

Who pays for water? Cost recovery and user fees in  
Boston's public water infrastructure, 1849 to 1895

By

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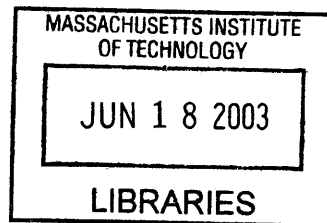
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## **ABSTRACT**

The experience of Boston, Massachusetts in recovering costs for their nineteenth century public water supply system, the Cochituate Water Works, is analyzed in light of current policy advice coming from international development banks. Lenders like the World Bank currently advise full-cost pricing for urban water services, and that utilities in developing countries use pricing to manage demand.

This thesis asks, how closely did a city in an industrialized country, in its developing stage, follow the policy advice proffered today? The annual reports of Boston's water department were reviewed to determine the extent that Boston recovered costs from users, and the extent that Boston used pricing to manage demand. Archival research revealed that while water rates covered annual operating and maintenance expenses, payment of the interest on construction costs was generally made by new loans or bond issues. The City did not meter households and was loathe to manage demand through price-mechanisms, preferring to augment capacity in the face of constrained water supplies.

Archival research also revealed the motivations behind Boston's policies of subsidization. The City initially offered low water rates and subsidized household connections because officials wanted to take advantage of economies of scale, believing that inducing universal subscription would move the system more quickly to financial self-sufficiency. Low water rates also resulted from a perceived high elasticity of demand for water services. The City raised rates during the first twenty years of water system operation in efforts to make the water department financially self-sufficient, but failed. A lack of political and public support for high prices made the City adopt policies of greater subsidization and rate reductions in later years.

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## 1.0 INTRODUCTION

Since the 1992 Dublin Statement on Water and Sustainable Development, there has been increasing emphasis on treating water as an “economic good,” which entails charging more cost reflective prices for all of its uses. Lenders like the World Bank have been promoting demand-side approaches to water supply projects and the phasing out of subsidies. Low water prices are seen as unsustainable because they lead to a cycle of insufficient revenues for proper maintenance, deterioration in service quality, and consumers increasingly less willing to pay for services. Low water prices also lead to over-consumption that strains system capacity. Full cost recovery by user fees is promoted in the face of limited financial resources to increase efficiency, and in many cases to make the provision of infrastructure services more attractive to private investors. The development literature prescribes full cost recovery by users and demand-driven urban water supply projects on the grounds of economic efficiency and sustainability, when the experience in industrialized countries, until quite recently, has been the subsidized supply-driven provision of water infrastructure.

A major part of the prevailing policy advice from development banks today is that urban water supply projects should recover all costs from users. The rationale behind charging users the full cost is that the benefits of piped water supply, like better health and convenience, are private goods more appropriately financed through private means. Additional motivations behind full cost recovery through user fees are that central governments have an increasingly limited capability to fund water supply services, and state subsidization as traditionally practiced in developing countries does not achieve its goals of expanding services and ‘serving the poor.’

A related piece of policy advice coming from international donors is that pricing should be used as a tool of demand management. Pricing urban water services at cost is efficient, makes it transparent to see who is using and paying for what, and provides the appropriate economic signals to conserve resources and delay investment in new capacity. Importantly, it also sensitizes users to the fact that piped water is expensive, and that high quality services, such as 24-hour uninterrupted supply, come at a price.

This thesis looks at how closely a city in a “developed” country followed the advice proffered today when it was a “developing country” city in the nineteenth century. Specifically, the thesis examines the route that Boston, Massachusetts took in financing public water supply before the city’s role in extending supply was taken over by a metropolitan district in 1895. Did the city recover the costs of public water supply from users? Did nineteenth century Boston use pricing to manage demand? Before beginning research, the presumed answers to these questions were no and no. Thus, the question relevant to the current debate about full-cost pricing of urban water services was: If not, why not?

### ***Methodology and Findings***

In order to determine the nature and extent of water supply subsidies in Boston, the annual reports of Boston’s water departments were reviewed in the archives of the Boston Public Library and Massachusetts Institute of Technology.<sup>1</sup> By piecing together information reported in annual water department reports, related city reports, and Huse’s (1916) research on the financial history of Boston, a fairly good picture of Boston’s experience in financing public water supply could be gleaned. Another rich source of materials providing greater social context was the ‘Making of America’ database of nineteenth century American books and journals, available online from Cornell University and the University of Michigan.<sup>2</sup>

Archival research revealed that construction costs for Boston’s water supply system were indeed generally not paid through user fees. Annual expenses for maintenance and operations were generally met through user fees, but water rates did not generally cover interest payments on the debt incurred for construction. Evidence nevertheless indicates that the city made early concerted efforts towards user fee cost recovery. The state legislation enabling Boston to provide public water from Lake Cochituate intended that the city would eventually recover capital costs through rates to users. The designers of Boston’s supply system planned for cost recovery through user fees in 1849, and devoted “much attention to the maturing of the system of

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<sup>1</sup> The exact quantification of subsidization proved impossible because the accounting for costs by the water department was not straightforward and was inconsistent throughout the years. Another source of confusion was that balances as reported in water department annual reports were different than those reported by the City Auditor, who for many years operated under a different fiscal year, and a different system of accounting.

<sup>2</sup> Making of America is “a digital library of primary sources in American social history from the antebellum period through reconstruction.” Every page of every text is searchable by word through optical character recognition. Available at <http://moa.umdl.umich.edu/> and <http://cdl.library.cornell.edu/moa/>

rates, to be charged for the use of the water ... to indemnify the City for the cost of the work.” Nevertheless, Boston had difficulties achieving even the more modest goals of paying for interest, operations, and maintenance of the water works from annual water rates.

The subsidized supply-driven approach to providing water services in nineteenth century American cities has been traditionally attributed to an emphasis on the public good aspects of water supply services, such as fire protection and public health.<sup>3</sup> The almost universal understanding that public water supply confers public benefits, together with a desire of governments to keep a ‘basic’ service like water affordable, also led to the subsidization of municipal water services in today’s developing countries.

In the case of Boston, however, archival research has revealed that although public benefits to piped water supply were identified, the main motivation for establishing a public piped network was for the private benefit of households. Only as rates to users failed to recover annual costs did the rhetoric related to the public benefits become more pronounced. Other more significant motivations for subsidization and low water prices in nineteenth century Boston were a perceived high elasticity of demand, a desire to exploit economies of scale, and a lack of public and political support for higher prices.

Although some historians have identified engineers as the major actors influencing the development of Boston’s public water supply,<sup>4</sup> the annual reports of Boston’s Water Boards indicate that city politics played a major role in shaping water management decisions in Boston. For example, by at least 1862, city-wide metering was discussed as technologically feasible by water department managers. High costs were the main objection to metering households; yet in the face of constrained supplies the city resorted to even more costly measures of constructing new supply facilities instead of metering households. Demand management measures recommended by water department managers, such as higher charges for the use of wasteful

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<sup>3</sup> Rogers et. al. (2002), p.1: “The ‘sanitary revolution’ of the 19<sup>th</sup> century saw the demand for public ownership and management of most [private water supply companies] in the name of public health. This, of course, did not obviate the need for water to be treated as an economic good, but a heavy emphasis on the public-good nature of water and its disposal led to the development of heavily subsidized public systems.”

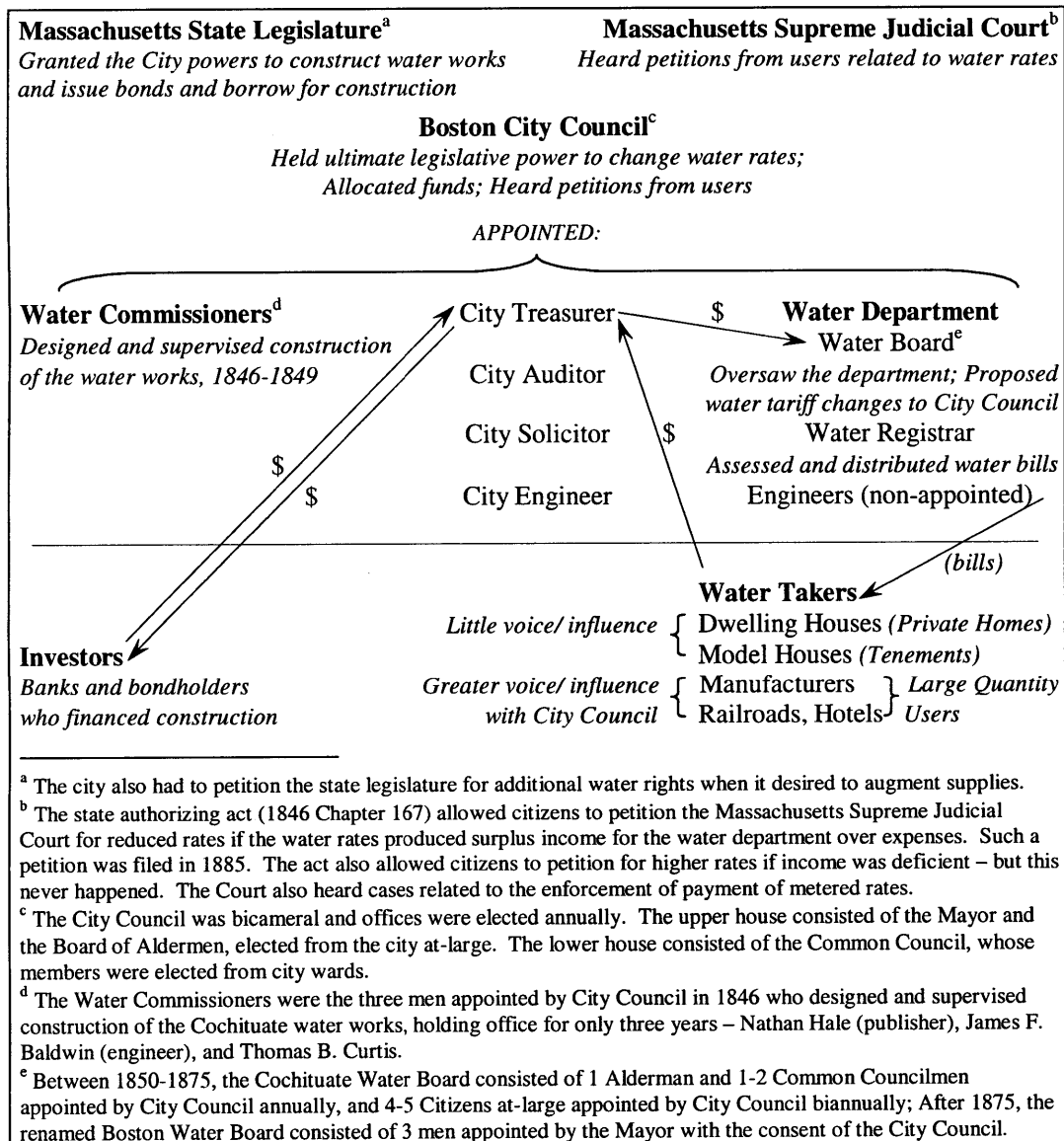
<sup>4</sup> See Nesson, Fern L. *Great Waters: A History of Boston's Water Supply*. Hanover, NH: University Press of New England, 1983.



water fixtures, were continuously voted down by the City Council. Powerful interests such as hotels, manufacturers, and real estate developers successfully lobbied for reduced water rates and policies of greater subsidization. By the 1870s, the city abandoned the notion that user fees should cover costs of construction.

The Appendix contains a timeline that highlights major events significant to Boston’s efforts to recover costs through users. Figure 1.1 describes the relationships between the various actors that provided and paid for public water services in Boston, mentioned in this report.

**Figure 1.1 –Major Actors Associated with Boston's Public Water Supply**



### ***Thesis Structure***

Urban water supply utilities can recover costs through a variety of means, including user fees, taxes, loans, bond issues, and investment income. Chapter 2 will discuss the reasons why full cost recovery by user fees is advocated today for developing country cities. The chapter will detail Boston's experience with recovering costs through user fees, and highlight how similar types of policy debates occurring today played out over one hundred years ago.

In order to recover costs of urban water services through user fees, utilities need to measure the water delivered and consumed. Thus, the other major policy advice for urban water utilities in developing countries is to meter and charge volumetric rates. Chapter 3 will discuss why metering is employed today, and the constraints precluding the universal adoption of meters in practice. The chapter will detail nineteenth century Boston's experience with metering and other demand management measures. It will highlight the fact that urban water planners in developing countries today face some of the same constraints that nineteenth century Boston water planners faced when they tried to induce more efficient use of water.

Chapter 4 will discuss the major differences and similarities between Boston's approach to financing urban water infrastructure and the prevailing policy advice given to developing countries today. Although there are limitations to a comparison, the analysis of differing philosophy and context shed light on the motivations behind the policy choices in the two cases.

## 2.0 COST RECOVERY THROUGH USER FEES

Piped water supply is expensive. For industrialized countries today, funds for urban water supply infrastructure are typically raised through bond issues. Municipalities raise the money needed to finance major infrastructure investments, and repay shareholders over time using either increased user fees or transfers. With both fiscal pressures and water scarcity increasing, municipalities are turning to recovering costs through user fees. Municipal managers face tightened budgets and dwindling financial support for water infrastructure from the state and federal government. Planners and environmental groups both recognize the power of higher user fees to curb water use, thereby forestalling the need for developing new water sources.

Despite the very different economic, political, and cultural context found in countries of the developing world, development agencies are providing policy advice for cost recovery through user fees that is similar to that proffered in the west. This policy advice, and the objections often made to cost recovery through user fees in developing countries, are discussed in the following section. Section 2.2 explores one of these objections—that the water supply systems in industrialized countries, at similar stages of development, were not funded through user fees—using the case of nineteenth century Boston.

### 2.1 *Theory and Practice of Cost Recovery through User Fees*

Water supply infrastructure in the developing world has been historically financed by central government transfers. Developing countries have continued on this trajectory to the present day, with users facing nominal or no fees for their water supply services.<sup>5</sup> A recent breakdown of financial sources for investment in the water and sanitation sector in developing countries is 65-70% of funds coming from the domestic public sector (this would include user fees, taxes, transfers, and loans), 5% from the domestic private sector, 10-15% from international donors, and 10-15% from international private companies.<sup>6</sup>

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<sup>5</sup> The World Bank has estimated that users of public water supply services in developing countries typically pay only one-third of the total costs incurred by the utility to supply those services. Briscoe, "The Challenge of Providing Water in Developing Countries," undated, p.2.

<sup>6</sup> Winpenny, James, *Financing Water for All: Report of the World Panel on Financing Water Infrastructure*, March 2003, p.6.

There are many reasons why water supply services in developing countries have traditionally not been supplied through user fees. Water supply is perceived as having public goods characteristics, justifying state involvement in its provision. Water supply services are also perceived to be a 'basic' service underpinning overall economic development. Historical subsidization has also stemmed from a concern about affordability for poor households. Often this issue has been highly politicized, and elected officials campaign on the promise of free water.

Over the past fifteen years, aid agencies have increasingly pushed developing countries to shift from centrally funded to user funded water supply services. The experience of the World Bank has been "unequivocally that services are efficient and accountable to the degree that users are closely involved in providing financing for the services" and that "deficiencies in financing arrangements are a major source of poor performance in the sector."<sup>7</sup> The World Bank believes that cost recovery should be sufficient to pay for operations, maintenance and a fair return on capital investment, and provide for this outcome through loan covenants.<sup>8</sup>

Aid agencies advocate cost recovery through user fees for a variety of reasons. One of these is the belief that government should use their limited financial resources for overall economic development instead of social services. Most developing country governments are too overburdened with debt and budget deficits to be able to subsidize chronic shortfalls in the water sector. Foreign aid flowing into the water sector in developing countries comprises less than ten percent of estimated investment needs,<sup>9</sup> and users themselves are seen as the major untapped resource for financing.<sup>10</sup>

Also, experts from the World Bank insist that the benefits received from piped water supply are largely private in nature, and efficiency requires that public goods be publicly financed and private goods privately financed. The Senior Water Advisor of the World Bank explains that

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<sup>7</sup> Briscoe and Garn, 1995, p.62.

<sup>8</sup> World Bank, 1993, p.126.

<sup>9</sup> Munashinge, 1990, p.36.

<sup>10</sup> Brookshire and Whittington, 1993, p.1884.

implicit in the principle is a belief that social units themselves...from households to river basin agencies – are in the best position to weigh the costs and benefits of different levels of investment of resources for benefits that accrue to that level of social organization.<sup>11</sup>

In this view, amenity and health benefits of water supply are seen as only conferred upon the household. While nineteenth century Americans perceived significant public health benefits to water supply, today such benefits are attributed to sanitation instead of water supply. Because sanitation services provide benefits external to the household, these services are seen as necessarily partially financed with public funds at the appropriate level beyond the household.

Additionally, the prevailing wisdom is that subsidization as practiced in the developing world does not benefit the poor, precludes the expansion of piped water services to unserved areas, and fosters political interference in the sector. Political interference ostensibly occurs to ‘keep tariffs low.’ According to the development literature, giving politics a central role in determining urban water tariffs has meant that costs are too high because utilities are not accountable to users; coverage is low, with the poor being the last to get services; and the underserved have to resort to buying water from vendors who typically ask prices ten times those one would have to pay an efficient utility.<sup>12</sup>

Finally, development banks argue that the poor are much better off when urban water services are managed as an economic good. Studies have shown that the urban poor are willing to pay for improved water services.<sup>13</sup> Affordability is a concern with regard to initial connection fees, but this has been successfully addressed through installment plan financing.<sup>14</sup>

Whereas some developing countries have adopted the donors’ advice and moved toward fuller cost recovery through user fees, others have resisted. Among the objections is a belief that water supply is a human right upon which state-owned or privately operated utilities cannot put a price. Another objection is that industrialized countries themselves don’t uniformly practice what they preach, either currently or historically.

