



The New York City Water Supply: A model for protecting water at its source

Dŵr Cymru Welsh Water

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DEP is the largest combined water and wastewater utility in the United States, with 6,000 employees and an annual budget of more than \$4 billion.

WATER SUPPLY

- Deliver 4,165 ML of water to 9.5 million New Yorkers every day and maintain 11,265 kilometers of water mains
 - Protect our 4,850-square-kilometer watershed, including 19 reservoirs and three controlled lakes
-



WASTEWATER TREATMENT

- Treat 4,920 ML of wastewater each day
 - Operate and maintain 14 plants, 96 pumping stations, and 12,070 kilometers of sewers
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AIR, NOISE, AND HAZARDOUS WASTE

- Update and enforce the air code to reduce local emissions, and regulate hazardous waste and noise pollution





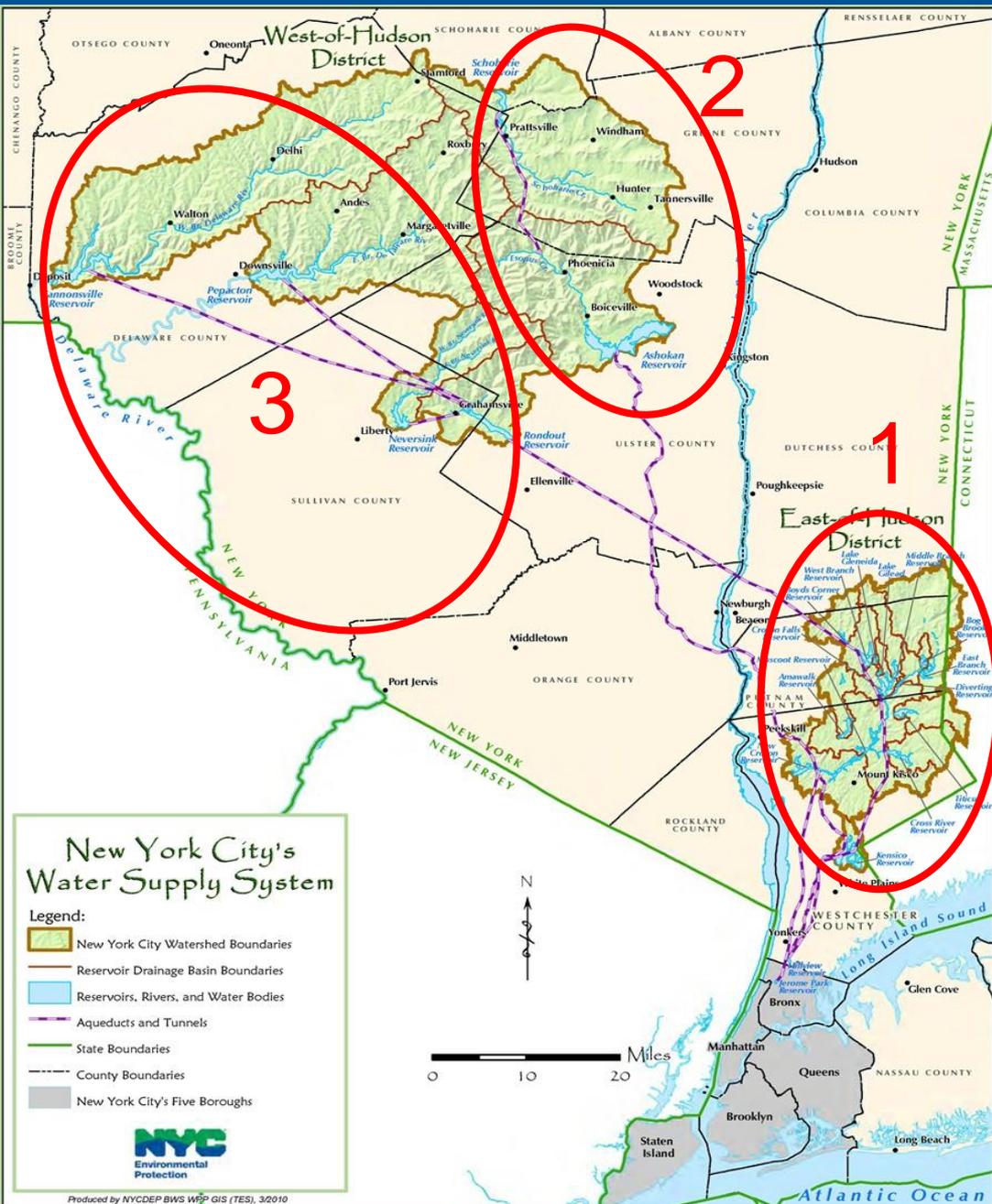
- Surface water supply conveyed by gravity alone
- 19 collection reservoirs, 3 lakes and 2 distribution reservoirs
- 2.2 million ML total reservoir storage capacity
- 9.5 million consumers (~1/2 New York State population)
- Delivers roughly 4,165 ML of water each day
- Watershed = 4,850 square km
- Watershed covers parts of 8 upstate counties in NY plus a small portion of CT
- Nation's largest municipal water supply
- 90 percent unfiltered

The mission of the Bureau of Water Supply is to reliably deliver a sufficient quantity of high-quality drinking water to protect public health and quality of life of the City of New York.

- Source Water Operations
- Water Treatment Operations
- Water Quality
- Watershed Protection Programs
- Planning
- Management Services & Budget
- Environmental Health & Safety
- Research Application



