1

Sanitation Practices in Pre-Chadwickian America

Prior to the 1830s, many American cities faced poor sanitary conditions and suffered crippling effects of epidemic disease. Few communities could boast of well-developed technologies of sanitation, and much of the responsibility for sanitation rested with the individual.

As England urbanized and industrialized in the eighteenth century, provincial urban communities only began to challenge the rural-dominated North American landscape. Colonial towns and cities grew in political, social, and economic importance, but only modestly in size and number.[1] The 1790 federal census showed that city dwellers represented less than 4 percent of the nation's population, and only two cities exceeded 25,000. Philadelphia (42,520) was the largest city in a country with just twenty-four urban places. By the end of the 1820s, the urban population had almost doubled, although fewer than 7 out of every 100 Americans lived in cities or towns.[2]

The limited scale of American urbanization does not mean that cities faced few health risks or that communal sanitary services were unneces-

sary. In the largest cities, the rate of growth was a key factor in stimulating concern about health and sanitation. New York, Philadelphia, Boston, and Baltimore experienced impressive rates of growth in each decade between 1790 and 1830.

Along with growth, European sanitation practices helped shape the initial American responses to water-supply, sewage, and refuse problems. Local circumstances affected the timing of new sanitary service delivery, but the forms and methods traveled across the Atlantic with the colonists or were borrowed directly from Europe.

While American urban communities seldom faced sanitation problems on a par with their European counterparts in these years, public and governmental perceptions and reactions were quite similar. Few people had an inkling about the causes of disease and illness. Individuals or private scavengers were usually responsible for disposing of wastes. And the role of government in protecting the community's health, guarding against the ravages of fire, cleaning streets, and providing pure water was obscure and untested in all but the largest cities.[3]

If American towns fared slightly better than European urban areas, it probably had more to do with less crowded conditions than with an enlightened outlook about sanitation. The "healthiness" of American towns was a matter of degree, however. Tolerance for nuisances and the almost serendipitous occurrence of epidemic disease played major roles in determining the sanitary quality of the communities. As late as the 1860s, Washingtonians dumped garbage and slop into alleys and streets. Pigs roamed freely, slaughterhouses spewed noxious fumes and effluent, and vermin infested dwellings—including the White House.[4] Few towns and cities were free of nuisances, and showed little resolve to move against the "noxious trades"—soapmakers, tanners, slaughterhouses, butchers, and blubber boilers—especially if they were located in the poorer areas.

Animals resident in urban communities were a part of preindustrial life. Horses for transportation; cattle, hogs, and chickens for food use; and dogs and cats as pets roamed freely through many vacant lots, streets, and alleys. Pigs and turkeys, in particular, were widely accepted as useful scavengers. Manure and dead animals were simply annoyances balanced against the value of sharing space with contributors to the town's welfare.[5]

Epidemic disease was taken much more seriously than sanitation, especially since many colonists feared it as the wrath of God.[6] While the relative isolation of North America limited the number of epidemics in colonial towns, they were no less ruinous than those in Europe once they spread. Transatlantic trade and urban growth in the seventeenth and eighteenth centuries led to an array of infectious disorders, including smallpox, malaria, yellow fever, cholera, typhoid, typhus, tuberculosis, diphtheria, scarlet

fever, measles, mumps, and diarrheal disorders. Disruptive events, such as the Revolutionary War, reintroduced epidemics to major cities and towns.[7]

Smallpox was probably the worst of the early scourges, but while they were less frequent, yellow fever and diphtheria were as virulent. Yellow fever first attacked the Atlantic Coast in the 1690s, peaked around 1745, temporarily subsided, and then reappeared savagely in the 1790s in the port cities of Boston and New Orleans. In 1793, yellow fever took 5,000 lives in Philadelphia—one out of every ten residents. In 1798, the dread disease struck New York, killing 1,600 to 2,000 people out of a population of 80,000. By the 1820s, yellow fever virtually disappeared in northern states, but remained a chronic problem from Florida to Texas.[8]

The line between individual and governmental responsibility for responding to community needs was obscure through the early nineteenth century. Before then "the city was to be an environment for private money-making, and its government was to encourage private business."[9] In addition, at least until the political system was pressured to encourage wider participation, local government catered to the "better sort."[10]

