Map Resource Guide for Teachers
New York City's Water Story: From Mountain Top to Tap

What does this map tell us?

New York City's Water Story: From Mountain Top to Tap (see addendum) has been created to help young people explore the New York City Water Supply System and how the water cycle affects their everyday lives. Maps are also tools for finding our way. Students can locate places and natural and human-made features within the watersheds and New York City that relate to their study of water; they can examine and compare different features by exploring their physical and cultural characteristics and how they function in our interdependent world.

The map can complement multi-disciplinary lessons. It can foster an understanding of the geography of the region during past times and how today it has played important roles in the life cycle of people, their ideas, and living environments.

Graphic symbols, place names, lines, shapes, colors, patterns, elevations, and scale are just some of the valuable map-reading skills that can be developed while students are engaged in cooperative learning activities.

Background

Encompassing almost 2,000 square miles, the New York City Water Supply System consists of the Croton, Catskill, and Delaware Watersheds. Within these three watersheds, rain and snow are captured and stored in 19 reservoirs and three controlled lakes, with a capacity to hold approximately 580 billion gallons of fresh water. About one billion gallons of water is delivered each day to more than 8.6 million people by gravity.

Objectives

- To help students understand where their water comes from and the implications of building, operating, and maintaining a water supply system.
- To learn about watersheds as a living, working, natural landscape.
- To identify the natural and constructed features of the New York City Water supply system.
- To encourage discussion about many relevant topics, including geography, topography, climate change, land use, engineering, scale, economics, water quality, eminent domain, watershed protection, forestry, technology, conservation, stewardship, and careers.

Suggested Activities

1) Use **New York City's Water Story: From Mountain Top to Tap** to explore the New York City water supply system. Ask your students: If a raindrop fell within a watershed, how would it get to consumers? What path could water take if it were to spill over a dam instead of going through an aqueduct?
2) Map scavenger hunt: Identify the largest and smallest reservoir, the highest and lowest reservoir elevations, the legend, compass, etc.
3) Using the map's photographs and captions, create a storyline for water travelling from a reservoir to NYC.
4) Design your own map that features your environment.

5) Create a folktale about the water system and its history.
6) Create a reservoir timeline.
7) Research the history of the water supply system, its impact on local communities, agricultural and recreational activities, watershed protection, and other topics.
8) Research the Watershed Memorandum of Agreement (1997) and the Filtration Avoidance Determination (2007).
9) Use the Watershed Activity to familiarize students with watersheds.
10) Discuss this quote from naturalist and Catskill Mountain resident, John Burroughs:

"To find the universal elements enough; to find the air and the water exhilarating; to be refreshed by a morning walk or an evening saunter . . . to be thrilled by the stars at night; to be elated over a bird's nest or a wildflower in spring - these are some of the rewards of the simple life."

11) Introduce vocabulary in the Glossary.
12) This map can spark conversation about many other themes. Follow-up lessons can cover topics such as:
    a. Stream ecology
    b. Forest management
    c. History of the water supply
    d. Drinking Water quality
    e. Wastewater treatment
    f. Harbor Water Quality
    g. Water Conservation
    h. Careers
13) Introduce and discuss some of the essential questions listed below.
14) Compare the 1938 Water Supply of New York City map with the new Water Story map. (See addendum)

Essential Questions

History/Social Studies:

- Before looking at this map, where did you think your water came from? How does this map shift the way you view your environment?
- How is water a part of New York City history?
- How has the history of our water supply system shaped our traditions and ideas about water as a society?
- What is the historical timeline of the NYC water supply system?
- Where else might NYC have gone to get water? What challenges would this alternative have presented?
- Why do you think NYC had to look for water outside of the city? What is eminent domain?
- Who are some of the key figures in the creation of NYC's water supply system?
- What other primary and secondary sources could we use to learn more from this map?
- What is the value of maps?

Water Cycle

- Why is water important?
- How do you use water?
- How much of our Earth is covered in water? How much is fresh water?
- How is water recycled by natural processes on Earth?
- What other organisms and ecosystems depend upon the water cycle?
- How do the properties of water affect living things and the natural environment?

