19th and 20th c. Sanitary Revolution & Metropolitan Boston's Urban Water Supply

MIT Class Field Trip to the WaterWorks Museum

Susan Murcott
D-Lab WASH Class

Outline

- Ninevah, Iraq – 7th c BCE water system.
- Boston's water system in 19th and 20th centuries
- Ellen Swallow Richards, George Whipple and the first water laboratories in Massachusetts: MIT (university) and Chestnut Hill (municipal)

Ninevah's Urban Water Supply System – 7th century BCE

Romans as Water System innovators?

- Although the Romans are considered the greatest aqueduct builders of the ancient world, *qanāt* systems were in use in ancient Persia, India, Egypt, and other Middle Eastern countries hundreds of years earlier. *Qanāts* are tunnels that harvest springs or streams in mountains or hills and channel it into underground channels to bring water to the plains below to provide oasis in the desert.
- Limestone aqueducts built by the Assyrians about 691 BCE to bring fresh water to the city of Nineveh are closer to the Roman aqueducts.
- Approximately two million large blocks were used to make a water channel 10 metres (30 feet) high and 275 metres (900 feet) long across a valley.

[4]Ref: https://www.britannica.com/technology/aqueduct-engineering

Why Nineveh is Important Today

1. The hydrological works of Nineveh document a period of climate change prior to the collapse of its civilization

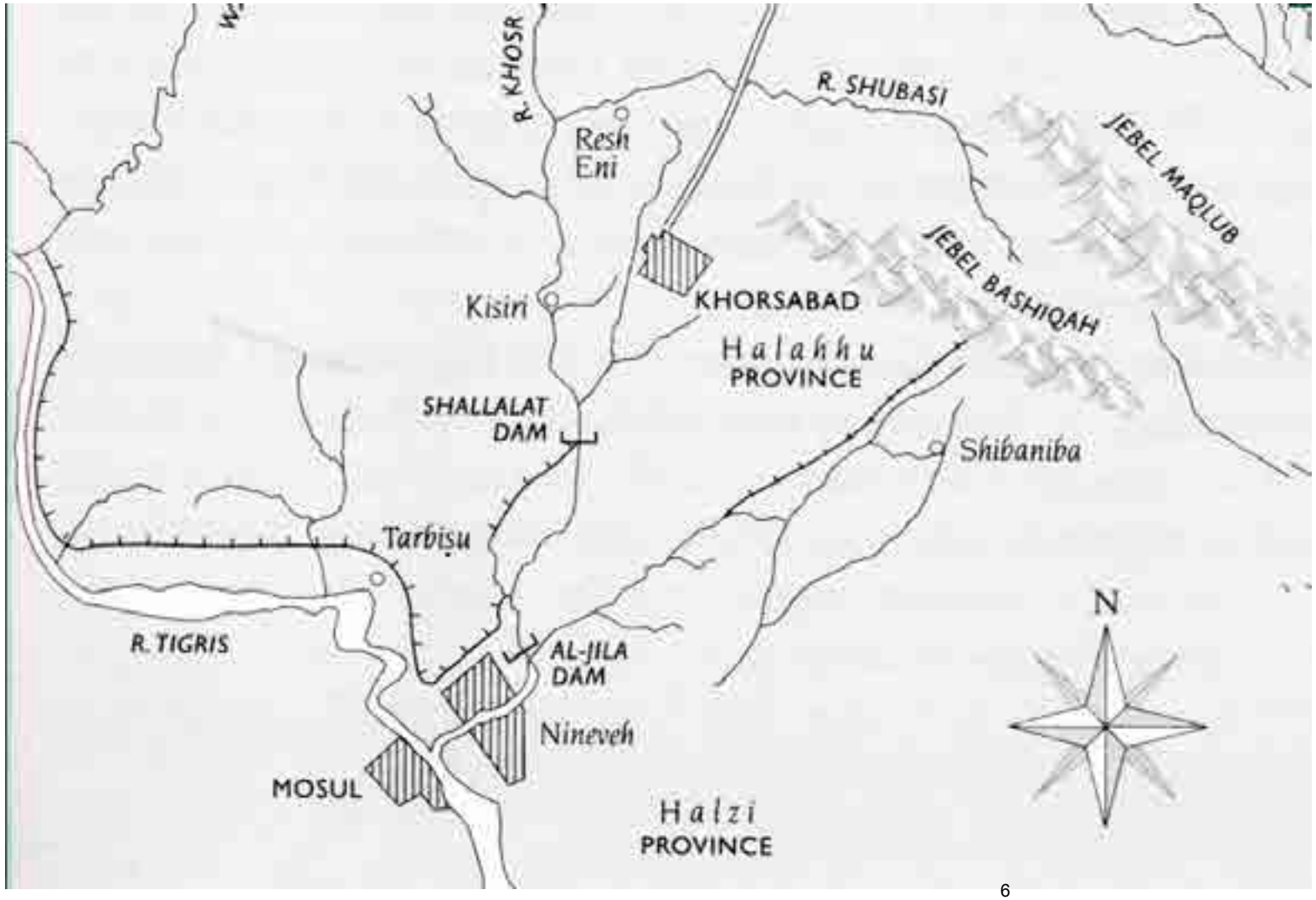
2. The discovery of the four systems of canals document how climate change affected Iraq in the 7th century BCE and could provide an insight in the region today

3. The hydrological works of Nineveh document the use of “Archimedes” water pump 6 centuries before Archimedes

4. These two discoveries (canals and pumps) document that hydrology was advanced as early as the 7th century BCE

Map showing location of the ancient City of Ninevah

Ref: Stephanie Dalley, *The Hanging Gardens of Babylon*. Oxford University Press, 2011, p. 91.



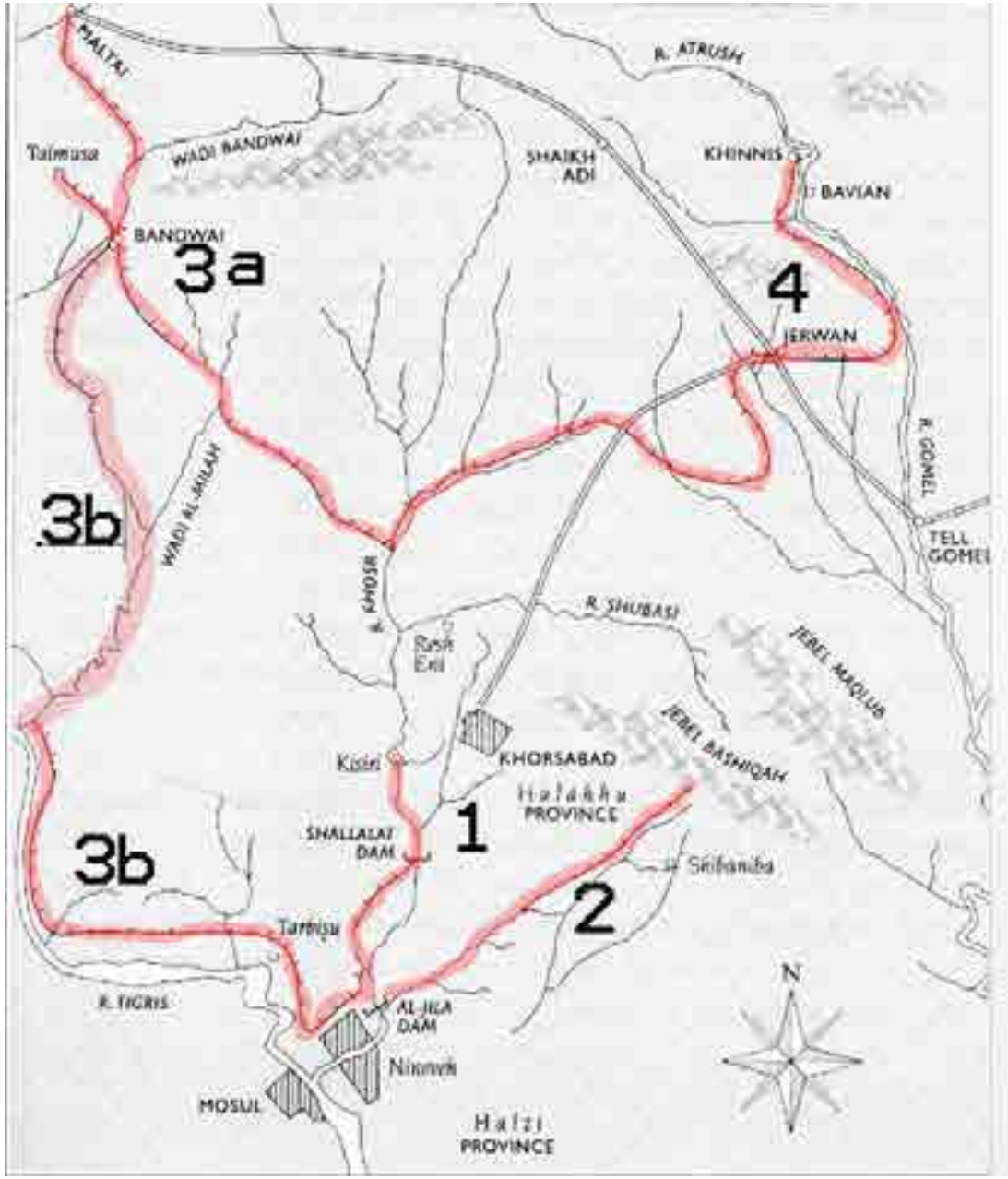
- Ninevah was the largest city in the world for some fifty years until the year 612 BC when, after a bitter period of civil war, it was sacked by a coalition of its former subject peoples, the Babylonians, Medes, Chaldeans, Scythians, and Cimmerians.

