Massachusetts Water Resources Authority

ACEC Massachusetts

Metropolitan Tunnel Redundancy Program Update

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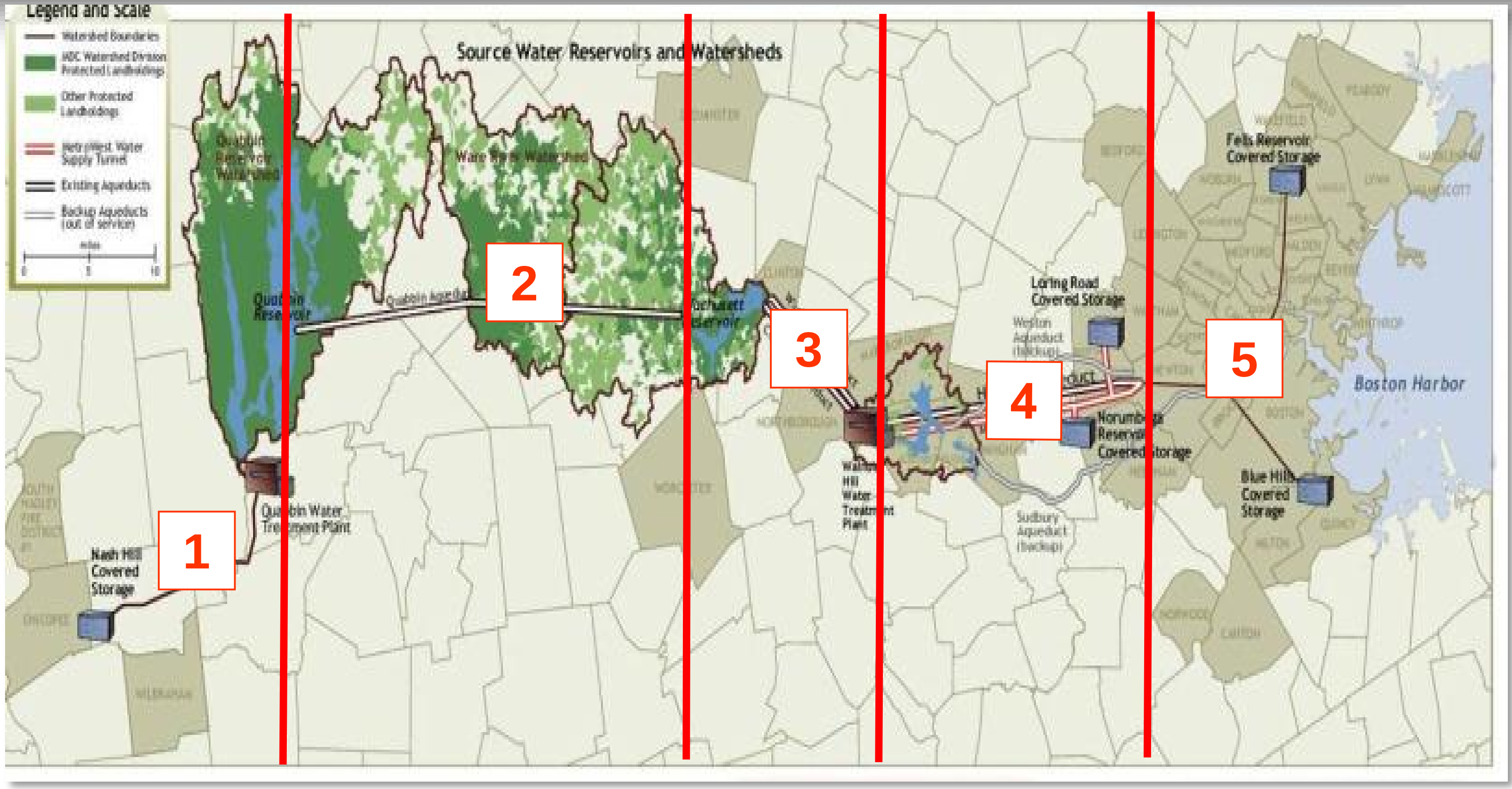
November 13, 2018

MWRA Water Transmission System



1. Chicopee Valley Aqueduct
2. Quabbin Aqueduct
3. Cosgrove Tunnel / Wachusett Aqueduct
4. MetroWest Tunnel / Hultman Aqueduct
5. Metropolitan Tunnels

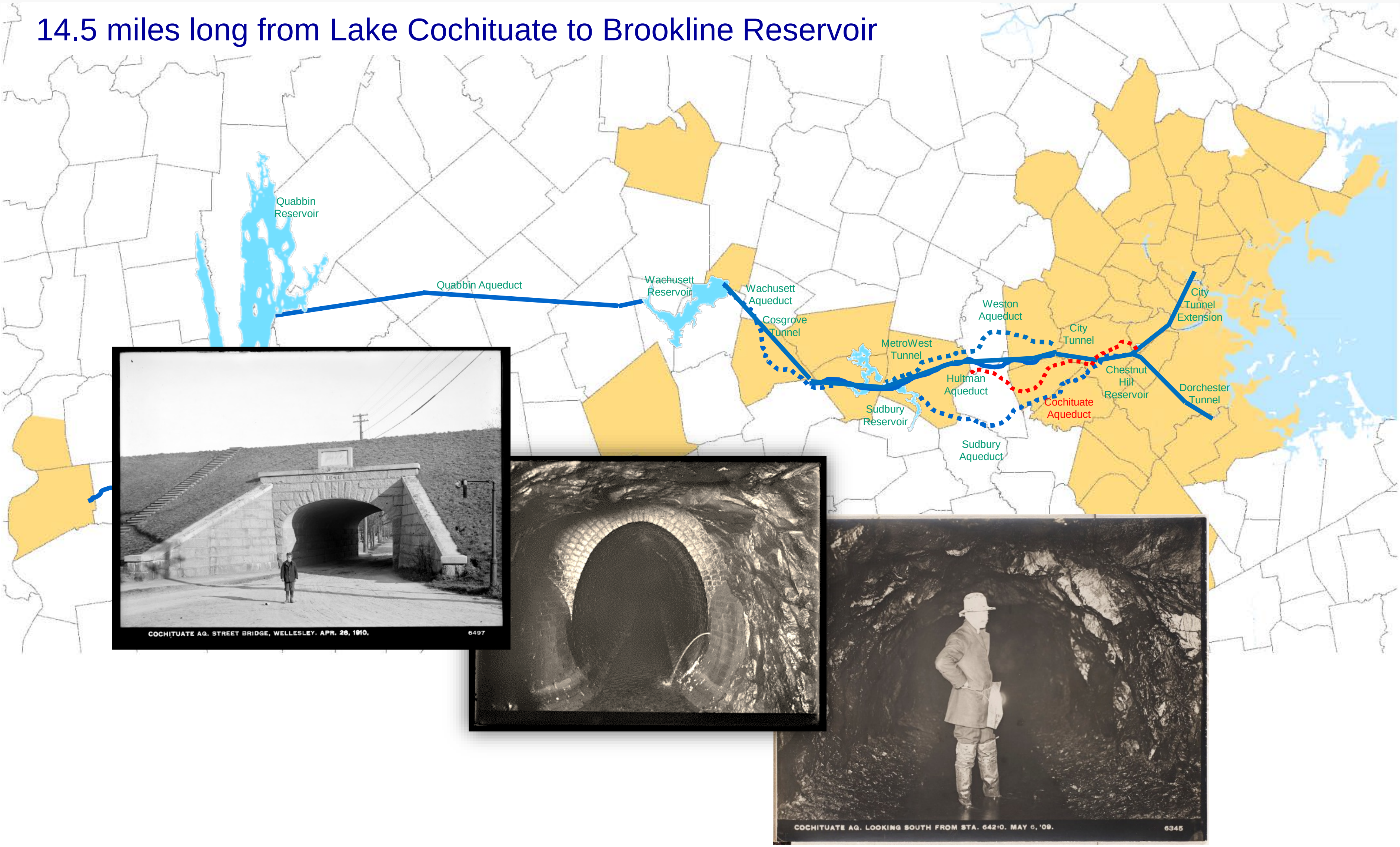
MWRA Water Transmission System

The MWRA has a long history of aqueduct and water tunnel construction as part of our water transmission system

- Cochituate Aqueduct (1840s) - inactive
- Sudbury Aqueduct (1878) - inactive
- Wachusett Aqueduct (1897) - inactive
- Westin Aqueduct (1903) - inactive
- Quabbin Aqueduct (originally the Wachusett-Colebrook Tunnel, 1939)
- Hultman Aqueduct (1940)
  - Southborough Tunnel (1940)
- Chicopee Valley Aqueduct (1949)
- City Tunnel (1950)
- City Tunnel Extension (1963)
- Cosgrove Tunnel (1967)
- Dorchester Tunnel (1976)
- MetroWest Water Supply Tunnel (2003)

Cochituate Aqueduct (1840s)

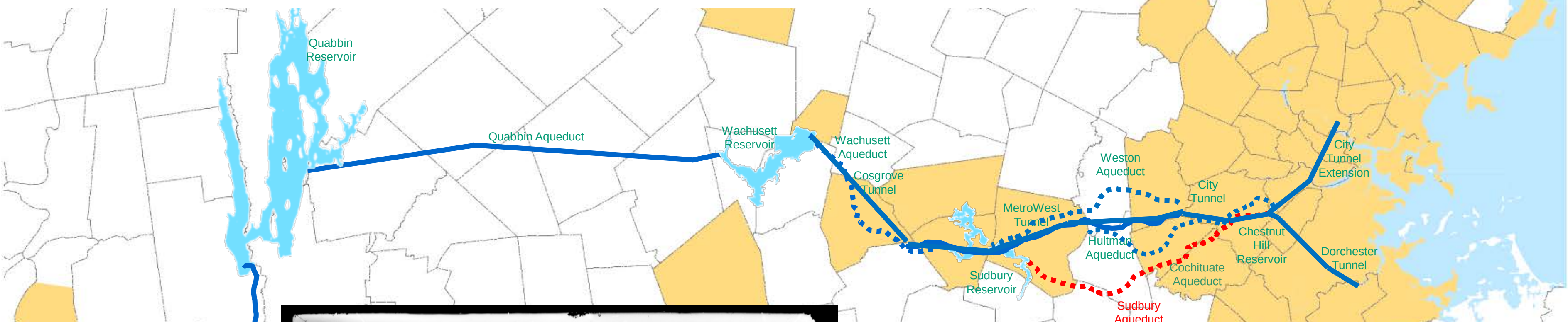
14.5 miles long from Lake Cochituate to Brookline Reservoir