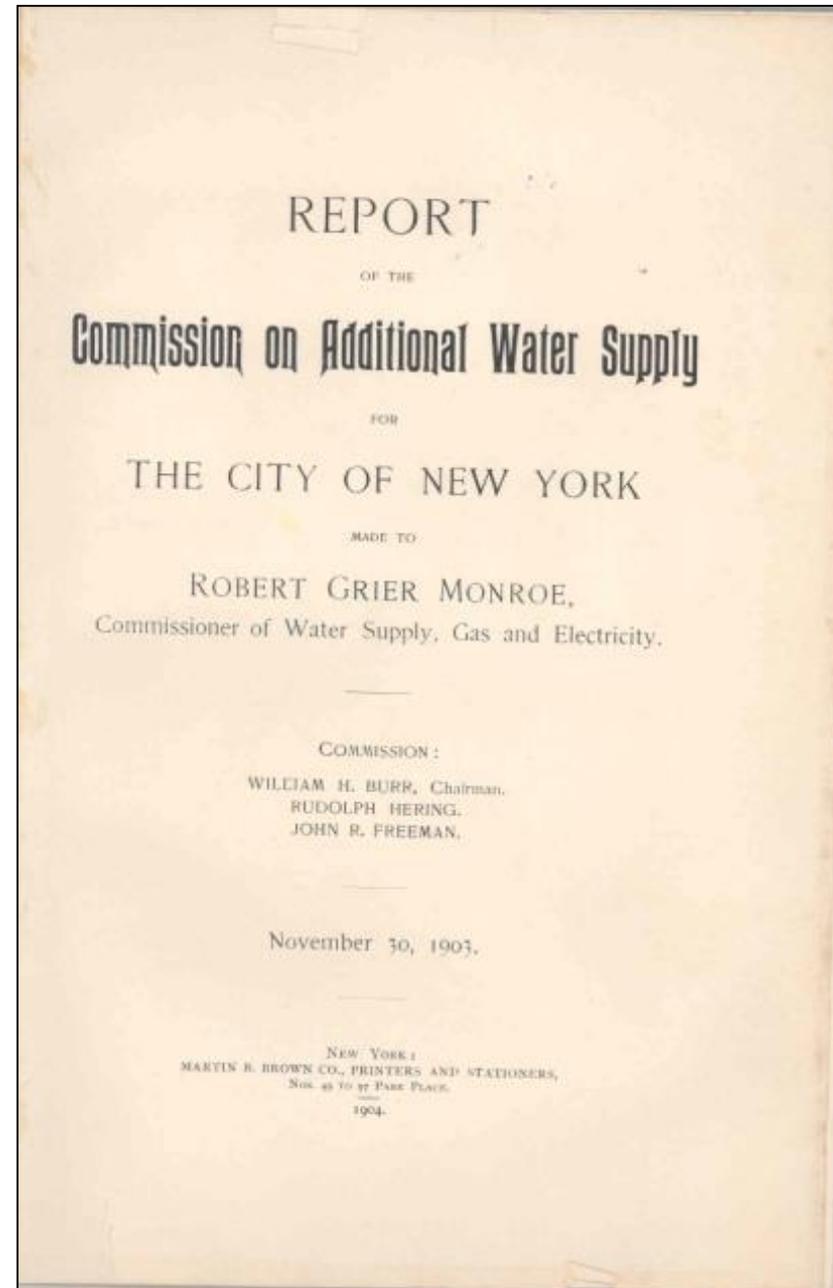
Water Supply Systems



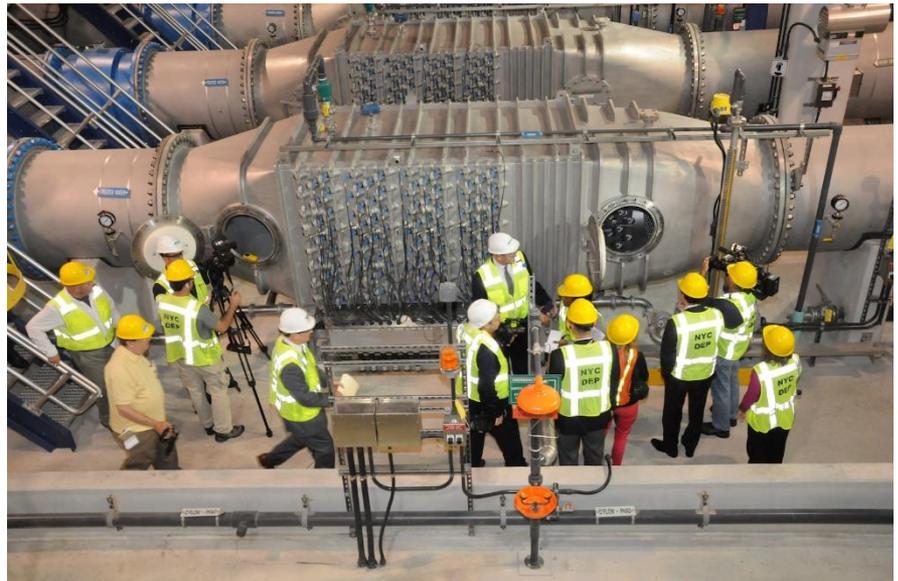
NYC's water supply = three distinct systems:

- 1) Croton System – 1830s-1890s
 - 347,000 ML
 - 10 percent of daily supply
 - Only filtered system
- 2) Catskill System – 1905-1928
 - 550,000 ML
 - 40 percent of daily supply
 - Unfiltered system
- 3) Delaware System – 1937-1965
 - 1.2 million ML
 - 50 percent of daily supply
 - Unfiltered system

- General Problem
 - Provide greater New York area with an abundant quantity of water with satisfactory quality
- Requisite Qualities of Public Water Supply
 - Free of organisms
 - Agreeable appearance
 - Odorless and tasteless
 - Not too hard
 - Not contain substances that are liable to corrode pipes
 - Should have cool and equable temperature



- Manages the delivery and treatment of more than 4,165 ML / day
- Responsible for maintenance of infrastructure that includes:
 - Over 280 water supply facilities
 - Water supply reservoirs & lakes
 - Treatment facilities:
 - Chlorine, UV, Fluoride, Filtration
 - 36 shafts
 - 630 kilometers of large aqueducts
 - 29 water supply dams
 - 57 bridges & 99 miles of roads
 - 7 wastewater treatment facilities in the catchment area
 - Operation of the works



- Ensures that the water supply meets all drinking water standards Collects ~50,000 samples/year throughout the watershed and NYC distribution system.
- Performs more than 580,000 laboratory analyses/year
- Operates four NYS Certified Water Quality Laboratories
- Robotic monitoring = 1.6 million tests/year

Water Quality Monitoring Parameters

- ❖ **Pathogens** – *Giardia* and *Cryptosporidium*
- ❖ **Microbiology** – coliform bacteria, *E. coli*, phytoplankton
- ❖ **Nutrients** – e.g. phosphorus and nitrogen
- ❖ **Physical Properties** – e.g. turbidity, pH, temperature
- ❖ **Metals** – e.g. lead, copper, mercury
- ❖ **Organic Compounds** – e.g. disinfection by-products, pesticides
- ❖ **Process Control** – e.g. chlorine, fluoride, conductivity

Over 200 different parameters



Watershed Protection Programs

Engineers who created New York City's water supply system always understood the need to protect drinking water at its source.

