"... Some will have it telluric, but as far as I can read the opinions of the physicians of the world it is a disease of which they know very little ...."[13]

New York was not alone as the disease spread west and south reaching Philadelphia, Baltimore, and urban centers in the South. Among those staying behind that summer was Myndert van Schaick,[14] an alderman serving as treasurer of the Council's Board of Health. It was his duty to stay and in so doing, he saw firsthand the effects of the disease on both the populace and the city's ability to recover. The city did recover, and he reinitiated the discussions to find a suitable source of clean water. He lobbied the council to again undertake engineering studies for both a proper source and adequate distribution. The outcome evolved into a project for which Wright was retained in October 1832.

Wright placed surveyors in the field to gather topography and stream cross sections. He did so in the Bronx watershed, all to continue the efforts that he and Canvass White had conducted earlier. Although Alderman van Schaick felt Wright to be "a very able and experienced engineer," it was the Alderman's feeling that the Bronx watershed was not the proper source, but that the source should rather be the Croton River. Even though Van Schaick was an Alderman, Wright was retained by the Water Committee to explore the Croton River watershed; Van Schaick retained DeWitt Clinton Jr.,[15] son of the Erie Canal proponent. Thus, in the fall of 1832, as Wright had his team in the Bronx watershed, Clinton was likewise deep in Westchester County studying the Croton Watershed.[16]

The younger Clinton had experience with railway and canal work and was engaged with the Army's Bureau of Topographical Engineers when he accepted the engagement by the city. Work got underway in the late fall and relied to a great degree on Canvass Whites' previous study material. In fact, White had studied the Croton Watershed, even going as far as gauging the streams for capacity but felt that the expense of obtaining the water far exceeded the benefits. Wright also held this notion as well because it was his belief the costs of conveyance exceeded the benefit to the city. His report was turned into the council in November and Clinton's the next month.

Wright's report, relying on the newly completed field surveys, was brief but recommended that the Bronx Watershed, supplemented with water from the Bryam Ponds, would be enough to supply the city with clean water at a modest budget. Restating White's conclusion, the Croton River was economically untappable, but with further study, water could be redirected into the Bronx Watershed.

Clinton's report, on the other hand, was lengthy and went into detail to address the opinions of previous studies and went so far as to recommend the Croton Watershed as the preferred source. From his study of the river channel, Clinton concluded from calculations that if a dam were placed nine miles above the mouth, the watershed could supply 20 million gallons per day. Costs for land and water rights would be relatively low owing to the

somewhat undeveloped condition of the area and would be an advantage over similar expenses in the Bronx Watershed. Clinton's cost analysis for structures, land, and property costs was $2.5 million.

Two alternative studies were before the Council, and although the Wright report was looked on with favor, the choice went to the Croton Watershed. Legislators in Albany passed a resolution in February 1833, clearing the way for developing the Croton Watershed as New York's water supply source. Legislative approval came about with the political maneuvering of newly elected state senator, Myndert van Schaick. Canvass White was retained as chief engineer for the project but within months resigned the position to take on another canal development. Following his departure, the Croton project considered the services of three engineers, with each requested to conduct initial surveys and submit their feasibility reports. Among the three were David Bates Douglass[17] and John Martineau.[18] Martineau was a former Erie Canal engineer, and Douglass a military engineer with service in the War of 1812. Reports were submitted to the council in early 1835 that made recommendations as to the proper way to tap the Croton. When considering the various means and costs of the necessary dam, route, and method of conveying aqueduct and ultimate distribution, a hybrid of the Martineau and Douglass reports was felt to be the proper approach. Wright separated himself from further activity with the water supply question and continued other engagements. Although his active connection with the water supply program in New York came to an end, he did not necessarily stop paying attention to developments with the project.