Epidemics forced the government to deal with public health, at least from crisis to crisis, but the absence of regularized preventive action had to do with limited knowledge about contagious diseases. Previous experience became the best teacher. More affluent citizens, for example, could escape the city. In New York, about one-third of the 27,000 residents fled during the 1805 epidemic. The poor, who were unable to flee, usually suffered the most. To make matters worse, economic activity ground to a halt during epidemics as merchants and other business owners took flight, leaving workers at least temporarily unemployed. As the districts of the laboring poor grew, these became the focus of perceived threats to the city's health.[11]

Quarantining those who contracted or were suspected of contracting a disease was another method of reducing its spread. Massachusetts Bay Colony set up quarantining regulations as early as 1647 based on concern about the "great mortality" in the West Indies. Other communities lagged behind in passing such laws, and in many cases quarantine regulations were only temporary measures.[12]

Boston is often credited with authorizing the first permanent local board of health in the United States in 1797.[13] The threat of disease, especially yellow fever, stimulated some interest in permanent boards in other communities, but the few that were established often focused on nuisance abatement. Laypersons, especially the mayor and some council members, sat on the boards and rarely exerted much authority. Between 1800 and 1830, only five major cities established boards of health, and between the 1790s and 1830 all but Boston's were temporary.[14]

As late as 1875, many large urban communities had no health depart-

ments of any kind, partly because they did not have the authority to issue health regulations without approval from their state legislatures.[15] Equally important, until the mid-nineteenth century, was the peculiar relationship between epidemic diseases and the available means to control them. The propensity to regulate public health found greater sustained efforts in dealing with issues of nuisance. It was easier to visualize some sort of danger or inconvenience coming from noxious odors or putrefying wastes than from the mysterious appearance of yellow fever or smallpox.

Crude sanitary regulations were common in the American colonies by the late seventeenth century. In 1634, Boston officials prohibited residents from throwing fish or garbage near the common landing. Between 1647 and 1652, the local government passed other ordinances, including one that dealt with the construction of privies. In 1657, the burghers of New Amsterdam were among the first to pass laws against casting waste into streets.

Some effort was made to regulate the noxious trades by requiring butchers, tanners, and slaughterers to keep their property free of nuisances or by ordering the removal of slaughterhouses from the town limits. Between 1692 and 1708, Boston, Salem, and Charleston passed laws dealing with nuisances and trades deemed offensive or dangerous to the public. In New York City, the office of city inspector was established in 1804—the first permanent office concerned specifically with sanitation. Erratic enforcement of sanitary laws undermined the effort to protect the public health throughout colonial America, however, and continued to be a problem.[16]

New York City also was the first American city to establish a comprehensive public health code in 1866. In several ways, the courts provided an alternative remedy to municipal regulation. Much of the environmental law in the United States has been based on nuisance law derived from English common law. Nuisance law was primarily formulated from lawsuits relating to the use of land. Private nuisance action would lie where the defendant's unreasonable use of his or her property interfered with the reasonable use of the plaintiff's property. In the case of a public nuisance, an action could be brought against someone who obstructed or caused damage to the public in the exercise of the public's common rights. Private and public nuisance law had the capacity to abate specific sources of pollution instead of demanding a regulatory approach. Nuisance actions theoretically could be used to challenge individuals, municipalities, and industries relating to all manner of pollution.[17]

Throughout the nineteenth century, interpretations of nuisance were inconsistent. Before the Industrial Revolution—when the courts were more inclined to place economic concerns ahead of environmental issues—the application of nuisance doctrines could focus on strict property rights between individuals. Even in this period, the courts often were willing to protect the

growth and economic expansion of towns and cities by invoking the public nuisance doctrine against individuals in violation of local ordinances and by protecting local governments from lawsuits.[18] Before the 1830s, the idea of nuisance played a more important role in efforts to dispose of liquid and solid wastes than the fear of epidemics.

For much of the country, dependence on wells or nearby watercourses for water supplies, the use of privy vaults and cesspools for human and household liquid wastes, collection of refuse by scavengers, and dumping or burning of garbage, ashes, and rubbish provided adequate sanitary services. In low-density areas, these methods resisted change or outright replacement. The practices often were publicly regulated but rarely publicly managed.

