1. NAME OF PROPERTY

Historic Name: Croton Aqueduct

Other Name/Site Number: Old Croton Aqueduct

2. LOCATION

Street & Number: N/A Not for publication: __

City/Town: Croton to NYC Vicinity: New York City

State: NY Counties: Westchester, Bronx & New York

Codes: 119, 005 & 061 Zip Code: N/A

3. CLASSIFICATION

Ownership of Property		Category of Property	
Private:	___	Building(s):	___
Public-local:	X	District:	___
Public-State:	X	Site:	___
Public-Federal:	___	Structure:	X
		Object:	___

Number of Resources within Property

Contributing	Noncontributing	
2	___	buildings
___	___	sites
1	___	structures
___	___	objects
3	___	Total

Number of Contributing Resources Previously Listed in the National Register: 3

Name of related multiple property listing: ___________________

4. STATE/FEDERAL AGENCY CERTIFICATION

As the designated authority under the National Historic Preservation Act of 1986, as amended, I hereby certify that this ____ nomination ____ request for determination of eligibility meets the documentation standards for registering properties in the National Register of Historic Places and meets the procedural and professional requirements set forth in 36 CFR Part 60. In my opinion, the property ____ meets ____ does not meet the National Register Criteria.

Signature of Certifying Official Date

State or Federal Agency and Bureau

In my opinion, the property ____ meets ____ does not meet the National Register criteria.

Signature of Commenting or Other Official Date

State or Federal Agency and Bureau

5. NATIONAL PARK SERVICE CERTIFICATION

I, hereby certify that this property is:

____ Entered in the National Register ____
____ Determined eligible for the National Register ____
____ Determined not eligible for the National Register ____
____ Removed from the National Register ____
____ Other (explain): ____

Signature of Keeper Date of Action

6. FUNCTION OR USE

Historic: Government Sub: public works
Industry waterworks

Current: Vacant/Not in Use Sub:

7. DESCRIPTION

Architectural Classification:
Other: enclosed aqueduct

Materials:
Foundation: Stone
Walls: Brick (conduit interior), Stone (conduit exterior)
Roof: ____
Other Description: ____

Describe Present and Historic Physical Appearance.

Constructed between 1837 and 1842, the Croton Aqueduct originally consisted of a forty-mile long, enclosed conduit running from a dam on the Croton River, through western Westchester and Bronx Counties, and southward to central Manhattan. (See Photograph #1) The Aqueduct is 66 feet wide throughout most of its length, narrowing to 33 feet, and widening to as much as 200 feet in several short sections. Except where it was bored through solid rock, the Aqueduct was constructed by cut-and-cover method. The Aqueduct is primarily an underground structure, the primary feature of which is a brick-lined, horseshoe-shaped tunnel measuring eight and one-half feet high by seven and one-half feet wide. (See Photograph #2) The complete Aqueduct structure rests on a stone foundation. The actual conduit, or tube, stands on a bed of concrete and is sheathed with walls of hammered stone. (See Photograph #3) In addition to several major engineering features, the Aqueduct required the construction of 16 tunnels (varying in length from 160 to 1260 feet), 114 culverts, 33 ventilator shafts, and 6 waste weirs.[1] The Aqueduct conduit and all of these attached engineering features are considered a single contributing resource. Two additional contributing resources are the Overseer's House and Barn, which are described later in this section.

A large portion of the original Aqueduct, beginning at the New Croton Dam, and running south to the Westchester County/Bronx County boundary, is owned and managed by New York State as the Old Croton Trailway, a recreational trail. Throughout most of

[1] George H. Rappole, "The Old Croton Aqueduct," IA: The Journal of the Society for Industrial Archeology 4 (1978): 19.

Westchester, and much of the Bronx, the Aqueduct appears as a level or bermed grassy path. In those section which were tunneled through rock, the Aqueduct is indistinguishable from the surface. At several points the path of the Aqueduct is obscured by paved parking lots or streets. During a tour of more than a mile of the trail, however, the Aqueduct's presence becomes more readily apparent. Travelling this much distance one would encounter some of the Aqueduct's many above ground features, which range from relatively modest masonry ventilator shafts, gatehouses, waste weirs, and culverts, to more substantial engineering features, such as the large bridges and viaducts required to maintain the Aqueduct's gradual descent across undulating topography. As it passes farther south, through the Bronx, the Aqueduct is in a more urban context, and again is less clearly discernable to the casual observer.

Today, the original dam and the northernmost two miles of the Aqueduct are submerged under the greatly enlarged reservoir created behind the New Croton Dam after 1907. The portion of the Aqueduct below the New Croton Dam, in Westchester and Bronx Counties, possesses high levels of integrity.[2] However, after crossing the High Bridge to Manhattan, virtually all of the above ground features (and much of the underground conduit) have been obliterated. The northernmost twenty-six miles of Aqueduct, from the New Croton Dam to the Westchester County/Bronx County line, is listed in the National Register of Historic Places. Additionally, the "Site of the Old Croton Dam" and the High Bridge are listed as individual National Register properties. The National Historic Landmark outlined in this nomination incorporates all of these National Register properties, as well as the submerged portion between the old and new Croton Dams, and the Bronx portion of the Aqueduct which runs from the Westchester/New York City line to the Manhattan end of High Bridge. This nomination presents the Croton Aqueduct as a slightly discontinuous National Historic Landmark which is divided into five sections because four short sections of Aqueduct have lost their historic integrity due to mid-twentieth century road construction projects.