Final design for the delivery system included a high dam on the Croton River, a masonry aqueduct to cross the Harlem River, sixteen tunnels, and an inverted siphon to carry water to a receiving reservoir at Yorkville ending with a distribution reservoir at Murray Hill. At a cost approaching $4.2 million for the aqueduct delivery system, the distribution system would incorporate more than 160 miles of pipe with twenty-inch diameter mains and six-inch diameter branch lines at an additional cost of $1.3 million. After decades of political wrangling and various engineering studies, post-choleric New York had before it the remaining question: spend the money and proceed, or not. Voting was held to get the people's answer. Politics ran deep but the measure carried and within weeks the organizational structure was in place to execute the project, with David Bates Douglass retained as chief engineer and survey crews going into the field in Westchester County to begin design surveys.

Douglass was a Yale graduate and had served as an army engineer. Along with some canal experience, he had taught in a school, the precursor to New York University. His wife, Irene, was the daughter of Andrew Ellicott, the respected colonial surveyor. Later in his career, he served as a consultant on railway work later to become portions of the Long Island Railroad.

Douglass took his position with the aqueduct project in June 1835. His survey crews were in the field within weeks. To Douglass' credit, his military service was honorable and his academic credentials, both as student and teacher, were respected. However, his approach to practical engineering matters remained somewhat rigid with no regard to the time-honored tradition of completing a task on time and on budget. To further complicate matters, the city officials faced the realization that they may well have waited far too long; once again, a tragic price would be paid for years of inaction. Philip Hone, former mayor and past president of the Delaware and Hudson Canal, recorded:

> How shall I record the events of last night, or how attempt to describe the most awful calamity which has ever visited these United States.[19]

Wintertime darkness fell on December 16, 1835, with temperatures well below zero degrees. Throughout the city, cisterns and wells along with both rivers were frozen. About nine o'clock in the evening, a watchman noticed smoke coming from a building on Merchant Street (now Hanover Street). Fire companies were deployed but in less than half an hour, thirteen buildings were ablaze. By midnight, the fire encompassed entire city blocks to the order of close to thirteen acres. Firefighting capability proved helpless to the point that by four o'clock in the morning, it was thought that the entire city would burn to the ground. Before dawn, the military intervened and with systematic explosive demolition, buildings in the fires path were removed, creating a firebreak. At sunrise, as smoke still enveloped the entire island, it was cataloged that over 675 buildings had been destroyed. Wright was living on Greene Street at the time. Philomela, who had been ill for a long time, had died the previous May. No doubt he was still grieving, but he gathered his remaining family and evacuated to a safer location. Although his home was north of the immediate fire, it would seem the prudent thing to do to keep his family safe.[20]

****

City leaders were losing patience with Douglass because his slow methodical approach to the work went against the urgency felt by the council. Douglass was slow to produce, in a timely manner, the property acquisition maps necessary to obtain land. His request for more staff and materials went unheeded, and unknown to him at the time, Stephen Allen, head of the Water Committee, had begun communication with another engineer. To counter the lack of documents from Douglass, Allen sought out John Jervis to help provide examples of technical materials. Jervis, then working on the Chenango Canal, supplied Allen with examples of specifications as a favor in return to Allen, who had secured a position for Timothy, Jervis'

brother. Timothy was working in one of Douglass' survey crews, and no doubt, had kept his brother abreast of progress on the aqueduct project.

Douglass' relationship with the council reached a point of no return in 1836, when he requested further surveys in Westchester County to aid in ongoing right-of-way litigation with landowner damage claims. The claims were primarily the result of the changed alignment resulting from an increase in the conduit diameter. Douglass was held accountable by the council for the design changes, and the argument continued all the way to the state legislature, where local landowners petitioned for compensation. The divide between the city and Douglass widened such that, by October 1836, Douglass was forced to resign. Within days, John Jervis was retained to fill the position.[21]

Early in 1836, Jervis had left his position with the Chenango Canal to take another engineering assignment with the Erie Canal enlargement, taking with him William McAlpine,[22] his former assistant on the Chenango Canal. About the same time, while dealing with management problems with the aqueduct project, members of the council's committee approached Jervis in September to gauge his interest in the position as chief of the Croton, which he accepted the following month. McAlpine remained with the Erie Canal enlargement as Jervis filled engineering assistant positions.

