
By Stuart Glishoff

By the Civil War, American cities had outgrown the cisterns, wells, and springs that furnished most of the nation's drinking water. As domestic water sources dried up or became polluted, cities were compelled to develop public water supplies by bringing in water by gravity from mountain streams or, more commonly, by pumping it from nearby rivers and lakes. In the years 1860 to 1896, the number of public water supplies increased from 136 to 3,196; a little more than half, including nearly all of the largest ones, were municipally owned. Tragically, population growth and industrialization led to such increased pollution of surface waters that most communities drank their own sewage or that of their neighbors upstream. Typhoid fever and dysentery became endemic, and urban mortality rates were shockingly high. In the following decades, effective methods of water purification were discovered that prevented most waterborne diseases, and cities rushed to take advantage of them. By the mid-1920s, nearly all urban water supplies were being filtered or chlorinated.¹

The urban quest for pure and abundant water supplies is as old as American cities themselves. The townsite for Boston was selected largely on the basis of the area's springs. Newark residents received much of their water from two streams that came together to form a small triangular pond, which the city fathers set aside for common use. As the need arose, fire cisterns were placed beneath the streets and public pumps were built throughout the community for the convenience of residents. For over a century, Newark's requirements for water were met in this manner, supplemented by private wells and springs.²

By 1800, rusticity had become a luxury that the nation's leading cities could ill afford. As cities grew, streets within the community were filled in or were converted into sewage outlets. The water collected from roof gutters was flecked with the soot of nearby chimneys. The older wells, when they worked, provided a diminished supply of heavily mineralized and often polluted water. Volunteer fire companies were formed to combat the growing menace of fire
in the congested cities, but, armed only with buckets and primitive hand pump engines, the fire fighters were virtually powerless. Cities turned first to private aqueduct companies to satisfy their water needs, but with disappointing results. Building a modern municipal waterworks required a large initial outlay of capital and heavy subsequent expenditures for maintaining and extending the system. Few aqueduct companies became rich selling water, and they balked at providing water for important civic purposes such as flushing gutters and drains and installing fire hydrants. They were also reluctant to service remote districts or to furnish water to high elevations because of the extra expense involved. Most distressing was the companies' unwillingness to abandon polluted water supplies in which they had made a large investment or to enlarge their waterworks in anticipation of future population growth.

Fires and epidemics brought to a head the growing public dissatisfaction with private ownership of urban water supplies and led to demands for municipal control. In 1801, Philadelphia began pumping water from the Schuylkill River. The Schuylkill waterworks was significant for two reasons: it was the first large municipally owned waterworks, and it marked the first use of steam engines for municipal water conveyance. Steam engines provided a constant supply of power for operating water pumps and also greatly enhanced the ability of engineers to raise water from low-lying rivers and lakes.

In 1835 New York City undertook the most ambitious municipal waterworks so far. Work began on the construction of a dam on the Croton River 40 miles north of New York, from which the water was to be taken by gravity in masonry aqueducts to the city. To maintain a uniform grade, the aqueducts had to be tunneled through hills and carried over deep ravines and across numerous streams. Boston and Baltimore also developed upland water sources, although in the latter city fiscal conservatism prevailed and a small nearby stream was tapped.

During the years 1850-1920, water was a vital concern of American cities, second in importance only to transportation improvements. The specter of pestilence hung over a city without a pure water supply, deterring persons and businesses from settling there. Urban destines were inextricably tied to local health conditions. For example, New Orleans, which suffered grievously from attacks of cholera and yellow fever, began to lose its control over western commerce to its healthier rivals to the north, St. Louis and Chicago. One local physician calculated that from January 1846 to May 1850 the economic cost of preventable sickness and premature death to New Orleans was over $45 million. Similarly, epidemics in Memphis in the 1870s nearly destroyed its economy, and it was not until the following decade, when major sanitary reforms including the introduction of sewerage and a new water supply were made, that the city's fortunes began to recover. In northern cities the principal threat came from typhoid fever. A high typhoid fever death rate not only caused economic losses; it also damaged a city's reputation for salubrity and sanitary enlightenment, which, as the Newark Board of Trade noted, could be more harmful than the disease itself.

One city's misfortunes of health were often another's gain. Atlanta had long remained free from major epidemics (which local leaders attributed to its mild climate) and enjoyed the reputation of being one of the few healthy cities in the South. When a massive yellow fever epidemic struck Louisiana in 1905, Atlanta welcomed persons fleeing the pestilence. The local chamber of commerce boasted that over 4,000 refugees were sheltered in Atlanta without a single case of sickness. To emphasize the city's alleged immunity from yellow fever, the Atlanta Board of Health defied a state quarantine imposed on persons coming from the area of the epidemic. Despite the testimony of the city bacteriologist that the *aedes aegypti* mosquito was present in Atlanta, the mayor encouraged the board in its actions. The general council supported them both with a resolution stating:

> the demand of the state board is uncalled for ... and tends to put Atlanta in a false light ... This city has built up a reputation based upon its history as well as its natural advantages, which is of vast advantage and importance to itself and its citizens.

Ultimately, however, the city had to acquiesce to the state's supremacy in matters of quarantine.