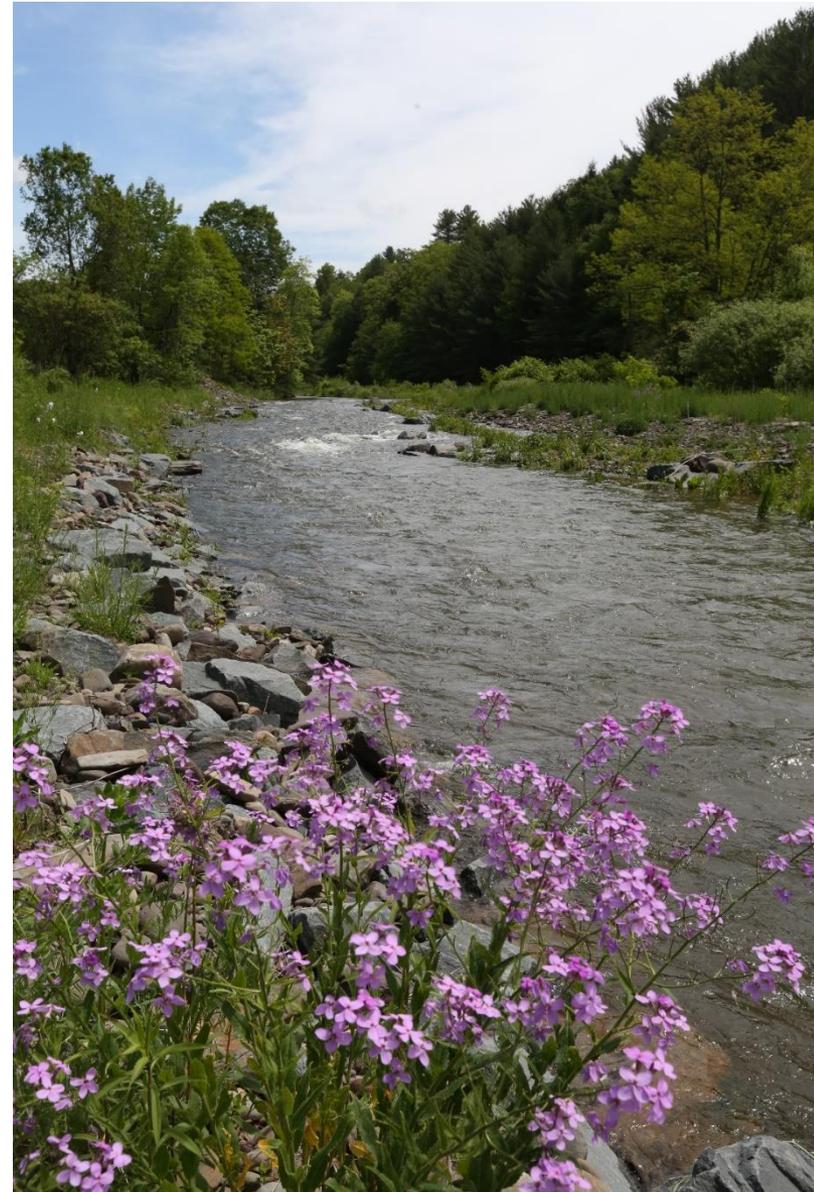
- Upland supply in rural, forested areas
- Preservation of buffer lands around reservoirs
- Early establishment of “sewerage plants” on headwaters of reservoirs
- Purposeful planting of nearly 3 million trees along reservoir buffers

“It is important that vigilance should be exercised to maintain the quality of all the present supplies by protecting them from pollution and treating them by approved modern methods, and that the structures should be kept constantly in good repair.”

- J. Waldo Smith, 1915

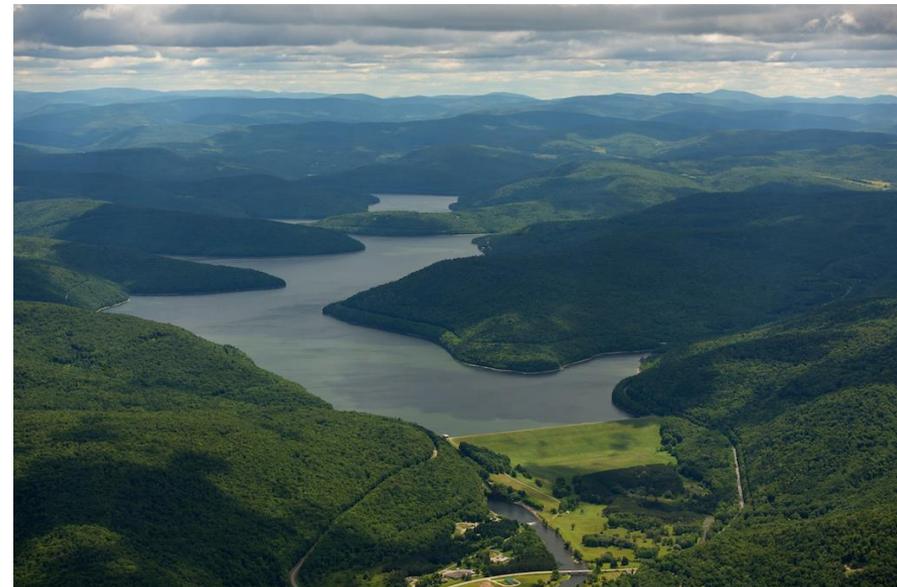


- U.S. Environmental Protection Agency sets for Surface Water Treatment Rule in 1989
- Requires surface supplies to filter
- Systems eligible for waiver if they meet certain criteria
 - Fecal or total coliform
 - Turbidity
 - Inactivation of giardia
 - Maintain a watershed control program that demonstrates adequate control on activities liable to affect microbiological quality of source water
- Later updates to the rule focused on *Cryptosporidium*



Issues driving NYC approach

- Concern over whether City could meet subjective criteria of watershed “control”
 - NYC owned less than 8% of catchment area
 - Regulations were outdated
- City leaders alarmed by potential cost of filtration for Catskill-Delaware Supply
 - More than \$10 billion to construct
 - Upwards of \$200 million annually for operations
 - Largest public works project in the history of NYC
- Firm belief that protecting water at its source was most cost-effective and environmentally sound approach



Pursuit of Filtration Avoidance

- City proposed draft watershed regulations in 1990
- First iteration of regulations were particularly onerous
 - Regulations on working farms that required setbacks from streams and other watercourses
 - Farms would have lost significant amounts of working land
 - Septic tanks subject to a variable buffer based on slope and depth to groundwater
 - Would have made many sites undevelopable
- Watershed communities band together to protest the regulations

Watershed Issue

The CITY of NEW YORK is in the process of trying to pass regulations regarding the quality of water coming out of the DELAWARE/CATSKILL WATERSHED!

NEW YORK CITY HAS TWO CHOICES:

- ✓ Either strictly regulate the water flowing into the reservoir;
- ✓ or, spend \$4 Billion on a filtration system at the NYC end of the pipeline.

It is by far cheaper for NYC to regulate in the Watershed, BUT by implementing these regulations the City will place an economic burden on US, the people who live in the watershed.

These regulations will control the livelihoods of businesses, farmers, developers, landowners, and every resident in the watershed in one way or another.

THESE REGULATIONS ARE FOREVER!!

We, the people of the watershed are already subject to NY State water protection rules and have abided by them and will continue to do so. It is the law, and the law is very strict. To have NY City place their added regulations on us will hamper future development in this area and will change our very way of life.

SAY NO!
To NYC Watershed Regulations!

