#6 A Brief History of Water in Boston

Take a fantasy trip to colonial Boston

Close your eyes for a few minutes and let your mind wander back in time about 350 years, to the mid-17th century. The Massachusetts Bay had been settled by the British for several decades. Boston had not only become a city, it had also become a center of commerce. The city was small though; it then covered much of the area we now know as the North End and Government Center, and it supported a population of several thousand people.

Where do you imagine those people obtained their water? Surely they did not have sinks and tubs with hot and cold running water. How did they wash their clothes and bathe? What did they eat? Where did they go to the bathroom and what did they do with their waste? What did they cook in and eat from, and how did they wash their dishes?

For a city to be founded and for it to thrive, it must have an adequate supply of clean, fresh water. Without water, people simply cannot survive. Mesopotamia, "the Cradle of Civilization," grew because of the Tigris and Euphrates Rivers. More than 1500 years ago, the Romans had built 14 aqueducts that carried 50 million gallons of water each day a distance of 360 miles to Rome; each Roman citizen could use as much as fifty gallons of water every day!

Boston, one of the oldest cities in America and "the Cradle of Liberty," can trace much of its greatness to water. Not only was the city a great seaport, but from the time it was settled, it has had a generous supply of fresh water.

But water supplies are not limitless. In Boston's 350 years, it has faced many water crises and undertaken some truly remarkable public works projects for the purpose of supplying its citizens with water.

By 1652, water had become such a precious commodity in Boston that an entrepreneur saw an opportunity for a business. At a street corner close to where Faneuil Hall now stands, a newly formed company created the first artificial water supply in America. It wasn't fancy — only a 12-foot by 12-foot hole filled with water from nearby springs and covered with planks.

Boston's first public water supply, near the site of Faneuil Hall.

While the citizens wanted ready access to water for the sake of domestic convenience — it made cooking and washing much easier — they really needed it for fighting fires. With its dense wooden structures, a fire would have been disastrous for the young town.

For almost 150 years, Bostonians drew their water from local wells, but had no organized, central water supply. Then in 1795, when the population of Boston totaled about 18,000, the Jamaica Pond Aqueduct Company installed four wooden main pipes from Jamaica Pond to the city. They ran smaller wooden pipes directly to the homes of subscribers who paid for the service.

The Jamaica Pond Aqueduct Company was a private, for-profit corporation. In a manner similar to today's cable TV, they served only those people who paid to be part of their water delivery system. The debate as to whether water utilities should be publicly or privately owned continues today, and many of the nation's water companies do not belong to the public they serve.

When fires broke out in the area served by the Jamaica Pond Aqueduct Company, the firemen bored holes into the wooden mains and tapped them in order to fight the fire. After the fire was out, they plugged the holes and marked the spot so they would be ready in the event of another fire. It was from that practice that the term *fire plug* emerged.

By 1825, the city had suffered a devastating fire that destroyed several blocks, and the population had tripled since the turn of the century, to 50,000. The Jamaica Pond Aqueduct Company simply could not keep up with the increased demand. Low water pressure meant that people living in high areas, such as Mission Hill and Beacon Hill, sometimes had neither water nor fire protection. Worse, the water quality had become unreliable; it sometimes tasted so bad that customers could not drink it, and some reports claim that Boston's spring water was the cause of widespread illness. In a growing vibrant city where <u>everybody</u> needed good water, this situation was intolerable. Something had to be done.

In a pioneering engineering effort, Dr. Daniel Treadwell calculated that each of Boston's 6,000 families required 100 gallons of water per day; each of her 2,000 individual residents required 40 gallons; and industrial/ municipal uses required 500,000 gallons per day. Thus, calculated Treadwell, Boston needed an absolute minimum supply of 1,180,000 gallons per day. Indeed, at this bare-bones number, all other uses would have to be halted in order to fight fires. But regardless of the projected need, Boston simply did not have that much supply. They had to locate a source of water and develop it.