Due to the expense and imperfect operational abilities of early 19th century steam engines it was decided that the Croton's waters would flow by gravity. Therefore, the Aqueduct's route, design, and construction were determined by topographical considerations. In order to maintain sufficient water pressure to service New York City's fire hydrants and multi-story buildings, the gradual declination of the conduit had to be maintained. The engineers conducted careful surveys of the best

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[2] While the Aqueduct was taken out of service by the 1960s, a 2.5 mile section of the Aqueduct, between the New Croton Dam and Indian Brook in the Town of Ossining, has recently been reconditioned and plugged at the Indian Brook end. It presently serves as a tubular reservoir and conduit supplying the Village of Osssining with Croton Water.

route to avoid sudden variations in elevation. The terrain over which the Aqueduct traversed, however, varied widely. Throughout most of its route, the Aqueduct conduit was set as a shallow tunnel excavated through level ground. Where excavations were made into the side of hills, retaining walls were built on the lower side to support a covering of earth over masonry. In places where level ground was not available, the Aqueduct was tunneled through hills or carried across valleys on bridges or earthen embankments. (See Photograph #2) In both such cases, the cut-and-cover method of excavation had to be replaced with more expensive and time consuming methods which required more building materials and more complicated design and workmanship.

Standardized construction designs were developed for many of the features which occurred at multiple places along the Aqueduct. For example, Chief Engineer John B. Jervis' staff prepared standard designs for the culverts used to carry natural streams under the Aqueduct. (See Photograph #4 and Figure #1) These designs were prepared for culverts ranging from two to twelve feet in width. A given standard design was merely applied to each stream, depending on its size.[3]

> The culverts were constructed of cut stone, and were designed so that the stream could follow its natural course without damaging the aqueduct. Cut stone lines the bottom of the waterways; there are stone side walls surmounted by an arch of stone. Buttresses and wing walls are at each end of the culvert to guide the water to and from the channel-way, and parapet walls are located over the tops of the channel-ways at each end to sustain the embankment of earth over the culvert.[4]

To reduce the risk of creating irregular air pressure within the conduit, and to allow a certain "freshness" of the water during its forty-mile journey, Chief Engineer Jervis estimated that ventilation shafts should be incorporated at one-mile intervals. (In case his estimate was wrong, he included additional openings for future ventilator shafts in the top of the conduit at quarter-mile intervals.) The ventilators, most of which remain today, are hollow stone cylinders, usually about 10 to 14 feet high, caped with an iron grate to discourage vandalism and unauthorized entry into the Aqueduct. (See Photographs #5, #6 & #7, and Figure #2) Every third ventilator shaft included an entrance door for authorized access into the conduit. (See Photograph #8)

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[3] Larry D. Lankton, "Manhattan Life Line: Engineering the Old Croton Aqueduct, 1833-1842," 1979, Historic American Engineering Record (HAER No. NY-120), Prints and Photographs Division, Library of Congress, Washington, D.C., p. 70.

[4] Lenore M. Rennenkampf, "The Old Croton Aqueduct, National Register of Historic Places Inventory--Nomination Form," 1973, p. 7-2.

Six waste weirs along the Aqueduct's route allowed for more convenient draining and filling of the water within the conduit. (See Photographs #7, #9 & #10, and Figure #3) A section of the Aqueduct could be drained and made accessible for repair by placing wooden stop planks across the conduit at the upstream waste weir, and opening the diversion gates at the downstream weir. The water was thereby drained from this portion of the conduit into a culvert connected to a nearby stream. The presence of these control structures meant that only a portion of the conduit required draining, thus shortening the duration of the interruptions of water service to the City. Finally, workers waiting to enter the conduit would not have to wait as long as they would if the entire system required emptying. These non-roofed weir structures also served as ventilators.[5]

Unlike the standardized designs for repetitive features discussed above, the Aqueduct's major features required more specialized design, and are discussed in the following sections.

Old Croton Dam and Gatehouse

The original Old Croton Dam failed on January 8, 1841, shortly before the 90-foot granite dam with large earthen embankments would have been completed. Heavy rains on snow-covered frozen ground caused the Croton Reservoir to rise at a rate of fourteen inches an hour. When the dam's waste weir proved too small to discharge the rising water, the reservoir crested the dam, washing away the earth adjacent to the dam's masonry north bank. Although the masonry portion of the dam remained, the gap at its northern bank caused a flood which killed three people and destroyed three mills, four bridges, and six houses.[6] The Chief Engineer's new dam design replaced the earthen embankment with a stone barrier, and tripled the length of the dam. A stilling basin was added immediately downstream of the dam to break the impact of the cascading water. (See Photograph #11)

The second Old Croton Dam now lies submerged within the New Croton Reservoir, slightly west of Croton Dam Bridge, between New York Route 129 and Arcady Road. A gravity dam constructed with a rubble core and granite ashlar facing, it is 670' long and 57' high. At the time of completion, the dam backed-up the Croton River to a reservoir of about 400 acres.[7] According to Carl Condit's American Building, this was the first large masonry dam

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[5] Lankton, p. 86.

[6] Daniel L. Schodek, Landmarks in American Civil Engineering, (Cambridge: MIT Press, 1987), p. 206.

[7] Lenore M. Rennenkampf, "Site of Old Croton Dam; New Croton Dam, National Register of Historic Places Inventory--Nomination Form," 1973, p. 2.

in the United States. It served as a model for a number of municipal water supply dams built during the mid-nineteenth century.[8]

On the first leg of its journey to New York City, the waters of the Croton Reservoir originally entered a gateway upstream of the Old Dam, and flowed through a rock tunnel below the reservoir before passing through filtering screens.[9] Below a small stone gatehouse near the dam, the water passed through two sets of gates which regulated the amount of water entering the Aqueduct. (See Photograph #12) Before the enlarged New Croton Reservoir engulfed the old gatehouse under thirty feet of water at the turn of the century, its roof was removed, and the building was stabilized to prevent any building material from entering the Aqueduct.[10] The submerged Old Croton Dam and Gate House remain intact. When the reservoir level is significantly lowered the 1841 structures become visible and, for a time, serves again as a dam.