- How does seasonal change affect temperature and weather conditions over time?
- How can you describe the properties of water?
- Why are there different climates on Earth and how can climate be altered?

Watersheds

- What is a watershed?
- How does land-use differ across the watersheds? How do air, water, and land interact? How do plants and animals interact?
- How do people interact within the watersheds?
- How are plants, animals, and water in an ecosystem connected? What organisms thrive in Croton, Catskill and Delaware Watersheds? How does this compare to the organisms found thriving in New York City?
- What are the processes that help shape the land?
- How do plants, animals, and people respond to environmental changes?

Water Supply

- How were communities impacted by the building of reservoirs?
- How do we gather data about our water supply system?
- How do natural events impact our water supply?
- What force allows water to travel naturally from watersheds to NYC?
- What are dams and how are they constructed? What are spillways and how do they connect to natural systems?
- How do plants, animals, and landforms differ within the watersheds and New York City?
- How do living and nonliving things interact in this system?
- What investigations do scientists perform? How do scientists gather, use, and share water quality information?
- What role does the government play in regulating water? How is New York City water regulated? How is bottled water regulated?
- How has technology changed the way water systems are designed, constructed, operate, and are maintained? What are some current local, national and global water supply issues?

Drinking Water Quality

- How do forests influence water quality? What is the value of trees (and how do their many parts function)?
- Which forms of energy affect our water supply system (heat, electric, sound, chemical, mechanical, light)?
- How do the properties of water affect living things and the natural environment?
- How does weather impact water quality?
- How is water tested? What parameters are used? Who performs these tests?
- How is water quality protected?
- What is climate change and how does it impact water supplies and water quality?

Water Use and Wastewater Treatment

- How is water used at home and school?
- How much water do you use?
- What is wastewater? Where is your wastewater treated? How is your wastewater treated? What other processes are used for treating wastewater?
- What are sewers and how do the different types of sewers function? What are storm drains?
- What is the proper way of disposing of cooking grease and wipes? Why?
- How does water waste and the improper disposal of waste (such as cat litter, cooking grease and sanitary-wipes) impact wastewater treatment and harbor water quality?
- How can climate change and severe rain events impact wastewater treatment and harbor water quality? How can increased population impact wastewater treatment?
- How is stormwater managed in your community and in other watershed and New York City communities? What is green infrastructure?
- Where does wastewater go after treatment? Where does it go in other parts of the watershed and NYC?
- Why is New York City harbor water quality monitored? What parameters are tested and why?
- What chemical and biological tests can you perform on drinking water, streams, and harbor water? What observations are also scientifically useful? What do these tests indicate about water quality?
- How can you help ensure that wastewater treatment works effectively? How can you help protect stream and harbor water quality?

Our Role in the Community

- How were our reservoirs created? How were local communities impacted? Are these impacts still apparent today? How does this relate to economics?
- Do you think that the lives of students who live in the watershed or New York City are very different than yours? If so, how?
- How do we pay for water?
- What does conservation mean? How can we conserve water?
- Why is it important to care for our street trees and other forms of green infrastructure?
- Why is street litter more than just unsightly?
- What rights and responsibilities do we have as consumers and stewards of water?
- How would you attempt to solve a water conflict in the community (scarcity, pollution etc.)?
- What other questions come to mind when you look at this map?
- How can we best inform the community about the importance of stewardship?
- What stewardship activities already exist?
- How can we best inform the community about the value of creating and sustaining natural habitats?
- What jobs and careers are available in water-related fields? How can you take advantage of these opportunities?

