

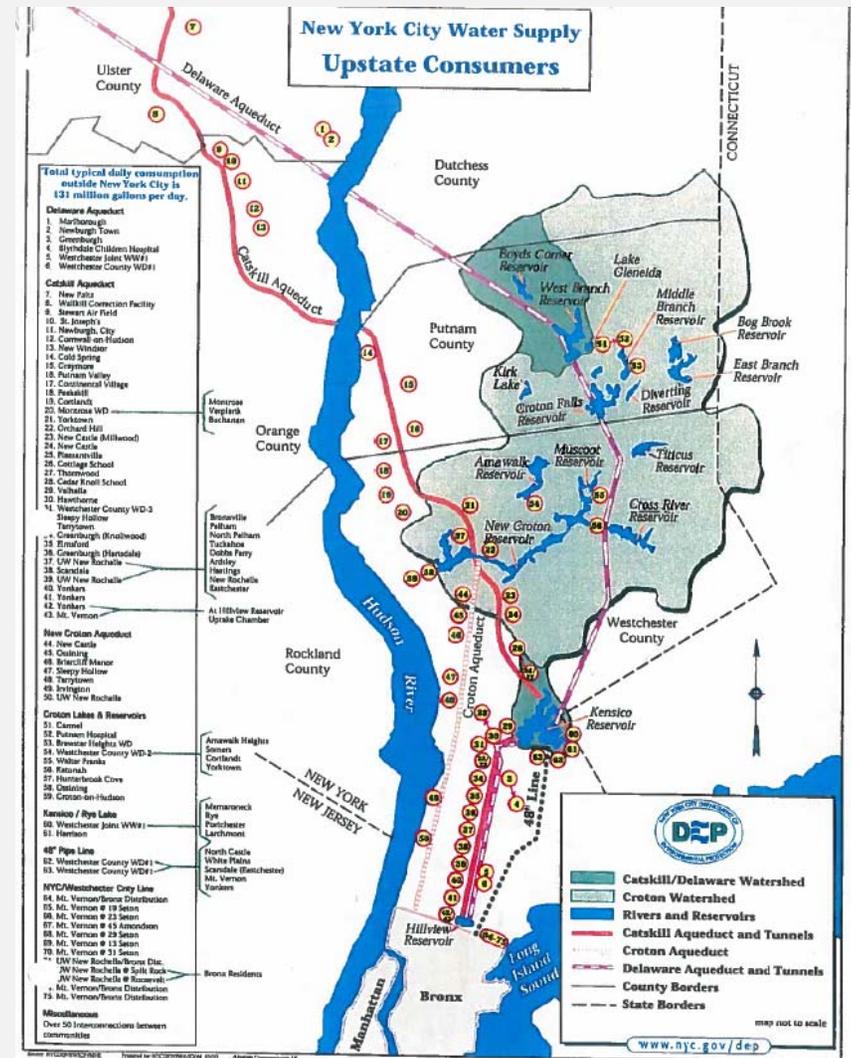


# History of New York City Water Supply System

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## Gravity Works

Paul D. Smith, P.E. – NYCDEP Bureau of Engineering  
Design and Construction





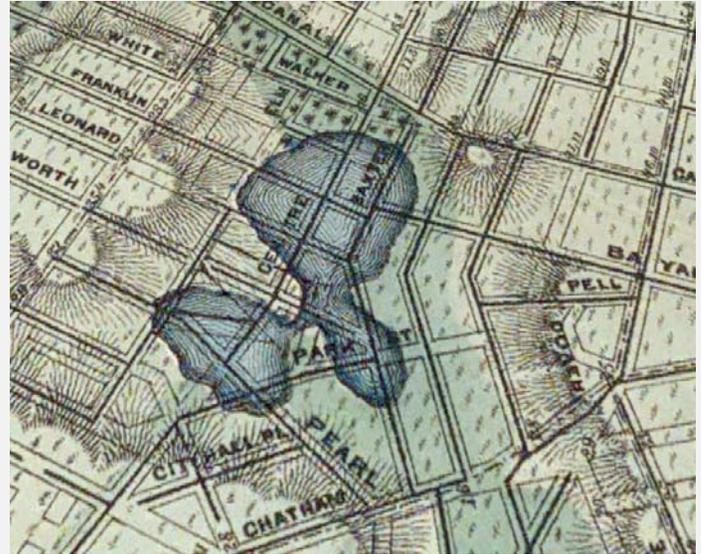


# NYC Water Supply History

- 1600-1700's
- 1800's Croton System
- 1900-1920's Catskill System
- 1920's to 1960's Delaware System
- 1980's to Present

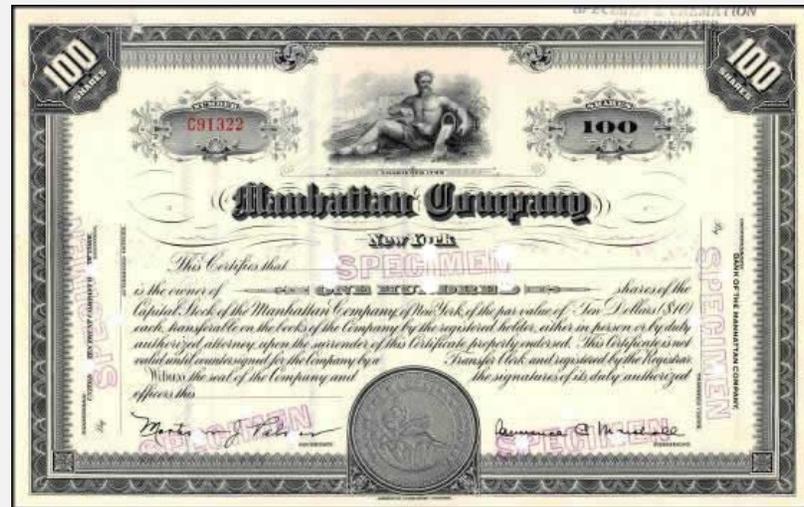
# NYC Water Supply History 1600's -1700's

- 1677 – First public well, dug at Bowling Green
- 1776 – (NYC Pop: 22,000) Collect Pond (S of present day China Town)
  - Water pumped through wooden mains from Collect pond, the reservoir and multiple wells



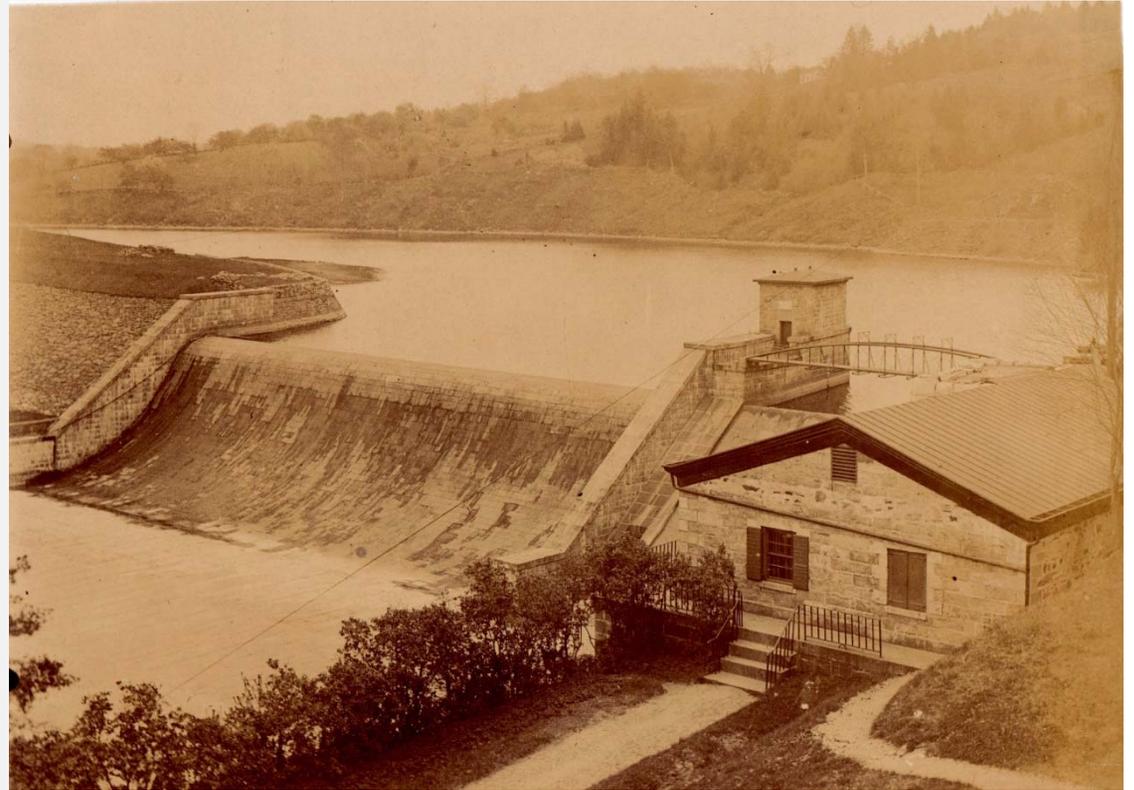
# 1800's Croton System

- 1800 – Manhattan Company (now Chase Bank) sank a well at Read and Center St, pumped water to Collect Pond
- 1811 – Commissioner's Plan
  - Established Manhattan's grid system
- 1830 – NYC built a tank for fire protection on Broadway and 13<sup>th</sup> St; water was conveyed through 12" cast iron pipes



# Old Croton Dam

- Constructed: 1837-1842
- *Croton River*
- *Construction: Town of Yorktown, Westchester Co*
- Capacity: 600 Million Gallons
- 670 feet long, 57 feet high



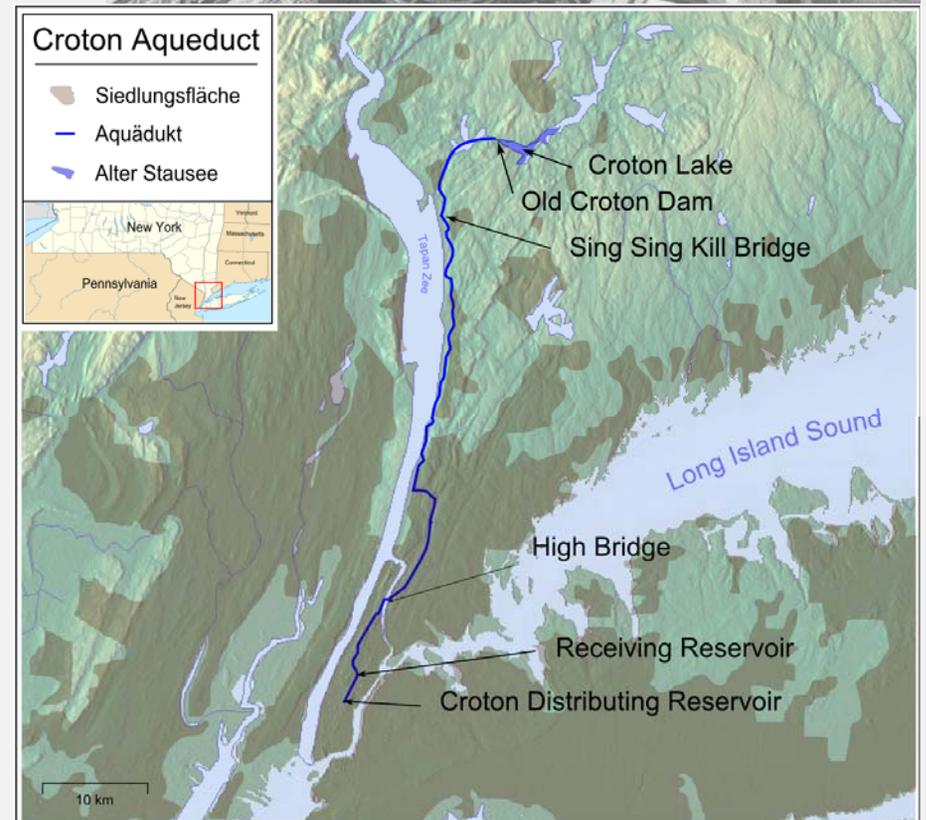
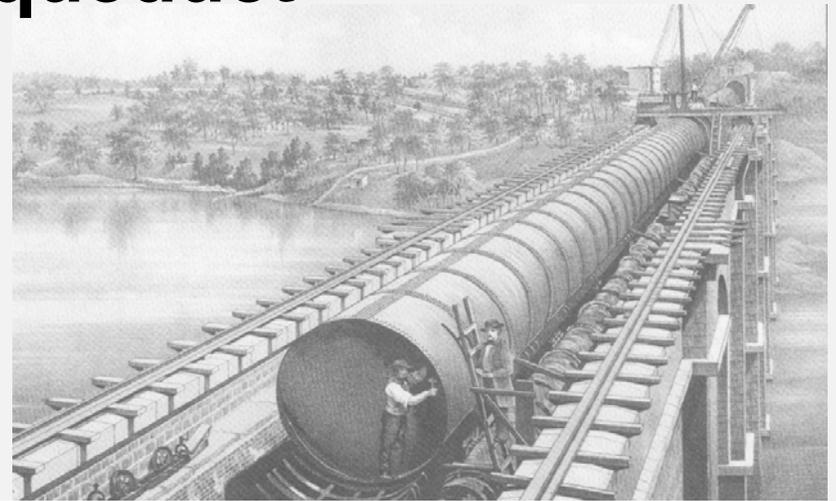
# 1835 NYC Fire

- Dec 16-Dec 17
- Water taken from rivers froze in pipes of hand-pump carts
- Shipping and merchant area between Wall St and Hanover square
- 700 buildings destroyed
- Fire fighters came from NJ
- Sailors from Brooklyn Navy Yard were finally able to put it under control by blowing up buildings in the fires path with gun powder

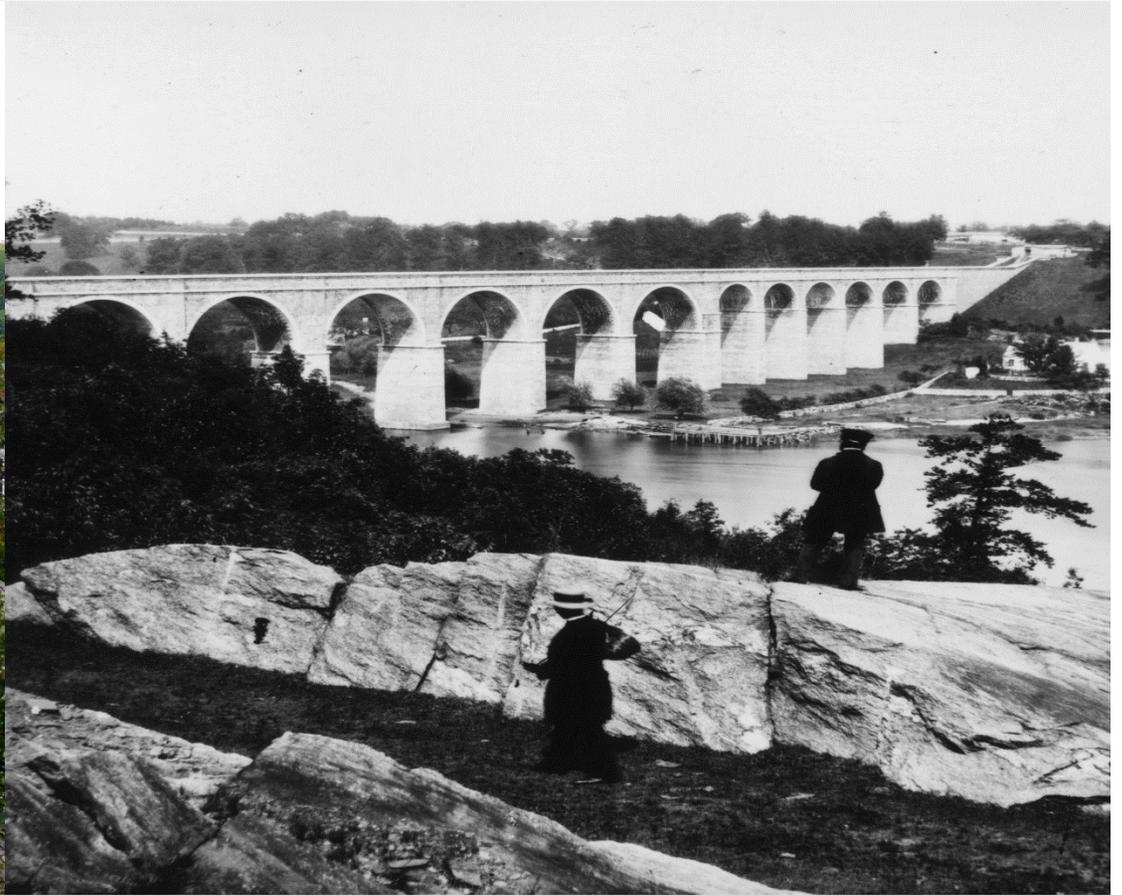


# Old Croton Aqueduct

- **Constructed 1837-1842**
- **Capacity 90MGD**
- 40 mi long
- From Old Croton Dam to Central Park then to 42<sup>nd</sup> St reservoir (discontinued 1925)

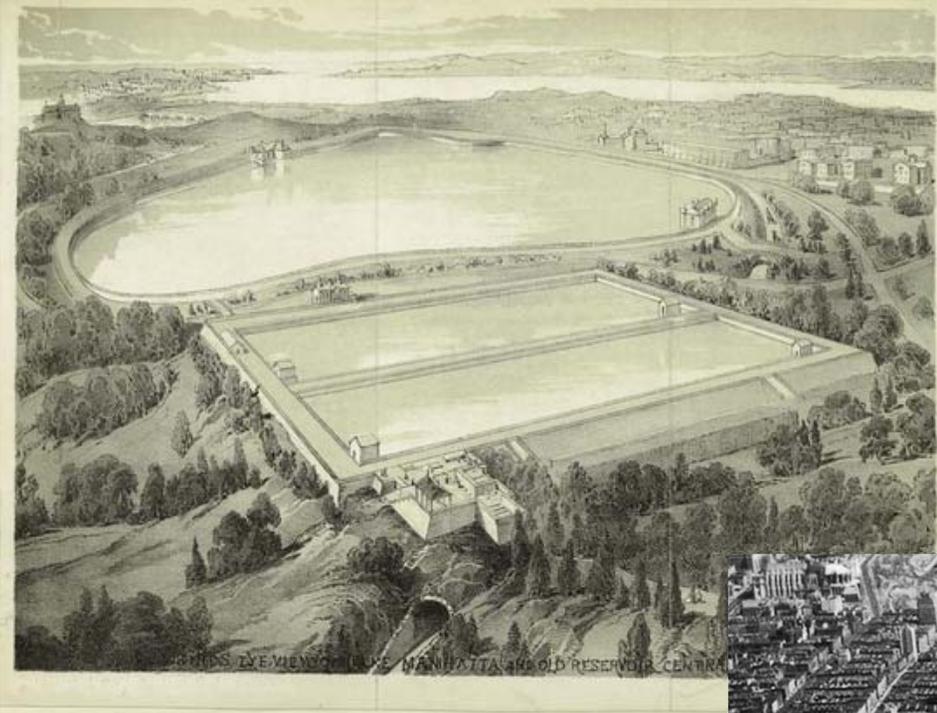


# High Bridge



High Bridge has recently opened to the public in the last 2 years.

