NEW YORK CITY WATERSHEDS

An Overview with Activities

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About This Publication:

This publication is a summary of the last two decades of work nonprofit GrowNYC has conducted with teachers and partners in classrooms and field sites throughout New York City. The emphasis is on service-learning in focus: students can learn about watersheds, and then take action to help protect the watersheds they live in. This manual provides information about watersheds in New York State, anecdotes from GrowNYC's work, as well as specific classroom activities.

27 schools of the schools that have participated in GrowNYC's watershed program are represented here, doing service learning projects in 7 watersheds in NYC: the Hudson River, East River, Harlem River, Bronx River, Newton Creek, Jamaica Bay, and Flushing Bay.

INTRODUCTION:

Fact: Water is a plentiful and renewable resource. But look closer: 97.5% of the world's water lies in oceans and estuaries, i.e., is salt water. Salt water cannot be used for drinking or other domestic purposes; desalinization is a difficult, timely and expensive process which is not realistic in most places.

Of the 2.5% that is freshwater, 70% is frozen in the icecaps of Antarctica and Greenland (1). Some is in glaciers that are melting due to climate change, threatening the available water supply in several areas of the world. Some is in deep underground aquifers that are difficult or impossible to access. Less than 1% of the world's fresh water is available for human use (2). This comes from rivers, lakes, and aquifers that can be tapped. Seventy percent of freshwater is used for irrigation and 20% for industrial purposes leaving only 10% for drinking, cooking, cleaning and other domestic functions (3).

Variations in climate, topography, and resources have led to the uneven supply and availability of water across regions on Earth. Differences in access to technology are responsible for variations in the ability of different societies to prevent and/or remove bacterial, viral and chemical pollution from waters intended for drinking, recreation or other intimate human use. Perhaps as much as a third of the world's population lives in countries where water supplies do not meet demand (4). 2.6 billion people live in countries which do not have adequate sanitation (5).

Worldwide between 800 million and 1.1 billion people, about 11-15% of the world's population, drink dirty water every day. This leads to the prevalence of diseases such as dysentery, cholera and schistosomiasis (river blindness) primarily in Africa, Asia and some parts of Latin America.

NEW YORK CITY'S WATER HISTORY

NYC is fortunate; it has one of the great drinking water supply systems in the world. The Croton Reservoir, Dam and Aqueduct were completed in 1842, bringing fresh, clean water from the Croton River, in what is now Westchester County, to the city for the first time. Prior to that the city depended on wells and ponds in the city which were polluted with animal and human waste and with salt from the estuarine waters around the city- the Hudson and East rivers, etc. Disease, and fires which could not be properly extinguished due to lack of a plentiful water supply, ravaged the city for the first 220 years of its existence.

The Croton supply was expanded in the 1880's to meet the needs of a growing population. In the wake of the union of the five boroughs into one city in 1898, city leaders, with the consent of the state government, used eminent domain to acquire private lands to build the Ashokan Reservoir and Dam and Catskill Aqueduct (1905-1915) and then the Schoharie Reservoir and Gilboa Dam (1915-1927) to form the Catskill Watershed, West of the Hudson River (WOH). The system was expanded again so that by the mid 1960's the city had six WOH reservoirs and the Catskill and Delaware Aqueducts.

NEW YORK CITY'S WATER SYSTEM- A TALE OF THREE WATERSHEDS

The system holds 550 billion gallons of water, currently delivers over one billion gallons of water a day to more than eight million people in NYC, one million in Westchester County and many more visitors and employees who work but don't live in the city. The city receives water from sources in three watersheds The Delaware and Catskill Watersheds provide 90% of the city's water without filtration. The older Croton Watershed supply, which delivers 10% of the water, is filtered at a plant constructed in the northwest Bronx in a section of Van Cortlandt Park.

Gravity is the force that brings the water through the aqueducts into tunnels and reservoirs just north of the city where it is tested, chlorinated, fluoridated and distributed into tunnels that take it to the city's water mains and eventually through water pressure into the residential and commercial buildings and outdoor fountains of NYC.

WATER USE IN THE CITY

Once people use water in their homes it goes down the drain into sewers into sewage treatment plants where most physical particles, bacteria and viruses are removed through primary (physical) and secondary (biological) treatment but many of the toxic chemicals remain. The coastal waters around the city – Hudson River, Long Island Sound, East River, etc., receive effluent from the sewage or wastewater treatment plants that is supposed to be clean enough so that the receiving waters are considered fishable and swimmable but not drinkable.

The city's sewer system is a combined system, that is water from the streets goes into the same sewers as water from homes and businesses. During and after periods of heavy rainfall this can create Combined Sewer Overflow (CSO). This means that the volume of water in the sewers becomes too great for the wastewater treatment plants to handle causing them to shut down and send untreated sewage into the coastal waters around the city. This process leads to polluted water and the closing of waters and beaches to swimming and fishing. In a densely populated city like NY with aging infrastructure as little as 1/10 of an inch of rain can overwhelm the system. It is estimated that 27 billion gallons of untreated sewage enter NYC's waters annually.

WATERSHEDS WITHIN NYC

Thus water conservation is important, not only to keep our upstate supply plentiful, and to eliminate the need to seek other less pristine supplies, but also to relieve pressure on the sewage plants in the city to prevent the effects of CSO's. Techniques to reduce stormwater runoff- tree planting, mulching trees, green roofs, community gardens and rainwater harvesting systems help to manage the amount of water draining into sewers and shoreline areas and in the process preserve the quality of local waters. Using non-toxic cleaners and other environmentally friendly products both in and out of the home and disposing of all waste properly can reduce pollution in local waters.

A watershed is an area that drains to a specific body of water like a river or creek. The water cycle weaves through a watershed: As it rains water strikes the land and infiltrates into soil and refills groundwater supplies, falls into water bodies, runs off land into surface waters, is absorbed in the roots of trees; when the rainfall fills the water bodies it eventually evaporates or transpires through the internal cycle of plants and trees and returns to the atmosphere where it condenses into clouds and eventually returns to Earth again.

The water cycle should interact with the land in a watershed in a balanced fashion. Soils should be permeable enough and/or be covered with enough vegetation so that water infiltrates into the ground to help plants grow and replenish groundwater supplies. Compacted soils with little vegetation will lead to excessive runoff, which in turn will cause erosion, flooding during and after rains, poor stormwater management and pollution of surface water supplies. On the other hand soils that absorb rainwater, once they are saturated, will generate runoff that can help replenish local waters. Nonpoint source pollution, or pollution from many diffuse sources is the result of rainfall or snowmelt moving over and through the ground. The moving water picks up and carries organic and non- organic pollutants into the nearest water body. In a balanced watershed nonpoint source pollution will be managed effectively, with vegetation absorbing enough water to control runoff of animal wastes and chemical pollutants, and erosion.

Treated water refers to water from residences and businesses, and from the street/surface level, that flows into the sewer system to a sewage treatment plant. Any area from which treated water flows is in the "sewershed" of the sewage treatment plant that receives that water. The area is also in the watershed of the body of water which receives the effluent (treated water) from the sewage treatment plant or the runoff of the untreated surface water from the land.

Untreated water is precipitation that falls on the surface of the land and runs off into one or more local waters without entering the sewers. Untreated water is also water from homes, businesses and the street level that enters the sewer system but is sent into one or more local waters due to a CSO event.

For example DeWitt Clinton High School in the northwest Bronx is in the Wards Island Sewage Treatment Plant sewershed, the Upper East River watershed (where effluent from the Wards Island Sewage Treatment Plant goes), and the Bronx River watershed where surface runoff enters the river. Schools in the Sunnyside and Long Island City sections of Western Queens are in the Newtown Creek Sewage Treatment Plant sewershed, and in the watersheds of the East River and Newtown Creek while those in the Astoria and Jackson Heights neighborhoods are in the Bowery Bay Sewage Treatment Plant sewershed and in the East River, Flushing Bay and Newtown Creek watersheds.

All of these waters are estuaries, that is they are coastal waters in which fresh water is mixed with salt water. The only exception to this within the city is the first five miles of the Bronx River within the city's limits, which is fresh water. The final three miles of the river in the city becomes estuarine as it flows towards the East River.

References:

Notes 1,2, and 5: "Human Appropriation of the World's Fresh Water Supply"; www.globalchange.umich.edu/globalchange2/current/lectures/freshwater_supply/freshwater.html

Notes 3 and 4: "A Thirsty Planet", National Geographic Maps for National Geographic Magazine, National Geographic Society, Washington, D.C., July 2002

Additional Resources:

http://www.theglobaleducationproject.org/earth/fresh-water.phphttp://www.dec.ny.gov/lands/67073.html

http://www.lakecountyil.gov/PublicWorks/PublicInformation/Documents/Indoor%20Water%20Conservation%20Flyer.pdf

http://www3.epa.gov/watersense/our_water/water_use_today.html

CLASSROOM ACTIVITY

I - NYC Water

Answer the following questions based on the Introduction, NYC Water Supply Map, the vocabulary list, and the pages on the sewage treatment plants in NYC, and the watershed descriptions in Section IA.

1. What is a watershed?

2. What are the names of the three watersheds that provide NYC with drinking water?

3. Through what structures does the water flow to NYC?

4. Which physical force brings the water to NYC?

5. What are the names of the 6 upstate reservoirs west of the Hudson River that hold NYC's water?

6. What happens to the water from upstate NY after you use it in your house or at school?

7. What are some of the major bodies of water along NYC's coastline? Can we drink this water? Why?

8. What is an estuary?

9. What sewershed and watershed is your school in?


Catskill/Delaware Watersheds
Croton Watershed
Schoharie Reservoir
Pepacton Reservoir
Cannonsville Reservoir
Ashokan Reservoir
Neversink Reservoir
Rondout Reservoir
West Branch Reservoir
New Croton Reservoir
Kensico Reservoir
West Branch Delaware
East Branch Delaware
West Delaware Tunnel
East Delaware Tunnel
Neversink Tunnel
Delaware Aqueduct
Catskill Aqueduct
Schoharie Tunnel
Esopus Creek
Hudson River
Delaware River
Neversink River
Delhi
Hunter
Phoenicia
Kingston
Poughkeepsie
Liberty
Ellenville
Walton
Downsville
Deposit
Gilboa
Dreenia
DELAWARE COUNTY
SULLIVAN COUNTY
ULSTER COUNTY
DUTCHESS COUNTY
GREENE COUNTY
COLUMBIA COUNTY
SCHOHARIE COUNTY
ALBANY COUNTY
RENSSELAER COUNTY
OTSEGO COUNTY
CHENANGO COUNTY
PUTNAM COUNTY
ORANGE COUNTY
ROCKLAND COUNTY
WESTCHESTER COUNTY
NASSAU COUNTY
PENNSYLVANIA
NEW YORK
NEW JERSEY
CONNECTICUT
MASSACHUSETTS
Bronx
Queens
Brooklyn
Staten Island
Groundwater Service Area
Long Island Sound
Atlantic Ocean
New York Bay
Environmental Protection
New York City's Water Supply System
Catskill / Delaware Watershed Area
Croton Watershed Area
Rivers and Reservoirs
Catskill Aqueduct and Tunnels
Croton Aqueduct
Delaware Aqueduct and Tunnels
County Borders
State Borders
www.nyc.gov/dep

KEY VOCABULARY

Watershed- Land area over and through which water flows to reach a water body, usually a river.

Sewershed- Area in which all water from homes, businesses and streets goes through sewers to a specific sewage treatment plant.

Coastline- Land area along the water.

Structure- For this activity, it is a human made object such as a building or bridge.

Physical Force- Pressure on an object or living organism by something other than itself.