Our Water Supply System

Croton System-Collecting Reservoirs and Lakes

Amawalk Reservoir
- 6.7 billion gallons

Bog Brook Reservoir
- 4.4 billion gallons

Boyd's Corners Reservoir
- 1.7 billion gallons

Cross River Reservoir
- 10.3 billion gallons

Croton Falls Main Reservoir
- 14.2 billion gallons

Diverting Reservoir
- 900 million gallons

East Branch Reservoir
- 3.9 billion gallons

Middle Branch Reservoir
- 3 billion gallons

Muscoot Reservoir
- 4.9 billion gallons

New Croton Reservoir
- 19 billion gallons

Titicus Reservoir
- 7.2 billion gallons

Lake Gilead
- 380 million gallons

Lake Gleneida
- 165 million gallons

Kirk Lake
- 565 million gallons

Catskill System-Collecting Reservoirs

Ashokan Reservoir
- 128 billion gallons

Schoharie Reservoir
- 17.6 billion gallons

Delaware System-Collecting Reservoirs

Cannonsville Reservoir
- 95.7 billion gallons

Neversink Reservoir
- 34.9 billion gallons

Pepacton Reservoir
- 140.2 billion gallons

Rondout Reservoir
- 49.6 billion gallons

West Branch Reservoir
- 8 billion gallons

Catskill/Delaware Systems-Storage, Balancing and Distribution Reservoirs

Hillview Reservoir*
- 900 million gallons

Kensico Reservoir
- 30.6 billion gallons

Croton System-Distributing Reservoirs

Jerome Park Reservoir*
- 800 million gallons

Central Park Reservoir*
- 1 billion (no longer in service)

Silver Lake Reservoir (tanks)*
- 100 million gallons

* The Hillview, Jerome, Central Park and Silver Lake Reservoirs are fed by water flowing through aqueducts and water pipes. This is unlike New York City's 19 other reservoirs that are fed by creeks, streams and rivers.

Our Wastewater Treatment System

New York City Wastewater Treatment Plants and Design Capacity MGD (million gallons per day).

The following lists are in order by the year the plants began operation, from the oldest to the newest.

Coney Island
- 110 MGD

Jamaica
- 100 MGD

Wards Island
- 275 MGD

Bowery Bay
- 150 MGD

Tallman Island
- 80 MGD

26th Ward
- 85 MGD

Hunts Point
- 200 MGD

Owls Head
- 120 MGD

Rockaway
- 45 MGD

Port Richmond
- 60 MGD

Oakwood Beach
- 40 MGD

Newtown Creek
- 310 MGD

North River
- 170 MGD

Red Hook
- 60 MGD

New York City Owned and Operated Wastewater Treatment Plants Located in the East- and West- of the Hudson Watersheds and Design Capacity MGD (million gallons per day).

*Port Jervis
- 2.5 MGD

Grahamsville
- 0.18 MGD

Tannersville
- 0.8 MGD

Mahopac
- 0.3 MGD

Pine Hill
- 0.5 MGD

Grand Gorge
- 0.5 MGD

Margaretville
- 0.4 MGD

* Located outside the New York City watersheds. The U.S. Supreme Court required New York City to build and operate a wastewater treatment plant in Port Jervis as part of the 1931 decree that allowed the city to build the first parts of its Delaware Water Supply System.

For additional information about New York City wastewater treatment plants, please refer to the map located in the addendum of this teacher guide.

Glossary

These terms appear on the water supply map:

Aqueduct: Conduit, or structure, used to carry water over a long distance.

Dam: Barrier used to obstruct the flow of water.

Ecosystem: System formed by the interaction of a group of organisms and their environment.

Evaporation: Process of liquid water becoming water vapor.

Erosion: Process in which a material is worn away by water or air, often due to the presence of rough particles.

Evapotranspiration: The sum of evaporation from land surface plus transpiration from plants.

Filtration: Using a filter, the process of removing substances from water, soil, and air.

Groundwater: Water found underground in the cracks and spaces in soil, sand and rock.

Hydrological Cycle (Water Cycle): The exchange of water through Earth's land, ocean, and atmosphere including the cyclic transfer of water vapor from the Earth's surface through evaporation and transpiration into the atmosphere, from the atmosphere to precipitation back to earth, and through run-off into streams, rivers, lakes, and oceans, and natural recycling continues.

Reservoir: Natural or artificial place where water is collected and stored for use.

Wastewater: Used water and solids from homes, businesses, and schools, and stormwater.

Wastewater Treatment Plant: Facility designed to receive and treat used water and stormwater to effectively improve water quality before being discharged into receiving waterbodies.

Watershed: Area of land where all water drains into the same region, such as a lake, river, or reservoir.

Important Resources

Find additional information about the New York City Water Supply System by researching these important watershed and New York City sites. You may also want to locate them on your map and plan a visit, if possible.