# Lake Manahatta and Yorkville Reservoir (Central Park Reservoir)



- Constructed 1858 -1862
- 1.03B Capacity
- 96 Acres
- Yorkville Reservoir  
(now Great Lawn)

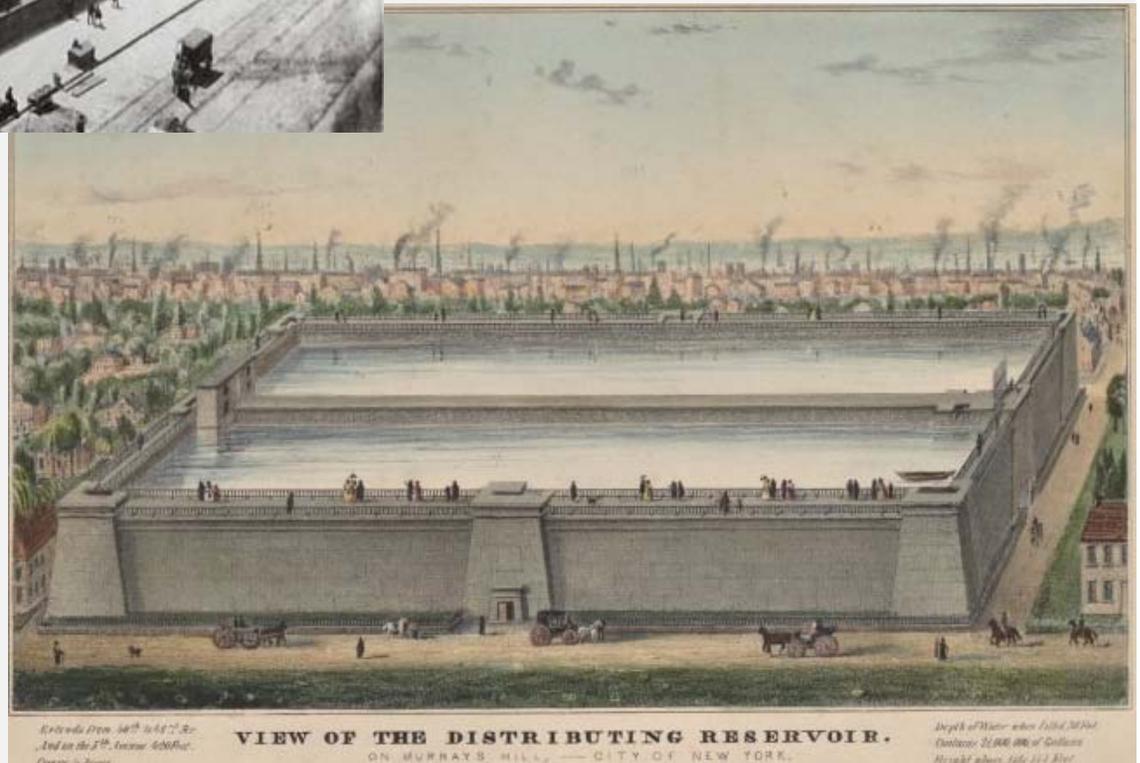


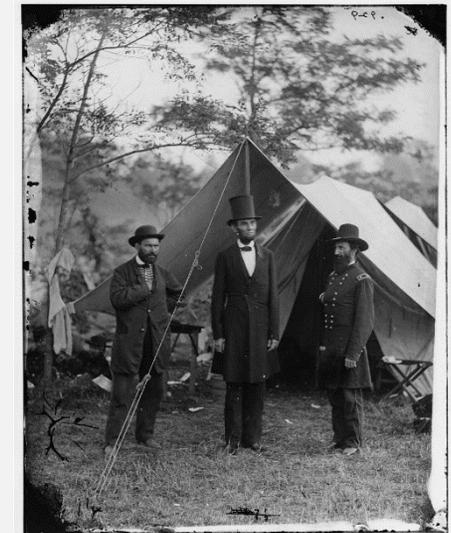
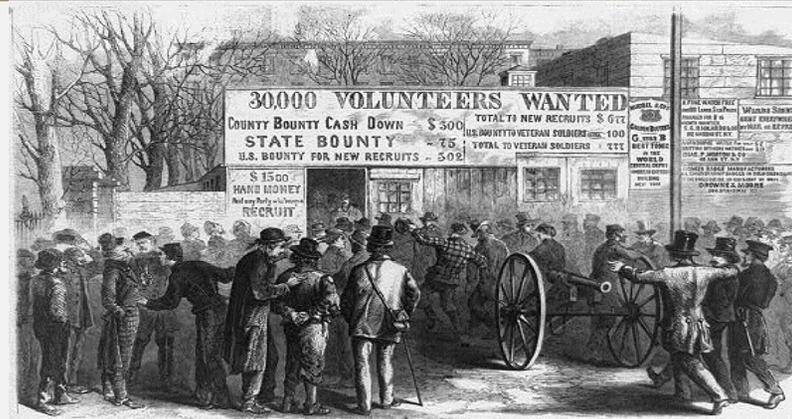
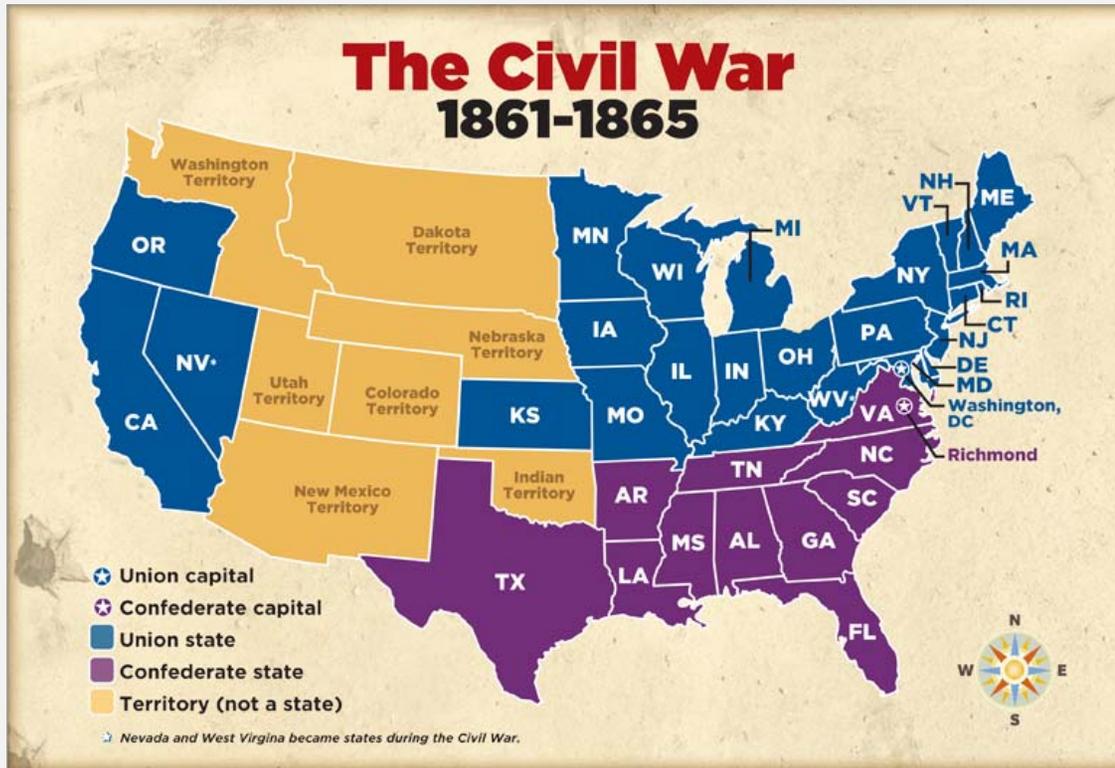
# Murray Hill Reservoir (Croton Distributing Reservoir)



- Completed 1842
- 5<sup>th</sup> Ave and 42<sup>nd</sup> St. (present site of NY Public Library)
- Capacity 20M Gallons
- 4 Acres
- 50ft High, 25ft Thick walls
- Public access parapets
- Demolished 1890s

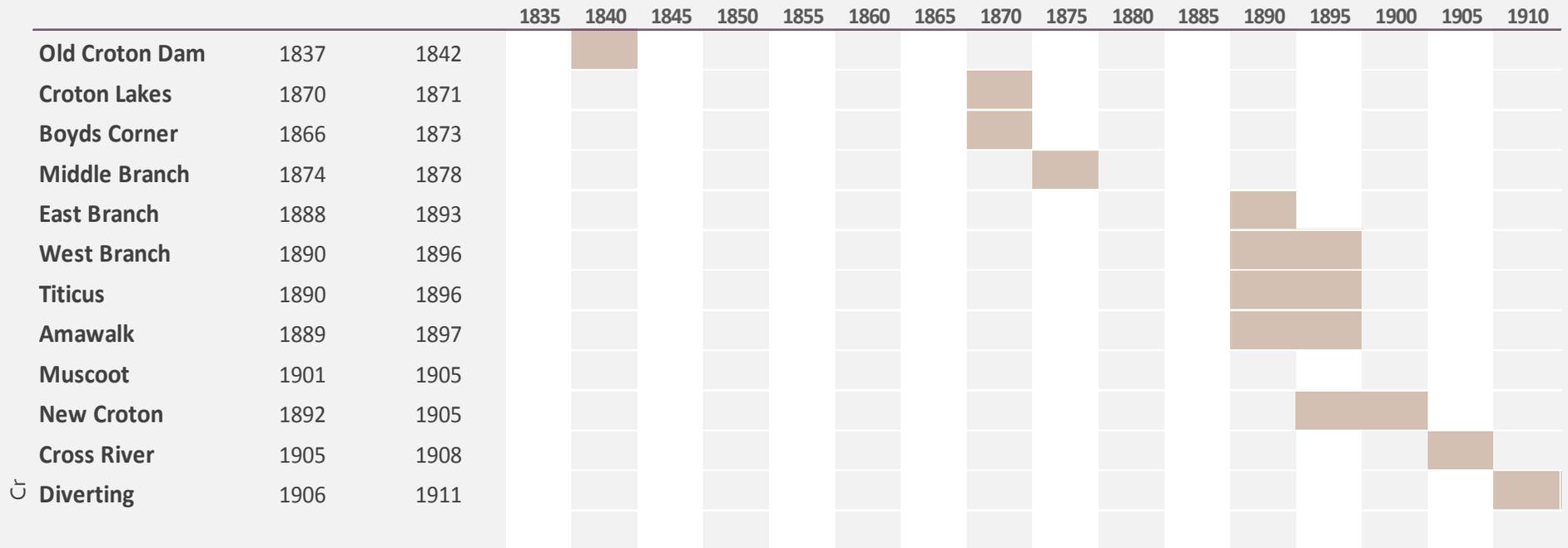
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President Abraham Lincoln  
 battlefield of Antietam, 1862  
 The battle of Antietam was the  
 bloodiest day in American History.

# Development of Croton System



# Boyd's Corner

- **Constructed 1866-1873**
- Town of Kent. Putman Co
- West Branch of Croton River
- Dam: 670 ft long, 57/78 ft high
- Capacity: 1.7 Billion Gallons
- Size: 300 acres, 5.6 mi shoreline



# Middle Branch Dam

- **Constructed 1874 - 1878**
- Town of Southeast Putnam Co
- Middle Branch of Croton River
- Dam:
  - 515 ft long, 94 ft high
- Capacity:
  - 3.0 Billion Gallons
- Size:
  - 404 acres, 6.6 mi shoreline



# June 25–26, 1876 Battle of the Little Bighorn



"The Custer Fight" by [Charles Marion Russell](#)



George Armstrong Custer



Frederick Benteen



Marcus Reno



Crazy Horse



Sitting Bull

<b>Location:</b>	Near the Little Bighorn River, Montana
<b>Commanders and leaders</b>	
Sitting Bull Crazy Horse Chief Gall Lame White Man Two Moon	George Armstrong Custer Marcus Reno Frederick Benteen Myles Keogh James Calhoun
Lakota Dakota Northern Cheyene Arapaho	7 <sup>th</sup> Regiment
<b>Strength</b>	
900–2,500	647
<b>Casualties and losses</b>	
136 warriors, 6 women 4 children killed up to 160 wounded	268 killed 49 wounded+6 Died of wounds

# East Branch and Bog Brook Reservoirs

- **Constructed 1888 - 1893**
- Placed in service 1891 & 1892
- Town of Southeast Putnam Co
- East Branch of Croton River
- Dams:
  - **Sodom** 500 ft long, 78/98 ft high
  - **Bog Brook Dam 1:**  
1340 ft long, 47/60 ft high
  - **Bog Brook Dam 2:**  
1956 ft long, 23/35 ft high
- Capacity: 3.9 Billion Gallons
- Size:
  - 521 acres, 11.8 mi shoreline
  - 381 acres, 5.6 mi shoreline
- Connected tunnel 1778 ft