As populations increased, such approaches became less workable. The result was the development of the first technologies of sanitation—"protosystems"—that emphasized more sophisticated technologies, were increasingly capital intensive, were publicly regulated and often publicly operated, and removed the individual from direct responsibility. Prior to the mid-nineteenth century, almost all protosystems in America were devised for water supplies.[19]

More than any other sanitary service, an efficient water-supply system was a key factor in the well-being of urban populations. "In the United States, at least until the end of the nineteenth century, the presence of potable water was a major consideration in the location of towns."[20] City leaders increasingly devoted attention to the delivery of water supplies as urban growth accelerated in the early decades of the nineteenth century.[21]

What was to be learned from Europe about developing an effective water-supply system was unclear prior to the mid-nineteenth century because the urban context was so different. Centralized systems—or large systems dominated by private companies—had grown up with several of the major cities of Europe. Some dated from Roman times or were influenced by the great aqueduct construction practiced by the Romans.[22]

Two technical advances made delivery of water more practicable in eighteenth-century Europe and prompted the emergence of new private water companies: the application of steam power to water pumping and the wider use of cast-iron pipes. The first steam-driven pump was said to be installed in London in 1761. In 1776, a company was formed to furnish Paris with water from the Seine through the use of a steam pump.[23] By the nineteenth century, the steam pump provided reliable power to complement or replace gravity systems and offered a way to increase the volume of water from its source to consumers.

The delivery of water through cast-iron pipes provided a durable, cost-effective, and technically manageable way to improve the distribution of water supply to individual structures. Aqueducts could get water to a city,

but provided no means to distribute it. Public wells were common, but did not solve the problems of transporting water to homes. Prior to the widespread use of pipes, cities relied on less-efficient means of distribution. Until the French Revolution, for example, the most common method for Parisians to obtain water was by dipping containers into the fountains in the public squares, or by "water carriers." Like Paris and other large cities, London relied on water carriers, especially for the houses of the affluent. The first significant use of cast-iron water pipe was developed to supply the Versailles Palace in 1685. In 1746, the Chelsea Water Works Company was probably the first to use cast-iron mains in London. Lead-pipe systems date back at least to thirteenth-century London, but lead was an inferior material with which to work, even without knowledge of its health hazards.[24]

Two events in late-sixteenth- and early-seventeenth-century London established England as a leader in citywide water supplies in Europe. First, in 1581 Dutch engineer Peter Morritz was granted a 500-year lease to construct waterwheel pumps on London Bridge to supply the city with water from the Thames. Some regarded this system as the first "modern" waterworks in London.[25]

A second key event was the incorporation in 1619 of the New River Company to supply water to individual houses. Water was brought to London from the River Lea and distributed through a network of wooden and then cast-iron pipes. The supply was superior to local, increasingly polluted sources. The success of the New River Company gave momentum to private enterprises organized to carry out public functions, and resulted in other companies.[26]

The early successes in providing water service in London were not sufficient to withstand some disagreeable impacts of the Industrial Revolution in the eighteenth century. The demographic shift in England at the time profoundly affected city growth and led to serious overcrowding in the major urban areas, with consequent health and pollution problems. As the world's first urbanized society, it was little wonder that England was the focal point for the development of good-quality water supplies to meet health and fire demands. In early-nineteenth-century London, rapid growth led to a frenzy among water companies scrambling to retain customers and to increase profits. Rapid construction in and around the city, and the refinement in pumping technology, made the business highly profitable for those who could capture the market.[27]

Between 1805 and 1811, five water companies were created by statute in London, and soon more joined them. Competition became so fierce that lines of rival companies were laid down in the same streets in populated districts, but not in sparsely populated areas. The battle for profits led to price wars, and by 1817 the eight water companies remaining in the competition

teetered on the brink of insolvency. They survived by dividing the supply by district and by agreeing to raise prices.

The experience in delivering water in other English cities was different. Local governments regarded water management as "too vital a matter to be left entirely to individual initiatives or to profit-seekers."[28] Several town authorities took much more direct control of water service than in London. Leeds, Derby, Macclesfield, Huddersfield, and Manchester all fought to promote public projects. But as the towns grew into cities, the ability of local government to deal effectively with water management became problematic.

Until the 1840s, Parliament was more inclined to rely on market forces than state support to provide water service. The ability of private companies to raise capital under the terms of enabling legislation also worked against management by local authorities who lacked the power for long-term borrowing. Also, the flight of wealthy citizens from town centers made it difficult to modernize water systems through public control.[29]

Unlike cities such as Manchester, which had struggled to keep local government at the center of water management, London had become "a bastion of private enterprise in the water industry."[30] The water monopoly, however, faced criticism for raising rates, limiting distribution, and providing what was perceived as poor-quality water. In 1821, the House of Commons appointed a Select Committee to investigate the state of the water supply in London, the first occasion when the city's water supply was examined as a whole.