☛ **Be Aware** ☛ **Be Concerned** ☛ **Get Involved**

**Donate To The
Coalition Of Watershed Towns**

Make checks payable to:
Coalition Account
Delaware County Treasurer

Mail your donation to:
The Coalition of Watershed Towns
PO Box 367, Delhi, NY 13753

- Historic 1997 Memorandum of Agreement
- Parties include New York City, New York State, EPA, watershed communities and environmental advocates
- Cleared the way for three core pillars of our source-water protection program:
 - Land acquisition
 - Enhanced regulations
 - Partnership programs
- Designed on a foundation of intensive water quality monitoring that started in 1980s
- Protection programs and remediation programs



Partnerships



**Department of
Health**



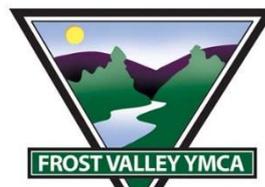
Watershed Agricultural Council
www.nycwatershed.org



THE CATSKILL CENTER
for Conservation and Development



**New York
ReLeaf**



Cornell University
Cooperative Extension

Watershed Protection Programs

To date New York City has committed \$2.7 billion toward its watershed protection programs. They include:

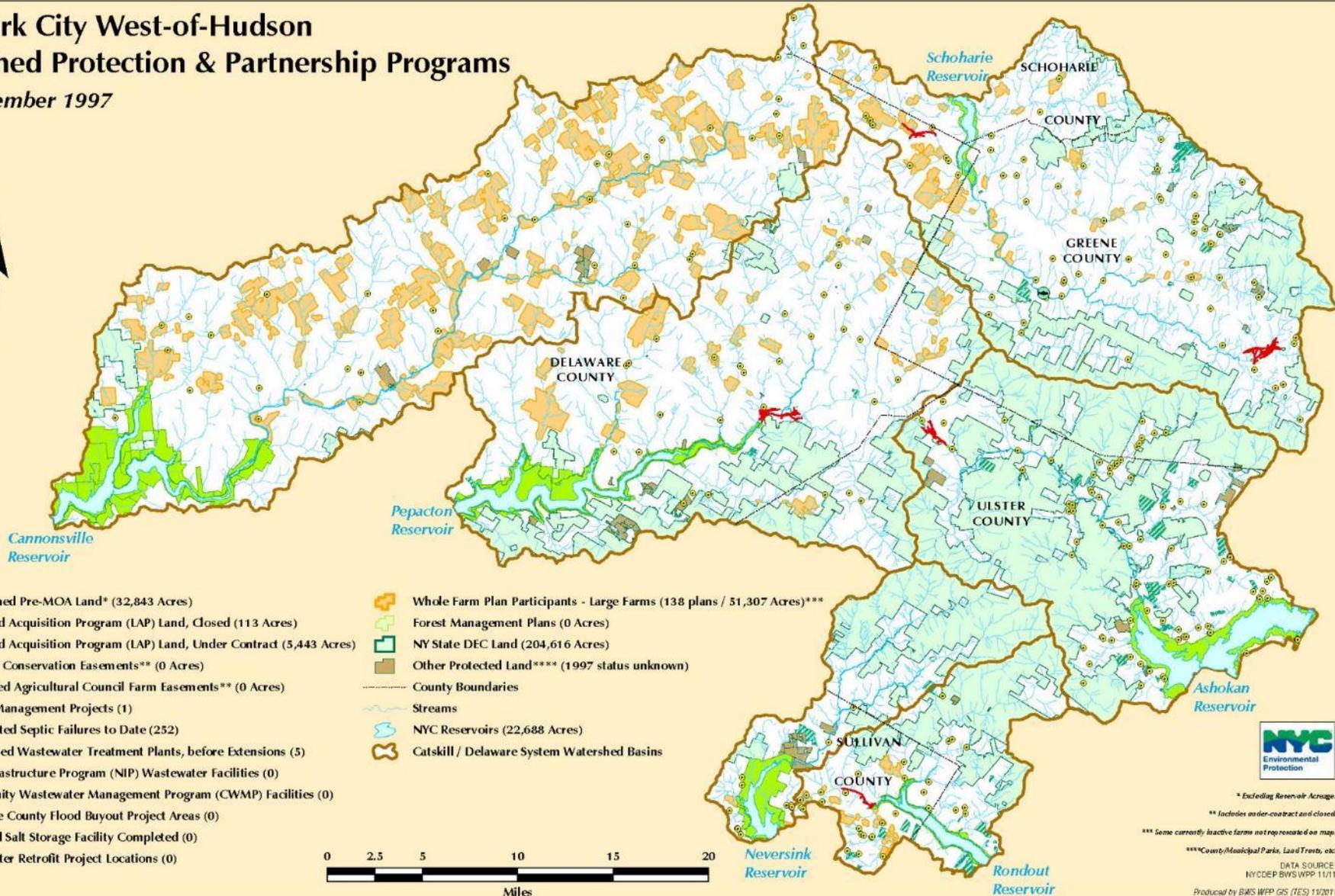
- Watershed Agricultural Program
- Wastewater treatment plant upgrades
- Septic rehabilitation program
- Land acquisition program
- Stream Management Program
- Forestry Programs
- Regulatory review of development
- Economic development
- Recreational programs
- Management of City-owned lands
- Local flood-hazard mitigation program



Watershed Protection Programs

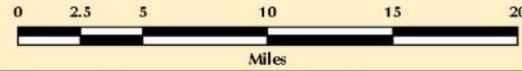
New York City West-of-Hudson Watershed Protection & Partnership Programs

As of December 1997



LEGEND:

- NYC-owned Pre-MOA Land* (32,843 Acres)
- NYC Land Acquisition Program (LAP) Land, Closed (113 Acres)
- NYC Land Acquisition Program (LAP) Land, Under Contract (5,443 Acres)
- NYC LAP Conservation Easements** (0 Acres)
- Watershed Agricultural Council Farm Easements** (0 Acres)
- Stream Management Projects (1)
- Remediated Septic Failures to Date (252)
- City-owned Wastewater Treatment Plants, before Extensions (5)
- New Infrastructure Program (NIP) Wastewater Facilities (0)
- Community Wastewater Management Program (CWMP) Facilities (0)
- Delaware County Flood Buyout Project Areas (0)
- Sand and Salt Storage Facility Completed (0)
- Stormwater Retrofit Project Locations (0)
- Whole Farm Plan Participants - Large Farms (138 plans / 51,307 Acres)***
- Forest Management Plans (0 Acres)
- NY State DEC Land (204,616 Acres)
- Other Protected Land**** (1997 status unknown)
- County Boundaries
- Streams
- NYC Reservoirs (22,688 Acres)
- Catskill / Delaware System Watershed Basins