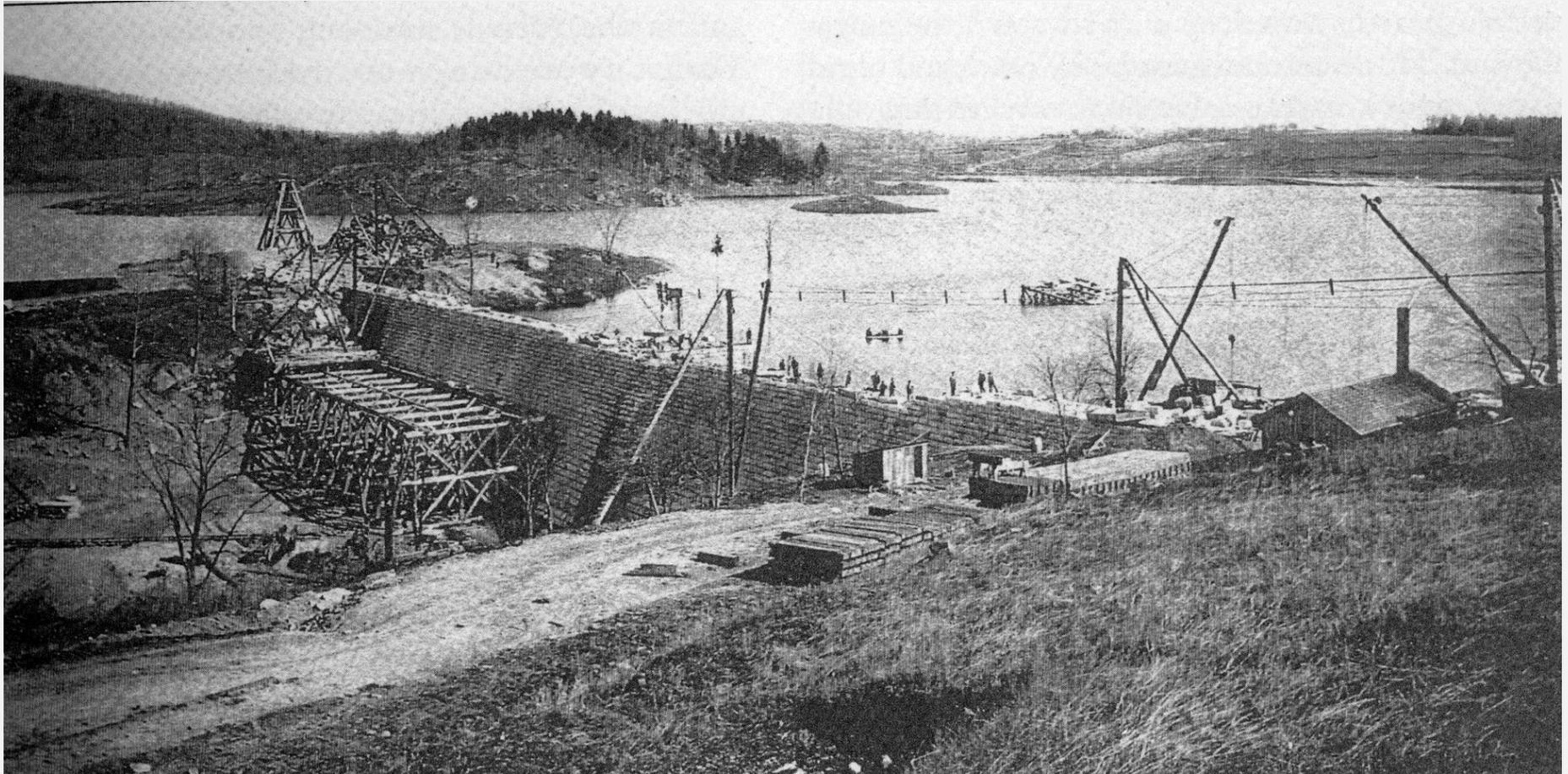


Sodom Dam



Bog Brook

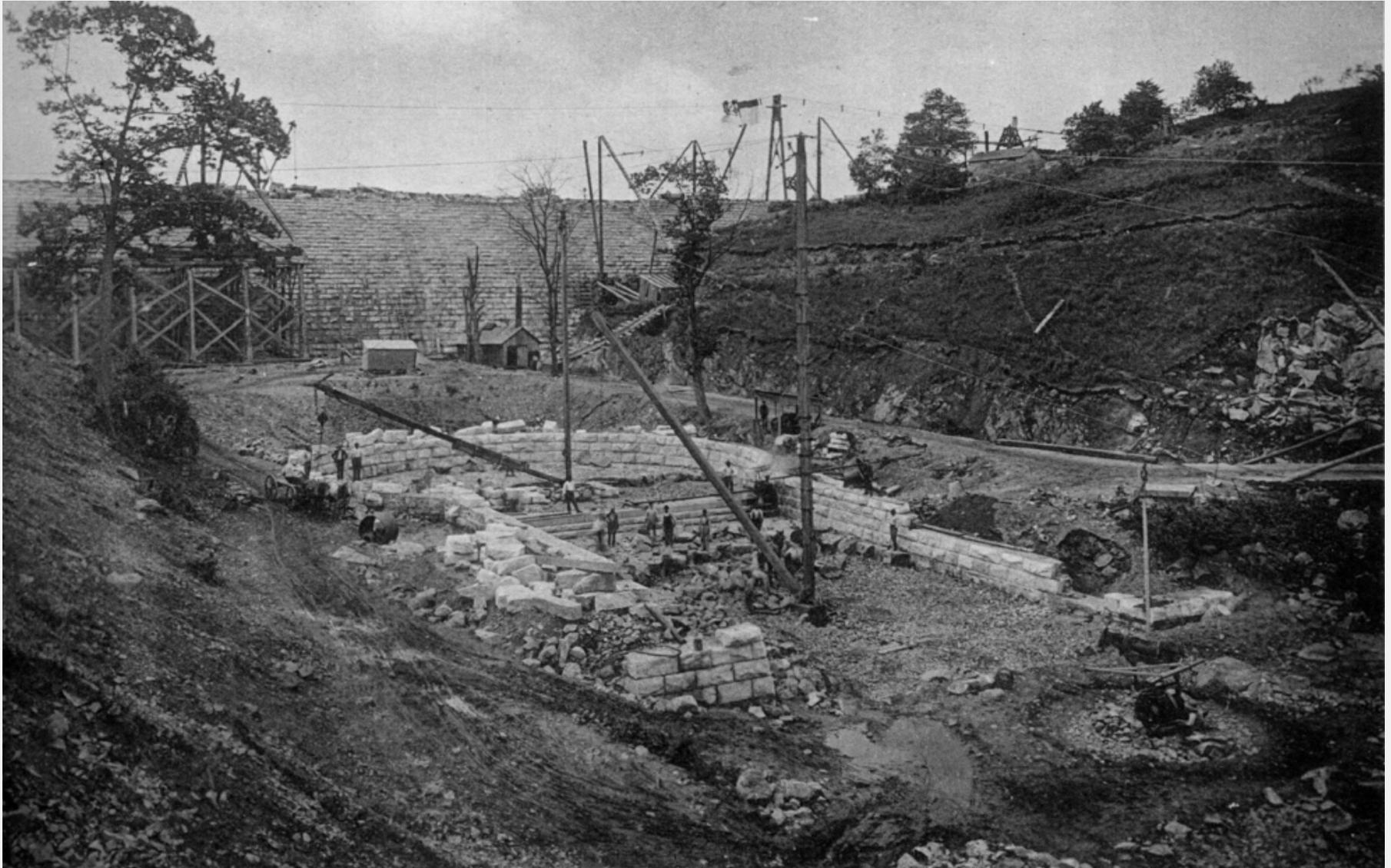
# East Branch Reservoir



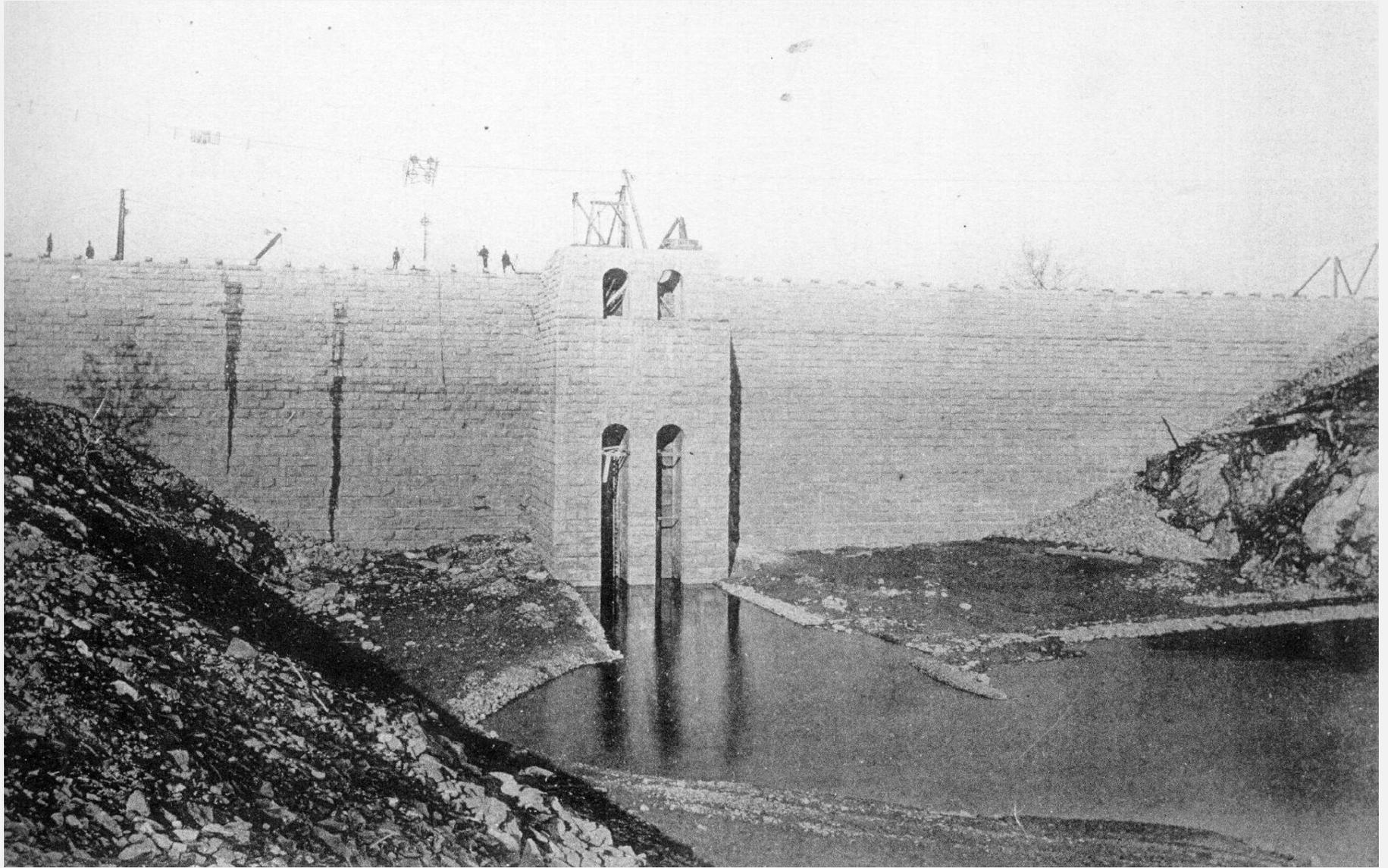
# East Branch



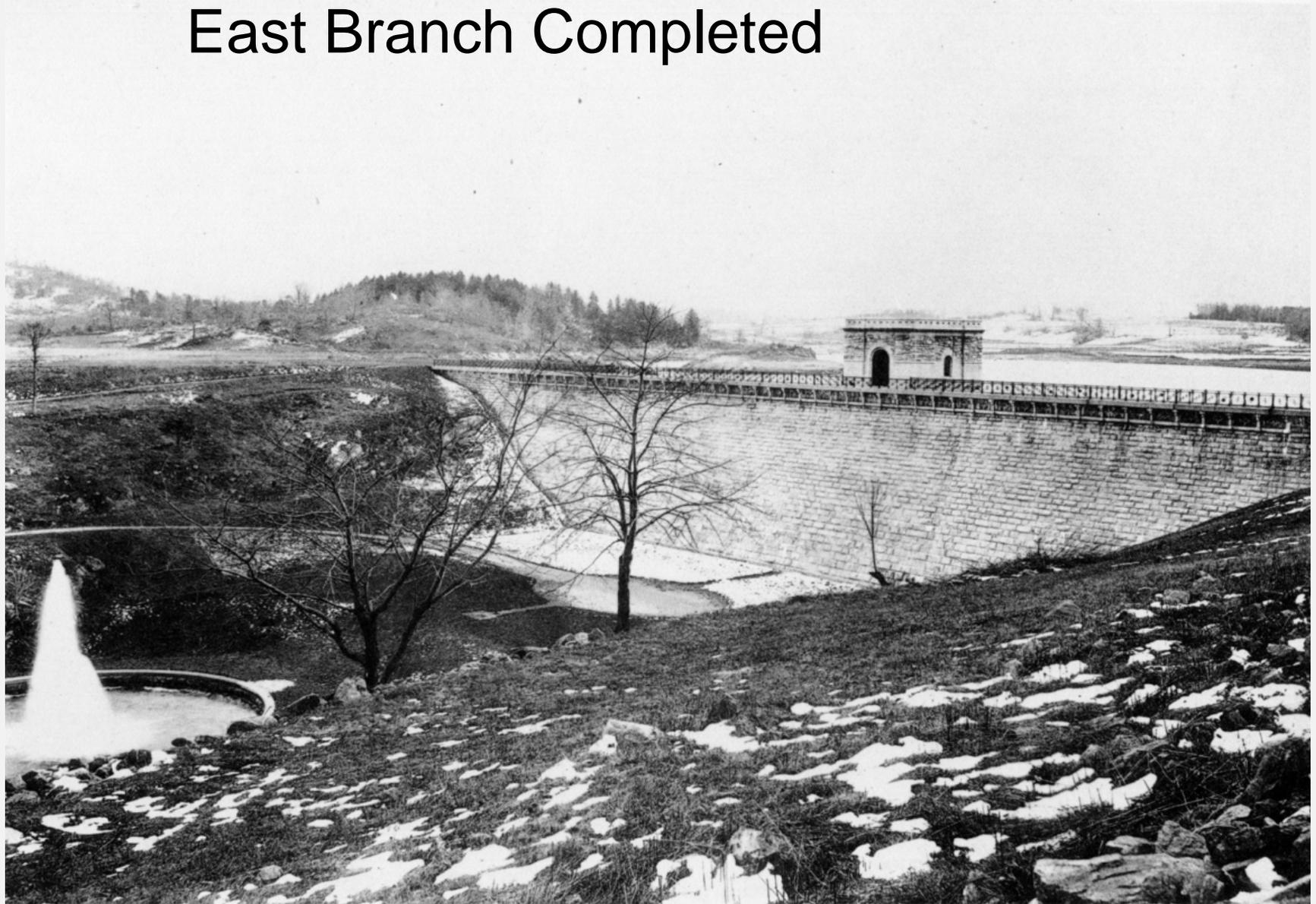
# East Branch



# East Branch



# East Branch Completed



# Bog Brook Tunnel Portal



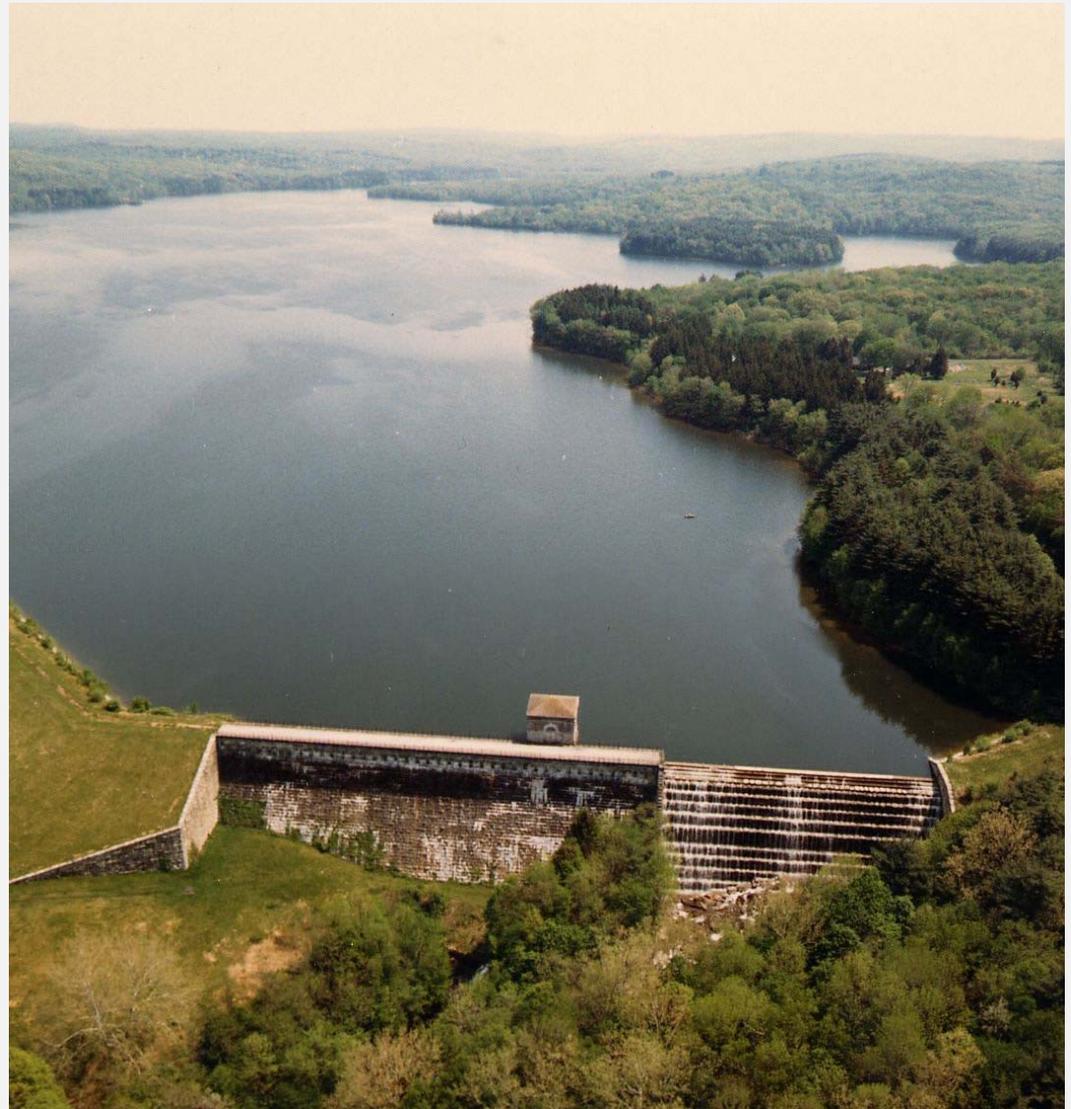
# Amawalk Reservoir

- **Constructed 1889 - 1897**
- Town of Somers, Westchester Co
- Muscoot River
- Dam:
  - 1280 ft long, 82 ft high
- Capacity:
  - 6.7 Billion Gallons
- Size:
  - 600 acres,
  - 6.0 mi shoreline

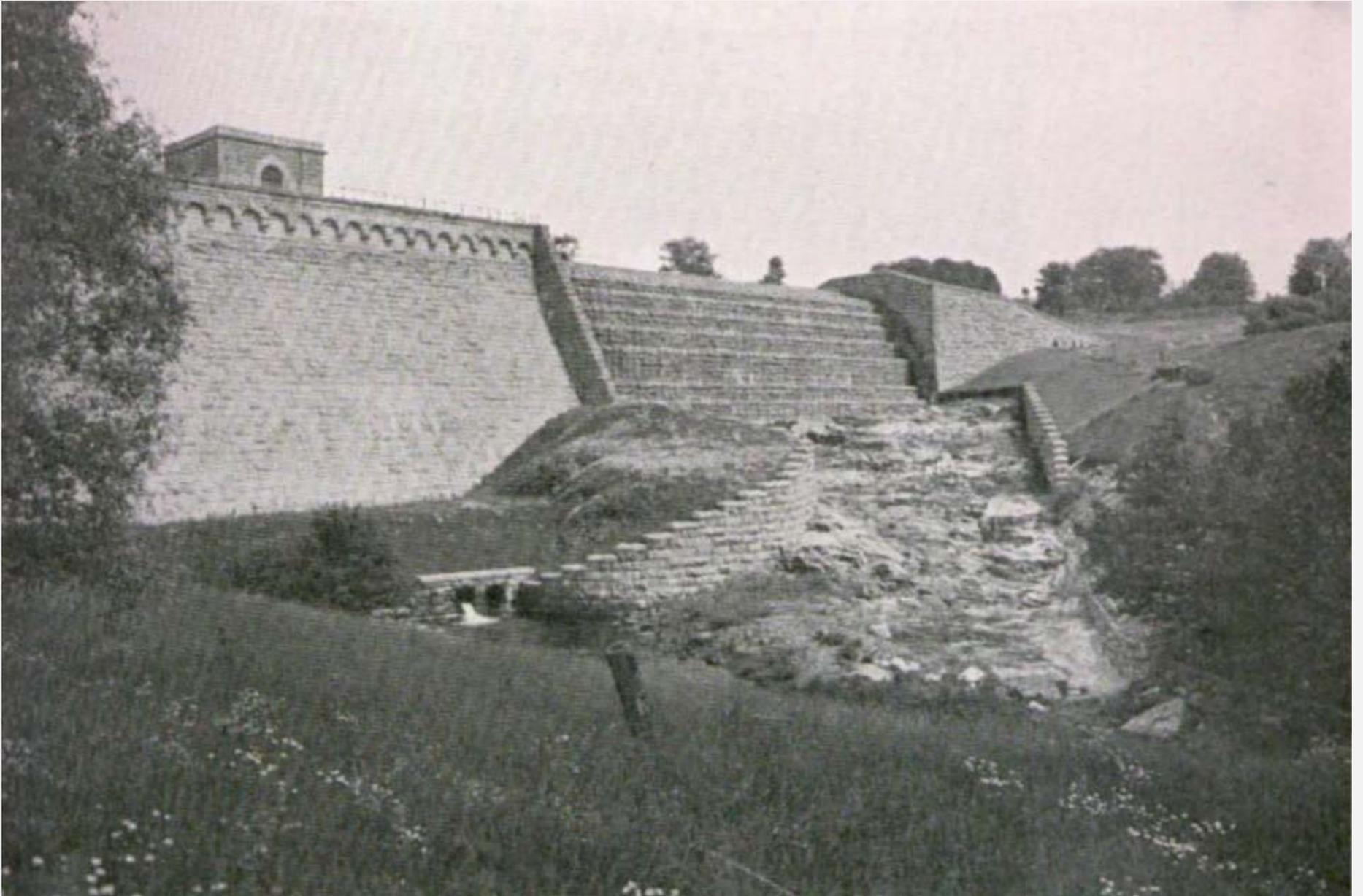


# Titicus

- **Constructed 1890 - 1896**
- Placed in service 1893
- Town of Bedford, Westchester Co
- Titicus River
- Dam:
  - 1519 ft long, 109/135 ft high
- Capacity:
  - 7.2 Billion Gallons
- Size:
  - 682 acres, 8.6 mi shoreline
- Communities Flooded:
  - North Salem



# Titicus



# 1890 Wounded Knee Massacre



In 1990, both houses of Congress passed a resolution formally expressing "deep regret" for the massacre.

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Date	29 December 1890
Target	Miniconjou Lakota Hunkpapa Lakota
Where	Near Wounded Knee Creek on the Pine Ridge Reservation, South Dakota

## 7th Cavalry

438 troopers  
22 artillery men  
with 4 Hotchkiss Mtn guns  
30 Oglala Scouts

## Deaths:

7th Cavalry:  
25 Killed

Lakota:  
150-300 killed  
• 84 men  
• 44 women  
• 18 children

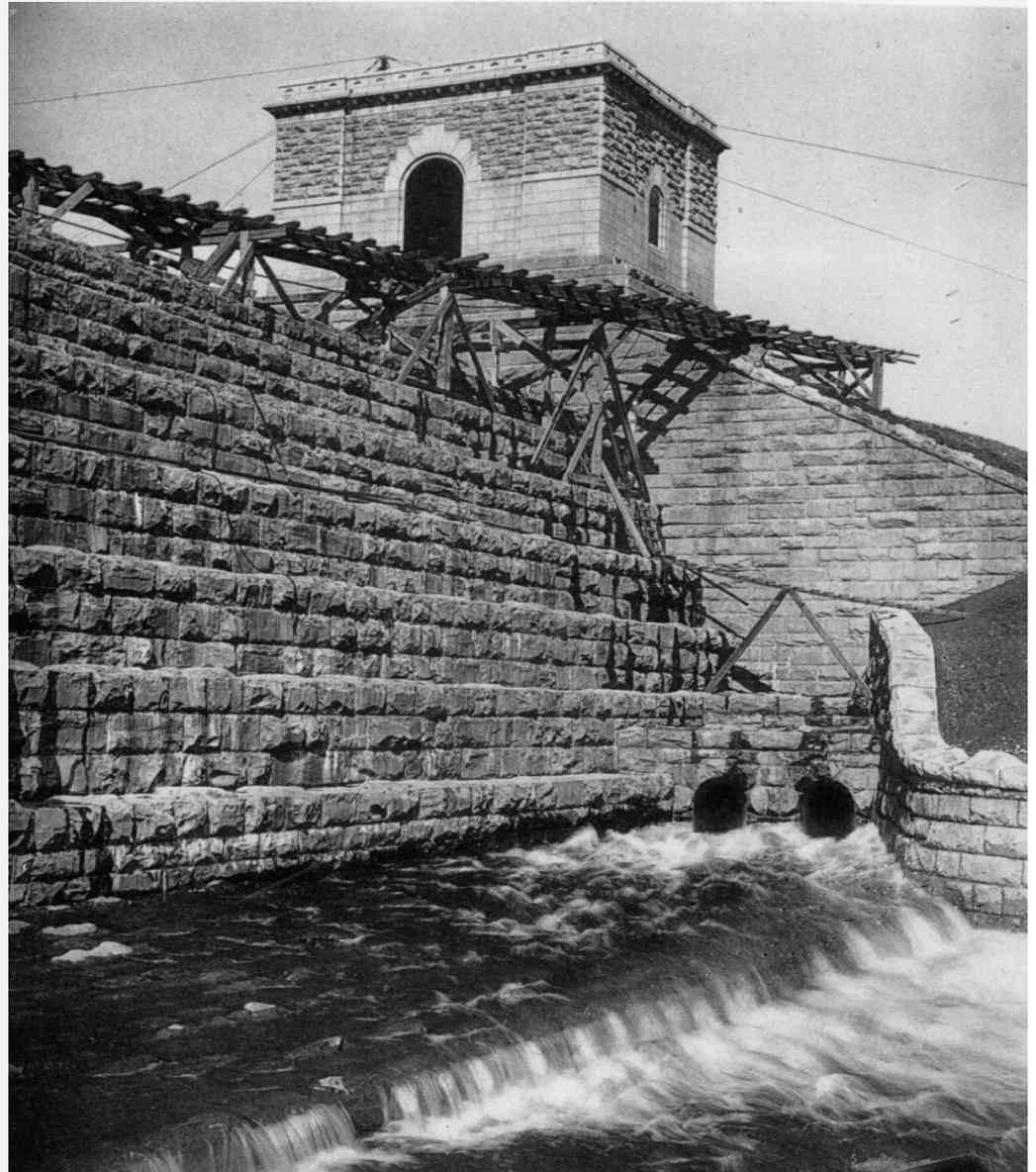
## Non-fatal injuries

39 wounded  
(6 later died)

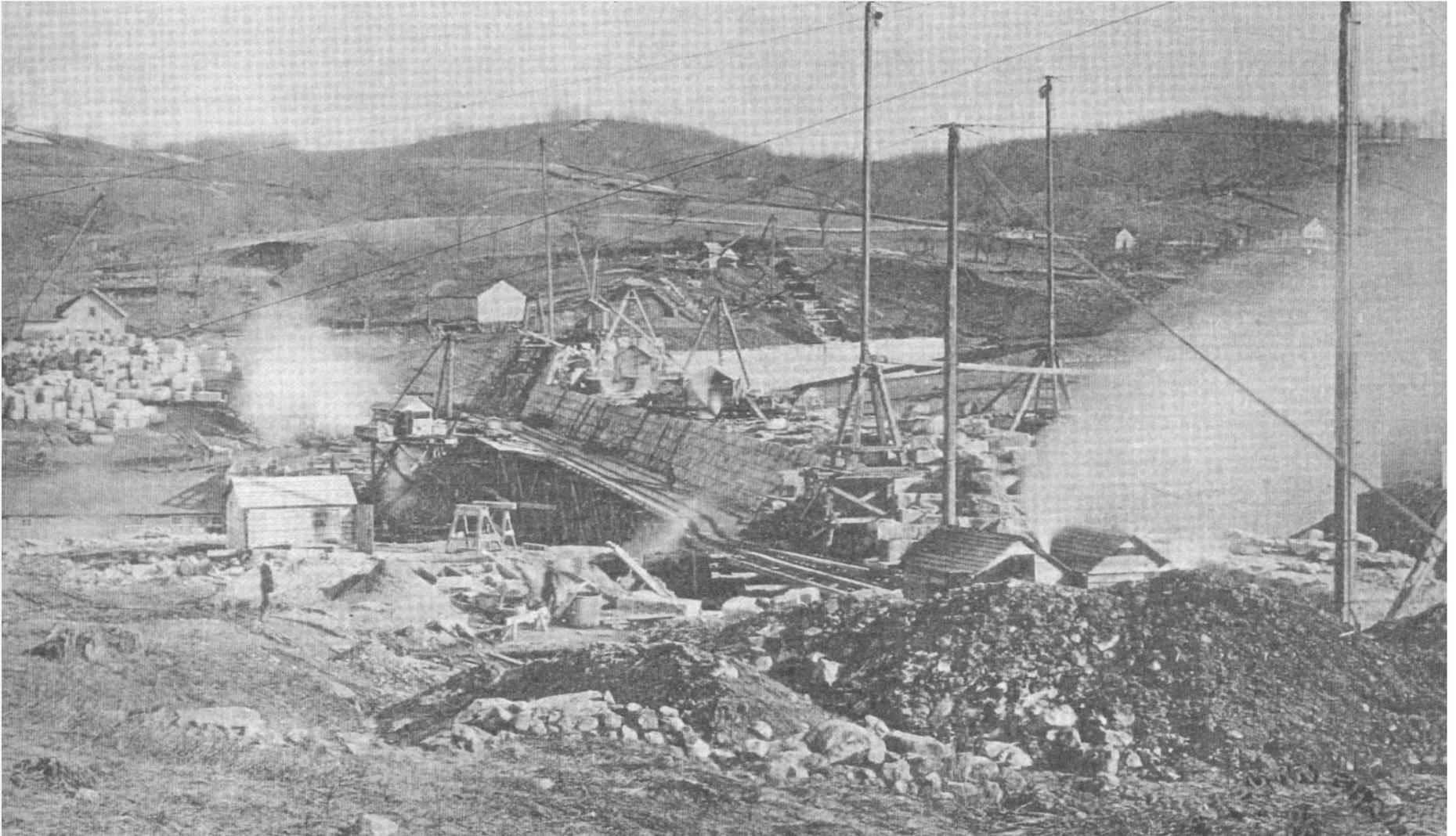
51 wounded  
(7 later died)