<u>Sing-Sing Kill Bridge</u>

The first major engineering feature south of the dam (other than the Aqueduct conduit itself) is the Sing Sing Kill Bridge at Ossining. (See Photograph #13) At this site the Aqueduct crosses a valley 536 feet wide and 70 feet deep. While the Sing-Sing Brook itself would have required only a modest arch, a much larger arch was required to accommodate a 20 foot roadway bridge which crossed the line of the Aqueduct at an odd angle. (See Photograph #14) Required by state law to minimize the creation of impediments to local landowners, the Chief Engineer also had to include a small passageway through the bridge to provide a land owner access from his house, which was on one side of the Aqueduct bridge, to his field on the other. (See Figure #4 and Photograph #15)

The bridges designed for valleys such as this had the appearance of massive masonry berms, with minimal archways for streams or roads. Historian Larry D. Lankton presented the following description of Jervis' design for the Sing Sing Kill Bridge:

> Although he [Jervis] referred to the entire 536 foot long structure as a bridge, for most of its length a solid stone wall, laid in cement, supported the conduit. Where the wall intersected the first road, Jervis put in a low arch spanning 20 feet, built

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[8] Carl W. Condit, <u>American Building</u> (Chicago: University of Chicago Press, 1982), p. 162.

[9] Rappole, p. 18.

[10] Rennenkampf, "Site of Old Croton Dam, National Register of Historic Places Inventory--Nomination Form," p. 7-1.

> slightly askew since the road and the wall did not quite meet at right angles. After passing the first road, the wall resumed for some 120 feet, its facade broken by a small arch for the home-owner, before it encountered the second road and its wooden bridge. To pass this obstacle, Jervis specified an impressive aqueduct bridge having a single elliptical arch spanning 80 feet. The underside of the arch stood nearly 70 feet above the stream's bed. At the termination of the bridge, Jervis again commenced the solid wall and carried it approximately 190 feet to complete the crossing.[11]

Jervis' design for the internal structure of this "bridge" is noteworthy. Concerned that such an elevated structure would be seriously undermined by the freezing and thawing of any leakage from the conduit, Jervis studied the examples of Roman, English, and more recent American canals and aqueducts. The first step in alleviating this problem, he determined, was to build a watertight aqueduct. Following the successful practice of the English engineer, Thomas Telford, Jervis concluded that these structures should not only be built of the best hydraulic masonry, but should be lined with cast iron to afford the greatest protection against leakage. As a final precaution, Jervis' design also included copper drains to carry any leakage safely away from the structure.[12]

Another major design feature to protect the long-term structural integrity of Jervis' elevated structures involved reducing the load of the structures themselves. (See Photograph #16) As Historian Lankton explained:

> The bridge's deck--the masonry conduit, lined with cast iron, filled with water, and topped with earth--would place a heavy load on the arch that Jervis could not reduce. He could, however, reduce the dead-load imposed by that part of the bridge that supported the deck and carried its load down to the arch. In most masonry bridges of the period, builders used an earthen or rubble fill to support the deck. Jervis chose not to follow this practice. Instead of totally filling the space bounded by the arch barrel, the exterior spandrel walls and the deck, he supported the deck on a series of interior spandrel walls, tied together with cross walls. By leaving large spaces between the walls, and by leaving hollow spaces in the walls themselves, he significantly reduced the dead-load on the arch.[13]

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[11] Lankton, pp. 71-72.

[12] Ibid., p. 74.

[13] Ibid., p. 75.

These air spaces also provided additional insulation against freezing, and facilitated drainage of condensation and any leakage which did occur.

The village of Ossining has restored the Ann Street Weir Chamber at the upstream end of the Sing-Sing Kill Bridge. They have installed lighting and exhibits, and provide tours of this section of the Aqueduct conduit.

Mill River Culvert

The next major feature to receive Jervis' attention was the Mill River Culvert, which ran north of Tarrytown's Sleepy Hollow Cemetery. Instead of designing a multiple-arch bridge for this site, Jervis yielded to economic considerations and built an enormous embankment across a valley 300 feet long and more than 80 feet deep. At the bottom of the valley, the Mill River passed through a 25 foot wide culvert arch. In contrast to the hollow construction method utilized for the Sing-Sing Kill Bridge, this massive structure featured a tall, dry-laid masonry foundation for the Aqueduct tunnel, flanked by massive earthen embankments, all of which was contained within a stepped-buttressed masonry retaining wall.

Jewells Brook Culvert

Also known as the Station Road viaduct, this 148 foot long, 60 foot tall embankment structure in Irvington is similar in construction to the Mill River culvert. (See Photograph #17 and Figure #5) A 14 foot wide, 12.5 foot high arch allows Station Road to pass below the massive embankment. A 6 foot wide, 6 foot high culvert allows Jewells Brook to flow unimpeded below the Aqueduct. (See Photograph #18)

Overseer's House and Barn

In the vicinity of each waste weir, a residence for the weir tender and area overseer was provided. Except for the one at Dobbs Ferry, they were all of frame construction and have not survived. The more substantial masonry residence at Dobbs Ferry was built in 1845 to house the Aqueduct's principal superintendent. (See Figure #6) Presently vacant, this two-story Overseer's House sits along the eastern side of the Aqueduct, south of Walnut Street. A large two-story rear addition was added around 1884. Immediately north of Walnut Street, along the western side of the Aqueduct, stands a two-story barn which was constructed for the Overseer around 1884. (See Figure #7) It is currently used by the State Parks Office as a maintenance building.