The findings did not satisfy the complainants since the report stated that there had been improvement in the supply, that the extension of the supply for private use and as a precaution against fire was satisfactory, and that the quality of the water in general was superior to every other European city. No action was taken, and many believed that the companies effectively were "whitewashed." The quality of the water supply continued to deteriorate in London. In some cases, the sewage outfall on the Thames River drained close to where water was drawn for the city. The river was rapidly becoming an open sewer.

A Royal Commission was appointed in 1827, again to inquire into the quality of London's water supply. Despite several shortcomings that were discovered, the report issued the next year essentially reiterated the findings of the previous study. But the commission did recommend that the city protect the quality of existing viable sources and obtain new sources. The commission questioned Parliament's support for market solutions to the water-supply problem, but Parliament failed to take action to regulate the private water industry.[31]

Soon an engineering solution emerged to provide a technical fix to an

increasingly discredited system. In 1804, John Gibb built a successful slow sand filter bed at Paisley, Scotland, and in 1827 Scottish engineer and mill owner Robert Thom built a slow sand filter bed at Greenock, Scotland. Glasgow became the first town to have a piped supply of filtered water in Great Britain.[32] The Chelsea Water Works Company in London constructed a similar filter, and Thames water was run through the filter for the first time in January 1829.[33] The results were so good that the Chelsea filter beds became the prototype for what became known as the "English system." Soon they were adopted for the whole of London's water supply, and spread rapidly around the world. A primary aim of the filters was to reduce turbidity of the water to aid industries dependent on clear water, but the health value of filtration was unclear.[34]

With the completion of the Royal Commission's report and the introduction of slow sand filter beds, water supply as a major public issue temporarily dropped out of sight in England. The immediate impact of the English experience was to apply new technologies for more effectively delivering water to private homes and businesses. The quality of that supply, however, remained suspect.[35]

Not until the mid-nineteenth century did English experiences with water-supply systems begin to influence American cities. Prior to that time, most municipal officials did not detect problems that led them to seek alternatives to existing approaches. Many American towns and cities were on the cusp of change as the nineteenth century unfolded, but only under unique circumstances did water-supply protosystems begin to appear.

The fear of fire and epidemics was a great motivator for change. The old "bucket brigade" was grossly inadequate when whole blocks of homes and shops were endangered by fire. Prior to the completion of Philadelphia's system in 1801, it took the bucket brigade fifteen minutes to fill one fire engine with water; after the system was in place it took one and a half minutes.[36]

The hydrant became the modern symbol for fire protection, since it meant that water would be immediately available and abundant to fight a major conflagration. New York City, which earlier had taken a leadership role in fire protection, was slow in installing hydrants and did not do so before 1830. Hydrants made water quickly available for emergencies, but they also increased the use of water, making a large supply even more necessary.[37]

While the fear of fire always loomed, the startling impact of an epidemic increased public pressure for improved water supplies. Fear alone was insufficient to lead towns and cities to abandon traditional sources of water and familiar methods of acquiring it. A community needed a political commitment, fiscal resources, and access to new technology. Prior to the mid-nineteenth century, only about half of the major cities and towns had some

type of waterworks. Most of them drew their supplies from wells, springs, or ponds, and did not have extensive distribution systems, if they had any at all. The great majority of the waterworks were located in the Northeast, with considerably fewer in the Old Northwest and Upper South.[38]

Before the turn of the century, most cities and towns depended on a combination of water carriers, wells, and cisterns to meet their needs. Even during the first several decades of the nineteenth century, many larger cities and smaller towns continued to rely on local sources of supply. Unless they hired water peddlers, each citizen used no more than three to five gallons per day.[39]

While community-wide water-supply systems developed slowly in American cities, in 1801 Philadelphia became the first to complete a waterworks and municipal distribution system sophisticated even by European standards. The necessary health, economic, and technical factors converged to produce what became a model for future systems. The Philadelphia waterworks, however, was an anomaly, since it did not spark an immediate nationwide trend.[40]

Concern for health prompted the campaign for a waterworks in Philadelphia. Despite uncertainty in determining disease causation, the correlation between pure water and good health was nevertheless a driving force in dealing with epidemics. *Scott's Geographical Dictionary* described the water in the densest areas of the city as having "become so corrupt by the multitude of sinks and other receptacles of impurity, as to be almost unfit to be drank."[41]