Hydrology of Nineveh in a Changing Climate

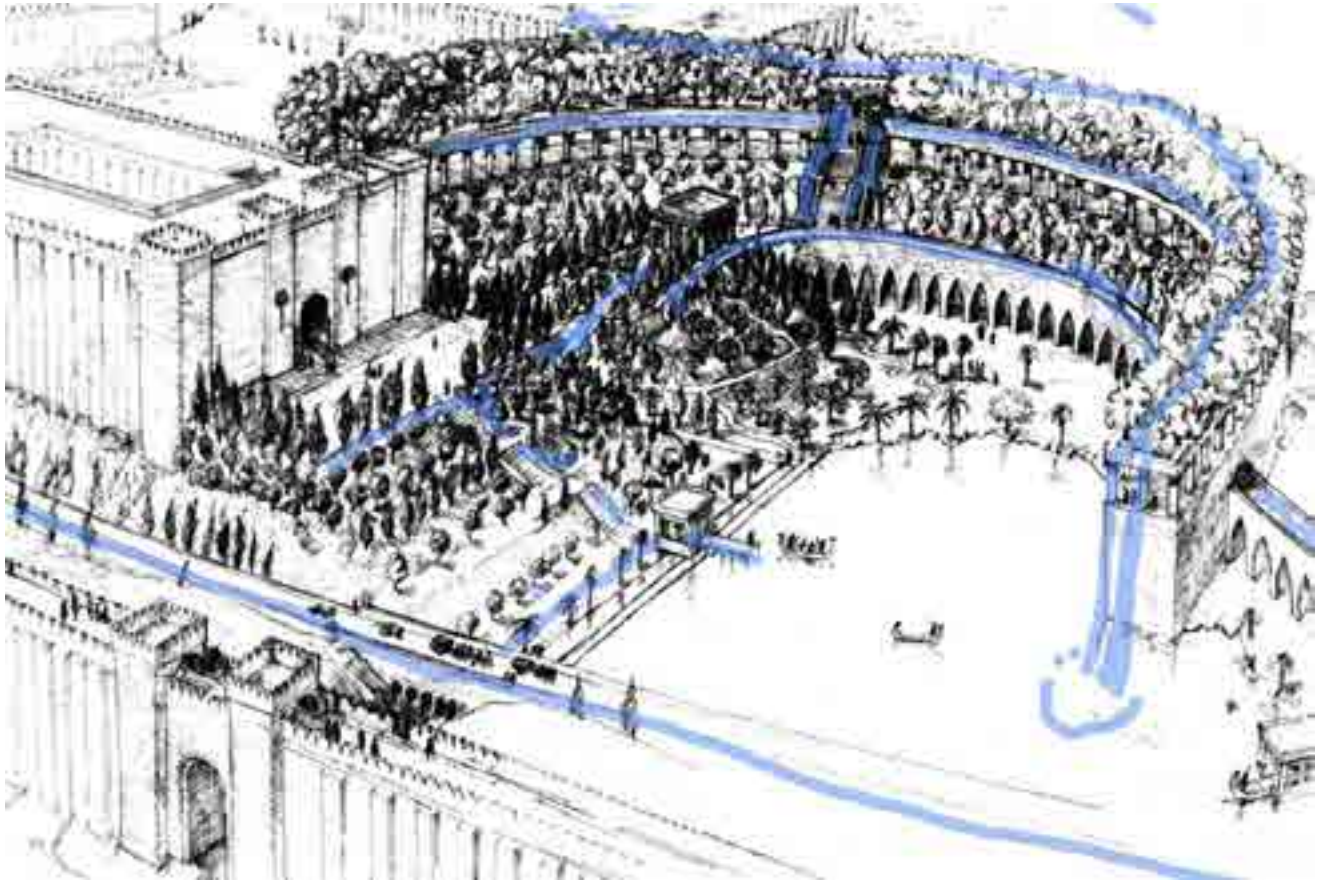
1. Climatology Problem: after 705 BCE Nineveh's water supply was drying up
2. Evidence: Four Water systems 705-688 BCE show water scarcity due to climate change

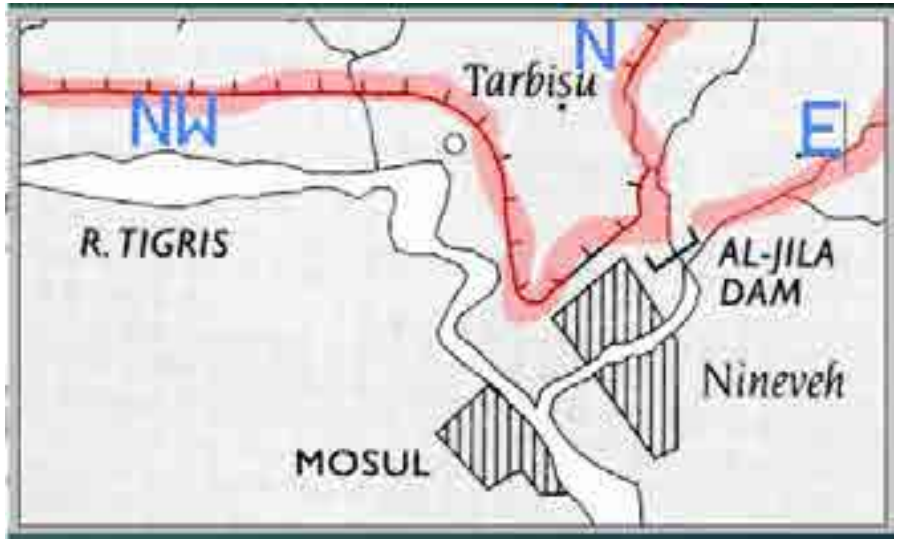
Hydrology of Nineveh Time span = 17 yrs

1. First System (705-703 BCE): Canal **13.4** km on Khosr R. from Kisiri to Nineveh
2. Second System (699 BCE): Canal **25** km: from Mt Musri (Jebel Basiqeh) to Khosr R just outside Nineveh,
3. Third System (696 BCE): Canals **150** km(Maltai to Faida) to Bandwai to Tarbisu to Nineveh.
4. Fourth System (688 BCE): Canals **50** km from Khinnis Mtns to Gomel R to Khosr R
5. Nineveh began to collapse due to water shortage in the area caused by water wars.



Nineveh before Its Collapse





The Hanging Gardens, one of the "7 Wonders of the World" and which have never been found in Babylon, but which are hypothesized to have been at Ninevah. Ninevah was destroyed due to climate, war & water shortages.

Boston's Water Supply System & the 19th and 20th c "Sanitary Revolution

The First Nation's "Great Spring"

First Nation tribes called Boston the "land with living fountains [springs]."

European Settlement of Boston

- The European settlement of Boston is tied to water.
- Puritan settlers chose Boston because of its access to fresh water.
- When the Puritans found Charlestown to be without clean water in 1620, William Blackstone, Boston's first European settler, extended a welcoming hand to John Winthrop and his congregation who were fleeing religious persecution in Britian.
- This scene is depicted in the Founders Monument on Boston Common.

17th & 18th c Water Supply in Boston and environs

Most of Boston's residents received their water from shallow wells. Quality was sometimes poor and availability sometimes sporadic.

Wells were either public or on private premises

Wooden pipes laid from Jamaica Pond to supply Boston

- In 1795, a system of wooden pipes made from tree trunks delivered water from Jamaica Pond to Boston