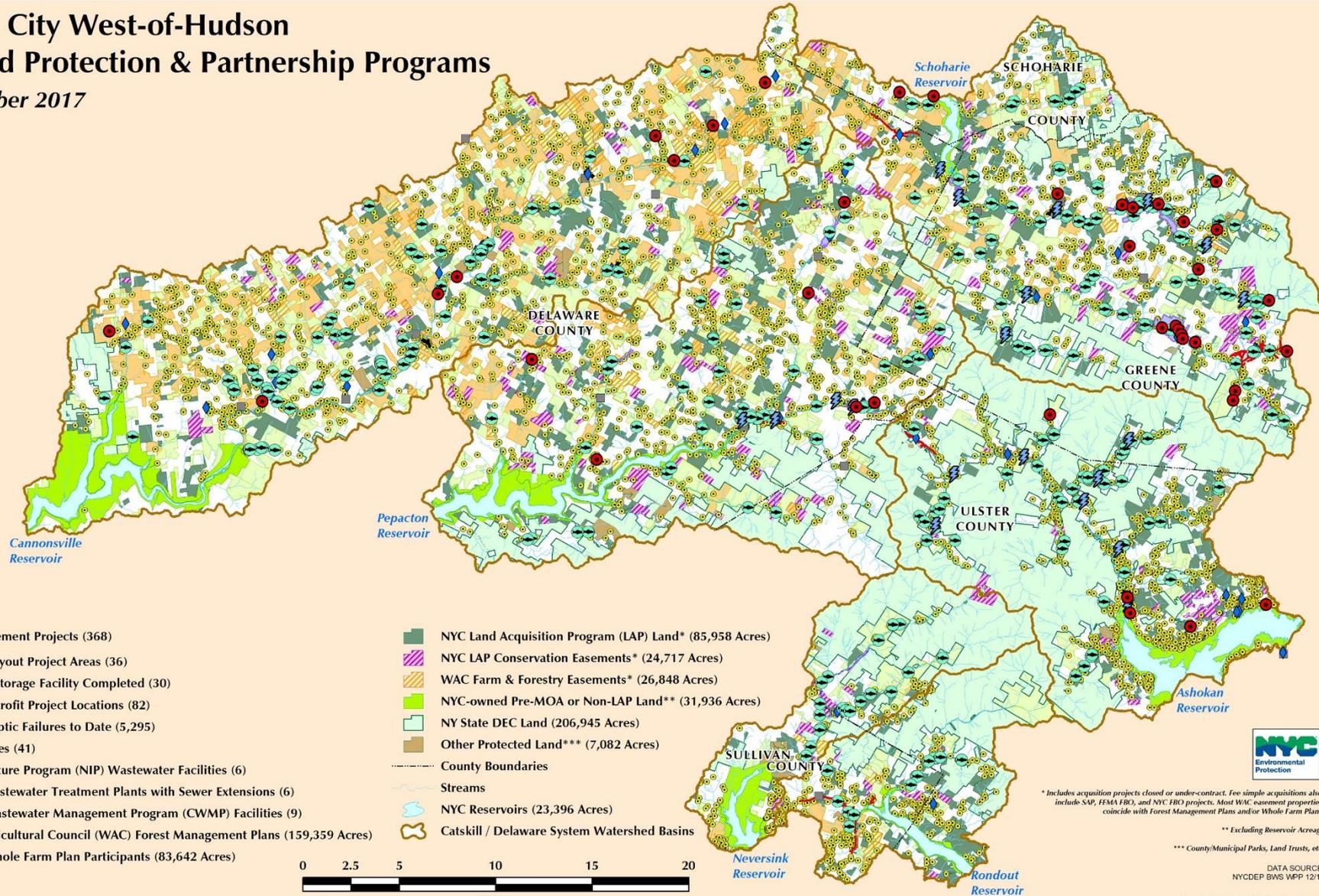


* Excluding Reservoir Acreage.
 ** Includes under-contract and closed.
 *** Some currently inactive farms not represented on map.
 **** County/Municipal Parks, Land Trusts, etc.
 DATA SOURCE: NYCDEP BWS WPP 11/11
 Produced by BWS WPP GIS (TES) 11/2011

Watershed Protection Programs

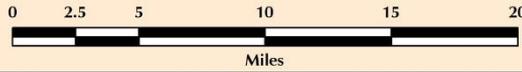
New York City West-of-Hudson Watershed Protection & Partnership Programs

As of December 2017



LEGEND:

- Stream Management Projects (368)
- FEMA Flood Buyout Project Areas (36)
- Sand and Salt Storage Facility Completed (30)
- Stormwater Retrofit Project Locations (82)
- Remediated Septic Failures to Date (5,295)
- WWTP Upgrades (41)
- New Infrastructure Program (NIP) Wastewater Facilities (6)
- City-owned Wastewater Treatment Plants with Sewer Extensions (6)
- Community Wastewater Management Program (CWMP) Facilities (9)
- Watershed Agricultural Council (WAC) Forest Management Plans (159,359 Acres)
- Active WAC Whole Farm Plan Participants (83,642 Acres)
- NYC Land Acquisition Program (LAP) Land* (85,958 Acres)
- NYC LAP Conservation Easements* (24,717 Acres)
- WAC Farm & Forestry Easements* (26,848 Acres)
- NYC-owned Pre-MOA or Non-LAP Land** (31,936 Acres)
- NY State DEC Land (206,945 Acres)
- Other Protected Land*** (7,082 Acres)
- County Boundaries
- Streams
- NYC Reservoirs (23,396 Acres)
- Catskill / Delaware System Watershed Basins



* Includes acquisition projects closed or under-contract. Fee simple acquisitions also include SAP, FEMA FBO, and NYC FBO projects. Most WAC easement properties coincide with Forest Management Plans and/or Whole Farm Plans.

** Excluding Reservoir Acreage

*** County/Municipal Parks, Land Trusts, etc.

DATA SOURCE: NYCDP BWS WPP 12/17

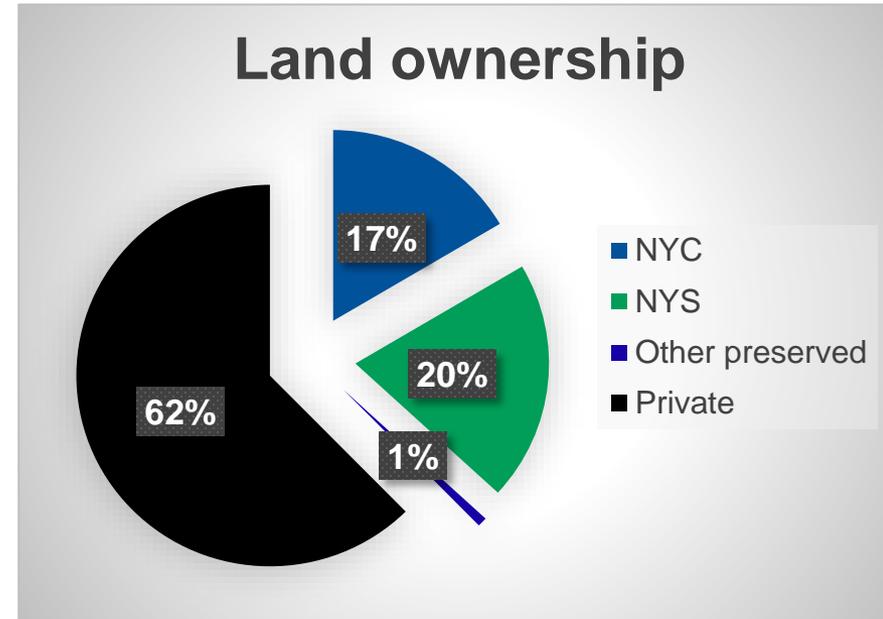
Produced by BWS WPP GIS (TES) 2/2018



Key Accomplishments

- A total of 596 square kilometers preserved by NYC
- 40 percent of catchment now preserved as forever wild
- 450 whole-farm plans on working farms
- 7,400 best management practices installed on those farms
- DEP completed the upgrade of all private and public wastewater treatment plants to meet regulations – more than 50
- More than 5,000 septic system repairs
- More than 364 project to restore stability to streams
- Comprehensive forest-management plan
- Regulatory program has reviewed more than 20,000 applications → 99.95% approval rate
- Started a program to examine and mitigate flood hazards
- Opened more than 545 square kilometers of land and water to recreation
- Catskill Fund for the Future yielded approximately \$90 million in direct and leveraged investments in the Catskills → creating or retaining more than 4,900 jobs.
- Expanded water quality monitoring program to include approximately 2 million analyses annually by scientists and robotic monitoring equipment