In this discussion of the development of urban water supplies in the late nineteenth and early twentieth centuries, three cities—Atlanta, Chicago, and Newark—will be emphasized to provide a cross-section of the national experience. Atlanta was chosen because it was the South's leading city and the speaker of the "New South" that emerged after the Civil War. Chicago was the urban phenomenon of the period, for in just seventy years it had developed from a desolate army post into the leading commercial and industrial center of the Midwest, with a population of over a million, second only to New York City. Furthermore, its vitality and rawness best symbolized the nation's surging urban development. Newark was selected to represent the Northeast and the smaller industrial cities of the era.

Throughout the first half of the nineteenth century the dangers of drinking impure water were misunderstood. Water was usually judged by its physical qualities; hence water that was clear, odorless, and tasteless was considered pure and safe. Some physicians believed that drinking hard water or water
contaminated with vegetable and animal matter was bad for the kidneys and was responsible for many stomach and digestive disorders. But it was not until Dr. John Snow's work with cholera in the 1850s that the link between polluted water and epidemic diseases was firmly established.\textsuperscript{10}

Snow, a distinguished London physician, wrote a pamphlet in 1849 wherein he argued that cholera was caused by an organic poison that attacked the intestines and was discharged in the feces. If the infected feces should find their way into public water supply, he maintained, an epidemic would ensue. In 1854 Snow had an opportunity to test his hypothesis. Investigating a cholera epidemic near Broad Street in London, in which five hundred persons had died, Snow was able to trace its origin to a polluted well. A workshop in the same area, which had its own well, reported no cases among its seventy employees. Simply by breaking the pump handle to the polluted well, Snow ended the epidemic.\textsuperscript{11}

Within a short time after the publication of Snow's work, cholera was brought under control in most parts of the Western world. The cholera vibrio is a frail organism that dies upon exposure to light or when deprived of moisture and thus is relatively easy to control. Cholera usually occurs only in communities where wretched living conditions prevail and where little or no attention is paid to personal hygiene. The last serious outbreak of cholera in the United States took place in 1873.\textsuperscript{12}

Snow's studies of waterborne transmission of disease were replicated by Dr. William Budd in his investigations of typhoid fever. Through the use of field studies and statistical investigation, Budd showed that typhoid fever also was spread through fecally contaminated water supplies. The typhoid bacillus, however, is a hardier specimen than the cholera vibrio, better able to withstand heat and cold or the actions of various disinfectants. Close scrutiny of watersheds and water supplies was essential in preventing typhoid fever epidemics. The problem was compounded by the widespread distribution of the disease. In addition to sewage-contaminated water, typhoid fever may be transmitted by milk produced under unsanitary conditions, by raw fruits and vegetables fertilized with night soil, by oysters and other shellfish harvested in polluted waters, and by flies that gain access to privies and kitchens. It may also be spread by convalescents and carriers, such as the well-known "Typhoid Mary," a New York City cook who, before her arrest, left a trail of at least twenty-eight sick persons in the homes where she worked.\textsuperscript{13}

As typhoid invariably accompanied the distribution of sewage-contaminated water into the homes of urban residents, the typhoid fever death rate was commonly used as a measure of the purity of the local water supply. In 1908, George C. Whipple, one of the nation's leading public health authorities, maintained that a typhoid fever death rate greater than 15 to 20 per 100,000 population was a sign that the water supply was being polluted. A death rate lower than that figure he attributed to "residual," or nonwaterborne, typhoid.\textsuperscript{14}

The knowledge that polluted water harbored deadly diseases posed a crisis for American cities, a majority of which obtained their potable water from nearby rivers and lakes that were being increasingly fouled by sewage and industrial wastes. The inhabitants of these cities were drinking extremely polluted water, with disastrous consequences. A few examples will illustrate the problems confronting American cities as they sought to satisfy the demands placed on their water supplies by rapid growth and industrialization.

By the end of the Civil War, the local wells and springs that supplied Newark with water had become inadequate, and the city turned to the Passaic River for relief. Fearing a return of cholera, which had three times ravaged the community, the Newark Aqueduct Board carefully considered the safety of the new water supply. A chemist engaged by the board for this purpose determined that the water of the Passaic River was as pure as that of the famed Croton, quite suitable for drinking and other domestic purposes. Confidence was expressed in the "law of purification," which stated that a stream would purify itself by oxidation after a few miles of flow. To be on the safe side, infiltration basins were set on the alluvial sand and gravel banks of the river to cleanse the water.\textsuperscript{15}

The precautions taken by the Newark Aqueduct Board were to no avail. As cities and industries developed along the Passaic River and its tributaries, the river became hopelessly polluted. In 1872 complaints about the quality of the water supply led to an investigation by the Newark Daily Advertiser, which disclosed that the river was being polluted with sewage, animal carcasses, dead human bodies, and industrial poisons. Professor Albert R. Leeds of the Stevens Institute in a report to the Board of Public Works of Jersey City, which also drew its water from the Passaic River, stated that chemical tests had revealed "a shocking degree of contamination by organic matter."\textsuperscript{16}

