Supply and Demand Management of Greater Boston’s Water System (1600s – the present)

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Massachusetts Water Resources Authority (MWRA)

- MWRA created in 1984
- Currently serves 2.5 million people in 61 communities
Metro Boston Water Supply History In Brief

• A Journey Westward
• Begin in Boston, then

• Move West Seeking:
  – Larger Quantities of
  – Purer Water, at a
  – Higher Elevation
Water System History - A Journey Westward

Early Boston
Early Boston Water System

• Early Bostonians relied on local wells, rain barrels and a spring on Boston Common for their water

• In 1795 wooden pipes made from tree trunks delivered water from Jamaica Pond to Boston

• By the 1840s, Jamaica Pond was too small and too polluted to provide water to Boston’s 50,000 residents

• A purer and larger source had to be found
Water System History - A Journey Westward
The Cochituate System

- After 20 years of study, the Cochituate System was chosen, and construction began in 1845
- 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 in 1848 at a dedication ceremony that drew 100,000
The Mystic Lakes System

• By 1870, Boston’s population soared to 200,000

• In 1870 the Mystic Lakes System in Winchester, Medford and Arlington was added to the Boston System

• But engineers soon looked west for a larger source

Mystic Reservoir at Tufts College
Water System History - A Journey Westward

Early Boston
Cochituate
Sudbury
The Sudbury System

- In 1878, the Sudbury River, 18 miles from Boston, was diverted through the Sudbury Aqueduct to the Chestnut Hill Reservoir.

- By 1898, the Fayville Dam and the Sudbury Reservoir were completed.
Soon - A Regional Solution Was Needed

- Boston continued to grow rapidly in the 1880s and 1890s

- And 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
Water System History - A Journey Westward
Chief Engineer Frederick Stearns planned a water source that would be gravity-operated and not require filtration.

In 1897, the site was chosen - the Nashua River was impounded by the Wachusett Dam, 38 miles from Boston.

6.5 square miles were flooded in the towns of Boylston, West Boylston, Clinton and Sterling.
The Wachusett Reservoir

- At the time it was constructed, the Wachusett Reservoir was the largest man-made water supply reservoir in the world.

- Its 65 billion gallons supplied 118 million gallons per day.

- Work was completed in 1905 and the reservoir filled in May 1908.
But Even In 1895, Engineers Set Their Sites Further West
And Planning Was Soon Underway

• In 1919, the Metropolitan District Commission was created consolidating responsibility for water, sewage and parks
• The MDC and the Department of Public Health were appointed to a Joint Board by the legislature to study water supply needs
• The Joint Board made projections to 1970 and determined current water supply would be inadequate by 1930
• In 1922, the Joint Board recommended the addition of the Ware River and the Quabbin Reservoir to the MDC water supply system
• The Quabbin Reservoir, 60 miles from Boston, could be gravity-operated and not require filtration
Water System History - A Journey Westward

- Quabbin
- Wachusett
- Cochituate
- Sudbury
- Early Boston
The Quabbin Reservoir

- Construction of the Wachusett-Colebrook Tunnel (now the Quabbin Tunnel) began in 1926, carrying flow from the Ware River to the Wachusett Reservoir.

- In the 1930s, the Tunnel was extended to the Swift River.
- This two-way tunnel carries flows east and west.
- In 1936, construction of the reservoir began.
- Construction of the Quabbin required the impoundment of the Swift River and the takings of four towns.

*Moving a house from Greenwich*
The Quabbin Reservoir

- The reservoir was filled with water from the Swift River and the Ware River

- Filling began in 1939 and was completed in 1946

- At the time, the 412 billion gallon reservoir was the largest man-made reservoir in the world
Current Reservoir Capacity

**Quabbin Reservoir**
- Storage: 412 billion gallons
- Depth: 150 feet
- Length: 17.9 miles
- Width: 3 miles

**Wachusett Reservoir**
- Storage: 65 billion gallons
- Depth: 129 feet
- Length: 8.5 miles
- Width: 1 mile
Cumulative Water Supply Capacity

Billion Gallons

- Lake Cochituate
- Mystic Lakes
- Sudbury System
- Wachusett Reservoir
- Quabbin Reservoir

Year: 1848 1870 1872 1908 1946
Population Growth & Water Usage Kept Growing

MWRA System Water Demand vs. Population

Population (mil.)

Demand (mgd)

1840 1860 1880 1900 1920 1940 1960 1980

Population vs. Water Demand

- Population (mil.)
- MGD
Demand Exceeded Safe Yield

Figure by MIT OCW.
Northeast Drought

• Just 20 years after Quabbin was completed, the drought of the 1960s led some to believe that the source might not be sufficient to serve water needs in the decades to come

• Capacity of the Quabbin Reservoir reached a historic low of 44% in May 1967
The Northfield Project was a proposal for skimming Connecticut River spring flood flows and diverting them into the Quabbin Reservoir, using a pumped-storage facility.

The measure was authorized by the legislature in both 1967 and 1970.