- Most programs are voluntary
- Most programs are funded by DEP but administered by partner agencies
 - Contracts with partners that set program targets, funding allocations, etc.
 - Mutually beneficial to stakeholders
- Enforcement of laws and regulations
 - Federal Clean Water Act
 - State Pollution Discharge Elimination System
 - NYC Watershed Regulations
 - Regulatory inspection staff
 - 220 uniformed environmental police officers
 - Mapping and aerial surveys





Watershed Farm – Planning and BMP



Watershed Farm – Planning and BMP





Stream Management Program



Stream Management Program



Stream Management Program



- Cannonsville Reservoir prone to significant algal blooms during the summer through the early 1990s
- DEP would regularly shut Cannonsville off for the entire summer
- Treated with copper sulfate
- Huge load of nutrients from under-performing wastewater plants and farms within the reservoir catchment
- Some of the worst water quality in any of New York City's 19 reservoirs



Cucumber Flavor in Philadelphia's Drinking Water

Gary A. Burlingame, John J. Muldowney, and Roy E. Maddrey

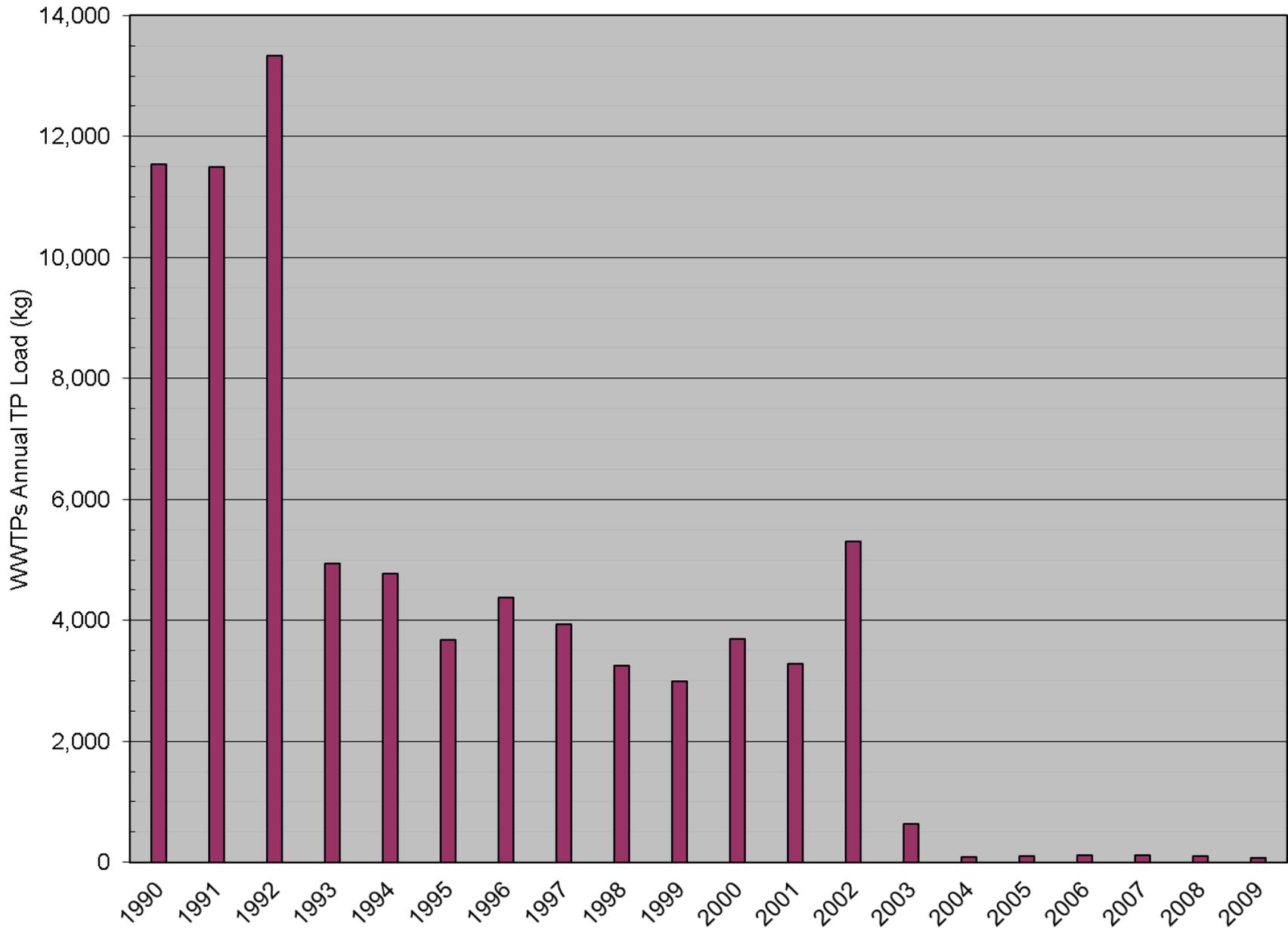
Since 1981, when the use of free chlorine was curtailed to control trihalomethanes at the Baxter Treatment Plant in Philadelphia, Pa., a seasonal cucumber flavor problem occurred. Flavor profile analysis was the only tool available to guide treatment. During 1990, the cucumber odor was tracked more than 250 mi (402 km) up the Delaware River to the Cannonsville Reservoir, and the odor-causing compound was identified as *trans,2-cis,6-nonadienal*. Algae growth beneath the winter ice produced the compound. Other treatment plants on the river that used free chlorine for disinfection and a final residual never had a problem with *trans,2-cis,6-nonadienal*. Therefore, use of chlorine was increased at the Baxter plant to control the cucumber flavor. Studies were conducted on *trans,2-cis,6-nonadienal* to describe its sensory characteristics and analytical detection limit.