# West Branch – 1895

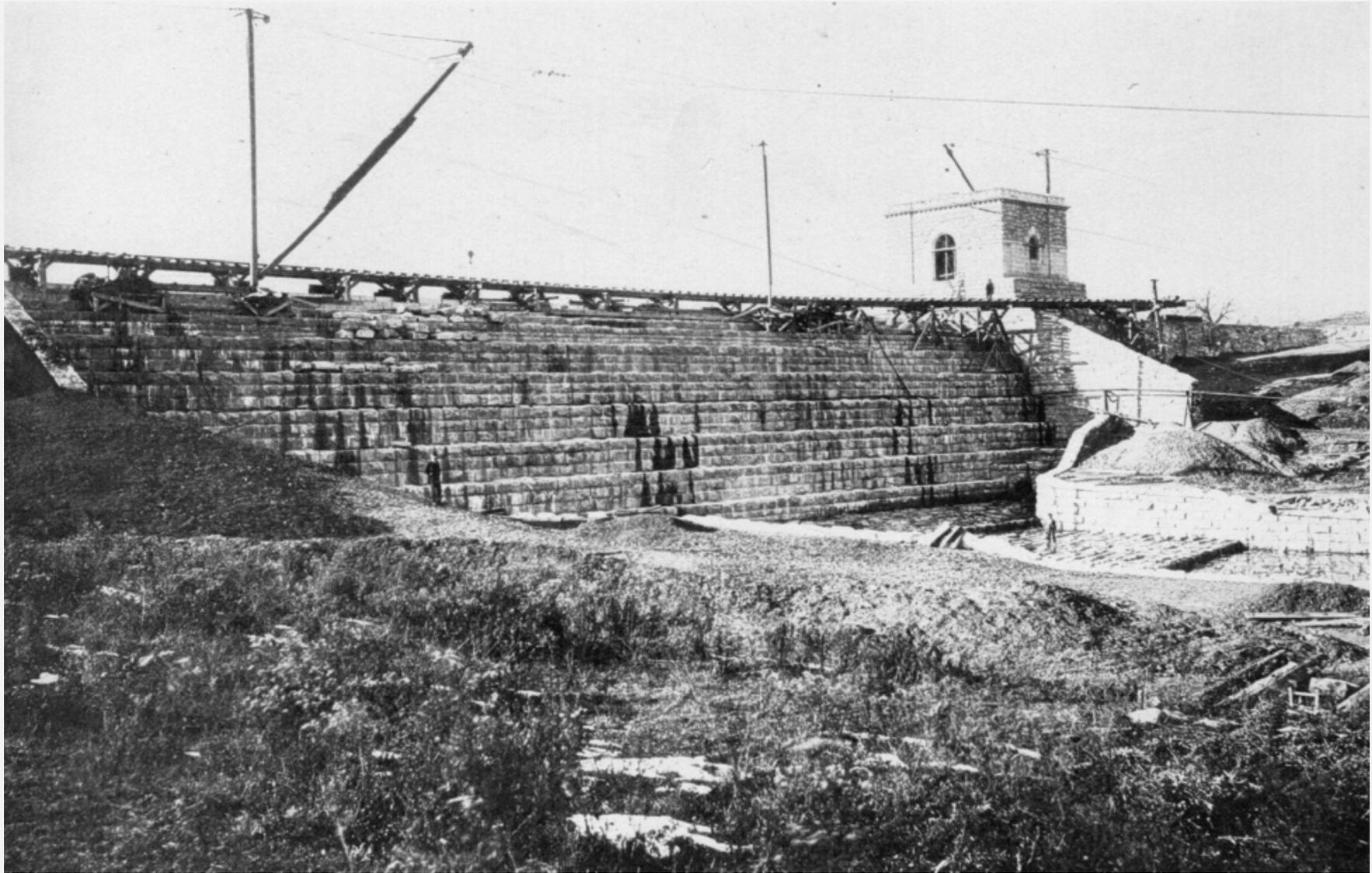
- **Constructed 1890 - 1896**
- Placed in service 1895
- Town of Kent & Carmel, Putnam Co
- West Branch of Croton River
- Carmel Dam:
  - 1800 ft long, 62/86 ft high
- Auxiliary Dam:
  - 720 ft long, 45 ft high
- Capacity:
  - 8.0 Billion Gallons
- Size:
  - 1.5 sq mi, 8.6 mi shoreline
- Presently a major reservoir for Delaware System



# West Branch – Early 1890s



# West Branch



# New Croton Reservoir

- Constructed: **1892-1905**
- Construction: Town of Cortland, Yorktown, New Castle, Bedford, Somers, Westchester Co
- Cornell Dam: 2168 ft long, 174/297 ft high
- Capacity:
  - **19.0 Billion Gallons**
- Size: 19 mi long
  - 1962 acres, 38 mi shoreline
- Communities Flooded :
  - Katonah
  - Golden's Bridge
  - Purdy's Station
  - Croton Falls
- Residents displaced: 2000





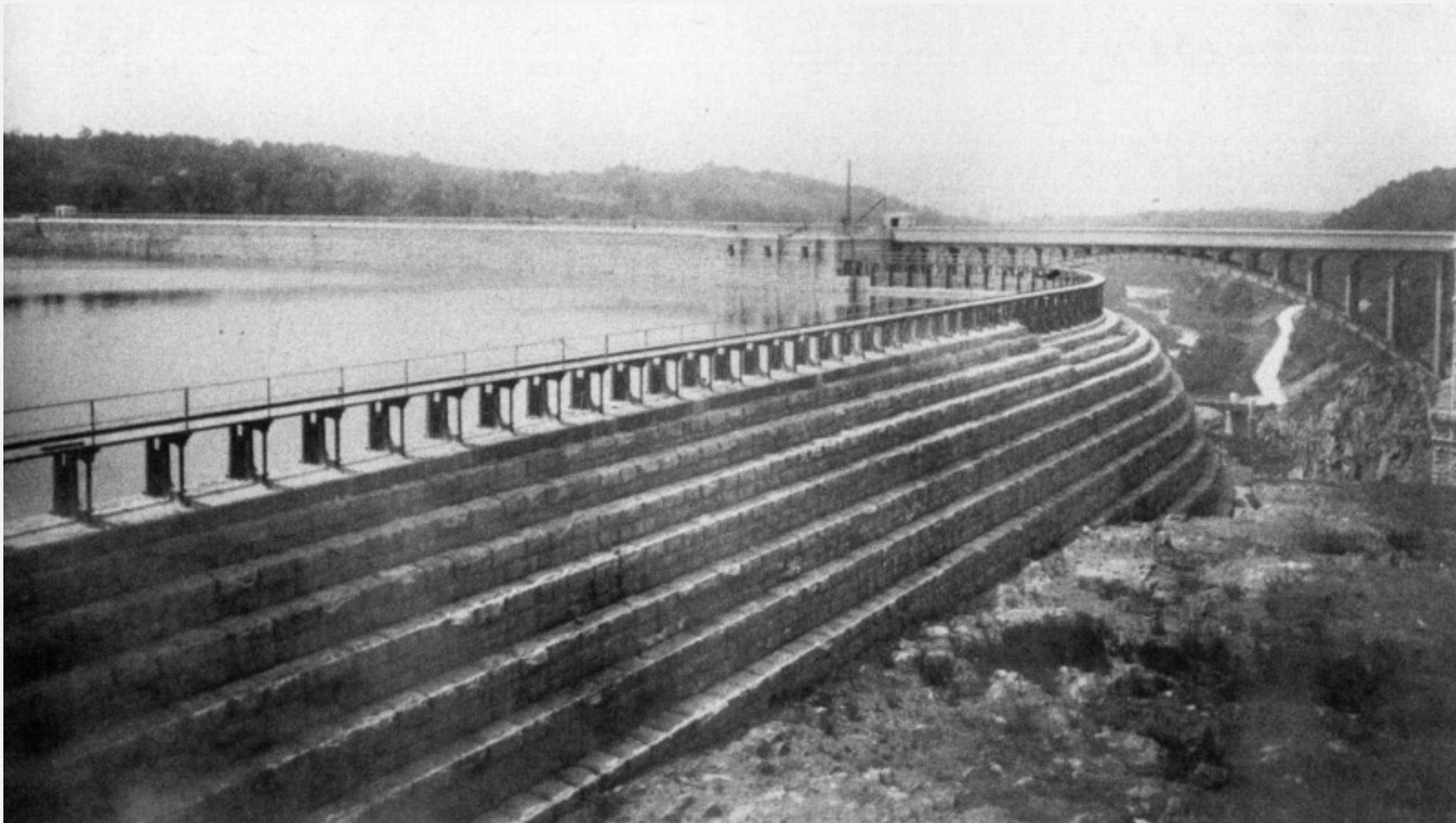
# Old and “New” Croton Lake Gate House



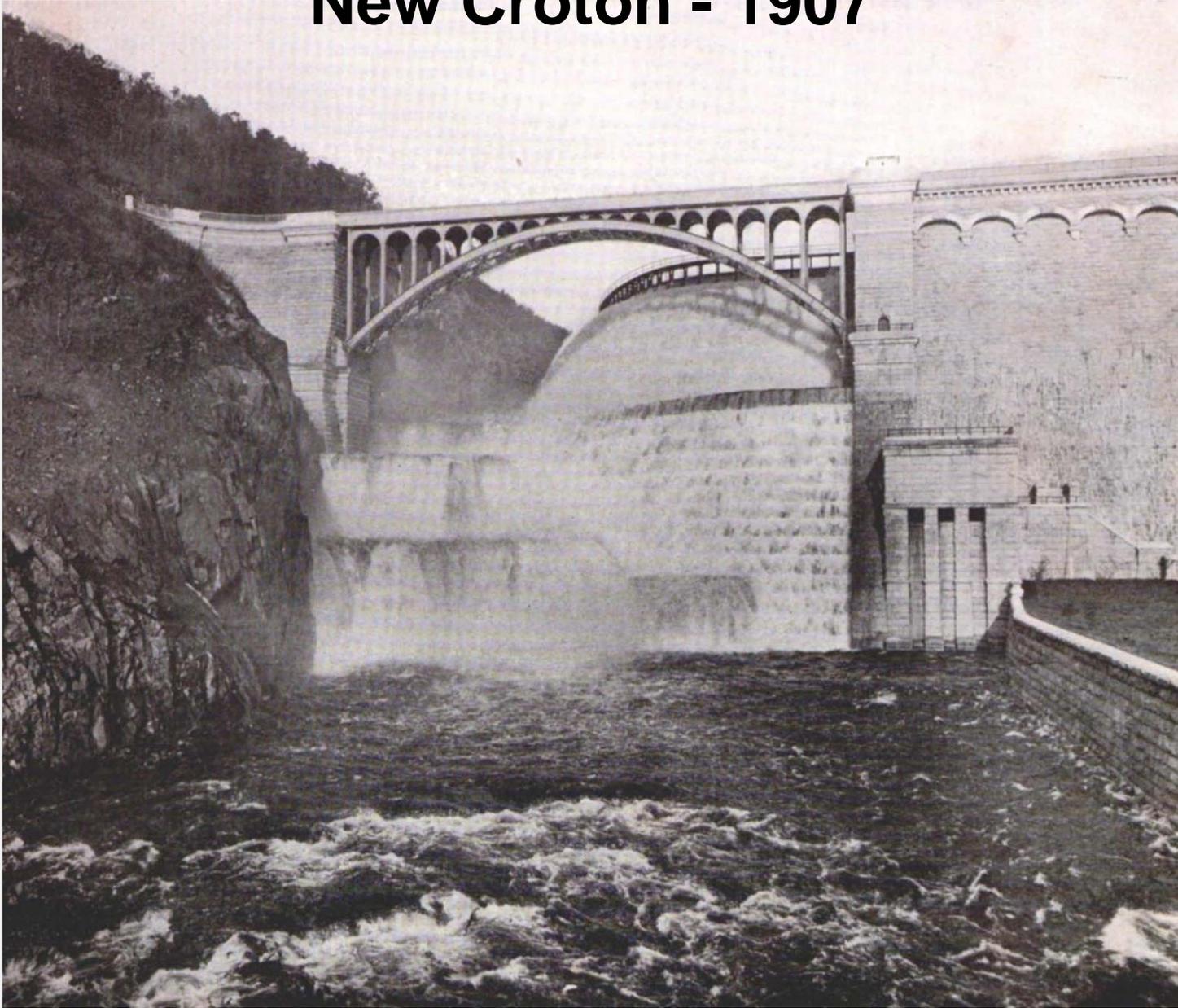
# Old and “New” & New Croton Lake Gate House



# New Croton - 1907



# New Croton - 1907



# New Croton – 1970's

- 1970's Original historic bridge replaced with steel arch in (during budget crisis)
- 1990's DEP initiated project to “repair” failing arch
- 2006 “repair” project cancelled
  - replaced with structure to original historic architecture

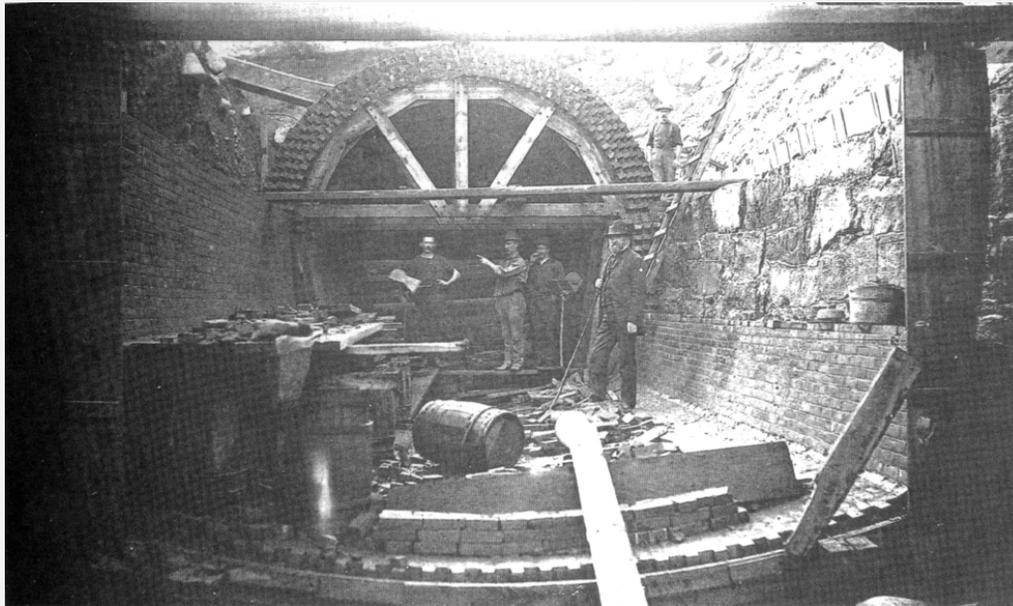


# New Croton 2006



# New Croton Aqueduct

- Constructed 1885-1893
  - 33 Miles
    - 24 mi brick lined rock tunnel
    - 9 miles masonry
- New Croton Reservoir to Jerome Park Reservoir to Manhattan
- Passes 300 ft below Harlem River
- Cost \$19.6M; 92 lives

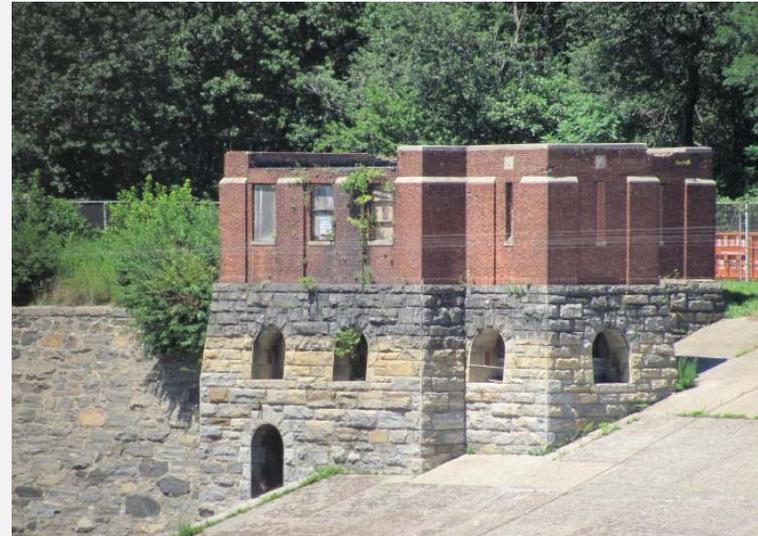
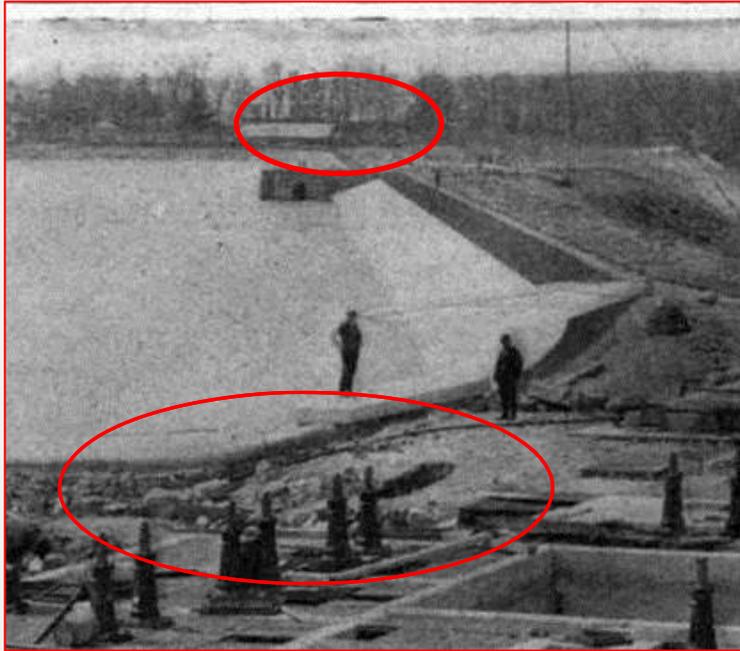


# Jerome Park Reservoir Overview

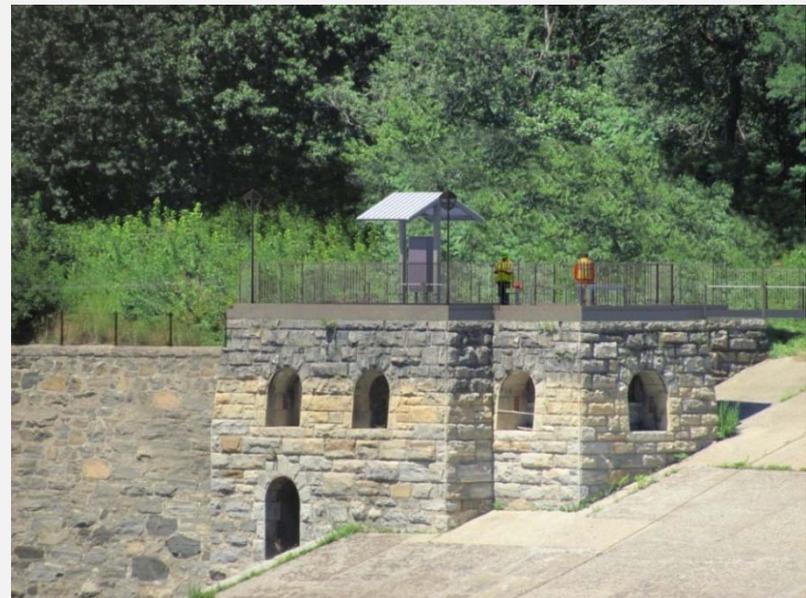
- Constructed in 1889 - 1906
- Named for Jerome Park Racetrack
- Original site planned for future sand filtration



