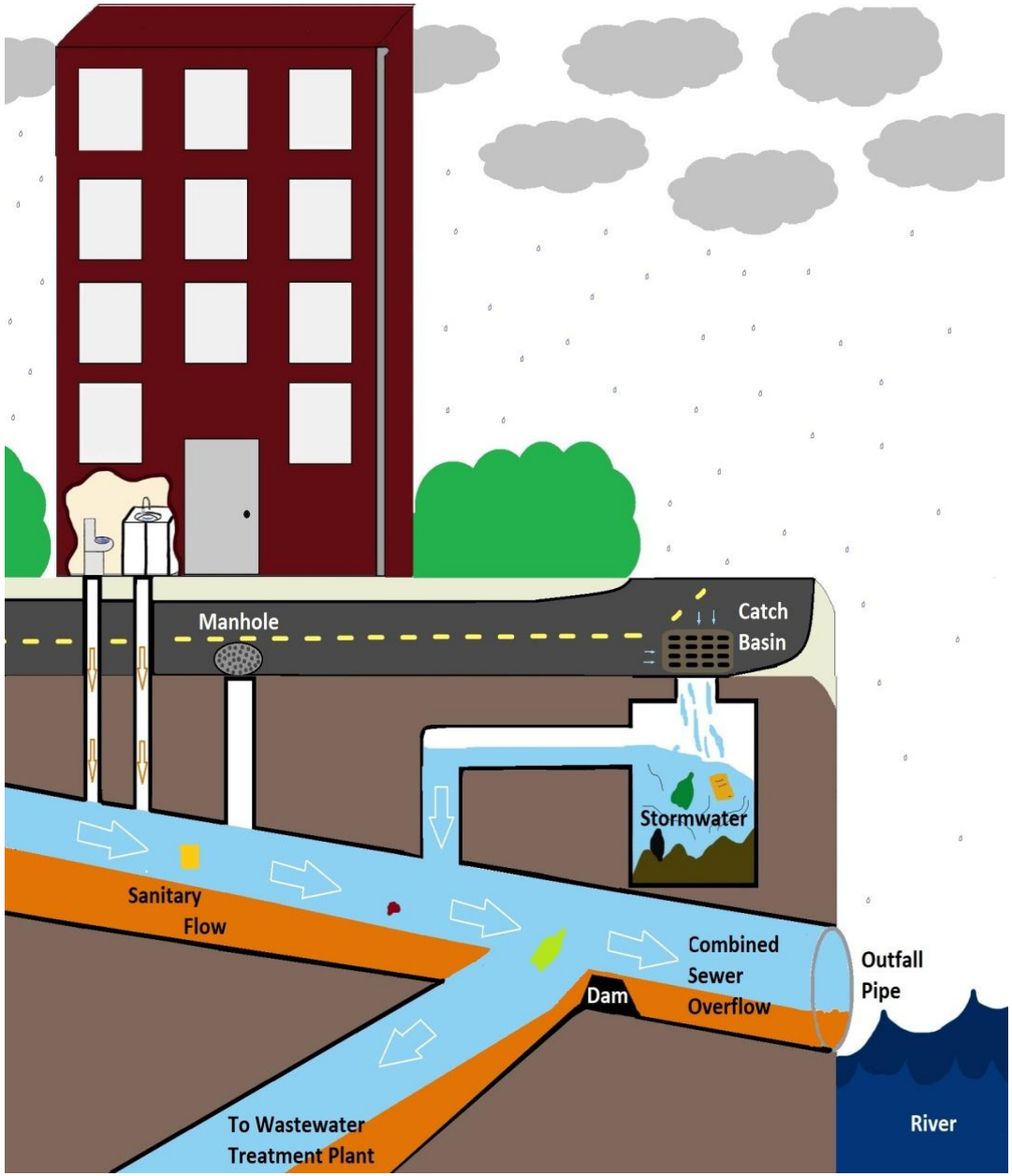


Our Combined Sewer System

A closer look at our **combined sewer system**:



Combined Sewer Overflows (CSOs)



During heavy rainstorms, combined sewers receive higher than normal flows.