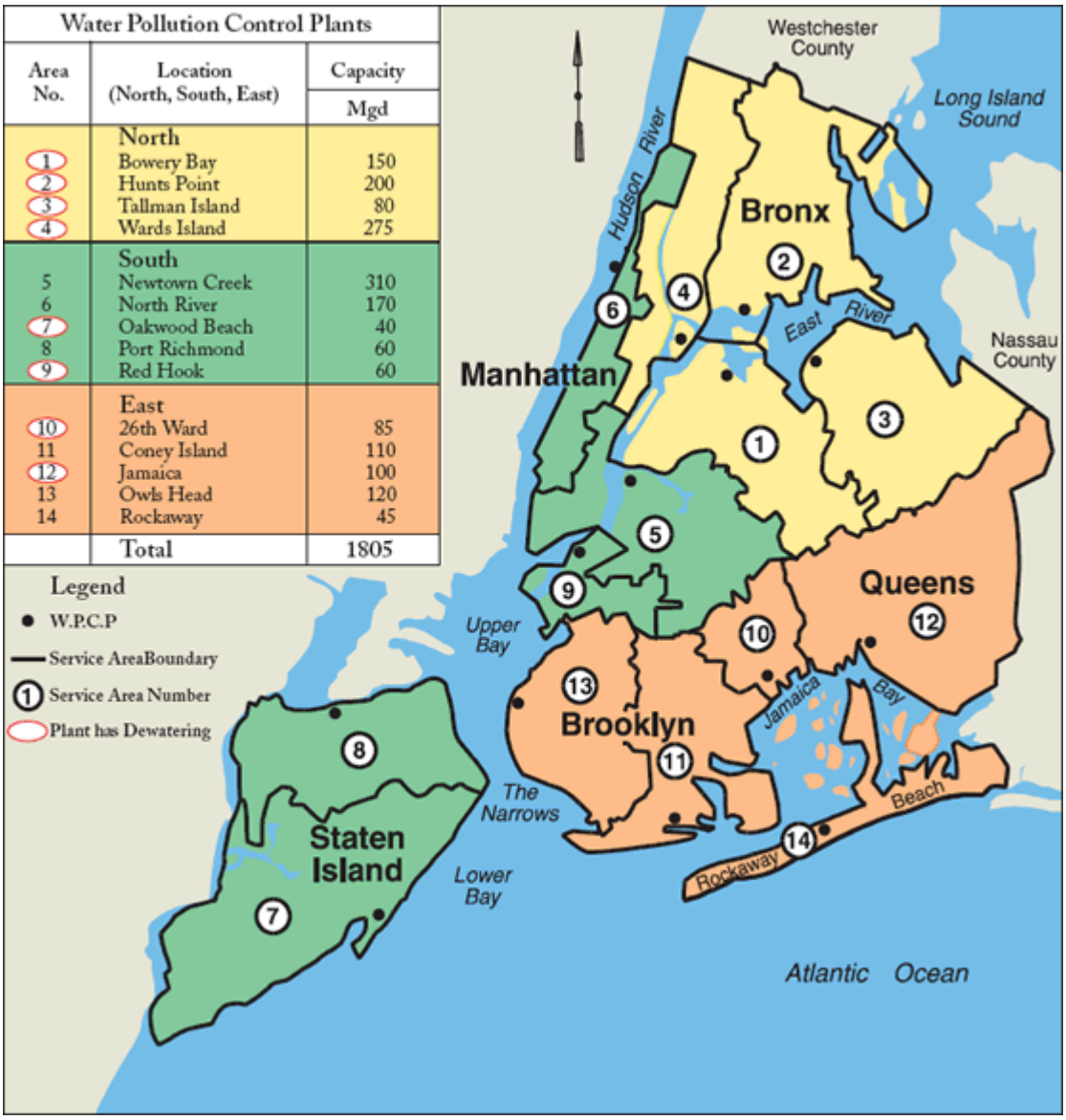
Aqueduct- an artificial channel for conducting water from a distance, usually by means of gravity

Reservoir- Body of water stored in an area and held in place by a large structure called a dam.

Estuary- A body of water along the coast in which fresh water (stream, pond, lake or river) is mixed with salt water (ocean water).

Gravity- Force which pulls two physical bodies or objects towards each other.

New York City Sewage Treatment Plant Locations and Capacities



Water Pollution Control Plants		
Area No.	Location (North, South, East)	Capacity Mgd
	North	
1	Bowery Bay	150
2	Hunts Point	200
3	Tallman Island	80
4	Wards Island	275
	South	
5	Newtown Creek	310
6	North River	170
7	Oakwood Beach	40
8	Port Richmond	60
9	Red Hook	60
	East	
10	26th Ward	85
11	Coney Island	110
12	Jamaica	100
13	Owls Head	120
14	Rockaway	45
	Total	1805

New York City's Wastewater Treatment System

Source: NYC DEP Website

New York City Wastewater Treatment Plants

26th Ward WWTP

Plant in operation:	1944
Design Capacity:	85 MGD
Dewatering:	26th Ward
Population Served:	283,428
Receiving Waterbody:	Jamaica Bay
Drainage Area:	5,907 Acres, eastern section of Brooklyn, near Jamaica Bay
Plant Staff:	93

Bowery Bay WWTP

Plant in operation:	1939
Design Capacity:	150 MGD
Dewatering:	Bowery Bay
Population Served:	848,328
Receiving Waterbody:	Upper East River
Drainage Area:	15,203 Acres, northeast section of Queens
Plant Staff:	81

Coney Island WWTP

Plant in operation:	1935
Design Capacity:	110 MGD
Dewatering:	26th Ward
Population Served:	596,326
Receiving Waterbody:	Jamaica Bay
Drainage Area:	15,087 Acres, south and central Brooklyn
Plant Staff:	69

Hunts Point WWTP

Plant in operation: 1952
Design Capacity: 200 MGD
Dewatering: Hunts Point
Population Served: 684,569
Receiving Waterbody: Upper East River
Drainage Area: 16,664 Acres, eastern section of the Bronx
Plant Staff: 108

Jamaica WWTP

Plant in operation: 1903 / 1943
Design Capacity: 100 MGD
Dewatering: Jamaica WWTP
Population Served: 728,123
Receiving Waterbody: Jamaica Bay
Drainage Area: 25,313 Acres, southern section of Queens
Plant Staff: 66

Newtown Creek WWTP

Plant in operation: 1967
Design Capacity: 310 MGD
Dewatering: Hunts Point WWTP
Population Served: 1,068,012
Receiving Waterbody: East River
Drainage Area: 15,656 Acres, south and eastern midtown sections of Manhattan, northeast section of Brooklyn and western section of Queens
Plant Staff: 88

North River WWTP

Plant in operation: 1986
Design Capacity: 170 MGD
Dewatering: Wards Island WWTP
Population Served: 588,772
Receiving Waterbody: Hudson River
Drainage Area: 6,030 Acres, west side of Manhattan above Bank Street
Plant Staff: 109

First and only Wastewater Treatment Plant in NYC to have a public

park built on top.

Oakwood Beach

Plant in operation:	1956
Design Capacity:	39.9 MGD
Dewatering:	Oakwood Beach WWTP
Population Served:	244,918
Receiving Waterbody:	Lower New York Bay
Drainage Area:	10,779 Acres, southern section of Staten Island
Plant Staff:	59

Rockaway WWTP

Plant in operation:	1952
Design Capacity:	45 MGD
Dewatering:	26th Ward WWTP
Population Served:	90,474
Receiving Waterbody:	Jamaica Bay
Drainage Area:	6,259 Acres, Rockaway Peninsula
Plant Staff:	41

Owls Head WWTP

Plant in operation:	1952
Design Capacity:	120 MGD
Dewatering:	26th Ward / Wards Island WWTPs
Population Served:	758,007
Receiving Waterbody:	Upper New York Bay
Drainage Area:	12,947 Acres, western section of Brooklyn
Plant Staff:	68

Wards Island WWTP

Plant in operation:	1937
Design Capacity:	275 MGD
Dewatering:	Wards Island WWTP
Population Served:	1,061,558
Receiving Waterbody:	Upper East River
Drainage Area:	12,056 Acres, western section of the Bronx and upper east side of Manhattan
Plant Staff:	118

Tallman Island WWTP

Plant in operation:	1939
Design Capacity:	80 MGD
Dewatering:	Tallman Island WWTP
Population Served:	410,812
Receiving Waterbody:	Upper East River
Drainage Area:	16,860 Acres, northeast section of Queens
Plant Staff:	71

Port Richmond WWTP

Plant in operation:	1953
Design Capacity:	60 MGD
Dewatering:	Oakwood Beach WWTP
Population Served:	198,128
Receiving Waterbody:	Kill Van Kull
Drainage Area:	9,665 Acres, northern section of Staten Island
Plant Staff:	46

Red Hook WWTP

Plant in operation:	1987
Design Capacity:	60 MGD
Dewatering:	Red Hook WWTP
Population Served:	192,050
Receiving Waterbody:	Lower East River
Drainage Area:	3,200 Acres, northwest section of Brooklyn and Governor's Island
Plant Staff:	55

IA

A Note to Educators

The following pages detail watersheds where students participating in GrowNYC's program have completed restoration projects. There are detailed descriptions of each individual watershed in NYC that students can use to deepen their understanding of watersheds. Descriptions are divided by area so that teachers can select just one watershed description to use based on school location. You can determine from the maps following whether your class or group is located within any of the watersheds. If not, go to google maps, enter the waterbody closest to you with the word "watershed" after it, and the watershed map will come up.

WATERSHED DESCRIPTIONS

The Hudson River Watershed in Northern and Western Manhattan

The land area from approximately 72nd Street to the northern tip of Manhattan above Inwood Hill Park, and from Central Park West to the Hudson River is in the Hudson River Watershed . The area is resplendent in the late afternoon in every season as sunshine splashes over the entire corridor along the River prior to the setting of the sun in the west. There is an abundance of park land from the western edge of Central Park and all of Morningside Park over to Riverside, Fort Tryon and Inwood Hill parks.

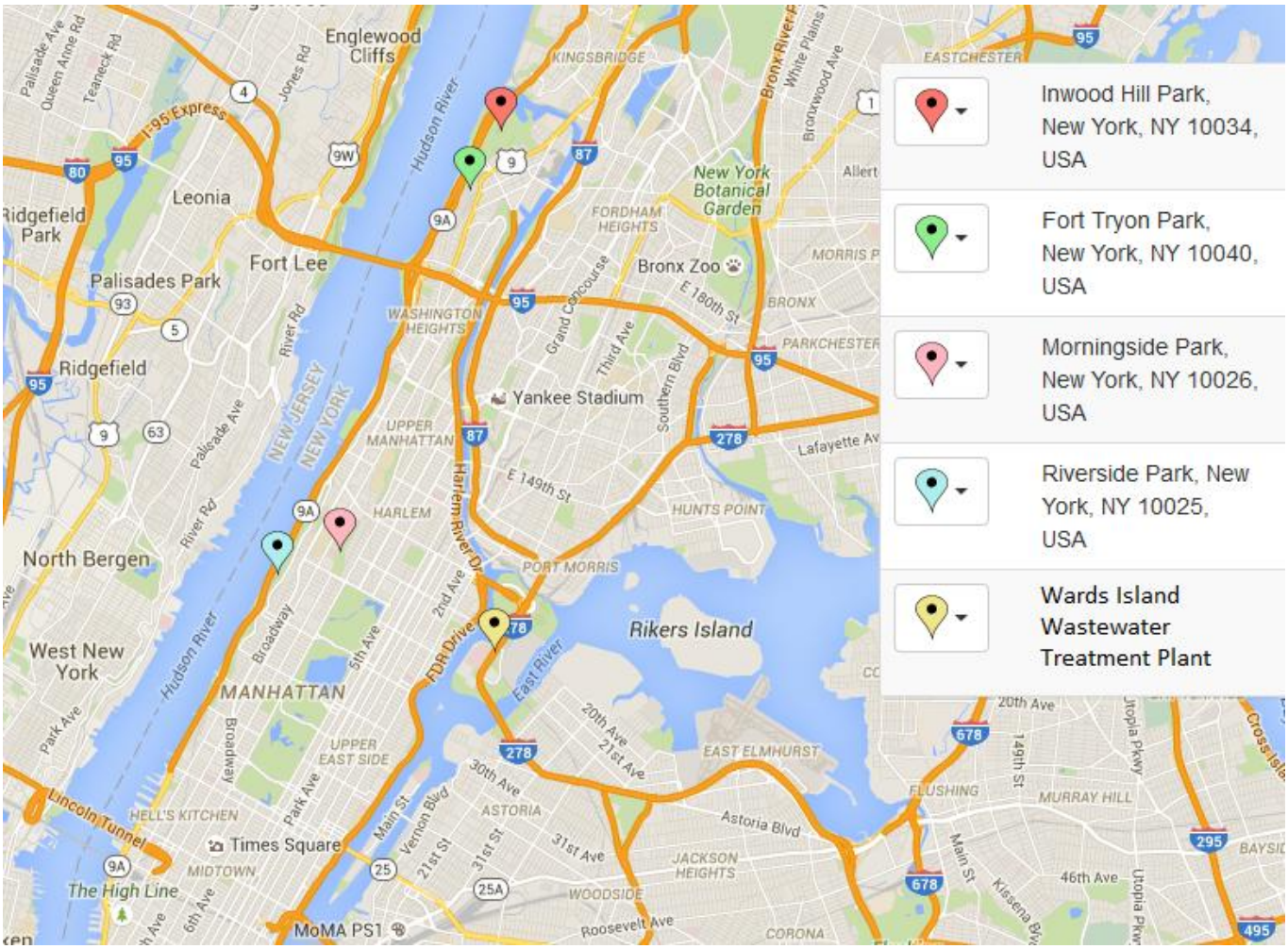
Wastewater from homes and businesses and storm water from the street level enters sewers that connect with the North River Water Pollution Control Plant (treats water on the Westside of Manhattan above the Battery), the last of the city's 14 sewage treatment plants to be built. The water will be treated and sent to the Hudson. During combined sewer overflow (CSO)events, which occur during and after a rainfall when water from the streets and water from homes and businesses combine in the sewers to create a volume of water too great for the sewage plants to handle, the sewer water and street level storm water will flow through CSO pipes and other outlets untreated into the Hudson. Some untreated surface runoff from streets and parks along the river's shoreline will enter the river as well. There are also some CSO outlets in the North River Sewage Treatment Plant sewershed that empty into the Harlem River and thus the northeastern section of the borough is in the Harlem River watershed.

GrowNYC has worked with students from Manhattan Comprehensive Day and Night HS, the High School for Environmental Studies (Manhattan), South Kortright Central HS from upstate NY, Edward R. Murrow HS (Brooklyn) and DeWitt Clinton HS (Bronx) to restore parks in shoreline areas in this watershed to prevent erosion and control stormwater runoff, reducing pollution of the Hudson in a number of ways and helping to decrease CSO events.

Students have planted 17,550 native trees, shrubs, herbaceous plants, ground cover plants and bulbs, removed invasive plants and vegetative debris from 136,000 square feet of park land, built two erosion control fences, wood chipped two trails and spread grass seed and/or mulch over additional park space, in Inwood, Ft. Tryon, Morningside and Riverside Parks. Native vegetation will prevent soil erosion into the river, reduce toxic runoff and absorb precipitation helping to lessen CSO's. Removing invasives opens the way for the growth of existing native plants and the planting of new ones.