Saw Mill River Culvert

The portion of the Aqueduct which crosses over the Saw Mill River and Nepperhan Avenue in Yonkers spans a valley approximately 300 feet wide. Jervis designed this engineering feature much like the other earth-filled embankments. The embankment which carries the gradually declining Aqueduct conduit across this valley is punctuated by a 20 foot wide road culvert and a 26 foot double-arch river culvert. (See Photograph #19) Jervis utilized the double culvert because it was less expensive to build than a larger single arch. During the late 19th century the original 20 foot road culvert was doubled in size. (See Photograph #20) During the 1980s, when Nepperhan Avenue was realigned, a large portion of the Aqueduct embankment immediately northwest (upstream) of the roadway arch was demolished. A new arch spanning the realigned roadway was designed to blend in with the remaining fabric. The earlier road arch was converted to pedestrian use.

High Bridge

Crossing the 1,450 foot wide Harlem River Valley to Manhattan proved to be the most politically divisive aspect of Jervis' work. Had economy been the primary determinant, the Aqueduct would have been carried across an "inverted syphon." The syphon would have descended in elevation at the upstream end of the Aqueduct, crossed the river on a low bridge, and risen up the opposite slope. Despite the resulting loss of water pressure such a design would have caused, this plan was favored by Jervis and others as an alternative to constructing an expensive high bridge. However, the political influence of land owners, who wished to maintain the option of making this portion of the Harlem navigable, prevailed. Jervis' final design repeated the light-weight, watertight construction used for the Sing-Sing Kill Bridge.

Until the 100 foot tall, 1,200 foot long bridge was completed in 1848, the Croton's water traversed this valley on a temporary inverted siphon. Despite the difficulty in securing stable foundations, the sixteen giant bridge piers were erected with arch widths varying from 50 to 80 feet. In contrast to Jervis' use of brick conduit on the Aqueduct's other engineering features, his final design for the High Bridge carried the Croton's water through two 36-inch diameter iron pipes. Jervis designed the channel through which these pipes ran to be larger than was necessary to accommodate the 36-inch pipes. This allowed the option of replacing the original pipes with larger ones as the city's demand for water grew to meet the maximum volume the Aqueduct was designed to carry. In 1862 a single 90-

inch diameter pipe replaced the original pair of 36-inch pipes.[14] In 1937 a steel arch over the river portion of the valley took the place of five of the bridge's original masonry piers. (See Photograph #21)

Manhattan Features

Since there are virtually no visible remains of the original Old Croton Aqueduct on Manhattan Island the nominated resource terminates at the western end of High Bridge. However, underground portions of the Aqueduct may remain in places undisturbed by later construction.[15] Jervis' elevated Receiving Reservoir, located on land which later became Central Park, was replaced by the larger Central Park Reservoir during the late 19th century. Similarly, Jervis' Egyptian Revival-style Distributing Reservoir at Murray Hill was later removed to make way for the construction of the main branch of the New York City Public Library. The few surviving features which were added later in the 19th century to increase the Aqueduct's water delivery capacity, such as the High Bridge Water Tower, are not included in this nomination.

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[14] Lankton, Larry D., "1842: Old Croton Aqueduct Brings Water, Rescues Manhattan From Fire, Disease," Civil Engineering (October 1977): 93.

[15] For information on the original Manhattan features of the Aqueduct, see: Lankton, "Manhattan Life Line," pp. 122-135; and Schodek, Landmarks in Civil Engineering, p. 210.

8. STATEMENT OF SIGNIFICANCE

Certifying official has considered the significance of this property in relation to other properties: Nationally: X Statewide:___ Locally:___

Applicable National Register Criteria: A X B___ C X D___

Criteria Considerations (Exceptions): A___ B___ C___ D___ E___ F___ G___

NHL Criteria: 1 & 4

NHL Theme(s):
XVIII.H Technology: Construction
XVIII.K Technology: Water & Sewage
XVIII.L Fire, Safety, Sanitation, and Pollution Controls
XXX.D American Ways of Life: Urban Life

Areas of Significance:	Period(s) of Significance	Significant Dates
Commerce	1842-1870	1842
Engineering	1836-1842	1842
Health/Medicine	1842-1870	1842

Significant Person(s): ___________

Cultural Affiliation: ___________

Architect/Builder: John B. Jervis (Engineer)
David Douglass (Engineer)

State Significance of Property, and Justify Criteria, Criteria Considerations, and Areas and Periods of Significance Noted Above.

Early in the 19th century, New York City officials came to realize that their city could not remain the economic capital of the "New Republic" without securing sufficient quantity and quality of water for domestic, sanitation, safety and manufacturing uses. These needs were ultimately assured by the decision to erect a massive gravity-fed, enclosed conduit to carry the Croton River's fresh water across forty miles of undulating terrain. This extraordinary early public works project played a somewhat obscure yet essential role in New York City's growth and development during the 19th century. The successful design and construction of the Croton Aqueduct not only made the city's rise to prominence possible, but it served as a model for other municipal water supply systems. In his recent book: Landmarks in American Civil Engineering, Daniel L. Schodek concluded:

> The New York City water supply system, completed in 1842, was in its time the model for large-scale municipal water systems throughout the United States....The system that resulted stood as an international example of engineering skills in an era of rapid growth and formed a cornerstone in the creation of the modern city.[16]

More for the entirety and scope of its design than for any single engineering development, the Croton Aqueduct was considered by its contemporaries as one of the most significant engineering projects of the early 19th century. This assessment was echoed more than a century later, when in 1975 the American Society of Civil Engineers designated the Old Croton Aqueduct a Civil Engineering Landmark.