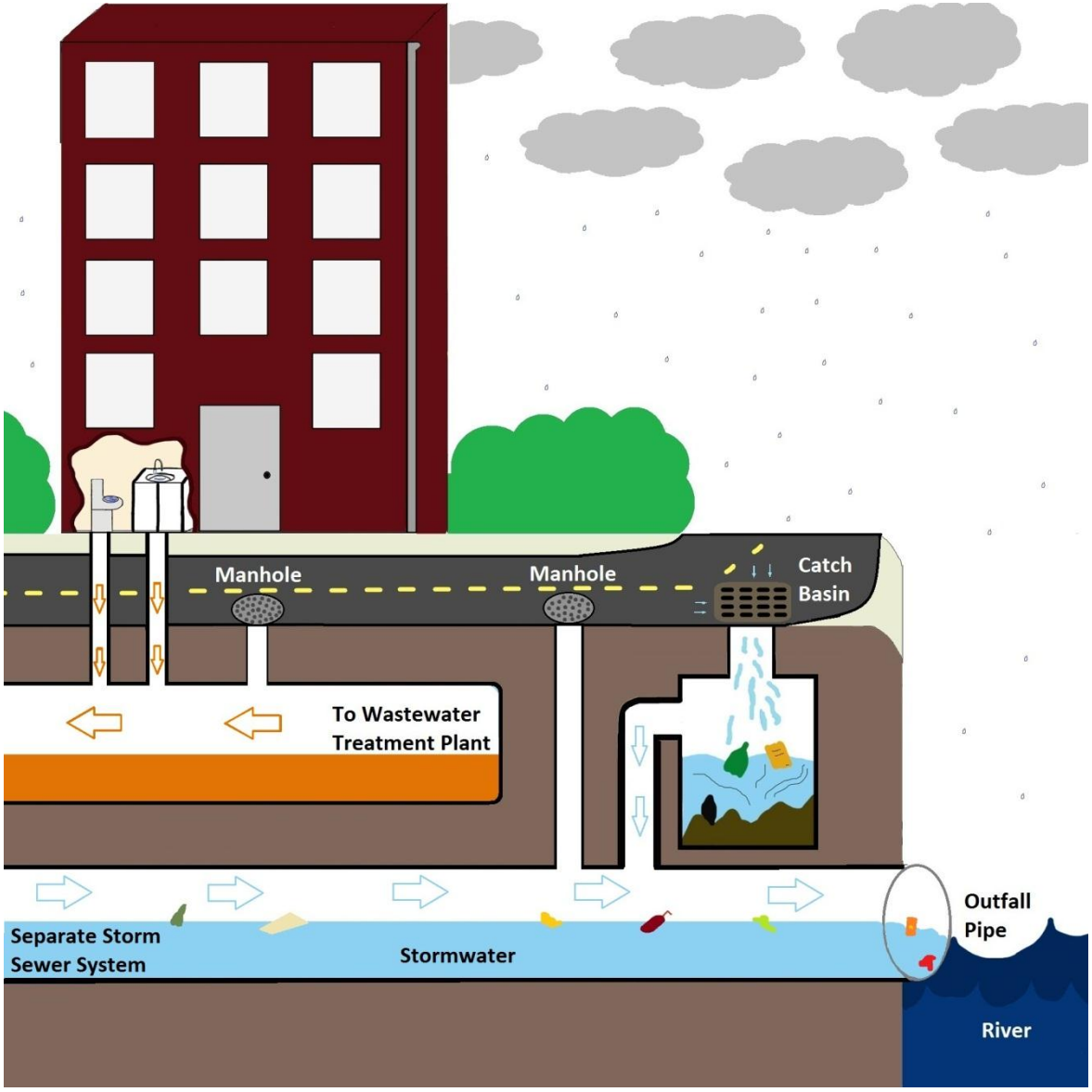
Treatment plants are unable to handle flows that are more than twice the design capacity.

When this occurs, a mix of stormwater and untreated wastewater discharges directly into the City's waterways, harming water quality.