Although the issue of finding a new source of water had arisen earlier in Philadlephia, ravaging yellow fever attacks in 1793 and 1798 led political and business leaders to form a watering committee to deal with epidemics. The consensus was that polluted water from wells and cisterns caused the fever, and that the city's private wells should be replaced by a community-wide system. The waterworks also could provide needed water to clean the streets, fight fires, and add to the aesthetic quality of the city through public fountains.[42]

After examining various options, the committee accepted the proposal of Benjamin Henry Latrobe. The English-born engineer was also a practicing architect, who later worked on the U.S. Capitol from 1802 to 1817.[43] Latrobe recommended a system to pump water from the Schuylkill River, and to distribute it through mains made of bored logs. He proposed that water would be moved by a steam engine along the river up to a tunnel running under the streets and then by gravity to a pump house at Centre Square in the city. Another steam engine at Centre Square would pump the water to reservoir tanks at the top of the building, and then gravity would distribute water through the rest of the system. He began work on the system in 1799 and

completed it in 1801.[44] Latrobe's aesthetics as an architect permeated the project. As one historian noted, "The Philadelphia Waterworks at Centre Square was an early example of Latrobe's influential neoclassical architectural style. The building was admired for its proportions and use of Greek protoypes."[45]

Even after full operation, the machinery never worked as planned. The cost of the system was high, the amount of water pumped was limited, and recurring yellow fever epidemics in 1802, 1803, and 1805 alarmed the citizens. In 1811, the Watering Committee replaced Centre Square with a larger plant in a different location. The plan of engineer Frederick Graff, Latrobe's former assistant, called for a pumping station along the Schuylkill at the foot of Fairmount rise (beyond the city limits), with construction of a reservoir on top of the hill in the city. The new facility was completed in 1815. Steam pumps again were employed, but the waterworks converted to more reliable water power in the 1820s. The Fairmount Waterworks served Philadelphia until 1911.[46]

In distributing the water, the new system in Philadelphia first relied on wooden pipes and eventually on iron pipes. From the seventeenth century until well into the nineteenth century, wooden mains were commonly used in American cities. The first wood conduits were probably laid in Boston in 1652. Winston-Salem, North Carolina, purportedly built the first citywide system with log pipes in 1776. While rotting and leaking were chronic problems, wooden mains had one advantage—in case of fire a hose could be connected directly to the main simply by drilling a hole in it. (After the crisis had passed, a wooden plug could be driven into the main. This practice probably was the origin of the term "fire plug.")[47] Soon after 1800, cast-iron pipe was introduced into the United States from England. By 1825, cast iron was half the price of lead, and only one-quarter the price in 1850.[48]

Not without its flaws, Philadelphia's waterworks was considered by many to be the most advanced engineering project of its time. Ultimately, Philadelphia had a system with a much greater capacity than existing demand, unlike comparable cities such as New York, Boston, and Baltimore.[49] To promote its use, citizens were initially offered free water for several years. Despite the fear of epidemics, many citizens had not been completely convinced to give up "their cold well water for the tepid Schuylkill water." By 1814, however, 2,850 dwellings were receiving water from the new system.[50]

The example of Philadelphia constructing a major waterworks was widely publicized, but a national trend in municipal, citywide waterworks was not evident until late in the century. Inexperience in dealing with such a major project, in part at least, helps to explain why urban population growth exceeded construction of waterworks for so many years. In 1800, there were seventeen waterworks for an urban population of 322,000; in 1830, there

were forty-five waterworks for 1,127,000 urban Americans.[51] "Municipal governments in the nineteenth century were just emerging as effective governing bodies; often the decision to obtain a water system was the first major undertaking of a city government and the first which required a large initial outlay financed by bond issues."[52]

Rural-dominated state legislatures often attempted to check city growth by controlling services from the state capital or restricting the taxing and financing power of the city in its charter. Thus it was exceedingly difficult for cities to provide services, even when they accepted responsibility for them. "Home rule" for many cities did not become a reality until late in the century. Not surprisingly, almost every city and town initially turned to private agents or companies to supply water.