In the Watersheds (and nearby)

- Agroforestry Resource Center
- Ashokan Center
- Catskill Center for Conservation & Development
- Catskill Fly Fishing Center and Museum
- Catskill Interpretive Center
- Center for the Urban River
- Clearpool Model Forest and Education Center
- Commemorative Reservoir Kiosks
- Cross River Reservoir
- Croton Gorge Park
- Delaware County Historical Society
- Empire State Railway Museum
- Frost Valley Model Forest and YMCA Education Center
- Gilboa Museum
- Hilltop Hanover Farm & Environmental Center
- Kensico Dam Plaza
- Lennox Model Forest
- Muscoot Farm
- NYC DEP Watershed Recreation Areas
- Old Croton Aqueduct State Historic Park
- Ossining Visitor Center & Heritage Area
- Siuslaw Model Forest
- Taconic Outdoor Education Center
- Teatown Lake Reservation
- The Keeper's House
- Time and the Valleys Museum
- Ward Pound Ridge Reservation
- Woodchuck Lodge

New York City

- American Museum of Natural History
- Central Park Reservoir
- Children's Museum of Manhattan
- Collect Pond Park
- The High Bridge
- Museum of the City of New York
- New York Hall of Science
- Newtown Creek Nature Walk
- New-York Historical Society
- Old Croton Aqueduct Trail
- Queens Museum
- South Street Seaport Museum
- Sugar Hill Children's Museum of Art
- Tenement Museum
- Visitor Center at Newtown Creek
- Under Your Feet and High Above You

Additional Resources

Organizations and Programs

- Bronx Children's Museum
- Brooklyn Grange
- Brooklyn Public Library
- Catskill Streams
- Catskill Watershed Corporation
- Center for Urban Pedagogy
- Climate & Urban Systems Partnership
- Cornell Cooperative Extension
- Explorable Places
- Friends of the Old Croton Aqueduct
- Gowanus Canal Conservancy
- Horticultural Society of New York
- National Geographic Society
- NYC Dept. Environmental Protection
  - Education
  - Flickr
- New York Public Library
- NYS Dept. Environmental Conservation
- Sense of Place Curriculum
- Trout-in-the-Classroom
- US Environmental Protection Agency
- US Forest Service
- US Geological Survey
- Watershed Agricultural Council
- Welikia Project

Books, videos, DVDs, and other media

- American Museum of Natural History New York Water Story
- Catskills Outdoor Recreation GIS Map
- Deep Water (DVD), Willow Mixed Media, 2005
- Deep Water (22 minutes) & Teacher Guide
- Greatest Tunnel Every Built (DVD), Eyepop Productions, 2009
- Living City: A Billion Gallons a Day, NY Times video
- Dirty Jobs: Rosenwach NYC Water Tanks
- New York City Municipal Archives
- ***Liquid Assets***, Diane Galusha. Purple Mountain Press, 2016
- ***Lowdown on the High Bridge***, Sonia Manzano. Bronx Children's Museum, 2016
- Trout-in-the-Classroom Video
- ***Water-Works***, Kevin Bone. The Monacelli Press, 2006
- ***Magic School Bus at the Waterworks (NYC Edition)***, Joanna Cole. Scholastic, Inc., 2016 (available only through DEP)
- The Street Beneath my Feet, Charlotte Guillain. Words to Pictures, 2017

For more information contact:
New York City Department of Environmental Protection
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Please email DEP's education office to suggest edits and provide comments about the map and teacher guide. Thank you.

NYC Environmental Protection

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Addendum

1. The Water Supply of New York Map (1938)
2. New York City Water Story Map (2019)
3. New York City Wastewater Treatment Plants & Their Drainage Areas Map (2019)