However none of this could happen or be maintained without the dedicated involvement of the caretakers of these parks and natural systems. Tim Wenskus, Rich Love, Jose Baez, Katerli Bounds, Barbara Trees and others from the Natural Resources Group of the NYC Department of Parks and Recreation have cared for the Inwood Hill Park forest and other areas. Marechal Brown spent a number of years as the Chief Gardener of Morningside Park for the NYC Department of Parks and Recreation. She spearheaded the renovation and revitalization of the park including working with student groups from many schools. Marechal Brown again, this time as Chief Horticulturalist of Northern Manhattan Parks, Jennifer Hoppa as Administrator of Northern Manhattan Parks and as Executive Director of the Ft. Tryon Park Historic Trust and others helped shape the makeover of Ft. Tryon Park, especially on the Broadway side. On the Ft Washington Avenue side of the park the Friends Committee of the Ft. Tryon Park Trust and a few dedicated gardeners and park workers employed by the Parks Dept. and/or the Trust have made the Heather garden into the splendor that it is and preserved the greenery around the garden. The Riverside Park Fund has organized significant groups of area residents and youth to bring Riverside Park into the overall renovation of the westside shoreline.

While some of the individuals have moved on, all of the above organizations are resources for teachers and youth leaders who want to give their students an environmental/outdoor experience in these parks. The Urban Park Rangers of the NYC Parks Department, who run the Inwood Park Urban Ecology Center, are another invaluable resource.


Inwood Hill Park, New York, NY 10034, USA
Fort Tryon Park, New York, NY 10040, USA
Morningside Park, New York, NY 10026, USA
Riverside Park, New York, NY 10025, USA
Wards Island Wastewater Treatment Plant
Englewood Cliffs
Leonia
Fort Lee
Palisades Park
Ridgefield
North Bergen
West New York
MANHATTAN
Times Square
MoMA PS1
The High Line
Yankee Stadium
Bronx Zoo
New York Botanical Garden
Rikers Island
Hudson River
East River
NEW JERSEY
NEW YORK
KINGSBRIDGE
FORDHAM HEIGHTS
WASHINGTON HEIGHTS
UPPER MANHATTAN
HARLEM
HUNTS POINT
PORT MORRIS
UPPER EAST SIDE
HELL'S KITCHEN
MIDTOWN
ASTORIA
EAST ELMHURST
JACKSON HEIGHTS
WOODSIDE
CORONA
FLUSHING
MURRAY HILL
BRONX
PARKCHESTER
EASTCHESTER
I-95 Express
Lincoln Tunnel
FDR Drive
Harlem River Dr
Grand Concourse
Southern Blvd
Astoria Blvd
Roosevelt Ave
E 149th St
E 180th St
Lafayette Av
20th Ave
21st Ave
30th Ave
31st Ave
46th Ave
149th St
Main St
Vernon Blvd
Broadway
Park Ave
5th Ave
2nd Ave
Third Ave
Palisade Ave
River Rd
Jones Rd
Teaneck Rd
Queen Anne Rd
Bronxwood Ave
White Plains
Utopia Pkwy
Kissena Blvd
Cross Isle

DeWitt Clinton High School and The Watersheds in the Northwest Bronx

DeWitt Clinton High School is in the Wards Island Sewage Treatment plant sewershed and in the East River and Bronx River watersheds. Although the school building is not in the Harlem River watershed, nearby Van Cortlandt Park is. Wastewater from homes and businesses and storm water from the street level enter sewers that connect to the the Wards Island plant. The water is treated and sent to the East River, thus Clinton is in that river's watershed. During combined sewer overflow events, which occur during and after a rainfall when water from the streets and water from homes and businesses combine in the sewers to create too much volume for the sewage plants to handle, the sewer water and street level storm water will flow through CSO pipes directly into the East River. Too, Tibbets Brook flows down from Westchester through Van Cortlandt Park Lake and drains into the Harlem River. Some surface level runoff from streets may also enter the Bronx River, placing the school in the Bronx River watershed as well.

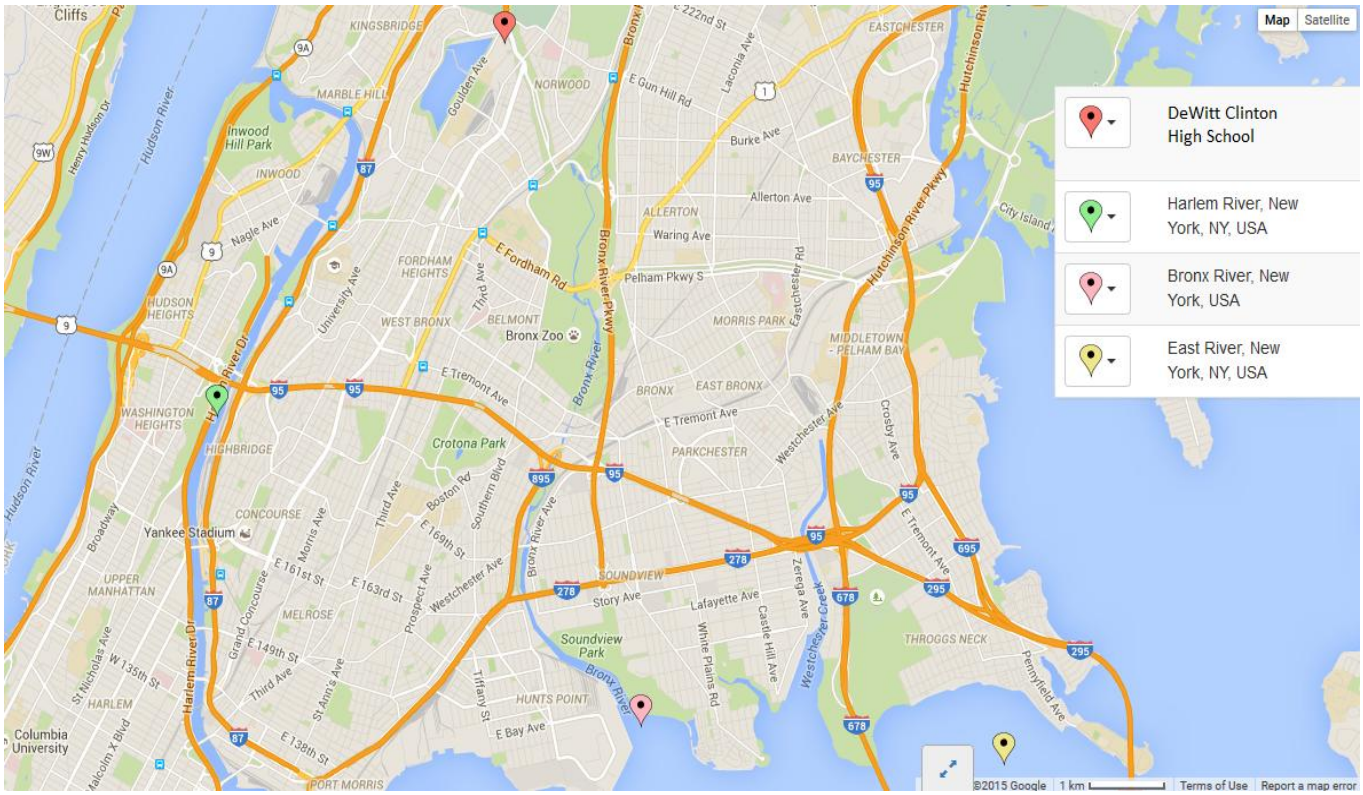
DeWitt Clinton students (and some from other schools) have worked to restore parks and other green areas in these watersheds to prevent erosion and control storm water runoff, reducing pollution of the rivers in a number of ways and helping to decrease CSO events.

Students have planted or mulched 7,600 native trees, shrubs, herbaceous plants, ground cover plants and bulbs, removed invasive plants from 50,000 square feet of land, wood chipped two trails and removed over 1,000 pounds of litter in Van Cortlandt Park, along the northern section of the Bronx River, on the Clinton campus and in the green areas on Mosholu Parkway. They have also built, planted and cared for Clinton's 2,200 square foot garden. Native vegetation will prevent soil erosion and runoff into the Bronx River and absorb precipitation helping to lessen CSO's in the Harlem and East rivers. Removing invasives opens the way for the growth of existing native plants and the planting of new ones.

This kind of restoration work combined with the addition of rooftop and street level gardens, water harvesting systems, bioswales (street level gardens which are designed to manage storm water) and other structures can reduce storm water runoff, lesson CSO's and protect coastal water quality. Watershed models constructed by students can contain some or all of these features.

However none of this could happen or be maintained without the dedicated involvement of the caretakers of these green areas and natural systems. All the work done by Clinton students has been supervised by the Bronx River Alliance Restoration Team, the Friends of Van Cortlandt Park, the Natural Areas Volunteers of the New York City Department of Parks and Recreation and

dedicated teachers from Clinton such as Mr. Ray Pultinas. People who pursue degrees and careers in conservation biology, wildlife conservation, forestry, horticulture, environmental science and environmental education/teaching do this kind of work.



CS 211 and Watersheds in the South Bronx

CS 211 is in the Hunts Point Sewage Treatment Plant sewershed and in the East River and Bronx River watersheds. Wastewater from homes and businesses and storm water from the street level enter sewers that connect to the Hunts Point plant. The water is treated and sent to the East River, thus 211 is in that river's watershed. During combined sewer overflow (CSO) events, which occur during and after a rainfall when water from the streets and water from homes and businesses combine in the sewers to create too much volume for the sewage plants to handle, the sewer water and street level storm water will flow through CSO pipes into the Bronx River-hence the 211 area water also drains to that river. Some surface level runoff from streets may also enter the Bronx River, another reason for placing the school in the Bronx River watershed.

211 students (and students from other schools) have worked to restore parks and other green areas in these watersheds to prevent erosion and control storm water runoff, reducing pollution of the rivers in a number of ways and helping to decrease CSO events.

GrowNYC students from Clinton HS, PS 211, and other schools have planted or mulched over 4,500 native trees, shrubs, herbaceous plants, ground cover plants and bulbs, removed invasive plants from over 36,000 square feet of land, and removed over 1,000 pounds of litter along the Bronx River and on the 211 campus. 211 students have also planted and cared for their garden. Native vegetation will prevent soil erosion and runoff into the Bronx River and absorb precipitation helping to lessen CSO's in the East River. Removing invasives opens the way for the growth of existing native plants and the planting of new ones.

This kind of restoration work combined with the addition of rooftop and street level gardens, water harvesting systems, bioswales (street level gardens which are designed to manage storm water) and other structures can reduce storm water runoff, lesson CSO's and protect coastal water quality. Watershed models constructed by students can contain some or all of these features.

However none of this could happen or be maintained without the dedicated involvement of the caretakers of these green areas and natural systems. All the work done by 211 students has been supervised by the Bronx River Alliance Restoration Team and dedicated teachers from 211 such as Mr. Godlewicz, Ms. Infante, and Dr. Roca. People who pursue degrees and careers in conservation biology, wildlife conservation, forestry, horticulture, environmental science and environmental education/teaching do this kind of work.

From the Bronx River Alliance

Europeans first began exploring the region in the 17th century. For admission prices and hours, call (718) 817-8700.

Drew Gardens

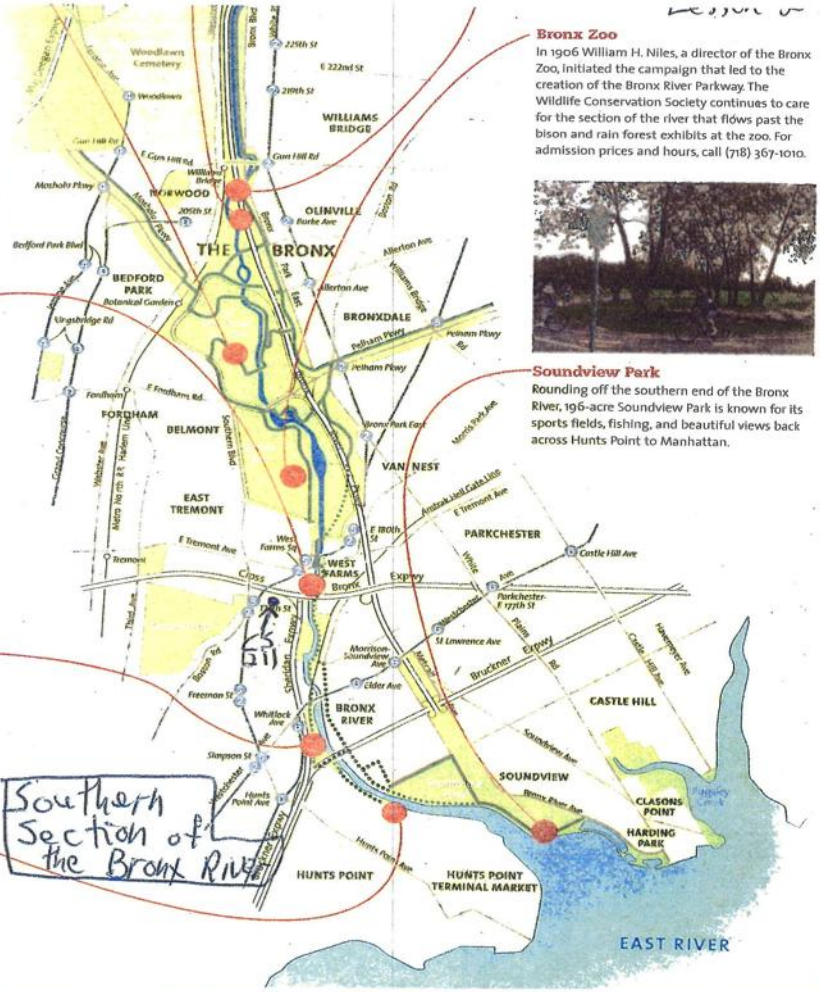
In the late 1990s, the community of West Farms marshaled thousands of volunteers for meetings, clean-ups, plantings and celebrations that resulted in the transformation of a one-acre vacant lot along the river into a thriving community learning garden. For more information about Drew Gardens, call (718) 542-0109, x11.