Private companies received franchises through the issuance of corporate charters, which was a typical way to generate public works activities in the eighteenth and early nineteenth centuries. Since few companies could meet the expectations of the cities for good service, plentiful and pure water, and low price, those who agreed to do so received franchises with substantial concessions. It was not unusual for a franchisee to get a long-term contract, exclusive rights to supply water, the right to acquire property by eminent domain, exemption from taxation, and other benefits.[53] In 1800, sixteen of seventeen (94.1 percent) American waterworks were private, and thirty-six of forty-five (80 percent) in 1830.[54]

In New York City, a freshwater pond had been the major source of supply even after 1800, while water from many private wells suffered saltwater infiltration and pollution from privy vaults, cesspools, and street drainage as early as 1750. In 1774, the Common Council contracted with an English engineer to build a municipal system using a steam engine to lift water into a central reservoir. The Revolutionary War derailed the project, and not until 1799—after a devastating yellow fever epidemic—was it renewed. City leaders realized that rivals Boston, Philadelphia, and Baltimore were building or were proposing to build waterworks.

Water quickly became the focus of a major political struggle. The council requested the legislature to provide it with special powers to establish a water system. Assemblyman Aaron Burr maneuvered to acquire a charter for a new private water company—the Manhattan Company—instead of supporting the development of a municipal system. The perpetual charter granted the company wide powers with few obligations, and Burr was intent on using the company to amass surplus capital in the hopes of building a banking business.

From the vantage point of water-supply service, the company was modestly successful. At its peak, it provided water for only one-third of the city, and was continually embroiled in controversy. Between 1801 and 1808, Burr

faced staggering political setbacks, including losing control of the Manhattan Company. He was dropped from the board in 1802, making way for the rise of his political rival, DeWitt Clinton.

Clinton soon realized that meeting the demand for citywide distribution of water was impossible with the existing system. Discussions about selling the company to the city became more frequent, but in the short term the charter was revised, and the company continued its favored position.

The deteriorating quality of the water supply weakened the Manhattan Company's hold on the city's water service. In 1825, a bill granting a charter to the New York Water-Works Company was enacted. Controversy over its charter, the lack of good supplies of pure water in the immediate area, and the pressure from the Manhattan Company and other rivals ended the short-lived venture. The basic requirements for good, accessible sources of water were not met until the completion of the Old Croton Aqueduct in 1842, which provided for the first workable municipal system in New York City.[55]

Boston also endured a long water-supply debate before it developed an adequate protosystem in the 1840s. From 1630 to 1796, the city derived all of its water from wells and cisterns, and the quality was "hard, highly colored, often odorous, saline, bad-tasting, and sometimes polluted."[56]

In 1796, Govenor Samuel Adams approved an act creating the Aqueduct Corporation, which built a line from Jamaica Pond in Roxbury to the city. The distribution network was extended in 1803, but it did not provide service for the entire community. There was no further attempt to improve the existing system until 1825, but civic leaders chronically argued over the water supply through the mid-1840s.[57]

The pattern in the Midwest, South, and elsewhere was similar to experiences in the Northeast. Some of the larger cities made the transition to citywide systems early, with most cities and towns following more slowly. Cincinnati was the first "western" city with a waterworks. In 1813, community leaders contracted to drill "possibly 30" public wells in a single season. However, an 1817 ordinance chartered the Cincinnati Manufacturing Company to develop a system, one of the earliest such concessions granted. In 1839, the works was sold to the city. At the time of the purchase, the property only consisted of a pumping station and reservoir grounds. The company had run into financial trouble in the intervening years, and chronic problems in meeting its obligations stimulated distrust of the company and kept alive the possibility of public control.[58]

The St. Louis Water Works was built in 1830. In 1821, a general concern about fire hazards led to a demand for a better water supply. Finally, in 1829 the city council offered a $500 prize for the best plan. Within a short time the city signed a contract with Wilson and Company, and the work on the

installation began in 1830, but water did not move through the pipes until the 1840s.[59]

Benjamin Latrobe brought his innovations from Philadelphia to New Orleans, which was on the brink of a major growth spurt. His plan was to secure a franchise for himself and his investors to turn a profit from the sale of water. The New Orleans waterworks was similar to Philadelphia's in several respects. A steam engine would pump water from the Mississippi River through a pipe into six elevated wood reservoirs. Gravity would carry the water through a combination of wooden and iron pipes. Benjamin's son, Henry, completed drawings of a fountain, which was never built, along the riverfront square.