Other cities located along the banks of rivers that washed heavily industrial areas suffered grievously from waterborne diseases. During 1890-91, Lowell and Lawrence, Massachusetts, experienced a severe typhoid fever epidemic. Both cities obtained their water from the Merrimac River, a large stream draining an industrial area in New Hampshire and northern Massachusetts. The source of the epidemic was traced to several outhouses overhanging the banks of a small tributary of the Merrimac River a little upstream from Lowell. The privies were owned by local businesses, and a number of workers had used them while ill with typhoid fever. The epidemic began in Lowell, where it claimed 132 lives.
in a population of 78,000. From Lowell it spread downstream about a month later to Lawrence, population 47,000, where 74 persons died. 17

Pittsburgh received its water from the Allegheny and Monongahela rivers. Both rivers were contaminated by the sewage and industrial wastes of large communities located within a few miles of Pittsburgh. The water was not filtered and was sometimes muddy and tasted bad. In 1894-1906, Pittsburgh’s typhoid fever death rate never fell below 100 per 100,000 population. More than 5,000 cases occurred each year. Nearby Allegheny drew its water solely from the Allegheny River and suffered even more from typhoid than its neighbor. 18

The cities along the Great Lakes were blessed with large supplies of fresh water at their doorsteps and were thus spared the expense incurred by the great eastern metropolises in bringing in water from distant highlands. But the lakes were also used as sewage receptacles, with predictable results. Moreover, the typhoid fever epidemics of the lake cities were likely to be of long duration since, as the epidemic intensified, the sewage of the city became more saturated with typhoid bacilli, which in turn increased the pollution of the water supply. 19

Chicago’s first waterworks, established in 1842, was operated by the privately owned Chicago Hydraulic Company. The company’s primitive pump and distribution system served only a small number of Chicagoans and in 1852, during a severe cholera epidemic, the city assumed management of the waterworks. In 1854 the waterworks was enlarged to provide lake water for all who wanted it. To avoid shoreline pollution and to escape the ill effects of the Chicago River, which carried off the city’s wastes, the intake of the waterworks was located some 600 feet out in Lake Michigan. 20 As the pollution of the Chicago River grew worse, it became necessary to move the intake deeper and deeper into the lake.

City officials attempted to improve the water supply by reversing the flow of the Chicago River so that it emptied into the Mississippi River system instead of Lake Michigan. This rerouting was possible because Chicago was situated at a very low point on the divide separating the Lake Michigan and Mississippi River watersheds. 21 With the building of the Illinois and Michigan Canal in 1848, the Chicago River had become linked to the Mississippi by means of the Des Plaines and Illinois rivers. In 1862 a pumping station was built on the Chicago River to redirect its current. However, the Illinois and Michigan Canal, which had been opened as a barge canal, was not deep enough to handle the city’s increasing waste, much of which still found its way into Lake Michigan. The canal was deepened in the late 1860s but without success. Hence Chicago continued to suffer from typhoid fever, dysentery, and other waterborne diseases. 22

The Civil War left much of the South prostrate, but Atlanta recovered quickly and rose from the ashes to become the state’s leading transportation and commercial center, with a population in 1870 of nearly 20,000. It was first proposed to let private interests furnish the city with water. But, when two aqueduct companies organized for this purpose failed to act, the city decided to build its own waterworks. The South River, which flows below downtown Atlanta, was chosen as the source of the new supply. The waterworks, completed in September 1876 at a cost of $226,000, had a daily capacity of two million gallons. A single sixteen-inch main conveyed water from the pumping station over a distance of approximately five miles into the city, and from there three additional miles of smaller mains fanned out to serve the business district. 23

The waterworks’ major purpose was to provide an increased volume of water for business and industrial needs and fire protection; it seems to have been no part of the plan to furnish citizens with a potable supply for drinking and household uses. The South River reservoir was fed by rain washings from the city’s natural drainage courses, which by the 1870s had become open sewers. The initial proposals for waterworks in the 1860s had emphasized the value of water for sanitary purposes, but the limited capacity of the waterworks was wholly inadequate for flushing the crude rock sewers built after 1873. Even for the main purposes it proposed to serve, the waterworks was inadequate the day it went into operation. The chances for obtaining sufficient pressure to combat fires were best at night when industrial use was minimal, but the pumping machinery often had to be repaired in the evenings because of the daily overload that was placed on it. 24

In the absence of a dependable municipal water supply, some well-to-do residents purchased drinking water delivered from Ponce de Leon and outlet springs, but the great majority of citizens continued to drink from public and private wells. The results of a study published in the Atlanta Medical Register in 1883 indicated that many wells were badly contaminated. The main sufferers were Negroes, whose relation to the city’s topography corresponded to their social status; their lots and wells received the drainage from the premises above, since the extension of sewer outfalls invariably stopped in black neighborhoods. The lack of pure, wholesome water combined with poor drainage in the hollows of the city led to increased sickness among the poor. The lower sections of the city were literally drained on from above by the downtown business area and the homes of the wealthy that occupied the higher elevations. 25 Commenting on the fact that the death rate among Atlanta’s Negroes in 1885 was two and a half times greater than that for whites, Mayor George Hillyer said, “I believe that if good clear water were supplied to all the lower
levels of the city, where so many of the colored people live, and their contaminated wells were all filled up and obliterated, a very marked change for the better would immediately appear."