The developers looked into Spot Pond in Stoneham, the Mystic River, and the Charles River, but none were acceptable. (Spot Pond later became a source of supply for the northern metropolitan area.) Not only had industries such as tanneries already polluted the Charles, Boston's spring water was notoriously hard, harsh tasting and unhealthy. Regretfully, the heavy machinery of politics and business prevented any new supplies from being developed, so Bostonians had to make do with what they had...at least until 1834.

In 1834, the city hired Laommi Baldwin, a civil engineer from Woburn to again study the water supply issue. He came up with a dramatic idea: connecting the city to Long Pond (which is now Lake Cochituate) in Framingham by means of a buried aqueduct. The lake was high enough that gravity could carry the water the entire distance. That decision marked the beginning of the practice of bringing fresh water to the city from the less populated regions to the west, a practice that continues today.

For ten more years, the politicians and the planners continued to debate the water issue without taking action. Finally, in 1845, the state legislature granted the funds and the necessary legal rights to build an aqueduct system from Framingham to Boston. The legislature's action meant that Boston would be served by a public water system, one owned by all the people, not by private companies as its earlier ventures had been.

Construction began the following year, in 1846. In the system's entire 14.3 mile distance, the aqueduct dropped less than four feet! (3 inches of drop per mile.) The aqueduct ran underground at a depth of at least four feet so it would not freeze. It crossed streams, and at the Charles River, the builders installed an inverted siphon which allowed the water to continue flowing even though it went uphill.

Two years later, in 1848, the system was complete and the citizens of Boston held a great celebration on the Commons. Their decisions and problems, however, were far from over.

The City of Boston now had a good reliable water supply. But that water had to be delivered to each home. Of what material should the pipes be made? Iron was too rigid and the inner diameter tended to become encrusted, thus causing the flow rate to decrease. Copper was considered the best available material, but it required careful craftsmanship and was very expensive. Some people feared that lead pipes posed a potential health hazard. Others, however, concluded that a thin impenetrable layer would build up on the inside of the pipe, eliminating any potential danger. Lead pipes won the debate, although the water company provided copper to anyone who wanted to pay extra. To this day, no one is certain how many old Boston homes still have lead water pipes.

By 1868, the city had more than 1,500 fire hydrants, 20,000 homes, and almost 6,000 businesses and municipal buildings. The population exceeded one-quarter million and for the first time some of the most far-sighted individuals envisioned the day when the water supply from Lake Cochituate would not be adequate for Boston.

Despite the reliable supply of fresh water from Framingham in the west, the communities to the north of Boston maintained their own water supplies. Most notably, the cities of Charlestown, Chelsea, Everett and Somerville received water from Mystic Lake, the headwaters of the Mystic River. By the 1890s however, the Mystic supply accounted for less than 25% of the total supplied by the western water network, which now included not only Lake Cochituate, but also a series of reservoirs along the Sudbury River, including the Sudbury Reservoir (which could still be put back into use today). Moreover, the Mystic Lake supply soon became polluted, and the northern water supply was abandoned in 1898. Now, almost a century later, we are still relying on waters from the west to bathe and nourish the city.

Just before the turn of the century, the state legislature commissioned a major study of Boston's water needs. Based on population projections and public health criteria, the study was submitted in 1895, and it recommended a long-range plan for developing water sources in the Nashua, Ware and Swift

River watersheds. The first step in that plan, building the Wachusett Reservoir on the Nashua River by the newly created Metropolitan Water Board, began that same year. As a planning document, the 1895 study has served the metropolitan area for nearly a century.

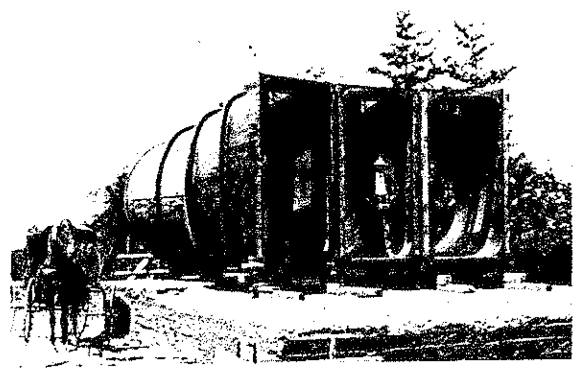
The Metropolitan Water Board, like its predecessors and successors alike, continually searched for new sources of supply. Even though many planners considered water conservation as an option, the general public never thought seriously about using less. Conservation was simply not part of their consciousness.