Benjamin Latrobe was known for accepting projects that he was not immediately prepared to undertake. And since he was occupied in the Northeast, he sent Henry to the Crescent City in 1811 to begin the work. He himself did not arrive on the scene until 1819. Aside from the English engineer's absence, technical setbacks, and problems with investors, the Latrobes also had to contend with the disruption of the War of 1812. To his credit, Henry kept the project from unraveling. But in a major blow to his father and to the project, young Henry succumbed to yellow fever in 1817. Until Benjamin arrived in New Orleans, one of Henry's associates took charge. Upon completion of most of the work on the waterworks, Benjamin himself apparently contracted yellow fever and died. Within a year, the New Orleans Water Works Company, struggling to survive, was sold to the city. This project was Benjamin Latrobe's final engineering legacy.[60]

The technical achievements in developing early water-supply protosystems had some bearing on levels of consumption in the early nineteenth century. The new systems, however, did not provide for equity of service. In the mid-1820s, Cincinnati had more than 26,000 feet of wooden pipes, but served only 254 industrial and home users. At the time, the daily consumption of water probably averaged between three and five gallons per person, with higher consumption by those who could afford to purchase additional supplies.

For all the improvements begun by private companies through franchises, accessibility to water supply was still largely linked to class. Affluent neighborhoods and the central business district received the lion's share of water, while the working-class districts often relied on polluted wells and other potentially unhealthy local sources.[61] As historian Sam Bass Warner Jr. suggested, "Philadelphia, as the pioneer in waterworks, was the first to discover that to bring a water pipe to the sidewalk was still a long step from installing taps, toilets, or tubs inside the houses. For the urban poor, a generation and even longer elapsed before owners of slum properties installed plumbing."[62]

Despite the limitations of the new water systems, the few American cities that turned to community-wide approaches set patterns for modern sanitary services of the near future. Protosystems were precursors to more elaborate centralized systems adopted by the late nineteenth century. As in England, the application of these new technologies ran ahead of an effective understanding of the causes of disease and pollution, while they nevertheless attempted to enhance the healthfulness of the city and provide better protection against fire.

In the case of waste disposal, there was little or no linkage at this time between the search for a pure and plentiful water supply and methods of eliminating an array of rejectamenta and effluvia. Waste disposal had yet to rise much above the level of nuisance in the eyes of the public or city officials. In dealing with waste, Americans relied on approaches that had been commonly practiced in Europe for many years. Before the mid-nineteenth century, few large American or European cities constructed drainage systems and refuse-disposal facilities on a par with the great civilizations of Babylon, Mesopotamia, Carthage, or Rome. The ancient societies with the most highly developed sanitary systems offered large and dispensed services through hierarchical authority, but services were not equally distributed among the classes.[63]

Americans adopted Old World methods, focusing on individual responsibility for disposal of wastes as befit the circumstances of the country's urban centers prior to 1830. Cesspools, manure pits, and the pail system for removal of waste from privy vaults met local needs in much of Europe until the nineteenth century. Sewerage was primarily utilized for drainage rather than carrying wastewater. Sewers, if they existed at all, were mostly open ditches.[64]

The earliest mention of sewers in England dates back to the fourteenth century, but these were simply drainage ditches.[65] Prior to 1700, London had no sewers of any kind. In theory, cesspools or cesspits were viewed as the proper receptacles for excrement, and sewers were channels for surface water.[66] But in practice this did not occur. Until 1815, it was illegal to discharge waste other than kitchen slops into the drains of London. If deposited on land, much of the wastes could eventually flow through ditches along with rainwater or through covered and walled streams.

The introduction of the first water closets in England in 1810 offered city dwellers a more convenient—and seemingly more sanitary—method of disposing of human waste. This technical wonder encouraged greater use of water and, when linked to cesspools, reduced the effectiveness of the cesspools. Because of the volumes of water utilized, cesspool waste did not percolate into the soil but overflowed the cesspools and found its way into the streets and city drainage systems.[67]

Progress in refuse collection and disposal fared little better than sewerage before the nineteenth century. While the English Parliament banned waste disposal in public watercourses and ditches, the practice continued. Until the fourteenth century, Parisians were allowed to cast garbage out of their windows, and although several attempts were made at collection and disposal, the mounds of waste beyond the city gates were so high by 1400 that they obstructed the defense of the city. The plagues that invaded Europe between 1349 and 1750 provided some inducement for better sanitation, but responsibility largely remained an individual matter until the 1800s.