In the great northeastern seaports that had developed upland water supplies the problem was more one of quantity than quality. Both the land area and the population of cities were growing enormously, adding new burdens to municipal water systems. In 1854-98, Philadelphia, Boston, and New York annexed much of the surrounding countryside. Philadelphia's annexation of Spring Garden, Kensington, and West Philadelphia in 1854 more than doubled its size; and the incorporation of Brooklyn, Queens, Richmond, and sections of the Bronx in 1898 placed an additional 1.5 million water consumers within the city limits of New York. Most of these suburban districts either did not have public water supplies or had inadequate waterworks that would have to be expanded.  

A rising standard of living for the urban middle class also exacerbated the water supply problem. Before the Civil War few persons enjoyed the comforts of indoor plumbing. Philadelphia, which had a reputation among travelers as the cleanest American city, had only 3,521 baths in 1849. New York in 1856 had 1,361 baths and 10,384 water closets in a population of over 630,000. By the late nineteenth century, private bathroom fixtures such as bathtubs, shower baths, and water closets were becoming standard items in new home construction and a necessity for the middle-class market, thus placing new strains on municipal water supplies.

Population growth, annexation of suburban areas, industrial demands, a rising standard of living, and wasteful water practices—all combined to render obsolete the expensive water supply systems of the eastern metropolises within a few years after their completion. Boston, New York, and Baltimore responded by enlarging the existing waterworks and by impounding new water supplies from relatively distant mountain watersheds. Municipal self-congratulations following the completion of this expansion were short-lived, however, because water consumption was growing faster than anyone had predicted and would soon threaten to exceed even the increased capacity of the waterworks. Cities had a seemingly insatiable thirst that could be quenched only by the tapping of still larger and more distant watersheds.

Within ten years after completing the Croton Reservoir system, New York City was confronted with the first of many water shortages that would occur intermittently for the next hundred years. In the early 1860s the capacity of the waterworks was increased from 42 million gallons a day to 72 million gallons, and a billion-gallon reservoir was constructed in Central Park. These extensions, however, were not sufficient, as became apparent in 1870 and 1880 when the city suffered severe droughts that sharply decreased the availability of water from the Croton River. During the hot summer months public water was available only on the first stories in tenement buildings. Many persons were forced to resort to wells. Consequently, in both years the typhoid fever death rate in New York City climbed sharply to more than 40 per 100,000 population. In 1885 construction began on the New Croton Aqueduct. Completed in 1893, it had a capacity of 300 million gallons a day, which together with the old Croton waterworks and other improvements gave the city a daily supply of 425 million gallons. Since the average daily consumption was only 183 million gallons, there appeared to be ample margin for future population growth. But city leaders had not counted on the expansion of the city's boundaries in 1898, nor could they foresee the enormous tide of immigrants that would inundate New York from 1885 to 1914. In a characteristically bold decision, New York in the early 1900s decided to tap the Catskill Mountains watershed 100 miles to the north. Even when that project was completed, the city still had to search for new water sources.

In Philadelphia city officials made an unwise decision to enlarge the Schuylkill waterworks despite that waterway's growing pollution. Proposals that water from upland streams some twenty-five to thirty miles away be impounded and brought to the city by an aqueduct were rejected because of the expense involved. As a result, Philadelphia suffered the notoriety of having one of the highest typhoid fever death rates in the country.

Even good water supplies could become accidentally polluted, as was demonstrated by the typhoid fever epidemic that struck the small mining community of Plymouth, Pennsylvania, in 1885. The epidemic was notable for its severity and for its influence in awakening Americans to the need for treatment of public water supplies. The river that supplied Plymouth's water ran through a mountain wilderness and was known for its purity. However, a man who occupied one of the few houses in the watershed area had contracted typhoid fever while in Philadelphia for the Christmas holidays. He returned home on 2 January 1885 and remained ill with the disease until the middle of April. During the course of his illness his excreta were cast without disinfection upon the snow and frozen ground within a few feet of the edge of a bank overlooking the river. Throughout January and February the excreta remained trapped on the frozen earth. But during the first week of spring there was a thaw, and on 4 April the temperature climbed to seventy degrees. As the snow and ice melted, accumulated excreta from many weeks were washed into the river, carrying with them the still potent typhoid bacilli. The first case of typhoid fever in Plymouth occurred on 9 April. Within a week, from 50 to 100 cases were appearing daily in all parts of town and among all classes of people. By
the time the epidemic had run its course, 1,104 of the town's 8,000 residents had been stricken, 114 of them fatally.31

Plymouth's tragic experience stimulated American interest in new methods of water purification. Some water supplies were already undergoing treatment in slow sand filters, in which water was percolated through a bed of sand and gravel to remove suspended matter. During the 1860s the city of St. Louis, searching for a means of making its water supply less turbid, had sent James F. Kirkwood to Europe to investigate the latest methods for clarifying river water. His classic Report on the Filtration of River Water appeared in 1869. Although St. Louis rejected Kirkwood's proposal for building a filtration plant on the Mississippi River, several other cities went ahead with the construction of slow sand filters based on his designs. The first slow sand filter plant was built in Poughkeepsie, New York, in 1872. The plant's primary purpose was aesthetic—to improve the water's clarity, taste, and odor.32