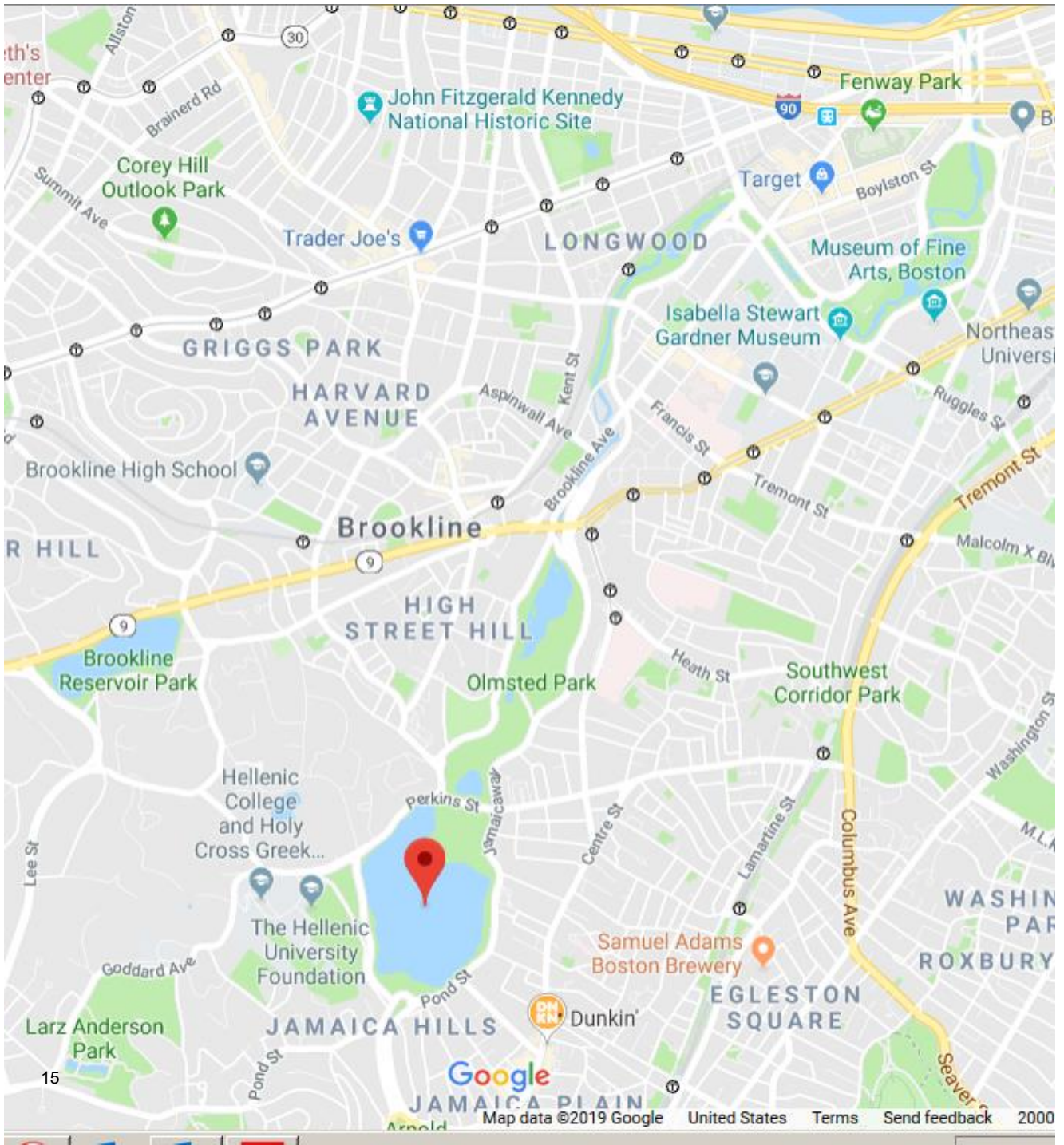
- But, by the 1840s, Boston had 50,000 residents and Jamaica Pond was insufficient to provide enough water and too polluted to provide safe water

- A purer and larger source had to be found

https://newyorkhistoryblog.org/2016/09/histroy-underground-old-wooden-water-pipes/

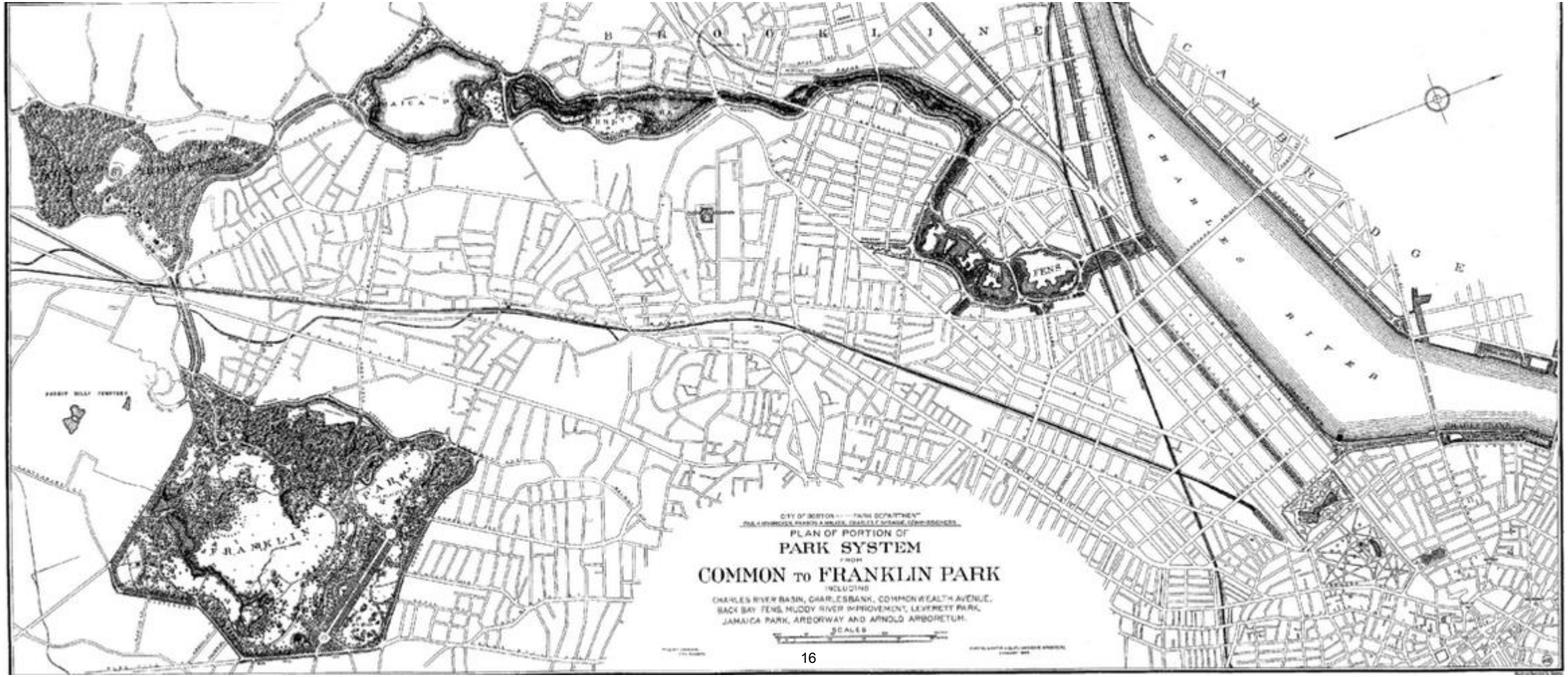
Ellen Swallow Richards sampling water from Jamaica Pond (c. 1874). See: Mass State Board of Health "On the Present Conditions of Certain Rivers of Massachusetts"

Where is Jamaica Pond?



Olmstead Park System and Emerald Necklace (1880)

- *Frederick* Law *Olmsted* (April 26, 1822 – August 28, 1903



Boston's Population Growth in 19th and early 20th c.

Year	City of Boston	Outside Boson
1910	670,585	
1870	200,000	
1860	177,840	571,543
1850	136,881	434,908
1840	93,383	304,501
1830	61,392	246,607

Between 1820 – 1880, Boston's population increased more than 8 times!

Ref: http://www.demographia.com/db-bos1790.htm and Geo. Whipple "Present Status of Water Purification in the U.S." 1911. Class reading assignment for today!

- the **population of Boston** in **2019** as per estimated figures = 698,898.8.

Population from 1790

Year	City of Boston	Outside Boston	Metropolitan Area	Share in Boston	Boston Share of Growth
2003	581,616	3,450,513	4,032,129	14.4%	-24.8%
2000	589,141	3,412,611	4,001,752	14.7%	6.8%
1990	574,283	3,209,534	3,783,817	15.2%	9.4%
1980	562,944	3,099,888	3,662,832	15.4%	Metro Loss
1970	641,071	3,067,639	3,708,710	17.3%	-16.0%
1960	697,197	2,660,410	3,357,607	20.8%	-35.7%
1950	801,444	2,263,900	3,065,344	26.1%	12.7%
1940	770,816	2,054,139	2,824,955	27.3%	-20.5%
1930	781,188	1,993,049	2,774,237	28.2%	11.0%
1920	748,060	1,724,019	2,472,079	30.3%	25.6%
1910	670,585	1,499,038	2,169,623	30.9%	29.7%
1900	560,862	1,238,805	1,799,667	31.2%	30.2%
1890	448,477	979,115	1,427,592	31.4%	27.9%
1880	362,839	757,978	1,120,817	32.4%	51.0%
1870	250,526	650,280	900,806	27.8%	48.0%
1860	177,840	571,543	749,383	23.7%	23.1%
1850	136,881	434,908	571,789	23.9%	25.0%
1840	93,383	304,501	397,884	23.5%	35.6%
1830	61,392	246,607	307,999	19.9%	33.9%
1820	43,298	211,376	254,674	17.0%	32.6%
1810	33,787	191,685	225,472	15.0%	27.6%
1800	24,937	168,491	193,428	12.9%	36.0%
1790	18,320	156,740	175,060	10.5%	

County based metropolitan area (1960 definition) - Essex, Middlesex, Norfolk, Plymouth and Suffolk Counties

Pre 1900 data from "Residence and Social Structure: Boston in the Antebellum Period," by Leo F. Schnore and Peter R. Knights in *Nineteenth- Century Cities; Essays in the New Urban History*, Edited by Stephan Thernstrom and Richard Sennett, New Haven: Yale University Press, 1969

By mid-19th c. – a person was more likely to die in urban areas in the U.S. than in rural areas

- During the mid-19th century, mortality rates, especially in urban areas, rose.
- Some likely causes:
  - Increased immigration and internal migration (rural to urban),
  - Rise of slums and increased population densities,
  - Unsanitary conditions leading to transmission of infectious diseases (typhoid, cholera, other),
  - Ignorance of germ theory of disease.