One of the key issues before the planners in 1895 was whether to filter and treat the readily available water or develop a water supply system along the sparsely populated lands to the west. Their conclusion, that the public preferred "a clean, unpolluted upland source,"[1] was pivotal in the decision to build the Wachusett Reservoir.

Building the Wachusett Aqueduct

The Wachusett Reservoir differed from Lake Cochituate in an essential way. The watershed area around Lake Cochituate was small and unprotected, and development was imminent. The water would soon be unfit for consumption. Thus the Metropolitan Water Board built the new reservoir in an area with an undeveloped watershed. Only in that way could they try to protect the water's purity. Of the watershed's 65,000 acres, nearly 5,000 were purchased for protection and more than two million trees were planted.

By 1908, the Wachusett Reservoir was complete and full, and feeding water to Chestnut Hill. Its designer, Frederic Stearns, had been awarded a gold medal at the Paris Exposition for the reservoir's plans. With a capacity of 67 billion gallons, it was at the time the largest man-made reservoir in the world.



The Weston Aqueduct

In 1919, not 15 years after Wachusett's completion, discussions had begun for the construction of "a great reservoir" in central Massachusetts that would be connected to Wachusett. To protect the supply, the plan-

1. SYSTEM DESCRIPTION paper p.III-4, from The Commonwealth of Massachusetts, A General Description of the Water Supply of the Metropolitan District Commission, October 23, 1940, pp.9-10.

ners recommended all forms of public recreation be absolutely banned from the new reservoir. Their motivation was noble: they wanted to ensure an unpolluted supply that would purify the water naturally. The high quality of the water available to us today must be credited to the individuals who successfully fought for such assurances.

Authorization to begin building the Quabbin Reservoir came in the mid-1920s. Construction began in earnest in the early 1930s after a ruling by the U.S. Supreme Court on a case brought by the State of Connecticut cleared the way. Construction caused the removal of four towns, forced the relocation of 2,500 people, eight schools, eleven churches, six mills, and 34 cemeteries; in the town of Ware, the Quabbin Park Cemetery was established for the reburial of many of the 7,500 bodies that had to be removed. Quabbin is the largest single-purpose man-made water supply reservoir in the world.

The Quabbin Reservoir, in the valley of the Swift River, has 39 square miles of surface area, is 18 miles long, and has 186 square miles of watershed. It stores up to 412 billion gallons of water before sending it on its 65 mile journey to Boston. The Quabbin is so large that one drop of water entering its upper end takes nearly four years before it leaves through the Quabbin Aqueduct on its journey to our faucets and fire hydrants, and it is that feature more than anything else that assures the purity of our water. Time for the natural action of the sun, sedimentation, and the changing seasons is what purifies our drinking water.

The Quabbin Reservoir has touched many lives since its conception 70 years ago. Among them was Xavier Henry Goodnough, for whom the Goodnough Dike was named. He served

The town of Enfield before the building of Quabbin.

Quabbin as it appears today looking across the valley that was Enfield.

as the chief sanitary engineer of the state's Board of Health. Working with Frederic Stearns, he helped to bring the Quabbin project to completion. The critics of Quabbin assaulted the idea, claiming it would cost as much as $200 million to build. Goodnough insisted the price would not exceed $60 million. He was right; the final cost was $56 million. He also correctly guessed that the reservoir would require six years to fill up.

As an interesting side note, the word *Quabbin* is an Indian word from the Nipmuck Indians meaning "place of many waters." It is fascinating that Indians in the center of what is now Massachusetts used a word that is so close to the Latin word for water, *aqua*.

The tunnel and aqueduct system that connects these reservoirs to the city is also a remarkable work of planning and engineering. For the most part, water flows through wide tunnels buried deep underground, pushed along by gravity rather than energy-consuming electric pumps. Pumps do not take over until the water actually reaches the city.