It had long been suspected on the basis of statistical investigation that polluted water was responsible for the transmission of cholera, typhoid fever, and other waterborne diseases, but conclusive evidence was lacking until the development of bacteriology and the germ theory of disease. No one had ever looked through a microscope at the microorganisms responsible for these diseases, much less demonstrated that the tiny organisms were the sole cause of the illnesses. Finally, in the 1880s Robert Koch provided the long-awaited laboratory proof that microorganisms were responsible for many of these most fearful diseases. The cholera vibrio and the typhoid bacillus were soon discovered and were shown to be transmitted through any medium that provided a circuit between an infected excreta and a healthy intestine. Studies made in the United States in 1883 by William Ripley Nichols of the Massachusetts Institute of Technology and Dr. Morton Prince of Boston similarly pointed to the dangers of fecal contamination and the value of filtration in cleansing water.33

By the 1880s several American cities were involved in some form of research on filtration. The Lawrence (Massachusetts State Board of Health) Experiment Station was the leading research center in water purification and the one that placed the practice on a sound scientific footing. The station housed a brilliant staff of sanitary engineers, chemists, and biologists who pioneered the interdisciplinary approach to the study of water purification and sewage treatment. One of the important discoveries made at this laboratory was that improved slow sand filters could remove typhoid germs in river water supplies. In 1893 the experiment station built a slow sand plant for the city of Lawrence, which had suffered unmercifully in the past from typhoid fever. The effectiveness of the plant was immediately apparent. The typhoid fever mortality rate in

Lawrence dropped from an average of about 120 per 100,000 population in the years 1887-92 to an annual rate of between 20 and 30. By 1900 about twenty cities had constructed slow sand filters.34

Within a few years rapid sand or mechanical filters replaced slow sand filters in the United States. Experiments revealed that the mechanical filters were better suited for removing dirt and clay and the bacteria that adhered to them. This feature was especially important in the Midwest, where the rivers were highly turbid. In addition, mechanical filters were easier and less expensive to clean. Slow sand filters required frequent scraping and washing, whereas the mechanical filters could be cleaned by reverse flow, eliminating an important labor cost. In 1902 Little Falls, New Jersey, installed the first large municipal mechanical filter.35

In the first two decades of the twentieth century several significant advances were made in water treatment. Water plants added sedimentation and coagulation basins to remove suspended matter from the water before it was sent to the filters. The annoying problem of algae in stored water, which caused water to have a "fishy" taste, was overcome by the addition of copper sulfate. Most important, chlorine was found to be effective against pathogenic microorganisms. In 1908 the privately owned Jersey City Water Company at Boonton Reservoir began the first continuous chlorination of an urban water supply to disinfect the suspect water of the Rockaway River.36

The development of scientific methods of filtration and disinfection increased the water options available to cities. Some cities abandoned their polluted water supplies for clear mountain streams. A few fortunate communities, notably Memphis, discovered that they were located on huge aquifers that could supply pure water at little expense. Most cities, however, did not have alternative water sources available to them and had to rely on filtration and disinfection to make their water supplies safe.

It was usually futile for cities to attempt to prevent the pollution of commercial waterways, as will be seen in the case of Newark. A few cities, such as Milwaukee, that were drinking water contaminated by their own sewage built sewage-treatment plants, but this approach was usually rejected because of the high cost. Cities that invested a great deal in impounding mountain streams were compelled to protect their purity, most often by instituting sanitary patrols of the watershed and by removing leaking privies and other nuisances from the area. Of course, Chicago's solution, to rid Lake Michigan of pollution by reversing the flow of the Chicago River, was unique.

Local conditions, such as the topography of the city and its drainage system, its size and financial condition, and the water sources it could tap, determined how each city responded to the water crisis. In Newark there was strong
Financial incentive for maintaining the existing waterworks. The Passaic River plant had been built at a cost of more than $1 million, which was about the amount of Newark's total tax appropriations for 1880. The cost of a new water supply was estimated at between $2 million and $4 million. Rather than undertake such an expensive project, Newark and Jersey City adopted a plan for cleansing the Passaic River and making it safe for drinking once again. The plan had its genesis in a water scare that struck Newark in 1880. Complaints were received from all sections of the city that the water smelled like cresote, tasted bad, and was discolored. Upon investigation, inspectors discovered that carbolic acid from the Kingsland Paper Mill on the Third River, some two miles above the Newark intake, was contaminating the water. An indictment was brought against the mill for creating a public nuisance, and the company was forced to stop discharging its wastes into the river. Encouraged by this success, Newark and Jersey City joined forces to prevent further pollution of the Passaic. On 27 October 1861, the Board of Inspection of the Pollution of the Passaic River and Its Tributaries, composed of members of the water departments of Newark and Jersey City, was organized. The board established a sanitary patrol to achieve its goals, undertaking its task with much fanfare and great promise. The chief engineer of Jersey City confidently predicted that in a few years the water would return to its original state of purity and both Jersey City and Newark would "have the best, purest and most abundant source of water supply of any city within 500 miles." 

The board's accomplishments during its first years of operation gave grounds for the optimism of its supporters. In 1884 the board reported that the rigid inspection of the stream has succeeded in keeping it free from [the] carcasses of dead animals, from its being used as a dumping place for night soil, offal and refuse of all description. It has caused the removal of closets and drains which formerly carried the excreta of thousands of [mill and factory] operatives and river bank inhabitants directly into the Passaic or some of its tributaries. It has caused the smaller communities located on Second and Third rivers to give up the project of converting these streams into sewers, and instead to resort to systems of sewage utilization. . . . It has caused so large a community as that of the town of Passaic to seriously consider the problem of disposing of its sewage by a method which should return the effluent waters in a purified condition to the Passaic.  