Boston's population increase was growing rapidly to internal migration & immigration…

especially Irish, but also Germans, Canadians, Scots and English in the 1st wave 1820-1880

Immigrants arriving at Constitution Wharf in Boston. From Ballou's Pictorial*, October 31, 1857.*

Ignorance of Germ Theory of Disease: e.g. Typhoid Fever Traced. to contaminated well water at Fuller's Tavern in North Boston by Austin Flint M.D

- 1843: An anonymous stranger's illness contaminated the Fuller's Tavern Well, in North Boston, and typhoid fever was responsible for 10 deaths and 28 sickened people. with 10 deaths after

- A study by Austin Flint, M.D. (born Petersham Ma 1812, graduated Harvard Medical School 1833) pointed to the actual cause of the typhoid as contaminated well water, predating John Snow's brilliant epidemiological work during the London cholera epidemic by 11 years (1854) *(Boston Historical Society)*

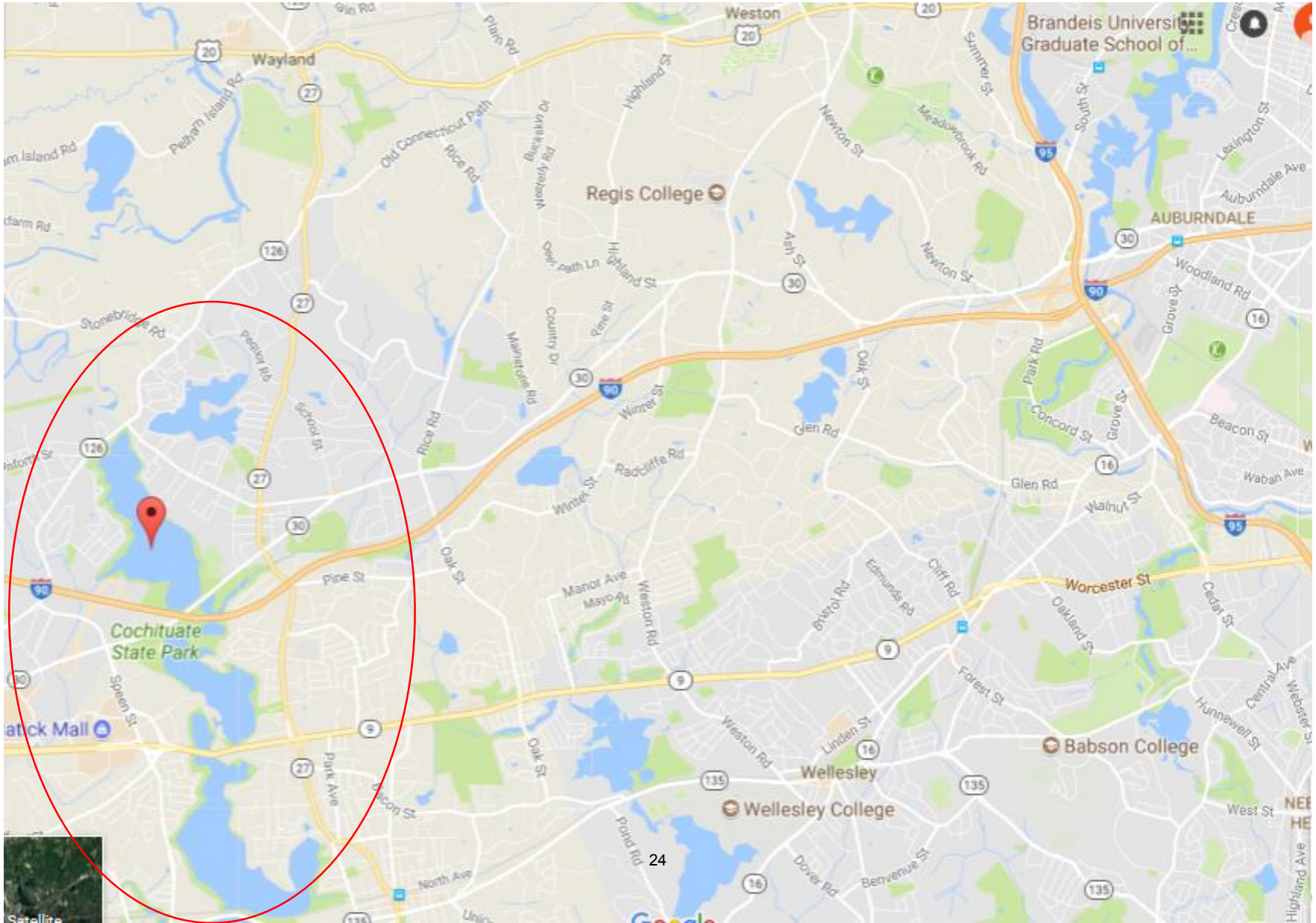
The 19th and early 20th c. “Sanitary Revolution”

- In early 1800s in Europe and North America, infant mortality was high.
- Average life expectancy was only about **40** years. (Today, average American male life expectancy is **76.1** years and average American female life expectance is **81.1** years.)
- In the late-19th and early 20th century, this picture changed dramatically. As per our Cutler and Miller reading, mortality rates in the U.S. fell by a remarkable 40% between 1900 to 1940.
- Key figures in this sanitary revolution were from numerous eminent institutions (e.g. State Board of Health, MIT, Harvard, Tufts, Boston University, Wellesley) which played major roles in this sanitary revolution locally and nationally.
- Abundant water supplied to greater Boston by the Massachusetts State Board of Health/Metropolitan Water Supply had a huge impact on quality of life.

The Cochituate System -- 1848

- Boston needed more water and after 20 years of study, construction began on the Cochituate System in 1846 and was completed by 1848.
- The Sudbury River was impounded and Lake Cochituate was formed 14.5 miles from Boston. It provided 2 billion gallons of storage and 10 million gallons per day!
- Water flowed into the Frog Pond on Boston Common at a dedication ceremony on Oct. 25, 1848. Water was sent through a fountain which reached 80 feet high! The event drew 100,000 people! (population of greater Boston was ≈ 350K)
- Intended to meet water demand for next 50 years!

Cochituate Reservoir – on Google Map



Brookline Reservoir – part of the Cochituate System

- Water flowed through the Cochituate Aquaduct to the Brookline Reservoir (still extant on Rte. 9/Boylston Street in Brookline).
- The aqueduct was an egg-shaped, brick conduit, 76” H x 60” W x 14 miles long!
- The Reservoir was built as a drinking water supply for the City of Boston.
- This area itself was once low-lying pasture land with a marsh in the center and a stream running through it.
- The system was built to feed the Beacon Hill Reservoir that stood at the intersection of Hancock, Derne, and Temple Streets. The Brookline Reservoir was filled to capacity in 1848.

The Brookline Reservoir was the Terminus of the Cochituate Aquaduct

- In 1902, the City of Boston decided to sell the reservoir and its surrounding land.
- Wealthy neighboring homeowners, (including Amy Lowell, John C. Olmsted, Walter Channing, Edward Atkinson, and George Lee), contributed more than $50,000 towards the purchase price of $150,000.
- The Brookline Reservoir is still extant on Rte. 9/Boylston Street. However, due to concerns with dam safety, many old trees have been felled, diminishing the beauty of this site.

Brookline Reservoir

The Mystic Lakes System

- By 1870, with Boston's population soaring to 200,000, the Mystic Lakes System in Winchester, Medford and Arlington was added to the Boston water system

- But Boston was still running out of water and a larger source was needed!

But within 25 years the Cochicutate System wasn't big enough! Why?

1. Growing population, many living in contaminated conditions

2. 1872 Great Boston Fire

3. Invention of flush toilets!

Great Fire of 1872

Great Boston Fire occurred on Saturday and Sunday, November 9 & 10, 1872

Image is in the public domain.