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<sup>11</sup> Briscoe and Garn, 1995, p.65.

<sup>12</sup> Briscoe, 1997, *Managing Water as an Economic Good: Rules for Reformers*, 1997.

<sup>13</sup> McPhail, 1993.

<sup>14</sup> Briscoe, 1995, p.32.

Even now OECD countries have a mixed record on cost-recovery through user fees. Ireland, for example, does not charge water rates and recovers all the costs for domestic water services entirely through the general taxation system. Korea recovers 77% of operating and capital expenditures through user charges. While most OECD member countries are reported as adopting the principle of “full cost recovery” for the management of public water supply systems, the definitions vary as to which costs should be paid by user charges.<sup>15</sup>

Full cost recovery through user fees is not generally practiced in the United States today, although the majority of funding for drinking water and wastewater services comes from local ratepayers and local taxpayers. A recent survey of 112 medium- and large-sized American wastewater utilities found that 55% of revenues came from user charges, 15% from reserves and interest, 15% from bond proceeds, 4% from property taxes, 3% from state revolving loan funds, 2% from federal and state grants, and the remainder from other small sources.<sup>16</sup>

Indeed, full cost recovery through user fees wasn’t practiced historically in America, either. The next section discusses the experience of the city of Boston, Massachusetts, in financing its first piped public water system during the latter half of the nineteenth century.

## ***2.2 The Experience of Cost Recovery in Nineteenth Century Boston***

Many of the debates now playing out between donor agencies and developing countries over the role of user fees in financing water supply infrastructure are similar to those documented during the development of Boston’s first piped water network. After a brief description of Boston’s experience with a mandate for cost recovery through rates to users, the following sections will touch upon how debates related to the public good nature of water services and affordability played out in Boston. Boston’s water department managers did not explicitly express concerns about the affordability of services to ‘the poor,’ but perceived a high elasticity of demand that necessitated low water rates for all households. By offering low water rates, the City hoped to get all households to connect to the piped network. They believed that by taking advantage of economies of scale, the water department would move more quickly to financial self sufficiency.

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<sup>15</sup> OECD, *Household Water Pricing in OECD Countries*, 1999.

<sup>16</sup> U.S. Congressional Budget Office, *Future Investment in Drinking Water and Wastewater Infrastructure*, Nov. 2002, p.6.

### ***Boston's Nineteenth Century Mandate for Cost Recovery through User Fees***

Much like the World Bank would recommend, the enabling legislation for Boston's first public water supply, the Cochituate Water Works, tasked its planners to aim for full cost recovery through user fees. Boston's Water Commissioners<sup>17</sup> took the mandate to heart and

devoted much attention to the maturing of the system of rates, to be charged for the use of the water, upon a basis which shall favor its introduction for all purposes for which it can be advantageously used, at prices which, while they are just and reasonable, will be likely to insure the greatest amount of income, to indemnify the City for the cost of the work.<sup>18</sup>

In planning for cost recovery, the Water Commissioners looked to the more developed examples of New York and Philadelphia for best practices. Their rejection of these other systems as insufficient shows they at least intended water rates to recover recurrent expenses of operations, maintenance, and interest on debt. They found in Philadelphia "at no time since the foundation of the works has the income been sufficient to pay the interest of the cost of the construction." In New York, they saw that revenues in 1848 from the Croton Aqueduct comprised only 36% of the annual interest payment on the stock issued for its construction, and the remaining \$455,000 had to be assessed in taxes that year.<sup>19</sup> Cost recovery through water revenues proved similarly elusive for the managers of Boston's water department, the Cochituate Water Board.<sup>20</sup>

The 1846 Act<sup>21</sup> of the Massachusetts State Legislature authorizing the development of the Cochituate water supply gave the City Council power to regulate the price for the use of water, with a view to the payment, from the net income, rents, and receipts therefore, not only of the semi-annual interest but ultimately of the principal also of the "Boston Water Scrip,"<sup>22</sup> so far as the same may be practical and reasonable.

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<sup>17</sup> Three Commissioners were appointed by the City Council in 1846 to superintend the construction of the Cochituate water works. Their tenure was limited to three years.

<sup>18</sup> 1849 City Document No. 4.

<sup>19</sup> 1849 City Document No. 57.

<sup>20</sup> The Board consisted of one member from each branch of the City Council, five members from the citizens at large, one Engineer, and one Water Register, elected by the City Council. After 1862, the Board consisted of one member elected annually from the Board of Aldermen, two men elected annually from the Common Council, and four citizens at large, two to be elected for one year and two for two years. The Act to Unite Charlestown with Boston (1873, Chapter 286, Section 12) provided that the Mystic Water Board would continue as a separate organization under direction of City Council of Boston until it was decided to unite with Cochituate Water Board. The accounting for the Cochituate-Sudbury and Mystic systems remained separate through 1895, when Boston's supply system was taken by the Commonwealth's newly established Metropolitan Water District.

<sup>21</sup> Chapter 167 of Acts of 1846 Legislature: Act for supplying the City of Boston with Pure Water, passed March 30, 1846

The 1846 authorizing act intended that the department would be financially self-sufficient within two years of the completion of system construction. The legislature allowed the city to add interest payments to the principal during the first two years of operation, after which the ‘construction account’ would be closed. Any net surplus from water rates was to be put into a sinking fund to be managed by the mayor, treasurer, and auditor, and applied to the payment of the water debt.

The City began construction of the Cochituate supply in 1846, financing early work with temporary loans.<sup>23</sup> The first major funds for construction were obtained through bonds issued in America in 1847 amounting to one million dollars, or an estimated \$20.8 million in 2000 USD.<sup>24</sup> This amount was scheduled to be paid after 1857 in five equal annual installments. Evidence suggests city officials initially believed that debt incurred for construction could be in part paid by the sale of city lands to private real estate investors, because Boston’s finance committee made the schedule of repayment coincide with the period in which they expected that city-improved ‘Neck’ lands would be sold.<sup>25</sup> During his speech at the public Water Celebration on the Boston Common in October 1848, Mayor Josiah Quincy Jr. predicted that “the city lands will rapidly extinguish the principal, and our posterity will enjoy free water on a free soil.”<sup>26</sup> Quincy Jr. was however apparently the last of Boston’s mayors who placed great faith in the amortization of city debt with land revenues. After his tenure, lands were sold ‘on more liberal terms’ as a means to build up the city and increase taxable property.<sup>27</sup>

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<sup>22</sup> The Boston Water Scrip were the certificates of debt issued by the City for the construction of the water works, in both the London bond market and American bond markets, amounting to \$5,421,000 by 1852 (1852 City Document No. 67). The Act of the legislature establishing the Boston Water Board in 1875 construed the Boston Water Scrip as including the whole amount of outstanding loans representing the cost of the water works.

<sup>23</sup> Boston attempted to obtain a long-term low-interest loan in Europe, but according to Huse (1916), in the summer of 1846, European bankers told Boston’s loan negotiator that there was no market for American stocks.

<sup>24</sup> All figures have been converted to constant 2000 U.S. dollars (USD), unless otherwise noted. The source of the inflation index used to convert dollar amounts is [http://oregonstate.edu/Dept/pol\\_sci/fac/sahr/cf166502.pdf](http://oregonstate.edu/Dept/pol_sci/fac/sahr/cf166502.pdf), last accessed in May 2003.

<sup>25</sup> Huse, 1916, p.100. The “Neck” was the narrow bridge of land, in alignment with present-day Washington Street, connecting Boston’s original landmass, the Shawmut Peninsula, to the mainland. Much of Boston’s present-day landmass is filled wetlands. The City improved the filled lands by laying out streets and squares before selling them at auction. See Whitehall, W.M., *Boston: A Topographical History*, Cambridge: Belknap Press, 1959.

<sup>26</sup> Boston City Document No. 54, 1848, p.41.

<sup>27</sup> Huse, 1916, pp.95-6.



In the end, reduction of the water debt was not made out of water rate revenues or from taxes to any great extent.<sup>28</sup> As temporary water loan obligations became due, they were funded in water bonds. In 1852 the city issued bonds at 4.5% in the London market sufficient to finance the completion of the works, payable in 20 years. Reductions in the 'water debt' were obtained from new loans, incorporated in the city debt proper. In his 1860 report, the City Auditor explained that apparent reductions in 'water debt' were merely transfers:

... all the payments which have been made to reduce the Water Debt below the actual cost of the Water Works, have been made from city funds, and are in fact merely *transfers* from the Water Debt to the City Debt, as the Water Works have, thus far, contributed nothing towards *reducing the cost*; their income, from all sources, not being sufficient to meet the interest on the cost, (*including extensions*,) and the expenses of carrying out the works [emphasis in the original].<sup>29</sup>

Indeed, between 1858 and 1879 the Water Board and the City Auditor disagreed about the nature of water department financial self-sufficiency, arguing over the matter in their annual reports. The Water Board claimed financial self-sufficiency when its revenues covered annual expenditures on maintenance, operations, and interest payments on the original cost of construction up to 1851. The City Auditor, on the other hand, interpreted the expenditures of the department to include later costs for construction, as well as the various transfers made to the city debt from the water debt. Interpreting financial self-sufficiency in this strict sense, the Auditor would annually appropriate a portion of water revenues to pay a portion of the city debt.

In their 1858 report, the Water Board made the argument that the 'water debt' should be construed only as that amount borrowed for construction to May 1<sup>st</sup>, 1851, plus two years interest, and "not liable to increase under any circumstances contemplated by the [1846 enabling] act." The Board asked the Auditor to define the water debt this way, and impudently suggested

If he thinks best, [the City Auditor] can also exhibit the *cost* of the Works as he has hitherto done; though it is not very obvious why the delinquency of the City Council in providing adequately for the expense of this department of the city service should be more prominently exhibited than for any other branch of city expenditure. [emphasis in original]<sup>30</sup>

This expression and the opinion that subsequent deficiencies should be 'otherwise provided for than by loan' reveal that the Water Board may have believed that water supply services should

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<sup>28</sup> Huse, 1916, p.102.

<sup>29</sup> 1860 City Document No. 56, p.7.

<sup>30</sup> 1859 City Document No. 8, p.14.

have been paid by annual taxation. More likely was that in the face of failing to meet even operating, maintenance, and interest payments from water rate revenues, the Water Board forced an interpretation of a mandate for department self-sufficiency that made them appear a financially sound department. Changing the definition of department financial self-sufficiency proved easier than managing demand and raising prices to cost-recovering levels. The Water Board succeeded in 1879 in putting an end to the policy of using water revenues to pay a portion of the city debt. In addition to making the Water Department happy, this action produced department surpluses that enabled decreases in the rates to metered water takers, who had been ‘grumbling’ about high rates for some time (further discussion in Section 3.3).<sup>31</sup>

An illustration of the different terms of accounting used by the Water Board and City Auditor are depicted in Figure 2.1. The figure shows that what the Water Board designated as “cost of construction” is nearly the same trend as what the City Auditor would call the water department’s cumulative expenditures over receipts.<sup>32</sup> The trend of cumulative expenditures over receipts, derived from numbers reported in the annual reports of the Water Boards, does not take into consideration loans and city appropriations made for the water works subsequent to May 1851.

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<sup>31</sup> Savage, 1981, p.180.

<sup>32</sup> Huse (1916) provides annual receipts and expenditures for the various city departments, from 1818 to 1908, culled from the reports of the City Auditor. The departure in the year 1872 probably reflects the Water Board acknowledging the transfer of \$19,000,000 (2000 USD) from the water debt to the city debt.

**Figure 2.1 – The Financial Condition of Boston’s Water Department, 1846-1895, as interpreted by the Water Boards and by the City Auditor**

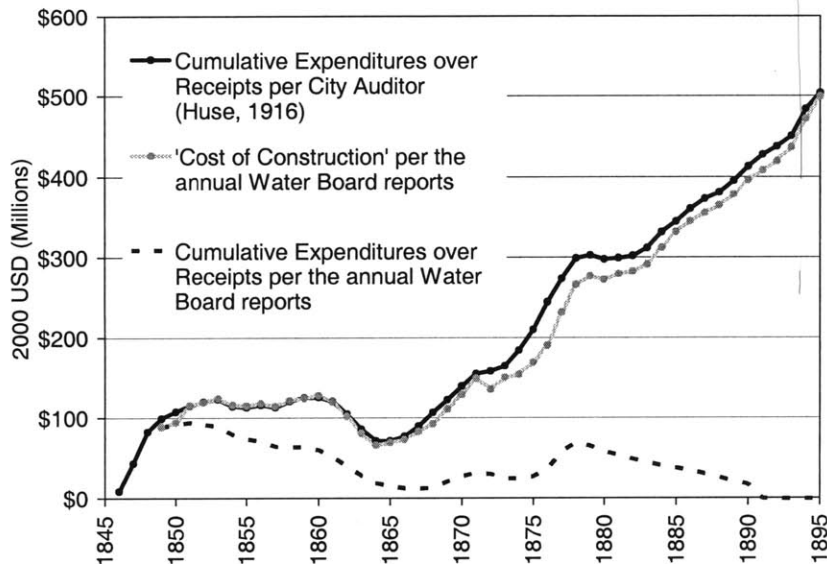


Figure 2.1 illustrates that capital costs for construction for Boston’s water supply in the 1800s were not paid by user fees. Construction was largely paid by loans, and not by general taxation. Only after the City Auditor transferred the sum of roughly \$19,000,000 (in 2000 USD) from the Water Debt to the City Debt was the water department said to have covered for the first time, in the fiscal year 1871-1872, “the running expenses of the works and the interest and premium on the debt incurred for their construction.”<sup>33</sup> Ultimately, the City was paid roughly \$252,000,000 (2000 USD) by the State of Massachusetts for the taking of its supply facilities in forming the Metropolitan Water District in 1895. The Mayor and Governor settled upon this figure because it approximated half (the ‘supply’ half) of the total cost of construction for Boston’s supply and distribution network up to 1895.

***Public Good Characteristics of Improved Water Supply***

As is the case today, the permanent nature and enormous capital costs of the water works led the city to identify loans as the proper means for financing construction. The Cochituate system was built to benefit future generations, and was intended to attract citizens to live in the city. The 1850 city census reported that

<sup>33</sup> 1872 City Document No. 63, p.18.

To prevent the removal of our citizens, it is important to present advantages in the City, which shall be deemed equal or superior to those of a suburban residence. We have already introduced the Cochituate Water, which is of the highest importance to the comfort and health of the citizens.<sup>34</sup>

Piped water supplies were particularly essential to the physical and economic development of Boston, since much of the city's landmass was reclaimed from the sea during the nineteenth century, precluding the use of wells for drinking water in those areas. A reliance on general revenues to ultimately finance capital expenditures was justified because the water system produced public goods for which users could not be easily charged. These included protection from fire,<sup>35</sup> better health, cleaner streets, and increased land values.<sup>36</sup>

Fire protection was perhaps the most widely identified public benefit of Boston's water supply in the 1800s, and the main scapegoat for justifying a lack of financial self-sufficiency in the water department. The City Auditor in 1854 conjectured that city savings in annual fire department appropriations and the reduced fire losses sustained by individuals and insurance companies, together with water revenues, were "much more" than the annual expenses and the interest on the cost of the works.<sup>37</sup> By 1870, the Water Board convinced the City to transfer approximately \$19,000,000 (2000 USD) from the water debt to the city debt because the sum "would not more than compensate this Department for the benefit derived by all the citizens for the use of the water by the Fire Department, and for other public uses since its introduction in 1848."<sup>38</sup> Only after this transfer was the water department able to cover annual expenses from water rates.

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<sup>34</sup> 1850 City Document No. 42, p.14.

<sup>35</sup> According to one expert, the peak load requirements of fire protection were also the primary determinant of the design of water systems and a major factor in their cost: "The demand for water in connection with fire protection alone, not so much in the quantity of water used as in the special construction of mains, hydrants, and reservoirs and the extraordinary pressure required, constitutes a considerable proportion of the total business of water works." Wilcox, Delos, *Municipal Franchises*, 1910, as quoted in Crocker and Masten, 2002.

<sup>36</sup> One observer noted "...the income from the water does not pay the interest on the scrip issued for obtaining this water. But the introduction of this water, at the expense of more than five million dollars of scrip of the city of Boston, has advanced the value of the real estate in this city, and why? Because the benefits, present and prospective, arising from the Cochituate water, are greater than the interest on the five millions or more of scrip which they have issued to bring that water into the city of Boston," from *Official Report of the Debates and Proceedings in the State Convention*, 1853, p.5.

<sup>37</sup> 1854 City Document No. 59, p.8.

<sup>38</sup> 1870 City Document No. 51, p.6.

An improved public water supply was also seen as conferring significant public health benefits upon nineteenth century Bostonians. In an age where disease was believed to spring from the atmosphere or ‘miasma,’ an abundance of water was necessary for cleansing people and their house drains. ‘Pure water’ was essential for both cleanliness and the sustenance of life itself.<sup>39</sup> One European visitor to mid-century Boston proclaimed that the entire cost of water works construction would be saved by the city in foregone drugs and medicine, and that “doctors must be the only people who will suffer from this liberal supply of the pure element.”<sup>40</sup> Lemuel Shattuck, in his 1850 Sanitary Survey for Massachusetts, described the Cochituate water as an ‘inestimable blessing to health.’