These events are called **combined sewer overflows.**

Our Municipal Separate Storm Sewer System

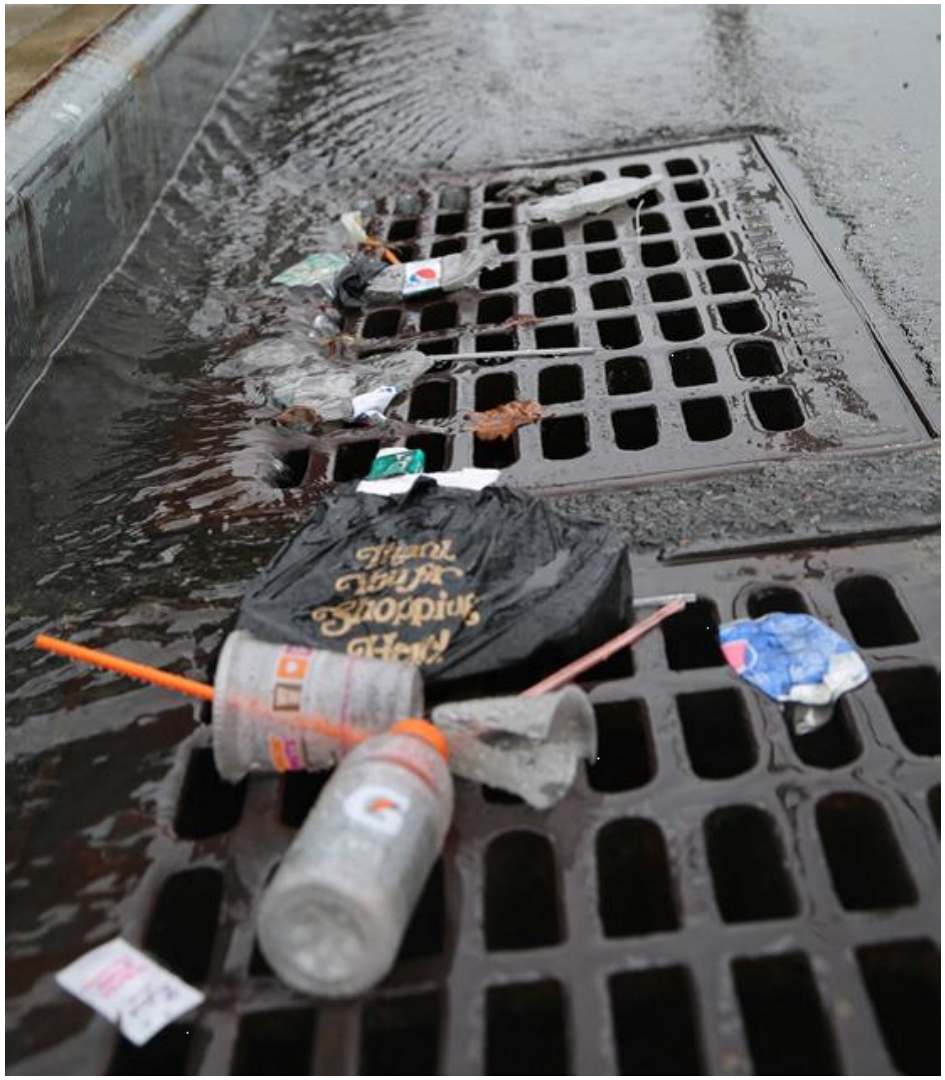
A closer look at our **separate storm sewer system** – also known as a **Municipal Separate Storm Sewer System (MS4)**:



Separate Storm Sewer Discharges

As stormwater runoff travels over streets and other impervious surfaces, it sweeps up **pollutants** such as oils, chemicals, sediments, and trash.

In areas with a **separate storm sewer system**, this pollution is carried by stormwater runoff through underground pipes directly into the City's waterways.



QUESTION

How many types of sewer systems can be found in NYC?

You're right! There are two.

Combined sewer systems are found most commonly, but there are also separate sewer systems.

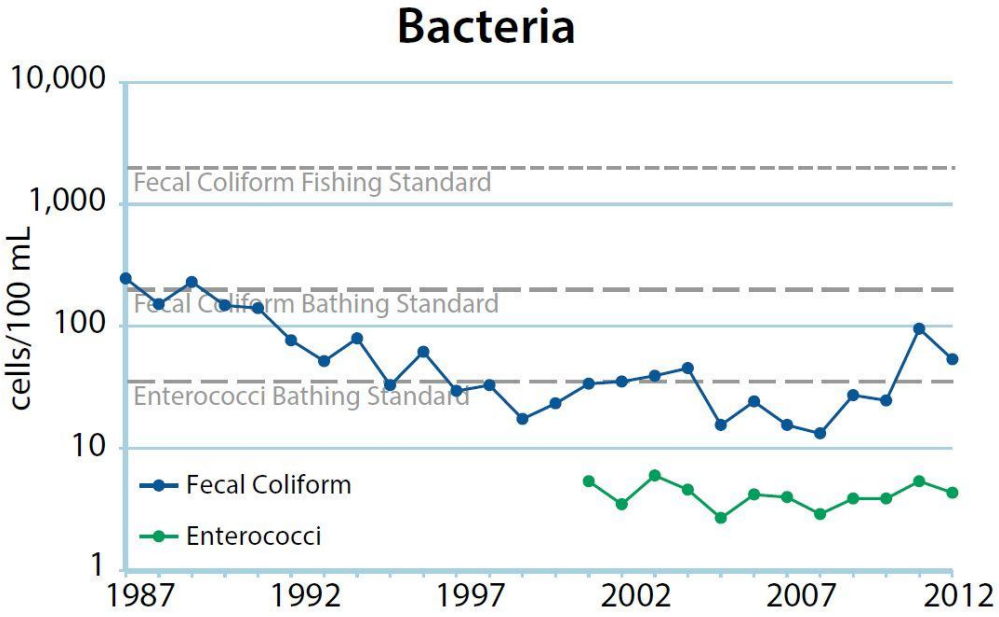
Water Quality

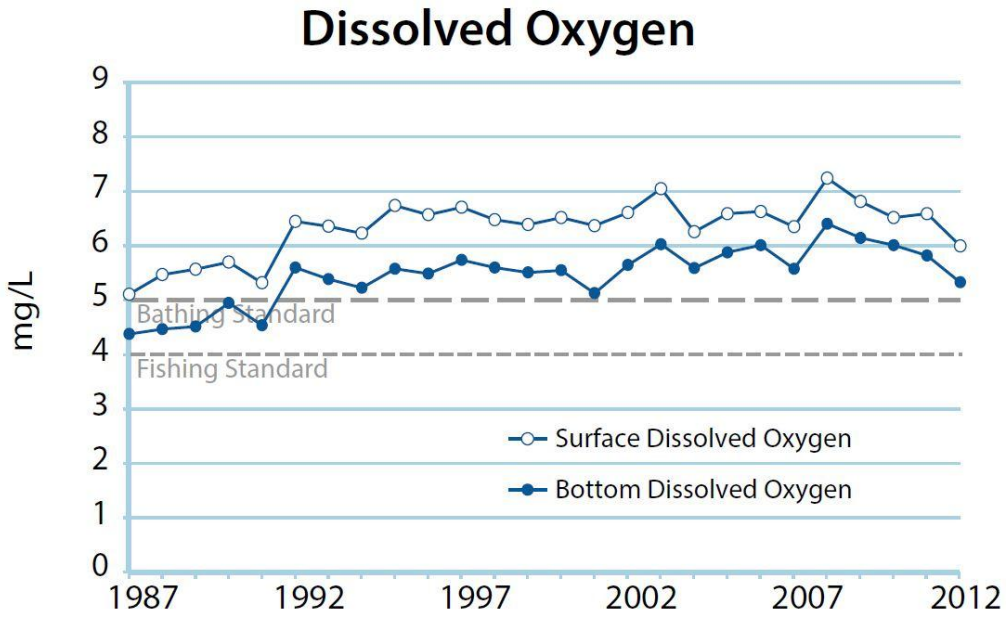
Water quality describes the characteristics of water relative to the needs of biotic species and humans. The cleaner the water (less litter, less pollution), the better the water quality. The DEP aims to have swimmable and fishable waters.

DEP uses dissolved oxygen and fecal coliform bacteria levels as indicators of water quality. State standards reflect a range of acceptable water quality conditions corresponding to state designated “best usage” of the water body. Additionally, the US Environmental Protection Agency (EPA) recommends a standard for enterococci in marine recreational waters.

Best Usage	Dissolved Oxygen	Fecal Coliform (geometric mean)	Enterococci (geometric mean)
Bathing and other recreational uses	Never less than 5.0 mg/L	Less than 200 cells/100 mL	Less than 35 cells/100 mL
Fishing or boating	Never less than 4.0 mg/L	Less than 2,000 cells/100 mL	No standard
Fish survival	Never less than 3.0 mg/L	No standard	No standard

Water Quality





In 2012, fecal coliform and enterococci counts in the New York Harbor were well below the bathing standard. Average dissolved oxygen continued to decline since 2008, but still exceeded the standards.

Wastewater infrastructure helps to keep our harbor clean. But CSOs and stormwater runoff, which could carry litter into the water, still threaten water quality.

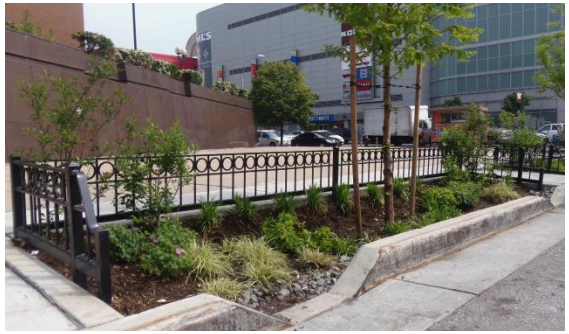
Green Infrastructure

Green infrastructure practices are designed and constructed to manage stormwater runoff when it rains. Green infrastructure controls stormwater by slowing down or absorbing stormwater runoff before it can enter the sewer system or local water bodies.

Green Infrastructure Technologies

There are many different types of green infrastructure technologies in use in NYC. There are vegetated systems, such as bioswales and green roofs, and non-vegetated systems, like cisterns and permeable pavement. Green infrastructure can be found in many different areas of the city – on a roof, along the sidewalk, or even underground.