Yet the board's efforts in combating the contamination of the Passaic River were largely unsuccessful. In 1880, the population of the lower Passaic River Valley was 250,000; by 1918 it was 800,000. Communities such as Passaic and Belleville, which the board hoped would use other methods of sewage disposal, found it easier to empty their wastes into the nearby Passaic River or its tributaries. Cities that had always used the Passaic for this purpose, such as Paterson and Newark, contributed ever-increasing amounts of waste. 

After some initial successes, the board was unable to prevent factory owners from polluting the river. "Legal notices and warnings are unheeded by them," reported Thomas W. Leeds, river inspector for the board of pollution, "and it will be a useless task for me to try to stop them until legal action is instituted against them." Civil proceedings were slow, and when the board threatened to bring criminal action against polluters, the owners banded together, "determined to sustain one another in the event of criminal action being instituted against any of them." 

While city officials tried to determine a course of action, the citizens of Newark coped as best they could with the situation. Many physicians advised their patients to filter and boil public water before using it, and thousands of Newarkers never drank Passaic River water under any circumstances. In its place they drank well water (which usually was polluted), spring water, distilled water, mineral water, aerated beverages, and beer. One popular beverage, Poland Spring Water, sold for the exorbitant price of eight dollars for forty gallons. Citizens spent about $250,000 annually for water substitutes, enough to pay the interest on the debt that would be incurred in obtaining a new water supply. 

The fortunes of Newark's largest water consumers, its extensive industrial establishments, were inexorably bound up with the water crisis. Newark's sizable lager beer industry, in particular, was threatened by lack of suitable water for brewing. In 1885 the president of the Board of Trade warned that Newark could never attain commercial eminence while the threat of pestilence cast a shadow over it. In 1889, largely because of pressure from the business community, Newark gave up on the Passaic River and contracted with a private aqueduct company to deliver water from the Pequannock River, an upland tributary of the Passaic. 

The abandonment of the Passaic brought a marked improvement in Newark's health. The death rate from typhoid fever in 1891, the last year Passaic River water was used exclusively, was nearly 80 per 100,000 population. In 1893, the first year that Newark relied solely upon Pequannock River water, the rate dropped to 30 per 100,000 population. Similarly, the typhoid mortality rate in Jersey City was cut by two-thirds after its adoption of a new water supply in 1898.
Chicago, which had a reputation for audacity, attempted to solve its water supply problem by sending its wastes to the Mississippi River. Following a water scare in the summer of 1879 in which sewage was discharged into Lake Michigan for thirty consecutive days, the Citizens’ Association of Chicago, an organization of prominent businessmen, appointed a Main Drainage Committee to find a permanent solution to the water problem. The association echoed the attitude of civic boosters everywhere—what was good for the country was good for business. A dependable water supply would improve Chicago’s business climate and thus ensure the prosperity of its citizens. In December 1880 the committee recommended the construction of a new and larger drainage channel paralleling and replacing the Illinois and Michigan Canal to increase the current in the stagnant Chicago River.

The proposed drainage canal was widely supported. City and state public health officials endorsed it, as did sanitary engineers. Leading Chicago social and business groups lobbied for the canal before the Illinois legislature, and the newspapers kept the subject constantly before the public. The Chicago medical profession was almost the only group with an interest in the canal who did not actively support it. At the time, physicians were not esteemed by the general public because they were unable to treat most illnesses and they were too preoccupied with trying to proscribe the practice of sectarian medicine to take much of a role in public health issues. Physicians were more interested in treating illnesses than in preventing them.47

In 1889 the Illinois legislature established the Chicago Sanitary District and created a public authority to finance, build, and maintain the canal. The authority was given sanitary jurisdiction over all of Chicago north of Eighty-seventh Street and some forty-three square miles of Cook County outside the city limits.48 In a combined referendum and election of sanitary district trustees held shortly thereafter, Chicagoans demonstrated their nearly unanimous support for the canal by a vote of 70,958 to 242.

Law suits, political fights, and administrative tangles delayed work on the canal until 1892. In the meantime, Chicago experienced the worst typhoid fever epidemic in its history. In 1890-92, the disease killed 4,494 persons. During the twelve-month period from April 1891 to April 1892, it accounted for 2,400 fatalities and probably at least 23,000 illnesses. Chicago’s typhoid fever death rate in 1891 climbed to 159 per 100,000 population, second highest in the nation.49

To guard against pollution while work on the canal proceeded, a new water crib was built four miles from the Lake Michigan shoreline in 1894. Finally, on 17 January 1900 the Chicago Sanitary and Ship Canal was opened. Twenty-eight miles long, twenty-four feet deep, and built at a cost of $45 million, the canal markedly improved the quality of Chicago water. But some of the city’s sewers along the lakeward continued to drain into Lake Michigan, and bacteriological examination of water specimens revealed that even a four-mile water intake did not provide complete protection. In 1902 Chicago experienced another epidemic of typhoid fever, which claimed the lives of 801 persons.50