Concrete Plant Park

For many years, industrial development and highway construction have limited public access to southern stretches of the river. A unique partnership between community organizations and NYC Parks led to the transformation of an abandoned concrete plant into a waterfront park.

Hunts Point Riverside Park

Hunts Point Riverside Park is the culmination of tireless work by community residents to secure land along the river for the Bronx River Greenway. Once an abandoned road end, the site was adopted, cleaned up and beautified by residents and eventually adopted by NYC Parks as parkland.



Bronx Zoo

In 1906 William H. Niles, a director of the Bronx Zoo, initiated the campaign that led to the creation of the Bronx River Parkway. The Wildlife Conservation Society continues to care for the section of the river that flows past the bison and rain forest exhibits at the zoo. For admission prices and hours, call (718) 367-1010.

Soundview Park

Rounding off the southern end of the Bronx River, 196-acre Soundview Park is known for its sports fields, fishing, and beautiful views back across Hunts Point to Manhattan.

Western Queens/Astoria Watersheds

The difficulty in returning electricity service to Western Queens in the wake of the Great Blackout of 2003 led to legal action and the establishment of the Greening Western Queens Fund, based on a fine levied against Con Edison by the Attorney General of the State of NY. The fund was administered by the North Star Foundation.

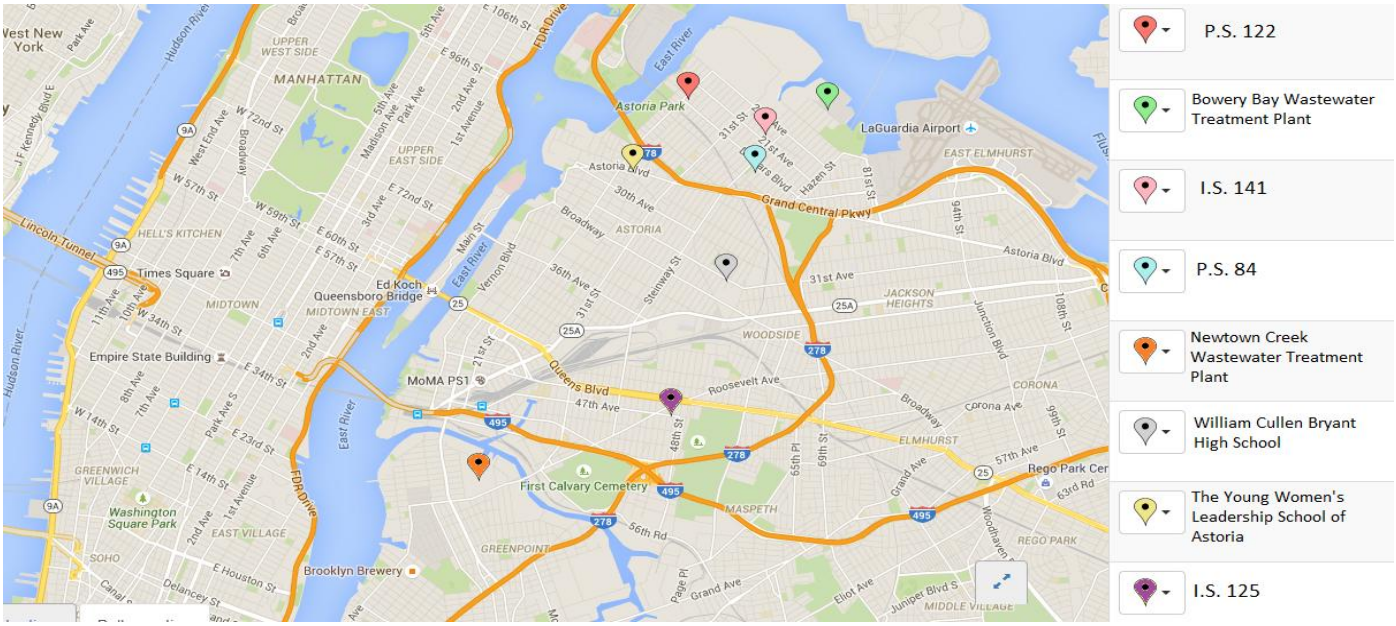
For three years a myriad of organizations performed greening services in Astoria, Sunnyside, Long Island City, and part of Jackson Heights. Several school gardens were orchestrated by GrowNYC's Open Space Greening Program and Grow To Learn while the Environmental Education program implemented its watershed and solar energy modules in 9 schools in the catchment area.

PS 84, PS 122, Young Womens Leadership School of Astoria, IS 141, IS 125 and William Cullen Bryant High School are located in the area of Queens that is in the East River watershed. They are also in the Bowery Bay Sewage Treatment Plant sewershed. Water from homes and businesses and storm water from the street level enters sewers that connect with the Bowery Bay Sewage Treatment Plant. The water is treated and then sent into the East River. During combined sewer overflow (CSO) events, which occur during and after a rainfall when water from the streets and water from homes and businesses combine in the sewers to create too much volume for the sewage plants to handle, water will go untreated into the East River, or through CSO outlets into Flushing Bay or Newtown Creek depending upon location. Hence, the schools are also technically in the Flushing Bay and Newtown Creek watersheds.. Some untreated surface runoff from streets and parks will enter the East River and possibly Flushing Bay.

In the Astoria section of Western Queens youth from PS 122, PS 84, Young Womens Leadership, IS 141 and Bryant HS have mulched 200 trees and planted over 3,200 goldenrod, beardsong, strawberry and other plants in the tree pits on their school campuses and blocks, at Astoria Park and at Woodtree Playground. Mulching and tree pit planting will help trees absorb water, reduce storm water runoff and help lessen CSO events in the Bowery Bay sewershed and the East River, Newtown Creek and Flushing Bay watersheds. This kind of restoration work combined with the addition of rooftop gardens, water harvesting systems, bioswales (street level gardens which are designed to manage storm water) and other structures can reduce storm water runoff, lessen CSO's and protect coastal water quality. Watershed models constructed by students can contain some or all of these features.

However none of this could happen or be maintained without the dedicated involvement of the caretakers of these green areas and natural systems The work described above has been

supported by Brian Aucoin, Matt Genrich and the Natural Areas Volunteers of the NYC Department of Parks and Recreation, Cheryl Blaylock and Sam Bishop of Trees New York and Kyle Richard of Partnership for Parks. People who pursue degrees and careers in conservation biology, wildlife conservation, forestry, horticulture and environmental science do this kind of work.



Wagner Middle School and Its Watershed/Sewershed

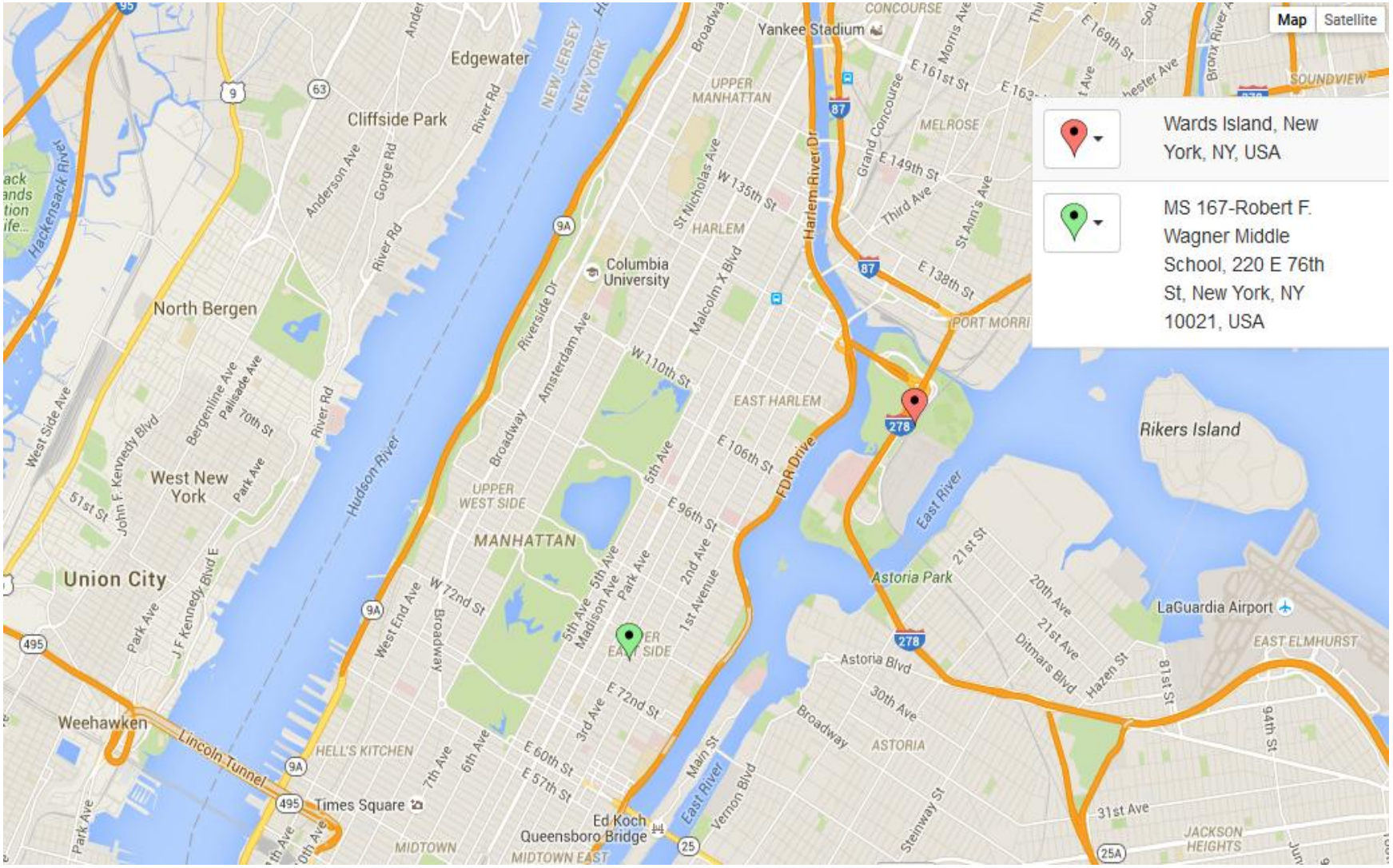
Wagner Middle School is in the Wards Island Sewage Treatment plant sewershed and in the East River watershed. Wastewater from homes and businesses and storm water from the street level enter sewers that connect to the Wards Island plant. The water is treated and sent to the East River, thus Wagner is also in that river's watershed. During combined sewer overflow (CSO) events, which occur during and after a rainfall when water from the streets and water from homes and businesses combine in the sewers to create too much volume for the sewage plants to handle, the sewer water and street level storm water will flow through CSO pipes into the East River. Some surface level runoff from streets may enter the East River as well.

PS/IS 217 on Roosevelt Island, which is in the same city council and school district as Wagner, is in the Bowery Bay Sewage Treatment Plant sewershed and in the East River watershed. Schools in the very southern part of the city council district (approximately below 59th street) are in the Newtown Creek Sewage Treatment Plant sewershed, and in the Newtown Creek and East River watersheds.

In 2013 and 2014, Wagner students worked to control storm water runoff by mulching the trees around the school block and by planting and caring for the school's garden. The mulch will help the trees absorb water in addition to improving their health. The garden will absorb rain water that would have run off that section of the concrete schoolyard into the streets and sewers. Both projects helped to reduce combined sewer overflow.

This kind of restoration work combined with the addition of rooftop gardens, water harvesting systems, bioswales (street level gardens which are designed to manage storm water) and other structures can reduce storm water runoff, lesson CSO's and protect coastal water quality.

People who are the caretakers of Earth can be volunteers from schools and neighborhoods. These people often work with dedicated professionals such as conservation biologists, foresters, wildlife conservationists, horticulturalists, gardeners, environmental scientists and environmental educators/ teachers to preserve and improve the environment.