Green Infrastructure Technologies



Right-of-Way (ROW) Bioswale

Greenstreet

Green Infrastructure Playgrounds

Green Roof

Rain Garden

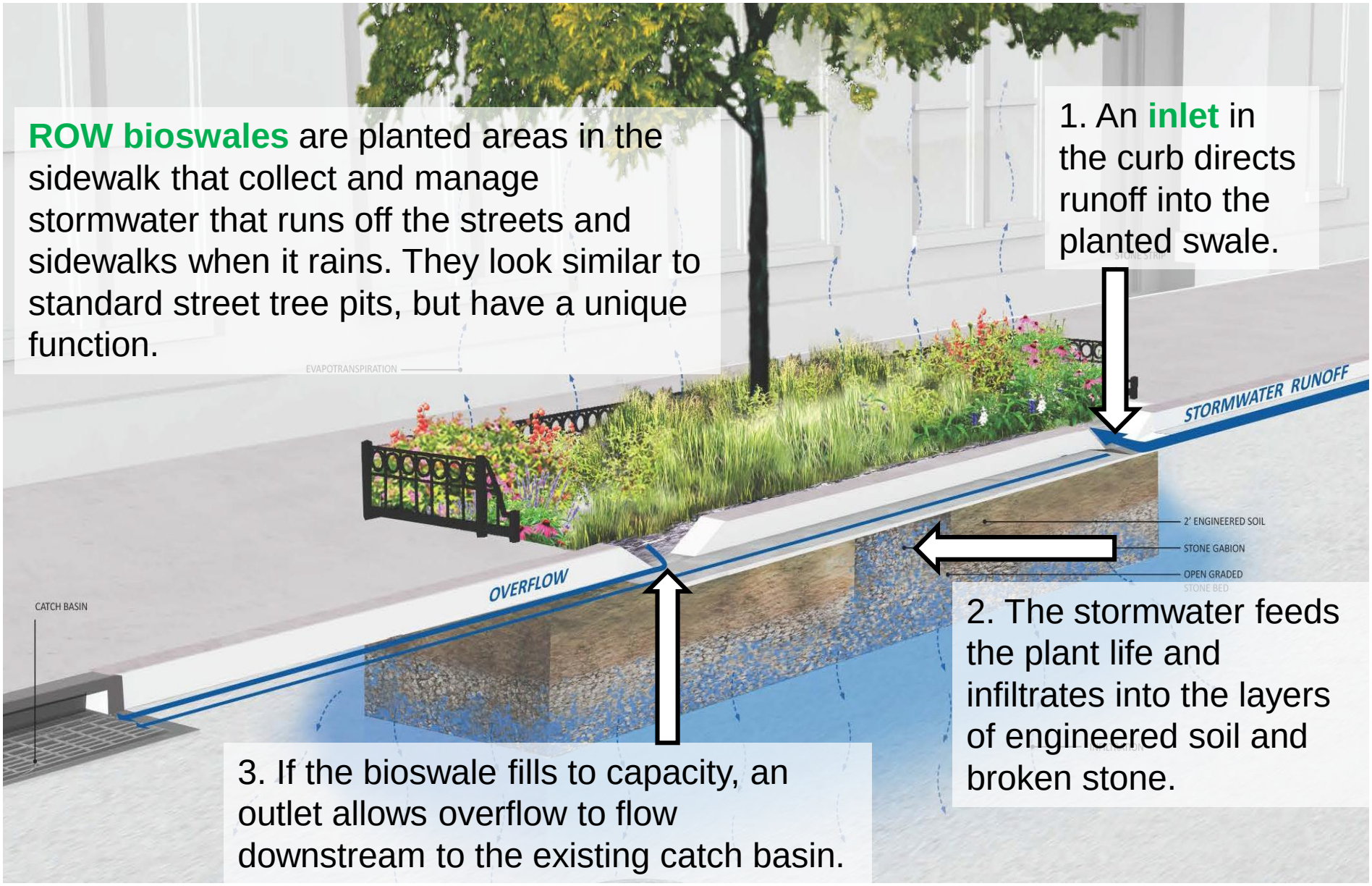
Cistern

Blue Roof

Porous Concrete

Permeable Pavers

Right-of-Way (ROW) Bioswales



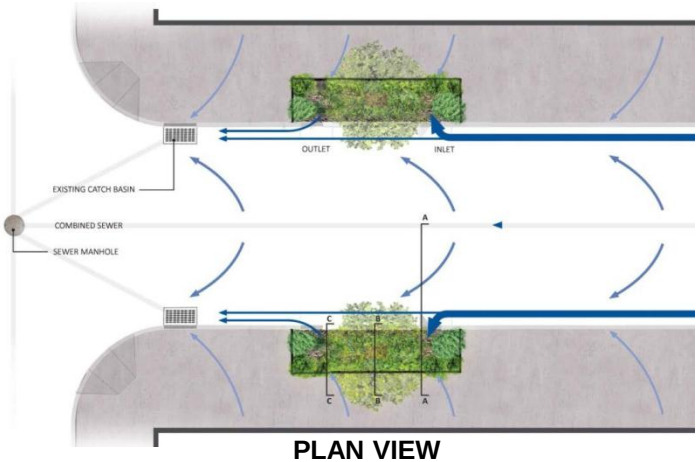
ROW bioswales are planted areas in the sidewalk that collect and manage stormwater that runs off the streets and sidewalks when it rains. They look similar to standard street tree pits, but have a unique function.

1. An **inlet** in the curb directs runoff into the planted swale.

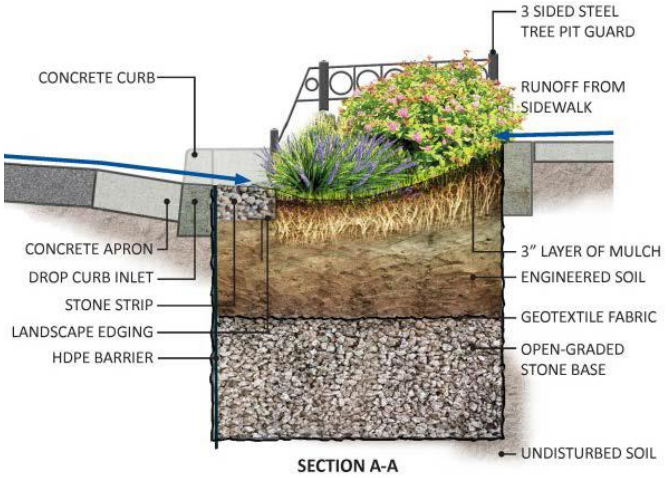
2. The stormwater feeds the plant life and infiltrates into the layers of engineered soil and broken stone.