Chicago’s vulnerability to typhoid epidemics in the early 1900s made it clear that the building of the sanitary and ship canal had not ended the pollution of the city’s water supply. In 1910 an intercepting sewer was built along the shoreline to reroute the area’s sewage. In 1912 Chicago began experimenting with chlorination and four years later chlorinated its entire water supply. At long last the city had solved its water supply problem. The typhoid fever mortality rate, which had averaged 67 per 100,000 in the 1890s was reduced by 80 percent over the next twenty years as pollution of Lake Michigan abated; the death rate fell to 1 per 100,000 in 1919 after chlorination came into use.51

In 1889 a committee of businessmen and public officials asked the noted sanitary engineer, Rudolph Hering, to study Atlanta’s water needs. Hering’s report recommended that Atlanta abandon the polluted South River for a copious supply of pure mountain water to be drawn from the Chattahoochee River. In 1891 the city purchased a 100-acre site for a pumping station on the Chattahoochee River above the mouth of Peachtree Creek and another site for a 176-million-gallon reservoir and relay station at an elevated point 3.5 miles from the city. On 29 September 1893, the new system went into operation and furnished a capacity of 20 million gallons per day.52 The opening of the Chattahoochee plant did not end the city’s water crisis. When the water came into the reservoir it was badly discolored by red clay particles. While the Chattahoochee River was relatively free of fecal contamination and other harmful wastes, it was filled with sand, necessitating that its waters be treated before being piped to Atlanta residents.53

Even worse than dirty water was no water at all. Throughout the years 1900 to 1910, the building of water mains and sewer lines failed to keep pace with the city’s rapid growth. In 1908, one-third of the city’s area and 40 percent of the population did not have water mains or sewers, a condition that the chamber of commerce described as being “worse than the plague-stricken cities of the middle ages.” Moreover, it was the richer, less populous areas that enjoyed modern sanitary facilities. Streets without water averaged 32 houses to the mile, whereas those with water had 104 per mile. In the absence of sewerage and running water, large numbers of Atlantans were forced to rely upon surface privies and wells, most of which were polluted. In addition, Atlanta had no sewage-treatment facilities. Trunk sewers took the bodily wastes of 80,000 persons to or near the city limits, where the untreated sewage
was dumped into streams. Because of these unsanitary conditions, the city continued to suffer greatly from waterborne diseases. From 1906 to 1910, Atlanta had an annual typhoid fever death rate of 62.1 per 100,000 population, second highest in the nation of any city of over 100,000 population.54

Atlanta's new reputation as an unhealthy city led the chamber of commerce to lobby for major improvements in the city's water supply and sewerage. Commenting on the importance of public health to a city's economic welfare, the chamber noted that it is only within the recent past that the interest of the community, in a financial or commercial sense, in the health of the individuals composing it has been aroused. Formerly the health question was viewed from the selfish standpoint of the individual or the family . . . But now municipal governments have come to realize that to them the general health is just as important and profitable as to the individual. With communities, as with individuals, it has developed that it is impossible to prosper without health, as it is to build a house without a foundation.55

In 1910 city officials proposed a $3 million bond issue, of which they earmarked $900,000 for the waterworks and $1,350,000 for sewage-disposal plants. In the months preceding the referendum, the chamber of commerce, with the blessings of Mayor Robert Maddox, waged an all-out fight for the bond issue. To spearhead the campaign, the chamber appointed a special bond committee with a war chest of $3,500. The chief efforts of the committee were directed toward registering voters and getting them to the polls on election day. The chamber of commerce was responsible for registering voters among the commercial classes. The Atlanta Federation of Trades was assigned the workingmen, and the Federation of Women's Clubs did the door-to-door canvassing. Everyone in Atlanta was listed according to occupation and assigned to an organization for registration. The chamber of commerce alone had thirty-two committees at work canvassing business houses and boasted that "no campaign in Atlanta's history was ever more systematically made. Each ward is divided into districts and every street is pushed by committees." The chamber's efforts paid off handsomely. On 1 February, by the lopsided tally of 8,409 to 66, voters approved the bond issue.56

The new waterworks and sewerage facilities built with the bond money resulted in a dramatic improvement in the city's public health. As city water and sewerage became available, citizens abandoned wells and surface closets (although 4,000 surface closets were still in use in 1917). From 1911 to 1916, the typhoid fever death rate fell from 56 to 17 per 100,000 population, a 70 percent reduction.57

Thus during the years 1860-1920 American cities succeeded in developing waterworks that provided safe and plentiful water for nearly all their inhabitants. The United States Public Health Service estimated that in 1923 nearly 31.5 million persons, or about 97 percent of the residents of the nation's hundred largest cities, used public water supplies; the remaining 3 percent were largely dependent upon private wells. A little over two-thirds of the cities' residents were furnished with surface water (open rivers, impounded streams, and lakes), one-fourth used mixed surface and groundwater, and less than a tenth used groundwater alone.58

The decline in the typhoid fever death rate attested to the progress made in safeguarding urban water supplies. During the decade of the 1880s, the forty-seven American cities with populations of 100,000 or more had an average typhoid fever death rate of 58 per 100,000. In 1923 the typhoid fever death rate for the nation's largest cities was 3.6, reflecting substantial advancement not only in the quality of public water supplies but also in general sanitation.59