The storage was built into the Northfield Mountain power reservoir.
Water Management Era Begins

- Earth Day and the rise of the environmental movement
- Citizen awareness and participation increased
- Founded as the Northfield Citizens Advisory Committee in 1977, the Water Supply Citizens Advisory Committee continues today
- MEPA established to open up decision-making
- Coalition forms against Connecticut River diversion and exploits Western Massachusetts resentment toward Boston
- State of Connecticut fights plan and threatens lawsuit
Nine Alternatives To Be Considered

- Demand Management
- No Action
- Connecticut River
- Watershed Management
- Millers/Tully Rivers
- Merrimack River
- Upper Sudbury
- User Sources
- Plymouth Aquifer
MWRA Formed

- MWRA began operations in 1985
- MDC retains watershed and reservoir management
- MWRA reviews Long Range Water Supply Study begun by MDC that included diversion options of Connecticut, Merrimack and Sudbury Rivers
- Extensive briefing and consultation process
- In November 1986, the Board of Directors voted to try water conservation for a 3-year period to curb demand
25 Separate Short and Long Term Policies

- Leak Detection, Repair and Metering
- Conservation and Demand Management
- Improved Use of Sources
- Water Supply Protection
- Management and Planning for the Future
- Outreach and Reporting
**Demand Management Strategy**

### WATER USE

#### Residential
- Toilet
- Shower
- Laundry
- Kitchen
- Tub & Sink
- Outdoor

#### Industrial
- Commercial
- Institutional
- Process
- Cooling
- Sanitary

#### Unaccounted
- For Water
  - Leakage
  - Meter Errors
  - Public Use
  - Other

#### Problem
- Inefficient Fixtures
- Poor Water Habits
- Inefficient Fixtures
- Once Through Cooling
- Inefficient Process Use
- Leakage
- Meter Errors

#### Response
- Retrofit Fixtures
- Public Education
- School Education
- Efficient Technology
- Technical Assistance
- Water Audits
- Technology Transfer
- Training & Education
- Leak Survey & Repair
- Test/Replace Meters
## Multimedia Approach

<table>
<thead>
<tr>
<th>Purpose</th>
<th>Technique</th>
<th>Distribution</th>
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<tbody>
<tr>
<td>Make consumers Aware</td>
<td>Bill Stuffers</td>
<td>Utilities direct mail</td>
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<td>Messages on Water Bills</td>
<td>Community centers</td>
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<td>Brochures</td>
<td>Town halls, Libraries</td>
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<td>Respond to Questions</td>
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<td>Personal contact</td>
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<td>Facilitate Decisions</td>
<td>Independent, credible sources</td>
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Water Savings at Home

• MWRA's Operation WaterSense in 1990s installed 1.3 million water saving fixtures in approximately 350,000 households.

• Public Education Outreach

• School Education program promotes water conservation awareness

• Code Changes Locally and Nationally
Promote Water Efficient Technologies

• Ultra Low Flow Toilets

• Energy Efficient Appliances
Water Savings In Businesses and Institutions

• Identify Possible Efficiency Improvements with Audits
• Demonstrate Their Effectiveness through Implementation
• Reach Out and Publicize Success

• Increasing Cost of Water and Sewer Service No Small Incentive

• Market Forces and Private Firms Keep it going
Source Protection and Development

• 1970’s Saw Many Sources Lost Due to Newly Identified Contaminants

• MWRA Concern:
  – MWRA Partially Supplied Communities Will Lose Their Sources
  – Adjacent Communities will Need MWRA Water

• MWRA Program:
  – 40 Local Community Source Protection Studies

• Potential New or Rehabilitated Sources Identified
Management and Planning for the Future

- Drought Preparedness Planning
- Redundancy Studies
- Conservation Policies For Contract Users and New Communities
- Routine Review of Leading Indicators on Demand
- Better Source Performance Indicators to Evaluate New Users
  - Not Just Safe Yield, but a Whole Suite of Tools
Conservation Worked!

- Total System Demand was reduced from 336 in 1987 to 256 mgd in 1997

- Boston’s Demand is the Lowest Since 1915
What Happened to Demand?

Real Versus Projected Demand Shows the Dramatic Change
MWRA Current Demand

- **DEP & Standard Practice Safe Yield**
- **WMA Registration – 312 mgd**
- **MWRA Conservative Safe Yield – 300 mgd**
- Water Available to Non-MWRA Communities with Deficits
- Communities With Active Interest Cushion for Partial Communities
- Projected Growth to 2030
- MWRA 5-Year Average Demand
- MWRA Current Demand
Conservatively, We Have 36 MGD Available

- DEP & Standard Practice Safe Yield
- WMA Registration
- MWRA Conservative Safe Yield Estimate
- Water Available to Non-MWRA Communities with Deficits
- Communities With Active Interest Cushion for Partial Communities
- Projected Growth to 2030
- MWRA 5-Year Average Demand
- MWRA Current Demand

36 mgd

50 mgd

12 mgd
“Safe Yield”

- DEP Safe Yield & Standard Engineering: 355 mgd
- All Time Highest Usage 1980: 342 mgd
- WSCAC 1984: 318 mgd
- WMA Registration: 312 mgd
- MWRA Conservative Estimate: 300 mgd

*Net of 31 million gallons of required releases*
• MWRA Uses the 1960’s Drought:
  – a One in 300+ Year Event
• Current 5-Year Running Average – 225 mgd

* Includes temporary supply to Cambridge during construction of local water treatment plant
## Summary of Demand Assumptions

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<tr>
<th>Build-Out Analysis</th>
<th>High Estimate</th>
<th>Medium Estimate</th>
<th>Low Estimate</th>
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<tbody>
<tr>
<td>Every Lot in Region is Developed</td>
<td>No Demand Reductions by Current Users</td>
<td>Continued Efficiency Changes</td>
<td>More Aggressive conservation</td>
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<td>Small Decrease in Local Source Availability</td>
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