3. If the bioswale fills to capacity, an outlet allows overflow to flow downstream to the existing catch basin.

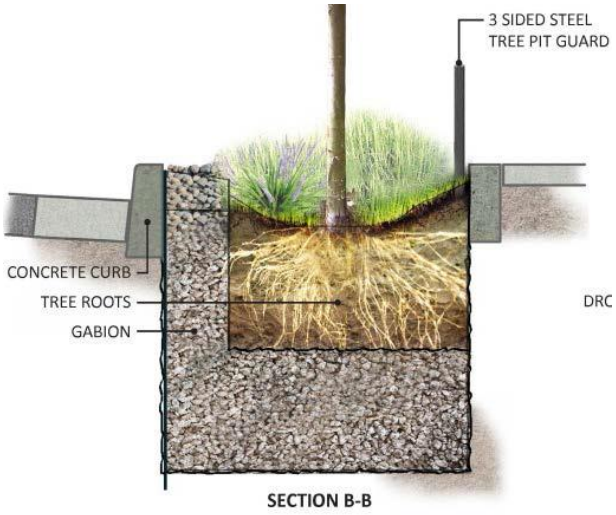
Right-of-Way (ROW) Bioswales



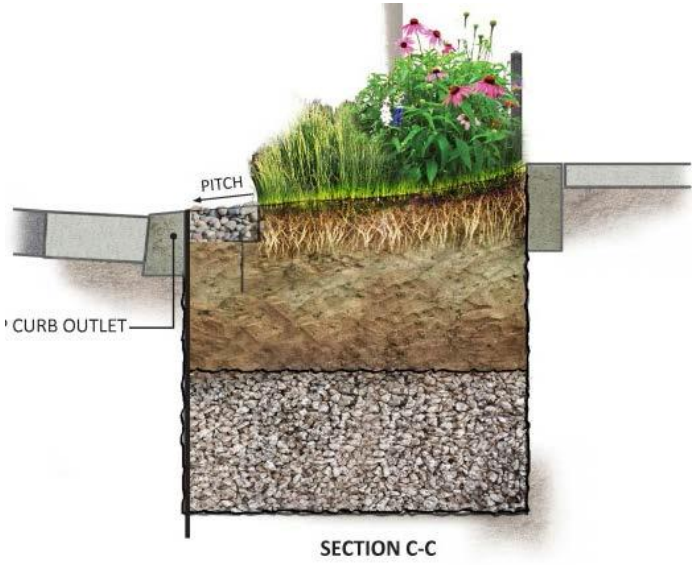
PLAN VIEW



SECTION A-A



SECTION B-B



SECTION C-C

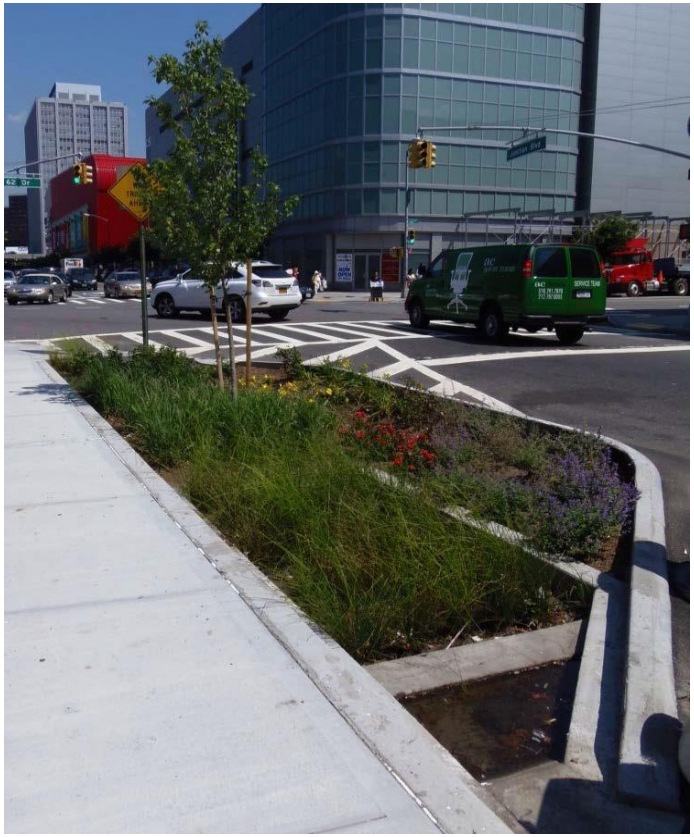
[Click to watch a ROW Bioswale in action]

Right-of-Way (ROW) Bioswales

Construction of a ROW Bioswale

Stormwater Greenstreets

Greenstreets are planted areas in the public that collect and manage stormwater that runs off the streets and sidewalks. But unlike ROW Bioswales, they are usually larger, and they are typically constructed in the roadway, not the sidewalk. Greenstreets vary in length, width, and soil depth based on the characteristics of the existing roadway.