Map
Satellite
Wards Island, New York, NY, USA
MS 167-Robert F. Wagner Middle School, 220 E 76th St, New York, NY 10021, USA
Yankee Stadium
Edgewater
Cliffside Park
North Bergen
West New York
Union City
Weehawken
Columbia University
HARLEM
EAST HARLEM
UPPER MANHATTAN
UPPER WEST SIDE
MANHATTAN
HELL'S KITCHEN
MIDTOWN
MIDTOWN EAST
Times Square
Ed Koch Queensboro Bridge
Rikers Island
Astoria Park
LaGuardia Airport
EAST ELMHURST
ASTORIA
JACKSON HEIGHTS
SOUNDVIEW
MELROSE
PORT MORRIS
Hudson River
East River
Harlem River
Hackensack River
NEW JERSEY
NEW YORK
Lincoln Tunnel
FDR Drive

Madison High School and Its Watershed

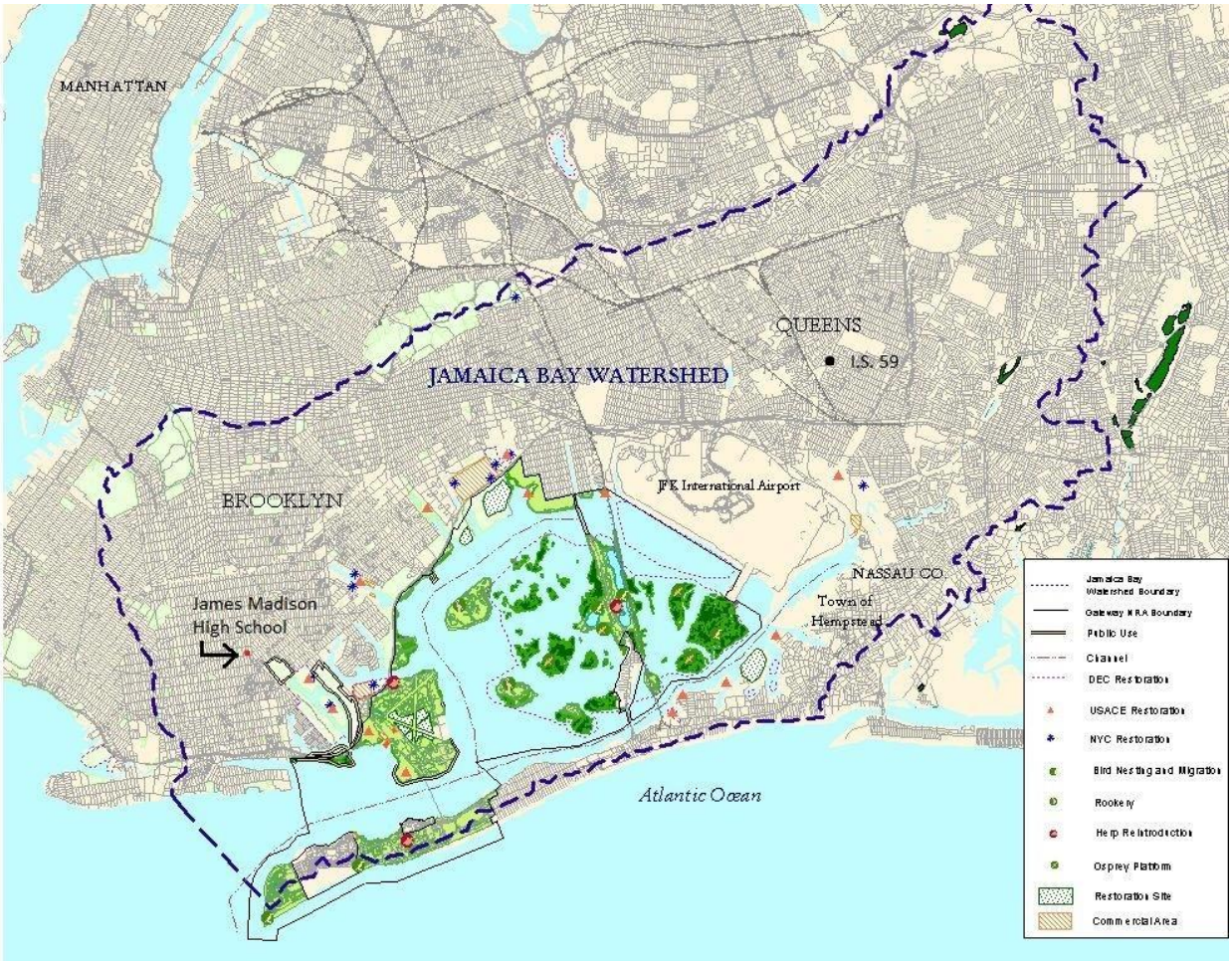
James Madison High School is in the Coney Island Sewage Treatment plant sewershed and in the Jamaica Bay watershed. Wastewater from homes and businesses and storm water from the street level enter sewers that connect to the Coney Island plant. The water is treated and sent to Jamaica Bay, thus Madison is in the bay's watershed. During combined sewer overflow events, which occur during and after a rainfall when water from the streets and water from homes and businesses combine in the sewers to create too much volume for the sewage plants to handle, the sewer water and street level storm water will flow through CSO pipes untreated into the bay and its tributaries such as Gerritsen Creek. Some surface level runoff from streets may also enter Jamaica Bay.

Madison students and (some from other schools as well) have worked to restore parks and other green areas in the Jamaica Bay watershed to prevent erosion and control storm water runoff, reducing pollution of the bay in a number of ways and helping to decrease CSO events.

Students have planted nearly 1,000 native trees, shrubs and other plants and thousands of square feet of salt marsh grass, and removed hundreds of pounds of litter from Marine Park along Gerritsen Creek, from Dubos Point and from land areas in the Rockaways. Native vegetation will prevent soil erosion and runoff into the bay and absorb precipitation helping to lessen CSO's. Removing invasives opens the way for the growth of existing native plants and the planting of new ones.

This kind of restoration work combined with the addition of rooftop and street level gardens, water harvesting systems, bioswales (street level gardens which are designed to manage storm water) and other structures can reduce storm water runoff, lesson CSO's and protect coastal water quality. Watershed models constructed by students can contain some or all of these features.

However none of this could happen or be maintained without the dedicated involvement of the caretakers of these green areas and natural systems. All the work done by Madison students has been supervised by the Urban Park Rangers and the Natural Resources Group of the NYC Parks Department. People who pursue degrees and careers in conservation biology, wildlife conservation, forestry, horticulture, environmental science and environmental education/teaching do this kind of work.


MANHATTAN
QUEENS
I.S. 59
JAMAICA BAY WATERSHED
BROOKLYN
JFK International Airport
NASSAU CO.
Town of Hempstead
James Madison High School
Atlantic Ocean
Jamaica Bay Watershed Boundary
Gateway NRA Boundary
Public Use
Channel
DEC Restoration
USACE Restoration
NYC Restoration
Bird Nesting and Migration
Rookery
Herp Reintroduction
Osprey Platform
Restoration Site
Commercial Area

Newtown Creek Watershed/Sewershed in Greenpoint and Bushwick, Brooklyn and Western Queens

Frances Perkins Academy, Automotive High School, PS 31, PS 34, PS 110 and IS 126 are all in Greenpoint and are located in the Newtown Creek Sewershed and Watershed. Water from homes and businesses and storm water from the street level enters sewers that connect with the Newtown Creek Sewage Treatment Plant. The water is treated at the plant and then sent to the East River, thus the schools are in the East River Watershed too. During combined sewer overflow (CSO) events, which occur during and after heavy rainfall when water from the streets and water from homes and businesses combine in the sewers to create a volume of water too great for the sewage plants to handle, the plant's intake will shut down sending untreated wastewater into the East River or through CSO outlets directly into the creek.

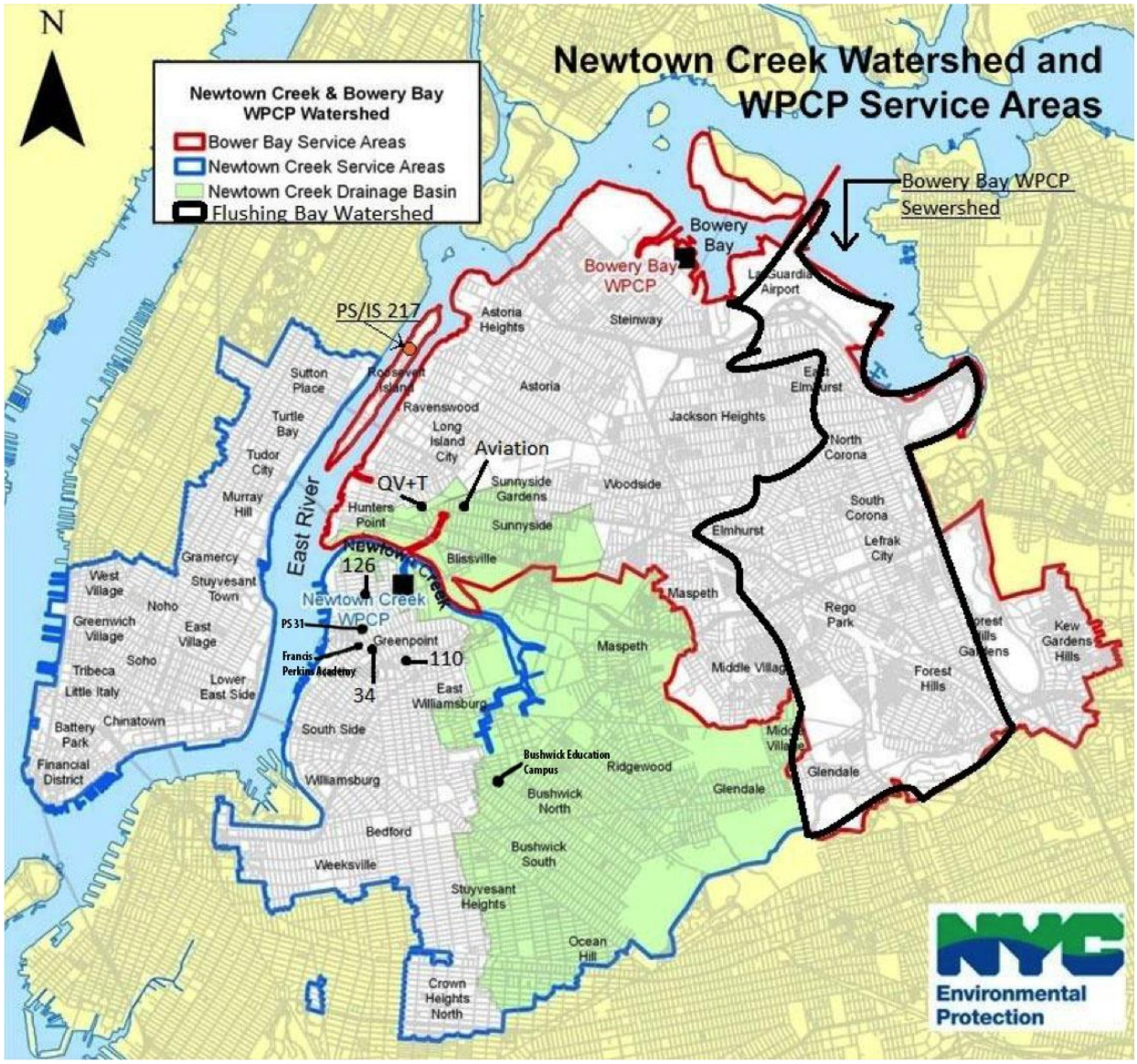
Frances Perkins and PS 31 students planted 13 large trees and 1,020 ground cover plants and shrubs and mulched 62 trees in McCarren Park during the 2011/12 school year. Aviation High School and Queens Vocational and Technical High School in the Long Island City/Sunnyside neighborhoods of Queens are directly in the Newtown Creek Watershed but also in the Bowery Bay Sewage Treatment Plant Sewershed and the overall East River Watershed. Aviation and Queens Vocational and Technical students mulched 122 trees and planted 126 bulbs and herbaceous plants in the neighborhood around the school and on school grounds in 2012/13.

Youth from the Academy of Urban Planning, the Bushwick School for Social Justice and the Academy of Environmental Leadership, all on the Bushwick Campus in Bushwick, Brooklyn, are in the Newtown Creek Watershed and Sewershed. These teens mulched 144 trees in Maria Hernandez Park and 27 trees on their campus. They also planted 33 daylillies on campus.

All of this work by students has led to the mulching of 355 trees and the planting of trees and other plants. Native vegetation and mulched trees will absorb water, reduce storm water runoff and help lessen the number and severity of CSO events. This kind of restoration work combined with the addition of rooftop gardens, water harvesting systems, bioswales (street level gardens which are designed to manage storm water) and other structures can reduce storm water runoff, lessen CSO's and protect coastal water quality. Watershed models constructed by students can contain some or all of these features.

However none of this could happen or be maintained without the dedicated involvement of the caretakers of these green areas and natural systems. The work described above has been

supported by Brian Aucoin, Matt Genrich and the Natural Areas Volunteers of the NYC Department of Parks and Recreation, Cheryl Blaylock and Sam Bishop of Trees New York, Kyle Richard and Bin Zheng of Partnership for Parks and Marechal Brown and Joseph Sanchez , also of the Parks Department. People who pursue degrees and careers in conservation biology, wildlife conservation, forestry, horticulture and environmental science do this kind of work.