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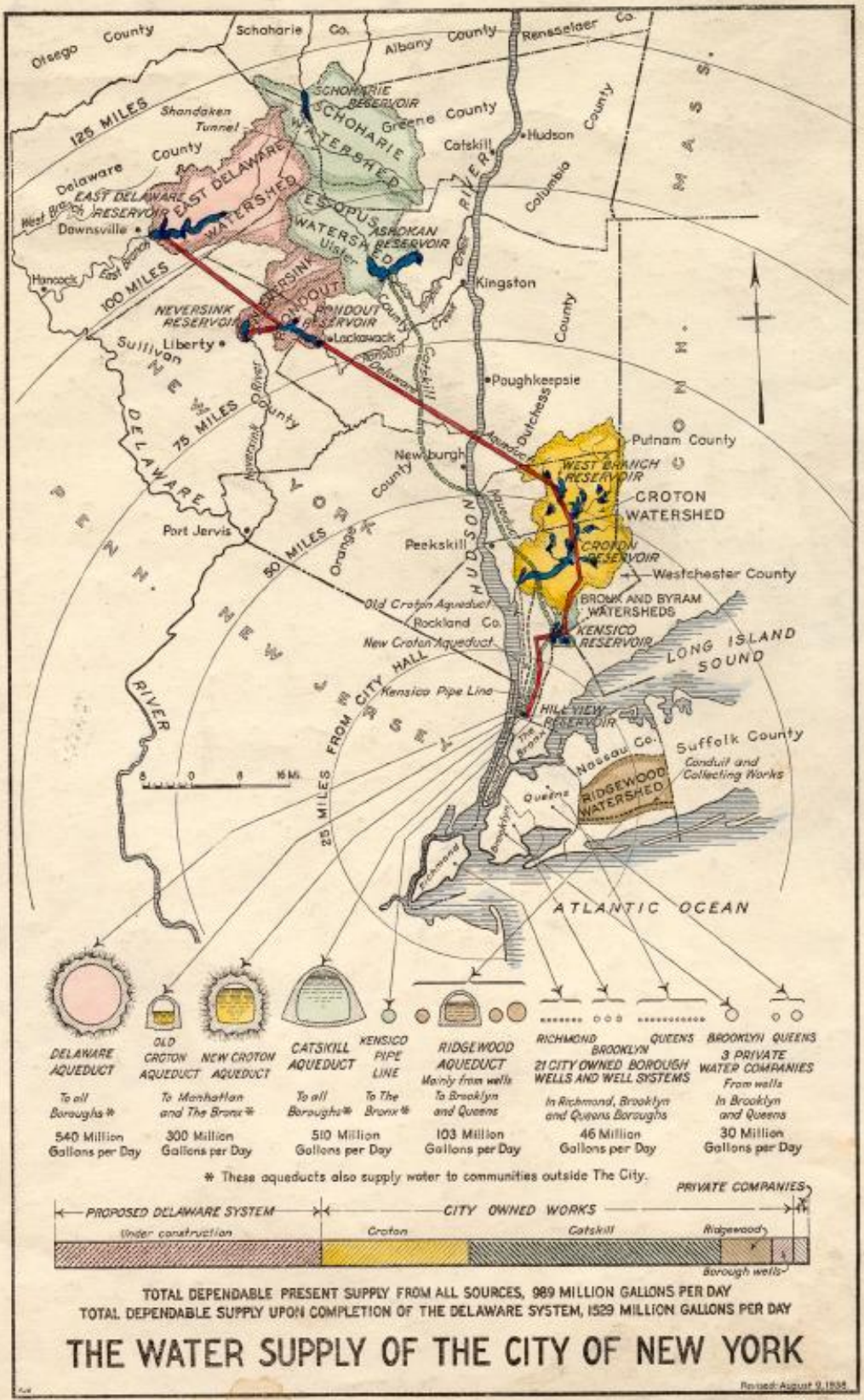