# Gatehouse No. 2

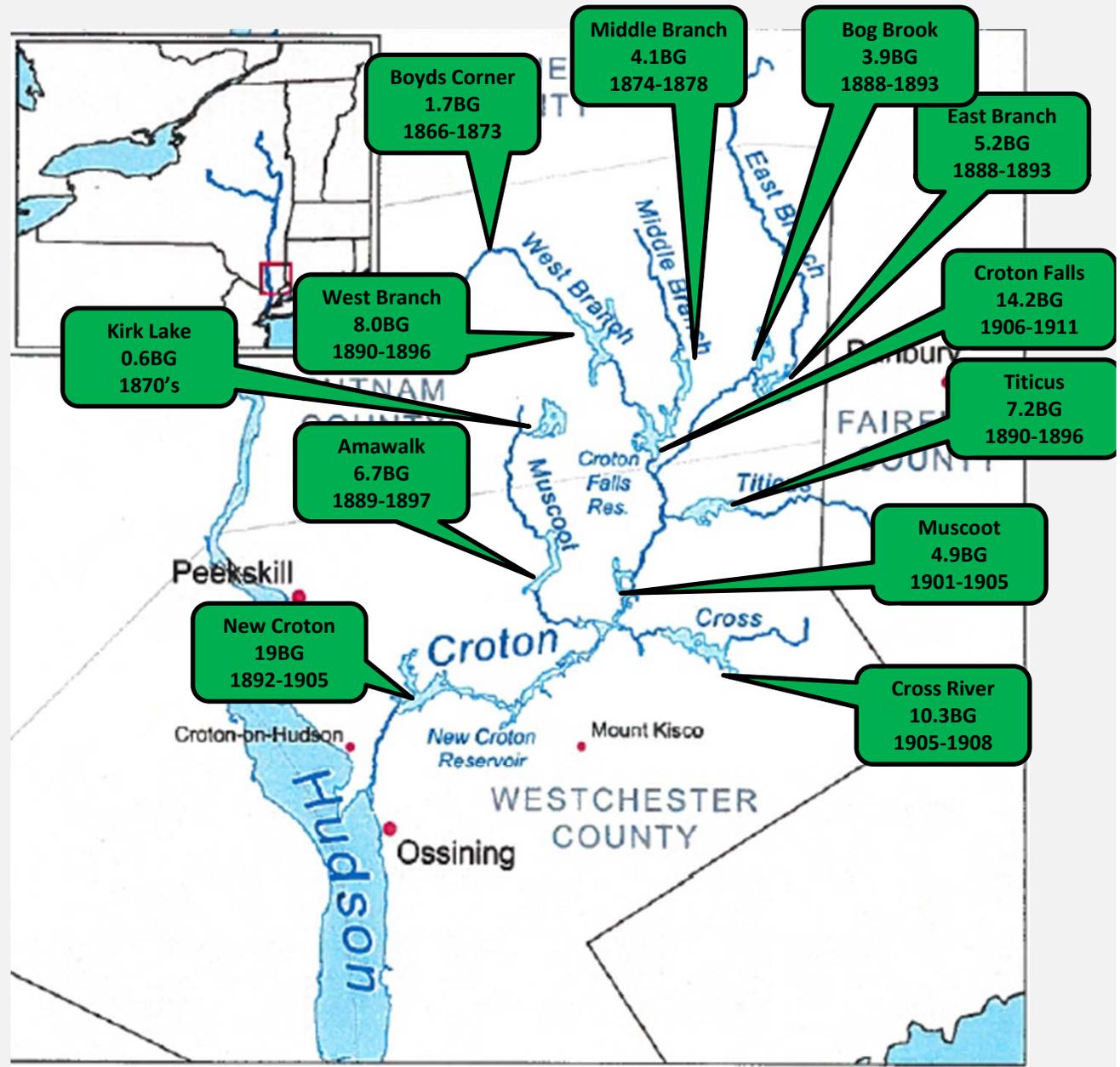


- Original Chambers did not include building (valves exposed)
- Superstructure constructed later
- 2000's- decommissioned and returned to original



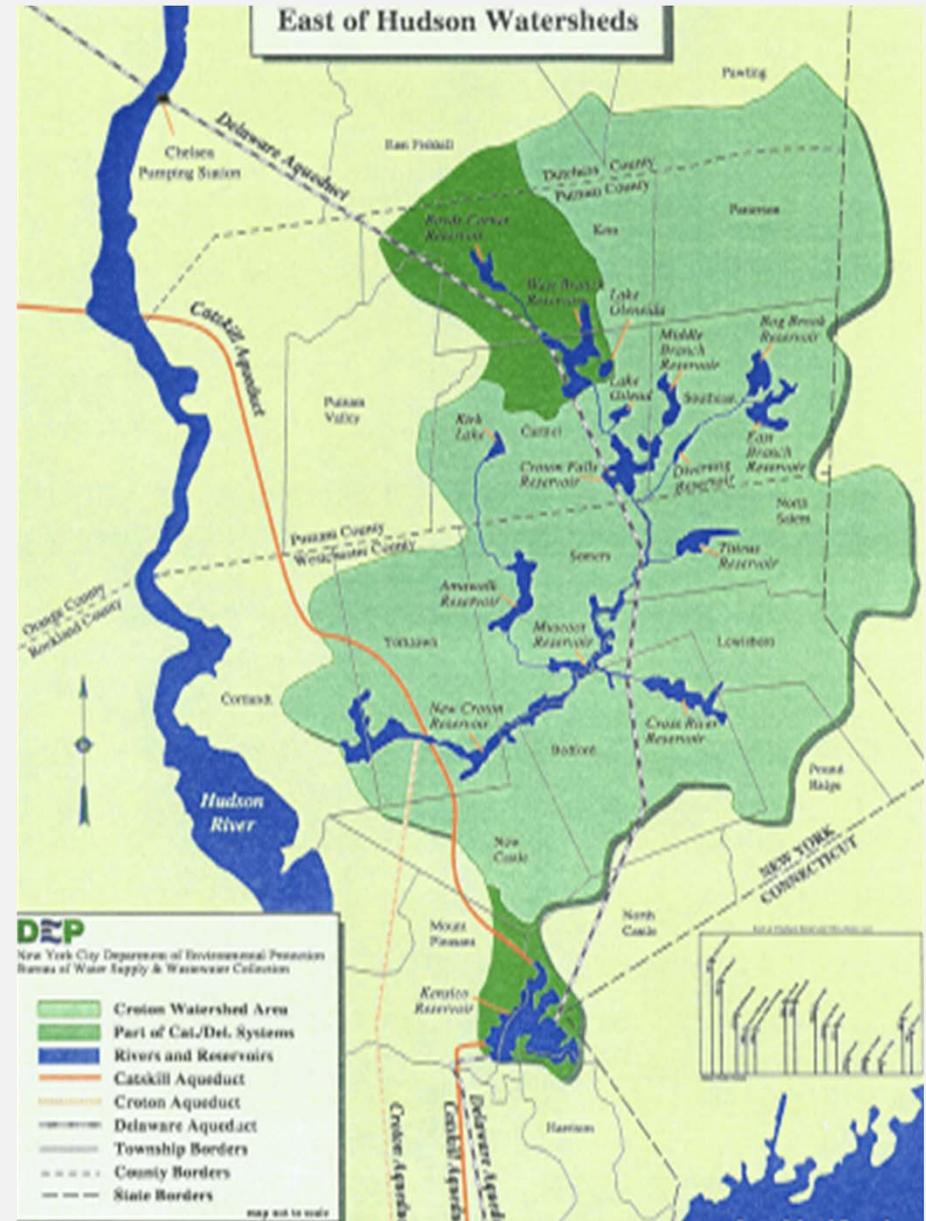
# Croton Reservoirs

- Croton System utilizes system of rivers to convey water to New Croton Dam then NCA to Jerome Park Reservoir, NYC



# Croton System Summary

- Constructed: 1837 - 1911
- 12 Reservoirs, 3 controlled lakes
- 375 sq mi watershed
- Croton Capacity:
  - 87.8 Billion Gallons
  - **Up to 290 MGD**
- Yield: **240 MGD**
  - **(214 MGD w/o West Branch)**



# 1980's – Present Upgrades Croton System

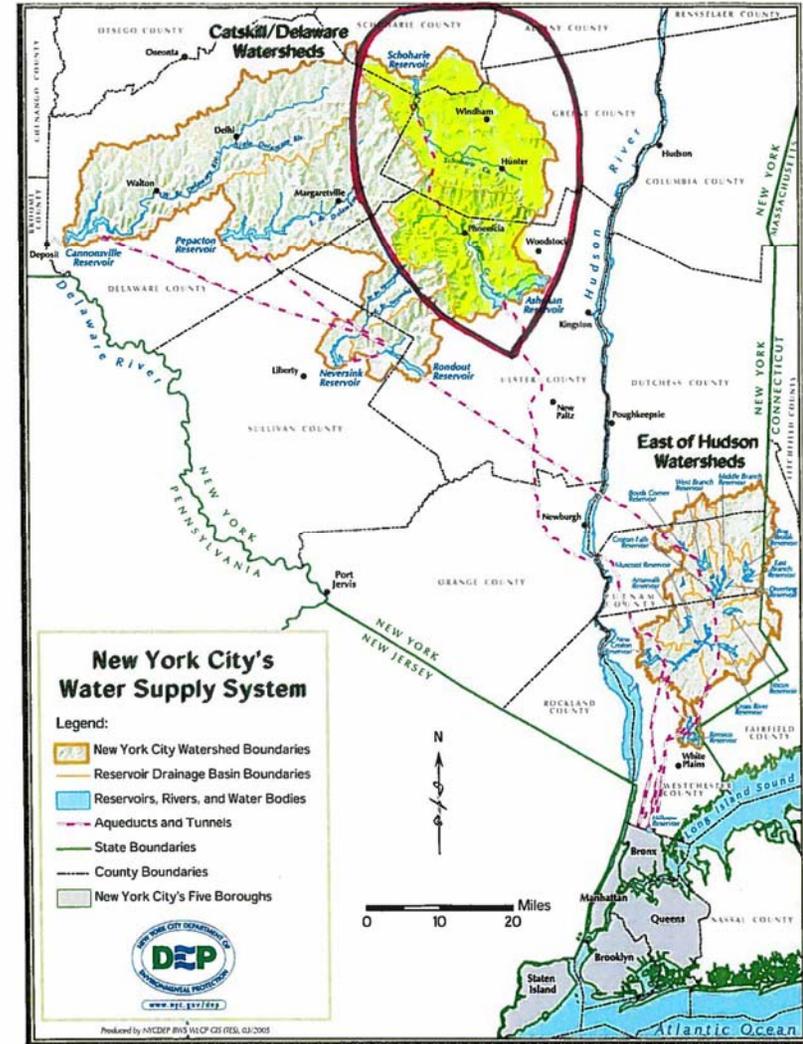
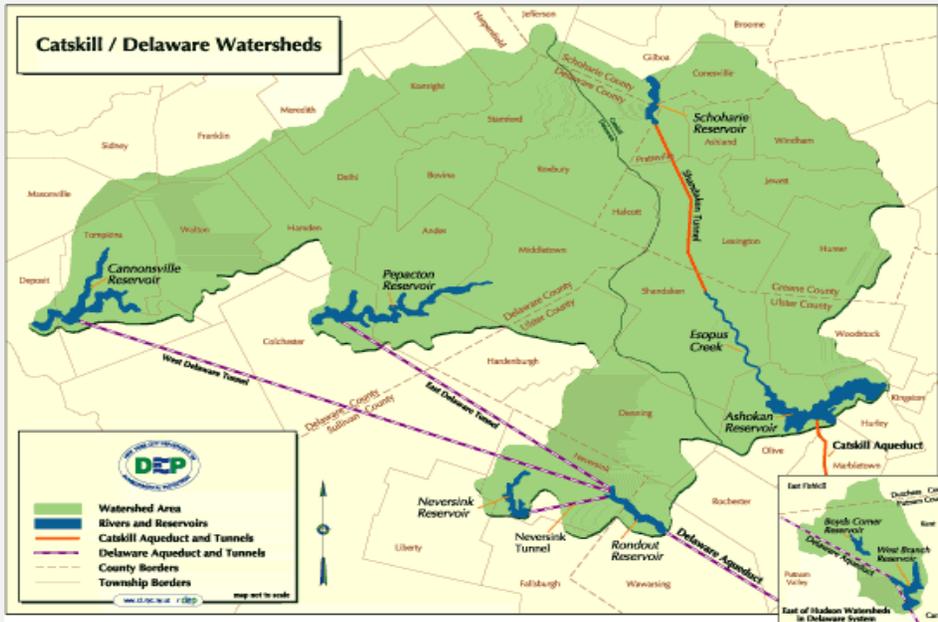
- Replacement of 100+yr old valves and gates
- Minor repairs to chambers
- New Bridges: Cross River, Kensico
- Stability Improvements
  - Major Dam changes at Boyds
  - Anchoring: Croton Falls, Titicus, Sodom
  - Repair spillway: West Branch
  - Fuse plugs: Titicus, Sodom, Bog, Middle Branch
  - New spillways: Boyds, Croton Falls
  - New spillways to meet ½ to full PMF
    - Croton Falls Dam
- Zebra mussel control



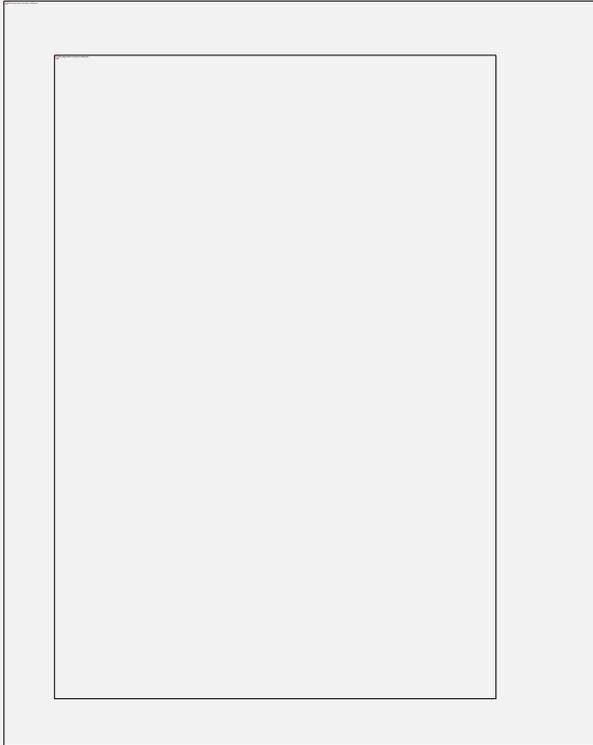


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# The Catskill System Constructed 1907-1927



# 1900- 1920's Catskill System



J. Waldo Smith, Chief Engineer

- 1905 Board of Water Supply created by State Legislature
  - Decided to develop Catskills
  - Appointed J. Waldo Smith as Chief Engineer
- 1906 First Contract
- **1914 - 1918 World War 1**
- 1915
  - Ashokan Reservoir Completed
  - Catskill Aqueduct Completed
  - Kensico Reservoir Completed
  - Water delivered to NYC
- 1928 Gilboa and Shandaken Tunnel completed

# Ashokan 1907-1915

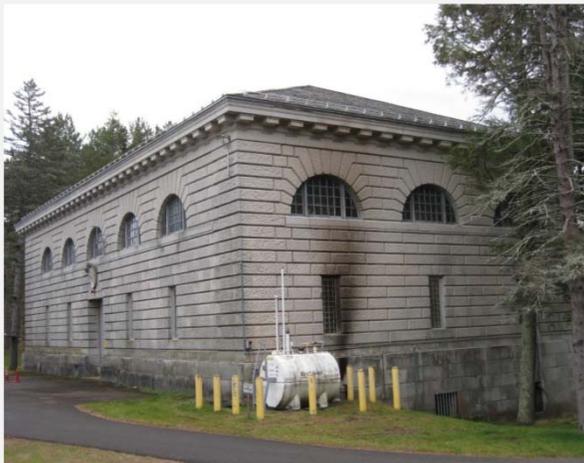
- **Constructed: 1907 - 1915**
  - Towns of Olive, Marbletown, Hurley Ulster Co
  - Esopus Creek
- Olive Bridge Dam: 4650 ft long, 210/252 ft high
- **Capacity: 123 Billion Gallons**
  - 256 sq mi Watershed
- Size: 12.8 sq mi, 12 mi long, 40 mi shoreline, max depth 190 ft
- Communities Flooded:
  - Shokan, BROADHEAD BRIDGE, Browns Station, Olive Bridge, West Hurley, Glenford, Olive, Ashton
- Residents displaced: 2000



# Ashokan Reservoir



Lower gate chamber



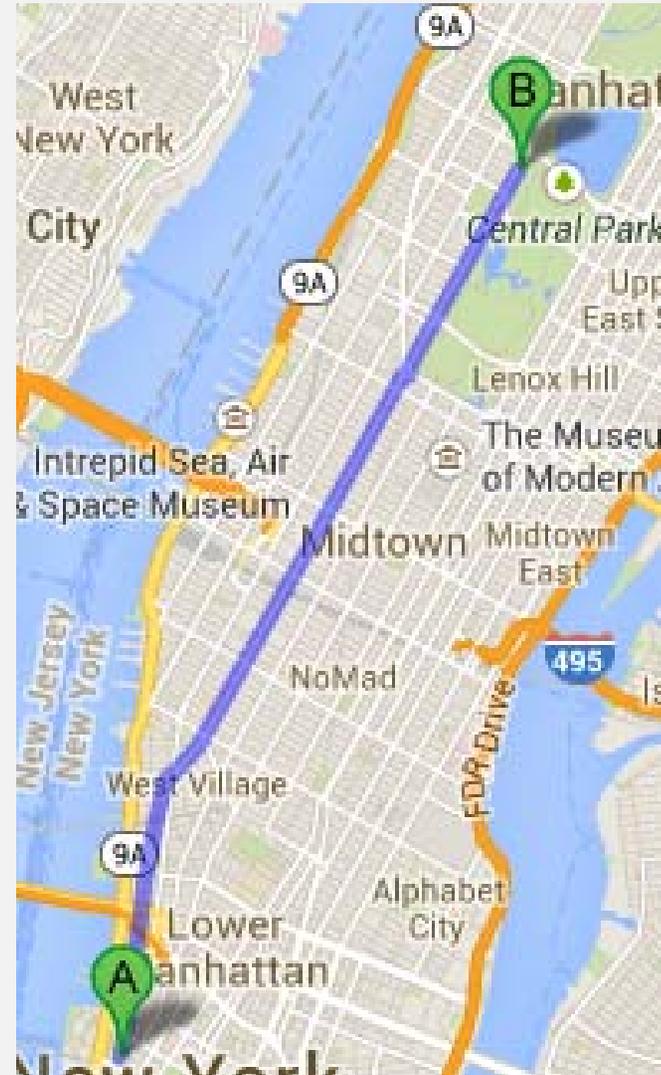
Screen Chamber



Upper gate chambers

# Ashokan Dams & Dikes - Perspective

- Croton System: ~15,575ft
  - 15 Structures
- Ashokan length Total: ~29,000ft (5.49mi)
  - 13 Structures