Great Fire of 1872

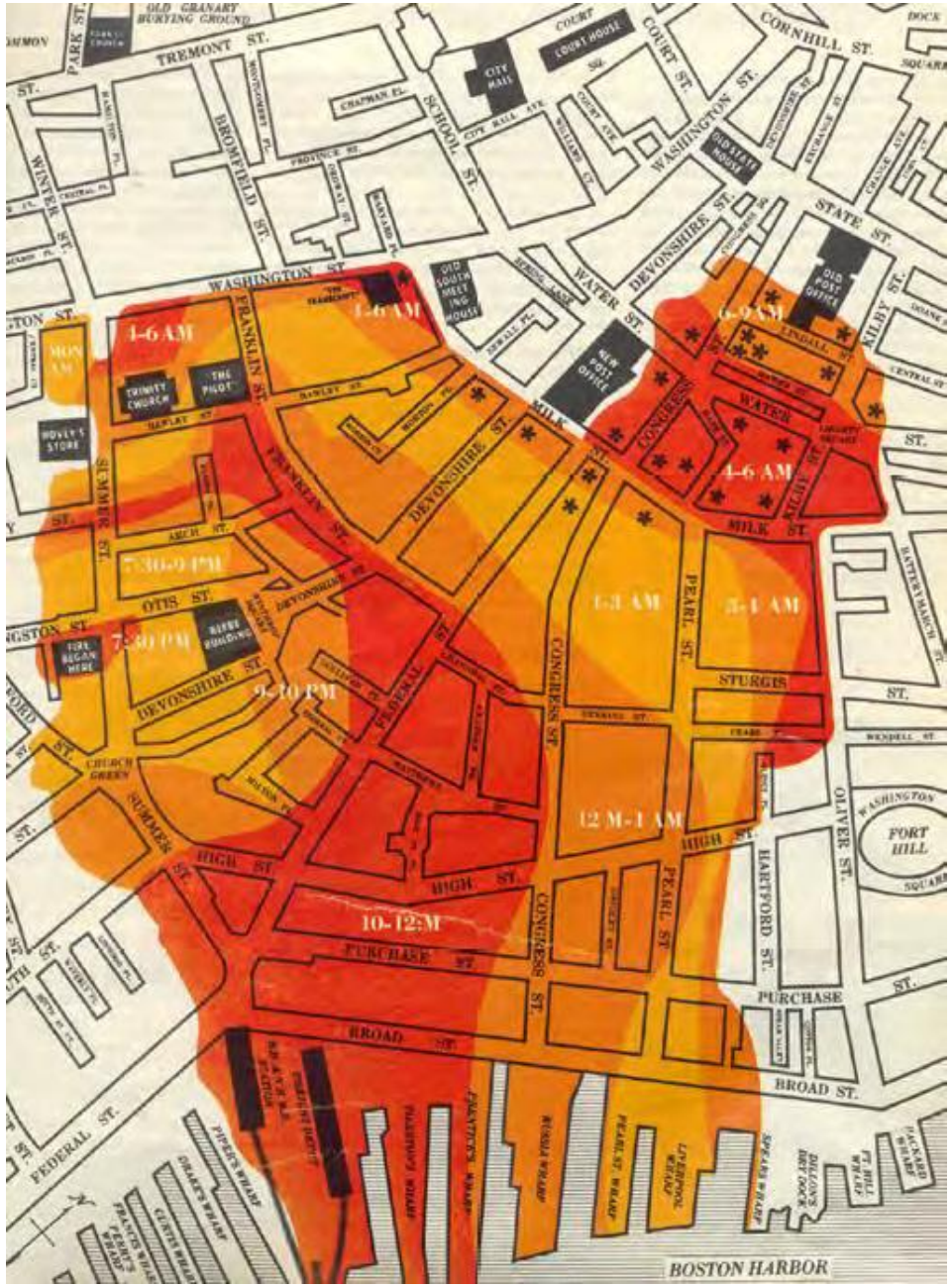
- Consumed 776 buildings in the heart of the city covering 65 acres
- Fought over several days by firemen from as far away as Maine.
- Resulted in 13 deaths and $75 million in damages,
- Caused bankruptcy of 70 insurance companies.

Franklin St. before & after the 1872 Great Boston Fire

These images are in the public domain.

Great Fire of 1872

- Criticism leveled at the Boston Water Department for having undersized mains in the area.
- There were no definitive standards on pipe sizes, nor minimum pressure requirements nor standards for hydrants and nozzles.
- As a result of the Great Fire, Boston revamped its water distribution system considerably to increase pipe sizes and available fire flows.



Great Fire of 1872 in Boston, burned the entire area from present-day South Station to Fanueil Hall

Water-related causes of the fire

- Most of the downtown area had old water pipes with low water pressure.

- Fire hydrant couplings were not standardized.

- The number of fire hydrants and cisterns was insufficient for a commercial district.

- Steam engine pumpers were not able to draw enough water to reach the wooden roofs of tall downtown buildings.

- https://en.wikipedia.org/wiki/Great_Boston_fire_of_1872

Boston

1860 6,500 flush toilets
100 miles of sewers

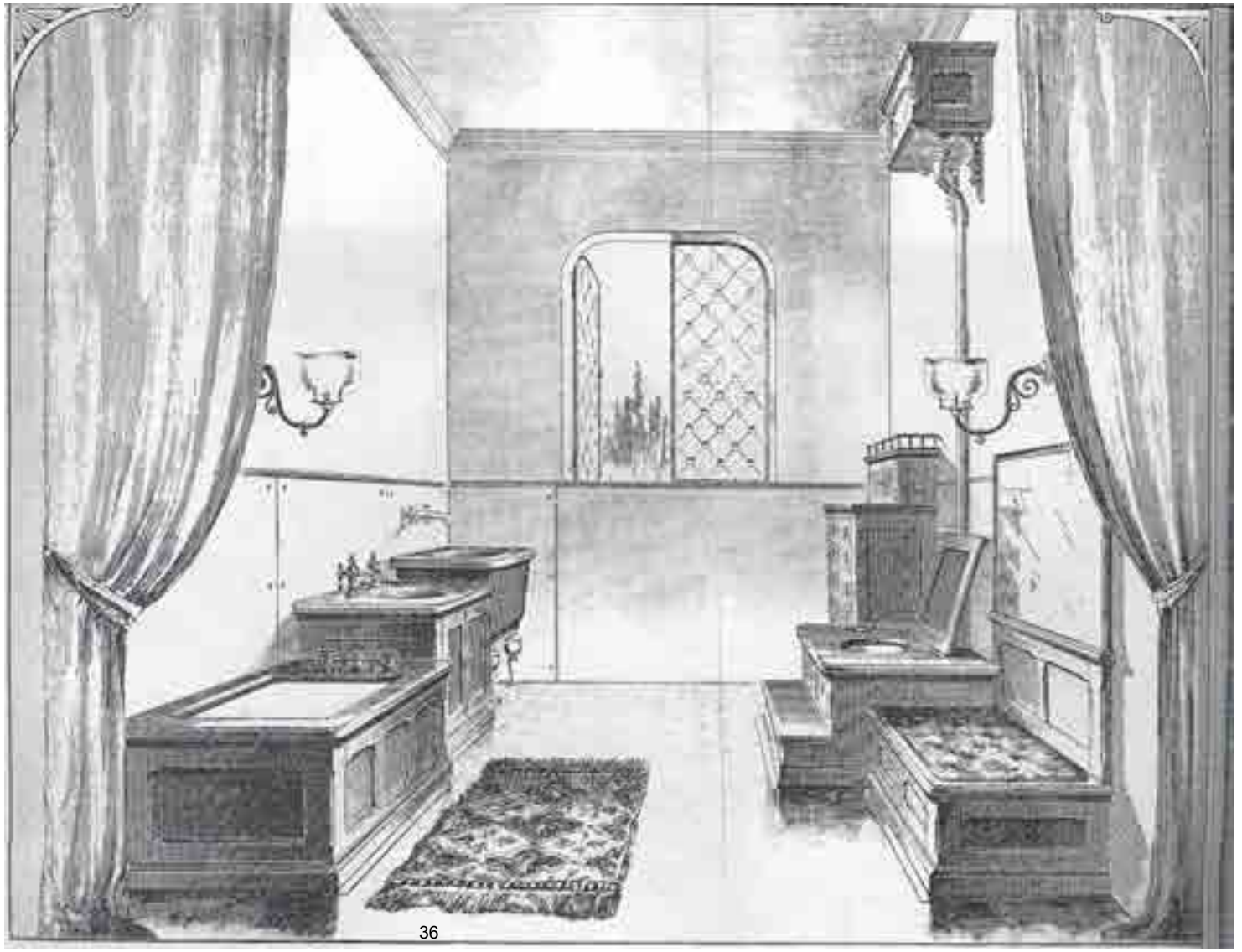
1885 100,000 flush toilets
226 miles of sewers

TREMONT HOUSE, TREMONT STREET, BOSTON
Photograph by William Halliday, about 1895.

Boston hotels advertised their Victorian Bathrooms as luxury features.

And, guests at the Trement Hotel and the Parker House consumed huge amounts water - 25,000 and 20,000 gallons of water per day respectively – at these hotels

Victorian Bathroom



1870 Chestnut Hill Reservoir Entrance Gate

Chestnut Hill Reservoir

- Chestnut Hill Reservoir was built on existing marshes and meadowland to supplement Boston's growing water needs.
- It lies entirely within the Boston city limits, but bordered by Brookline and Newton

Chestnut Hill Reservoir

Construction of Chestnut Hill System 1865 - 1870

- The Chestnut Hill Reservoir system was built between 1865 and 1870 to supplement the capacity of the Brookline Reservoir, which was then the terminus of the Cochituate Aqueduct.
- The Sudbury Aqueduct was completed in 1878, providing water to the Chestnut Hill Reservoir from the Sudbury River in Boston's western suburbs.
- The system was originally built with 48” mains, one to Brookline and one directly to the city.
- Both supplied water by gravity.

Chestnut Hill Reservoir and Pump Stations, Boston Landmark Commission, City of Boston, 1989. p.36.

Sudbury River Diverted to Chestnut Hill Reservoir

- In 1878, the Sudbury River, 18 miles from Boston, was diverted through the Sudbury Aqueduct to the Chestnut Hill Reservoir to supplement Boston's water supply

Chestnut Hill Gatehouses 1865 - 1870

- The Chestnut Hill Reservoir gates controlled the flow into the Chestnut Hill Reservoir from the Cochituate Aqueduct and the Sudbury Aqueduct

- And the Effluent Gate House carried water from the Chestnut Hill Reservoir to the Brookline Reservoir.

Image is in the public domain.

The gatehouse at the end of the Sudbury Aqueduct in Newton, Massachusetts, just above the Chestnut Hill Reservoir.

Effluent Gate House

- And the Effluent Gate House carried water from the Chestnut Hill Reservoir to the Brookline Reservoir

Image is in the public domain.

High Service Station at Chestnut Hill 1887 - 1888

- The first major structure on the site, the “high service pumping station,” is an excellent example of a Richardsonian Romanesque structure, designed by Arthur Vinal in 1887.
- It has a cathedral-line grandeur, a kind of ode to a “golden age of water engineering” yet it purpose was mainly utilitarian building – supplying water.
- Today this building is the WaterWorks Museum.