Otsego County
Schoharie Co.
Albany County
Rensselaer Co.
125 MILES
Shandaken Tunnel
SCHOHARIE RESERVOIR
SCHOHARIE WATERSHED
Greene County
Catskill
Hudson
Columbia County
MASS.
Delaware County
EAST DELAWARE RESERVOIR
EAST DELAWARE WATERSHED
Delaware West Branch
Downsville
ESOPUS WATERSHED
ASHOKAN RESERVOIR
Ulster
Esopus Creek
RIVER
Hancock
East Branch
100 MILES
Kingston
NEVERSINK RESERVOIR
NEVERSINK
RONDOUT RESERVOIR
RONDOUT
Lackawack
Rondout Creek
Catskill Creek
County
Sullivan
Liberty
Poughkeepsie
N. H.
PENN.
NEW YORK
75 MILES
DELAWARE
Neversink River
Delaware River
Dutchess County
Aqueduct
Putnam County
Newburgh
WEST BRANCH RESERVOIR
CROTON WATERSHED
Orange County
Port Jervis
50 MILES
Peekskill
CROTON RESERVOIR
Westchester County
Old Croton Aqueduct
BRONX AND BYRAM WATERSHEDS
Rockland Co.
KENSICO RESERVOIR
New Croton Aqueduct
LONG ISLAND SOUND
NEW JERSEY
RIVER
Kensico Pipe Line
HILL VIEW RESERVOIR
The Bronx
Nassau Co.
Suffolk County
Conduit and Collecting Works
RIDGEWOOD WATERSHED
Queens
Brooklyn
Richmond
25 MILES FROM CITY HALL
ATLANTIC OCEAN
DELAWARE AQUEDUCT
To all Boroughs *
540 Million Gallons per Day
OLD CROTON AQUEDUCT
NEW CROTON AQUEDUCT
To Manhattan and The Bronx *
300 Million Gallons per Day
CATSKILL AQUEDUCT
To all Boroughs *
KENSICO PIPE LINE
To The Bronx *
510 Million Gallons per Day
RIDGEWOOD AQUEDUCT
Mainly from wells
To Brooklyn and Queens
103 Million Gallons per Day
RICHMOND
BROOKLYN
QUEENS
21 CITY OWNED BOROUGH WELLS AND WELL SYSTEMS
In Richmond, Brooklyn and Queens Boroughs
46 Million Gallons per Day
BROOKLYN
QUEENS
3 PRIVATE WATER COMPANIES
From wells
In Brooklyn and Queens
30 Million Gallons per Day
* These aqueducts also supply water to communities outside The City.
PRIVATE COMPANIES
PROPOSED DELAWARE SYSTEM
Under construction
CITY OWNED WORKS
Croton
Catskill
Ridgewood
Borough wells
TOTAL DEPENDABLE PRESENT SUPPLY FROM ALL SOURCES, 989 MILLION GALLONS PER DAY
TOTAL DEPENDABLE SUPPLY UPON COMPLETION OF THE DELAWARE SYSTEM, 1529 MILLION GALLONS PER DAY
THE WATER SUPPLY OF THE CITY OF NEW YORK
Revised August 9, 1938.

Map on following page

New York City's Water Story: From Mountain Top to Tap

The water we use today is the same water that fell as rain when dinosaurs roamed the earth. In its endless cycle, water is the only substance that naturally exists as a solid, liquid or gas.

Water's journey from mountain top to tap begins when rain and snow fall on watersheds, the areas of land that catch, absorb, and carry water downhill to gently and swiftly flowing streams.

Streams provide life-cycle needs for fish and other aquatic organisms. Oxygen is trapped in the fresh water as it tumbles over rocks into deep pools. Overhanging tree branches keep water cool as fresh water continues its journey.

Water is naturally filtered by the soil and tree roots in dense forests as it travels toward reservoirs. The sun's heat energy releases some water molecules back into the atmosphere as gas, continuing the hydrologic cycle.

Thousands of skilled workers constructed dams and reservoirs to store large amounts of clean water and aqueducts to carry it great distances by gravity from watersheds to New York City.