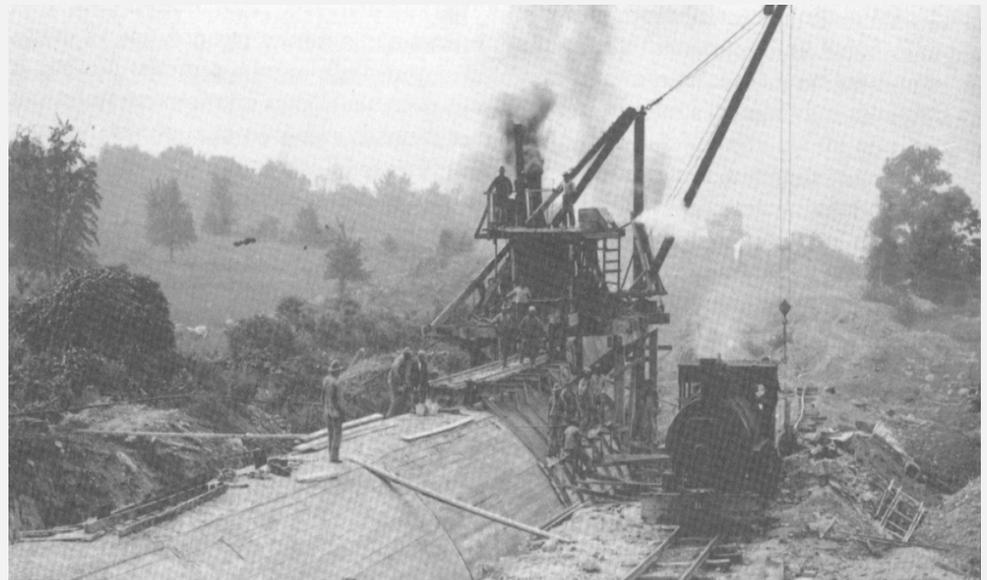
# Catskill Aqueduct



Typical Cut and Cover Section



Hudson River Drainage Chamber

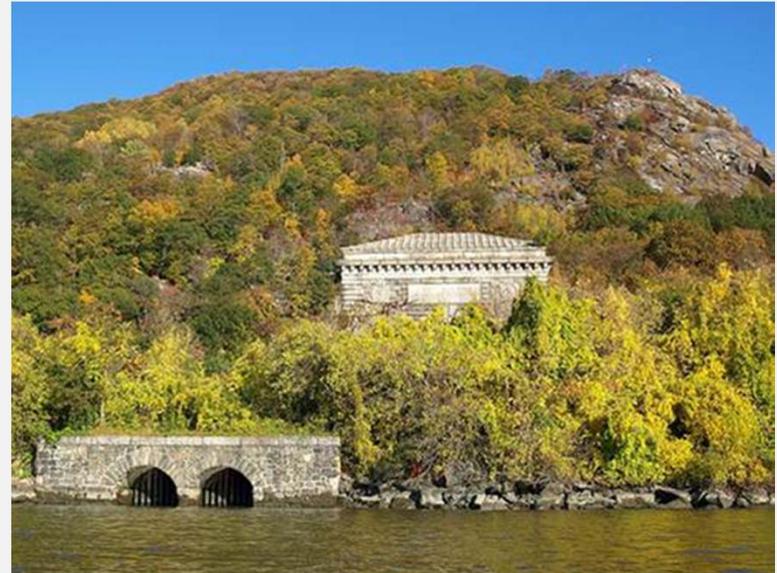


Catskill Aqueduct at Peekskill

# Catskill Aqueduct Shafts



Croton Lake Downtake



Hudson River Drainage Chamber



Catskill Influent Chamber



Upper Effluent Chamber

# Kensico Reservoir

- **Constructed: 1911 start removal of old dam/1913 – 1915 new dam**
- Town of Mt. Pleasant, North Castle, Harrison
- **Kensico Dam: 3300 ft long, 168/307 ft high (size of pyramids)**
- Capacity: **30 Billion Gallons**
- Storage/ Balancing Reservoir
- Size: 3.5 sq mi, 4.0 mi long, 35 mi shoreline, max depth 155 ft
- Communities Flooded:
  - Kensico
  - Armonk
  - Part of Valhalla

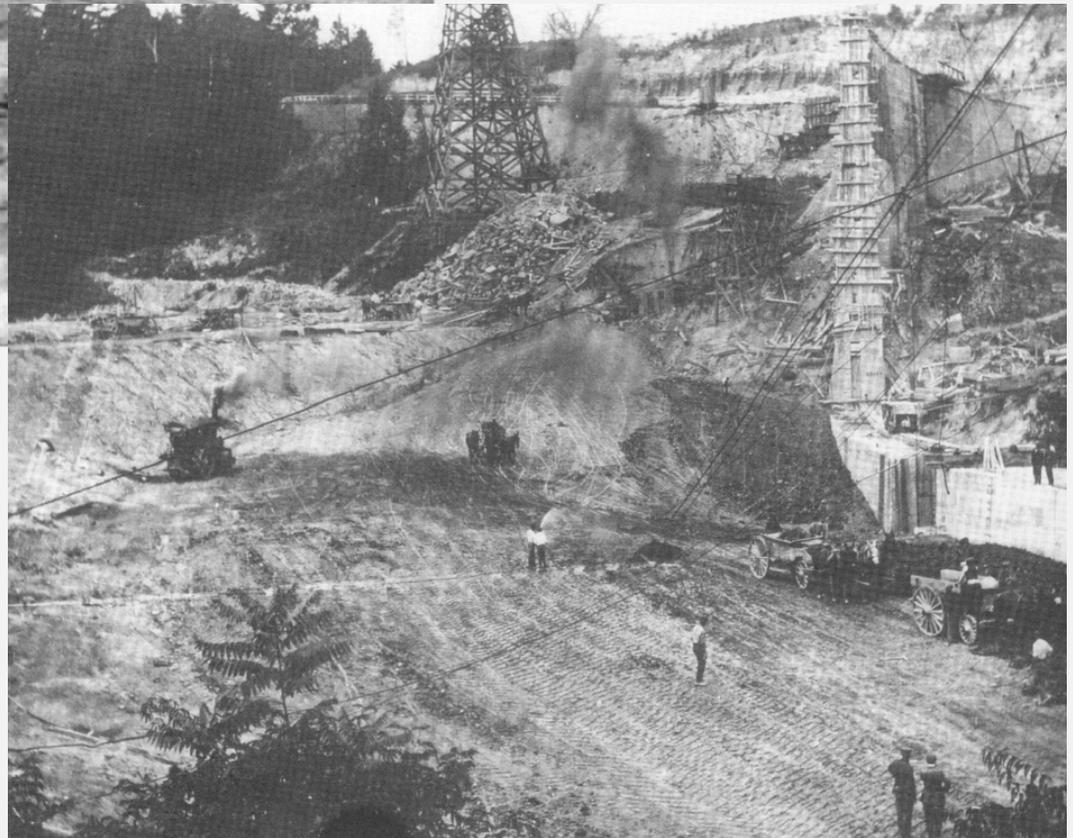


# Hillview Reservoir 1909-1915

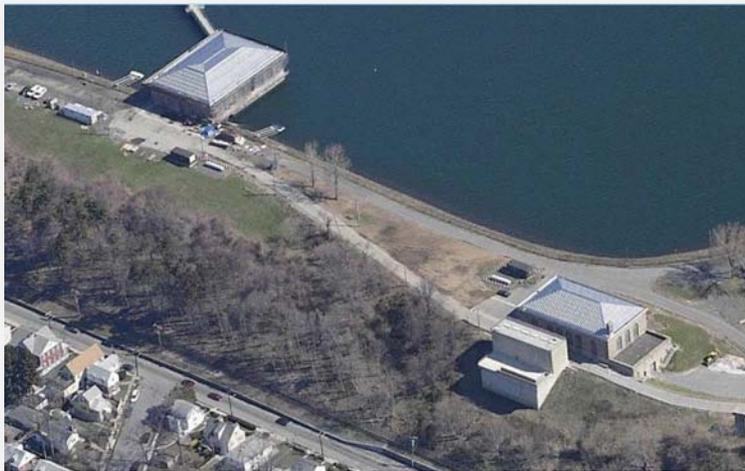


- Constructed: 1909 - 1915
- City of Yonkers
- Dug from a hilltop
- Capacity: 929 Million Gallons
- Storage/ Balancing Reservoir
- Size: 90 acres, max depth 36 ft
- Balances hourly flow for NYC
- Receives Flow from Catskill and Delaware Aqueducts from Kensico Reservoir
- Feeds City Tunnels 1,2,3

# Hillview



# Hillview Reservoir Today



# World War I - July 1914 to Nov 1918



## Commanders and leaders

### Allied leaders

[Georges Clemenceau](#)  
[Raymond Poincaré](#)  
[H. H. Asquith](#)  
[David Lloyd George](#)  
[Vittorio Orlando](#)  
[Victor Emmanuel III](#)  
[Woodrow Wilson](#)  
[Yoshihito](#)  
[Nicholas II](#)  
[Peter I](#)  
[Ferdinand I](#)

### Central Powers leaders

[Wilhelm II](#)  
[Franz Joseph I](#)  
[Karl I](#)  
[Mehmed V](#)  
[Ferdinand I](#)

**Military dead:** 5,525,000  
**Military wounded:** 12,831,500  
**Military missing:** 4,121,000

**Total:**  
 22,477,500 KIA, WIA or MIA

**Military dead:** 4,386,000  
**Military wounded:** 8,388,000  
**Military missing:** 3,629,000

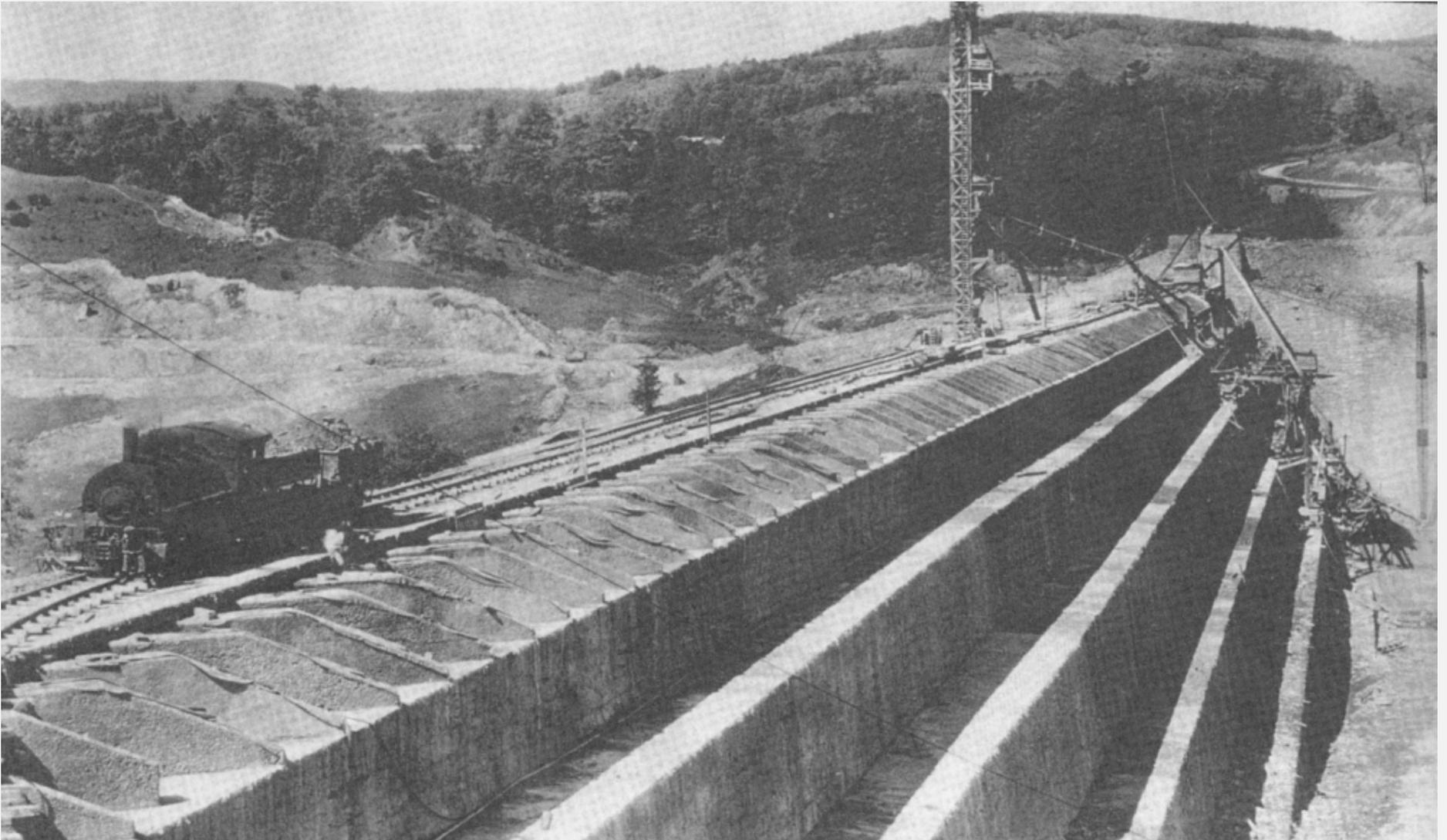
**Total:**  
 16,403,000 KIA, WIA or MIA

# Schoharie Reservoir - 1919

- **Constructed: 1919 - 1927**
- Towns of Gilboa, Roxbury and Prattsville  
Schoharie, Delaware and Greene Cos
- Gilboa Dam: 2000 ft long, 182 ft high
- **Capacity: 17.6 Billion Gallons**
- **Size:**  
1.8 sq mi, 5.8 mi long, 16.5 mi shoreline, max depth 150 ft
- Feeds Esopus Creek via the Shandaken Tunnel (18 mi)
- **Communities Flooded:**  
Gilboa
- **Residents displaced: 350**



# Gilboa Dam



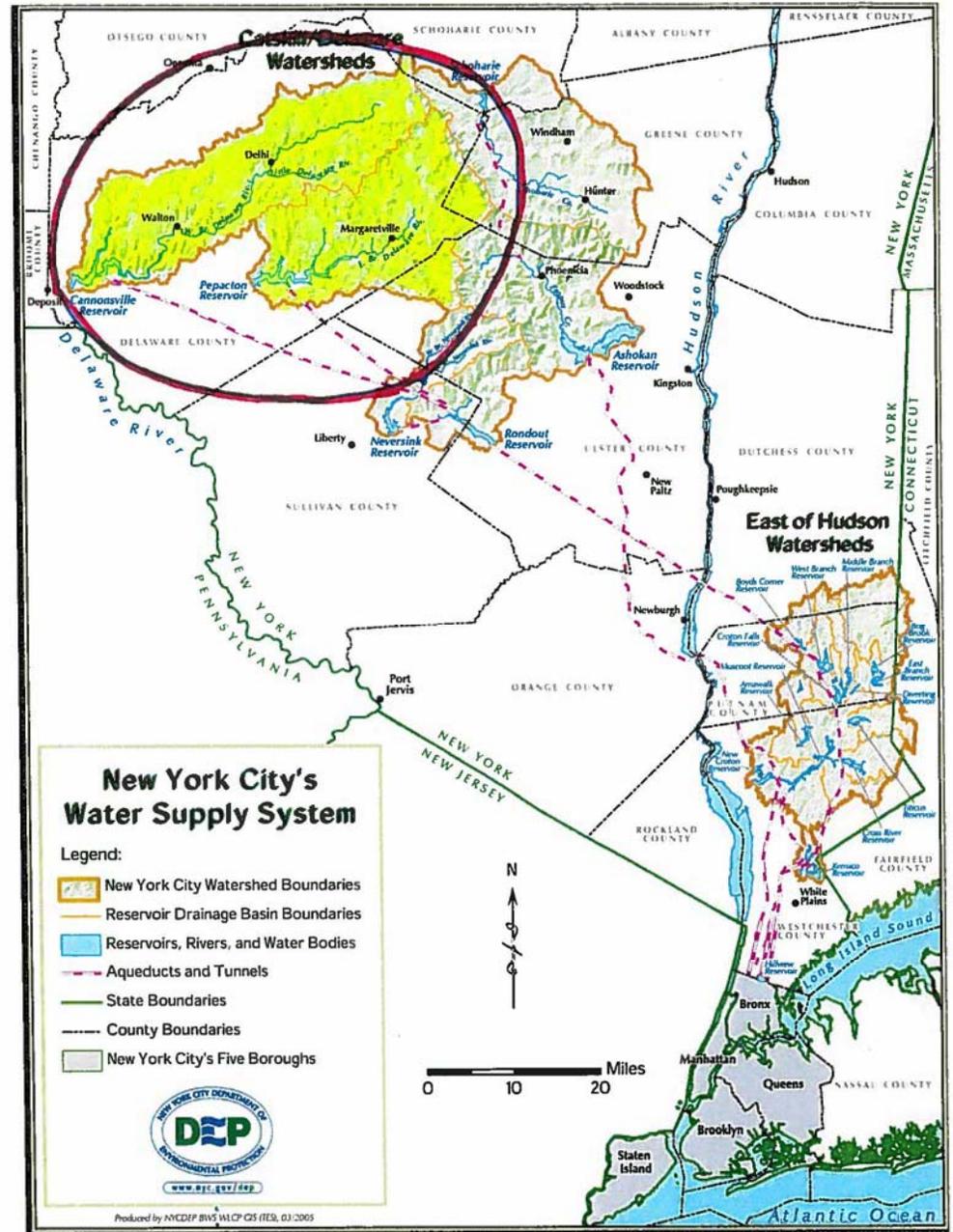
# Gilboa Dam



# Gilboa Dam - 2016



# Delaware Watershed



# 1920's- 1960's Delaware System

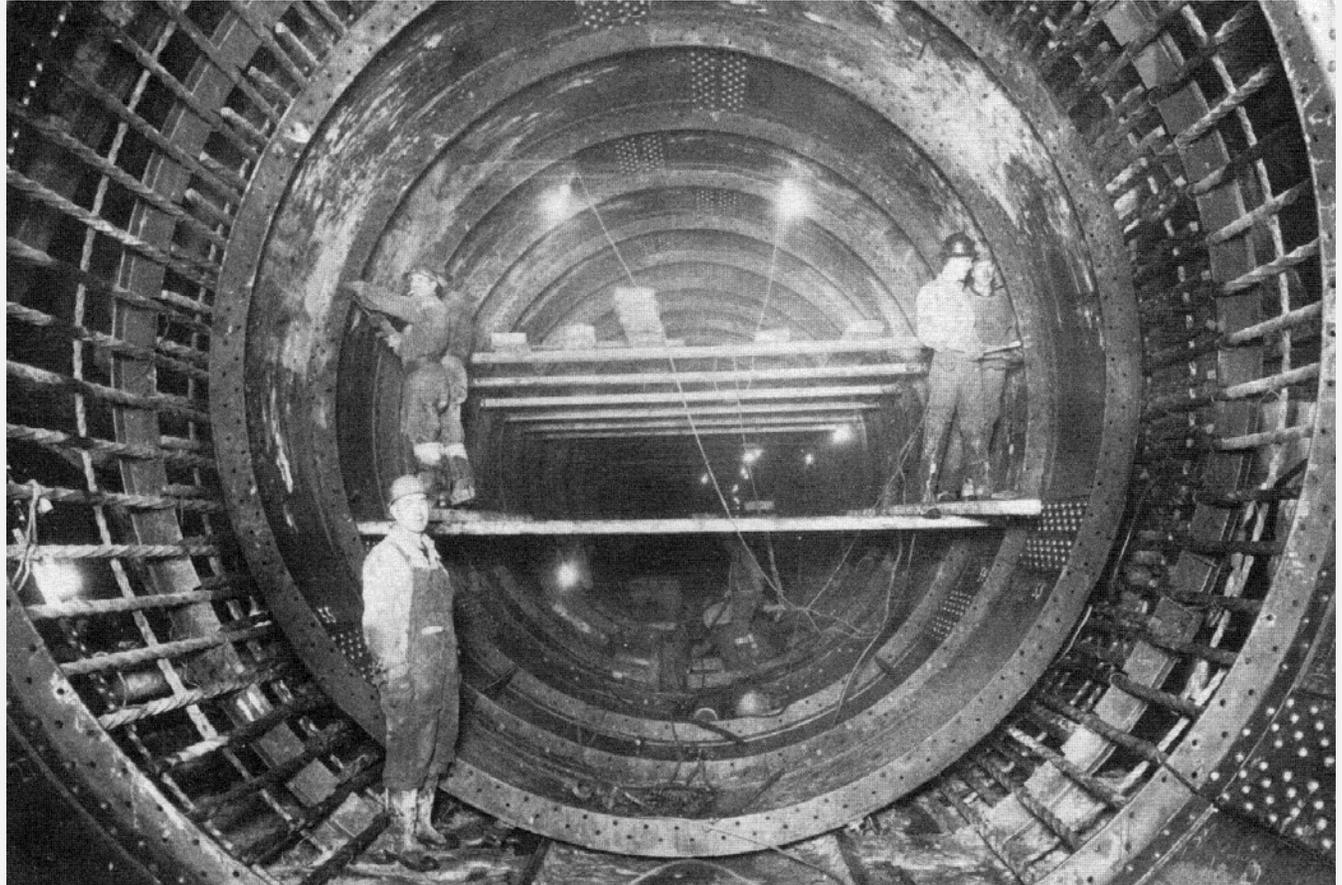
- 1920s Waldo Smith warned water consumption threatening Catskill supply
- 1923 NYS legislature passes act to work with representatives from NJ, PA and Fed
- 1928 Plan for Delaware and Rondout Reservoir approved by Board of Estimate
- *1929 Stock Market Crash*

# Delaware System

- 1931 NJ sues NYC
- **1931 Supreme Court denied NJ suit** Justice Oliver Wendel Holmes, "*A river is more than an amenity....*" authorizes diverting **440 MGD** required NYC to release sufficient water to maintain flow targets in the Delaware at Port Jervis and Trenton
  - Construct Port Jervis Wastewater Treatment Plant
- *1935-1945 World War 2*
- 1937 -1964 Construction
- **1954 Supreme Court amends the 1931 decision**
  - allows diversion of **800MGD** on condition that min flow in Montague NJ is 1750cfs
  - Chief Hydraulic Engineer of USGS designated as Delaware River Master

# Delaware Aqueduct

- Completed 1940s
- 85-miles long
- Longest continuous tunnel in the world, and
- Depths ranging from 300 to 2400 feet
- Intersects at Eastview for future sand filtration