History

Few other cities have the commercial advantages of being surrounded by water along their entire perimeter. Nevertheless, due to the tidal actions of the Atlantic's salty waters, Manhattan Island's off-shore water supply is brackish and unpotable. Through the 18th century, residents collected rain water in cisterns or drew water from springs and ponds. As the city grew, these limited sources became depleted and/or polluted from domestic and commercial spoilage. Typical among early 19th century cities, residents tried to ignore the nuisance created by their impure water supply. Those residents with more ample means hired others to carry palatable water from more distant sources. As demand increased and supply decreased, the city's inadequate water supply also made life and property more vulnerable to waterborne diseases and devastating fires.

Proposals to tap into nearby water supplies date back to 1774. Each attempt, however, met with failure, due either to poor planning, inadequate supply of fresh water, or the meddling of political and business interests. The inadequacy of Manhattan's water supply was rapidly becoming difficult to ignore.[17]

By the 1830s, conditions had worsened to such an extent that city officials were willing to commit large amounts of public funds to tap water supplies beyond Manhattan's shores. One such proposal called for tapping the Bronx River. While at first this plan seemed promising, it quickly became apparent that the Bronx River would soon fail to supply an adequate quantity and quality of pure water. Gradually, officials came to realize that they needed to identify a more vast and pure, and thus more distant, water source. By this time, the Croton River, forty miles north of central Manhattan, came under greater scrutiny. One of the

[16] Schodek, p. 203.

[17] Lankton, "Manhattan Life Line," pp. 4-7.

Croton's principal advantages was that it ran at a higher elevation than closer sources. This would allow its waters to be gravity-fed to the city, without the reliance on expensive and problematic steam-driven pumps. With the 1833 appointment by Governor William Marcy of a Board of Water Commissioners, the review of the options for a major aqueduct project began in earnest. The Water Commissioners selected Canvass White and Major David Douglass to serve as consulting engineers. When White was unable to break away from his work on the Raritan and Delaware Canal, Major Douglass was placed in charge.

After four laborious field surveys conducted over a three year period, Douglass finally settled on the best route for the Aqueduct. By this time, however, the Water Commissioners' frustrations with the Chief Engineer's slow progress became intolerable. Douglass' relationship with the Water Commission suffered most because of his apparent inability to conclude the survey portion of the work and prepare the plans and specifications necessary to begin construction. Finally, the Commissioners hired a new Chief Engineer and then fired Douglass on October 11, 1836.

John B. Jervis was more experienced than his predecessor in accomplishing the many tasks associated with large engineering projects. During his early years, Jervis had risen from axeman to resident engineer on a 17-mile section of the Erie Canal, affording him broad experience with all elements of such engineering projects. In contrast to Douglass' more academic background, Jervis had become an engineer from first-hand experience. He also worked hard to supplement his practical knowledge with an insatiable appetite for technical literature. Jervis had left work on the Erie Canal in 1825 to assume the responsible position of Principal Assistant Engineer on the Delaware and Hudson Canal and was ultimately appointed Chief Engineer. He later served as Chief Engineer of the Mohawk and Hudson Railway, the Chenango Canal, and immediately preceding his appointment to the Croton Aqueduct, served as Chief Engineer for the enlargement of the Erie Canal's eastern division.[18]

Shortly after assuming responsibility as Chief Engineer, Jervis inspected the proposed route of the Aqueduct and endorsed his predecessor's survey. Under Jervis' direction, his staff reviewed Douglass' incomplete construction plans, revising them where he thought improvements could be made. In one instance, Jervis believed Douglass' design "had squandered material on the conduit's top and skimped on the bottom." Since the Aqueduct was designed to include an air space between the top of the conduit and the highest level of water, the top arch, or roof, of the conduit did not have to be built to withstand the same pressures as the sides and bottom. Additionally, finding fault with Douglass' failure to include a foundation beneath the Aqueduct, Jervis added three inches of concrete along the sides, and six

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[18] Ibid., pp. 48-50.

inches under the bottom of the conduit. Another of Jervis' modifications included modest changes in the dimensions of the conduit's interior, which reduced the quantity of masonry used and simplified construction.[19]

To allow construction to begin the following spring, Jervis directed his staff to prepare the necessary land maps, construction plans, and specifications. By awarding contracts in four sections, construction was able to begin on the northernmost 8.5 miles of the Aqueduct while Jervis and his staff continued preparing plans and specifications on the remaining sections.

In the first test of wills between Jervis and the Water Commissioners, the Chief Engineer demanded that hydraulic lime, instead of common quick lime, be used for all the cement, grout, and concrete. As Historian Lankton explained:

> This material cost almost twice as much as common quick lime, but Jervis believed the aqueduct called for its greater convenience and especially its durability. Unlike mortar made with quick lime, hydraulic mortar set quickly in a variety of environments: dry, damp, or even under water. And once it set, hydraulic mortar was much less likely to be leached or washed out by water.[20]

After Jervis reported that he would not accept responsibility for any compromises on this point, the Water Commissioners reluctantly yielded to the Chief Engineer. This change increased the project costs by an additional $250,000.[21]

Construction of the Aqueduct and its major structures continued for five years (1837-1842). Throughout this period Jervis confronted an array of challenges, including those caused by labor problems, political interference, and acts of nature.