Sudbury Aqueduct (1878)

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

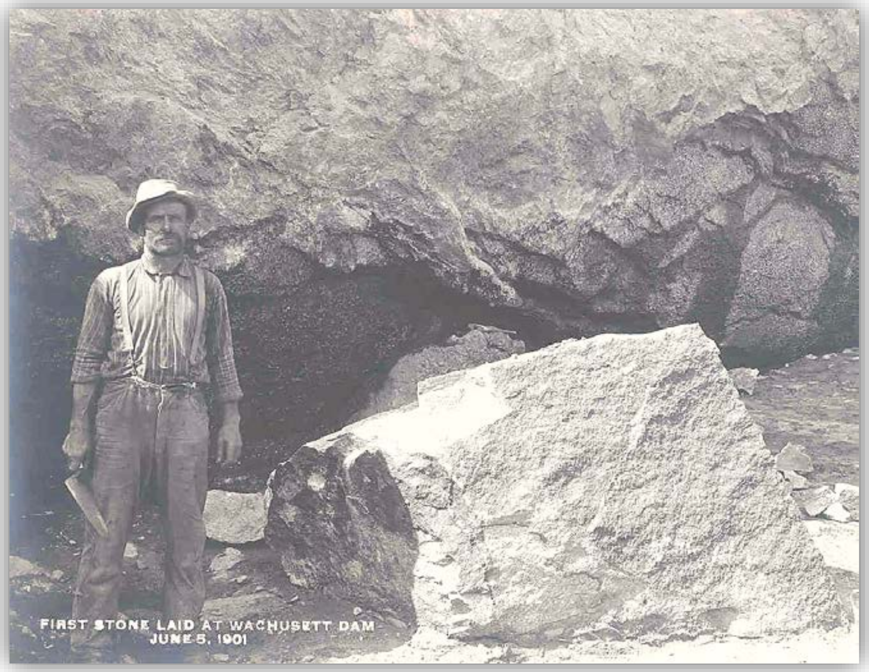
17.4 Miles, 7-9 ft. diameter



Boston Needed <u>More</u> Water

- In 1895, the Metropolitan Water Act called for the taking of water from the south branch of the Nashua River, the Boston Waterworks at Chestnut Hill and Spot Pond

- Chief Engineer Frederick Stearns planned a water source that would be <u>gravity-operated</u> and not require filtration

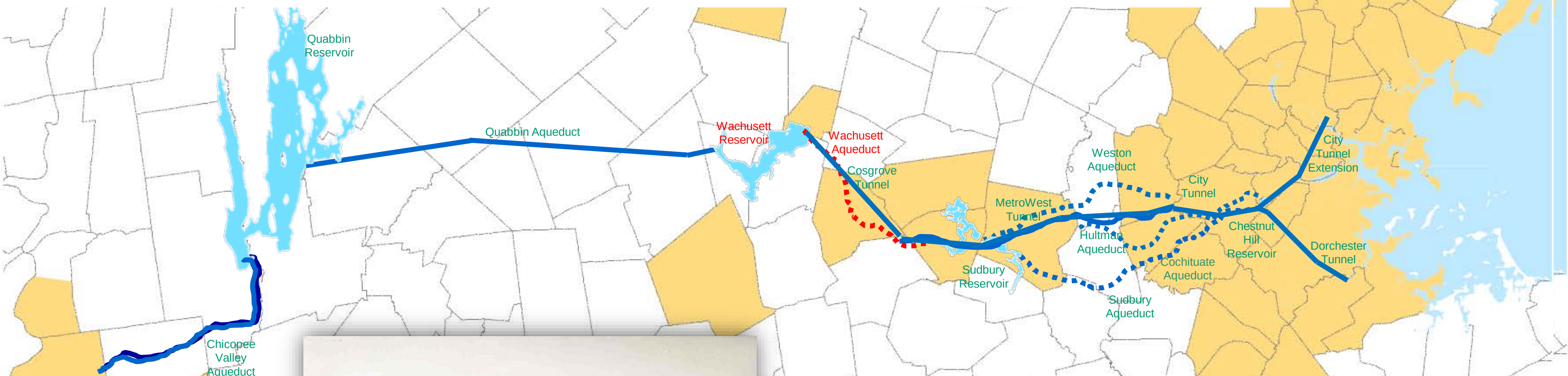


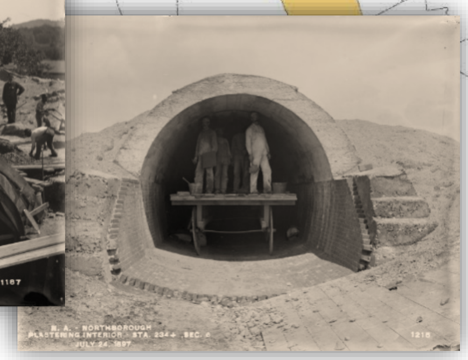
First stone laid at Wachusett Dam
June 5, 1901

Wachusett Reservoir and Aqueduct (1897)

The Wachusett Aqueduct was constructed to bring water from the Wachusett Reservoir to Sudbury Reservoir (12 miles, 10-12 ft. diameter)

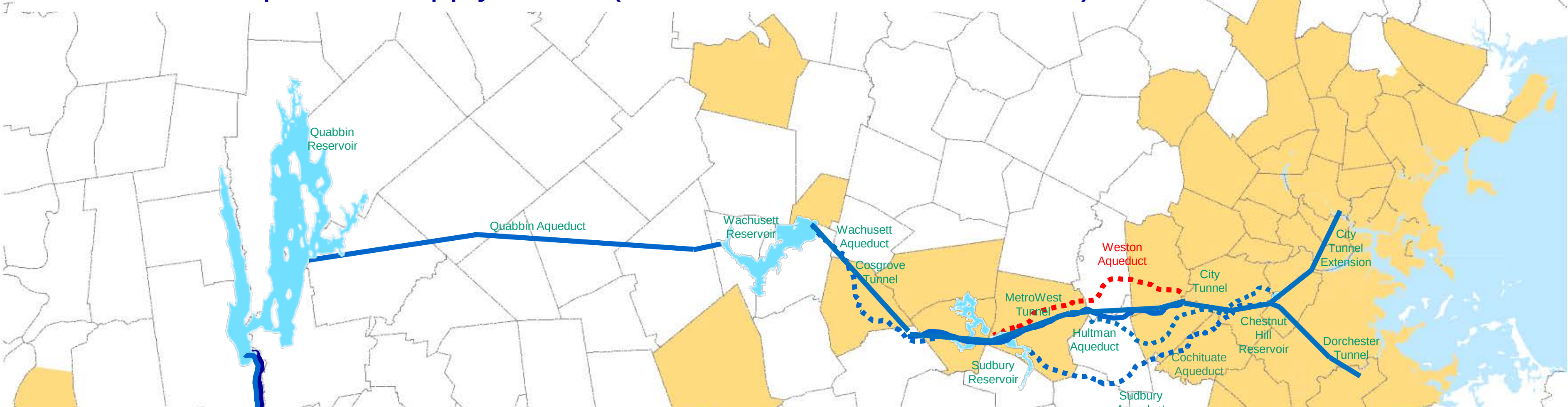
At the time it was constructed, the Wachusett Reservoir was the largest man-made water supply reservoir in the world; 65 billion gallons

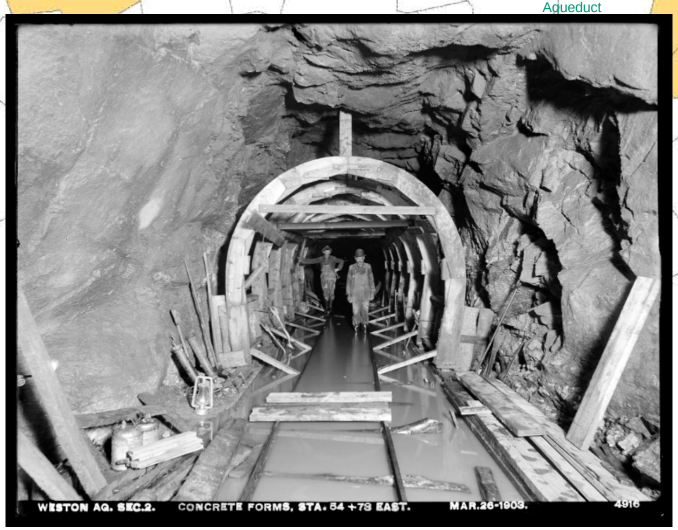




Weston Aqueduct (1903)

Conveyed water from Sudbury Reservoir to the Weston Reservoir and Weston Aqueduct Supply Mains (13.5 miles, 10-12 ft. diameter)