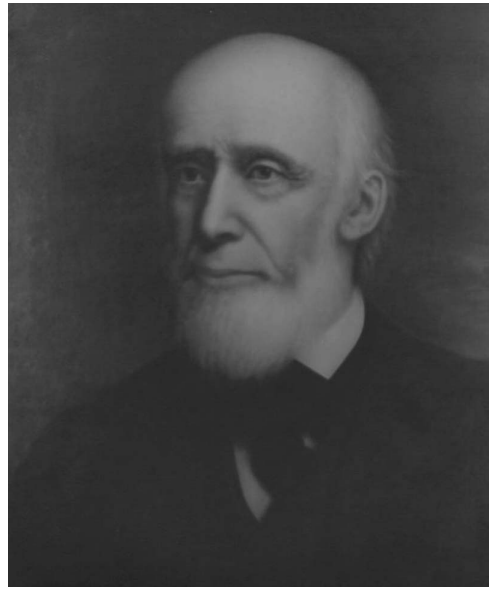

Figure 18: John Jervis (later in life).
Source: Courtesy of the Jervis Library, Rome, New York, used with permission.

Within weeks Jervis was in Philadelphia visiting the Fairmont Water Works, followed by a trip to Washington to visit the site for an aqueduct across the Potomac. His interest in the Washington work was in the pile foundations planned for the aqueduct piers because similar foundations were planned for the bridge across the Harlem River. Jervis brought the project to completion six years later at a cost of more than $10 million. However, for Jervis the project did not end with the opening of a valve to great celebration.

Within a few years of Douglass' dismissal and the subsequent hiring of Jervis, the project was still in the throes of reaching completion when Douglass publicly confronted Jervis and accused him of seeking out the position by purposely politicking behind the scenes. Through a series of published articles, Douglass asserted that then New York City mayor, Stephen Allen, had private meetings with one of the canal commissioners in Baltimore during the Democratic Convention.[23] Douglass asserted that discussions between the two pertained to the dismissal of Douglass, and as a result of subsequent correspondence between the commissioner and Jervis, he took the position once Douglass was let go.

The controversy did not go away with Jervis' formal counter argument and it stayed with him the balance of his career. Friends of Douglass would not let the issue rest, confronting Jervis and even more so considering the success of the project. Jervis argued that, in fact, he did nothing to solicit the position and was just offering sample specifications for Allen's use as a professional courtesy. Douglass was aware of Jervis', brother Timothy's presence and would use the arrangement, after the fact, to suggest that it was through his brother that Jervis gained information about progress and internal issues with the early stages of the aqueduct project.

Jervis was approached by the council about the position at the time of Douglass' dismissal and, on examination of the research, it appears Jervis did nothing inappropriate. However, an underlying question remains, why did the council contact Jervis in the first place? Yes, he was doing Allen a favor in providing sample specifications, but his technical experience at that time was of a single focus—canal engineering. So, to the question, evidence does seem to indicate the good possibility that Wright intervened. Wright was well-connected politically and felt his young protégé was capable and had the skills for the position, and never let any lingering issue with the confrontation on the Delaware and Hudson Canal influence his attitude toward Jervis. Did Wright exercise some behind-the-scenes endorsement of his younger counterpart? If he did, he had enough integrity to have not intervened if it was not in the best interest of the project.[24]

Jervis brought the forty-one-mile Croton Aqueduct to completion and it is considered a landmark civil engineering achievement. Whether in an open excavation, a mined excavation, or in an aerial structure, the conduit cross