Among the more routine challenges were those related to the oversight of the contractors' 4000 laborers. Several conflicts resulted from the resistance of the workers, mostly Irish immigrants, to comply with their supervisors' code of conduct. In a few instances, such as the strikes in the summer of 1837 and the spring of 1838, workers initiated labor strikes to protest unsatisfactory wages.[22]

The most drawn-out political challenge Jervis confronted related to the plan for carrying the Aqueduct across the Harlem River

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[19] Ibid., pp. 62-64.

[20] Ibid., p. 65.

[21] Ibid., p. 66.

[22] Ibid., pp. 103-106.

Valley to Manhattan Island. His original plan called for an economically and conservatively designed "inverted syphon," or low bridge. For more than a year, he was given conflicting directions whether or not to substitute a bridge tall enough to allow ships to pass. Ultimately, those property owners hoping future river improvements would bring maritime commerce to this unnavigable portion of the River prevailed, and Jervis was directed to design a more expensive high bridge.[23]

Perhaps Jervis' most frustrating challenge resulted from the failure of his nearly completed Croton Dam in 1841. On January 8, heavy rains on snow-covered frozen ground caused the Reservoir to rise at a rate of fourteen inches an hour. As the dam's waste weir proved unable to discharge the excess water fast enough, the reservoir surged over the dam, washing away the earth adjacent to the dam's north bank. Jervis' new dam design incorporated elements which would prevent such loss of life and property in the future.[24]

Such unfortunate events, however, were all but forgotten after July 4, 1842, when the Croton's water first reached Jervis' Egyptian Revival-style Distributing Reservoir. Within a few days, after the Reservoir had filled up, the burgeoning network of water mains began to carry water into some of the city's homes and businesses. The official dedication of the Aqueduct system was held on October 14, 1842. The celebration was attended by state and city officials, and was marked by ringing church bells, cannon salutes, and a parade which ended at City Hall.

Even though the Croton Aqueduct represented one of the most advanced planning projects of its day, it was unable to meet the city's demand for water after only a half century in operation. Not only had demand increased because of New York's unprecedented rate of growth, but per capita water use increased at an astounding rate. The convenient availability of water created an insatiable demand. Furthermore, as the availability of water on command became taken for granted, water wastage came to represent a significant portion of the water conveyed to the city. Therefore, to some extent, the Croton Aqueduct's very success hastened its obsolescence. The city's daily rate of water consumption rose from 40 million gallons in 1848 to 52 million gallons by 1863. Within five more years the Aqueduct was being operated beyond its designed maximum safe output of 75 million gallons per day. By 1873 the Aqueduct was charged with water virtually up to the roof of the conduit to yield nearly 105 million gallons per day. After 1891, a larger capacity "New" Croton Dam and Aqueduct began to provide a major portion of New York City's water supply. As additional and more distant water supplies were tapped during the 20th century, the original Croton Aqueduct carried a smaller and smaller percentage of the city's

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[23] Ibid., pp. 116-121 & 139-149.

[24] Ibid., pp. 103-106.

water. Finally, in 1965, the old Aqueduct was removed from service.[25]

Context

Most other U.S. cities also experienced water supply problems during the early 19th century. Contemporary with New York's Croton Aqueduct, Boston, Chicago, Cincinnati, Philadelphia, Pittsburgh, Richmond and St. Louis committed large amounts of private or public capital to develop water supply systems. By the time the Croton Aqueduct had been in operation for a decade, new water supply networks were underway in a second group of cities, including, Brooklyn, Buffalo, Cleveland and Washington, D.C.[26] Such early 19th century water supply systems shared certain similarities with the Croton, not the least of which was that they all proved unable to keep up with rising demand after only a few decades. Nevertheless, it is the Croton Aqueduct which was internationally recognized at the time of completion as a model for other cities, and remains today as the most significant tangible artifact of this landmark development in the history of urban water supply. As Historian Eugene P. Moehring wrote:

> New York became the first large city to liberate real estate and industry on a metropolitan-wide scale from the limitations of a feeble water supply....While Boston, Philadelphia and Cincinnati had aqueduct systems, they could not compare with Croton.[27]

The commitment of millions of dollars of municipal funds, and the planning and engineering required to carry the Croton's water forty miles into the City, represented an important maturation in the city-building process during the 19th century. The provision of sufficient quantities of pure water was vital to the city's public and fiscal health. Without such life-sustaining water, New York City's growth would surely have been restricted, as would have been her consequent role as the financial and cultural center of the United States.

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[25] Ibid., pp. 172-175.

[26] Ellis L. Armstrong, ed., History of Public Works in the United States: 1776-1976 (Chicago: Public Works Historical Association, 1976), pp. 217-219; and Nelson Manfred Blake, Water for the Cities: A History of the Urban Water Supply Problem in the United States (Syracuse: Syracuse University Press, 1956), pp. 217-229.

[27] Eugene P. Moehring, "Space, Economic Growth, and the Public Works Revolution in New York," in Infrastructure and Urban Growth in the Nineteenth Century (Chicago: Public Works Historical Society, Essay No. 14), pp. 29 & 33.