As indicated in Figure 2.1, all but thirteen of the one hundred cities surveyed by the United States government adopted their existing water supplies after 1859, a majority of them in the years 1860-99. Purification of water supplies came largely in the period 1900-1920. In 1880 only 30,000 Americans drank filtered water. By 1923 the only water that was not undergoing some form of purification was the groundwater found in deep artesian wells, which, because of its natural purification while in the ground, was safe to drink raw. Filtration was the primary method of treatment, while chlorine was used for disinfection.60

Businessmen spearheaded the fight for improved urban water supplies, a commitment prompted by both economic necessity and civic pride. They realized that, without a copious supply of clear water, industry would be threatened. There would be insufficient water for cooling, for producing steam, and for washing away filth. The threat of conflagration would grow, increasing the cost of obtaining fire insurance. The industrialists of each city, moreover, saw themselves bound together in competition with businessmen in other communities and were anxious that their city project an image of progress and modernity. A city with dirty streets and unflushed sewers was aesthetically offensive, a reproach to city boosters, and a poor advertisement.

Public health authorities vigorously supported the adoption of better water supplies, especially after the 1880s when the link between impure water and high urban death rates was firmly established. Initially some health officials
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had been reluctant to condemn the use of polluted water supplies because of the widely held belief that running water purified itself by oxidation after a few miles of flow. Furthermore, the discovery that diseases were caused by living organisms cast doubts on the value of chemical analysis in determining the safety of water supplies. Chemical examination of a water supply reveals the presence of organic matter or its constituents and thus is useful in detecting fecal contamination, but it will not reveal the presence of harmful microorganisms. The development of bacteriological methods of testing water and the accumulation of both statistical and laboratory evidence of the waterborne transmission of some major diseases gave public health officials greater confidence in calling for the abandonment of polluted water supplies. Finally, the general public overwhelmingly approved new water supplies in special referendums because they began to understand that pure water, in addition to its importance for health, was essential for cooking, washing, bathing, and other daily activities.

By impounding mountain streams, by bringing up water from beneath the ground, and by treating and disinfecting surface waters, Americans had secured safe, dependable water supplies for their cities. They did so, however, at the expense of nearby streams and lakes, which received ever-increasing loads of sewage and industrial wastes. For example, after Newark abandoned the Passaic River for its drinking water, the river's condition grew worse, since the incentive for protecting its purity had been removed. By 1894 the Passaic River had all the characteristics of an open sewer.53

Whipple believed that the loss of rivers for public use and the damage done riverfront property interests would inspire cities and industries to begin purifying their wastes. In a statement remarkable for its prescience he warned that unquestionably many American streams are being rapidly spoiled, and before it is too late much energetic work ought to be done to prevent this. Stream pollution is the result of the prosperity of our cities, but if by increasing our capital in the form of mills and factories, we decrease it in the form of natural water resources, we are not, as a nation, growing rich as rapidly as we think.54

Although a few persons voiced concern that society would suffer an incalculable loss if the recreational uses of its waterways were destroyed by pollution and although research was conducted on the treatment of effluents, little was done to prevent stream pollution. As long as environmental quality was regarded as a free resource, people would use the atmosphere and the waterways as receptacles for waste products. Efforts to protect rivers and lakes from
despoliation were doomed to failure by the widely held belief that the waterways should be utilized in the ways that best served their immediate economic interests. Moreover, the lack of a national uniform standard of stream pollution placed states with tough pollution laws at a competitive disadvantage alongside states with few restrictions in attracting industry. Because stream pollution was a state responsibility and because industries were mobile, officials refrained from prosecuting polluters for fear that they would move to another state. Even those states that boasted sewage-research facilities and regulatory agencies for protecting the purity of streams, either tacitly or openly permitted delinquency of their great waterways.63

In the years 1850 to 1930, American cities scored one of their greatest triumphs in making available pure and abundant water to millions of urban residents. Few individuals, however, thought beyond the current health and business needs of society and, as a consequence, the pollution of the nation’s waterways was allowed to go unchecked. Perhaps now, in view of mounting concern about the harm being done to the environment by uncontrollable growth, we will recognize our duty to posterity to pass on an unspoiled condition the natural wonders that are our rivers, lakes, and oceans.

Notes


4. Ibid., pp. 76–77.

5. Ibid., p. 26; APWA, History of Public Works, p. 218.


15. George B. Bailey, Report to the Newark Aqueduct Board upon the Subject of a Supply of Water for the City of Newark (Newark, 1861), pp. 23–24, 43; George B. Bailey, Report of the Nework Aqueduct Board (Newark, 1871), pp. 4–5.

16. Albert L. Lees, Shall We Continue to Use the Sewage Polluted Pecan? or Shall We Get Pure Water? (Jersey City, 1887), pp. 13–14.


19. Ibid., p. 163.


25. Atlanta Constitution, 5 September 1883, 30 January 1885; “Annual Report of the Committee on Wells, Pumps, and Cisterns for the Year 1878,” in Minutes of the City Council of Atlanta, City Hall, Atlanta, Georgia, vol. 9, n.d.


29. Blake, Water for the Cities, pp. 276–82; Whipple, Typhoid Fever, p. 276; APWA.
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60. USPS, Municipal Health, pp. 467-69, 474-77.
62. Whipple, Typhoid Fever, p. 266.

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60. USPS, Municipal Health, pp. 467-69, 474-77.
62. Whipple, Typhoid Fever, p. 266.