Although such public benefits to water supply were acknowledged from the beginning,<sup>41</sup> the early emphasis was nevertheless on bringing water to the city for domestic consumption and personal comfort. The public benefits of the Cochituate water supply were usually only explicitly acknowledged as water rate income did not cover costs (also see footnote 37). A means of paying for these public benefits such as fire protection weren’t planned for from the start.<sup>42</sup> The fire department only started paying for water supply services rendered in 1869, once the City Council declared it politically inexpedient to raise rates to users.<sup>43</sup> The earliest rhetoric of city officials indicates that the main motivation for constructing a public water supply in Boston was to bring water to households.<sup>44</sup>

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<sup>39</sup> The committee on water in 1839 assessed that “in the more crowded parts of the city, the most violent contests should frequently occur, to obtain enough of a hard brackish fluid, not for the purpose of luxury nor even of cleanliness but merely to sustain life in those filthy, wretched abodes of squalid poverty which might at once be rendered comparatively neat and wholesome by an abundant supply of what has never yet been seen there: pure water.” From Ward, 1963, p.22 (citing Boston City Doc. 19, 1839, p.6).

<sup>40</sup> Stuart-Wortley, Lady Emmeline, *Travels in the United States, etc. during 1849 and 1850*, New York: Harper & Brothers, 1851, p.41.

<sup>41</sup> In 1836, an engineer was tasked to assess the expense of introducing “an abundant and unfailing supply of pure water, to be employed for the purposes of domestic consumption, the promotion of health, protection from fire, and for ornament.” 1836 City Document No. 7, p.4.

<sup>42</sup> In 1850 it was decided that “The use of water for [extinguishing fires, flushing sewers, and for fountains and hydrants on the Common and public squares] is undoubtedly of great value to the City, but in consequence of the irregular demand for water in these cases, it is impossible to make a correct estimate of the quantity required [and the appropriate assessment].” 1854 City Document No. 54, p.32.

<sup>43</sup> In 1869 it was declared “...to increase the water rates for domestic purposes is attended with so many objections that it is clearly the duty of the City Council to avoid it if possible...no action in this direction ought to be taken until all other means of income have been exhausted.” 1869 City Document No. 96, p.4.

<sup>44</sup> Ogle (1996) on the other hand claims that in American cities in general, “officials regarded household running water as an afterthought, an incidental benefit to the more important need to supply water to firefighters and businesses, and they were rarely prepared for the extent to which households both consumed and wasted water” -

Boston ultimately borrowed heavily for the construction of water works, even amidst nationwide calls for municipal fiscal reform. Especially during the late 1870s, ‘pay as you go’ was the maxim in cities across America.<sup>45</sup> Boston’s Mayor Cobb expressed this sentiment when he condemned municipal indebtedness in 1876, explaining that

It would be difficult to hoodwink and cheat a people when the amount of the plunder has got to be paid in the very next tax bill, instead of being hidden amid the confusion, easily made inextricable, of an extensive book-keeping and a tangled computation of loans, payments, sinking funds, and interest accounts.<sup>46</sup>

The extraordinary growth of municipal debts had caused the Massachusetts legislature of 1875 to pass an act imposing a limit upon the borrowing power of cities. The water debt, however, was placed outside the limit.<sup>47</sup> Indeed, during this decade of fiscal reform, Boston constructed an extensive system of new supply reservoirs on the Sudbury River.<sup>48</sup> One Bostonian writing on the subject of municipal indebtedness during this period expressed the widely held view that

It is almost superfluous to point out that the possession of system of water works by any city or town is an object which justifies municipal expenditure to a certain degree, without reference to compensation in money derived from money rents.<sup>49</sup>

In light of this popular interpretation of water debt, it is not surprising that Boston failed to achieve a mandate of paying the principal on its debt through water rate revenues.

### *Affordability Concerns*

Boston’s water planners made water services affordable by having the city pay for the construction of service connections to households from the distributing mains, and by establishing a low water tariff relative to other cities. Boston strived for ‘universal subscription,’ i.e., 100% access of citizens to piped water. Efforts to achieve full coverage were driven not

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(p.37). Nevertheless, Rosen’s (1986) analysis of the Cochituate Water Board’s failure to maintain an adequate system to effectively deal with fires (p.210), along with the rhetoric of city officials, supports the idea that households were the intended main beneficiaries. Rosen (1986) even claims that the Cochituate Water Board was captured by the interests of real estate developers and well-to-do property owners, because residential real estate development was “where the most powerful demand for its activities lay” (p.211).

<sup>45</sup> Teaford, 1984, p.287.

<sup>46</sup> Huse, 1916, p.221. This quote highlights the difficulties one encounters when trying to figure out, over one hundred years after the fact, exactly how annual water department deficiencies were paid.

<sup>47</sup> Huse, 1916, p.222. Anderson (1984) says that “municipal water bonds, because of their relative stability and good payment record, were not as affected by debt restrictions as were other types of municipal borrowing.”

<sup>48</sup> Three of seven storage reservoirs were completed in 1878 at a cost of \$86.2 million (2000 USD).

<sup>49</sup> Hale, Charles, Municipal Indebtedness, Atlantic Monthly, Vol. 38, No. 203, December 1876, 661-673, p. 667.

only by the desire to maximize the public health gains of piped water supply,<sup>50</sup> but also by the belief that exploiting economies of scale would enable the system to move more quickly to the financial self-sufficiency identified as eluding the water departments in New York and Philadelphia.<sup>51</sup>

In developing countries today, the relatively high price of connecting to a piped water network (as compared to the monthly fees for water and service delivery) is considered to be the greatest affordability barrier to expanding network services to the poor. Boston similarly saw a high connection price as a deterrent to subscription, and subsidized all connections in order to lock in demand. Indeed, the average cost of labor and materials to the city per service connection was approximately twice the average annual dwelling house water rate in 1850. The policy to have the city pay for service connections originally passed in the City's Common Council on February 21, 1848, but was not concurred with by the Board of Aldermen and Mayor, who referred the matter to the Joint Water Committee (chaired by the Mayor and comprised of members of both houses of the bicameral City Council – the Common Council and Board of Aldermen). After consulting with the Water Commissioners and the City Engineer, the Committee unanimously recommended passage of the policy, reproduced below in Figure 2.2, as it appeared to the public in Boston's daily newspapers.

**Figure 2.2 –  
Notice of the City's service  
connection policy published  
per order of the Board of  
Aldermen and Mayor given  
June 12, 1848.**

From the June 15, 1848  
*Boston Courier*  
(Boston Public Library,  
Microfilm Collection).

<p>formerly Gov , and formerly as from Wiscon- n Rhode-Island. on Vermont. Michigan State s from Vermont Pennsylvania from Iowa Ter- tee Pamphlet. LCOHOL &amp; CO. STS' ROW, gists generally.</p>	<p>through Spofford's Gap, or some point towards Peterborough, equivalent thereto. By order of the Directors, JOHN PRESTON, Clerk of Peterborough and Shirley Railroad Co. New Ipswich, June 13th, 1848. 316—je15</p> <p><b>CITY OF BOSTON.</b> Ordered, That in the opinion of the City Council, the expense of introducing a service pipe through a sidewalk and one wall of each house or building should be at the cost of the city, and that this shall be done in such time and under such restrictions as the Commissioners may judge best; and that additional expenditure which may be needful in the opinion of the Water Commissioners to make the water avail- able, may be incurred by them at the expense and with the as- sent of the owner or tenants. Accepted in Common Council, and the order passed, March 2, 1848—yeas 46, nays none. The Board of Aldermen passed the same in concurrence, March 8, 1848. Published by order of the City Council. je15 S. F. McLEARY, City Clerk.</p> <p><b>NOTICE.</b> All persons are forbid trusting or harboring any of the crew of the British bark <i>Lord Elgin</i>, McHardy, Mas- ter, as no debts of their contracting will be paid by the Captain or Consignees. 312—je15</p> <p><b>FIRE BRICK.</b></p>	<p>es. Cherries. The above is at General Lyma can be had if d gress st.</p> <p><b>FOR S.</b> A new Unitar doors, water, &amp;c. &amp;c. three acres. These prem ride by Railro PRATT, 46 Part of the f House.</p> <p>Store m18-</p> <p>A D near a daily, f No 112 Wash</p>
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<sup>50</sup> Elkind, 1998, p.47.

<sup>51</sup> Savage, 1981, p.102.

The city's decision to pay for the construction of service pipes through the wall of each dwelling house was in part motivated by the experience of the private-sector company whose pipe system was the precursor of Boston's public network. The Boston Aqueduct Company, 'never a financial success,' was created in 1795 to carry water from Jamaica Pond.<sup>52</sup> By 1838, there were 15 miles of main supplying only about one in every four dwelling houses within the company's service area, with about 4,350 families opting not to apply for aqueduct water. The low subscription rate was ascribed by the Company to the abundance of wells in the city, as well as the difficulty of changing people's habits. A representative of the Company warned the planners of Boston's public supply that social marketing to exhort connections would probably fail:

notwithstanding the extraordinary efforts which have been made, for a few years past, to prove [wells] worthless, we believe it will not be an easy task to convince a large number of our fellow-citizens that those sources contain no other than a poisonous beverage, from which they and their fathers have drunken to a good old age, and for many generations.<sup>53</sup>

Installing service connections at the city's cost helped to provide Boston's public piped network with a subscription rate significantly higher than the 25% rate experienced by the Aqueduct Company. By 1850, there were 10,407 dwelling houses taking Cochituate water, out of a total of 13,463 water takers.<sup>54</sup> The state census of 1850 counted 15,194 total inhabited dwelling houses in Boston,<sup>55</sup> suggesting a subscription rate for dwelling houses of 68.5% in 1850. The 1852 map of the system's distributing mains indicates coverage throughout the city, including the areas identified as slum districts in Boston's 1849 report on cholera, such as Fort Hill and areas of the North End.<sup>56</sup> By 1870, 22,846 dwelling houses subscribed to the water, in a city of 29,511 dwelling houses (77%). The annexation of the outlying suburbs of Roxbury in 1868 and Dorchester in 1870 added approximately 7,000 dwelling houses to the total for wards from the

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<sup>52</sup> Huse, 1916, p.82. By 1817, 40 miles of pine water mains served about 800 families that paid a \$10 annual utility fee. This is equivalent to approximately \$128 in 2000 USD, roughly equivalent in real terms to the average annual water rate as designed by the Water Commissioners. APWA, 1976, p.219.

<sup>53</sup> March 19, 1838 Memorial presented to the Board of Common Councilmen by the Boston Aqueduct Company, in Boston City Documents series.

<sup>54</sup> The term water taker was used by the Cochituate Water Board, and encompasses all user accounts, such as dwelling houses (private homes), shops, factories, model houses (tenement buildings), etc.

<sup>55</sup> 1850 City Document No. 42.

<sup>56</sup> 1853 City Document No. 7.



city proper, and far fewer water takers,<sup>57</sup> so the subscription rate in the city proper was probably much closer to 100%. Indeed, in 1878 a survey by Boston's Board of Health found that 99% of households had plumbing for piped water services.<sup>58</sup>

Although it was not the impetus for adopting a policy of subsidized connections, keeping control of connections within the Water Board also avoided problems with quality control that other cities were experiencing. During an 1857 trip to Philadelphia, New York, and Albany, two members of the Water Board found that water departments in these other cities generally did not manage (nor pay for) the construction of service connections. They found in Albany:

The service-pipes in Albany are but four and a half feet below the surface of the ground, without boxing, or other precautions to keep them from freezing. They are inserted in the main at the expense of the water takers, and are at their own risk, as are the pipes within their own premises, no city officer having any supervision over their insertion.<sup>59</sup>

The situation in Philadelphia was reported similar to that in New York City, where they found:

The mains in New York are tapped under the supervision of the Water Board; but all service-pipes are attached to the tap and carried into the houses at the expense of the owners or tenants, and at their own risk.<sup>60</sup>

Central provision in Boston meant that when flaws were discovered in the standard, the City Engineer could pinpoint in 1854 that "The cast-iron service pipes, about 2,500 of which were laid five or six years ago, will probably have to be taken up, as they are rapidly filling with rust."<sup>61</sup>

Along with subsidized connection fees, low water rates were employed in Boston's efforts to achieve universal subscription. Nathan Hale, a member of the Water Commission in charge of

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<sup>57</sup> 1873 City Document No. 54. Also, 1870 City Document No. 51 notes that the annexation of Roxbury added only 1,419 water takers to the Cochituate system. When Dorchester was canvassed in 1870 with a view to ascertaining the probable number of water takers, of 506 responses, 41% said no, 34% said yes, and 25% said doubtful – Fitzgerald, 1876, p.17.

<sup>58</sup> "The examination covered nine distinct blocks of dwelling-houses in different districts of the city, ranging from the most expensive and fashionable to the most squalid. The average of all these was intended to represent the average for the whole city, as it undoubtedly does. Three hundred and fifty-one dwellings with an aggregate population of 3,500 persons were examined." U.S. Census Office, 1886, p. 132.

<sup>59</sup> Bradlee, 1868, p. 179.

<sup>60</sup> Bradlee, 1868, p. 179.

<sup>61</sup> 1854 City Document No. 54, Appendix p. 15.

developing the Cochituate works, described the proposed water charges at the 1848 Water Celebration<sup>62</sup> as

arranged upon the lowest scale which can afford the promise of an adequate indemnity for the cost of the work, and at lower rates in general, than are paid for water in any city within our knowledge. It was deemed suitable that the fruits of an enterprise, prosecuted at the common charge of all the citizens, and for the common benefit, should be enjoyed by all, on the most liberal terms, consistent with the sacred duty of providing for the debt, which is a necessary condition of the accomplishment of the work...<sup>63</sup>

Mayor Josiah Quincy Jr. also explained that

The water rent is placed at a price that renders it economical for every one to take it. All citizens, whether they take it or not, will, after the expiration of two years from the completion of the work, be obliged to make up the deficiency of the rent in the general tax. All therefore are called upon by the natural desire of enjoying what they are obliged to pay for, from economy and from public spirit, to take the water and receive a blessing which, after enjoying it for one year, neither they nor their families, would abandon for ten times its cost.<sup>64</sup>

Yet, the 'sacred duty of providing for the debt' was generally not achieved through water rates. Instead, department deficits were more often paid by loans incorporated in the city debt than by general taxation.<sup>65</sup>

Before the tariff designed by the Water Commissioners was passed by the City Council, elected officials debated whether the proposed charges would promise adequate cost recovery. The Commissioners designed the annual water rates for large quantity users on a decreasing block scale of \$130 per 100 gallons used per day if consumption exceeded 500 gallons per day (gpd), and \$196 per 100 gallons used per day if consumption was less than 500gpd.<sup>66</sup> These

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<sup>62</sup> "A great procession was organized on that day, under the direction of the city government, which marched through the principal streets to the Common, where, after a hymn sung by the Handel and Haydn Society, a prayer, an ode written by James Russell Lowell and sung by the school-children, addresses by the Hon. Nathan Hale and by Mayor Quincy, the water was let on through the gate of the fountain, amid the shouts of the people, the roar of cannon, the hiss of rockets, and the ringing of bells." From p.28 of Stanwood, Edward, *Boston Illustrated*, Boston: J.R. Osgood, 1872.

<sup>63</sup> 1848 City Document No. 54, p.27.

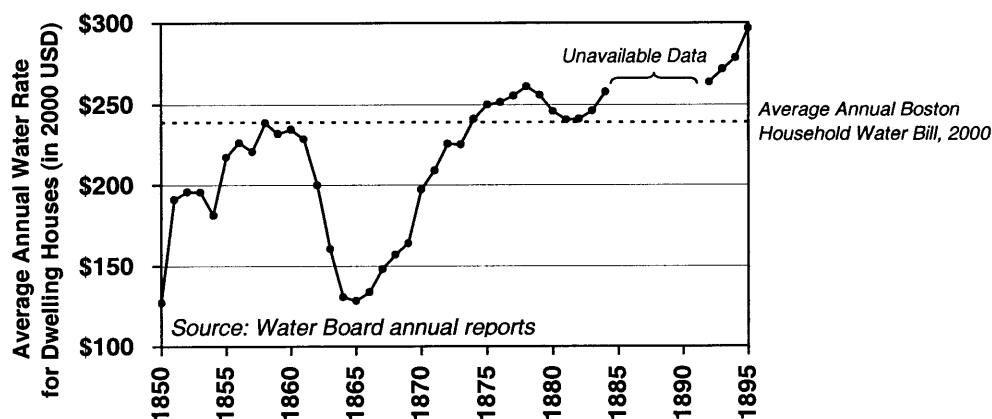
<sup>64</sup> 1848 City Document No. 54, p.41.

<sup>65</sup> Huse, 1916, p.102. Also, Bradlee (1868), pp. 145-6, notes "The Committee on Water recommended, on December 8<sup>th</sup>, 1851, that \$100,000 be set aside to pay the excess of interest over income, and that this amount be put into the annual appropriation," and that it was voted "that it is inexpedient to raise \$100,000 by taxation to meet interest on water debt, but that the deficiency should be charged to construction."