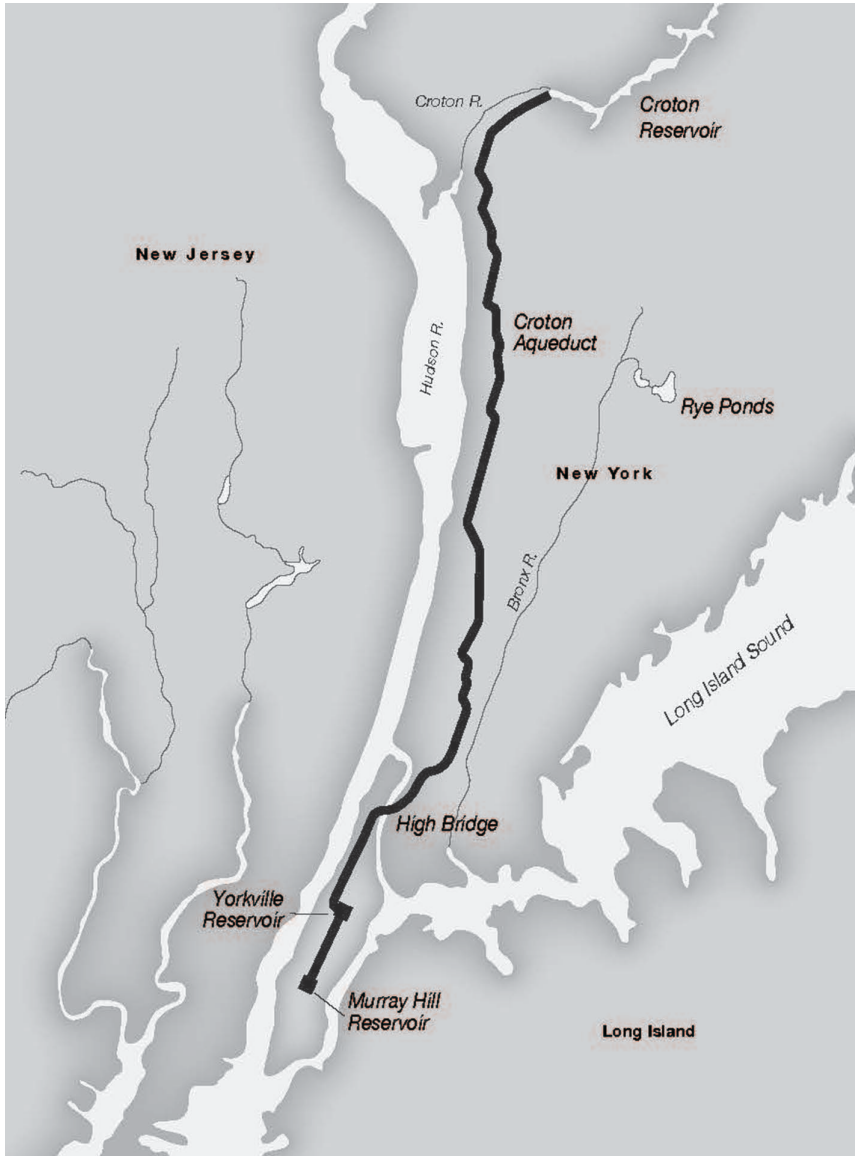

Figure 19: Route of the Croton aqueduct.
Source: Penworx Studios, used with permission.

section was brick-lined. It was somewhat horseshoe-shaped, with a height of about eight feet and a width of seven feet. He managed a cadre of assistant engineers on the project, many of whom would go on to lead successful careers. Further, he had brought back Horatio Allen following the railway work in South Carolina. James Renwick,[25] later to design the Smithsonian, joined the team along with Alfred Craven.[26]

In addition to the primary conduit itself, other structures were required including the dam on the Croton River. It was a combination of stone masonry and earth embankment with the stone masonry, standing fifty feet high and sixty-nine feet thick at the base and having a spillway one hundred feet long. The surface area of water impounded behind the dam covered more than 400 acres, with a holding capacity of 500 million gallons, allowing thirty million gallons delivered every day to the city. The High Bridge carrying the conduit across the Harlem River was 1,450 feet long with sixteen masonry arches on piers founded on bedrock and excavated in the dry with coffer-dams. Once on the island, the receiving reservoir was at Yorkville with walls of puddled earth and stone facing holding 150 million gallons. A distribution reservoir was at Murray Hill, holding 20 million gallons. Completed in October 1842 with a grand ceremony, water flowed through fountains at City Hall and Union Square. Wright had died within the months prior and would not witness the completion. The project was designated by ASCE as a National Historic Civil Engineering Landmark in 1975.[27]