One significant improvement for better refuse collection and disposal was the practice of paving and cleaning streets, which began as early as the twelfth century. Paris started paving its streets in 1184 when, according to contemporary accounts, King Phillip II ordered the streets paved because he was annoyed by the offensive odors from the mud outside his palace. In 1415, Augsburg was the first city in Germany to pave its streets. Street cleaning at public expense came sometime later—in Paris, not until 1609. In the German principalities, street-cleaning work was frequently assigned to Jews and to servants of the public executioner. But street paving and cleaning, like other sanitary services, were often confined to commercial thoroughfares or affluent neighborhoods.[68]

Drainage and the disposal of liquid wastes fared similarly in America as they had in Europe. What historian Joel A. Tarr has called the "cesspool–privy vault–scavenger system" dealt adequately with the disposal of human and household liquid wastes in many communities until they experienced rapid growth or seriously altered the disposal system by introducing running water, which inundated the cesspools and privy vaults.

Human waste occasionally was deposited in leaching cesspools, but more often in privy vaults in cellars or close to the house. Privy vaults were relatively small, and were either covered with dirt when filled and replaced or emptied by the individual or by private scavengers. Most city ordinances required that the vaults be emptied at night, thus the term "night soil" became a euphemism for human waste. The privy vault disposal method operated reasonably well for many years, but the vaults were rarely watertight, required regular attention, and produced noxious smells.

Household liquids and wastewater found their way to on-site cesspools or dry wells in many communities, but too frequently were simply cast on the ground. Under the best circumstances, wastes were recycled on farmland or sold as fertilizers. The record of such uses, especially for night soil, was as erratic in the United States as it had been in England.[69]

More problematic was the impact of wastewater once it left private property and the flow of stormwater through the streets. While the cesspool–privy vault–scavenger system provided rudimentary handling of wastes, existing

"sewers" offered increasingly little help in controlling drainage problems. By the end of the eighteenth century, major urban centers such as New York and Boston had sewers. A "sewer" in this early period was intended to carry off stormwater or to drain stagnant pools rather than to handle wastewater, and was most often a street gutter rather than an underground drain. In Boston, city authorities did not assume the maintenance of the drains or begin to build new ones until 1823. Only liquid wastes were allowed in the drains, and fecal matter was specifically excluded until 1833.[70]

As in England, many ordinances forbade placing any wastes in sewers in this period. Sometimes intentionally and sometimes quite inadvertently, the surface drains became open sewers carrying substantial waste matter that had been dumped there or came from overflowing cesspools and privy vaults.[71]

Unlike sewerage, street cleaning garnered serious attention because of the many functions that streets performed—transporting goods, allowing human and animal traffic, facilitating emergency fire service, and even offering a place for social encounters. Since streets were part of a community's "commons," street cleaning came to be regarded as a municipal responsibility before refuse collection. Individuals or scavengers carried the responsibility of disposing of refuse that they generated around their homes and businesses.

Pioneering sanitary engineer Samuel A. Greeley noted that "the beginnings of city cleaning were undoubtedly in street cleaning."[72] In many towns and cities, citizens frequently lodged complaints about the filthy state of the main thoroughfares and the neglect of conditions in alleys and on noncommercial streets. It was typical in Europe and America for city dwellers to use streets as a dumping ground for refuse. Horses and other animals contributed their share of wastes. Boston and New Amsterdam were first to pass ordinances prohibiting the most egregious practices, but these laws were difficult to enforce and rarely deterred citizens from tossing materials along almost every street and road.[73]

In some of the larger communities, scavengers removed clutter from streets and also carted away rubbish and garbage as early as the seventeenth century. Eventually, free-roaming swine and fowl were much less prevalent. In hiring scavengers, towns, especially those with moderate street use, could meet the street-cleaning needs of their citizens in nonresidential areas. Systematic street cleaning with paid crews became necessary in the mid-nineteenth century when greater vehicular traffic kicked up billows of dust and urban workhorses were more plentiful.[74] At best, many problems associated with liquid and solid wastes were dealt with casually in most towns and only with slightly more determination in larger cities until later in the nineteenth century.

There was little stimulus for American cities to alter their disposal practices prior to 1830. In the case of water supply, the fear of fire and epidemics, and eventually the experience of the English, produced some modest changes. The most significant was the construction of the Philadelphia protosystem. Yet this achievement was insufficient to set off a national trend. The English "sanitary idea" and the refining of the miasmatic theory of disease would provide the context in which elaboration in technologies of sanitation would take place in the mid- to late nineteenth century.