Image is in the public domain.

Waterworks Museum, Chestnut Hill

The architectural style used by Vinal and Wheelwright was Richardsonian Romanesque. H.H. Richardson's most famous work in perhaps Boston's Trinity Church in Copley Square.

High Service Station at Chestnut Hill 1887 - 1888

- When elevated territory was annexed to Boston mid-1870s, additional high service was needed.
- The pumps at Chestnut Hill were used to fill Fisher Hill reservoir one mile away, at a higher elevation of 241 feet.
- From there, the water went to Parker Hill Reservoir (now Mclaughlan field) on Mission Hill at 219 feet.
- In 1890, over half of the city water required high pressure service in order to be supplied with water from Chestnut Hill.

Low Service Pumping Station

- Construction began in 1898 on the 2nd pumping station at Chestnut Hill.
- It was needed to fill “near” storage and distributing reservoir at Spot Pond (Stoneham) and to increase low service pressure for an expanding downtown Boston.
- Storage capacity was increased to 15.7 billion gallons, and daily capacity to > 105 MGD

Image is in the public domain.

Erasmus Leavitt & the Leavitt Pump

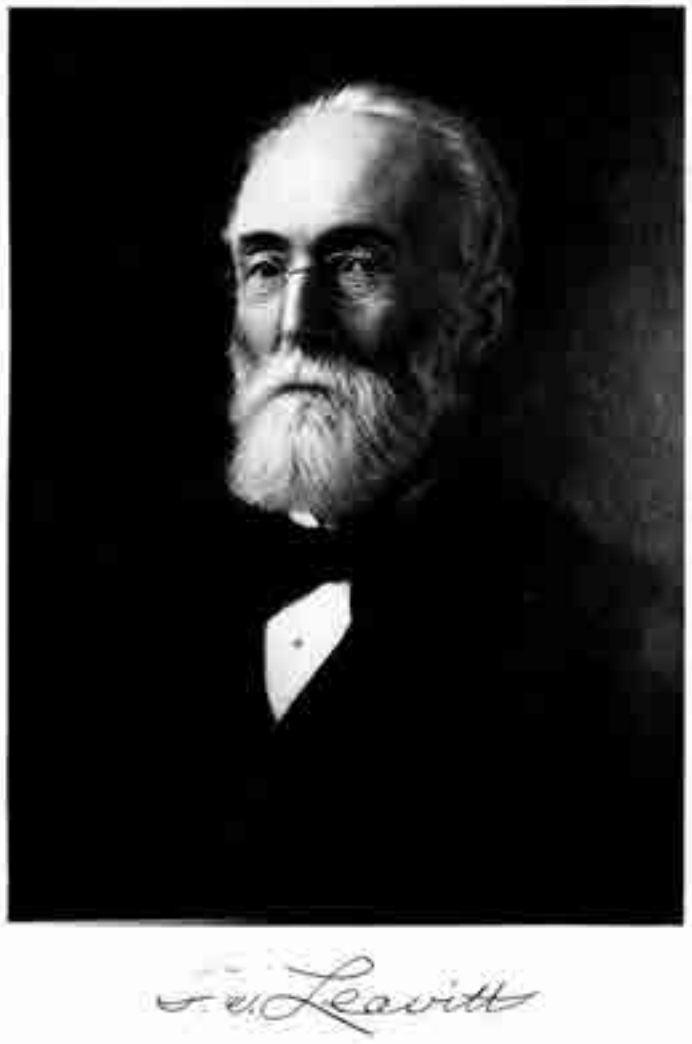


Image is in the public domain.

- The most important original technology of the facilities operation was the Leavitt engine in the High Service engine room, constructed 1892-1894 at Quintard Iron Works, New York.
- Erasmus Darwin Leavitt Jr. was one of America's foremost designers of large steam engines.
- Born in Lowell, Ma in 1836, died in Cambridge in 1916.
- Apprenticed in the Lowell Manufacturing Co. machine shop.
- Served in Navy in the Civil War. Taught steam engineering at the U.S. Naval Academy.
- Opened a private mechanical engineering practice in 1867.
- Received an honorary PhD from Stevens Institute of Technology in 1884.
- The Chestnut Hill engine is the only known surviving Leavitt work.
- Pump provided 20 million gallons per day (MGD)

The Worthington Pump

- The Worthington Pump is a horizontal pump. Like the Leavitt, it is also a steam-driven pump. (The steam is created in the boilers in which they boil water to genearate steam. The fuel was coal, brought in via the railroad behind the WaterWorks building. Today that is the "T" green line.
- Pump provided 15 million gallons per day (MGD).
- It is the only pump that might still work today if rehabilitated.
- All three types of pumps ran amazingly silently.

- If you worked here, you could hear others easily if talking in the big building.

The Allis Pump

- This was the first ____ - driven pump.
- Pump provided 30 million gallons per day (MGD)
- By early 1900, the Boston WaterWorks facility was providing 100 MGD of water to greater Boston.

Costs

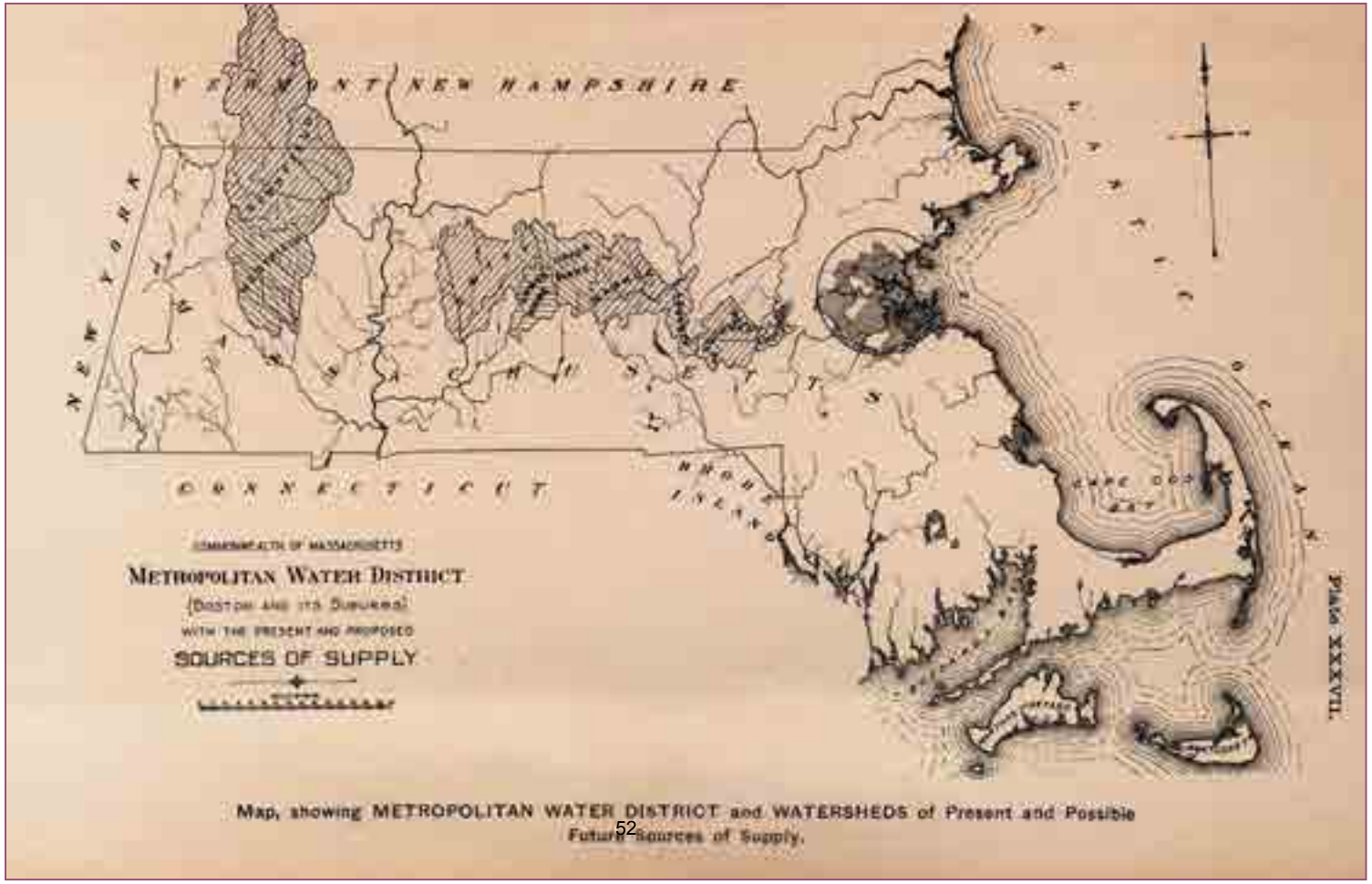
- According to the History of Boston Water works from 1868 to 1876, the total cost of land acquisition and construction, in that decade was almost 2.5 million dollars.
- However, revenue from the city water sales for the same period was over $ 565,000.
- The last third of the 19th century, Boston's sanitary project cost 1/3 of the total City budget*

* Chestnut Hill Reservoir and Pump Stations, Boston Landmark Commission, City of Boston, 1989. p.36.

Chestnut Hill Reservoir System

- The Chestnut Hill Reservoir and the high and low service pumping stations played a major role in the supply of water to the Metropolitan area for over 100 years.