Only a single tunnel connects the Quabbin to the Wachusett Reservoir. Named the Quabbin Aqueduct, it is 24.6 miles long, thirteen-feet in diameter, and it has a total vertical drop of 135 feet. With only a single link between the two large reservoirs, engineers can ensure that Wachusett is always full. As long it remains full, even if something were to happen to the tunnel to close it down, Boston would still have close to a year's supply of water while it was being repaired.

Two aqueducts take water from the Wachusett Reservoir on the journey to Boston: the original Wachusett Aqueduct and the new Cosgrove Aqueduct, built in 1964. The eight-mile-long tunnel is fourteen feet in diameter – wide enough for tractor trailer trucks to drive through! While the Wachusett Aqueduct is seldom used today, it provides essential redundancy to the system, allowing the Cosgrove Aqueduct to be maintained without depriving the city of water.

These two aqueducts lead to the old Sudbury Reservoir (which is not actively used but is still available in the event of a severe water emergency) near Southborough. From there, another series of aqueducts and tunnels — including the Hultman Aqueduct, the Weston Aqueduct, the Dorchester Tunnel, and the City Tunnel — carries the water to the pumping facilities around Boston, and from there, directly to your homes. By then, you could safely assume that the rainstorms that brought the water fell roughly three to four years earlier. The water has travelled more than 65 miles to get to your house, has been as much as 650 feet underground at times, and with the exception of some added fluoride and chlorine, has been treated solely by nature.

The System's Safe Yield

The total design size of a water system such as ours is determined primarily by water use projections and average rainfall. The total water that can go into the system is limited by several factors: rainfall, the size of the watershed, and the capacity of the reservoirs. Even if we had several years of very heavy rainfall, for example, much of that water may be lost downstream because the reservoir system is simply not large enough to hold it all.

The engineers and planners must employ complex mathematics to know how much water the system can provide safely. They must factor many variables into their calculations, including average rainfall, the amount of water the watershed will absorb, and the amount of water lost from the reservoir through evaporation. From these calculations, they determine "safe yield."

The Quabbin Reservoir in early 1989 when it was filled to only 70% of its capacity.

When the engineers designed the reservoir system, they did so with a limited population in mind. They didn't realize how much the Boston area would grow. They calculated the safe yield to be 300 million gallons per day, and for about 25 years we stayed within that limit. But beginning in 1969 (within the timeframe predicted by Frederic Stearns 70 years earlier), we began to exceed the maximum safe yield of the system.

Although we have exceeded the safe yield every year since then, in 1987, consumers began making significant strides in reducing water consumption. The leadership of the Commonwealth and individual consumers have started to tighten the system, plug the leaks, and conserve as much water as possible. This collective action represents an important step in Boston's water history.