As water filled the Murray Hill reservoir, Jervis would part company with the project. Although he did not get involved with construction of the distribution system in Manhattan, he did consult with the project from time to time. He took on work in Boston with its water supply needs and served as chief engineer with a railway project between Albany to New York City following the Hudson River. As his career advanced, he took on more railway work including the chief engineer's position with the Chicago and Rock Island Railroad running between Chicago and Davenport, Iowa, and crossing the Mississippi River at Rock Island, Illinois.

The Rock Island bridge, although an important span over a major river, became significant in another fashion. For the railway to cross the Mississippi River a bridge was planned and, as was expected, it also brought immediate political controversy as the steamboat industry fought against its construction. The bridge was completed but on the night of May 6, 1856, the steamboat, *Effie Afton*, rammed one of the bridge piers by accident. Carrying a full manifest of passengers and freight, it erupted into flames and sank, and damaged much of the bridge. There was no loss of life owing to the accident, but the subsequent litigation drew an international audience and involved extensive reporting on the part of Jervis, who was serving as the railroad's chief engineer. His report was quite thorough, and its completeness helped the attorney sway the judicial outcome in favor of the railroad. Although he was a young attorney at the time, Abraham Lincoln represented the

railroad in the litigation and with Jervis' report in hand, the railroad was exonerated.[28]

Now, as Croton Aqueduct construction advanced, Wright was pursuing other work, and although he had continued involvement with various canal proposals, he also took on engagements with railway developments in a variety of locations. Despite his advancing years, he continued to be sought out for both his engineering services and his opinion on a wide array of projects.

Endnotes

1 This excerpt comes from Irving's *Chapter CIX (109)* of the *Chronicles of the Renowned and Ancient City of Gotham, Salmagundi,* Issue 17, published on November 11, 1807. This excerpt is also recounted in Jones, 2008, p. 51.
2 A discussion of the early Dutch management of their scarce water supply is found in Koeppel, 2000, p. 13.
3 This extract describing the well production is taken from the chapter on New York in *The American Gazetteer* published in Boston, 1797. A recount of this is found in Blake, 1956, p. 13.
4 Aaron Burr (1756–836).
5 Theodosia Provost (1746–1794) was ten years older than Burr, and when the two got married she was the widow of a Swiss-born British military officer.
6 Joseph Browne was a doctor in Westchester County, New York, just north of New York City. As a curious aside, in the months following the double wedding, he became involved in a scheme to move the Boston Post Road onto property he controlled, and for which he began to start collecting toll for passage along the road. It was a scheme that Burr also got involved in, but more so to increase value of property he held adjoining that of Browne.
7 In 1798, Browne had written a paper discussing the origins of yellow fever and offered a theory that ample supplies of fresh water were necessary to limit the spread of the disease. A discussion of his writing can be found in Koeppel, 2000, p. 65.
8 Stephen Allen (1767–1852) was in the sail making business and a city political figure. He died tragically in the explosion of the steamboat, *Henry Clay*, while travelling up the Hudson River.
9 New York's *The Evening Post,* March 15, 1825. This excerpt is recounted in Koeppel, 2000, p. 131.
10 New York's *The Evening Post*, June 20, 1825. Recounted in Blake, 1956, p. 116.
11 Wright to Cocke, August 7, 1832.