Yet in 1895, boston was again running low on water, so engineers Set Their Sites Further West as Boston kept growing



Map, showing METROPOLITAN WATER DISTRICT and WATERSHEDS of Present and Possible Future Sources of Supply.

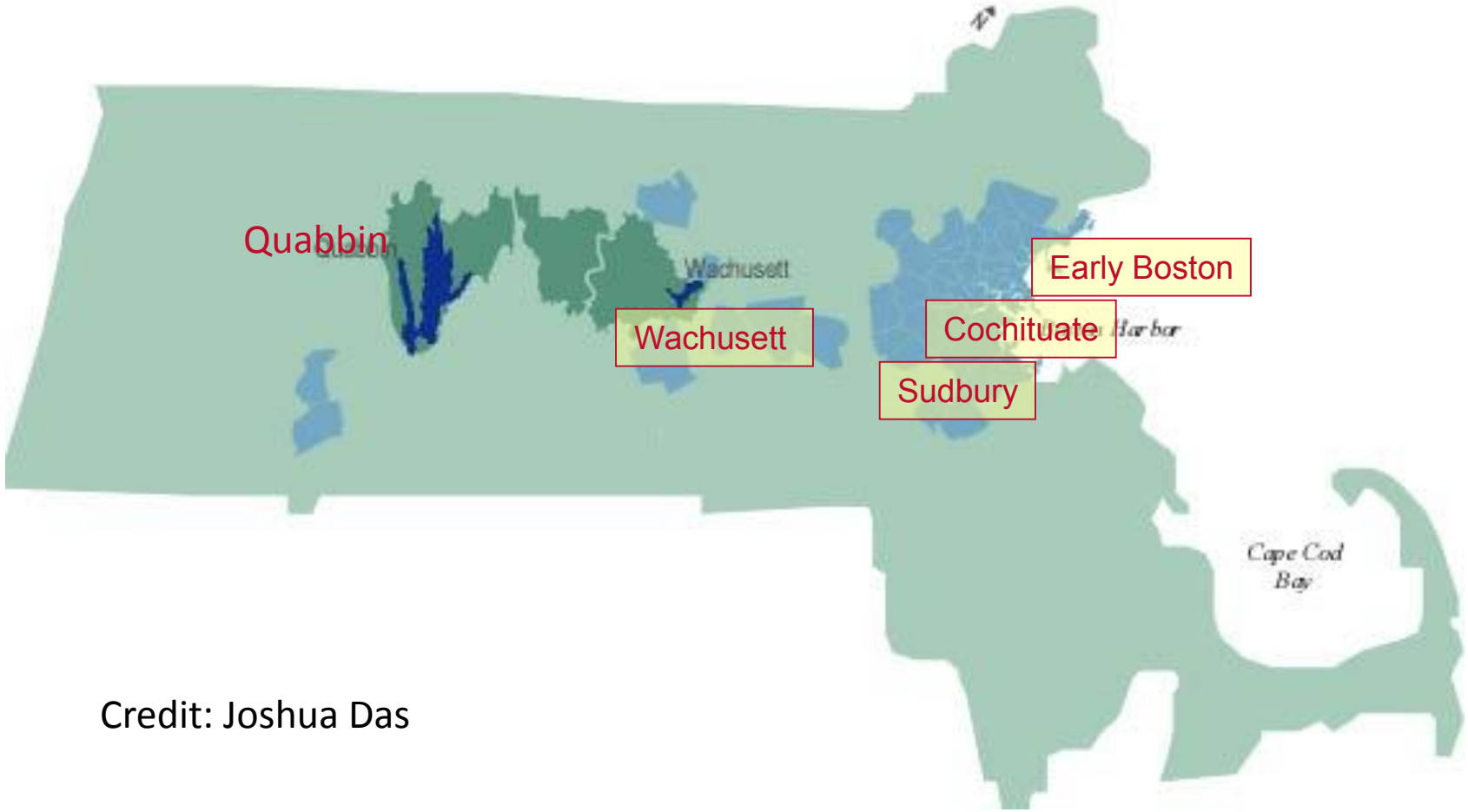
Image is in the public domain.

Boston and Massachusetts Water Demand Continued to Grow

- Boston continued to grow rapidly in the 1880s and 1890s
- Planners had not foreseen the advent of indoor plumbing
- In 1895 the Metropolitan Water District was formed to serve 11 cities and towns with a population of 750,000 and a water demand of 70 million gallons per day
- New water sources were considered: the Nashua River, the Merrimack River, Lake Winnipesaukee and Sebago Lake, Connecticut River, and more!

Credit: Joshua Das

Water System History - A Journey Westward



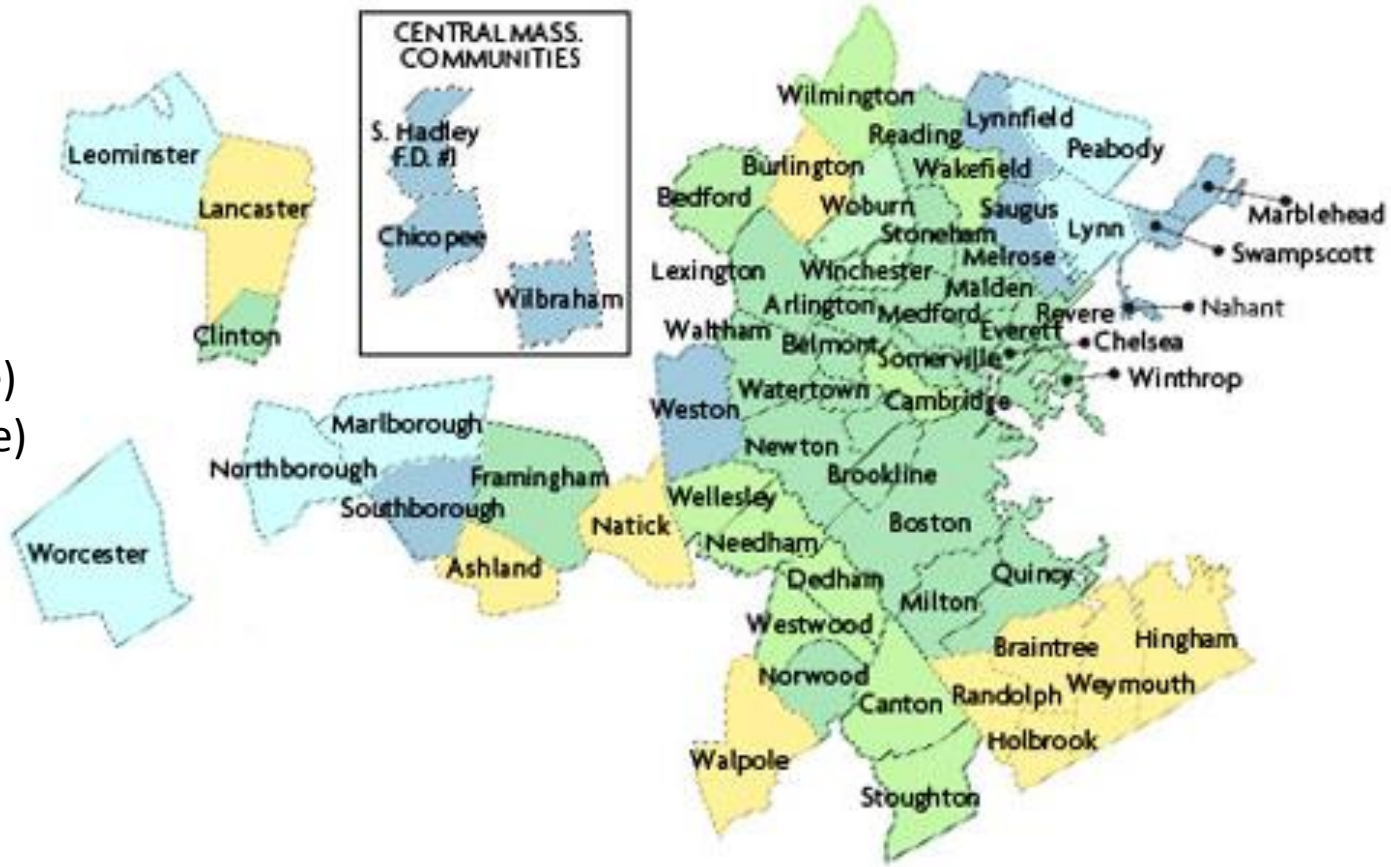
Credit: Joshua Das

Massachusetts Water Resource Authority (MWRA)

MWRA is a Massachusetts public authority established by an act of the Legislature in 1984 to provide wholesale water and sewer services to 3.1 million people and more than 5,500 large industrial users in 61 metropolitan Boston communities.