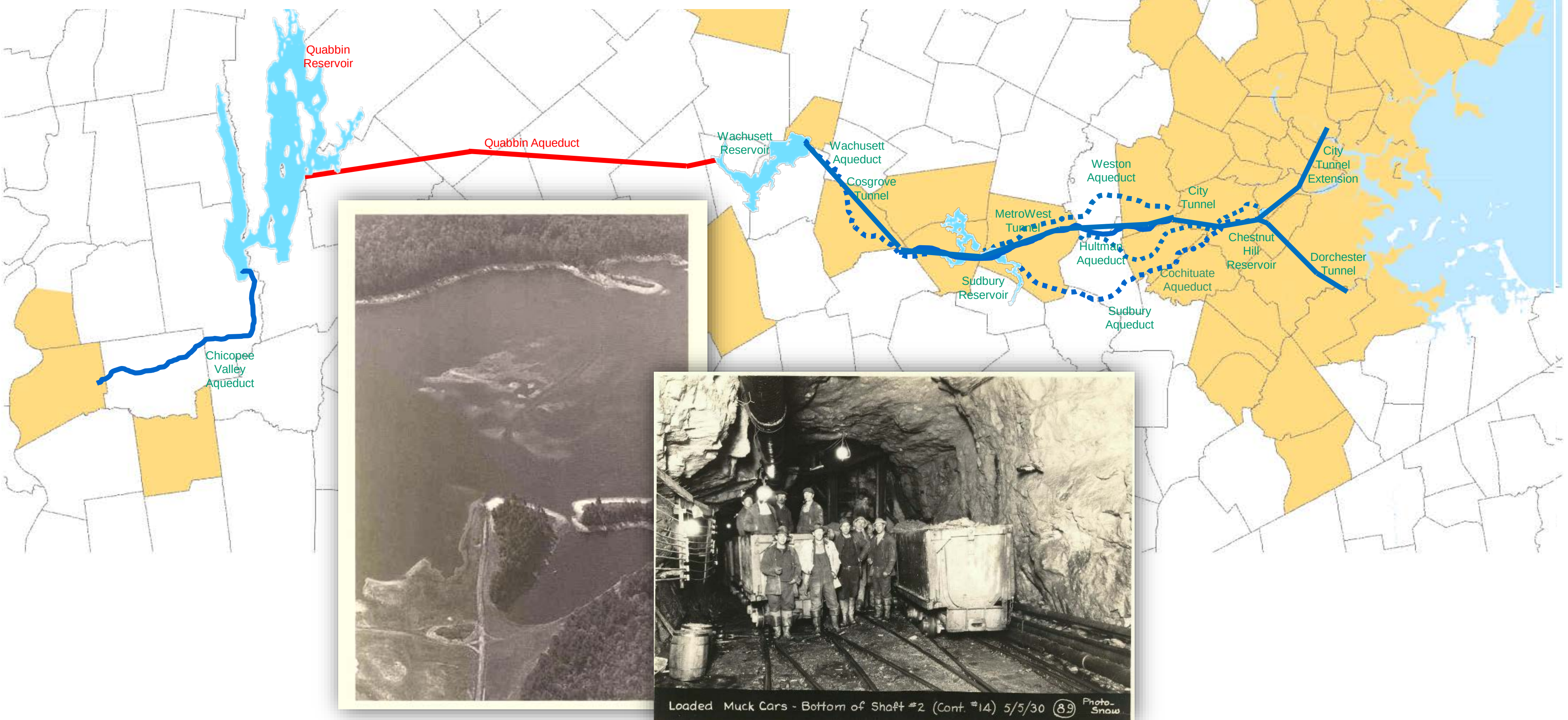




Quabbin Reservoir and Aqueduct (1939)

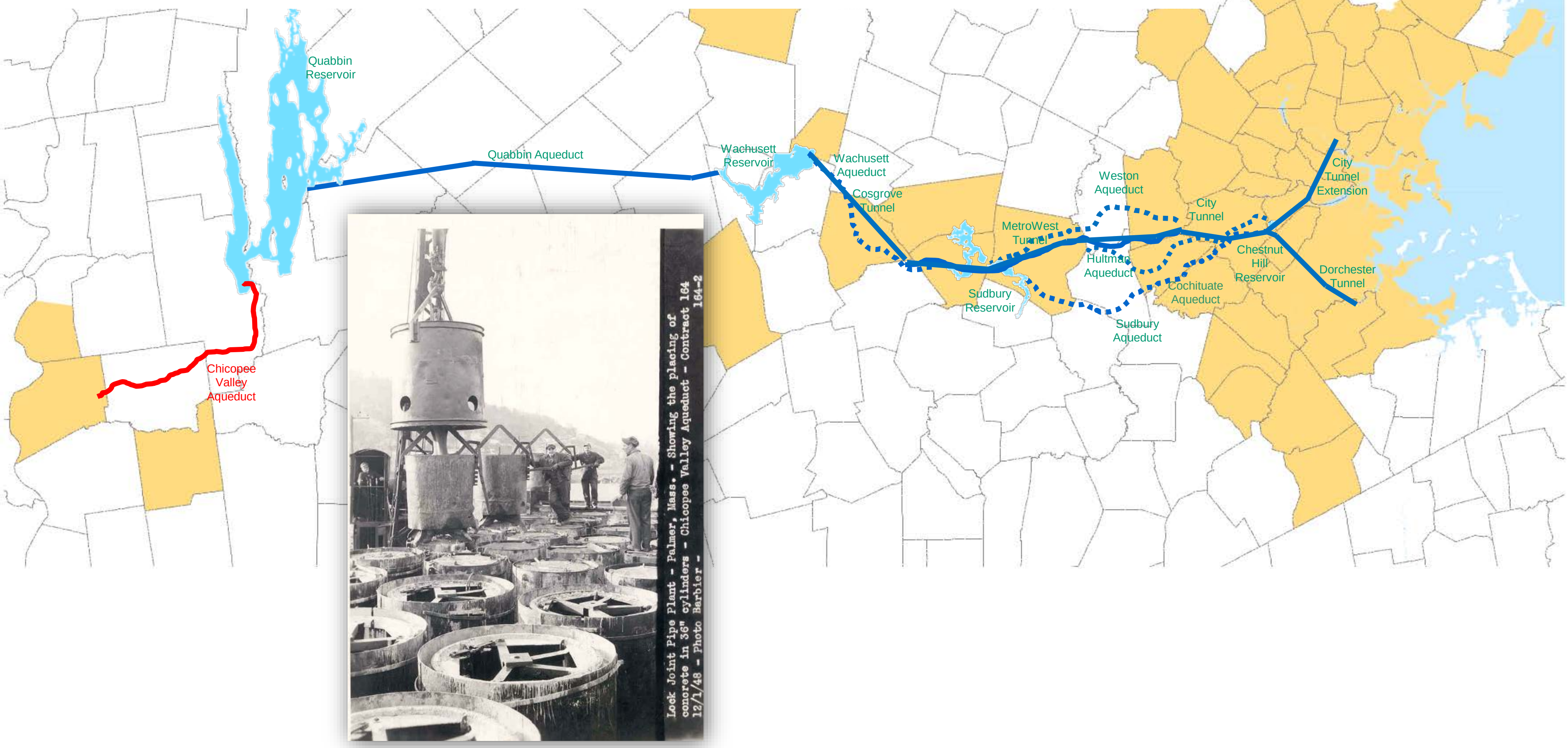
Construction of the Wachusett-Colebrook Tunnel (now the Quabbin Aqueduct) began in 1926. (24 miles, 13 ft. diameter)

In 1936, construction of the reservoir began



Chicopee Valley Aqueduct (1949)

The Chicopee Valley Aqueduct is a 14.8 mile, 4-foot diameter steel and concrete pipeline that supplies Chicopee, South Hadley FD 1 and Wilbraham from the Quabbin Reservoir

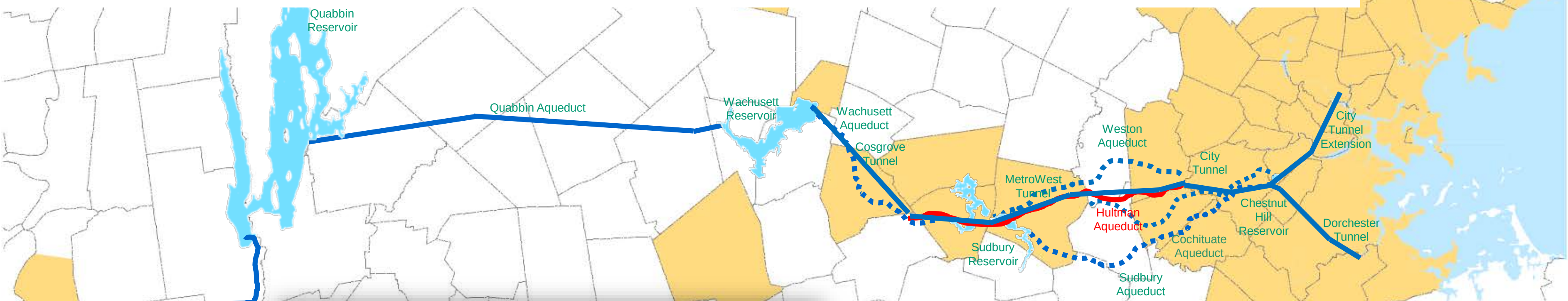


Hultman Aqueduct (1940)

In 1936, the Legislature approved the construction of a two high-pressure aqueducts to deliver water to the greater Boston area (15 miles, 11-12 ft. diameter)