Rain Gardens

Rain gardens are planted depressions with an engineered soil layer that promotes infiltration of stormwater runoff into the underlying soil. Rain gardens are built on public and private property to collect stormwater runoff from surrounding impervious surfaces, such as pathways and rooftops.

Green Roofs

Green roofs consist of a vegetative layer that grows in specially **engineered soil** (planting medium) over a waterproof membrane. Stormwater is detained by green roofs in the void spaces of the soil, and retained through vegetative uptake and evapotranspiration.

Extensive green roofs are 6 inches thick or less and covered in a thin layer of vegetation.
Intensive green roofs are 6 inches thick or more and can support a wider variety of plants. However, they are heavier and require more maintenance.

Waterproof Membrane

Extensive Green Roof

Blue Roofs

Blue roofs are designed without vegetation for the primary purpose of temporarily detaining stormwater. **Weirs** at roof drains create temporary ponding and allow for the gradual release of stormwater from the roof into the building's drain pipes.

Broken Stone Weir at Roof Drain

Blue Roof Trays

Rainwater Harvesting

Rainwater harvesting uses pipes, downspouts, and watertight receptacles (cisterns, rain barrels) to catch stormwater from roofs and other impervious surfaces and store it for non-potable uses. **Cisterns** are used for large impervious surfaces and can be placed above or below ground. **Rain barrels** are often smaller than cisterns and connect to the existing downspout of a roof.

Cistern

Rain Barrel

Permeable Pavements

Permeable pavement consist of a range of materials, such as pavers or porous concrete, over a permeable base material. Spaces between the paving materials allow water to pass through and be absorbed into the ground. Permeable paving can be used instead of traditional impermeable concrete or asphalt.

Permeable Pavers

Porous Concrete

Subsurface Detention

Open bottom **subsurface detention systems** provide temporary storage of stormwater runoff underground until it can infiltrate into the ground below. The systems can incorporate perforated pipe or stormwater chambers in the gravel bed for added detention volume.

Perforated Pipes

Stormwater Detention Chambers

Green Infrastructure Playground

P.S. 261 Before

P.S. 261 After

The new playground in Brooklyn will manage about one million gallons of stormwater annually.

Benefits of Green Infrastructure

NYC Environmental Protection

Greener and more beautiful streets and neighborhoods

Before

After

Before

After

Benefits of Green Infrastructure

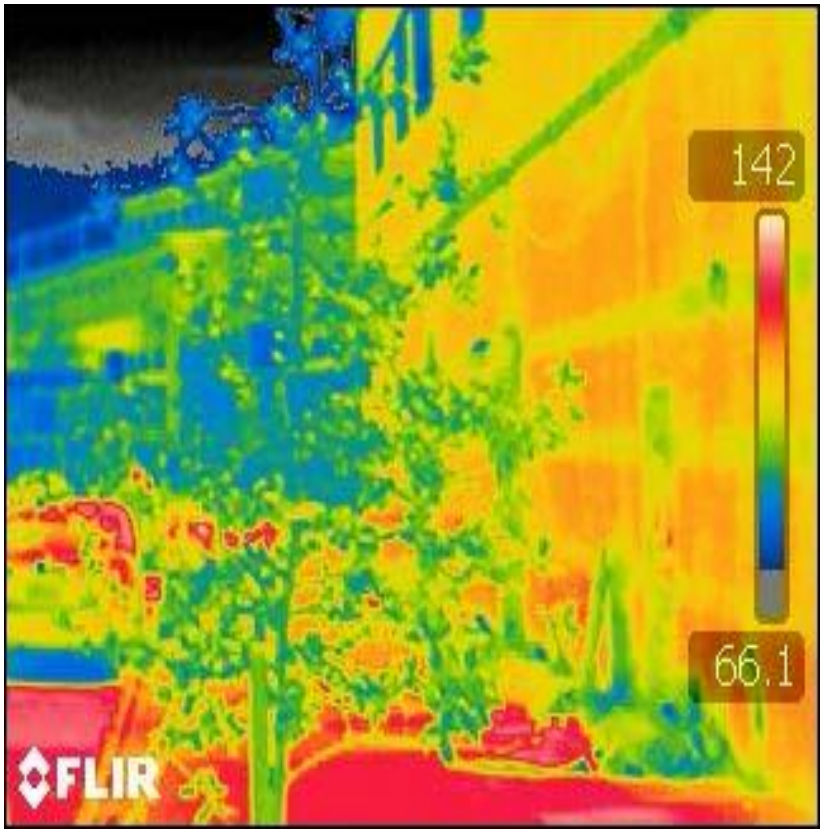
Combined Sewer Outfall

Improve Water Quality

Green infrastructure captures, absorbs and filters stormwater before it can enter the sewer system. In combined sewer areas, this helps reduce combined sewer overflows (CSOs), which can lead to the discharge of a mix of stormwater and untreated wastewater into our waterways during rain events. In areas with a separate storm sewer system, this helps keep pollutants from washing into our waterways.