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Previous documentation on file (NPS):

___ Preliminary Determination of Individual Listing (36 CFR 67) has been requested.
_X_ Previously Listed in the National Register.
___ Previously Determined Eligible by the National Register.
___ Designated a National Historic Landmark.
___ Recorded by Historic American Buildings Survey: #______
_X_ Recorded by Historic American Engineering Record: # NY-120

Primary Location of Additional Data:

___ State Historic Preservation Office
_X_ Other State Agency
_X_ Federal Agency
_X_ Local Government
___ University
___ Other: Specify Repository: ______________________________

10. GEOGRAPHICAL DATA

Acreage of Property: approximately 75 acres

UTM References: (unclosed figure)

	Zone	Easting	Northing		Zone	Easting	Northing
A:	18	600250	4565170	J:	18	594000	4538000
B:	18	595740	4564000	K:	18	593360	4535000
C:	18	594690	4561000	L:	18	593740	4532070
D:	18	595410	4557060	M:	18	594100	4529000
E:	18	595720	4554000	N:	18	593580	4526000
F:	18	595730	4551000	O:	18	592340	4524000
G:	18	595990	4548000	P:	18	590820	4521950
H:	18	595420	4544000	Q:	18	590000	4521580
I:	18	594760	4541000				

Verbal Boundary Description:

The portion of the Aqueduct being nominated for National Historic Landmark designation runs from the Croton River to the Manhattan side of the Harlem River. The Aqueduct is 66 feet wide throughout most of its length, narrowing to 33 feet, and widening to 200 feet in several short sections. Due to the presence of four short portions which have lost their integrity due to mid-twentieth century road construction, the proposed NHL for the Croton Aqueduct is presented in five discontinuous sections.

Section A:

The now submerged Old Croton Dam is located slightly west of and parallel to Croton Dam Bridge, between NY Route 129 and Arcady Road. Below the dam the submerged portion of the Aqueduct runs in a southwesterly direction for approximately two miles until meeting the New Croton Dam. [The New Dam is not directly associated with the mid-19th century significance of the Old Aqueduct and has not been evaluated for NHL nomination at this time.] At the southeastern end of the New Croton Dam, the Old Croton Aqueduct passes below the Croton Dam Plaza heading in a south-southwesterly direction. Continuing in this general direction, the Aqueduct crosses under Quaker Bridge Road East and the Quaker Bridge Road North, travelling in a south-southeasterly direction, under the Old Albany Post Road. The Aqueduct continues in this direction, crossing under Quaker Bridge Road North. At the intersection of Quaker Bridge Road and Flower Avenue, the Aqueduct tunnels under surface land presently owned by General Electric Corporation. The Aqueduct is crossed by Route 9A, Ogden Avenue and Piping Rock Road before it crosses under Albany Post Road (Route 9) immediately north of the Post Road's intersection with Audubon Drive.

The Aqueduct continues south through the Village of Ossining, passing under Beach Road and the intersection of Snowden Avenue and Van Wyck Street. After passing through the square block bounded by Snowden Avenue, and Van Wyck and Matilda Streets, the Aqueduct crosses under Malcolm Street. At Ann Street the Sing Sing Kill Bridge carries the Aqueduct over Broadway Avenue. The Aqueduct follows the north/south portion of Leonard Street, crosses through the block to Main Street, across the western tip of the next three square blocks bounded by Highland Avenue and Spring Street, before entering Spring Street at its intersection with Broad Avenue. At the northwest corner of the Park which is bounded by Everett and Washington Avenues, the Aqueduct turns southeast, diagonally crossing the park, continuing in that direction across Edward Street and under the next park and Highland Avenue (Route 9). The Aqueduct then curves until it runs due south for several hundred yards, crossing Scarborough Road immediately north of its intersection with Leicester Road. The Aqueduct then crosses Long Hill Road and Ridgecrest Road slightly east of their intersections with Scarborough Road. Continuing below the northwest corner of the Sleepy Hollow Country Club, the Aqueduct again passes under the Albany Post Road (Route 9), north of its intersection with River Road. The direction of the Aqueduct shifts from southwest to southeast after crossing below Country Club Lane. Via an inverted syphon, the Aqueduct passes under the Albany Post Road south of its intersection with Requa Street. The Aqueduct then curves due south until the intersection with a series of four ramps associated with the late 1960s construction of NY Route 117.

Section B:

Resuming south of the Route 117 interchange, the Aqueduct abuts the western boundary of the Rockefeller State Park Preserve until it crosses Pocantico River. At this point it runs along the eastern boundary of Douglas Park, in Tarrytown, overlooking Sleepy Hollow Cemetery to the west. The Aqueduct crosses Gorey Brook Road at its intersection with Ridge Street, running in a southeasterly direction to Bedford Road (Route 448), immediately west of its intersection with Webber Avenue. The direction of the Aqueduct shifts south at Andre Brook, crossing below Cobb Lane and between Hillside Place and North Broadway. It crosses Mekeel Avenue running due south, crossing under Hamilton Place and Neperan Road. Shifting south-southwest, the Aqueduct runs between Archer Place and Grove Street, and after crossing Elizabeth Street, runs between Broadway and Grove for three blocks. Continuing south below Leroy Avenue, the Aqueduct crosses Prospect Avenue, and then runs along the western side of southbound Martling Avenue, and crosses below White Plains Road (Route 119). The mid-1960s construction of the multi-lane New York State Thruway (I-87) resulted in the removal of the top portion of the Aqueduct conduit.

Section C:

Resuming immediately south of I-87, the Aqueduct runs west of Chestnut Avenue and east of Short Street and Croton Avenue, where it turns southwest. It crosses South Broadway (Route 9) before entering the Lyndhurst grounds, where it shifts to a southerly direction before crossing Sunnyside Lane, Meadowbrook Road and Fargo Lane.

Running parallel to Broadway, the Aqueduct crosses Main Street in Irvington, between Croton Place and Aqueduct Place and Lane. The Aqueduct passes over Station Road by viaduct, then runs along the western edge of a park, until crossing under Dows Lane and Clinton Avenue. The Aqueduct next crosses Arsley Avenue and Hudson Road East between Hancock and Bertha Places.