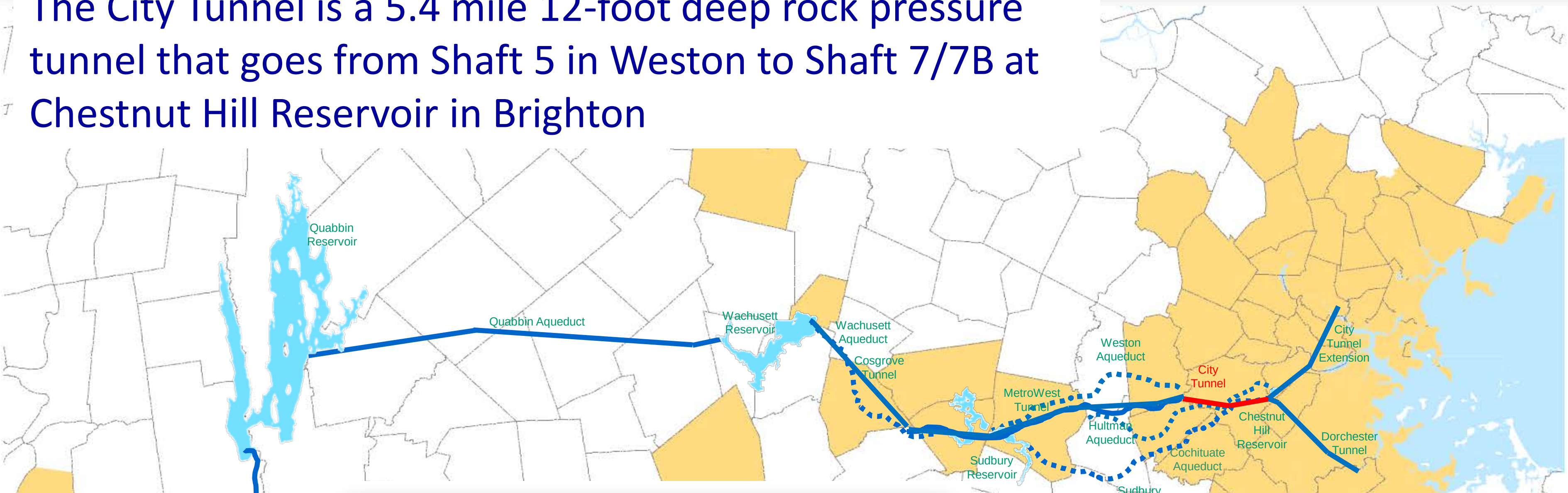
One barrel of the aqueduct system - the Hultman Aqueduct - was completed

But work on the second barrel did not resume after World War II



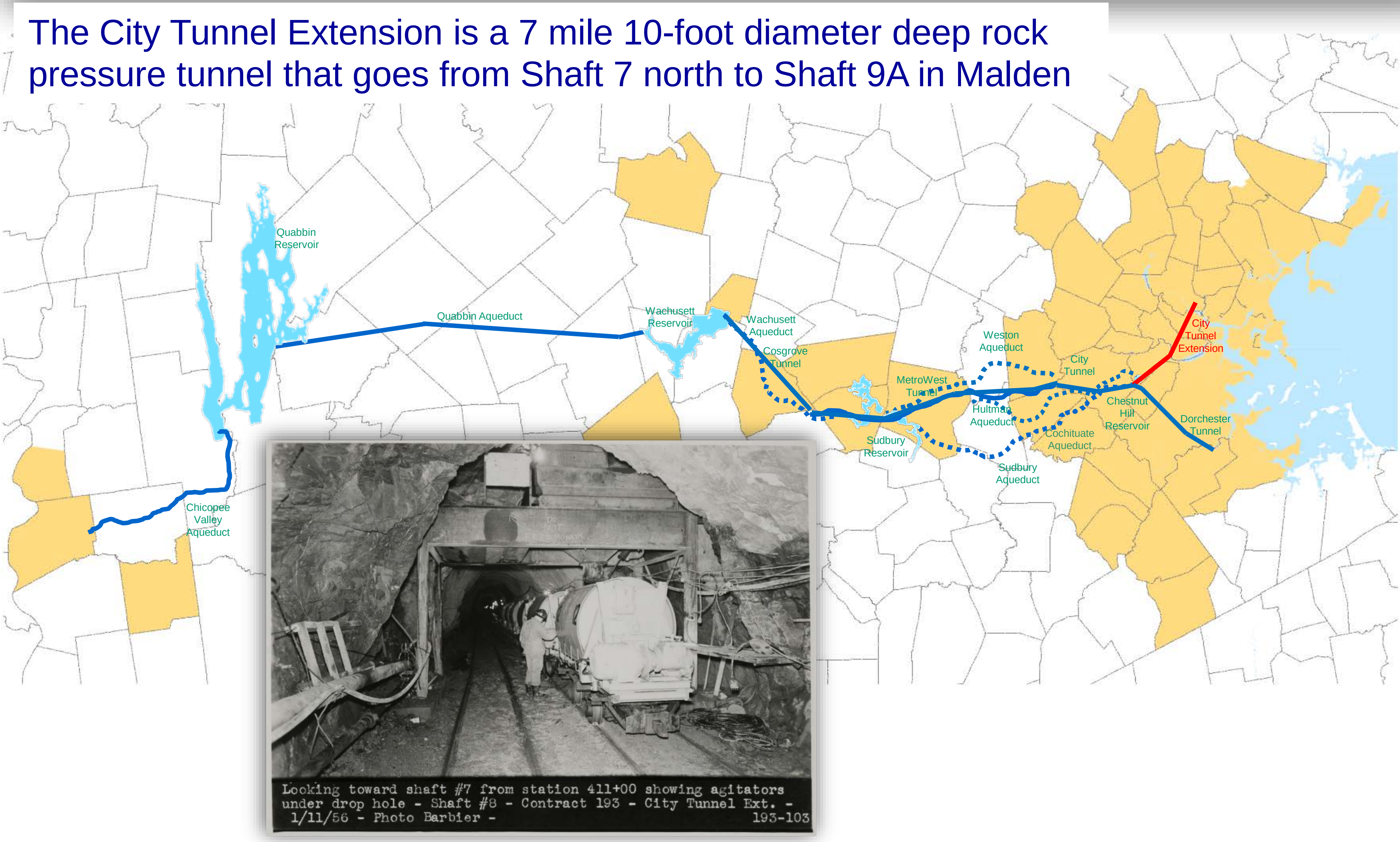
The City Tunnel (1950)

The City Tunnel is a 5.4 mile 12-foot deep rock pressure tunnel that goes from Shaft 5 in Weston to Shaft 7/7B at Chestnut Hill Reservoir in Brighton



City Tunnel Extension (1963)

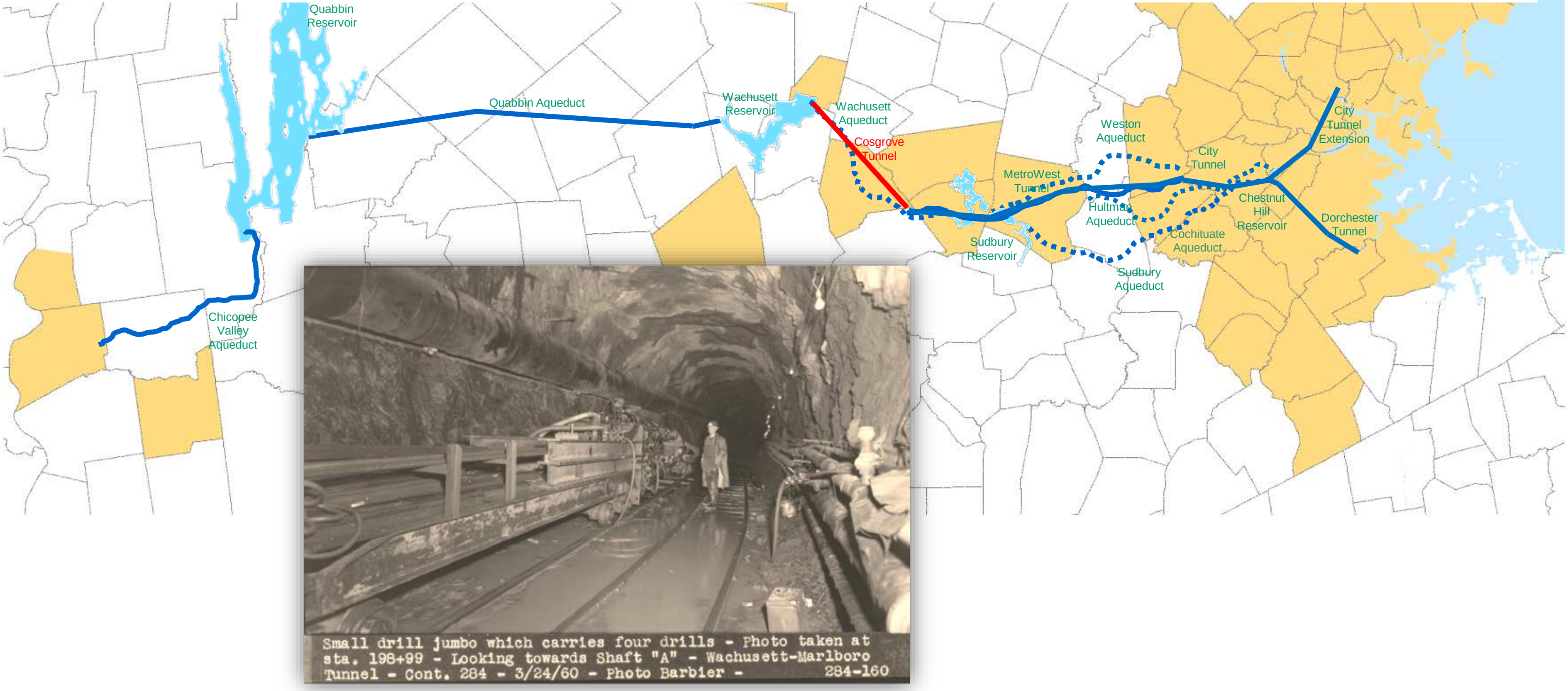
The City Tunnel Extension is a 7 mile 10-foot diameter deep rock pressure tunnel that goes from Shaft 7 north to Shaft 9A in Malden



Cosgrove Tunnel (1967)