Benefits of Green Infrastructure

Reduce Urban Heat Island Effect



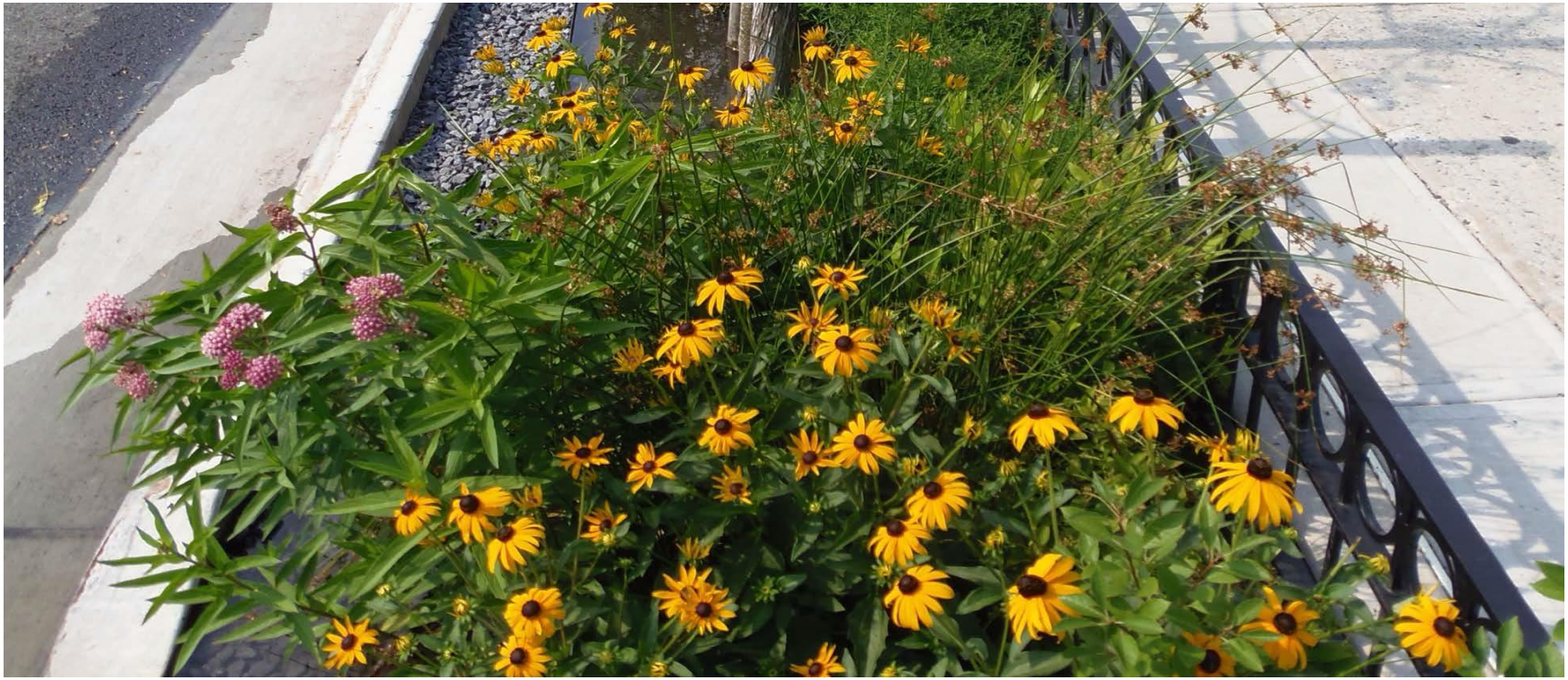
Urban heat island effect occurs when built-up urban areas become warmer than nearby areas because of differences in surface coverage.

The effect occurs year-round, but is of particular concern during the summer, when higher surface air temperature is associated with increases in electricity demand for air conditioning, air pollution, and heat stress-related mortality and illness.

Vegetated green infrastructure can mitigate the effect through added shade and increased evapotranspiration in areas otherwise covered by buildings, streets and sidewalks, and other paved surfaces.

Improve Air Quality

Green infrastructure offsets air pollution by directly removing pollutants from the air, indirectly reducing power plant emissions, and reducing the high temperatures and sunlight that contributes to tropospheric ozone formation.



Energy Conservation and Climate Change Offsets

Green infrastructure reduces the energy needed for heating and cooling our buildings, and eliminates atmospheric carbon dioxide through direct removal from the air and avoided emissions from power plants. The shading and climate effects of vegetated green infrastructure already save millions of dollars per year.

Thank you

For more information on DEP's Green Infrastructure Program, visit www.nyc.gov/dep.

For more education tools, contact the education office at educationoffice@dep.nyc.gov