<sup>66</sup> In many American cities today, water prices are given per thousand gallons (kgals). This tariff is equivalent to \$6.67/kgals for estimated amounts under 500gpd and \$4.44/kgals for estimated amounts over 500gpd. The calendar year was estimated at 300 days for tariff purposes, probably in recognition of Sundays and holidays.

consumption-based rates were estimated for large quantity users like brewers and distillers, because the use of meters for large quantity consumers was not adopted from the start. The implementation of consumption-based rates thus meant that the Water Commissioners had to visit the premises of every water taker to estimate daily average consumption.<sup>67</sup> As designed by the Water Commissioners, domestic annual rates were based on the assessed value of homes: \$111 (in 2000 USD) to each family occupying a house with an assessed value of up to \$111,000, and an additional \$22 for each additional \$22,200 of assessed value up to a maximum value of \$333,000 and corresponding rate of \$333. When multiple families in a single home took water from a single tap, the rate would be based only upon the assessed home value.<sup>68</sup> This scale of rates generated an average annual price paid by 10,407 dwelling houses of \$127 in 1850. This amount is slightly over half of the average water bill paid by Boston households in the year 2000 (see Figure 2.3).<sup>69</sup>

**Figure 2.3 –  
Average Annual Water  
Rates Paid by Boston  
Dwelling Houses,  
1850-1895**



Despite widespread support for low tariffs, some elected officials believed that Water Commissioners’ fees were too low. In December 1848, members of the City Council’s Water Committee proposed an alternative tariff schedule that included higher rates for large quantity users<sup>70</sup> (\$6.67/kgals<sup>71</sup> for all quantities instead of \$6.67/kgals for estimated amounts under 500gpd and \$4.44/kgals for estimated amounts over 500gpd). For domestic users, higher rates

<sup>67</sup> “The assessment of the amount to be paid for water in some cases, particularly when required for certain manufacturing purposes, has been attended with considerable embarrassment in the adoption of a satisfactory rule for determining the quantity of water used, on a principle which shall be equitable and uniform in its application to different parties. It has been necessary also that all the premises upon which the water is admitted, should be visited, before an entry is made on the books of the rate assessed,” 1849 City Document No. 18, p.6.

<sup>68</sup> According to the 1850 State Census, the average number of families to a dwelling house in Boston was 1.71.

<sup>69</sup> The average annual Boston household water bill paid in 2000 was \$239.09 (MWRA Advisory Board, 2000 Water & Sewer Retail Rate Survey).

<sup>70</sup> Rates were based on estimated consumption for large quantity users before the introduction of meters.

<sup>71</sup> 1000 gallons (US) equals 3.78541 cubic meters.

were proposed for everyone except those with the least valuable property (minimum of \$89 to a maximum of \$644 a year for houses ranging in assessed value from \$44,000 to up to \$400,000). This proposal also advised charging an additional \$22 for each water closet, urinal, and bath tub used in houses.

The relative affordability of the two tariff proposals was a major concern. Those opposed to the alternative proposal feared that instead of increasing revenue, the higher rates would “tend to retard the introduction of the water into general use” and consequently diminish revenues. They warned that

Although the amount of increased charge in each case, is but a small sum, it is sufficient to change the whole character of the schedule, so as to render it, comparatively with rates charged in other cities, a schedule of high rates, instead of one of low rates. The effect of so great a difference of rates on the number of customers who will take the water, cannot be doubted.<sup>72</sup>

Those in favor of the low rates pleaded that the task of establishing the water rates was “work too complicated to be undertaken by a large deliberative body” such as the City Council.<sup>73</sup> Shortly after the City Council deliberated on the matter, the City Solicitor delivered his opinion that the Water Commissioners were authorized to establish the water rents free from the control of the City Council, until the expiration of their office.<sup>74</sup> Thus, the lesser rates ensuring more universal subscription were adopted.

### ***Early Attempts to Recover Costs from Users***

Boston’s early water administrators made some attempts to price water services closer to their financial costs. Early demands for ‘free water’ on the part of various charitable interests were generally rejected by the Water Board and City Council.<sup>75</sup> For example, in February 1850 the

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<sup>72</sup> 1848 City Document No. 43, pp.12-13.

<sup>73</sup> This sentiment certainly contradicts the City Council’s future actions in quashing the ‘expert’ recommendations of the Cochituate Water Board for higher prices and demand management measures in the face of annual deficits.

<sup>74</sup> The City Solicitor interpreted the 1846 Act as providing that “the Water Commissioners ... *establish* the Water Rents, free from the control of the City Council; and *secondly*, that the City Council are authorised and required to *regulate* these Rents, from time to time, *after the expiration of the office of the Water Commissioners*, with a view to the payment, from the net income, rents and receipts therefor, not only of the semi-annual interest, but ultimately of the principal also, of the “Boston Water Scrip,” so far as the same may be practicable and reasonable [emphasis in original].” 1848 City Document No. 45.

<sup>75</sup> One exception is city departments, who did not pay for water supplied until 1869. In January 1853, the City Council had passed an Order authorizing the Cochituate Water Board to assess water rates on all Public Buildings, but this was repealed April 1854. Bradlee (1868) p.168, p.170.

Council rejected 'several petitions' for free water from the 'colony' associated with a sailing vessel. The Water Board believed setting a precedent of free water would inspire others to ask similar 'favors' and lead to administrative troubles and diminished revenues. In advising the Council, the Board warned that a desire for free water

may seem rather fanciful than real; but a very slight practical acquaintance with the collection of water rents will satisfy any one that there is a much wider-spread disposition than could at first be supposed, to get rid of paying the reasonable and low rates now charged.<sup>76</sup>

Also in early 1850, the Council rejected a petition for free water by an orphanage. To justify this position, the City Solicitor explained that water payments were pledged to the bond holders, and that by providing water free of charge, the City would be making an unauthorized taking of property:

If in the general view of the subject, the water is to be regarded as valuable property, the City Council have no more right to give it away, than they have the right to make a donation of the City lands, or of the money in the City Treasury.....If the City Council may give water to one institution of this kind, they may to all. If they may give it to a charitable institution, they may to an individual. If they may give it to a poor corporation, they may to a poor man. If they may give it to an institution which is doing great good in the community and on this account, they may give it to a good man. In short, the same reasoning would authorize the City Council to vote the water free at once, and thus take from the scrip holders the fund which is expressly set aside and pledged by law for their security.<sup>77</sup>

In fact, in February 1855, a Committee was chosen by the City Council to consider "making the water free" and paying the interest on the water debt by insuring the buildings supplied. On June 30th they reportedly found such a measure to be inexpedient.<sup>78</sup> Another early policy of the Water Board, in alignment with current policy advice for reducing utility losses, was the rejection of petitions to establish free 'drinking hydrants' in public streets.<sup>79</sup>

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<sup>76</sup> Bradley, 1868, p.127.

<sup>77</sup> Bradley, 1868, p.136.

<sup>78</sup> Bradley, 1868, p.175.

<sup>79</sup> On July 5, 1850, the Board decided not to establish drinking hydrants in public streets because "1<sup>st</sup>. They are liable to get out of order, and thus prove a source of frequent expense. 2<sup>nd</sup>. They often prove a nuisance to passers by, in consequence of boys collecting around them, and throwing water about; and in consequence of the mud and dirt, which it is almost impossible to prevent from collecting about them. 3<sup>rd</sup>. They necessarily cause a great waste of water. 4<sup>th</sup>. They are, in many situations, injurious to the revenue, by furnishing water free of expense to persons residing or doing business in the vicinity, who would, otherwise, be willing to pay for it. 5<sup>th</sup>. They are dangerous, in consequence of the accumulation of ice around them in the winter season." Bradley, 1868, p.128.

Further evidence of elected officials attempting to recover costs from users includes the enactment of several water rate increases during the first two decades of water system operation. To help reduce water department operating deficiencies, the City raised rates in 1851, 1855, 1860, and 1865.<sup>80</sup> Even in the face of public opposition, the City Council supported the recommended rate increases.

In 1851 the City Council, headed by a Mayor who condemned the extravagant expenditures of the city,<sup>81</sup> raised the tariff for both domestic users and large quantity users. Changes to domestic rates included changing the basis of the rate to include the number of families residing in a dwelling in addition to the property value, and extending the scale of rates to cover homes with assessed value up to \$444,000, resulting in a maximum annual water rate of \$533 for a single family. Changes to the rates for large quantity users included the refinement of the consumption blocks and increases in the corresponding prices. The first block remained 500 gpd (gallons per day) of estimated use, but price increased to \$11.11/kgals. For an estimated use of between 500 and 1,000 gpd, price was \$8.89/kgals. Up to 2,000 gpd of use, the price was \$7.33/kgals, and up to 10,000 gpd estimated use, the price was \$6.00/kgals. Customers consuming greater than 10,000 gpd would have their rates specially set by the Water Registrar, who could not set a price lower than \$2.22/kgals.<sup>82</sup>

The tariff for dwelling houses was increased pro rata in 1855. The new tariff also incorporated an annual \$100 charge for the use of any number of water closets and bath tubs in private homes. The City Council granted the recommended increase while rejecting the petition of citizens who found the water rate ordinance “oppressive, and unequal in many of its provisions, and [liable to] cause the loss of many water-takers.”<sup>83</sup> In planning the new schedule of rates for improved cost recovery, the Board members again looked to the practices of their colleagues in Philadelphia and New York. Philadelphia’s annual domestic rates in 1854 were \$50 for dwellings in courts

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<sup>80</sup> Rates in real (2000 USD) terms can be seen in Figure 2.3 for dwelling houses and in Figure 3.1 for large quantity consumers.

<sup>81</sup> In his 1850 inaugural address, Mayor Bigelow said “I have reason to believe that there is no other City in the world, (certainly not in our country) the affairs of which, in proportion to its size, are administered at so great an expense as our own.” Huse, 1916, p.102.

<sup>82</sup> In real terms, this minimum rate is actually lower than the previous minimum rate for the highest quantity consumers.

<sup>83</sup> 1854 City Document No. 82, p.3.

having one room on a floor and \$100 for all other buildings, regardless of value. The \$100 rate included a hydrant for each house, but an additional “specific rate” was charged for each water fixture on the premises. The Cochituate Water Board found that this type of scheme would not raise the desired funds and that the specific rate on water fixtures would be onerous. In New York and Albany, the domestic rates were graduated by the number of feet frontage, building height, and number of occupants, with allowances for one bath tub and one water closet. The Board found this scheme “hardly worth the time and trouble.” While they acknowledged that the water rate in Boston “for all other purposes is regulated, or attempted to be regulated, by the quantity actually consumed,” the Water Board decided the water-rate-as-property-tax “can be collected with the least trouble or annoyance to any one.”<sup>84</sup> The Water Committee of the City Council predicted that the 1855 rate increase would not immediately cover the annual deficit of the department, but as new users came onto the system, the income would fully equal the interest on the water debt within two years.

In 1860 the city raised the tariff for large quantity users. In the absence of metering, estimating the water consumption of the various classes of water takers had been difficult in Boston. In August 1859, however, a breach in the aqueduct allowed the Water Board to conclude that at least one half the amount of water brought into the city was being used for non-domestic purposes. Rates paid by dwelling houses at this time comprised approximately 61% of water rate revenue. Therefore, the Board raised the tariff from 1851 for large quantity (non-domestic) consumers, effective January 1, 1860.<sup>85</sup> The price of water in the lowest estimated block of consumption (under 500 gpd) increased to \$12.24 per thousand gallons of estimated use. The number of consumption blocks increased from five to eleven, and if estimated consumption was greater than the original cutoff of 10,000 gpd, the lowest possible tariff increased to \$4.08/kgals. The real effects of this significant rate hike were short-lived, however, because of high inflation in the early 1860s (see Figure 3.1).

Between 1859 and 1864, the numbers of meters applied to the service pipes of water-intensive businesses increased from 23 to 312. In 1865, metered water prices nominally increased after

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<sup>84</sup> 1854 City Document No. 25, p.7.

<sup>85</sup> Boston City Document No. 56, 1859.

the Water Board convinced the City Council to change the metered water tariff from the decreasing block scale (\$6.32/kgals to \$2.11/kgals) to a uniform rate of \$3.16/kgals.<sup>86</sup> The Board advised this change because it felt the amount charged for large quantities was too low and the amount charged for small quantities too high, and because rates needed to increase in light of the fact that “the deficiency of the current financial year will exceed that of last year.” Hoteliers who had been paying the lowest rate lobbied against this increase.<sup>87</sup> Nevertheless, the committee of the City Council deliberating on the issue sided with the Water Board. The committee voiced the concern that the “annual income of the Water Works should pay the annual cost of carrying them on.” The committee even suggested that further rate increases would be necessary:

and, although the Committee were not authorized to consider the matter of the rates for water not measured by meters, they cannot forbear to express their conviction that it will be found necessary to increase those rates at least ten per cent, and they respectfully call the attention of the City Council to the subject.<sup>88</sup>

By 1869 increasing user fees was no longer palatable, and a bi-decennial tradition of increasing water rates ended. The Committee of the City Council reporting on the matter explained

...to increase the water rates for domestic purposes is attended with so many objections that it is clearly the duty of the City Council to avoid it if possible...no action in this direction ought to be taken until all other means of income have been exhausted.<sup>89</sup>

Following this cue, the water department began charging the fire department for water and the maintenance of fire hydrants and reservoirs. The next year, \$19,000,000 (2000 USD) was transferred from the water debt to the city debt in light of past services rendered for fire protection purposes. In subsequent years, in the face of little public and political support for user fee cost recovery, the City offered multiple rate reductions to all users.

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<sup>86</sup> Because of inflation, this ‘increase’ resulted in a tariff lower than the lowest tariff (representing greatest consumption) of 1860.

<sup>87</sup> A report of the Cochituate Water Board (1865 City Document 35) identifies Parker Hotel as the main objector. Parker also brought the unsuccessful suit against the City in 1860 to prevent the Water Board from charging metered rates (see section 3.3).

<sup>88</sup> 1865 City Document No. 69, p.5. A pro rata increase in domestic rates was reviewed (1865 City Document No. 102) but not implemented – except for those with the most valuable properties (1865 City Document No. 110).

<sup>89</sup> 1869 City Document No. 96, p.4.



### **3.0 DEMAND MANAGEMENT: METERING AND ALTERNATIVE STRATEGIES**

Demand management strategies are used by water utilities to get people to use water more efficiently. They include physical rationing, price rationing (i.e., metering), and public education. Nineteenth century water planners in Boston did not plan for demand management initially, but turned to public education (i.e., notices to water takers asking them to use water more efficiently) and practiced limited price rationing in the face of unforeseen excessive water consumption. Historically in developing countries, cities have relied upon strategies of public education, and turned to physical rationing as systems fell into disrepair.

Metering is a central part of the prevailing water and sanitation policy advice currently given to less developed countries, and is seen as a way of pulling water and sanitation systems out of low levels of service. The Asian Development Bank has called metering the single most important area requiring improvement among water utilities.<sup>90</sup> There are valid arguments for and against metering voiced by the World Bank and developing countries, respectively. Many of these same debates played out in the Boston case, where there was a commitment to metering but reservations about the costs, as well concerns about the effects of reduced consumption on public health and the financial sustainability of the system. There is also evidence that there were significant political costs to price rationing in nineteenth century Boston.

#### **3.1 *Theory and Practice of Demand Management***

Cost recovery for water supply services through user fees may be accomplished through a variety of charging mechanisms, including flat-rate fees and earmarked taxes. If charges are to reflect usage, however, some form of volumetric charge must be employed. Metering and volumetric charges are advocated in industrialized countries to improve efficiency, to conserve water resources and to delay investment for capacity expansion. Nevertheless, today many OECD countries do not charge users based on metered consumption. For example, households are not metered in Ireland and Iceland; fewer than 25% of households in New Zealand are metered; and only 55% of households served by municipal water supplies in Canada are metered (OECD,

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<sup>90</sup> Asian Development Bank, 1997.

1999). Metering water connections in the United Kingdom was uncommon until private-sector participation in service delivery increased over the past decade.

Although the practice of metering in cities of the industrialized world is inconsistent, multilateral aid agencies consistently advocate metering at the household level for urban communities. Charging for water based on the amount used sends the appropriate economic signals to discourage wasteful uses of water. In current World Bank-financed projects, the real cost of new water supplies per cubic meter is typically two to three times greater than in preceding projects.<sup>91</sup> Universal metering is seen as a critical tool for demand management in the face of these increasing long-term development costs and growing water scarcity.

Measuring production and consumption also enables service providers to detect the locations of waste within the network and to determine the physical health of the water infrastructure. The World Bank estimates that non-revenue or unaccounted for water<sup>92</sup> represents a quarter of the total water supply in developing countries.<sup>93</sup> If this water lost to leaks or illegal connections could be captured by the utility, it could be used to increase utility revenues and meet currently unsatisfied demand, or to defer future capital expenditures necessary for additional supply.

Metering is also viewed as a way to pull water supply systems out of low levels of service, because it sensitizes users to the fact that water services are costly. The historical resistance to the use of price rationing in the developing world has meant that systems fall into disrepair. Metering is seen as a way to increase the transparency between the relationship of service costs to price, and to build support for tariff increases.

Some municipalities in the developing world, however, have resisted metering households. A survey of fifty utilities in developing country cities in the Asian and Pacific region found that on average only half of service connections were adequately metered (Asian Development Bank, 1997). Half the utilities did not have full metering of production and consumption. Eight utilities had incomplete metering, ten had very little metering, and Calcutta did not meter at all.