A case study: Cannonsville Reservoir

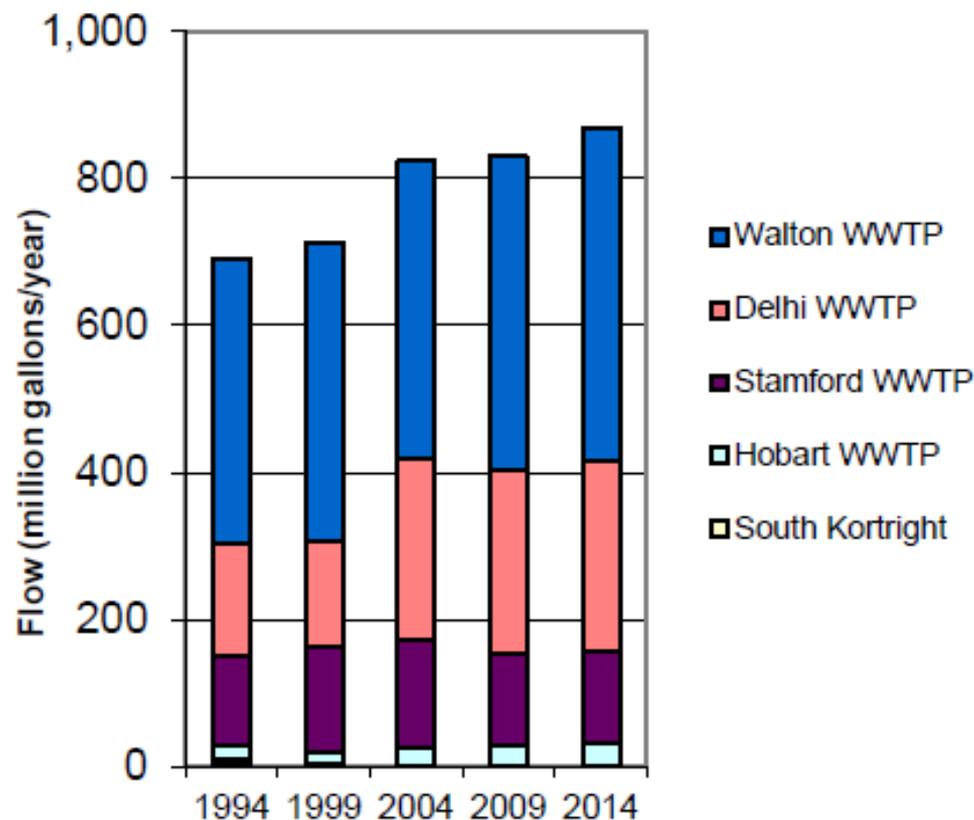
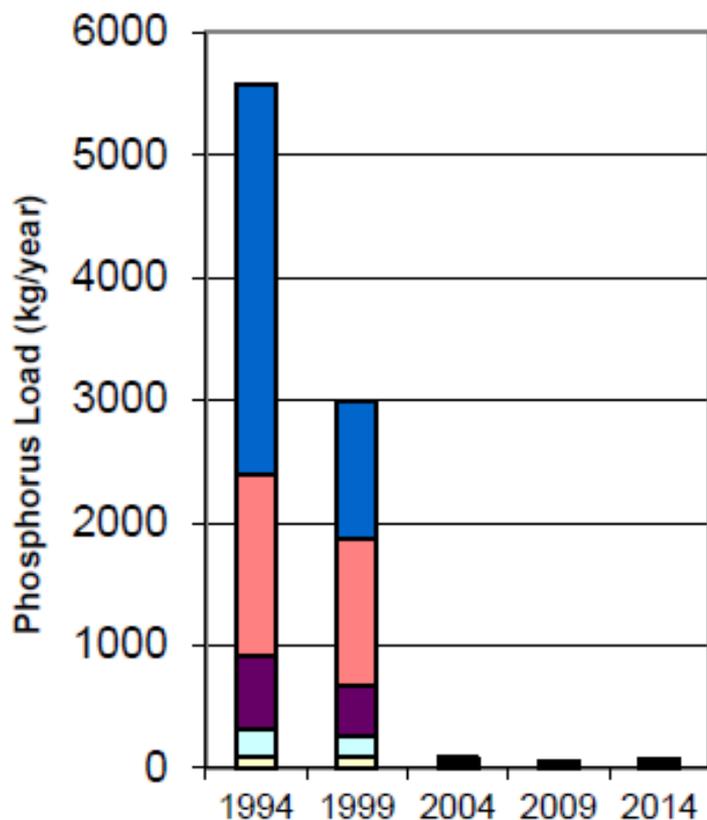
- Catchment management programs kick in mid-1990s
- 181 farms in the Cannonsville Reservoir catchment have whole-farm plans and infrastructure upgrades
- Eight wastewater treatment plants are upgraded
 - Failing primary and secondary systems
 - All upgraded to tertiary with microfiltration
- Algal blooms are no longer seen on Cannonsville Reservoir, even during the driest and hottest summers
- Now home to third best water quality of any reservoir in the system