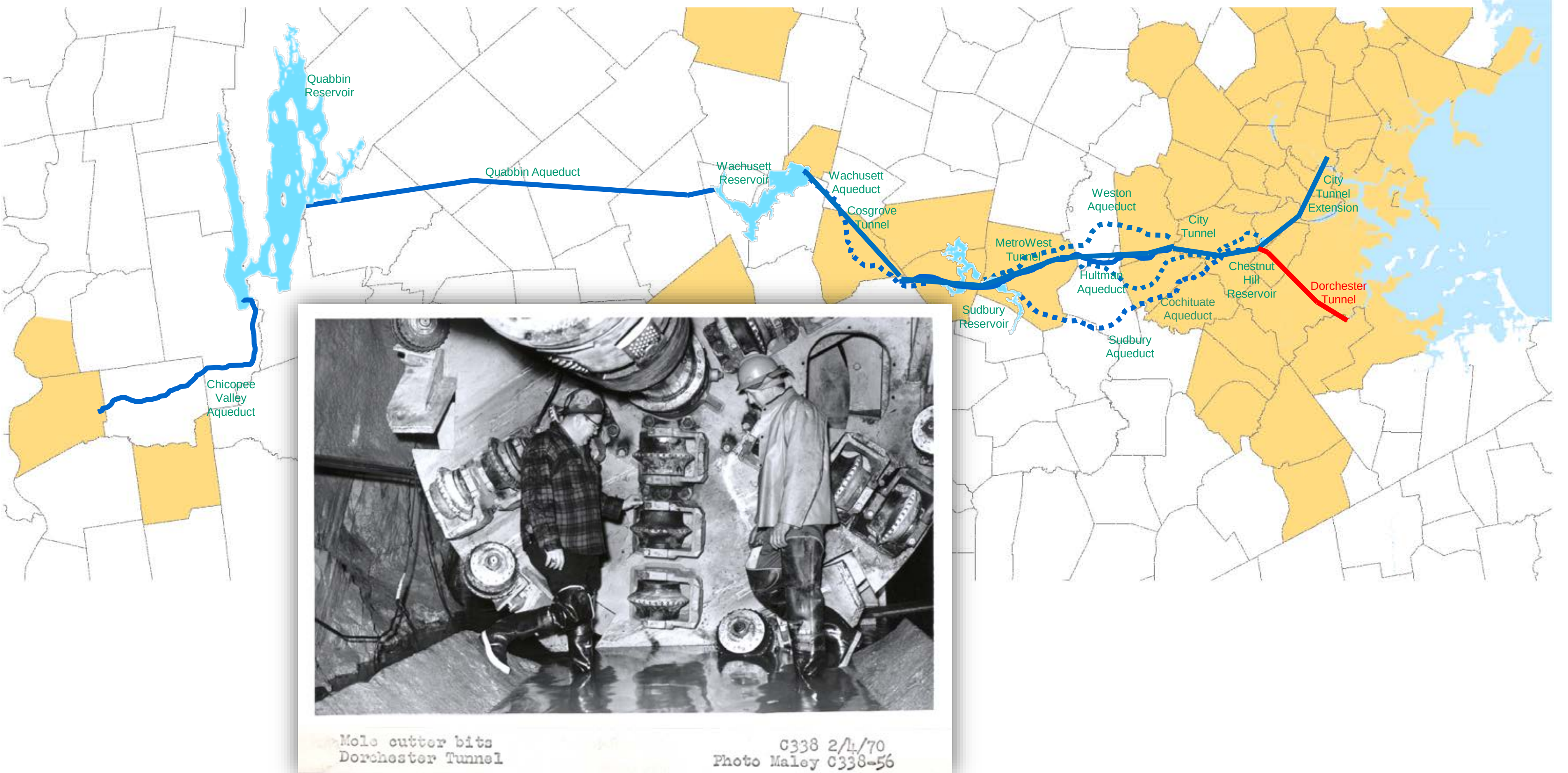
The Cosgrove Tunnel carries water 8 miles from the Wachusett Reservoir to the Carroll Treatment Plant

It is 14 feet in diameter and was constructed to replace the Wachusett Aqueduct with a pressurized tunnel



Dorchester Tunnel (1976)

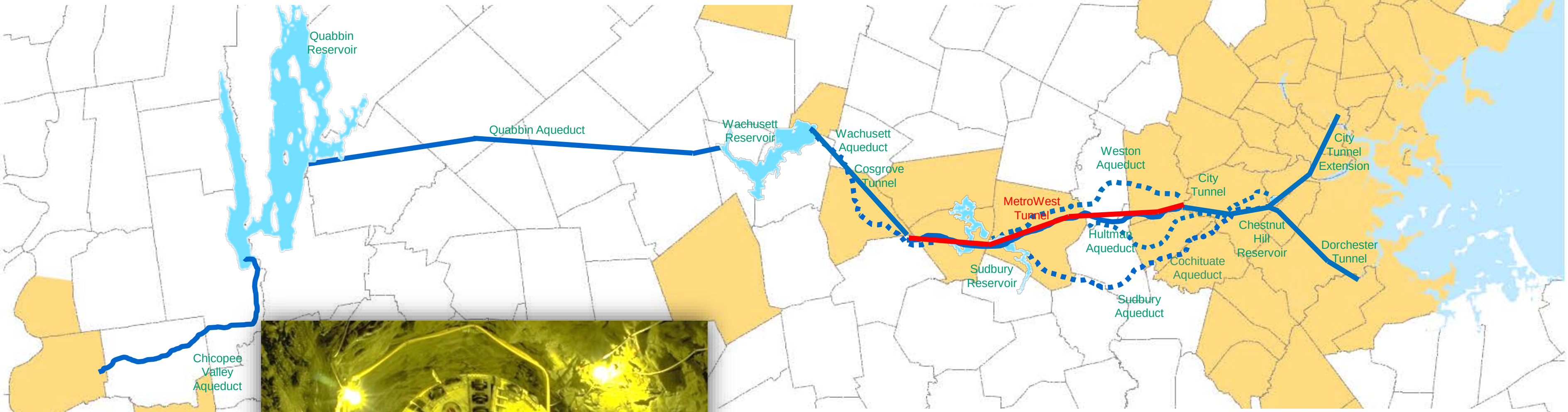
The Dorchester Tunnel is a 6.4 mile 10-foot diameter deep tock tunnel that was needed to serve the Southern High and Southern Extra High zones when the Sudbury Reservoir system no longer met water quality standards

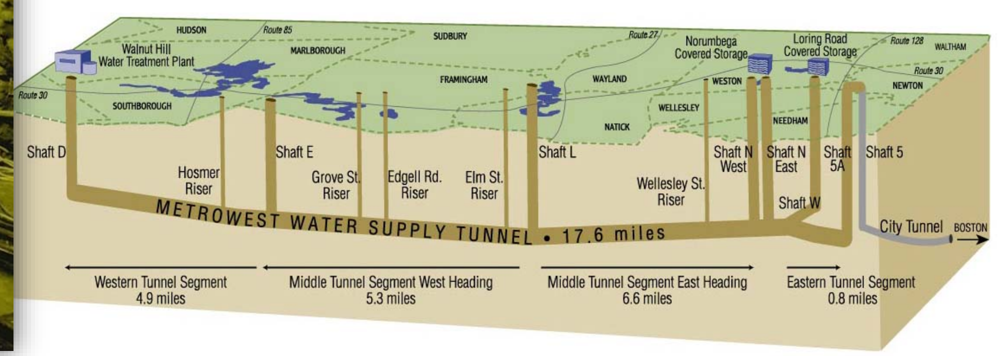


MetroWest Water Supply Tunnel (2003)

The 17.6 mile, 12 to 14 foot diameter deep rock pressure tunnel and was brought on-line in November 2003

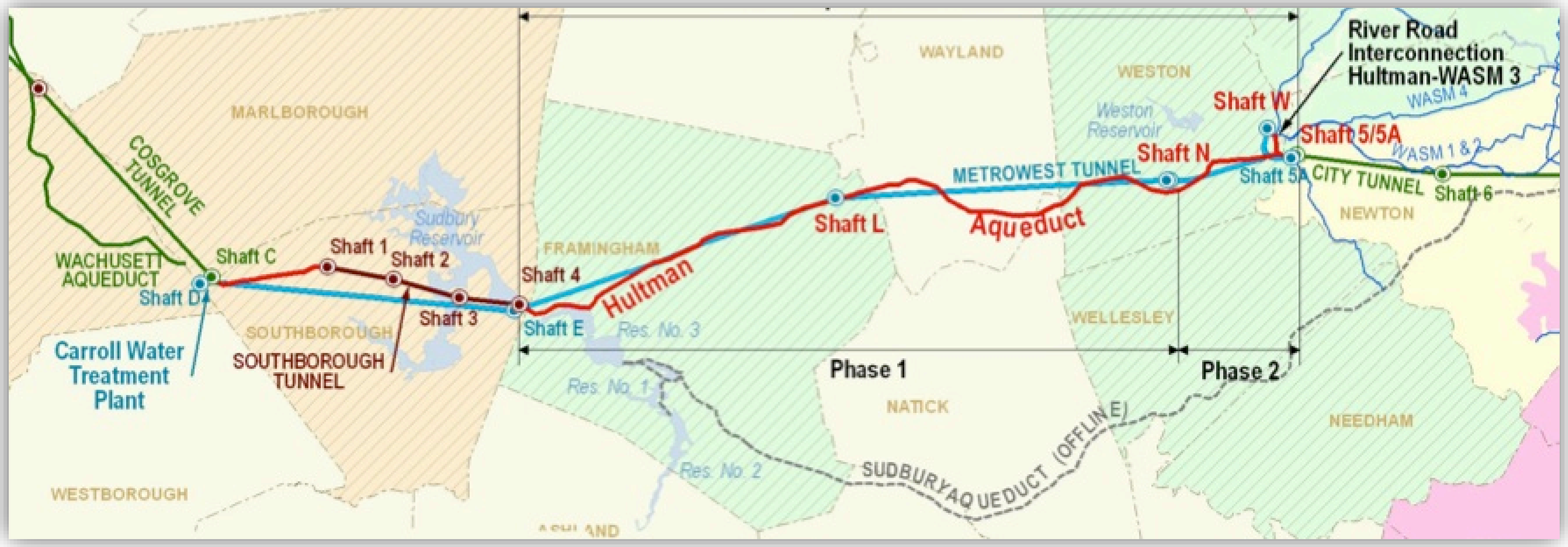
Provides Redundancy to the Hultman Aqueduct