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<sup>91</sup> Briscoe, 1996, p.13.

<sup>92</sup> Unaccounted for water is comprised of leakage and 'administrative loss' – water either stolen or provided freely.

<sup>93</sup> deMoor and Calamai, 1997, p.11.

Developing country cities have resisted metering for philosophical, practical, and political reasons. Philosophical objections include resistance to the monetization of water services. A major practical objection to universal metering in developing countries is the high cost involved. Besides the cost of the meter itself, costs of meter reading and maintenance can be significant in large cities.<sup>94</sup>

Another practical objection is that metering may be inappropriate under conditions of physically rationed supply. Urban dwellers in developing countries today often receive rationed water supply services, as opposed to the 24-hour “abundant and unfailing supply of pure water” provided nineteenth century Bostonians. In Hyderabad, India, for example, water-takers with house connections tend to collect all the water that flows through the tap during the short period that water supply is provided. Water consumption is thus constrained by the amount supplied, and meters would have a negligible effect on demand. There are also technological reliability considerations with using meters in physically rationed supply. For example, where supply is intermittent, the pressure from the initial burst of water through the pipes can result in artificially elevated meter readings.<sup>95</sup>

Implementation of metering and other demand management strategies is politically difficult where there are strong preferences for new development projects over improving efficiency. Reducing water losses is generally more cost effective than developing new supplies in the face of water scarcity. Nevertheless, politicians, engineers, and contractors have traditionally favored the construction of new supplies.<sup>96</sup>

Finally, metering in conjunction with particular tariff structures can create inequitable cross-subsidies. Current policy advice often recommends increasing block tariffs (or “social tariffs”), to promote conservation and subsidize services for the poor, who presumably consume less water than richer households or industrial firms. This type of tariff structure has been documented to

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<sup>94</sup> In Asia, West Africa, and Latin America, meter capital costs range from US\$15 to US\$25. Roth, 1987, p.241.

<sup>95</sup> Davis, J., S. Tankha, A. Ghosh, P. Martin, T. Samad, B. Zia, and G. Prunier. Good governance in water and sanitation: Case studies from South Asia. Report to the Water and Sanitation Program, South Asia regional office. 148 pp.

<sup>96</sup> Uitto and Biswas, 2000, p.22.

hurt rather than help the poor, however, in situations where poorer households pay the higher tariff because they share a single metered connection.<sup>97</sup>

### **3.2 *Demand Management for Water Supply in Nineteenth century Boston***

In many ways, the debates over the utility of metering water supply usage now playing out in the developing world mirror those voiced by Boston planners in the late 1800s. In the face of the increasing costs of procuring new supplies, waste detection through metering was identified as the best method for helping the city get by with available supplies. Inducing more economical water use was a constant preoccupation of Boston's nineteenth century water supply administrators. Nevertheless, the high financial and political costs of demand management measures such as metering meant that the city more often resorted to augmenting supply than reducing demand.

The first Cochituate Water Board instituted a program of purchasing water meters, a nascent technology in 1850,<sup>98</sup> to help prevent the wasteful use of water. As early as 1851, the Water Board found that consumption was more than twice the quantity the Water Commissioners had estimated as sufficient to supply the City's approximately 140,000 inhabitants. By the end of 1852, an ordinance was passed authorizing the Cochituate Water Board to "ascertain by meters or otherwise the quantity of water used in any case, and to establish the water rate to be paid therefor." The Board planned to use this ordinance to induce the more economical use of water, and warned that failing to do so would

... produce the necessity of either laying an additional main to the Brookline Reservoir, or of stopping the supply which is now afforded to the most profitable classes of water takers [manufacturers]. Each of these alternatives will add no small amount to the present taxes of the City, unless indeed the present water rates should be essentially increased, and also by postponing indefinitely the time when we can anticipate that the interest and current expenses will make the cost of the works an ever increasing bur[den] to the City.<sup>99</sup>

Meters were immediately seen as essential for curbing waste and delaying investment in additional capacity. Nevertheless, technological unreliability meant that the application of

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<sup>97</sup> Whittington, D. 1992. Possible adverse effects of increasing block water tariff in developing countries. *Economic development and cultural change*: 75-87.

<sup>98</sup> The first patent for a water meter was issued in England in 1824. Between 1837 and 1890, the U.S. Patent Office granted 678 patents for water meters. Melosi, 2000, p.124.

<sup>99</sup> 1853 City Document No. 7, p.9.

meters was slow in Boston. Between 1859 and 1870, the number of meters in use increased from 23 to 1,089. The number of meters fluctuated about this number until 1879, after which meter use increased fairly steadily. By 1895 there were 4,398 meters in use in Boston, representing 4,049 accounts for metered water, or less than 5% of all accounts – representing mostly industrial or commercial consumers.<sup>100</sup> Households were not metered in Boston until state legislation mandated the phasing in of household metering in 1907. Universal metering was not achieved until 1928.

Without the widespread use of meters, planners initially tried to manage consumption of large users with ‘quasi-volumetric’ charges. While domestic users were charged according to their property values and the number of families in residence,<sup>101</sup> consumption-based rates were estimated for large users. Implementation of a consumption-based tariff meant that members of the water department had to visit the premises of every water taker to estimate daily average consumption.<sup>102</sup> In 1850, users were charged \$130 (in 2000 USD) a year for each 100 gallons of daily consumption where the estimated daily average consumption exceeded 500 gallons a day. Where the estimated daily consumption was less than 500 gallons, the annual rate for each 100 gallons of daily consumption was \$196. These quasi-volumetric rates for large quantities corresponded to average prices for water of \$6.52/kgals for low volume users, and \$4.35/kgals for high volume users.<sup>103</sup> Although the Water Commissioners warned against “fraudulent representation of the quantity used,” or “wanton waste,” in which cases supply would be shut off, customers could easily stray from these estimates and err on the side of overuse, because payments for the use of water for the whole year were paid in advance on January 1<sup>st</sup>.

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<sup>100</sup> In 1895, metered Cochituate accounts represented, for the most part: 1,077 offices, stores, and shops; 706 ‘model houses’ (tenement buildings); 512 elevators and motors; 301 stables; 278 saloons and restaurants; 262 factories; 240 schools; 94 hotels; 68 railroad companies; 64 ‘wharves and shipping;’ 58 boarding houses; and various other industrial and commercial interests, as well as public buildings. 1896 City Document No. 32, p.29.

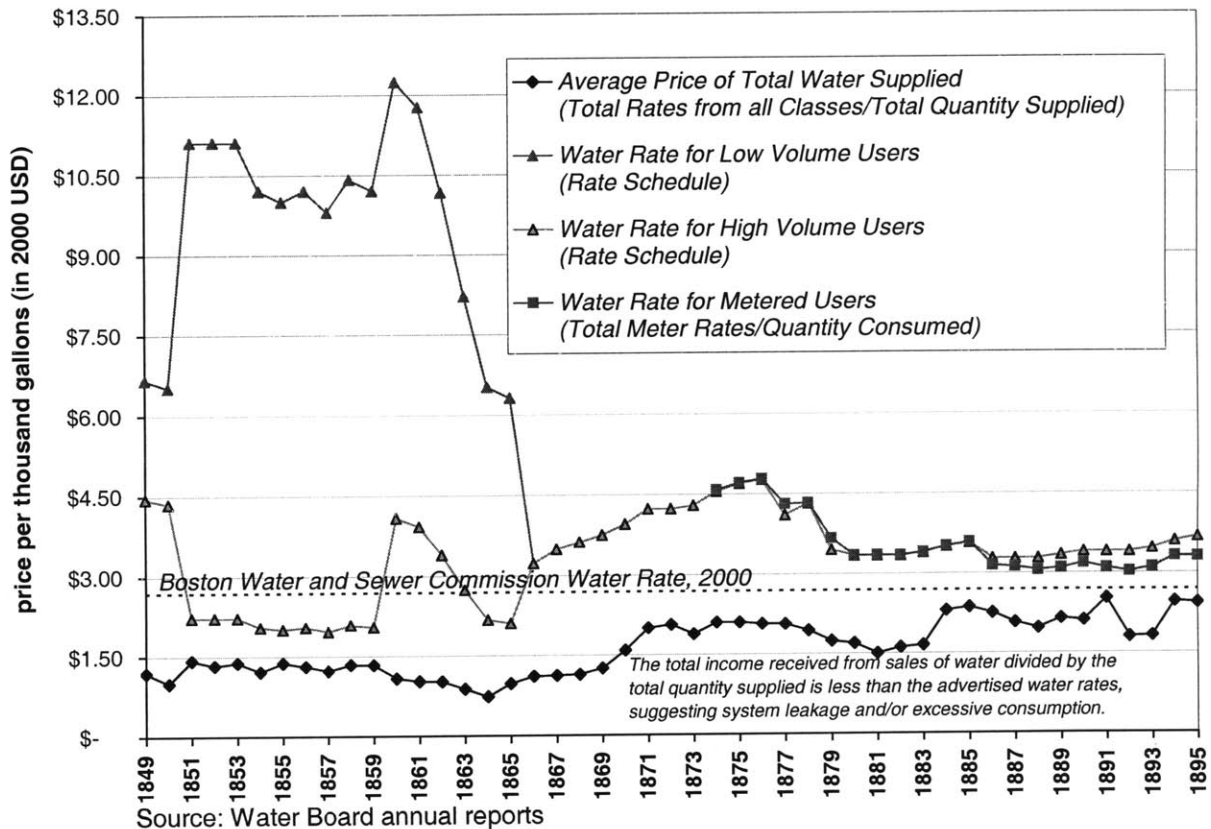
<sup>101</sup> While the Water Board acknowledged that the water rate “for all other purposes is regulated, or attempted to be regulated, by the quantity actually consumed,” the Water Board found the water-rate-as-property-tax “can be collected with the least trouble or annoyance to any one.” 1854 City Document No. 25, p.6.

<sup>102</sup> “The assessment of the amount to be paid for water in some cases, particularly when required for certain manufacturing purposes, has been attended with considerable embarrassment in the adoption of a satisfactory rule for determining the quantity of water used, on a principle which shall be equitable and uniform in its application to different parties. It has been necessary also that all the premises upon which the water is admitted, should be visited, before an entry is made on the books of the rate assessed,” 1849 City Document No. 18, p.6.

<sup>103</sup> The year was estimated at 300 days for purposes of setting rates for estimated consumption; presumably in consideration of Sundays and holidays.

These schedule rates are indeed higher than the average rate paid for water derived from dividing the total water rates received by estimated total consumption in a given year. Between 1849 and 1895, this average rate for all consumer classes, including dwelling houses, ranged between 75¢ and \$2.50 per thousand gallons (Figure 3.1). In 1879, the City Engineer estimated dwelling houses paid annual rates that corresponded to an average rate of \$1.90 per thousand gallons. For comparison, the average water rate in Boston in the year 2000 was \$2.69 per thousand gallons.

**Figure 3.1 – Boston Water Rates for Metered and Unmetered Users, 1849-1895**



The Water Board began metering large quantity users as soon as reliable meters were found, in order to increase receipts. Besides distilleries and other water-intensive places of business, the first suspects were hotels: buildings with multiple urinals and water-closets – fixtures that often ran with continuous streams of water. Of the first two hotels metered in 1853, metering revealed that one had been paying an annual rate that translated to 44¢ per thousand gallons (kgals), and the other had been paying roughly \$1.11/kgals. Once metered, and assessed at a rate of approximately \$3.56/kgals, the annual water revenue from these two hotels more than quadrupled from \$12,400 to \$57,800. Between 1861 and 1862, the application of meters to large

quantity users produced an estimated 9% decrease in the daily average consumption of water in Boston, amounting to nearly 1,600,000 gallons per day.<sup>104</sup>

A benefit of metering was that it allowed the Boston Water Board to enforce payments for water delivered through service-pipes, whether water takers used it or not. The Water Registrar asserted this policy when he complained that the public seemed to think that the registrar could make abatements in metered water rates at his personal discretion:

Numerous applications are made to this department for reductions or rebates on bills for water supplied through meters, on the alleged ground of leakage caused by defective plumbing, worn-out service pipes, or by wilful waste of water by tenants allowing the faucets to be turned on in full force in water closets, sinks, etc., without the knowledge or consent of the owners of the premises. The main object of the use of water meters is to enable this department to detect and check the useless and unwarrantable waste of an element so valuable and essential to the health and comfort of all the citizens, and this object can only be accomplished by enforcing payment for all the water passing through the meter, whether used or wasted.<sup>105</sup>

Water waste was a chronic problem for Boston's nineteenth century water works. The Water Board throughout the years variously referred to waste as "reckless," "extravagant," "wilful," and "evil." By 1851, the Water Board believed that two-thirds of the quantity supplied was wasted. The Cochituate system was planned assuming a demand of 28.5 gallons per capita per day (gpcd)<sup>106</sup> because the amount "seemed to be the largest quantity furnished to any city which is subject, for any portion of the year, to the influence of a cold climate, or where the habits of life are of 'British origin'." During the first decade of use in Boston, per capita water consumption was over double this amount, fluctuating between 60 and 70 gpcd. By 1860, an estimated water consumption of 97 gpcd was declared by the Board as "an amount believed to be without parallel in the civilized world."<sup>107</sup> The Water Board assumed that the largest form of waste occurred by letting water run at night, and often during the day, to prevent pipes from

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<sup>104</sup> 1863 City Document No. 10, p.9.

<sup>105</sup> 1893 City Document No. 38, p.1. This report might insinuate that the previous water registrar, noted to have served the office for the previous 38 years, had encouraged a public perception of the discretionary enforcement of metered water rates.

<sup>106</sup> Amount is equivalent to 130 liters per person per day. For comparison, Gleick (1996) recommends that international organizations and governments today adopt a minimum standard of 50 liters per person per day of clean water for basic needs (drinking, cooking, and hygiene).

<sup>107</sup> For comparison, Gibbons (1986) reports average daily per capita municipal water use in modern America to be 140 gpcd, with outdoor and indoor use contributing equally to that amount.

freezing. Other major sources of waste included hose use, livery stables - “washing horses with more water and less labor,” water closets, and urinals. One Cochituate water official even hypothesized that extravagant consumption was enabled by Boston’s superior system of common sewers which allowed citizens to place more water fixtures in their homes.<sup>108</sup>

The Cochituate Water Board early understood the power of meters in reducing consumption. In an 1857 report to the City Council on water waste and the need to construct an additional main from the Brookline Reservoir, they said that metering is the “one way, and only one, that is obvious, by which consumption can be diminished.” Meters were identified as both a means to increase rate revenues to levels more reflective of the amount supplied, and also as a means of conserving water to ensure a sufficient supply for all beneficial uses. The issue of water waste was

...not only a matter of profit and loss in money-, but...of a short supply of water...enforcing the terrible necessity of cutting off its employment in the manifold industries it promotes, in order to supply the household.<sup>109</sup>

The Boston Water Board of 1879 asserted that if the Water Commissioners who planned the system had known that “leakage and waste would nearly treble the quantity they estimated upon...they would have sounded a note of warning, and have insisted upon a method of distribution that would have compelled the tenant to pay for what he consumed.”<sup>110</sup> In 1880, when asked by the City Council to report on the best method for arresting water waste, the Board described metering as “the most efficient permanent method.”

Despite acknowledging the efficacy of metering in reducing demand, however, Boston did not meter households. Universal metering was generally not recommended, principally because of the costs, but also because it would both decrease receipts and reduce consumption to a level that would jeopardize the sanitary condition of the city. The widely held viewpoint was that

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<sup>108</sup> 1862 City Document No. 11, p.4: “It should be remembered that Boston is more thoroughly drained than most other cities where the supply of water is sufficient to meet all the wants of the people. This gives our citizens an opportunity of placing more water fixtures within their premises than people of most other cities enjoy... The original estimate of 28.5 gallons of water per day for each inhabitant was based on experience gained in the city of Philadelphia, at a time when there were but few, if any sewers within its borders; so it was a very unusual thing for a water taker to have more than one tap.”

<sup>109</sup> 1874 City Document No. 55, p.75.

<sup>110</sup> 1879 City Document No. 79, p.46.



...imposing a price upon the consumption may lessen the sanitary use of water. No restriction should be made that would lead people to avoid bathing, or freely flushing plumbing fixtures. Anything which discourages a liberal use of water is an obstacle to social progress.<sup>111</sup>

The Boston Water Board explained that

If every water-taker should be obliged to receive and pay for the water, by measure, there can be no question that the consumption would be immensely diminished – so also would be the receipts. The question with most takers would not be how much water can I use with convenience and comfort, but, how little can I get along with?<sup>112</sup>

‘Getting along with as little as possible’ approximates the efficient use of water espoused today. This demand-responsive approach was rejected as early as 1857 because of the perceived positive health externalities of consumption<sup>113</sup> but also because of a belief that reduced use would make it more difficult to generate sufficient revenues to cover the enormous sunk cost of Boston’s system.