MWRA Service Area Today

3.1 million people served
890,000 households served
5,500 businesses served
200 million gallons per day of water supplied (average)
350 million gallons per day of sewage treated (average)
43 sewerage communities
51 water communities
61 communities collectively



MWRA

Partial list of MWRA cities and towns and services provided

MWRA CUSTOMER COMMUNITIES	
Community	**Services provided by MWRA**
Arlington	Water and Sewer
Ashland	Sewer
Bedford	Water (partially supplied), Sewer
Belmont	Water and Sewer
Boston	Water and Sewer
Braintree	Sewer
Brookline	Water and Sewer
Burlington	Sewer
Cambridge	Water (emergency backup only), Sewer
Canton	Water (partially supplied), Sewer
Chelsea	Water and Sewer
Chicopee	Water
Clinton	Water and Sewer
Dedham	Water (partially supplied), Sewer
Everett	Water and Sewer
Framingham	Water and Sewer
Hingham	Sewer
Holbrook	Sewer
Lancaster	Sewer
Leominster	Water (emergency back-up only)
Lexington	Water and sewer
Lynn (GE only)	Water (partially supplied)
Lynnfield Water District	Water
Malden	Water and Sewer
Marblehead	Water

Marlborough	Water (partially supplied)
Medford	Water and Sewer
Melrose	Water and Sewer
Milton	Water and Sewer
Nahant	Water
Natick	Sewer
Needham	Sewer, Water (partially supplied)
Newton	Water and Sewer
Northborough	Water (partially supplied)
Norwood	Water and Sewer
Peabody	Water (partially supplied)
Quincy	Water and Sewer
Randolph	Sewer
Reading	Water and Sewer
Revere	Water and Sewer
Saugus	Water
Somerville	Water and Sewer
Southborough	Water
South Hadley Fire District #1	Water
Stoneham	Water and Sewer
Stoughton	Sewer, Water (partially supplied)
Swampscott	Water
Wakefield	Sewer, Water (partially supplied)
Walpole	Sewer
Waltham	Water and Sewer
Watertown	Water and Sewer
Wellesley	Sewer, Water (partially supplied)
Weston	Water
Westwood	Sewer, Water (partially supplied)
Weymouth	Sewer
Wilbraham	Water
Wilmington	Sewer, Water (partially supplied)
Winchester	Sewer, Water (partially supplied)
Winthrop	Water and Sewer
Woburn	Water (partially supplied), Sewer
Worcester	Water (emergency back-up only)

Chestnut Hill Laboratory, George Whipple and Ellen Swallow Richards

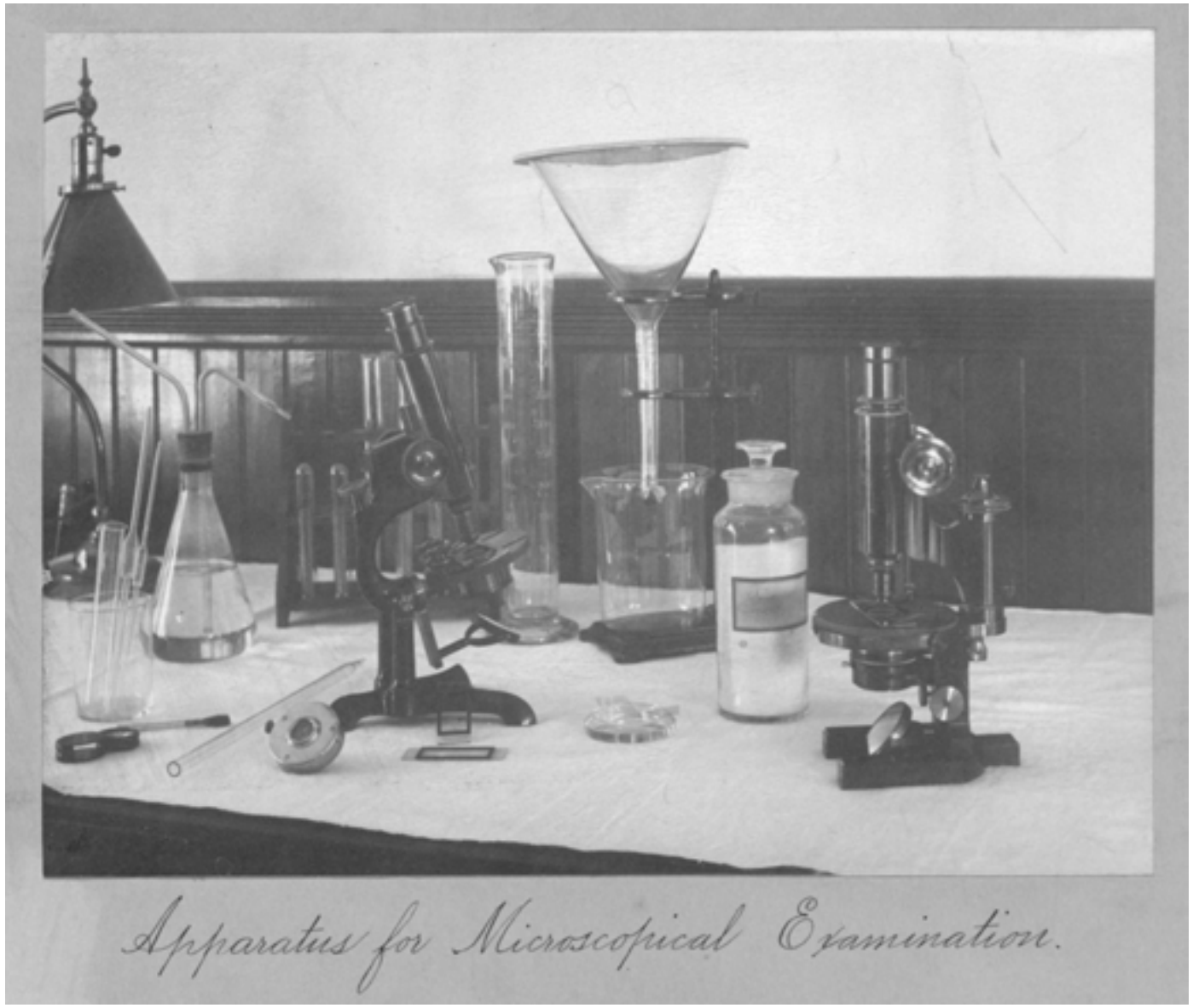
Chestnut Hill Biological Laboratory -- In 1889 the Water Board of the City of Boston established the Chestnut Hill Laboratory for systematic study of the biology of the water-supply sources

Images are in the public domain.

Whipple was Director of Chestnut Hill Biological Lab

- Whipple's dates: 1866 - 1924
- a protégé of MIT sanitary engineer, William T. Sedgwick (Sedgwick, who referred to ESR as his "great teacher), it is highly likely that Whipple was also a student of Ellen Swallow Richards, as she taught sanitary chemistry of water and food for 28 years at MIT, and Whipple was a student during 4 of those years.
- 1889 – 1897: in charge of the Chestnut Hill Laboratory at the Boston Waterworks

Lab Dedicated to Biological Water Analysis



1st (Municipal) Microbiological Lab in the Country?

- Chestnut Hill laboratory is "1st in the county dedicated to biological analysis." (or perhaps 1st microbiological analysis lab)
- Yet, Lawrence experiment Station was concurrently doing chemical and biological analyses. (Find out these dates
- And, MIT and probably some other big universities had biological laboratories devoted to water supply testing.
- So, Chestnut Hill Lab may be the first State or US government lab devoted exclusively to biological analysis of water supplies.

Lawrence Experiment Station (today known as William X. Wall Experiment Station)

- The world's first trial station for drinking water purification and sewage treatment.
- It was established in 1887 in Lawrence, Massachusetts.
- A new, 22,000 square foot building opened in 1954 at 37 Shattuck Street.[1]
- In 1975, it was added to the ASCE List of historic civil engineering landmarks.[2] In 1993, the facility was renamed after state senator William X. Wall, who had lobbied for the construction of the new station in the 1950s.[3]

1st Lab in Country Dedicated to Microbiological Water Analysis

- In 1889 the Water Board of the City of Boston established the Chestnut Hill Laboratory for systematic study of the biology of the water-supply sources – the 1st such lab in the country

Whipple and Chestnut Hill Biological Laboratory

- 1895: By this time, Chestnut Hill had been in operation for 6 years and the staff had made > 12,000 microscopic and > 6,000 bacterial analyses of water samples

- 1998: After the Metropolitan Water Board took control of Boston water supply, the Chestnut Hill Lab was moved to Beacon Hill. It was located on No. 3 Mt. Vernon Street on July 25, 1898.

- By 1895, the Chestnut Hill Laboratory had been in operation for six years, and the staff had made more than 12,000 microscopic and more than 6,000 bacterial examinations of water samples. Compare to… Ellen Swallow Richards work with State Board of health… in the 1870s and 1880s.

Ellen Swallow Richards

- 1874 Report to the Mass board of Health – representing several 1,000s of water sample analyzes by Ellen Swallow.
- 1887 Massachusetts Statewide Sanitary Survey: MIT's sanitary laboratory (Drown and Swallow) was conducted by ESR and staff she personally selected, trained and supervised.
- For nearly 2 years, Ellen analyzed 40,000 samples of the water and sewerage from 83% of the state's population. E.R. Richard’s analyses of water samples led to the formation of the Normal Chlorine Map, the standard map for sanitary surveys

George C. Whipple

After leaving the Chestnut Hill lab…

- 1897: Directed the Mt Prospect Laboratory in Brooklyn of the New York Water Dept
- 1904: Sets up private sanitary engineering practice in NYC in the firm Hazen and Whipple. The firm was renowned in water supply, water purification and sewage disposal.
- 1911: Appointed Gordon McKay Professor of Sanitary Engineering at Harvard
- 1913: Whipple, with William Sedgwick and Harvard Medical School Professor Milton J. Rosenau—founded the Harvard-M.I.T. School for Health Officers, the 1st professional training program in public health in the USA, which later became the Harvard School of Public Health

Story to be continued next week when we address Water Quality, Water Treatment and Health!

EC.715 / 11.474 D-Lab: Water, Sanitation, and Hygiene

Fall 2019