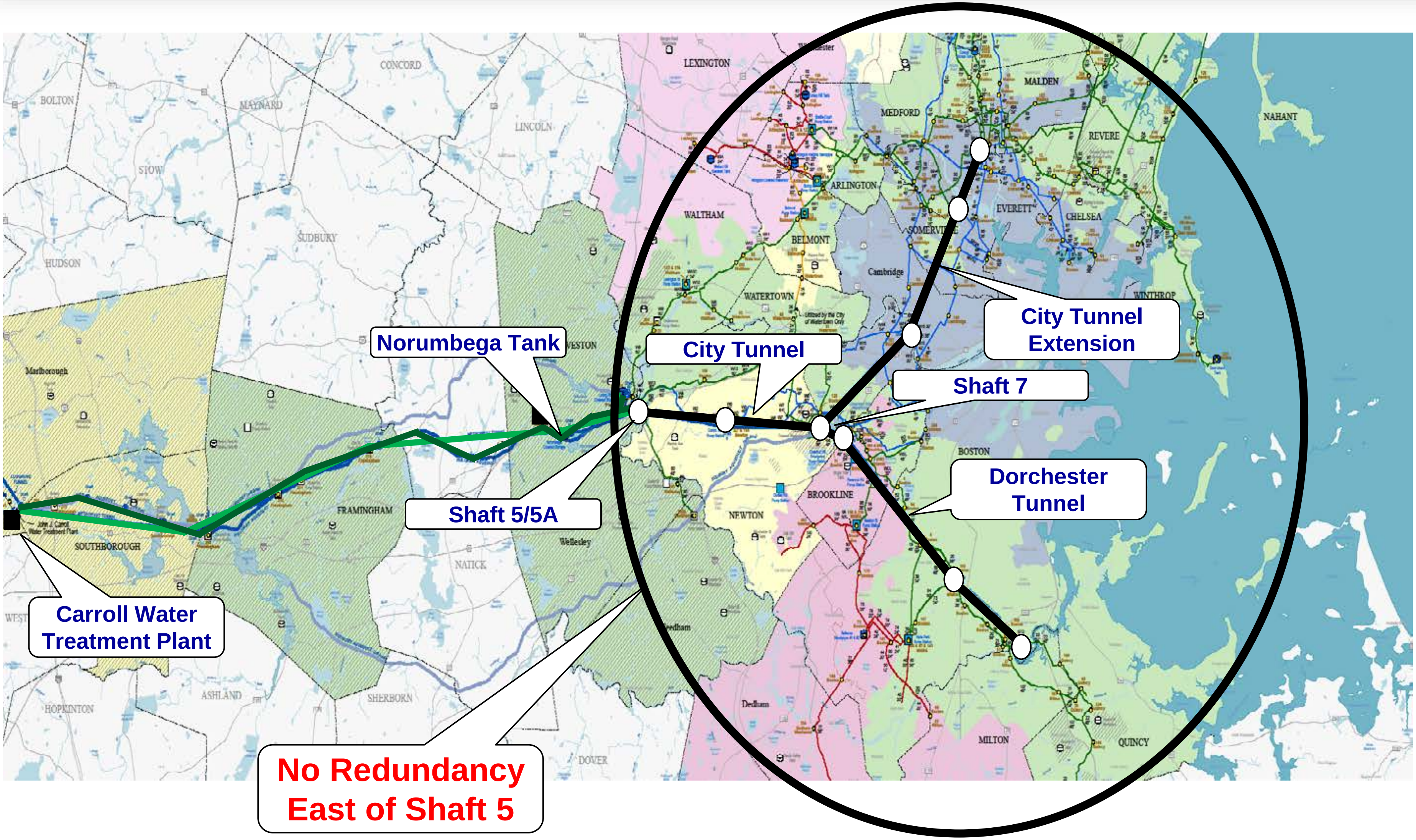


Hultman Aqueduct Rehabilitation (2013)

Once complete in 2013, for the first time since originally planned in the 1930s, the Metropolitan Water System has redundancy from the Carrol WTP to Shaft 5



Metropolitan Tunnel System



Condition of the Metropolitan Tunnel System

- Tunnel system:
  - Concrete-lined deep rock tunnels
  - Steel and concrete vertical shafts
  - Surface pipe, valves and appurtenances

- Little maintenance required for tunnels and shafts. Little risk of failure

- Pipe, valves and appurtenances need maintenance, rehabilitation, replacement

Valve Reliability Concern

- Valves that don't work
- Valves we can't exercise

Shaft 8 PRV Chamber

Shaft 8

Shaft 8

Access Can Be Difficult

- High ground water table
- Standing water in some chambers
- Corrosion is a concern