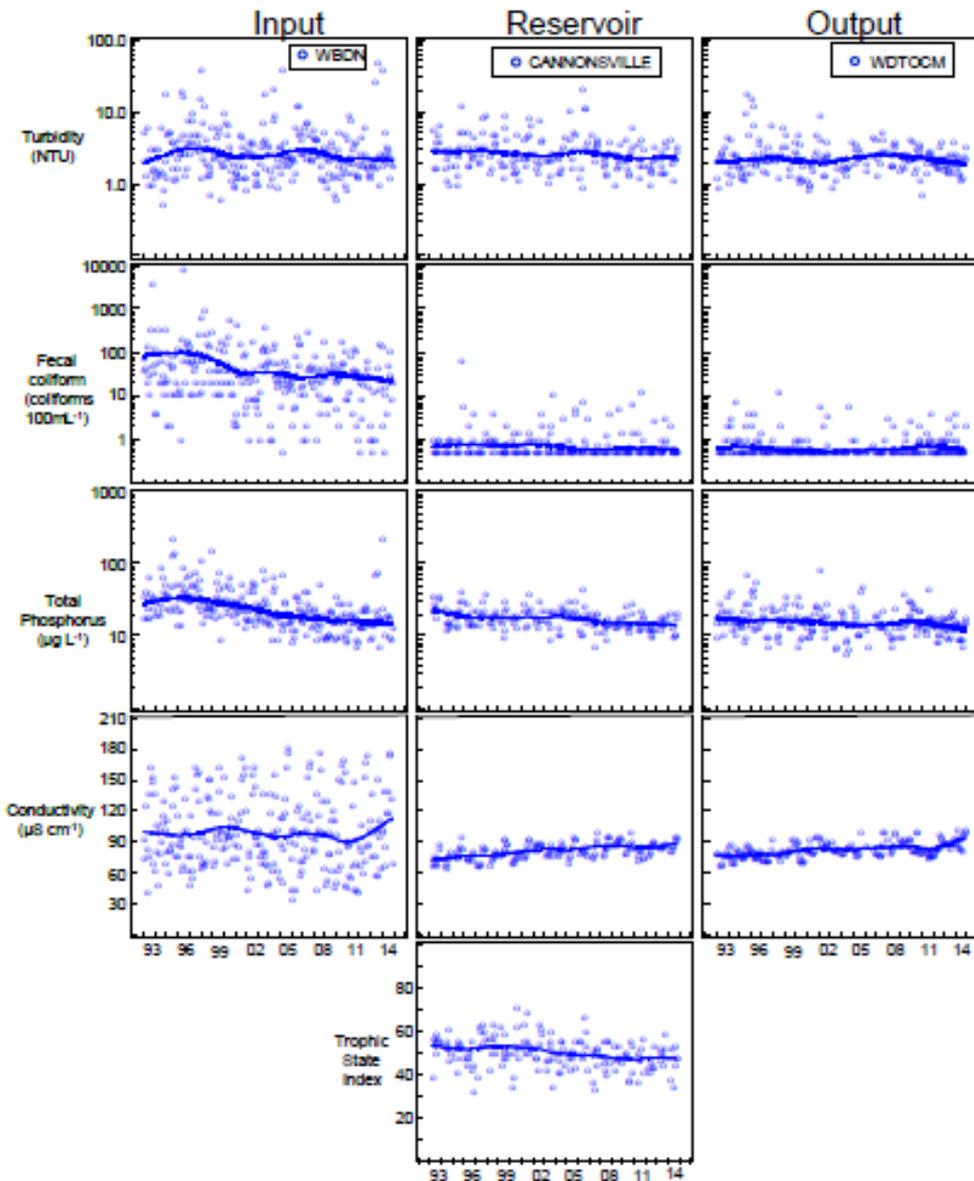
A case study: Cannonsville Reservoir



Cannonsville Basin



A case study: Cannonsville Reservoir



- **Water quality was good during the 2012-2014 status assessment period in the Cannonsville basin.**
- **Downward trends were detected for turbidity, fecal coliforms and phosphorus while significant upward trends were detected for conductivity.**
- **The decreases in turbidity may be linked to recovery from flooding events in 1995-1996, April 2005 and June 2006. Low inputs during drought (2001-2002) and from periods characterized by few intensity runoff events (2007-2009) are another factor.**
- **Recovery from various flooding events may also contribute to the declines in phosphorus but load reductions from wastewater treatment plants and food manufacturing maybe the primary cause.**
- **The conductivity increases are thought to be caused by increases from anthropogenic sources (e.g., road salt).**
- **Phosphorus reductions and low water clarity in 2005-2006 help to explain the decrease in trophic state.**

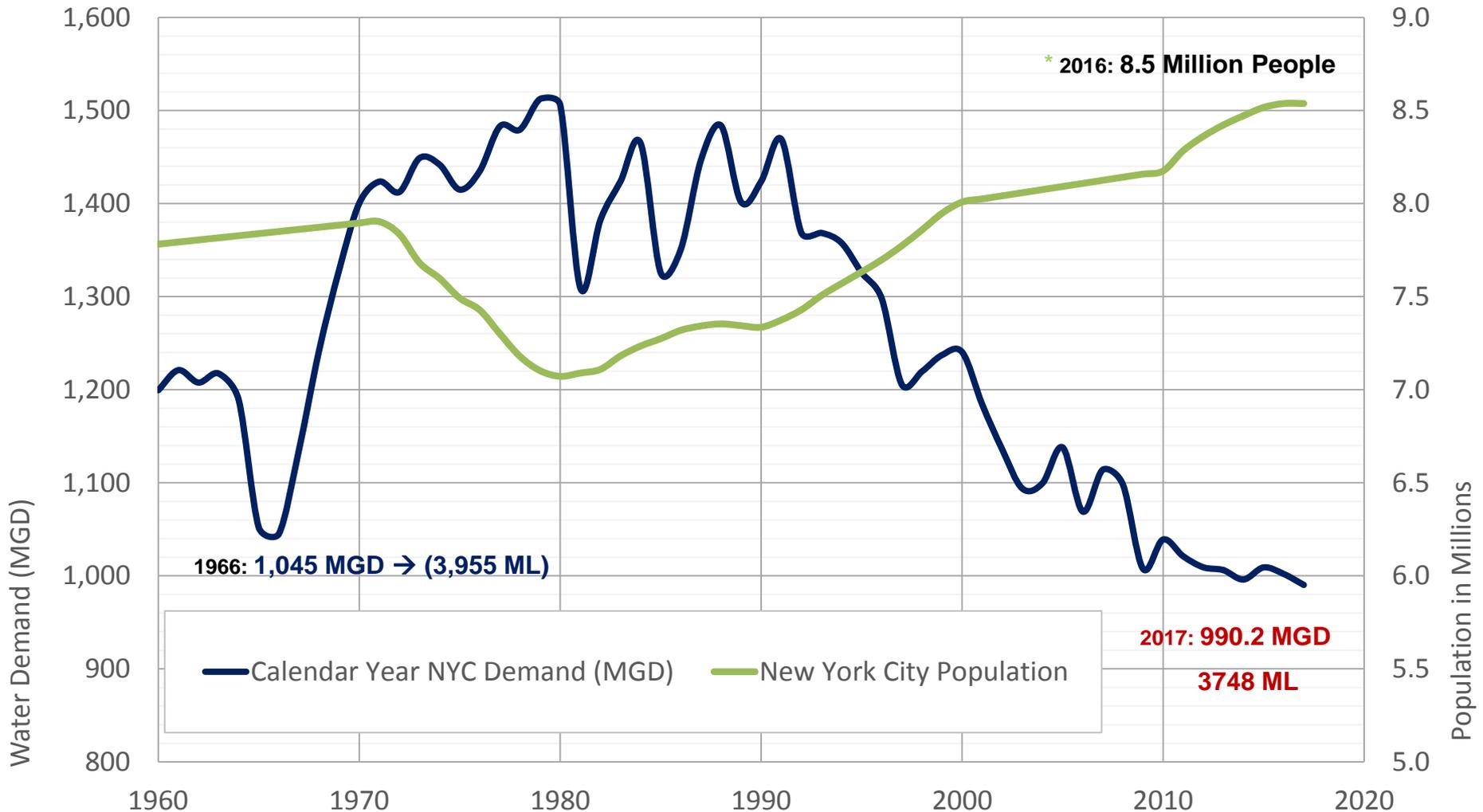
Challenges ahead...

- Floods → climate change
 - Historic floods 2006 & 2011
 - New FAD programs
- Droughts
- Invasive species
- Disinfection byproducts
 - Now measuring for precursors in the water supply
 - DOC and UV254
 - Creating a model for precursors
- State of good repair for infrastructure
 - \$14 billion in projects
 - Major work on dams, tunnels and treatment facilities



Successes in demand management

- Water consumption in NYC declined more than **30%** since the early 1990s – despite increasing population
- Since 2009, water usage has been below the 1960s drought-of-record



How is it funded?

- Water supply operations and catchment management programs are fully funded by ratepayers
- Approximately 890,000 connections to distribution system in NYC
- Additional 74 communities connected to the water supply north of NYC
 - Pay a 1/3 entitlement rate
- Annual budget for all of DEP is approximately \$3.5 billion
- Annual operating budget for water supply is approximately \$380 million
- Annual cost of watershed protection programs is approximately \$100 million
- Cost for water in NYC is approximately 1 penny per gallon



Questions and discussion...