High costs were argued to be the biggest deterrent to implementing universal metering in nineteenth century Boston. The Water Board of 1857 declared that a “good, simple and cheap meter is a great *desideratum*; and if one could be found that should be reliable, and come at a reasonable price, ([extract\_itex]240 or[/extract\_itex]290], or even cheaper,) it would undoubtedly be good policy to introduce their use to a certain extent.” The high costs only justified their application to the largest water users, and the Board made sure that costs did not exceed the benefits. Spending \$114,000 (2000 USD) on meters in 1859 was justified because the “increased charges for the use of water, against the establishments to which these meters have been attached, have already equaled, if not exceeded, this expenditure.” The assessment of quarterly meter rates were “great trouble to the Board,” but “great advantage to the city in increasing the income, and checking the waste.” By 1862, it was estimated that city-wide metering would cost \$500,000, or an estimated \$8,500,000 in 2000 USD. The Water Board of 1865 reiterated that “it is impracticable for the present to measure all the water, for the reason that the lowest cost of a reliable meter is about

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<sup>111</sup> Wingate, Charles F., The Water-Supply of Cities, *The North American Review*, Vol. 136, Iss. 317, April 1883, 364-375.

<sup>112</sup> Bradlee, 1868, p. 178, citing 1857 City Document No. 50.

<sup>113</sup> In 1879, however, the Water Board contended that the argument that water use should be unrestricted on account of sanitary considerations was “generally put forward to defeat any attempt to prevent leakage and unlimited waste.” The Board acknowledged that supplying an unlimited supply of water to leaky fixtures was, in fact, detrimental to public health. City Document No. 79, 1879, p.45.

[\$525,] and as out of the 27,000 water takers, at least 13,000 are at a rate of [\$125] per year, or less, and most of them at [\$63,] it will be seen that the interest and depreciation on a meter, would nearly equal the bill.”<sup>114</sup> As might be the situation in the case of urban dwellers receiving rationed water supply in developing countries today, the cost of meters exceeded the receipts for ‘low volume’ residential users in nineteenth century Boston.

Nevertheless, the Board failed to address the fact that the costs of metering were lower than the costs of new supply. After metering their own households for a year, the Water Board in 1866 predicted that the total adoption of meters might decrease Cochituate Lake withdrawals by one-third. They reiterated, however, the objection that the cost of a meter far exceeded the average rate currently paid by households.<sup>115</sup> As for the costs of new supply, by 1870, appropriations for the new Chestnut Hill Reservoir totaled \$2,200,000, or an estimated \$29,000,000 in 2000 USD.<sup>116</sup> This additional supply reservoir had been authorized by legislation passed in April 1865 and construction began that year. Because the City Engineer apparently erred on more than one occasion in the estimation of costs, additional appropriations to complete the work were made in 1868, 1869, and 1870.<sup>117</sup> Finding money for additional supply facilities met with much less difficulty than finding money for demand management measures. This mindset of favoring increasing supplies over reducing demand is still prevalent today, even in the face of increased water scarcity. Big development projects are exciting to engineers and politicians with short-term planning horizons. Politicians stand to gain political support from constituents by not using pricing to ration demand, while also garnering campaign contributions from the contractors and consulting firms that lobby for supply projects.<sup>118</sup>

Because they could not meter all households, Boston’s Water Boards attempted demand-management by other means for lower volume customers, but generally met with resistance from the City Council. The City Council often softened the stricter recommendations of the Water Board. For example, in the revised tariff of 1851, the Council did not incorporate a

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<sup>114</sup> 1865 City Document No. 76, p.7.

<sup>115</sup> 1866 City Document No. 61, p.8.

<sup>116</sup> 1870 City Document No. 65.

<sup>117</sup> The Cochituate Water Board found it “mortifying” to ask for additional appropriations in light of the engineer’s gross mistakes. 1869 City Document No. 59.

<sup>118</sup> Uitto and Biswas, 2000, p.22.

recommended \$67 (in 2000 USD) charge for additional bathtubs in dwelling houses, a \$67 charge on additional water closets, or a \$56 charge for ‘wanton waste.’<sup>119</sup> Also ignored in 1853 were the Board’s recommended prohibitive water rates for ‘Hopper’ and ‘self-acting’ water closets of \$245 and \$163 annually.<sup>120</sup> Of these two early makes of flush toilets, the ‘Hopper’ was considered to be the most egregiously wasteful of water.<sup>121</sup> The Council instead passed a generic \$100 rate for the use of any make and number of water closets or bathing tubs in dwelling houses.<sup>122</sup> With the City Council generally ignoring them, and the universal application of meters impractical, an exasperated Water Board in 1856 proclaimed that efforts toward producing greater economy and care in the use of water were “almost hopeless.” Nevertheless, they tried to reduce demand through programs of house inspection, the enforcement of penalties for waste,<sup>123</sup> and exhortations to water takers that they use “*strictest economy*” (see Figure 3.2).

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<sup>119</sup> 1850 City Document Nos. 29 and 41.

<sup>120</sup> Hopper water closets were relatively inexpensive; one New York firm advertised models at prices ranging from \$1.50 to \$3.50 (\$16 to \$70 in 2000 USD) in the 1860s (Ogle, 1996, p.77).

<sup>121</sup> The Water Board even voted to outlaw ‘Hopper’ closets on November 12<sup>th</sup>, 1861 – two weeks prior to the notice of Figure 3.2 – but “the Board having no power to enforce this regulation, it became a dead letter.” Bradlee, 1868, p.198.

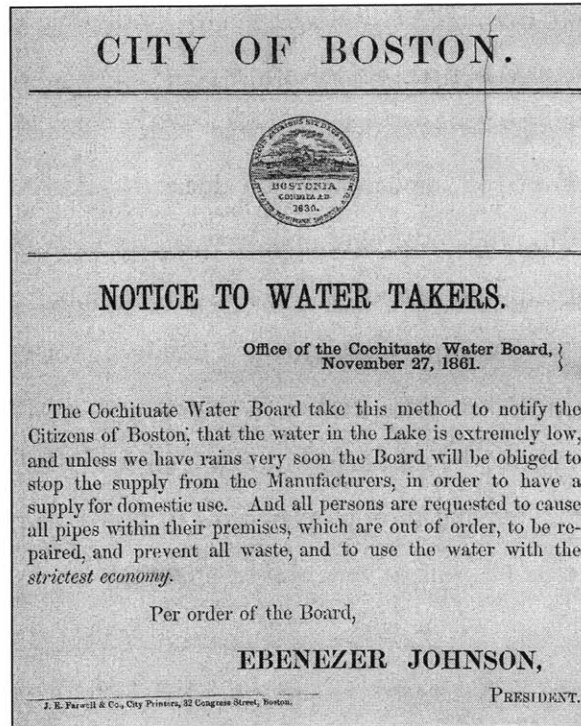
<sup>122</sup> Other demand management recommendations that the City Council did not incorporate into the revised tariff for January 1, 1855 included: specific rates on water fixtures used anywhere other than dwelling houses, increased stable rates, and increased rates for large quantity manufacturing purposes (1855 City Document No. 9, p.9).

<sup>123</sup> In 1852, those guilty of ‘malicious’ waste were fined \$2 (\$44 in 2000 USD): 1852 City Document No. 51, p.4. The Water Board of 1855 complained that this penalty of \$2 did not even cover the cost of shutting off and letting on water: 1856 City Document No. 11, p.7. By 1877, the penalty was still \$2: Sect. 24 of the Ordinance providing for the care and management of the Boston Water Works, as printed on the back of a residential water bill dated January 1<sup>st</sup>, 1877.

**Figure 3.2 –  
Notice to Water Takers to prevent  
waste of water during a time of short  
supply, November 27, 1861.**

From U.S. Library of Congress, Rare  
Book and Special Collections Division,  
Broadside and Printed Ephemera  
Collection

[http://memory.loc.gov/ammem/rbpeht  
ml/pehome.html](http://memory.loc.gov/ammem/rbpeht<br/>ml/pehome.html)



The first system of house-to-house inspection was instituted in 1865, to detect leakage and wilful waste, and resulted in a “notable decrease” in consumption. The inspection system was maintained “with more or less rigor, but as it proved annoying both to the citizens and the Water Board” it was relaxed upon the introduction of the additional supply of Sudbury River water in 1872.<sup>124</sup>

In fact, the 1872 introduction of Sudbury River waters into the Lake Cochituate became a personal liability problem for the Water Board. The episode illustrates the extraordinary circumstances under which the City Council actually paid heed to the Board’s calls for better demand management. A temporary channel between the river and lake was opened, apparently illegally, between June and September, conveying 1.7 billion gallons of Sudbury waters to the lake.<sup>125</sup> In 1874 the committee of the City Council reporting on the need for additional supply ‘reminded’ the Council that the Water Board was loathe to connect to the Sudbury, as the personal property of the members of the Water Board of 1872 was ‘under attachment’ for taking

<sup>124</sup> 1879 City Document No. 79, p.48.

<sup>125</sup> 1873 City Document No. 103.

the Sudbury waters during the drought of 1872.<sup>126</sup> The committee concluded their report urging citizens to use water with greater caution. Within days, the City Council revised the ordinance on the management of the water works giving the Water Board discretionary powers to charge higher rates for hose use and for water closets and bath tubs used in households.

Thus, it seems that it took extraordinary circumstances for the City Council to adopt long-recommended measures to curb waste. Even after this small victory, the Water Board still desired greater control over the management of the works, saying of the revised ordinance:

This is well, as far as it goes, but the Board, having charge of the Water Works, should have full authority over the rates, and also over the fixtures that are put into the premises of water takers.<sup>127</sup>

Greater discretion, however, had been explicitly denied the Water Board in the ordinance establishing the new Boston Water Board in 1874. The new Board, consisting of three mayoral appointees chosen with the advice and consent of the City Council, merged the affairs of the Cochituate and Mystic Water Boards.<sup>128</sup> The ordinance establishing the new Board passed in the upper branch of the City Council (Mayor and Board of Aldermen) on April 21, 1874, but failed in the lower branch (Common Council). It only passed after it had been “amended to make it clear that the Board cannot act as the agent of the City until empowered by the City Council.”<sup>129</sup> The ability of elected officials to interfere with the sound management of municipal water departments remains a major obstacle to implementing pricing reforms aimed at creating more sustainable water supply services in the developing world today.<sup>130</sup>

In the face of constrained supplies,<sup>131</sup> the Water Board began another system of house inspection with the establishment of the Inspection and Waste Division in July 1883. The Boston Water Board also began detecting system waste through Deacon meters applied directly to the mains

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<sup>126</sup> 1874 City Document No. 85, p.iv.

<sup>127</sup> 1875 City Document No. 88, p.12.

<sup>128</sup> The Mystic Water Works served Charlestown, annexed in 1873.

<sup>129</sup> 1875 City Document No. 38. This may reflect an attempt of the Common Council to retain some power over the Board, which it lost when the new ordinance made the Water Board mayoral appointees subject to confirmation instead of officials elected by the City Council. Ten years later, Boston’s charter of 1885 transferred all executive powers to the Mayor and his appointees, finally denying council committees their previous authority to supervise municipal departments and to interfere in the administrative business of the city (Teaford, 1984).

<sup>130</sup> Savedoff, W.D. and P.T. Spiller, *Government Opportunism and the Provision of Water*, Chap. 1 in *Spilled Water*, Washington D.C.: Inter-American Development Bank, 1999.

<sup>131</sup> By 1878, three of seven planned reservoirs were completed on the Sudbury River at an approximate cost of \$86,000,000 (2000 USD). In 1880, the Water Board recommended building another. Daily consumption in Boston had almost doubled between 1872 and 1880 due to increases in population and continued waste.

supplying an entire district. The Board credited this district waste detection system together with the program of house-to-house inspection with achieving a 23% reduction in per capita water demand between 1883 and 1885. Of the new system the Water Board explained:

It is a matter of frequent complaint that the system of house to house inspection established by the Board is annoying to water takers, and that the frequent visitations of inspectors to premises of water takers is looked upon as a system of espionage liable to become very disagreeable and unpopular...there is no present remedy...People *will not* repair their defective fixtures, and *will not* stop wasting water, unless compelled to do so by official visitation, or by the adoption of a measurement system which will oblige them to pay for all the water used. The city must either be content to buy a new supply, and furnish water literally as free as air, or it must apply such restrictive measures as now prevail in Boston.

The Board has used every precaution, and adopted every possible measure, to insure courteous treatment to the water takers and secure efficient results to the city. This system, vigorously followed up, will prevent a large part of the daily waste; and no other method will accomplish it except the recording meter or measurement system. When this is applied, and people are required to pay for water as they do for gas, they will not waste it. The meter or measurement system could not be universally applied to Boston except at a very large expense, and even then it would require several years [emphasis in the original].<sup>132</sup>

The Water Board clearly understood the need to treat water as a scarce resource, yet the actions of elected officials continually undermined their efforts. While they acknowledged the great expenses related to house inspections, they saw no other practical way to limit consumption and prevent the necessity of extending the Sudbury reservoir system and obtaining additional supplies at an expenditure of “several millions of dollars.”<sup>133</sup> Ultimately however, the City decisively acted in favor of buying new supplies, and Mayor Hart abolished the house inspection and district waste detection divisions in January 1889. Both programs had operated with a total annual budget of approximately \$992,000. In their place, a new inspection and waste service was organized within the department with a budget limit of \$472,000. Perhaps as a result of this cost-cutting, by 1893, per capita water consumption in Boston soared to its highest level yet, 109 gallons per day.

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<sup>132</sup> 1884 City Document No. 123, p.11.

<sup>133</sup> 1885 City Document No. 118.

The City's lack of commitment towards inducing efficiency stymied the efforts of the Water Board and forced them to adopt inefficient strategies. Two years before the downsizing of the waste inspection program by the Mayor, the Water Board was forced to change their tune about whether Boston made economical use of water. In 1887 the City appeared before the State Legislature as an applicant for additional water rights on the Sudbury River. The Water Board this year ardently defended the legitimacy of requesting additional supply and dismissed evidence offered by opponents related to statistics of American and English cities that used less water. They went so far as to assert that "our consumption is not only not wasteful, but is quite economical."<sup>134</sup> In the face of the high political costs of reducing demand and effectively raising prices, the Water Board had no option but to support a policy of augmenting supplies. Most American cities at the end of the nineteenth century also avoided the implementation of effective demand management measures. During the 1890s, only four of the fifty largest American cities metered more than fifty percent of their taps, and twelve metered more than ten per cent.<sup>135</sup> Boston wasn't one of these cities; in 1895, only 5% of the Cochituate accounts were for metered water, representing an estimated 24% of total consumption and 41% of total rate revenues.<sup>136</sup>

In the context of cities of the developing world today, resorting to supply augmentation schemes has been recognized as failing to solve underlying problems of urban water service inefficiencies. Although augmentation projects may be politically viable in the short-term, because they avoid the sensitive issue of raising prices, they are financially unsustainable in the long-term.<sup>137</sup> This was true in the case of Boston, where inefficiencies worsened upon the introduction of new supplies. By the 1880s, excessive water consumption in Boston was both financially and environmentally unsustainable.<sup>138</sup> These problems were resolved at the state

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<sup>134</sup> 1887 City Document No. 27, p.8.

<sup>135</sup> Melosi, 2000, p.126.

<sup>136</sup> 1896 City Document No. 32, pp.28-9, and 1897 City Document No. 32, p.146. Chapter 524 of 1907 provided that all cities and towns obtaining supply from the metropolitan water system should after December 31, 1907 provide meters for all water services thereafter installed, and also annually equip 5 percent of all services without meters at that date. Only until 1927 were 99% of services in Boston metered.

<sup>137</sup> Saleth, R.M. and Dinar, A., 1997.

<sup>138</sup> The New York Times reported on October 28, 1881 that "The bad condition of the Cochituate water of Boston is not a recent affliction, as for more than a year past a considerable proportion of the rate payers have been forced to buy their water for drinking. The public supply is now becoming intolerable for any household purpose." On September 5, 1885, it was reported that "The investigation of the water supply from Sudbury river and Cochituate... shows a serious pollution of the supply by sewage," and that "by comparison with the water supplied to 14 other cities, Boston's water contains the largest proportion of... the products of sewage contamination."

level in the 1890s, with the formation of metropolitan districts for water supply and sewerage, and the payment of millions of dollars from the state to the city for Boston's water supply facilities.

### **3.3 Political and Legal Challenges to Metering**

Whereas arguments against metering water supply services in nineteenth century Boston were nominally focused on cost, considerable evidence exists to suggest that city politics worked to subvert the water board's use of meters in pursuit of demand-management and cost-recovery objectives. Large users (e.g., hotels, industrial houses) and real estate developers had considerable influence with the City Council, which had ultimate legislative power over water rates. Hotel proprietors in particular were upset at being what they considered unfairly targeted to pay meter water rates that were greater than what other large users paid based on annual schedule rates. In 1860 they secured an injunction preventing the Water Board from shutting off their supply for the non-payment of metered water rates.<sup>139</sup>

In both the 1870s and 1880s, public pressures for low rates seem to have played an integral role in getting elected officials and water administrators to adopt stronger policies of water supply subsidization. The City Council provided their constituents with lower water rates by reducing the cost categories that user fees funded. Rate reductions began in 1876, when the Standard Sugar Refinery and other large users petitioned for reduced meter rates. These rates had nominally been a constant flat rate for the previous ten years, but were rising in real terms due to deflation.<sup>140</sup> In support of their case, they noted that New York City's metered rate for the largest consumers (over 10,000 gpd) was only one-third of Boston's flat rate. The legislative committee reporting on the issue supported the petitioners, arguing that higher water rates hurt

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<sup>139</sup> The next year however, the Water Board's metering of hotels was sustained by the Massachusetts Supreme Judicial Court. 1862 City Document No. 9, p.12. also see: *Harvey D. Parker & another vs. City of Boston*, 83 Mass. 361; 1861 Mass. LEXIS 127; 1 Allen 361

<sup>140</sup> The CPI index upon which I have relied to estimate prices in real (\$2000) terms, indicates an inflationary period coinciding with the Civil War (1861-1865), deflation thereafter, inflation in 1880, and deflation thereafter. Huse (1916) indicates that depression especially hit Boston after 1873, that 1880 witnessed a short-lived revival in business, followed in 1884 by further depression. He also indicates that property valuation fell 23% between 1874 and 1879, and valuation figures did not reach the level of 1874 until 1890. McGuire (1990) says "in terms of its length and magnitude, the deflation of the 1860s through the 1890s was the most striking in US history."