# Rondout Reservoir - Merriman Dam

- **Construction:**
  - 1937 - 1943
  - 1946 - 1954
- Rondout Creek
- Towns of Wawarsing, Neversink
- Ulster & Sullivan Counties
- Merriman Dam:
  - 2400 ft long, 195 ft high
- **Capacity:**
  - **49.6 Billion Gallons**
- **Size:**
  - 7.5 mi long, 19.4 mi shoreline
  - Max depth 175 ft
- **Communities Flooded:**
  - Eureka
  - Montela
  - Lackawack
- **Residents displaced: 1200**



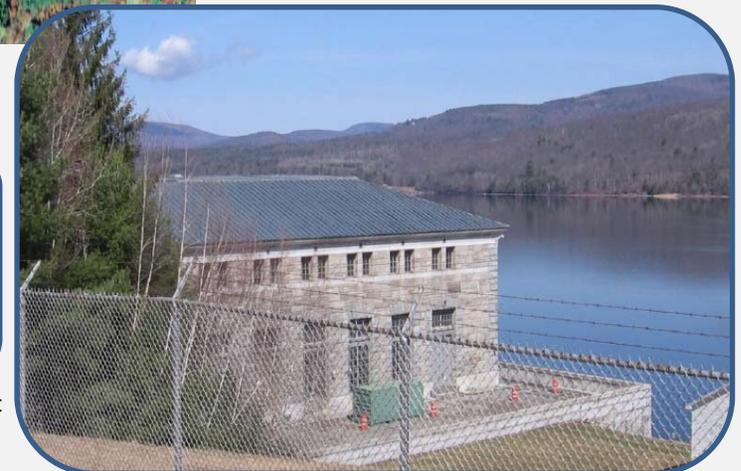
East Delaware Outlet Chamber  
- Power Plant



West Delaware Outlet Chamber – Power Plant



Neversink Intake Chamber – Power Plant



Rondout Effluent Chamber

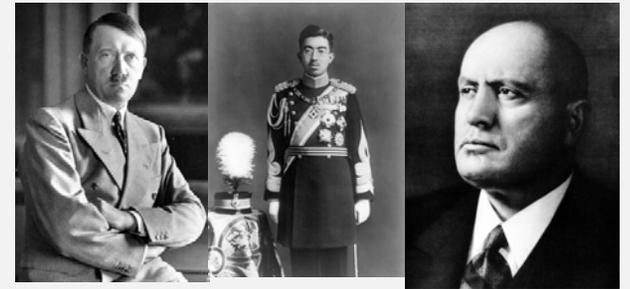
# Neversink Reservoir

- **Construction:**
  - 1941 - 1943
  - 1946 - 1953
- Neversink River
- Towns of Neversink
- Sullivan County
- Neversink Dam:
  - 2820 ft long, 195 ft high
- **Capacity:**
  - **34.9 Billion Gallons**
- Size:
  - 5 mi long, 17 mi shoreline
  - Max depth 175 ft
- Communities Flooded:
  - Neversink
  - Parts of Bittersweet & Aden
- Residents displaced: 342



Neversink Intake Chamber

# World War II 1939-1945



## Commanders and leaders

### Main Allied leaders

Joseph Stalin  
Franklin D. Roosevelt  
Winston Churchill  
Chiang Kai-shek

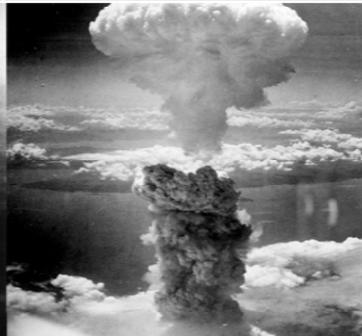
### Main Axis leaders

Adolf Hitler  
Hirohito  
Benito Mussolini

## Casualties and losses

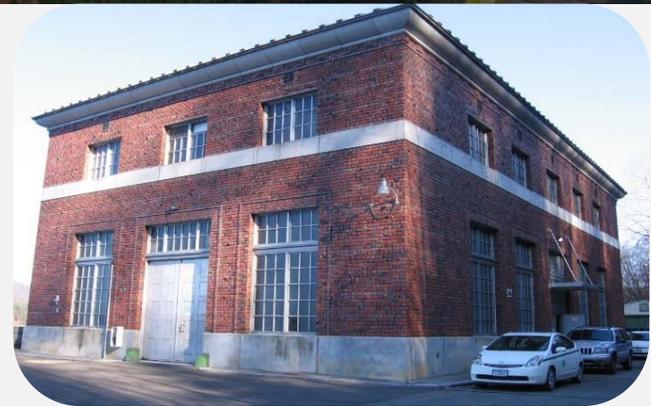
**Military dead:** 16,000,000 +  
**Civilian dead:** 45,000,000+  
**Total dead:** 61,000,000+

**Military dead:** 8,000,000+  
**Civilian dead:** 4,000,000+  
**Total dead:** 12,000,000 +



# Pepactan Reservoir

- **Constructed: 1947 - 1954**
- East Branch of Delaware River
- Towns of Colchester, Andes, Middletown
- Delaware County
- Downsview Dam:
  - 2450 ft long, 204 ft high
- **Capacity:**
  - **140.2 Billion Gallons**
- Size:
  - 18.5 mi long, 51mi shoreline
  - Max depth 180 ft
- Communities Flooded:
  - Arena
  - Pepacton
  - Shavertown
  - Union Grove
- Residents displaced: 974



East Delaware Intake Chamber

# Cannonsville Reservoir

- **Constructed: 1955 - 1967**
- West Branch of Delaware River
- Towns of Deposit & Tompkins
- Delaware County
- Stilesville Dam:
  - 2800 ft long, 174 ft high
- **Capacity:**
  - **95.7 Billion Gallons**
- **Size:**
  - 16 mi long, 51.3 mi shoreline
  - Max depth 140 ft
- **Communities Flooded:**
  - Beerston
  - Cannonsville
  - Granton
  - Rock Rift
  - Rock Royal
- Residents displaced: 941



West Delaware Intake Chamber

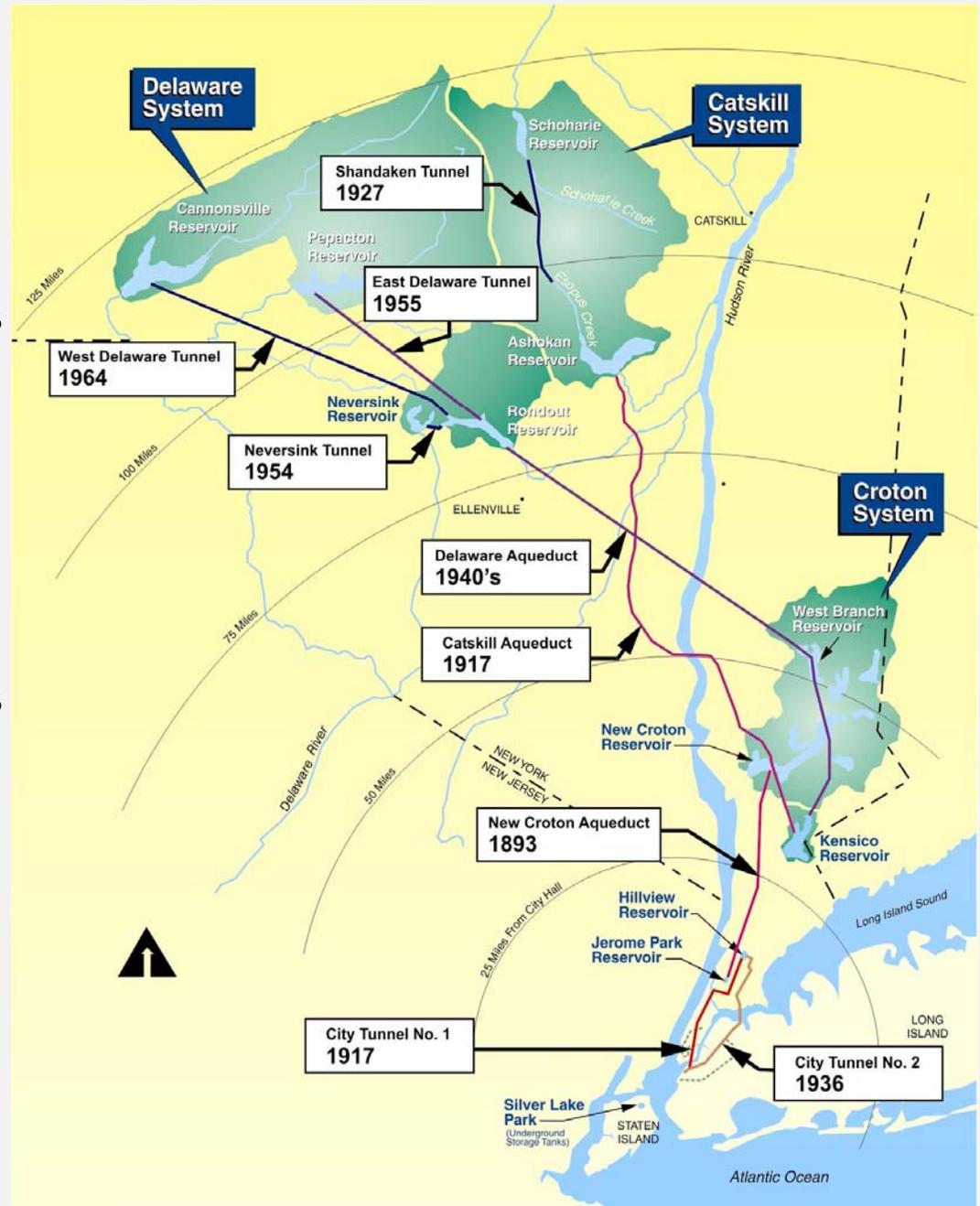
# Catskill and Delaware

## Catskill System

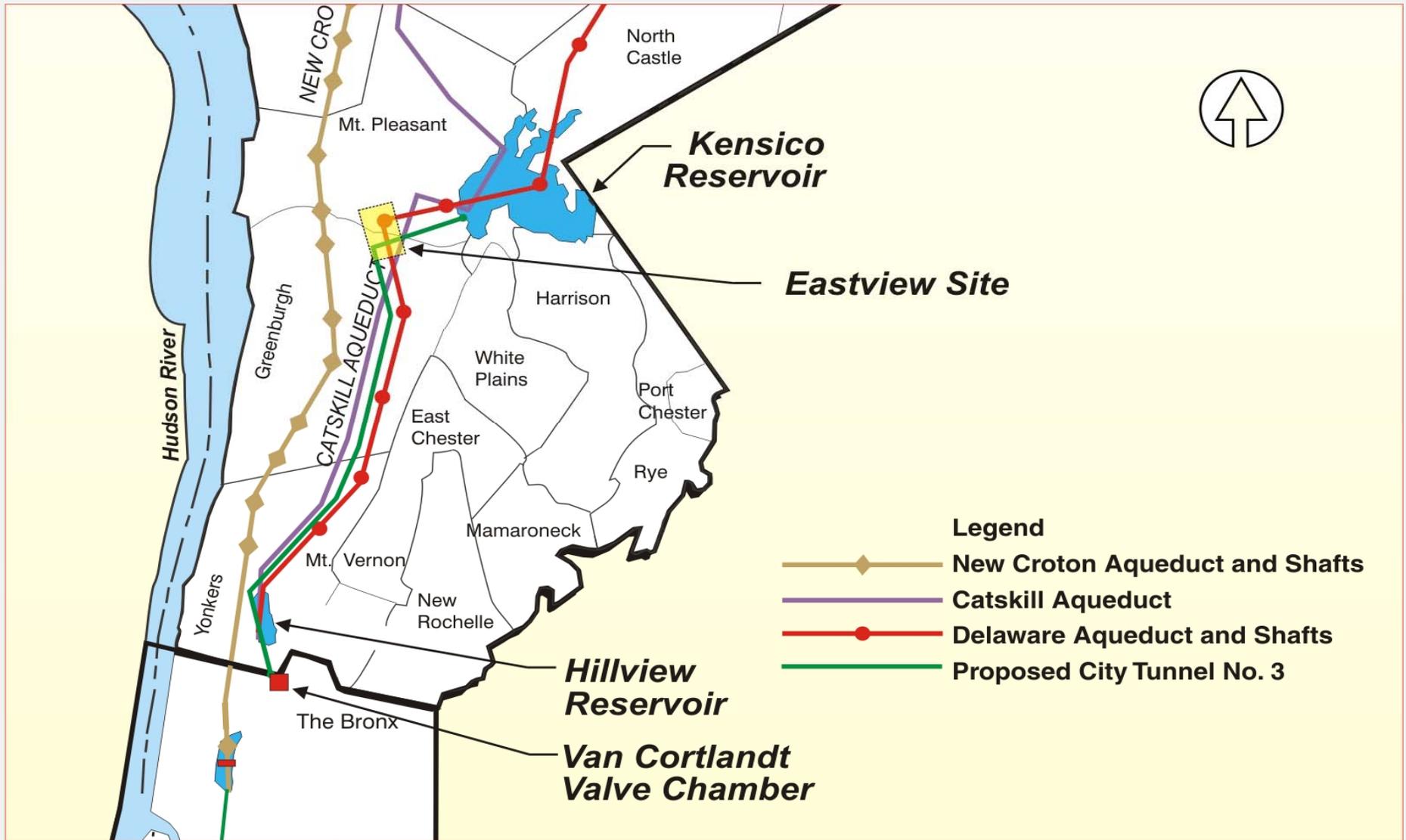
- Built in 1920's
- Two reservoirs
- Stores 140 Billion gallons
- Gravity

## Delaware System

- Built in 1940's
- Four Reservoirs
- Stores 320 Billion gallons
- Gravity



# Water Supply Kensico to Hillview





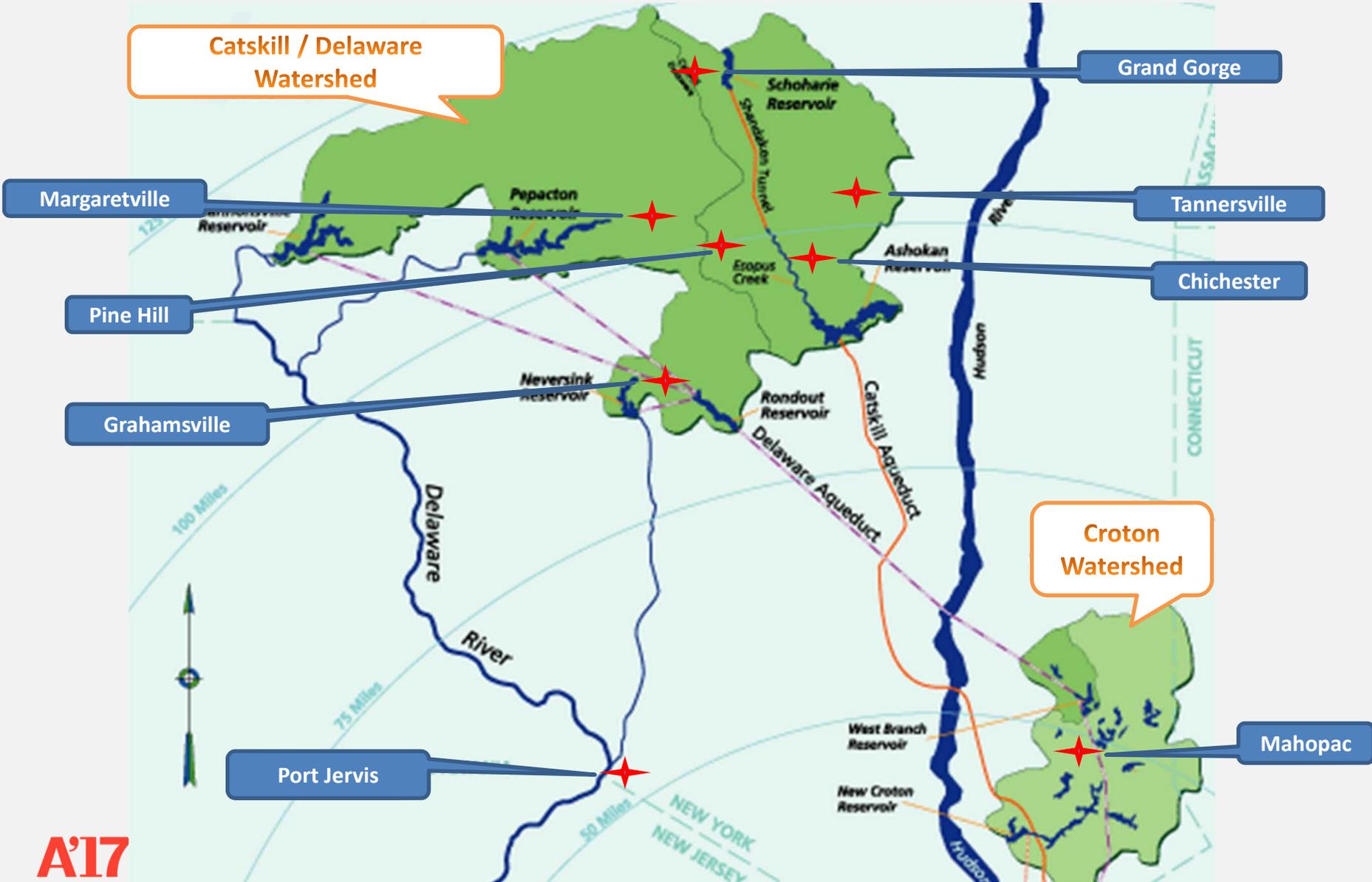
**A'17** AIA Conference on Architecture 2017  
April 27-29, Orlando

# 1990's to Present

## Quality over Quantity

- Croton Water Treatment Plant
- FAD for Catskill and Delaware Systems
- Wastewater Treatment Plants
- CAT-DEL UV
- Water demand reduction
- Repairs of 100 year old tunnels and aqueducts
  - City Tunnel 3
  - Rondout West Branch Tunnel
  - Catskill Pressurization – Kensico Eastview Connection 2
  - Cat South
- Cat-Del Filtration

# Wastewater Treatment Plants



# Upgrade of STP's



Grand Gorge  
WWTF



Tannersville WWTF

# Pine Hill WWTF



- Grand Gorge and Tannersville plants, were designed as square, precast concrete buildings that employed a historical neo- classical style typical of waterworks facilities in the region.
- The Pine Hill community objected to this “monolithic windowless tomb-like structure”. Located on the main corridor route to tourist-attracting ski resort areas, they wanted the facility to present a picture of regional spirit and style.