12 The various pandemics that have afflicted New York City are well documented in the literature. One discussion regarding the 1832 cholera epidemic and the international spread of the disease is found in Burrows and Wallace, 1999, p. 590. Various city aldermen did not evacuate and stayed because they felt they had too. According to Murray in his edited autobiography, all the aldermen were "ex-offico" members of the Board of Health. His recounting of events of the epidemic can be found in Murray, 1908, p. 55. It is interesting to note that on the same page of the document, Murray has complimentary things to say about Wright's tenure as street commissioner.
13 Wright to Cocke, August 7, 1832.
14 Myndert van Schaick, (1782–1865) served several years in the New York State Assembly and was treasurer of the City Board of Health at the time of the epidemic.
15 De Witt Clinton Jr. was born in 1805 and had experience in surveying. In 1831, he took a position with the War Department's Topographical Bureau He returned to the city in 1832 to accept Van Schaick's engagement.
16 An account of Van Schaick's comment regarding Wright and the former's strong support of the Croton Watershed can be found in Koeppel 2000, p. 147.
17 David Bates Douglass (1790–1849) born in New Jersey, was educated at Yale, and fought in the War of 1812. He taught at West Point prior to his retention by the Croton Aqueduct project.
18 Information about John Martineau is somewhat sketchy. He did perform surveys and reported during the review of the proposed Croton Aqueduct. He also proposed the use of wrought iron pipes in inverted siphons in lieu of the High Bridge across the Harlem River—a proposal that was not implemented.
19 The comments of Philip Hone regarding the 1835 fire come from his diary and are recounted in Koeppel, 2000, p. 174.
20 Discussions about the details of the spread of the fire can be found in Koeppel, 2000, p. 175, as well as Burrows and Wallace, 1999, p. 596.
21 Discussions about the events leading up to the dismissal of Douglass and the subsequent hiring of Jervis can be found in Koeppel, 2000, Larkin, 1990, and FitzSimons, 1971.
22 William McAlpine (1812–1890) was born in New York City and first worked with Jervis on the railroad portion of the Delaware and Hudson Canal development. His career embraced canal, railroad, and waterworks projects. He served as president of ASCE in 1868–69.
23 William Bouck (1786–1859) was an Erie Canal commissioner and spent several years in the New York legislature. He served as governor of New York in the years immediately after Wright's death.

24 Discussion regarding possible intervention by Wright on behalf of Jervis in consideration for the chief engineer's position with the Croton can be found in Larkin, 1990, p. 87. A comment mentioned by Jervis in his memoir and further elaborated on in FitzSimons, 1971, p. 164 provides a defense of Wright in regard to the elder's preference of the Bronx Watershed as the proper source—evidence that the younger engineer still held his former tutor in high regard.

25 James Renwick (1790–1863) was born in England and after coming to America became a Columbia graduate, where he spent a good deal of his career teaching. He was involved with studies on the Delaware and Hudson Canal and was instrumental in the implementation of the inclined planes on the Morris Canal.

26 Alfred Craven (1810–1879) was born in Washington, DC. He graduated from Columbia and worked in railway and canal work, including work on the Croton Aqueduct. He was involved in the 1839 attempt to form a professional society, and it was in his aqueduct office that the society formally organized in 1852. He was president of ASCE in the years following William McAlpine, 1870–1871.

27 There are numerous discussions within the engineering literature regarding the details of engineering and construction of the Croton Aqueduct. One of the first providing a good deal of description of the engineering and operation of the aqueduct can be found in *Scribner's Monthly,* Vol. XIV, 1877, pp. 161–176. Also, Koeppel, 2000 and Blake, 1956, contain material pertaining to both the political and engineering aspects.

28 Discussions of the steamboat *Effie Afton,* its crash into the railroad bridge at Rock Island, Illinois, and the involvement of then lawyer, Abraham Lincoln can be found in Larkin, 1990, pp. 141–142 and in FitzSimons, 1971, p. 14. It is interesting to note that Henry Farnum, a former assistant to Jervis on the Erie Canal who would have been acquainted with Wright, also worked with Jervis on the Chicago and Rock Island Railroad. Farnum is the engineer who is given credit for the Mississippi River Bridge because he had taken over as president of the line at Jervis' departure. However, Jervis remained as a consultant to the railway and compiled the report following the accident.