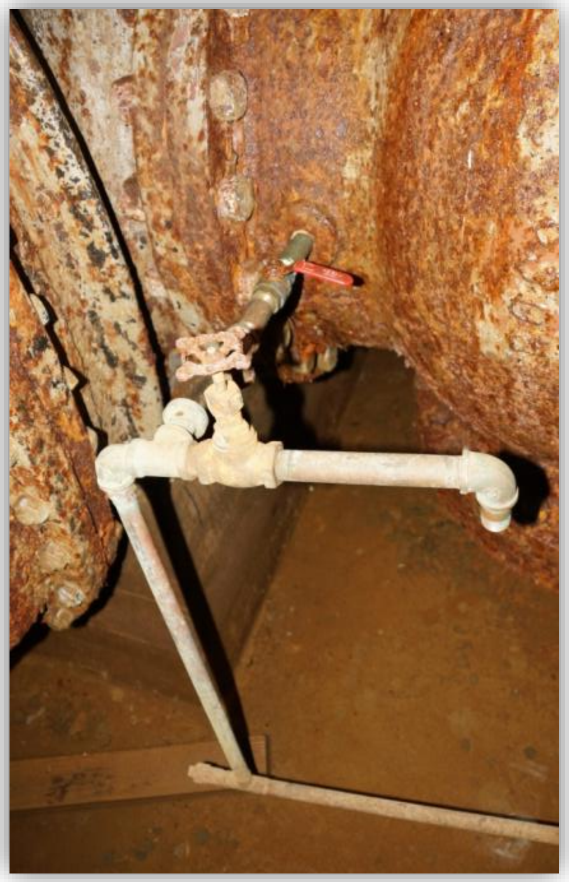
Shaft 7C connection to Section 58

Chamber at Shaft 7C

Shaft 7D connecting pipe air valve chamber

Appurtenances Can Be Liabilities

Small pipe failures can lead to shut downs



Control piping at Shaft 8

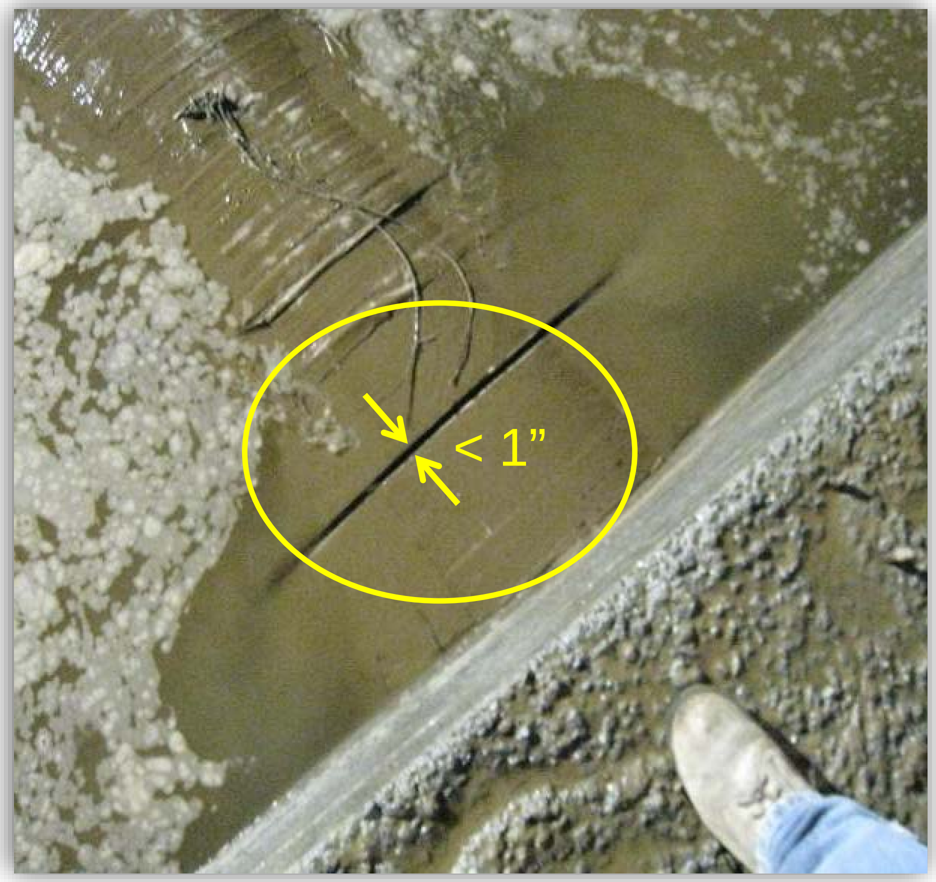
Air valve at Shaft 9A

Shaft 8 PRV Chamber

The Great Water Main Break of May 2010

Small pipe failures can lead to big problems

250 MGD flow at Shaft 5 break….



…came from a small gap in the pipe

Impact of the May 2010 Water Main Break

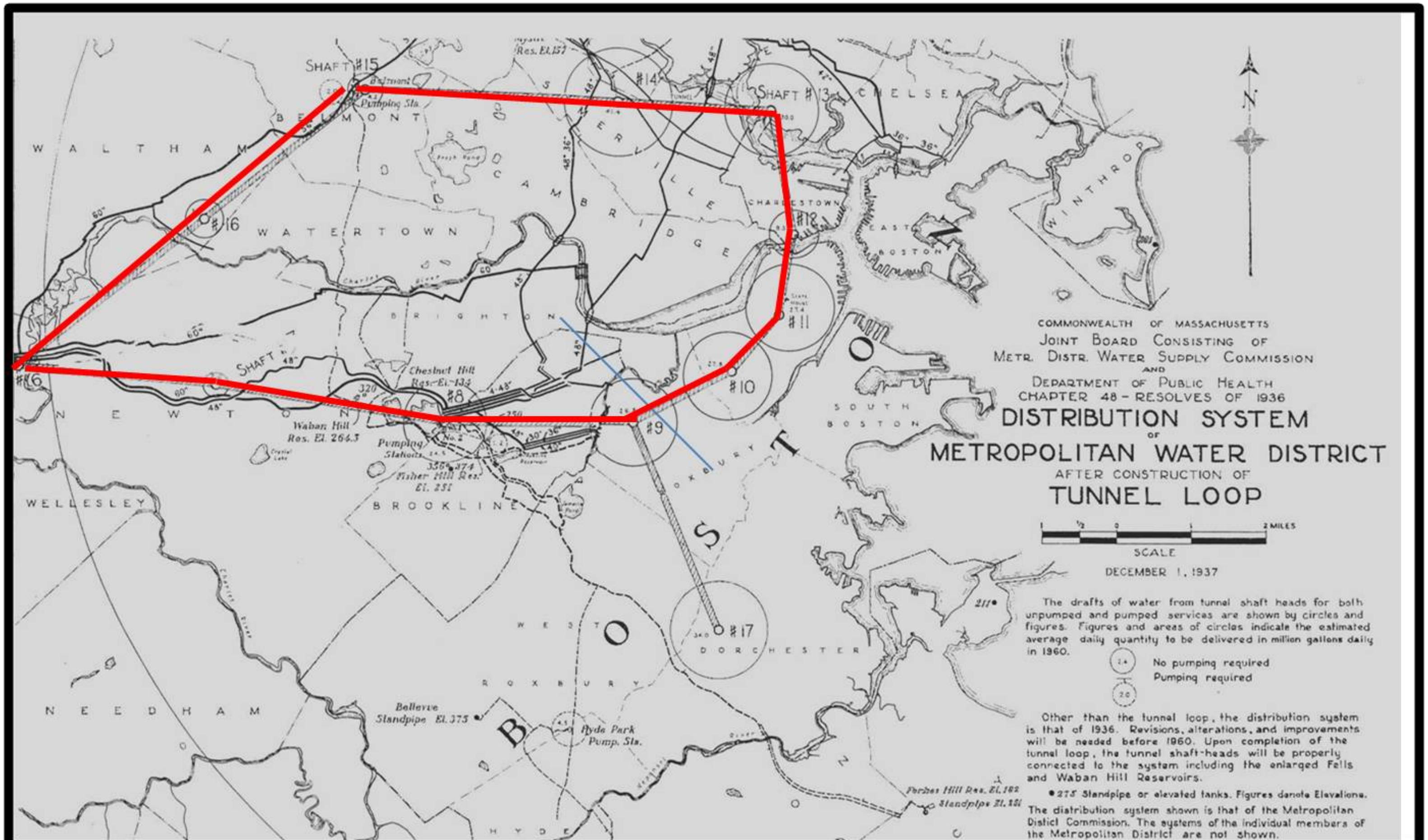
- A coupling located on 10’ dia surface piping at Shaft 5 failed
- Approximately 80 mg of potable water was discharged directly to the Charles River before flow was shut off
- The Hultman Aqueduct was shut down for major rehabilitation work and could not provide immediate backup
- To maintain water delivery, parts of the distribution system were reconfigured and switched to emergency backup
- Emergency backup means water with emergency chlorination and no other treatment would flow into the system
- A state of emergency and a boil water order was issued for ~2 million people located in 30 communities
- MDH issued guidance for…food preparation…health care…hospitals…etc.
- Some major food manufacturers, retailers, and restaurants had to close
- Dunkin & Starbucks had no brewed coffee! **For 2 days**!!!!
- Within less than 2 days of the break, the pipe was repaired, full flow was restored, tested, confirmed safe, and the boil water order was lifted

We Need Redundancy!

- Why do we need a redundant water distribution system?
  - Valve reliability for the Metropolitan Tunnels is a concern.
  - Without the ability to close (and then reopen) valves, there is no way to isolate a portion of the Metropolitan Tunnel System
  - Many valves have reached the end of their useful life but can't be replaced because shutdown of the City Tunnel would be required…which we cannot do
  - A failure anywhere within the Tunnel System requires shut down at Shaft 5, which is the limit of current distribution redundancy
  - Water main break at Shaft 5 in May 2010 put a "sharp point" on the need to operate these valves and have full redundancy

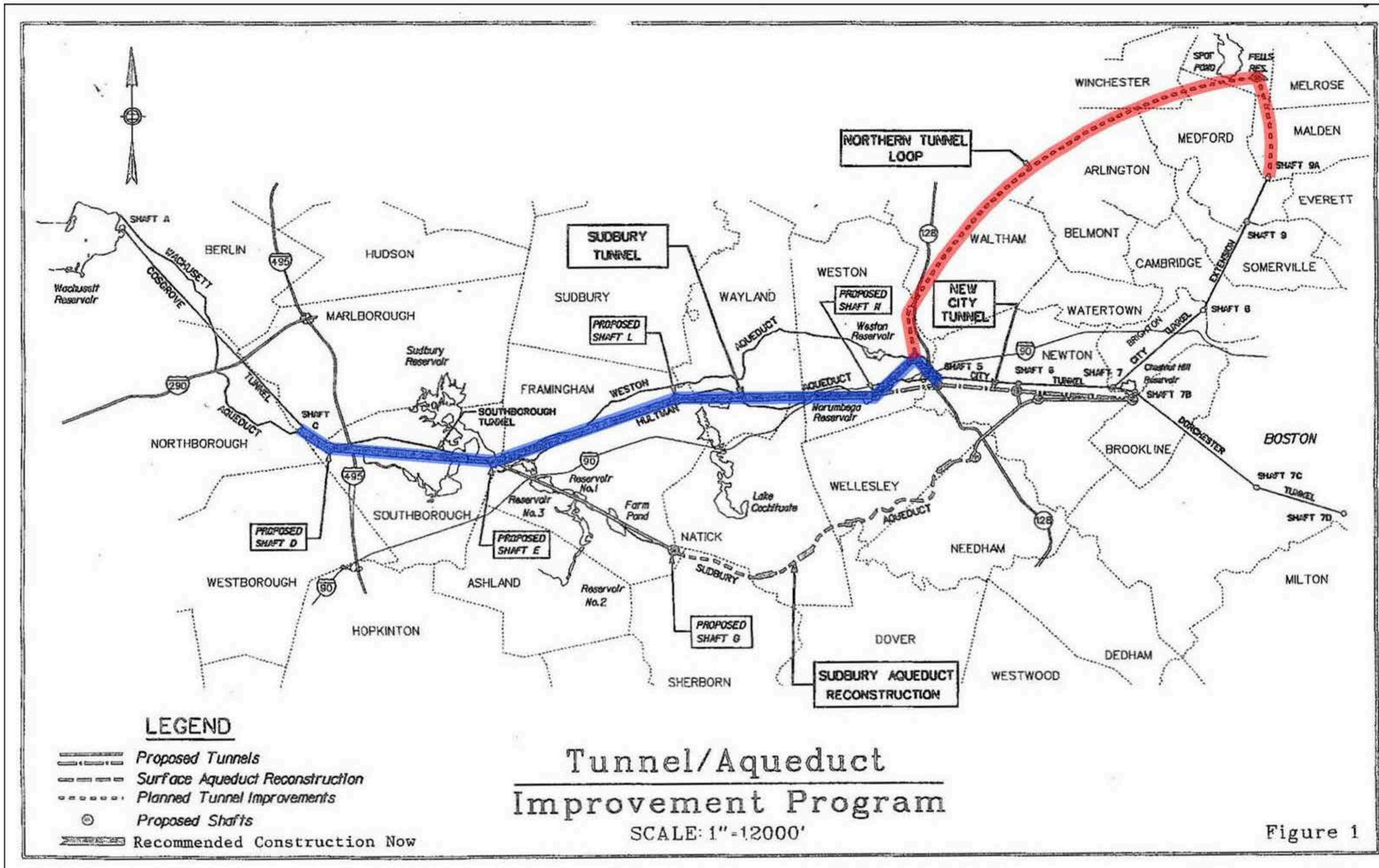
- If we do nothing, another failure will eventually occur