Boston's competitive advantage, and reduced the metered rate by 16.7%.<sup>141</sup> These meter rates were reduced by an additional 20% in 1879, after the Water Board successfully lobbied for the abolishment of the long-standing and often debated policy of using a portion of water revenues to pay a portion of the interest on the general city debt.<sup>142</sup> Only by abandoning the notion that the department should strive for financial self-sufficiency by attempting to cover the costs of construction was it possible to provide users with the low rates they demanded.

As metered users had proven not amenable to rate increases, the Water Board increased non-metered rates in the face of operating deficiencies in 1885. This action was immediately stymied "a very unusual exhibition of public clamor," spearheaded by a major real estate developer and landowner in Boston.<sup>143</sup> The 'public clamor' involved the first use of a clause in the 1846 enabling legislation, whereby 100 citizens could petition the Massachusetts Supreme Judicial Court for the reduction of water rates upon the evidence of the water department showing a surplus of receipts. Although the Board considered this action "simply the natural complaints of the persons immediately affected by the increase of rates," the City Council vetoed a rate increase for non-metered water takers. The Boston Water Board 'cheerfully' conformed to the City Council's mandate to rescind a change in water rates, but 'respectfully' represented that such action was 1) "not in accordance with our judgment," 2) not "in keeping with the spirit of the original law, which provides that the Water Department shall be, as far as possible, self-sustaining," and 3) not "a course of action as would be adopted by a business corporation under similar circumstances." The Water Board believed that the petitioners were grossly misinformed about the financial condition of the department, and looked forward to proving the 'absolutely erroneous' nature of the petitioners' statement of facts in front of a judge. Nevertheless, the City

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<sup>141</sup> 1876 City Document No. 99, p.2. Boston's Joint Standing Committee on Water also explained that New York can afford such low rates because "the expense of maintaining the water works enters the general taxation, and the consumer not only pays a direct tax for the water he uses, but also his proportionate share of the cost of providing it." This is further evidence that taxation had not been relied upon to finance water works in the case of Boston.

<sup>142</sup> 1879 City Document No 79, p.5: "the Board [was] determined to make a strong effort to effect a change in the policy of using the income of the water works to pay the interest on an assumed debt," and "on the 24<sup>th</sup> of January, 1879, the Auditor informed the Board that, after consultation with the Mayor and the City Solicitor, he had decided that a tax should be levied for all interest on the city debt over the amount which might be due on the water scrip." Also, "Figures and statements...prepared and made by the Board to show the effect of the former policy on the water accounts...found their way into the 'Sunday Herald,' of February 23, 1879." (The cited newspaper is not available at the Boston Public Library's microfilm collection.)

<sup>143</sup> In 1893, William Minot, the lead petitioner, was "Boston's largest landowner." Kennedy, 1992, p.113.

Council did not give them the opportunity, and decreased non-metered rates 6% in 1886, before the petition was even heard in court.<sup>144</sup>

Also in 1886, meter rates were decreased by an average of over 10%, and in a manner giving higher volume water takers a larger proportionate reduction. The next year, dwelling houses were given a further 10% reduction in their annual rates.<sup>145</sup> These rate reductions were justified by the Water Board by the existence of large department surpluses, attributed to the action of the City Council “in providing that the cost of the extension in main-pipes and appurtenances shall not be charged to the annual revenue hereafter.”<sup>146</sup>

By reducing water rates, Boston’s elected officials won the hearts of their constituents. In the long term, however, rate reductions meant increased borrowing and higher taxes. Cities of the developing world today do not have Boston’s easy access to loans, bond markets, and taxation to fund the maintenance and expansion of water services. In this context, the politicization of price-setting can lead to the ‘low-level equilibrium trap’ where low prices result in low quality, limited service expansion, operational inefficiency, and corruption.<sup>147</sup>

### **3.4 Equity and Fairness Concerns**

The use of metering and increasing block tariff structures in developing-country water supply schemes to further poverty-alleviation goals has been criticized as ineffective because the poor, who tend to share metered water connections, end up paying higher average prices for water services (Section 3.1). In nineteenth century Boston, debates regarding the fairness of charging different users for essentially the same service were forestalled because metered users—who faced higher average prices—tended to be commercial and industrial customers. Towards the end of the century, however, lower-income tenement buildings were also metered, thereby presenting the highest unit-volume charges to some of the city’s poorest residents.<sup>148</sup> The

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<sup>144</sup> 1885 City Document No. 31, pp.1-2; 1885 City Document No. 118; 1886 City Document No. 25; and *William Minot, Jr. & others v. City of Boston & another*, 142 Mass. 274; 7 N.E. 920; 1886 Mass. LEXIS 319.

<sup>145</sup> 1887 City Document No. 27, p.3.

<sup>146</sup> 1885 City Document No. 118.

<sup>147</sup> Savedoff and Spiller, *Spilled Water*, 1999.

<sup>148</sup> In 1895, 706 Model Houses (tenement buildings) paid meter rates (out of 4,049 metered rate payers for the Cochituate system) and 6,612 Model Houses paid annual rates (out of 85,183 annual rate payers in the Cochituate system). 1896 City Document No. 32, pp.28-29.

inequity of charging the city's poorest residents with the highest prices for water was nevertheless generally ignored by city officials.<sup>149</sup>

Water Board officials did occasionally debate the fairness of the cross subsidy within the metered tariff schedule. Instead of increasing block prices, Boston adopted decreasing block pricing. Both estimated consumption rates and metered rates were designed on a decreasing block scale until 1865, when it was decided that the variable tariff was objectionable to all but the largest water users who paid the lowest rate. The Water Board had identified a few faults with the variable tariff, including discrimination in favor of large manufacturers over small. The Board also showed concern that domestic users were subsidizing larger users.<sup>150</sup> Although the Board addressed these equity and fairness concerns, their main motivation for changing the tariff to a uniform rate in 1865 seems to have been as a means to increase department revenues to cost recovering levels.

Uniform rates for metered water were upheld for twenty years, and reflected the general belief that "Water is public trust to which all citizens have equal interest and from which all should derive equal benefit."<sup>151</sup> By 1886, the Water Board reverted back to a decreasing block scale, explaining that

It has been decided that there is no authority for making different rates to different persons on account of the use to which water is devoted, that is to say, a hospital must pay as much as a stable, a manufacturer must pay as much as a hotel, quantity for quantity. But on the other hand, there is authority for equalizing the charge to large consumers, in view of the lessened cost of procurement, delivery and maintenance of the larger quantity consumed, by making the rates for "excess" over certain fixed limits at a lower rate. This is not, as might on superficial view be supposed, a "discrimination" and it cannot become so unless in carrying out the principle it be perverted by practical injustice and inequality. It will be our duty to avoid any error in this direction.<sup>152</sup>

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<sup>149</sup> In 1870 a tenant of a tenement building occupying an apartment with its own (unshared) water fixtures succeeded in preventing the Water Registrar from cutting off the building's supply when the owner of the tenement building refused to pay the new metered rate, which doubled the non-metered water bill of the tenement building. See *Henry F. Young v. City of Boston & another* 104 Mass. 95; 1870 Mass. LEXIS 60.

<sup>150</sup> "The water was originally brought into the city to furnish the mass of the people water, at the lowest possible rate, and it is very apparent that, if we sell it to manufacturers and others, who use it for the money they can make from it, at less than cost, the loss must fall upon the general consumer." 1865 City Document No. 76, p.7.

<sup>151</sup> 1876 City Document No. 99, p.5.

<sup>152</sup> 1886 City Document No. 25, p.2.

This quote from the Water Board shows that they understood that tariff design and the analysis of tariff implementation in practice required periodic re-evaluation. Nevertheless, because consumption was not universally metered in nineteenth century Boston, it was impossible to accurately quantify ‘unaccounted for water’ and the cross subsidies between large users and domestic users. The ‘losers’ in Boston were likely the occupants of tenements with shared water fixtures paying meter rates passed on to them in their rents. Nevertheless, cross subsidies between different classes of users were not transparent in nineteenth century Boston, nor were such inequities generally acknowledged by Boston’s Water Boards in their various reports.

## 4.0 DISCUSSION AND CONCLUSION

Research into Boston's nineteenth century water supply planning reveals both differences and similarities between the city's early approach and the prevailing policy advice given to developing countries today. One limitation of such comparative analysis is the considerable inference required—particularly concerning political motivations and maneuvering—when analyzing the historical account of Boston's water supply system. Often, pricing policies were justified on multiple grounds. For example, throughout the years, various city officials stated that households could not be metered because of the high costs of meters, but also because of a concern about the effects of reduced consumption on both the financial viability of the water department and on public health. The Water Board eventually criticized public health concerns as a veiled attempt by the public to keep city officials from forcing people to repair their pipes and fixtures and change their wasteful ways.<sup>153</sup> Compared to what would be expected considering the central role public health concerns are traditionally assumed to have played in establishing subsidized water supply services, the annual Water Board reports are in fact relatively silent about the role of public health concerns as a driver for policy. Although an analysis drawn largely from the annual reports of Boston's water department may be limited, several interesting contrasts and comparisons are worth noting.

### *Benefits of Water Supply as Public or Private Goods*

First, both in nineteenth century Boston and among water and sanitation professionals working in developing countries over the past several decades, major shifts in thinking about the nature of the benefits derived from piped water services were related to changes in policy regarding the use of pricing as a demand management tool, as well as the appropriate role of the state in delivering services. In Boston, rhetoric became more public good-oriented only once user fee cost recovery proved untenable. In the developing world, the shift in thinking about the nature of water supply benefits has been the other way, from public to private.

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<sup>153</sup> In 1879 the Water Board contended that the argument that water use should be unrestricted on account of sanitary considerations was “generally put forward to defeat any attempt to prevent leakage and unlimited waste.” The Board acknowledged that supplying an unlimited supply of water to leaky fixtures was, in fact, detrimental to public health. City Document No. 79, 1879, p.45.

In Boston, an early understanding of the largely private nature of benefits from piped water supply fostered a preoccupation with cost recovery from the start. However, as Boston's water department progressively failed to meet annual expenses from water revenues, the shortfalls were justified by benefits received from fire protection and increased land values. The fire department in fact only started paying for water supply services, through annual hydrant and reservoir charges, once it had been decided by the City Council that raising rates to users was objectionable and to be avoided. The very next year in 1870, \$19,000,000 (2000 USD) was transferred from the water debt to the city debt in light of benefits received from fire protection<sup>154</sup> and 'other public uses' since 1848. Historically in many developing country cities, urban water services have been provided at nominal prices because of perceived public good characteristics. Municipalities did not concern themselves with recovering costs through users until donors started pushing this agenda over the past ten years.

### ***Pricing as a Tool of Demand Management***

Despite different philosophies related to the public and private nature of water benefits, the two cases exhibit the same reluctance to use pricing as a demand management tool. For the case of the developing world, this result is expected—if water is a public good, governments should be expected to push for making it as affordable as possible. In Boston, the two main reasons for low water prices were (1) the desire to exploit economies of scale and a concern about reduced demand, and (2) the gradual eroding of public and political support for cost recovery through user fees.

Decision makers in Boston initially saw demand management through pricing as inimical to recovering costs. City officials argued that low prices would better ensure the long-term financial viability of the system. They believed that with low prices, everyone would connect to the system and revenues would be maximized to pay for the system's enormous sunk cost. The three appointed officials who supervised the design and construction of the Cochituate system rejected recommendations for a higher tariff and also refused to charge extra rates for fixtures known to use large quantities of water. In light of low willingness-to-pay under private sector

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<sup>154</sup> Because of the prevalence of wooden construction, fire protection was a much bigger concern in nineteenth century Boston than it is in developing country cities today.

provision in Boston, the Commissioners generated demand by subsidizing all connections, offering a low tariff, and warning citizens that water department deficits would be paid out of general taxation. By 1854, their policies reportedly succeeded in providing Boston with greater water revenues in proportion to the population than New York, Philadelphia, Cincinnati, Richmond, or even London, a city served by multiple private water companies.<sup>155</sup>

From the perspective of Boston's water planners, low prices meant improved cost recovery, because low rates would encourage more people to connect to the system to help pay for the costs. Demand-responsive water planners of the twenty-first century, on the other hand, understand low user charges to lead to a 'low-level equilibrium trap' – a cycle of insufficient revenues to ensure proper maintenance, deterioration in service quality, and consumers increasingly less willing to pay for services. When urban water services are subsidized with low prices and limited central government subsidies in developing countries, other research has demonstrated that service expansion and coverage suffer, with the poor being the last to get services.

Boston's argument that high prices would hurt long-term financial viability was also voiced as a reason for not metering households. Although experience showed that metering large quantity consumers increased receipts, city officials contended that metering households would reduce both consumption and receipts to deleterious levels. In other words, at lower levels of consumption, officials perceived a high elasticity of demand.<sup>156</sup> This perception is at odds with present-day conceptions of the price elasticity of household water services. The earliest numerical estimates of the price elasticity of residential water demand were made in the latter half of the twentieth century. The first major study conducted in 1967 found that in-house water demand for American households was consistently price inelastic.<sup>157</sup> Small increases in the price

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<sup>155</sup> 1854 City Document No. 54, pp.17-18.

<sup>156</sup> This high elasticity of demand for water services was voiced as an objection to the higher initial tariff schedule proposed in 1848: "Although the amount of increased charge in each case, is but a small sum, it is sufficient to change the whole character of the schedule, so as to render it, comparatively with rates charged in other cities, a schedule of high rates, instead of one of low rates. The effect of so great a difference of rates on the number of customers who will take the water, cannot be doubted." 1848 City Document No. 43, pp.12-13.

<sup>157</sup> Gibbons, 1986, p.9. The 1967 study was by Howe and Linaweaver and is consistent with later findings. Outdoor household water use and summer-time use are generally found to be more price-elastic.

of water were found not to significantly decrease the quantity of water a household consumed to meet basic daily needs.

Boston's general aversion to use price to manage demand is at odds with the perspective of demand responsive planners in developing countries today. Today, metering is not only advocated to conserve water and delay future investments in capacity, but also to sensitize people to the idea that water costs a lot of money to deliver. Boston water officials perceived a very high price-elasticity of demand for household use and were thus hesitant to sensitize households to these costs. It is unclear, however, whether the political unacceptability of raising rates or this perception of a high price elasticity of demand played a greater role in preventing officials from effectively managing demand through pricing in Boston.

### ***Public versus Private Institutional Arrangements***

Nineteenth century Bostonians also generally had opposite interpretations of state- and market-provided services than the prevailing wisdom today. Currently, failure to provide efficient water services is often attributed to the interference of politics into the management of a water department which should be operated on a business model.<sup>158</sup> Failures of water sector privatizations are often attributed to defective regulation and government expropriation.<sup>159</sup> In nineteenth century Boston, the private sector, not the public sector, was generally perceived as the faulty institution. The Boston Aqueduct Company was 'never a financial success,' served only one out of four houses in its service area, and couldn't 'convince' people to abandon their wells and buy piped water supply.

While the prevailing wisdom was in support of publicly provided supply-driven services, a minority of citizens in nineteenth century Boston did in fact call for privately provided services, or at least a more demand-responsive public approach. Petitioners against a public supply in 1838 insisted that continued reliance on private wells and private aqueduct water could meet Boston's needs. One petition claimed that a private company could meet Boston's needs at lesser expense, and asked the city to "ascertain the names of all the citizens who are ready and

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<sup>158</sup> Indeed, Boston's own water department expressed considerable grief in later years when the City Council neglected or vetoed their recommendations for higher water rates.

<sup>159</sup> Savedoff and Spiller, *Spilled Water*, 1999.



willing to pay annually for the use of the water, at such rates as the City Council, in their wisdom, may believe it can be afforded.” Another petition asked that the public water supply project be “suspended, until more information may be obtained as to who wants and who will pay.”<sup>160</sup> These calls for ‘willingness-to-pay’-type surveys and demand responsive water planning were nevertheless not the majority concerns that they are today in the field of international development.

By 1898, the superiority of public versus private management of water services was reportedly self-evident. In an 1898 editorial, the story of Boston’s ‘struggle’ against petitioners in 1838 to provide public water would be described as illustrative of later struggles to put other Boston utilities in public hands.<sup>161</sup> By 1898, the 1838 protests to the public provision of water services were identified in hindsight as “absurd.” According to the editorial, by “pandering to private corporations,” the state exhibited a “distrust of the people” and an “enfeebling paternalism.” Today, these types of characterizations would be sooner linked to an insistence on subsidized service provision by the state. To provide services as Boston did, whether or not people wanted them, would be characterized today as paternalistic. Likewise, the provision of services through market-mechanisms such as full cost pricing is interpreted by development banks as the most trustful of people. According to today’s prevailing wisdom, people themselves, and not the state, “are in the best position to weigh the costs and benefits of different levels of investment” for benefits that accrue to themselves.