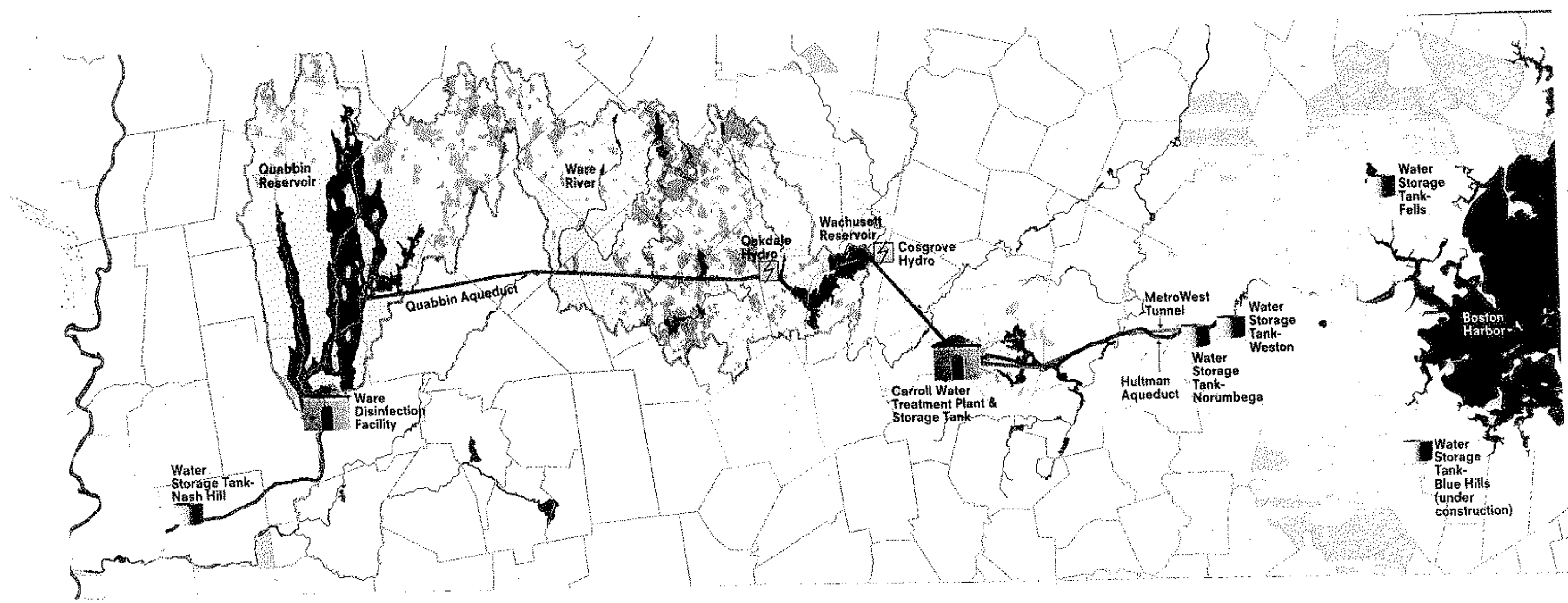
A major study, begun in 1980, examined a number of alternatives for the metropolitan area's long-range water supply. One option, first suggested by planners in 1967, entailed diverting flood flows of the Connecticut River to the Quabbin. The direction that has emerged from planning, however, first under the MDC and continuing under the MWRA since 1985, has been a comprehensive program to conserve water and protect local sources. The program strives to improve efficiency by reducing waste in the commercial, residential, industrial and municipal sectors. Another major thrust is to reduce "unaccounted for" water, meaning water which is not paid for due to leaks, underregistration of meters, or delivery to unmetered users. Citizens and MWRA leaders have agreed that an aggressive conservation campaign should precede the development of a new water supply.

This effort will require that everyone practice water conservation, such as:

- using low-flow faucets and showerheads,
- taking shorter showers,
- installing toilet dams and flushing only when necessary,
- watering lawns and gardens only in the late evenings or early mornings,
- running dishwashers and clothes washers only when they are full, and
- finding and repairing leaks.

This *Water Wisdom* program is the result of the MWRA commitment to water conservation and water awareness. The MWRA is hard at work repairing and maintaining the system, and it is actively promoting water conservation among all of its customers. In 1988, the MWRA had reduced its recoverable leakage to only 7% of total water use. The Authority accomplished this reduction through an aggressive leak detection and repair effort that uses high-tech listening equipment for hearing leaks from far underground and repairing them before they become pipe ruptures. Through conservation and system maintenance, we consumed an average of only 324 million gallons per day in 1988, a savings of 11 million gallons per day over 1987 despite a continually growing population and a strong economy.

The long-term future of the water supply system remains something of a mystery. No one knows if — or how long — we will be able to provide water to greater Boston without developing a new supply. It is certain, however, that aggressive conservation efforts have reduced water consumption. Clearly, conservation will push back the need for new supply, but a truly successful conservation initiative will require continuing effort and the help and participation of every citizen.


Quabbin Reservoir
Ware River
Quabbin Aqueduct
Ware Disinfection Facility
Water Storage Tank-Nash Hill
Oakdale Hydro
Wachusett Reservoir
Cosgrove Hydro
Carroll Water Treatment Plant & Storage Tank
MetroWest Tunnel
Hultman Aqueduct
Water Storage Tank-Norumbega
Water Storage Tank-Weston
Water Storage Tank-Fells
Boston Harbor
Water Storage Tank-Blue Hills (under construction)