In Dobbs Ferry, it crosses a section of Mercy College. After crossing Langdon Avenue, the Aqueduct is carried over the north and then the south branches of Wickers Creek. Turning south-southwest, it crosses Cedar, Oak, Elm, Chestnut and Walnut Streets between Main Street and Broadway. Immediately north of Walnut Street the boundary expands to nearly 200 feet to include the old maintenance building and the two-story Overseer's House. The boundary then resumes its 66 foot width before crossing Broadway (Route 9) at its intersection with Eldridge Place, then runs parallel to Broadway and along the east side of Washington's Headquarters Avenue, and across Colonial and Hillside Avenues.

In Hastings-on-Hudson it runs between Broadway and Sheldon Place, crossing Flower Avenue and then Minturn Street. The Aqueduct then shifts south-southeast, crossing Edgar Lane, Fraser Place, Elm Place, Villard Place and Baker Lane before turning south-southwest near Reynolds Field across the intersection of Broadway (Route 9) and Main Street. Crossing Washington Avenue, it runs in a line immediately east of Aqueduct Lane, continuing in that direction until crossing Pinecrest Road and the western end of Glen Drive. The Aqueduct runs through the New York Orphan Asylum and then through Elizabeth Seton College slightly west of the Lenoir Preserve.

After crossing the northernmost portion of Odell Avenue in Yonkers, the Aqueduct curves west to run along Untermyer Park's western side and closely parallel to the eastern side of Warburton Avenue. It continues this close parallel to Warburton, crossing Roberts Lane, Arthur Street, Phillips Road, Glenwood Avenue, Wicker Street and Lamartine Avenue. At the intersection of Willow and Cottage Places, the Aqueduct begins an east-southeast curve, crossing Broadway (Route 9) at its intersection with Bishop William J. Walls Drive. It crosses Ashburton Avenue immediately west of its intersection with Palisade Avenue. Running slightly north of and parallel to Walsh Road, the Aqueduct crosses Summit Street and Madison Avenue. Immediately west of Saw Mill River Culvert, a short section of the original Aqueduct and berm has been demolished and reconstructed as an arched overpass due to road widening.

Section D:

The original Aqueduct resumes across the Saw Mill River Culvert and crosses Walnut Street, running through the square block bounded by Yonkers Avenue and Croton Terrace. After crossing Seymour Street, it gradually crosses Yonkers Avenue at an angle. At the intersection of Yonkers Avenue and Saw Mill Parkway, the Aqueduct enters the northernmost portion of Tibbets Brook Park, running parallel to the southwesterly curve of Yonkers Avenue. The Aqueduct then continues within the Park along its eastern boundary. Crossing over the southernmost portion of Wendover Road, the Aqueduct runs immediately west of, and parallel to Midland Avenue. It crosses McLean Avenue twice before entering the long block bounded by Sedgewick and Hancock Avenues.

Running between the parallel streets of Sedgewick and Hancock Avenues in lower Westchester County, the southbound Aqueduct crosses into New York City (the Bronx) and enters Van Cortlandt Park. Continuing in a southerly direction for about 2500 feet, the Aqueduct runs toward and along the eastern side of the Mosholu Parkway. Approximately 700 feet north of the intersection of Mosholu Parkway and the Major Deegan Expressway, the Aqueduct angles away (due south) from the Parkway before crossing under the Expressway. It then follows along the southeastern side of the Expressway until it crosses into the center strip of the Parkway. At this point, the Aqueduct continues south for approximately 2000 feet.

The Aqueduct exits the Park and continues south through the square bounded by Saxon Avenue and W. Mosholu Parkway. At the northeastern tip of Jerome Park Reservoir, the Aqueduct follows the east side of the Reservoir, along Goulden Avenue, passing the intersection with Kingsbridge Road. Between Kingsbridge and Fordham Roads, the Aqueduct berm is clearly visible as it runs immediately west of Aqueduct Avenue West, between University and Grand Avenues. Below Fordham Road, the visible Aqueduct berm runs immediately east of Aqueduct Avenue East. Crossing Burnside Avenue via syphon, the Aqueduct continues south through the long block between University and Harrison Avenues. At Morton Place, the Aqueduct begins to run under University Avenue.

Section E:

South of its intersection with Featherbed Lane, the original Aqueduct was replaced with a 24 foot diameter steel syphon to accommodate the mid-twentieth century construction of the Cross Bronx Expressway. After approximately 600 feet, the original Aqueduct resumes at a point south of University Avenue's intersection with Ogden Avenue. It continues under University Avenue until passing 170th Street, where the Aqueduct enters and crosses High Bridge. The nominated resource terminates at, and includes, the small gatehouse structure located at the extreme western end of High Bridge.

Boundary Justification:

The boundaries of the five sections include the Aqueduct and the minimum area necessary to accommodate the width of its built-up berm. The northernmost boundary begins at the Old Croton Dam, and the southernmost boundary ends at the Manhattan end of High Bridge. The four gaps between the five sections have been excluded because they have been altered or demolished to accommodate mid-twentieth century road construction. The Landmark is terminated at High Bridge due to the uncertainty of the survival of the Manhattan portion's underground features, and because this portion of the Aqueduct maintains virtually none of its original above ground features. Nevertheless, the great majority of the Old Croton Aqueduct survives, and the Landmark's termination in upper Manhattan provides a symbolic reference to the landmark engineering feat of carrying the Croton's waters to Manhattan.

11. FORM PREPARED BY

Name/Title: Robie S. Lange / Historian

Organization: History Division, NPS Date: October 1991

Street & Number: P.O. Box 37127 Telephone: 202-343-8151

City or Town: Washington State: DC ZIP: 20013-7127