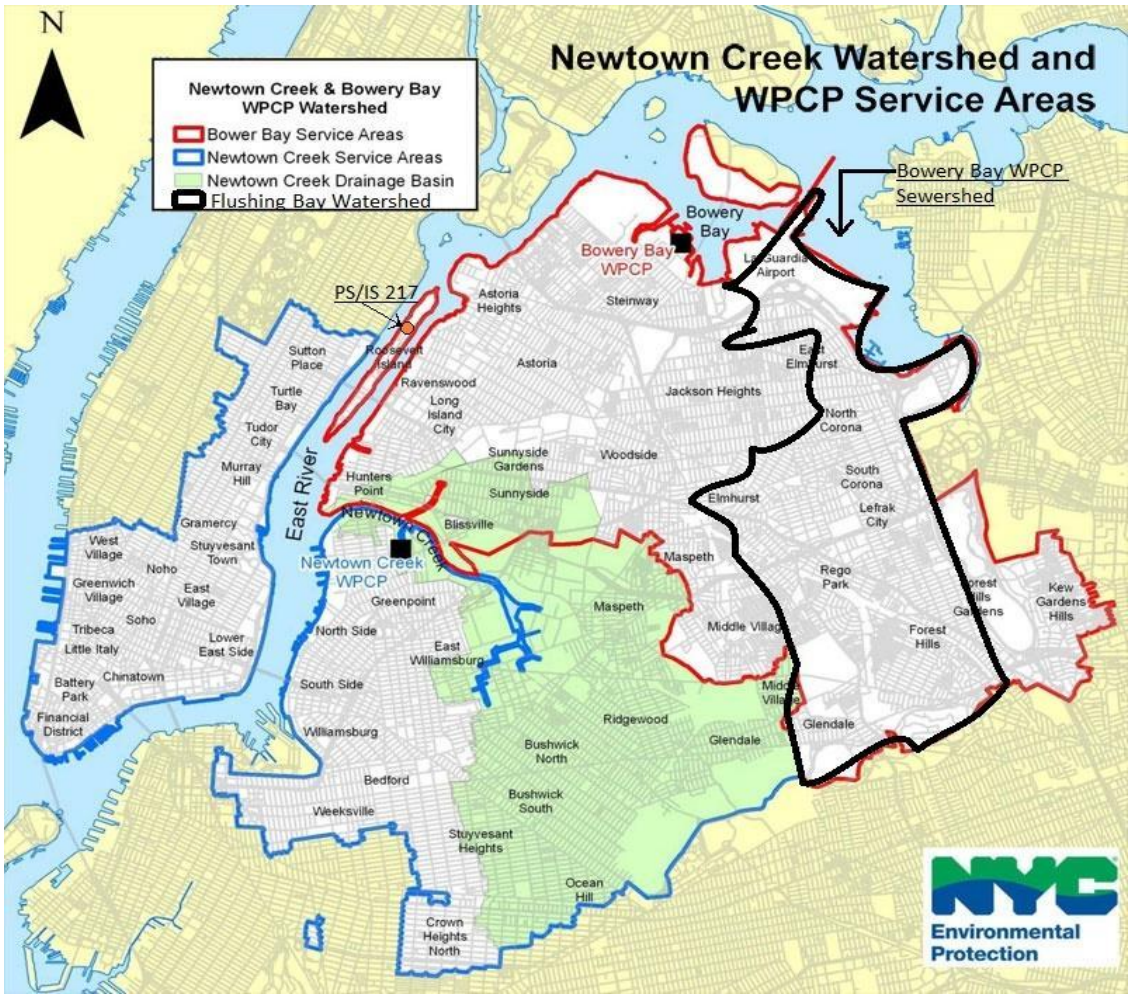


PS/IS 217 and Its Watershed/Sewershed

PS/IS 217 on Roosevelt Island is in the Bowery Bay Sewage Treatment Plant Sewershed and in the East River Watershed. Wastewater from the school, homes and businesses and storm water from the streets enter sewers that connect to the Bowery Bay plant. The water is treated and sent to the East River, thus 217 is also in that river's watershed. During combined sewer overflow (CSO) events, which occur during and after a rainfall when water from the streets and water from homes and businesses combine in the sewers to create too much volume for the sewage plants to handle, the sewer water and street level storm water will flow untreated through CSO pipes into the East River. Some surface level runoff from streets and green areas on Roosevelt Island may enter the East River as well.

Students at PS 217 planted 500 bulbs on the school's campus in 2014. This kind of restoration work combined with the addition of rooftop gardens, water harvesting systems, bioswales (street level gardens which are designed to manage stormwater) and other structures can reduce storm water runoff, lesson CSO's and protect coastal water quality.

People who are the caretakers of Earth can be volunteers from schools and neighborhoods. These people often work with dedicated professionals such as conservation biologists, foresters, wildlife conservationists, horticulturalists, gardeners, environmental scientists and environmental educators/ teachers to preserve and improve the environment.


Newtown Creek Watershed and WPCP Service Areas
N
Newtown Creek & Bowery Bay WPCP Watershed
Bower Bay Service Areas
Newtown Creek Service Areas
Newtown Creek Drainage Basin
Flushing Bay Watershed
Bowery Bay WPCP Sewershed
Bowery Bay
Bowery Bay WPCP
PS/IS 217
Astoria Heights
Steinway
Astoria
Ravenswood
Long Island City
Jackson Heights
North Corona
Sunnyside Gardens
Woodside
Sunnyside
Hunters Point
Blissville
Elmhurst
South Corona
Lefrak City
Maspeth
Rego Park
Middle Village
Forest Hills
Kew Gardens Hills
Glendale
Ridgewood
Bushwick North
Bushwick South
Bedford
Weeksville
Stuyvesant Heights
Ocean Hill
Crown Heights North
Williamsburg
South Side
North Side
East Williamsburg
Greenpoint
Newtown Creek WPCP
Newtown Creek
East River
Sutton Place
Turtle Bay
Tudor City
Murray Hill
Gramercy
Stuyvesant Town
West Village
Noho
Greenwich Village
East Village
Soho
Tribeca
Little Italy
Lower East Side
Chinatown
Battery Park
Financial District
Environmental Protection

Intermediate School 59 and Its Watershed

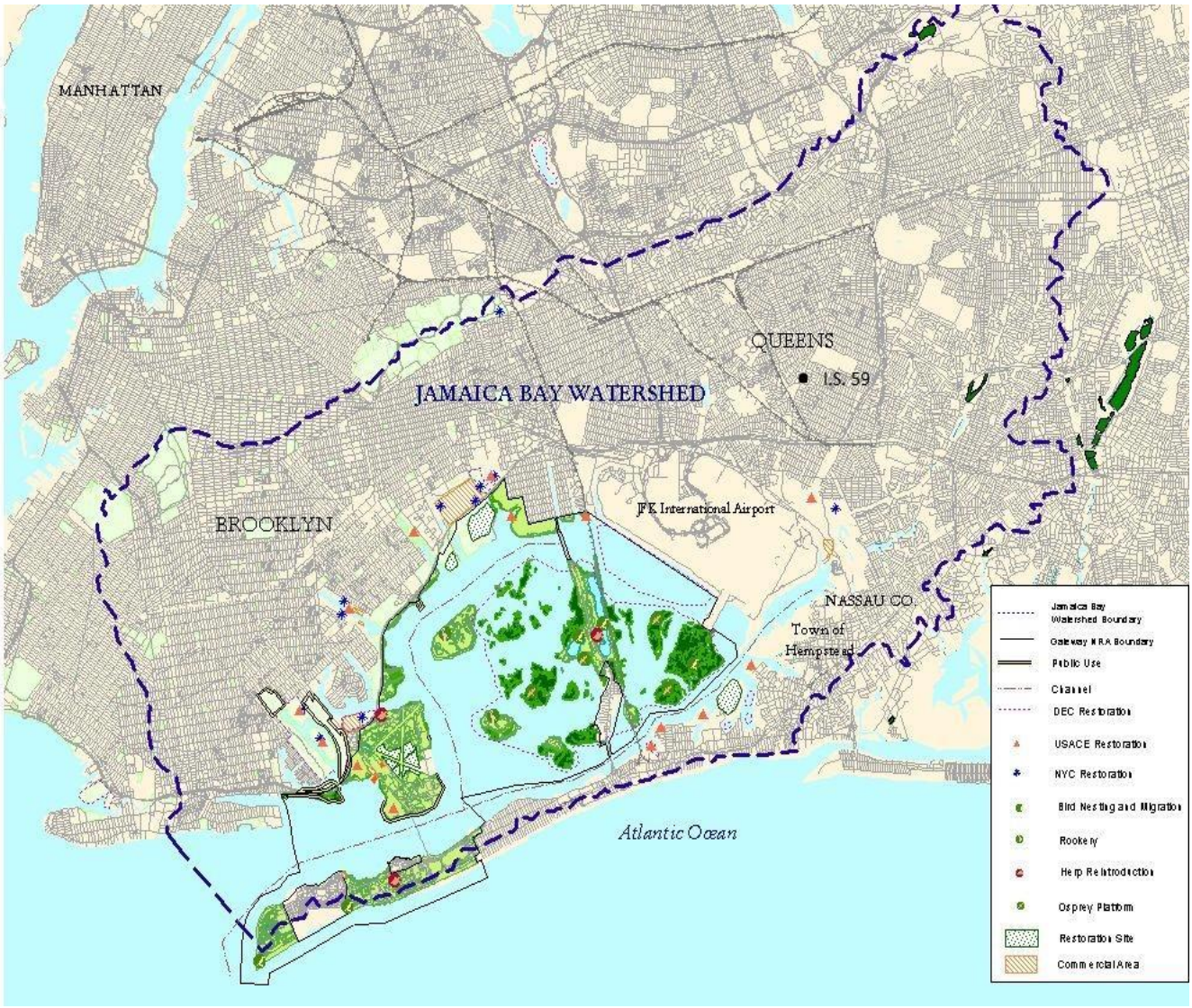
Intermediate School 59 is in the Jamaica Sewage Treatment plant sewershed and in the Jamaica Bay watershed. Wastewater from homes and businesses and storm water from the street level enter sewers that connect to the Jamaica plant. The water is treated and sent to Jamaica Bay, thus IS 59 is in the bay's watershed. During combined sewer overflow events, which occur during and after a rainfall when water from the streets and water from homes and businesses combine in the sewers to create too much volume for the sewage plants to handle, the sewer water and street level storm water will flow through CSO pipes untreated into the bay and its tributaries such as Gerritsen Creek. Some surface level runoff from streets may also enter Jamaica Bay.

Students from several schools have worked to restore parks and other green areas in the Jamaica Bay watershed to prevent erosion and control storm water runoff, reducing pollution of the bay in a number of ways and helping to decrease CSO events.

Students have planted nearly 1,000 native trees, shrubs and other plants and thousands of square feet of salt marsh grass, and removed hundreds of pounds of litter from Marine Park along Gerritsen Creek, from Dubos Point and from land areas in the Rockaways. Native vegetation will prevent soil erosion and runoff into the bay and absorb precipitation helping to lessen CSO's. Removing invasives opens the way for the growth of existing native plants and the planting of new ones.

This kind of restoration work combined with the addition of rooftop and street level gardens, water harvesting systems, bioswales (street level gardens which are designed to manage storm water) and other structures can reduce storm water runoff, lesson CSO's and protect coastal water quality. Watershed models constructed by students can contain some or all of these features.

However none of this could happen or be maintained without the dedicated involvement of the caretakers of these green areas and natural systems. All the work done by students has been supervised by the Urban Park Rangers and the Natural Resources Group of the NYC Parks Department. People who pursue degrees and careers in conservation biology, wildlife conservation, forestry, horticulture, environmental science and environmental education/teaching do this kind of work.


MANHATTAN
QUEENS
I.S. 59
JAMAICA BAY WATERSHED
BROOKLYN
JFK International Airport
NASSAU CO.
Town of Hempstead
Atlantic Ocean
Jamaica Bay Watershed Boundary
Gateway N.R.A. Boundary
Public Use
Channel
DEC Restoration
USACE Restoration
NYC Restoration
Bird Nesting and Migration
Rookery
Herp Reintroduction
Osprey Platform
Restoration Site
Commercial Area

CLASSROOM ACTIVITY

II– Building a Model of a WATERSHED

Introduction: We are going to use basic household and craft materials in order to build a model watershed. We will watch how water moves through the watershed and transports pollutants along the way. Remember, watersheds are important to the environment because they help absorb and collect water.

Supplies Checklist

- Aluminum Tray
- Paper Towel Rolls
- Straws
- Foil
- Construction Paper (green, blue, other)
- Scissors
- Spray Bottle
- Supplies brought from home by students and teacher

Directions

1. You could make two tall mountains on the outer edges of the tray. You could then have a river run between the mountains down to a lake. You could also make a shallow depression for the lake to hold water. If you would like to construct your watershed differently, be creative and come up with your own ideas on how to build your watershed. Also see the pictures of watersheds below.

2. Start constructing structures like buildings, rivers, mountains, and trees to put in your watershed.

Reflection

3. Use the spray bottle to spray water over the watershed. Watch what happens to the water. Where does it go? Does it move? Does it stand still? Is it absorbed? Does it form puddles?
   Record your observations below:

_____
_____
_____
_____
_____

5. Imagine it is raining outside right now. Where does the raindrop go after it hits the school building? Where does it go from there? Where does it end up?