### ***Pressures for ‘Free’ Water***

Early on, Boston recognized the importance of charging users for water services, and followed today’s prevailing policy advice for improving the financial condition of urban water utilities. City officials immediately refused to give away ‘free’ water, either by contract to special interests or through public standposts. Historically in many developing country cities, urban water services have been provided at nominal prices because of its status as a ‘basic’ service underpinning overall economic growth. Water services in the developing world today are popularly perceived as more of a ‘basic’ or ‘social’ service than other utility services. Today,

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<sup>160</sup> Editor’s Table, *The New England Magazine*, Vol. 23, Iss. 6, Feb. 1898, 774-780.

<sup>161</sup> *ibid.* In this editorial, the author argued that Massachusetts should give the city the right to decide whether or not it wanted to own and operate its public street rail services, instead of leaving them in private hands.

water sector privatizations elicit widespread consumer opposition claiming a basic ‘human right to water,’ and some water experts even advocate a ‘human right to water.’<sup>162</sup> In South Africa, this ‘human right to water’ is constitutional. The United Nations Committee on Economic, Cultural and Social Rights has recently declared that “Water should be treated as a social and cultural good, and not primarily as an economic commodity.” Nineteenth century water administrators in Boston faced similar public pressures to de-commodify water services.<sup>163</sup> City officials in their rhetoric called piped water supply a ‘blessing.’ Nevertheless, they never disregarded the essential nature of water services as a commodity or ‘valuable property.’

### ***Water Services to the Poor***

Historically low prices for water services in the developing world have been traditionally justified because of perceived public benefits and because high prices were considered unaffordable to the urban poor. In nineteenth century Boston, however, the poor did not factor largely into the water supply debates documented in the annual reports of the Water Boards.

Boston’s argument that metering would decrease consumption to unhealthful levels could perhaps be interpreted as a concern for the affordability of services to the poorest city residents. Nevertheless, by metering low-income tenement buildings before private homes, the city provided Boston’s poor with the highest per-unit prices for water. Although city officials moralized about the unhealthful living conditions in Boston’s slums in various reports, there is little evidence of a concern for the affordability of water services for the poor in particular.

### ***The Politics of Water Supply Planning***

In both nineteenth century Boston and in the developing world today, reforms aimed to price water closer to its cost of supply have been undermined by the interference of politicians into the affairs of a water department run by appointed officials. In the case of Boston, an early effort of some members of the city council to influence appointed officials to adopt *higher* prices seems contrary to the prevailing wisdom that elected officials with shorter time horizons are prone to

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<sup>162</sup> Gleick, *The Human Right to Water*, *Water Policy* 1(5) 487-503, 1999.

<sup>163</sup> The Cochituate Water Board said in 1850 that “a very slight practical acquaintance with the collection of water rents will satisfy any one that there is a much wider-spread disposition than could at first be supposed, to get rid of paying the reasonable and low rates now charged.” Bradlee, 1868, p.127. Bradlee also reports that in 1855 the City Council debated whether to ‘make the water free,’ deciding in the negative.

favor policies of low prices.<sup>164</sup> In this particular instance, the Water Commissioners' desire to take advantage of economies of scale and induce as many water connections as possible demanded low prices. These appointed officials purported that low prices would *improve* the city's ability to recover costs through user fees. Elected officials in Boston generally undermined efforts of subsequent Water Boards to induce more efficient use of water with price-mechanisms. Consumption in Boston had greatly exceeded that planned upon by the Water Commissioners, requiring immediate actions to curb waste. The City Council nevertheless disapproved recommended prohibitive rates for wasteful water fixtures, set insufficient penalties for water waste, and slashed budgets for programs of waste inspection. Elected officials also vetoed a water tariff increase passed by the Water Board, apparently bowing to pressure from real estate development interests. Moreover, the City Council lowered water rates (thereby encouraging greater waste) by adopting stronger policies of subsidization for construction costs. The political infeasibility of raising tariffs to full cost recovering levels seems to have played a major role in getting the City to move further away from a policy of user-fee cost recovery towards the end of the century.

Urban water and sanitation planning in developing countries often has to contend with state and even national politics because of a lack of access to financing. Cities in developing countries have been historically reliant on central government transfers for the provision of water services. When funds for urban water supply projects are obtained from international development bank loans, repayment is guaranteed by the central government and is not tied to the financial success of projects. This lack of accountability makes it difficult to implement policies of user fee cost recovery. Boston on the other hand paid for all costs within the municipal entity, first as a municipal corporation able to issue bonds and obtain loans, and also as a political entity able to tax its citizens for repayment. Bonded indebtedness could not be honorably repudiated, and debt obligations to bond holders would be a strong incentive to attempt to recover costs through users in nineteenth century Boston. The City Solicitor demonstrated this fact when he explained that

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<sup>164</sup> The City Document reporting on this subject (1848, No. 43) reveals that the Water Committee members themselves were in disagreement about whether to adopt a higher or lower rate schedule. They would have voted on the issue, but the City Solicitor found that the Water Commissioners were free to establish the rates without interference from the City Council.

Boston could not give away free water because water rates were pledged to the holders of water scrip (bonds).

Despite these incentives to recover costs through users, Boston heavily subsidized the construction of public water supply services. Of all major American cities at the end of the nineteenth century Boston was in fact considered “the most willing and able borrower.”<sup>165</sup> Income data for nineteenth century Boston is hard to come by, but according to Teaford (1984), American city dwellers at the end of the century in general had far higher per capita income and approximately double the wages of European city dwellers. American cities could thus more easily finance extensive public works, offering the highest levels of service, through bond issues, loans and taxation. Developing country cities today, however, do not share nineteenth century Boston’s relatively unlimited access to loans and bond markets for the construction of piped water supply networks. Although Boston was initially turned away from European bond markets in 1846, they could eventually secure loans and sell bonds at home and in London. The only source of loan funds for many developing country cities is the international development community, which is increasingly hesitant to lend for water supply and sanitation projects. Increased water scarcity and higher levels of population growth exacerbate the fiscal pressures in the developing country water sector. In the face of these fiscal pressures, user-fee financing is much more attractive.

### ***Conclusion***

Ultimately, this research has shown that contrary to popular thought, public water services in a nineteenth century American city were initially intended to be provided on a user fee basis. Generally, the historical provision of urban public water supply services in the developed world has been referred to only as the subsidized counterpoint to the model of full cost recovery from users. The trajectories of the approaches to the financing of water services in nineteenth century Boston and developing countries in general can in fact be seen as opposite. Boston planned for user-fee cost recovery from the start, and moved toward subsidized service provision only when cost recovery through water rates proved untenable. Developing countries subsidized water services from the start, and are being advised to move towards cost recovery through user fees

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<sup>165</sup> Teaford, 1984, p.292.

now that subsidized service provision has proven untenable. Full cost recovery by user fees is clearly not an easy task. Research into the institutional arrangements that foster successful urban water pricing reforms in the developing world will be essential for overcoming the barriers to recovering costs from users.

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## **Boston City Document Series**

The Boston Public Library has a comprehensive Index to City Documents in the Government Documents department. The series is viewable in the Microfilm Department, on reels organized chronologically. Most of the Annual Reports of the Water Boards are also available at the Massachusetts Institute of Technology Retrospective Collection. Following are the documents viewed for the preparation of this report.

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**1874 Doc. 94**, Report of the Mystic Water Board on an Order of the City Council Relating to Sewerage, 28-Oct-1874  
**1874 Doc. 102**, Report of the Medical Commission upon the Sanitary Qualities of the Sudbury, Mystic, Shawshine, and Charles River Waters  
**1874 Doc. 108**, Report of Committee on Water on Subject of Proposed Purchase of Jamaica Pond and of Supply for West Roxbury and Brighton, 21-Dec-1874  
**1875 Doc. 7**, Request of the Cochituate Water Board for an Appropriation of \$1,530,000 for a new conduit, a new siphon, and for storage basins  
**1875 Doc. 17**, Annual Report of the Superintendent of Sewers for the year 1874  
**1875 Doc. 20**, Report of the Committee on Finance Appropriating \$1,500,000 for extension of the Cochituate Water Works and Granting Authority for said extension, Feb-1875  
**1875 Doc. 38**, Report of the Committee on Ordinances with and Ordinance Establishing the Boston Water Board  
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**1875 Doc. 62**, An Act to authorize the City of Boston to Construct a sewer in the Mystic Valley, Chapter 202, approved 10-May-1875  
**1875 Doc. 86**, 10<sup>th</sup> Annual Report of Mystic Water Board from 1-Jan-1875 to 30-Apr-1875  
**1875 Doc. 88**, Report of the Cochituate Water Board for the year ending 30-Apr-1875  
**1876 Doc. 19**, Report of Joint Standing Committee on Water on the Subject of Charging City Departments for the Use of Water  
**1876 Doc. 80**, Report of Cochituate Water Board, year ending 30-Apr-1876  
**1876 Doc. 99**, Report on Reduction of Meter Water Rates 23-Nov-1876  
**1877 Doc. 57**, First Annual Report of Boston Water Board, year ending April 30, 1877  
**1878 Doc. 62**, Second Annual Report of Boston Water Board, year ending April 30, 1878  
**1879 Doc. 79**, Third Annual Report of Boston Water Board, year ending April 30 1879  
**1880 Doc. 108**, Fourth Annual Report of Boston Water Board, year ending April 30, 1880  
**1881 Doc. 101**, Fifth Annual Report of Boston Water Board, year ending April 30, 1881  
**1882 Doc. 87**, Board of Health report

**1882 Doc. 124**, Sixth Annual Report of Boston Water Board, year ending April 30, 1882  
**1882 Doc. 161**, An Ordinance for the Regulation of Plumbing  
**1883 Doc. 142**, Seventh Annual Report of Boston Water Board, year ending April 30, 1883  
**1884 Doc. 123**, Eighth Annual Report of Boston Water Board, year ending April 30, 1884  
**1884 Doc. 156**, Report of the Board of Health upon certain published statements relative to the sanitary condition of the south cove and other localities, Dec. 1, 1884  
**1885 Doc. 118**, Ninth Annual Report of Boston Water Board, year ending April 30, 1885  
**1886 Doc. 25**, Tenth Annual Report of Boston Water Board, year ending December 31, 1885  
**1887 Doc. 27**, Eleventh Annual Report of Boston Water Board, year ending December 31, 1886  
**1888 Doc. 20**, Twelfth Annual Report of Boston Water Board, year ending December 31, 1887  
**1888 Doc. 21**, 16<sup>th</sup> Annual Report of the Board of Health  
**1889 Doc. 118**, Thirteenth Annual Report of Boston Water Board, year ending December 31, 1888  
**1890 Doc. 32**, Annual Report of Boston Water Board, year ending December 31, 1889  
**1891 Doc. ??**, Fifteenth Annual Report of the Boston Water Board, year ending December 31, 1890  
**1891 Doc. 59**, Opinion of Corporation Counsel as to power of City Council to delegate duties of Water Board to City Engineer  
**1892 Doc. 39**, Annual Report of Water Income Department, January 1, 1891 to February 1, 1892  
**1892 Doc. 40**, Annual Report of Water Supply Department  
**1893 Doc. 38**, Annual Report of Water Income Department, year ending January 31, 1893  
**1893 Doc. 39**, Annual Report of Water Supply Department  
**1894 Doc. 38**, Annual Report of Water Income Department, year ending January 31, 1894  
**1894 Doc. 39**, Annual Report of Water Supply Department  
**1895 Doc. 38**, Annual Report of Water Income Department, year ending January 31, 1895  
**1895 Doc. 39**, Annual Report of Water Supply Department  
**1896 Doc. 32**, Annual Report of Commissioner, year ending January 31, 1896  
**1897 Doc. 32**, Annual Report of Commissioner  
**1897 Doc. 116**, Report of Expert relative to changes in business methods in department  
**1898 Doc. 37**, Annual Report of Commissioner  
**1898 Doc. 41**, Message of Mayor relative to disposition of sums received by the city for taking of water supply system  
**1899 Doc. 38**, Annual Report of Commissioner  
**1900 Doc. 41**, Annual Report of Commissioner  
**1900 Doc. 150**, Mayor's Message concerning settlement by the Commonwealth on account of taking water supply system

## 6.0 APPENDIX

### **Timeline of Events Significant to Cost Recovery and User Fees in Boston's Public Water Infrastructure**

- 1795** The (private) Boston Aqueduct Company is incorporated to carry water via wooden pipes from Jamaica Pond to residents of Boston.
- 1837** The financial panic of 1837 forestalls planning for a public water supply in Boston.
- 1846** The Massachusetts state legislature passes 'An Act for supplying the City of Boston with Pure Water' (1846 Chapter 167). Long Pond, the source of supply, is renamed Lake Cochituate. The City Council appoints three Water Commissioners to supervise water works construction.
- 1848** In March, the City Council decides that the City will pay for the construction of service pipes from the distributing mains through the sidewalk and one wall of every house and building.
- 1849** In May, an "Act in addition to 'An Act for supplying the City of Boston with Pure Water'" passes, extending by fifty percent the amount of scrip (bonds) that Boston could issue for construction.
- Upon completion of the works in late 1849, an ordinance passes providing that all rights, powers, and authority given to the city should be exercised by a Board, consisting of a commissioner, an engineer, and a water registrar (elected annually by City Council) and by a Joint Standing Committee of the City Council on water.
- 1850** An ordinance establishes the Cochituate Water Board to consist of: 1 alderman, 1 common councilman, 5 citizens at large, 1 engineer, and 1 water registrar elected annually by the City Council.
- 1851** The water tariff is increased for households and consumers of large quantities (i.e., manufacturers).
- The construction account closes on May 1<sup>st</sup>, 1851. During the next two years the City can add to this amount interest payments. After that, the Water Department is expected to be financially self-sufficient.
- 1855** The water tariff is increased for households, who are also now charged extra for the use of any number or make of water closets and bath tubs within their houses.
- 1860** The water tariff for large quantity consumers is increased.
- Hotels secure an injunction preventing the Water Board from cutting off supply for the nonpayment of metered rates.
- 1861** The Massachusetts Supreme Judicial Court upholds the Water Board's metering of hotels.

- 1862** An ordinance related to the election of the Cochituate Water Board changes the board to consist of: 1 alderman and 2 common councilmen (elected annually), 4 citizens at large (elected biannually); the Water Registrar is elected annually by the City Council and is under the direction of the Water Board.
- 1865** In order to increase water revenues, the Water Board convinces the City Council to change the tariff for large quantity users (both metered and unmetered) from a decreasing block scale to a uniform rate.  
The Water Board institutes a system of house-to-house inspection to detect leakage and willful waste.  
State legislation authorizes the construction of a new supply reservoir at Chestnut Hill.
- 1869** The Fire Department starts paying annual charges for each hydrant and reservoir supplied and maintained by the Cochituate Water Department, after the City Council decides it is objectionable to raise water rates to consumers.
- 1870** The City transfers approximately \$19,000,000 (2000 USD) from the water debt to the city debt because the sum “would not more than compensate [the Water] Department for the benefit derived by all the citizens for the use of the water by the Fire Department, and for other public uses since its introduction in 1848.” It was only after this transfer of funds that water revenues were able to cover for the first time, in the year 1871-72, “the running expenses of the works and the interest and premium on the debt incurred for their construction.”
- 1872** The Massachusetts state legislature authorizes Boston to take, hold, and convey waters of Sudbury River and Farm Pond (1872 Chapter 177).
- 1873** Boston annexes Charlestown, giving Boston control of the Mystic Water Works.
- 1874** Between 1874 and 1879, property valuation falls 23% in Boston.
- 1875** The Massachusetts State Legislature passes an act limiting the debt cities could incur for providing municipal services, excepting debt incurred for water purposes.  
An ordinance establishing the Boston Water Board passes in the City Council, merging the affairs of the Cochituate-Sudbury and Mystic Water Works, consisting of three persons appointed by the Mayor with the consent of the city council.
- 1876** Meter rates were reduced 16.67% after pressure from manufacturing interests convinced the City Council that high rates hurt Boston’s industrial competitiveness.
- 1879** Meter rates were reduced an additional 20%, after the Water Board successfully lobbied for the abolishment of the long-standing and often debated policy of using a portion of water revenues to pay a portion of the interest on the general city debt.
- 1883** The Boston Water Board institutes a new program of house-to-house inspection and district waste detection.

- 1885** Boston's charter of 1885 transfers all executive powers to the Mayor and his appointees, finally denying council committees their previous authority to supervise municipal departments and to interfere in the administrative business of the city.  
The Water Board raises rates for non-metered consumers (households). "A very unusual public clamor" ensues, spearheaded by a major land owner and real estate developer in Boston. Citizens petition the Massachusetts Supreme Judicial Court for rate reductions. The Board immediately rescinds the increase upon the order of the City Council.
- 1886** The City Council reduces non-metered (household) rates 6%, before the petition for rate reductions filed in 1885 is heard in court.
- 1887** Households are given a further 10% rate reduction, after the City Council decided that "the cost of extension in main-pipes and appurtenances shall not be charged to the annual revenue hereafter."
- 1889** Boston's mayor abolishes the inspection and waste detection system inaugurated in 1883 and authorizes the organization of a new system to be run with less than half the operating budget of the former.
- 1890** The Boston Water Board offers a 7% rebate on water bills.
- 1891** The Boston Water Board offers a 10% discount on water bills.
- 1895** Massachusetts State Legislature passes 'An act to provide for a metropolitan water supply' (1895 Chapter 488).