# Pine Hill Architectural Elements

- Pine Hill was re-designed:
  - “Village” setting of eight Victorian-style buildings
  - Façades: ornamental precast concrete to replicate Victorian wood ornamentation.
  - Roofs: standing seam metal roofs protected with an extended-life, deep green polyvinyl fluoride-based paint.
  - Windows: high-performance, clear insulating glass.
  - Walls: super-insulated for maximum energy efficiency

# Croton WTP @ Mosholu Site Preconstruction View 2004

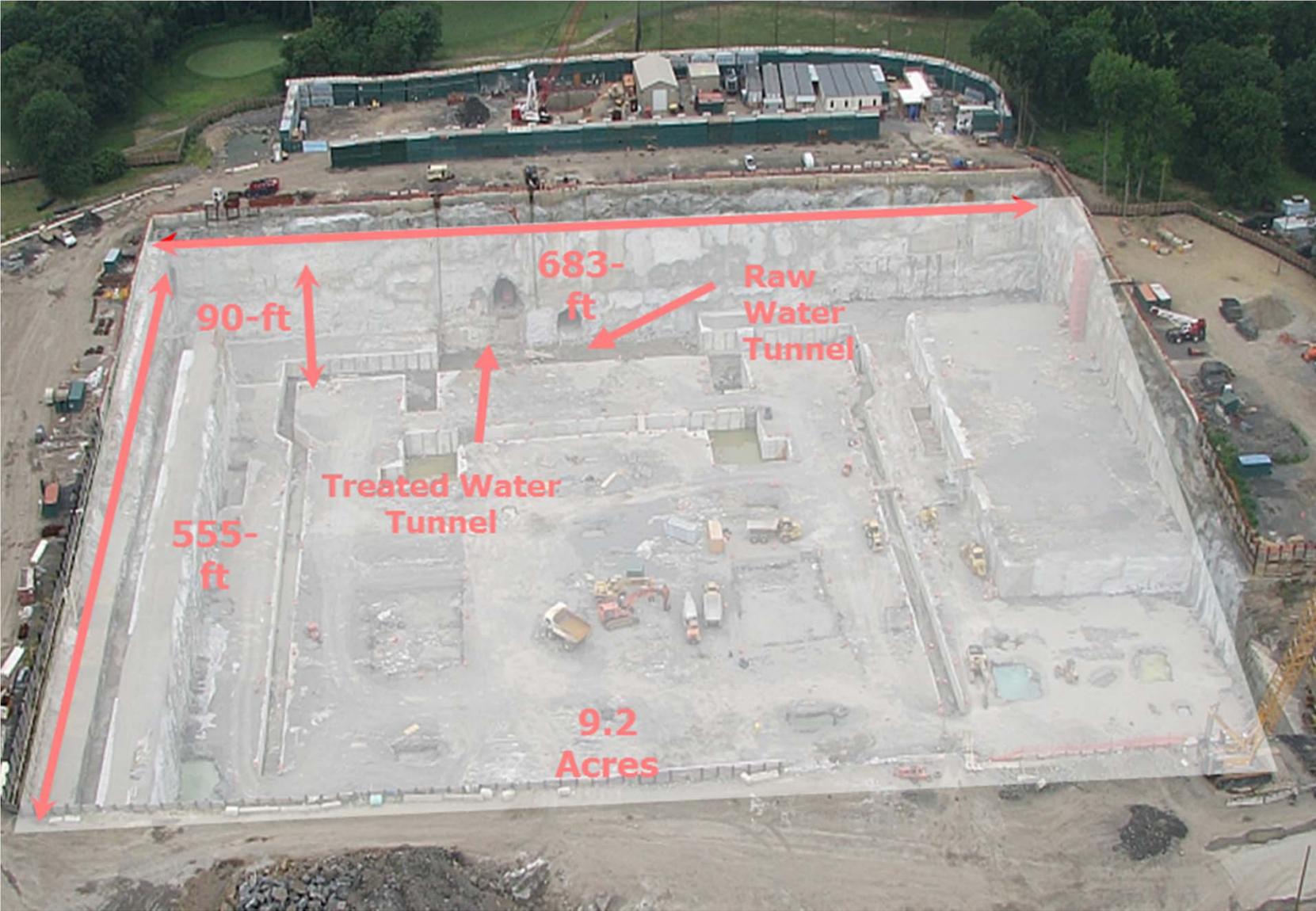




# Croton WTP @ Mosholu Site Model View



# Croton Water Treatment Plant July 2007



# Croton Water Treatment Plant - November 2010



# Croton Water Treatment Plant - September 2011



# Croton Water Treatment Plant - June 2014



# Croton Water Treatment Plant - May 2015



# Filtration Avoidance Determination - USEPA

- New watershed regulations were promulgated on May 1, 1997 (since revised and updated)
- Three primary components:
  - **Watershed rules & regulations**
  - **Land acquisition program**
  - **Voluntary partnership programs**
- Economic incentives for watershed stakeholders
- Assessed and refined every five years
- Basis for continued Filtration Avoidance Determinations

# Filtration Avoidance Determination

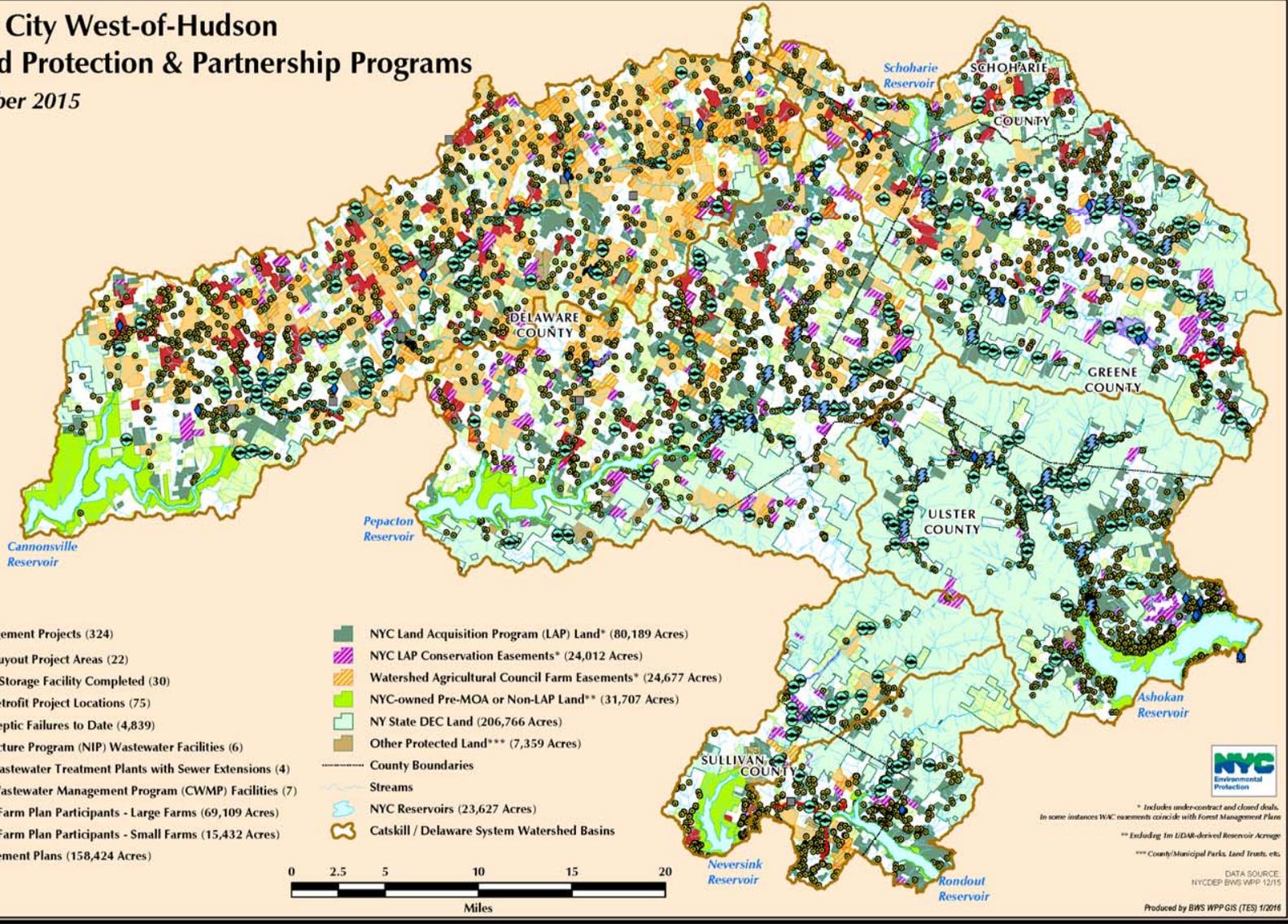


- Agriculture & Forestry
- Stream Management
- Land Acquisition
- Land Management & Recreation
- Education & Outreach
- Stormwater Management
- Wastewater Infrastructure



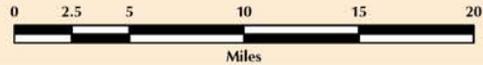
# New York City West-of-Hudson Watershed Protection & Partnership Programs

As of December 2015



**LEGEND:**

- Stream Management Projects (324)
- FEMA Flood Buyout Project Areas (22)
- Sand and Salt Storage Facility Completed (30)
- Stormwater Retrofit Project Locations (75)
- Remediated Septic Failures to Date (4,839)
- New Infrastructure Program (NIP) Wastewater Facilities (6)
- City-owned Wastewater Treatment Plants with Sewer Extensions (4)
- Community Wastewater Management Program (CWMP) Facilities (7)
- Active Whole Farm Plan Participants - Large Farms (69,109 Acres)
- Active Whole Farm Plan Participants - Small Farms (15,432 Acres)
- Forest Management Plans (158,424 Acres)
- NYC Land Acquisition Program (LAP) Land\* (80,189 Acres)
- NYC LAP Conservation Easements\* (24,012 Acres)
- Watershed Agricultural Council Farm Easements\* (24,677 Acres)
- NYC-owned Pre-MOA or Non-LAP Land\*\* (31,707 Acres)
- NY State DEC Land (206,766 Acres)
- Other Protected Land\*\*\* (7,359 Acres)
- County Boundaries
- Streams
- NYC Reservoirs (23,627 Acres)
- Catskill / Delaware System Watershed Basins



\* Includes under-contract and closed deals. In some instances WAC easements coincide with Forest Management Plans  
 \*\* Excluding 1m LIDAR-derived Reservoir Acroge  
 \*\*\* County/Municipal Parks, Land Tracts, etc.  
 DATA SOURCE: NYCDEP BWS WPP 12/15  
 Produced by BWS WPP GIS (TES) 1/2016

# FAD Water Treatment

- **1989 -Surface Water Treatment Rule (SWTR) promulgated**
  - Filter or meet requirements specified in SWTR
  - 2-log *Giardia*, *Cryptosporidium* inactivation



*Giardia cyst*



*Cryptosporidium*  
oocyst

# Cat-Del Ultraviolet Disinfection Facility



# Eastview Site with Filter Plant

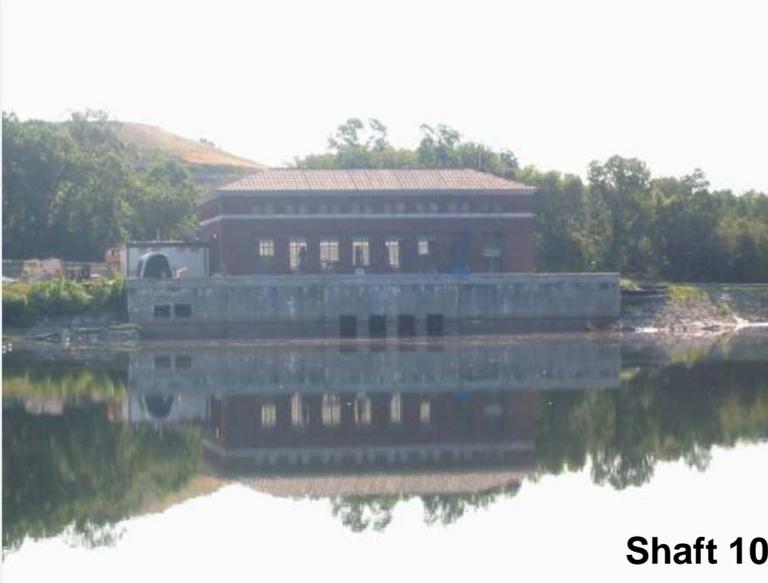


	Approximate Footprint/Area
Mount Pleasant	83 acres
Greenburgh	66 acres

# Croton Falls Dam – 1950s



# Original Croton Falls PS Concept

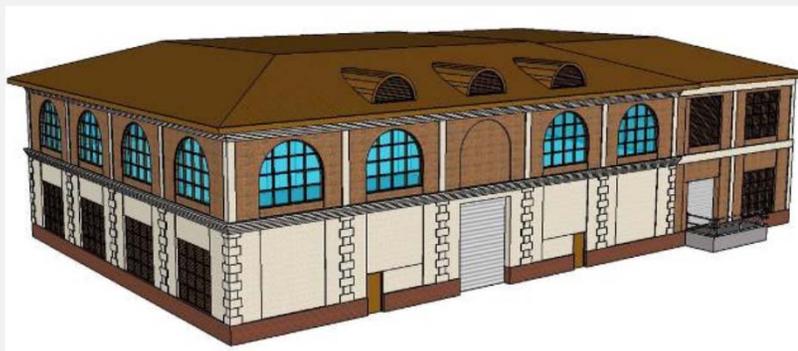


Shaft 10



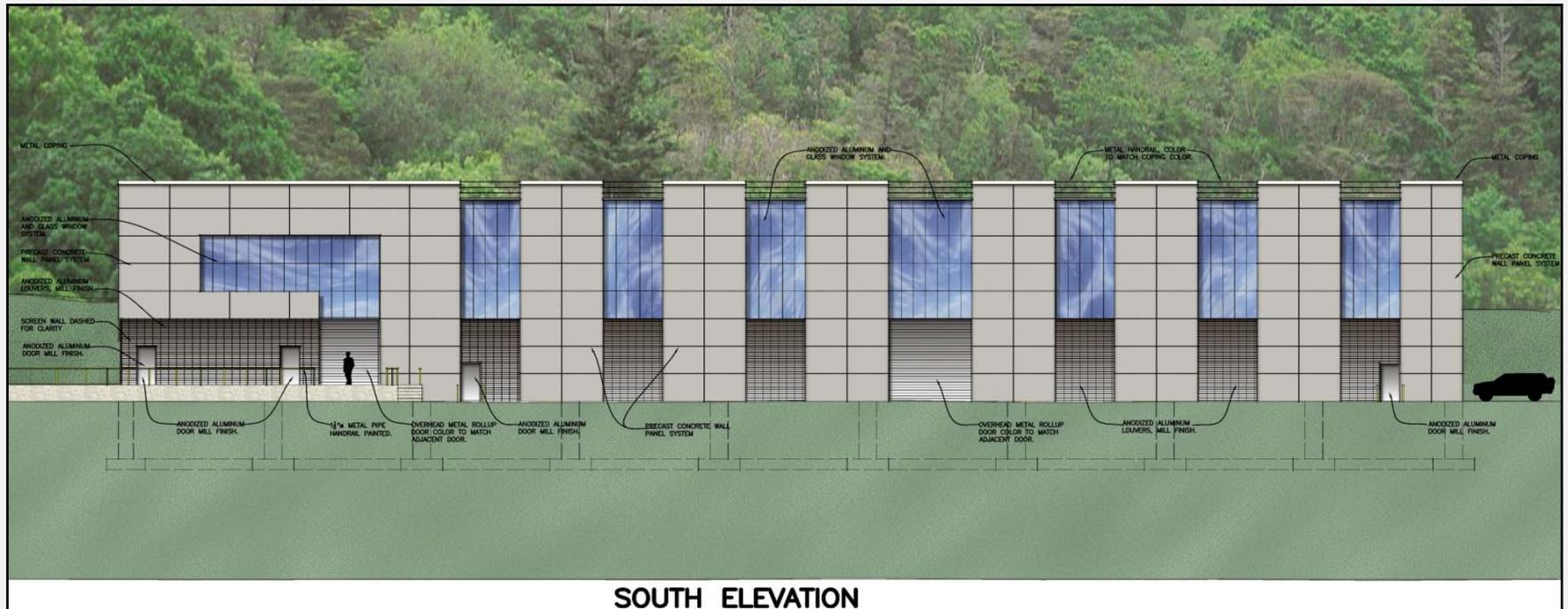
Shaft 13

Nearby Delaware Shafts



Original Concept was rejected

# Croton Falls Pump Station South Elevation



- 13,560 SF, 45 ft Tall
- Anodized aluminum Doors, windows and louvers
- Below grade pump room to help reduce the visual size as well as passive insulation





# Croton Falls Pump Station - Sustainability

## Heat Island Effect:

- Roof: standing seam metal roof
- min Solar Reflectance Index (SRI) of 78 to reduce the buildings heat gain.

## Light Pollution Reduction:

- Exterior lighting - no direct uplight
- Rain screen provides sun shade and clerestory windows
  - minimize heat gain
  - minimize light pollution from interior sources.

## Optimize Energy Performance

- First floor: below grade adds insulation
- Insulated precast concrete panels
- Terracotta rain screen - sun screens and to minimize light pollution
- High efficiency glazing and horizontal solar shades to lower energy consumption of the HVAC system.
- Temperature to be 55 deg min (unmanned facility)
- Large clerestory windows, with high efficiency glazing

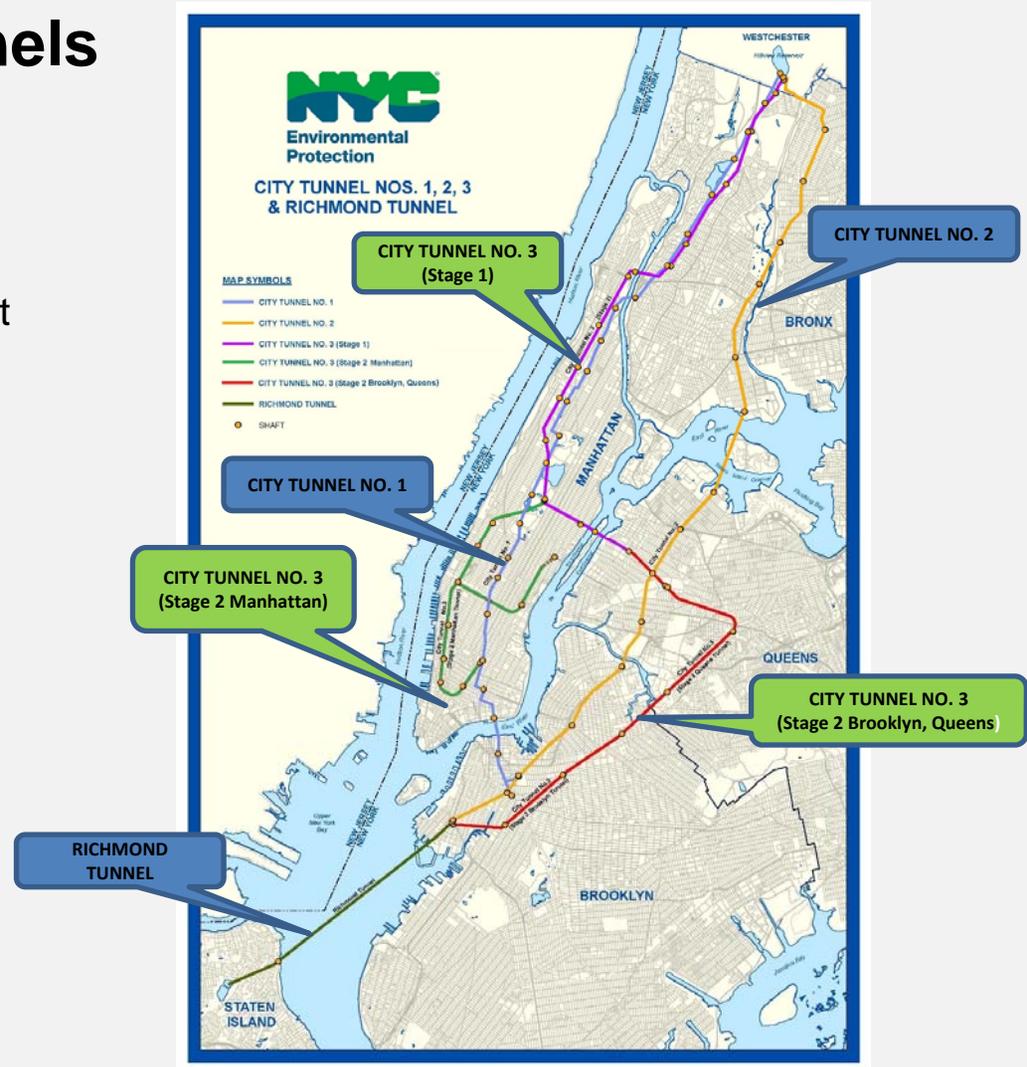
## Materials and Resources Recycled Content:

- Aluminum roofing made from 90% recycled material
- Structural steel contains 25% recycled content.
- Precast concrete walls contain fly ash, slag cement, and silica fume.

# City Tunnels

1917 City Tunnel 1  
1936 City Tunnel 2

City Tunnel 3  
Stage 1: Hillview to Roosevelt Island  
Stage 2: Lower Manhattan  
Stage 3: Kensico to Hillview  
Stage 4: Hillview to Queens



# City Tunnel 3

## **Stage 1: Construction:1970 -1993**

- 1998 In service
- 13 mi drill and blast

## **Stage 2 – Manhattan**

- In service 2013
- Redundancy for C.T. #1
- 8.5 mi TBM (10 ft diameter)

## **Stage 3: Kensico to Hillview**

## **Stage 4: Hillview to Queens**

## **Stage 2 – Queens/Brooklyn**

- Redundancy for C.T. #1 in Brooklyn  
Redundancy for C.T. #2 in Queens,  
Brooklyn, and Staten Island
- 10.5 mi (15 – 20 ft. diameter)

# Hybrid TBM (EPB)

## Similar TBM Designs:

- City Tunnel 3~ 20ft OD
- RWBT Bypass Tunnel 21 ft OD
- Kensico Eastview Connection Tunnel ~30 ft OD



# Tunneling - Fire in the hole



# Questions?



# Why Public Service?

- Ability to make a difference
- Ability to take charge / make decisions early in career
- Time
  - For raising family
  - For vacations

## Question 1

What is the role of architects in your utility infrastructure systems?

*(Multiple choice, with more than one answer allowed)*

- a. NA – not included
- b. Potable water plants
- c. Wastewater plants
- d. Pumping Stations
- d. Reservoirs
- e. Tunnels and aqueducts

## Question 2

To what extent does the presence of design in legacy infrastructure influence your current infrastructure?

*(Multiple choice, only one answer allowed)*

- a. NA – no legacy infrastructure with aesthetic value
- b. Design vocabulary of legacy infrastructure is used as standards for contemporary projects
- c. Contemporary projects expected to have aesthetic value but not expected to follow earlier design vocabularies
- d. No expectation of aesthetic value for contemporary projects

## Question 3

Which aspects of infrastructure system design do you think architects can influence?

*(Multiple choice, with more than one answer allowed)*

- a. Aesthetics
- b. Environmental practices in building / construction, e.g., sustainable design and materials
- c. Habitat / land use, e.g., wildlife conservation or corridors, community amenities)
- d. Mitigation, e.g., noise, view corridors
- e. Cost
- f. Construction methods
- g. Public perception
- h. Individual reliance on infrastructure systems

## Question 4

### DISCUSSION

Looking ahead, how can architects shape the presence and role of infrastructure in society and daily lives?