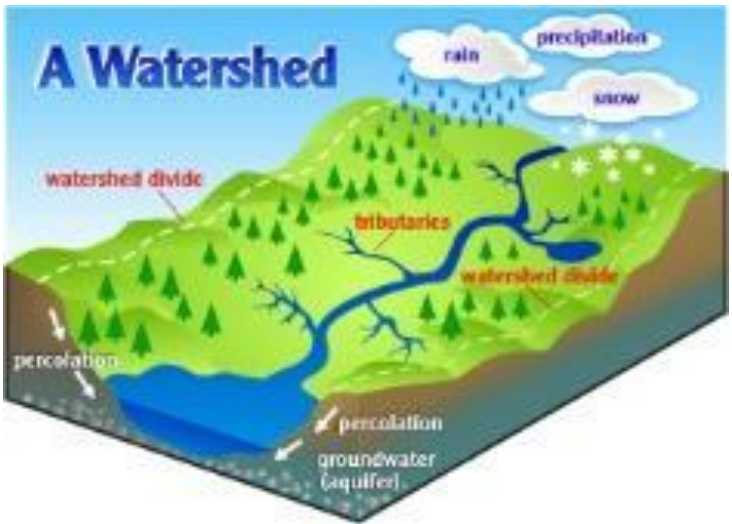
_____
_____
_____
_____
_____

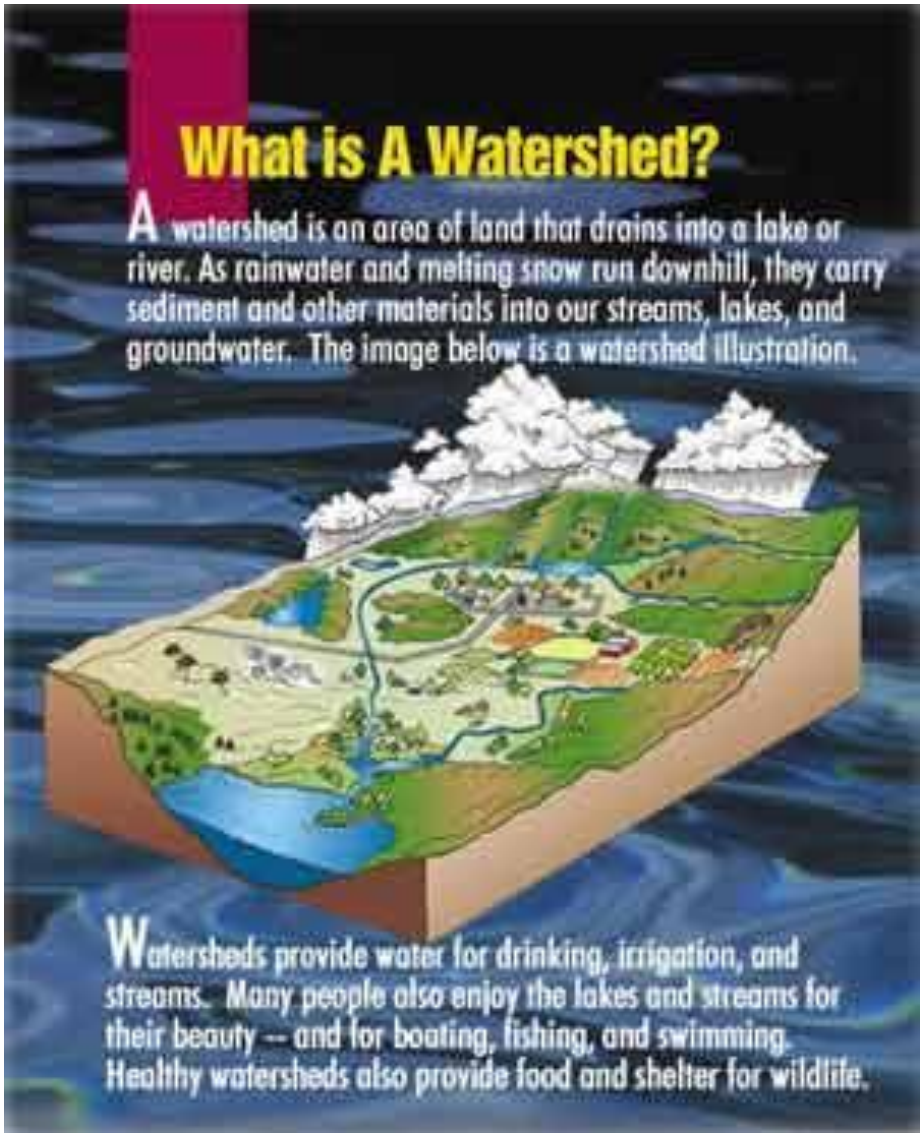
6. What can people do to protect watersheds and the streams, rivers, creeks, ponds, and lakes in the watersheds?

_____
_____
_____
_____
_____

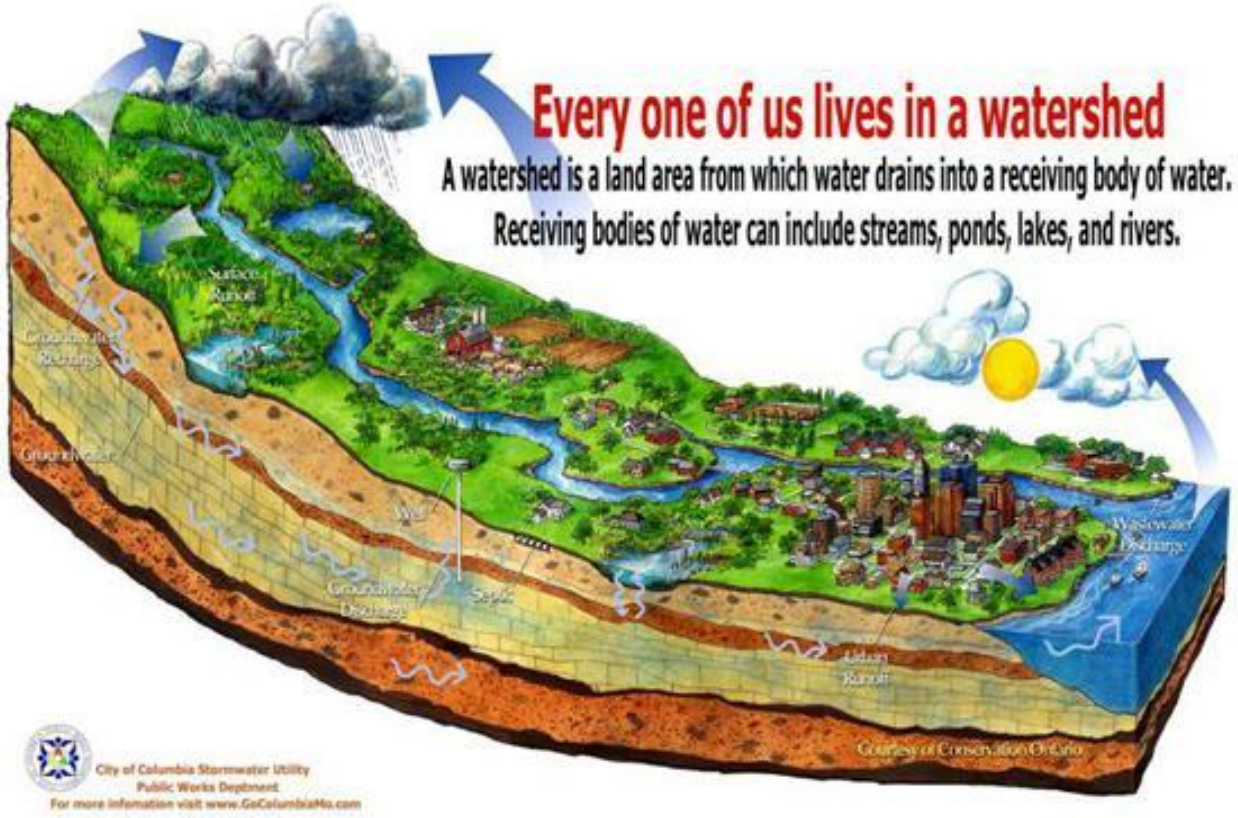
7. How would you educate people about protecting their watersheds?

_____
_____
_____
_____
_____




What is A Watershed?
A watershed is an area of land that drains into a lake or river. As rainwater and melting snow run downhill, they carry sediment and other materials into our streams, lakes, and groundwater. The image below is a watershed illustration.
Watersheds provide water for drinking, irrigation, and streams. Many people also enjoy the lakes and streams for their beauty -- and for boating, fishing, and swimming. Healthy watersheds also provide food and shelter for wildlife.

Groundwater filtering through the soil is also part of the watershed. However, the lack of vegetation in urban areas and increase of impervious surfaces such as roads, cement and asphalt covering the soil in addition to buildings impedes natural filtration. This is the main cause of combined sewage overflow (CSO) following a rain or snowstorm where the sewer system flow exceeds average capacity. During the Habitat Restoration portion, we partner with other organizations such as TreesNY to help revitalize urban communities by planting trees and vegetation to minimize CSO events.



Evapotranspiration: combined processes of evaporation and plant transpiration from the Earth's land surface to atmosphere.

Runoff: excess water flowing over land once soil is infiltrated to full capacity from rain and melt water.

Infiltration: process of surface water entering the soil.

Impervious (surface): does not allow to pass through; an impenetrable surface (examples: pavements, roads, sidewalks…)

Watershed:

http://www.portal.state.pa.us/portal/server.pt?open=514&objID=588795&mode=2

http://www.mywatersheds.com/the-watershed/what-is-a-watershed-2/#!prettyPhoto

Generic Run Off image

http://science.nasa.gov/earth-science/oceanography/ocean-earth-system/ocean-water-cycle/

Generic Watershed image

Urban watershed model:

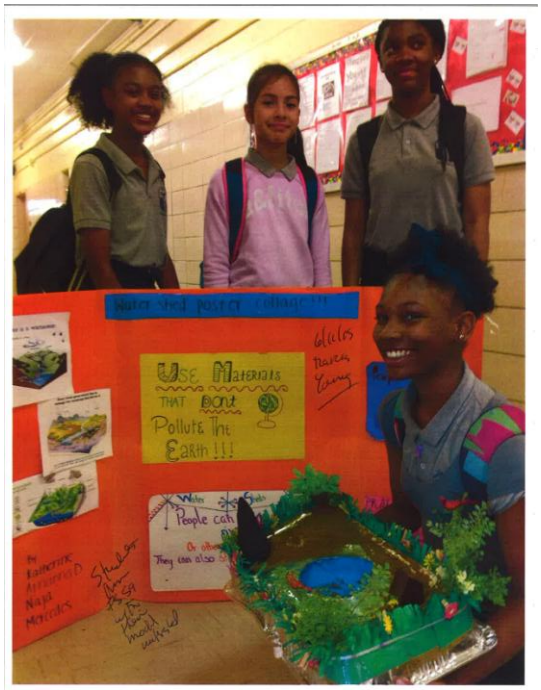
http://www.conservation-ontario.on.ca/source_protection/files/watershed_labeled_hor.jpg

CLASSROOM ACTIVITY

II A- CREATING A WATERSHEDS DISPLAY

Review the students' answers to questions 5, 6, and 7 on the Model Watershed Demo sheets. Choose the most accurate and well written statements and assign specific ones to each group. Give the students magic markers, crayons, decorative paper of different color and grade, and ask them to prepare signs/posters briefly describing their model watersheds using the statements they or their classmates made. Each group should prepare at least one sign; more can be made by each group but they are not required to do so.

Set up the kids' models with accompanying posters or signs in an appropriate venue- the school library, school entrance, auditorium, etc. Displays can also be set up in a public venue such as an environmental facility or museum. Invite other classes, parents and community residents to view the models. The watershed class(es) should be present for at least one session during which they explain their models and answer questions.



STUDENTS FROM IS 59- JAMAICA, QUEENS, WITH THE MODEL WATERSHED THEY DISPLAYED AT THE NY HALL OF SCIENCE- STEMTASTICS FAIR