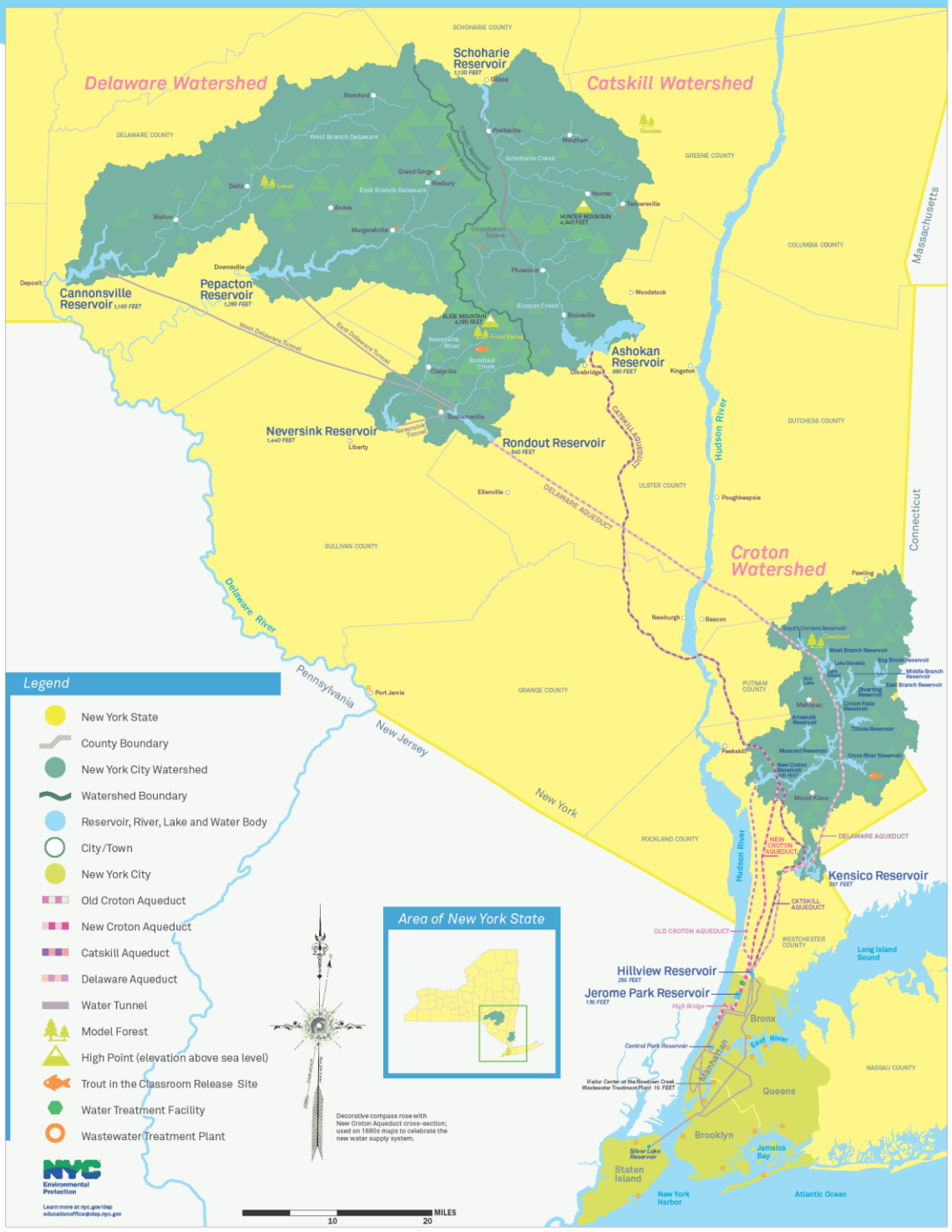
The 41-mile Old Croton Aqueduct was the first to deliver a clean and plentiful supply of water to New York City. The High Bridge, completed in 1848 and hailed as an engineering masterpiece, carried the aqueduct across the Harlem River on large stone arches.

Water flowed through the Croton Aqueduct, filling reservoirs where the Great Lawn in Central Park and the New York Public Library on Fifth Avenue now stand. New Yorkers rejoiced in 1862 when another reservoir was built in Central Park to support the needs of a growing city.

Today, thousands of miles of tunnels and pipes deliver one billion gallons of water each day from the Croton, Catskill, and Delaware watersheds to more than 9 million people. How do you use water? How much water do you think you use?

After water is used for cooking, bathing, and other activities, it travels down the drain and through sewer pipes to wastewater treatment plants where it is cleaned and returned safely to the waterways surrounding New York City.

Water is all around us. We experience it in many different ways using all of our senses. As water cycles through its endless journey, we appreciate that it will continue to nourish us and all living things.



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NEW YORK CITY
WASTEWATER TREATMENT PLANTS
AND THEIR DRAINAGE AREAS

nyc.gov/dep
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