CLASSROOM ACTIVITY

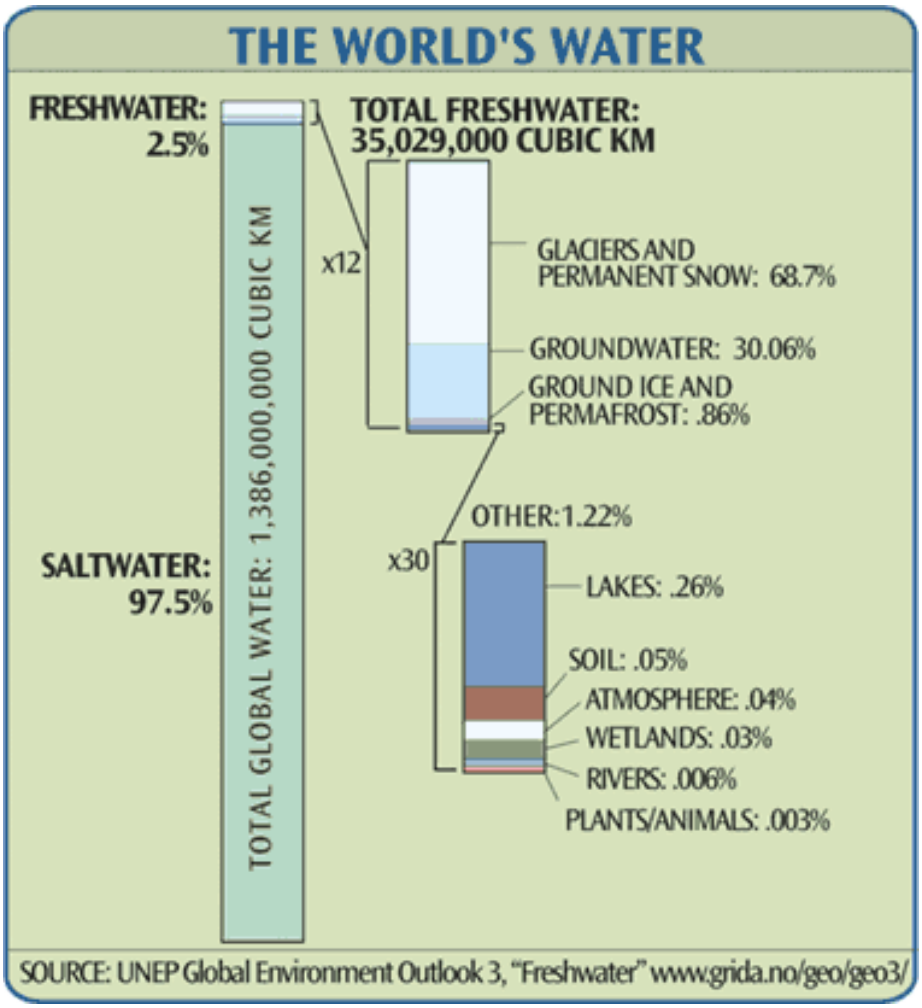
II B- Watershed Restoration Projects

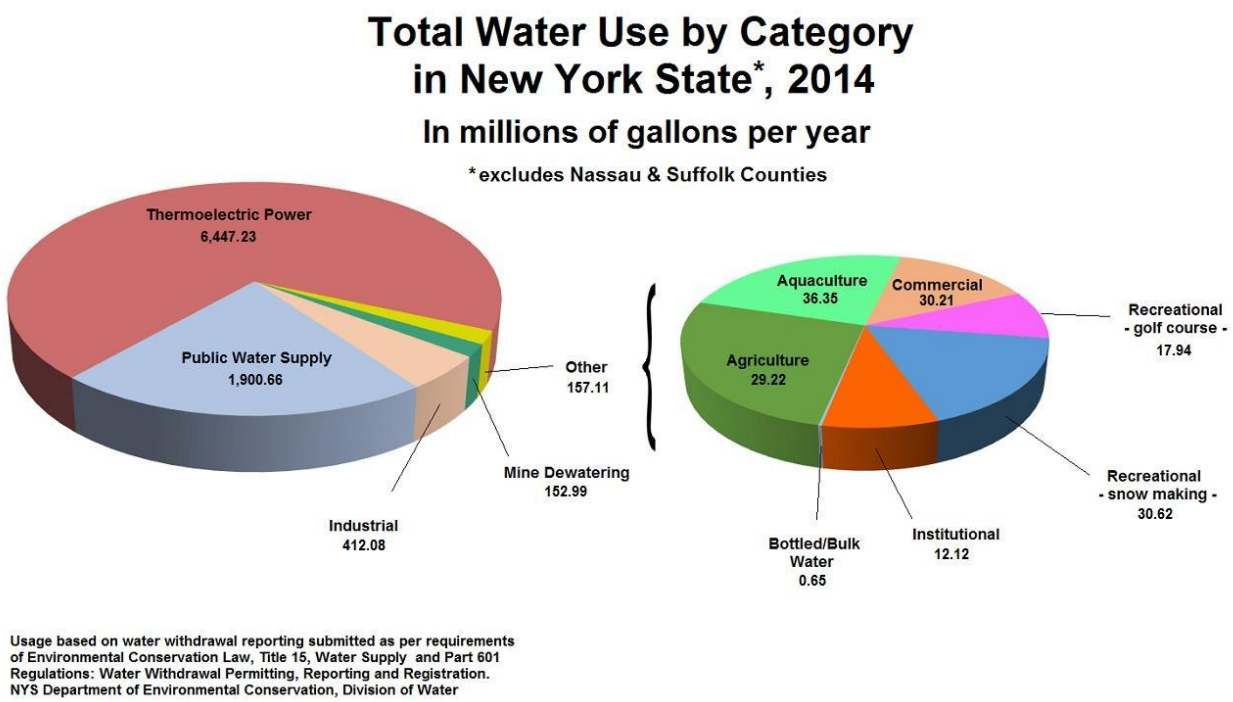
In GrowNYC's Environmental Education Program the restoration projects have been one or more of the following: native tree or shrub planting, planting herbaceous plants, ground cover plants or bulbs, mulching trees, removing invasive plants, removing plastic floatables and other specialty projects such as installing matting to facilitate the planting of native plants and prevent the return of invasives. Planting prevents erosion and storm water runoff and preserves water quality. Mulching helps trees absorb water and control storm water runoff and keeps trees healthy. Invasive removal takes out plants that don't do a good job of holding soil in place and absorbing water in and can be replaced by native plants that perform those services better. Litter removal protects fish and other water based organisms.

Organizing such a project is a straightforward process. In NYC, an email or phone call to the parks department will yield information with respect to a person or group most responsible for the local body of water near the school, e.g., Bronx River Alliance; contact with that person or group should provide necessary information about what dates and sites are available. That contact will also have information on the history and ecology of the specific watershed which can be merged with the material in this manual. The agency representative may also be available for a presentation to the class(es).

For more information on project organizing google GrowNYC's" Training Student Organizers Curriculum" and/or Urban Environmental Education by Jeff Frank and Mike Zamm.

III- Summary Fact Sheets On Water





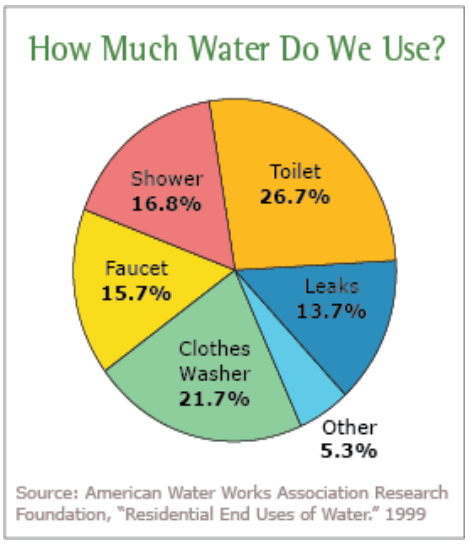
The most prominent uses of water in the state of New York is for the generation of thermoelectric power and for the public water supply.

Some things New Yorkers can do in order to reduce the amount of water used for generating thermoelectric power:

➢ Reduce Electricity Use: By using less electricity, New Yorkers can lessen the demand for water to be used to produce electricity.

➢ Use Alternative Energy: Alternative renewable energy sources such as solar and wind can produce electricity without the need to use water for energy production.

Some things New Yorkers can do in order to reduce the amount of water used for the public water supply:



➢ Replace Old Toilets: New low-flow high efficiency toilets use a lot less water per flush than older toilets.

➢ Wash Full Loads: Washing only full loads can lead to doing laundry/dishes less frequently, saving more water.

➢ Shorter Showers: Spending a few less minutes per shower can save hundreds of gallons per month.

➢ Smart Faucet Use: Simply turning the faucet off while not in use (brushing teeth, shaving, lathering hands with soap, etc.) saves a considerable amount of water.

➢ Fix Leaks: Fixing leaks will save water, as well as money from paying for water that is used for nothing.

IV-Perspectives on Two Watersheds

JAMAICA BAY

The A train (Far Rockaway version) ride from Howard Beach-JFK across Jamaica Bay to Broad Channel is one of the most beautiful urban public transportation rides in the world. The train snakes along a section of track that is merely several feet above the massive expanse of Jamaica Bay. Early on a sunny morning the bay shimmers with reflected light. It takes the traveler more than a few seconds to really comprehend that he/she is in NYC.

The small boats and simple houses along the shoreline are in contrast to the structure of steel and concrete upon which the electric powered iron horse rumbles on its way to the Rockaways.

Jamaica Bay is one of nature's great gifts to NYC.

"The Jamaica Bay Wildlife Refuge, part of the Gateway National Recreation Area, is one of the most significant bird sanctuaries in the Northeastern United States and one of the best places in NYC to observe migrating species." (1-http://www.nyharborparks.org/visit/jaba.html)

The park's unique landscape contains a variety of rare native habitats including a salt marsh, upland field and woods, several fresh and brackish water ponds, and an open expanse of bay. There is a wide variety of ranger and partner-led programs offered year-round. (Ibid.-1).

Approximately 1,400 acres of tidal salt marsh have been lost from the Jamaica Bay Marsh Islands since 1924. There is no consensus among experts on the cause of this- explanations range from rising sea levels and warmer temperatures to nitrogen input from water run-off. A number of restoration projects have or are being implemented to try and remedy this situation (US Army Corps of Engineers, New York District).

One of these restoration efforts, the 2010 Nitrogen Agreement between Jamaica Bay ECO-Watchers, American Littoral Society, NY/NJ BayKeeper, Natural Resources Defense Council and the City of New York has resulted in the biggest positive impact to water quality since sewage treatment began. The amount of nitrogen released into the bay has decreased from 50,000 pounds per day to 30,000 pounds daily. The effect includes cleaner water and decrease in algae

blooms and fish die-offs (2-Water Wire, Waterfront Alliance, http://waterfrontalliance.org/2015/11/03/state-of-jamaica-bay-improving) .

There are a number of critical habitat rehabilitation projects including the Sunset Cove Marsh Restoration being undertaken by the NYC Department of Parks (Ibid-2).

GrowNYC's Environmental Education program has a significant history in the Jamaica Bay Watershed. In the late 1980's students from Beach Channel High School, under GrowNYC's (then Council on the Environment of NYC) supervision, conducted a campaign to galvanize public support for Dubos Point, a 33 acre wetland adjoining the bay. Students planted salt marsh grass, removed litter, and tabled at nearby shopping centers to educate local residents about the importance of the wetland in protecting Jamaica Bay.

The project played a role in creating the context within which a number of city, state and federal agencies and the National Audubon Society signed an agreement to preserve and protect Dubos Point.

In the 1990's and early 2000's GrowNYC involved students at Beach Channel in building a wildlife habitat on the campus, which was adjacent to the bay and in planting hundreds of native trees, shrubs, herbaceous plants and bulbs on campus to provide habitat, prevent erosion and preserve water quality.

Youth from Madison HS removed hundreds of pounds of litter from Marine Park along Gerrittsen Creek in the Jamaica Bay Watershed. Youth from Madison later helped to organize the Friends of Marine Park which generated many projects to preserve and improve the watershed.

More recently students from IS 59 in Jamaica, Queens planted hundreds of herbaceous plants and bulbs and mulched trees on their campus which is in the Jamaica Bay Watershed. The project will help manage storm water runoff and combined sewer overflows in the Jamaica Sewage Treatment Plant sewershed.

IS 59 youth also built models of a watershed and displayed them to educate others about watershed protection at the STEMTASTICS Fair at the NY Hall of Science in Flushing Meadows Park in Queens.

THE DELAWARE WATERSHED

Tucked in a corner of the northwestern Catskills, 175 miles from NYC, the Little Delaware River flows towards the Cannonsville Reservoir where it performs its role as a tributary to the giant reservoir by emptying into the West Branch of the Delaware River, which in turn is impounded to form the reservoir. Delaware River water is shared by four states- NY, NJ, Delaware and Pennsylvania.

It is in this area, in the 1.3 million square foot Delhi Outdoor Education Center, built and landscaped first by Americorps members from SUNY Delhi's Catskill Outdoor Education Corps and then students and staff in the University's Division of Applied Science and Recreation, that youth from DeWitt Clinton High School have planted some 3,000 native trees and thousands more willows to prevent erosion and preserve water quality.

Within the city's massive 2,000 square mile drinking water supply system, the Delaware Watershed is the largest of the three watersheds (Catskill and Croton are the other two), providing 50% of the water from 4 large reservoirs including the Cannonsville. Due to its distance from the city and its somewhat obscure location, the Delhi section of this watershed does not receive as much public attention or remediation as other areas in the city's vast water network. Too, most schools when they visit the watershed opt for the closer Croton or Catskill sheds. They stay at the Clearpool Education Center in the Croton Watershed or at Frost Valley in the closer section of the Catskills rather than Delaware County's 4H Camp Shankitunk where the Clinton kids have stayed for 13 out of the last 14 years when they visit the watershed. Many children from the vicinity attend the 4H camp run by Cornell Coop Extension during the summer and quite a few of these kids have gone on to environmental careers.

This corner of the water supply system has been pounded with storms in recent years as has the overall region, causing significant erosion, making the work of the Clinton students more important. Dave DeForest of the aforementioned Applied Science and Recreation Division of SUNY Delhi and Catherine Skalda of the Delaware County Soil and Water Conservation District have been extremely supportive. Cornell and the camp staff are also invaluable resources.

The Clinton students have often visited "best practices" farms when they are in the watershed and two of the best are Betty Acres Organic Farm which produces the most wonderful aged cheeses while practicing humane treatment of its cows so that they live twice as long as those in larger commercial operations and Lucky Dog Organic Farm which grows vegetables and on which the Clinton teens have performed invasive removal, harvesting and seeding projects in the last two years.

REFERENCES

- NYC Department of Parks and Recreation-Natural Resources Group: http://www.nycgovparks.org/greening/natural-resources-group
- Fort Tryon Park Historic Trust:

  https://www.forttryonparktrust.org/
- NYC Department of Parks and Recreation- Northern Manhattan Parks:

  http://www.nycgovparks.org/park-facilties/northern-manhattan-parks/master-plan
- NYC Department of Parks and Recreation- Riverside Park Fund:

  https://riversideparknyc.org/
- NYC Department of Parks and Recreation- Urban Park Rangers:

  http://www.nycgovparks.org/programs/rangers
- Bronx River Alliance:

  http://www.bronxriver.org/
- Friends of Van Cortlandt Park :

  http://vancortlandt.org/
- Natural Areas Volunteers of NYC Department of Parks and Recreation:

  http://www.nycgovparks.org/registration/nav/1761
- Trees New York:

  http://www.treesny.org/
- Partnership for Parks:

  http://www.cityparksfoundation.org/partnerships-for-parks/