Original 1936 Tunnel Loop Plan



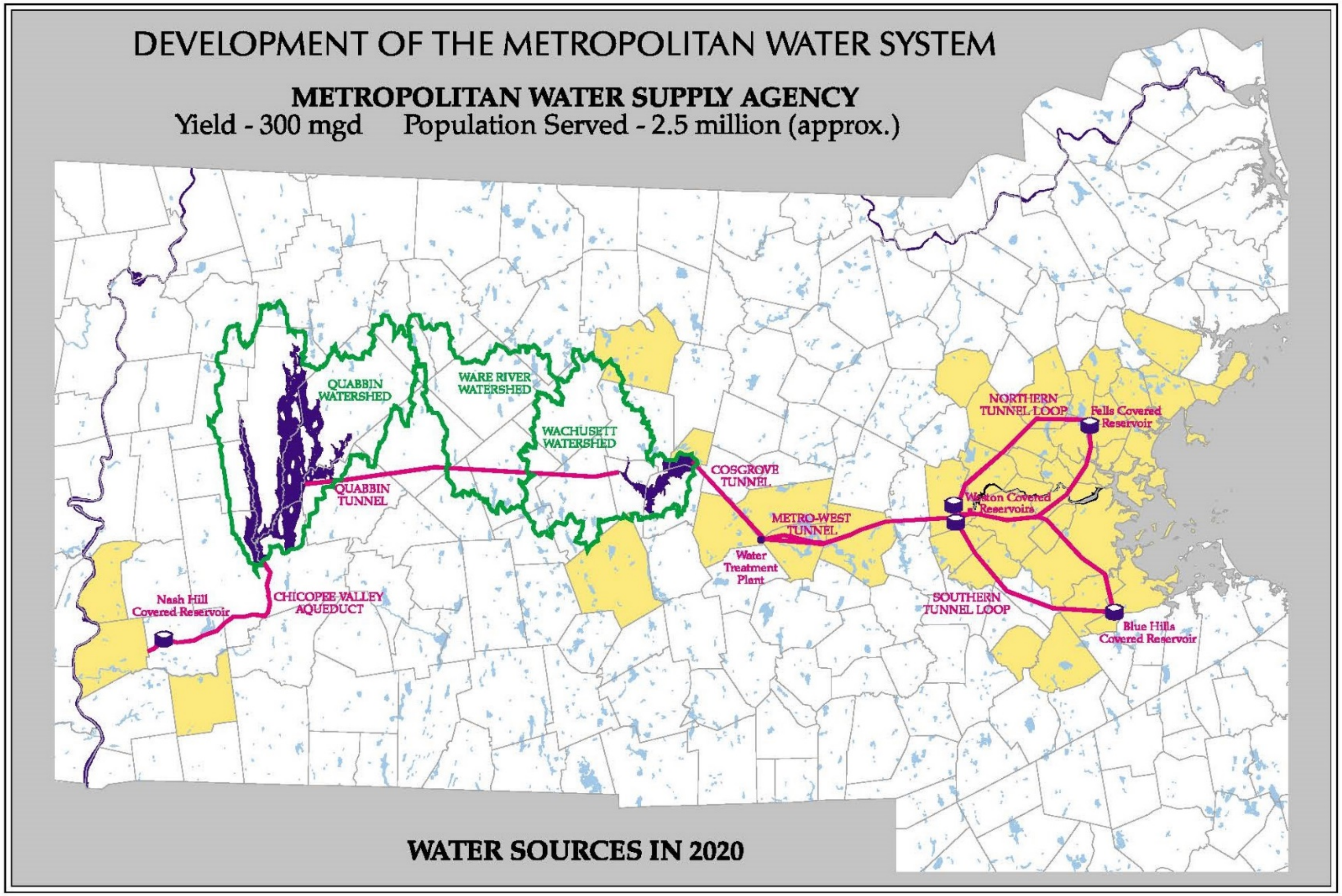
Previous Redundancy Evaluations (continued)

1990 Plan – MetroWest Tunnel followed by Northern Tunnel Loop



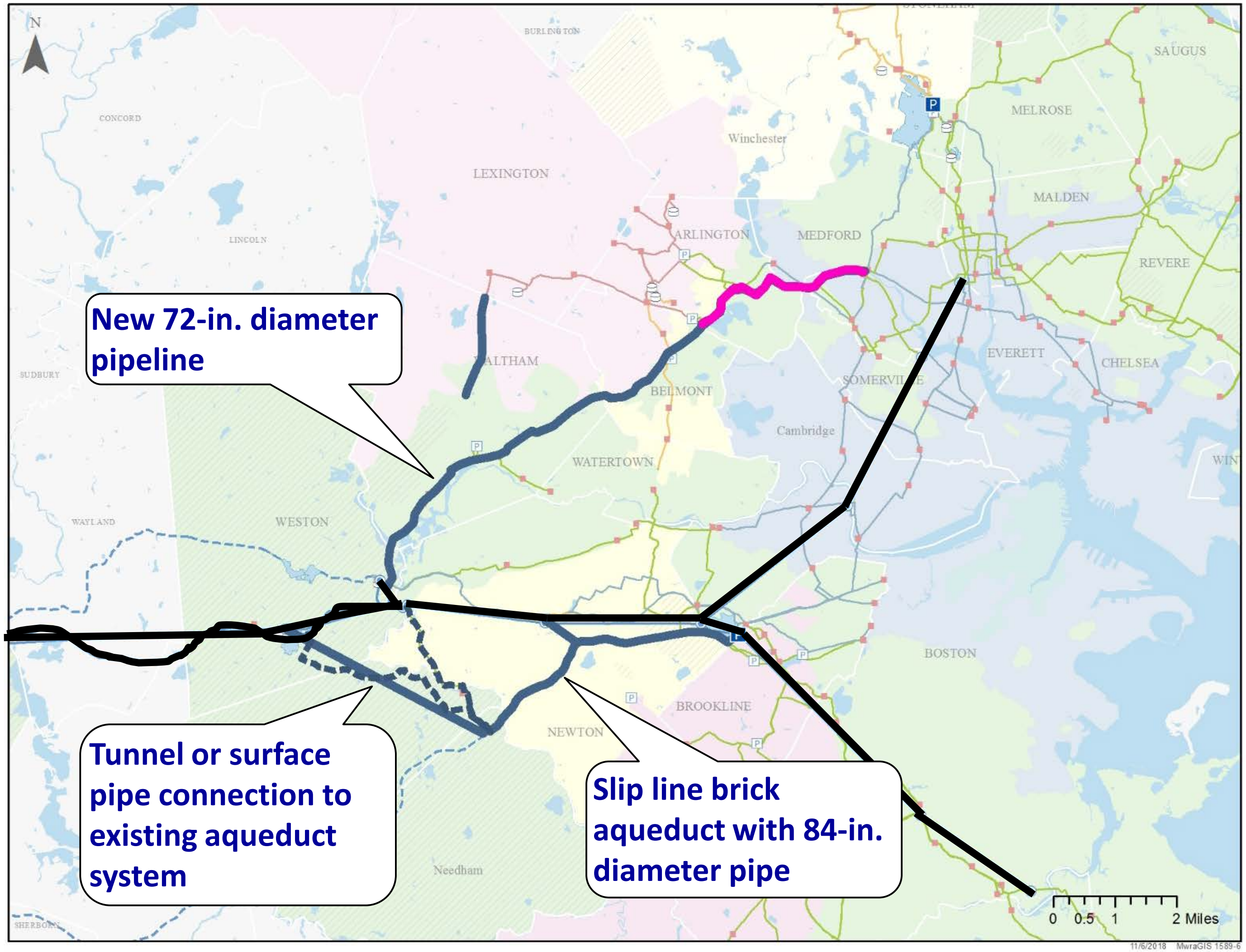
Previous Redundancy Evaluations (continued)

1996 Plan – MetroWest Tunnel followed by Northern <u>and</u> Southern Tunnel Loop (in 2020)



Previous Redundancy Evaluations (continued)

2011 Plan – Surface piping with Northern and Southern Components



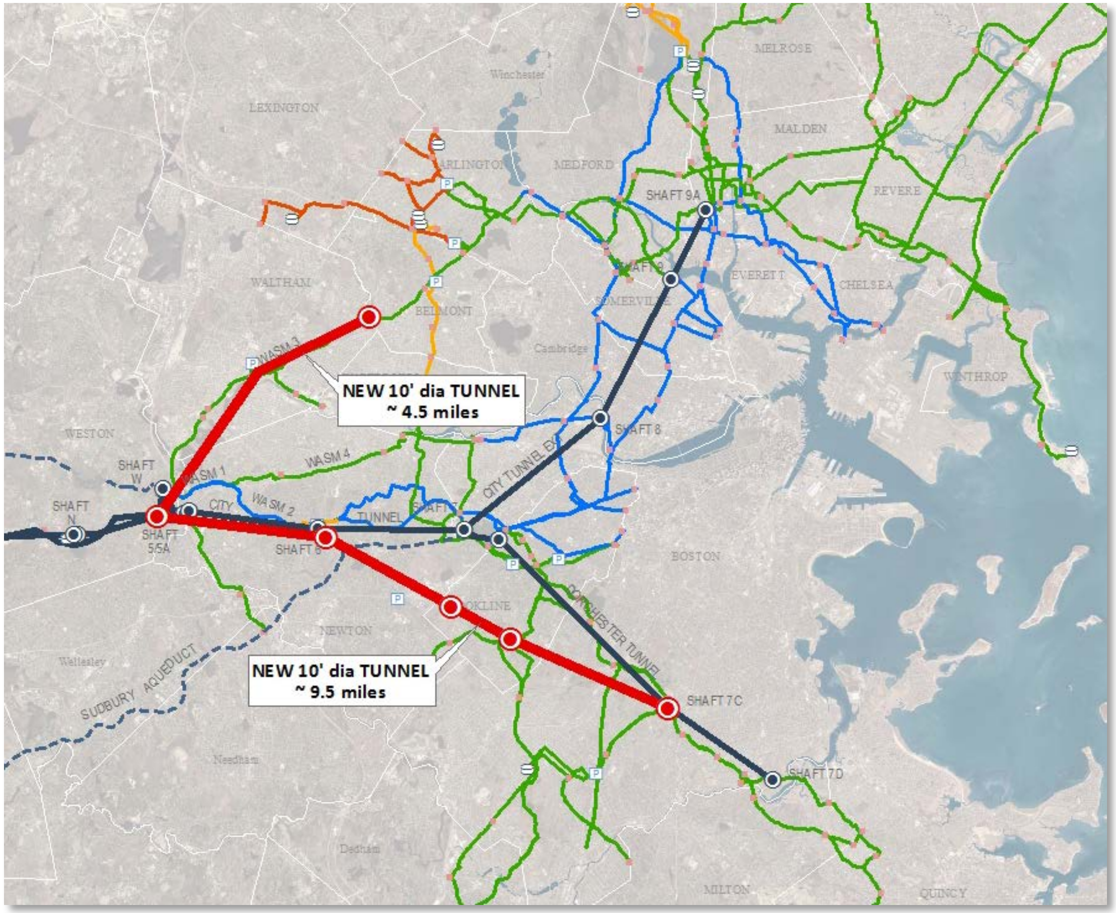
Alternative Analysis

- Extensive alternatives were identified and evaluated
- Long distance large diameter pipeline alternatives present significant implementation challenges
- Operational reliability problems were identified with Chestnut Hill Pump Station and other proposed pump stations
- Recommended tunnel alternative meets service objectives and goals
  - Allows planned maintenance of 60+ year old infrastructure that are beyond their useful life
  - Allows emergency response at normal level of service
  - Constructible

Recommended Alternative

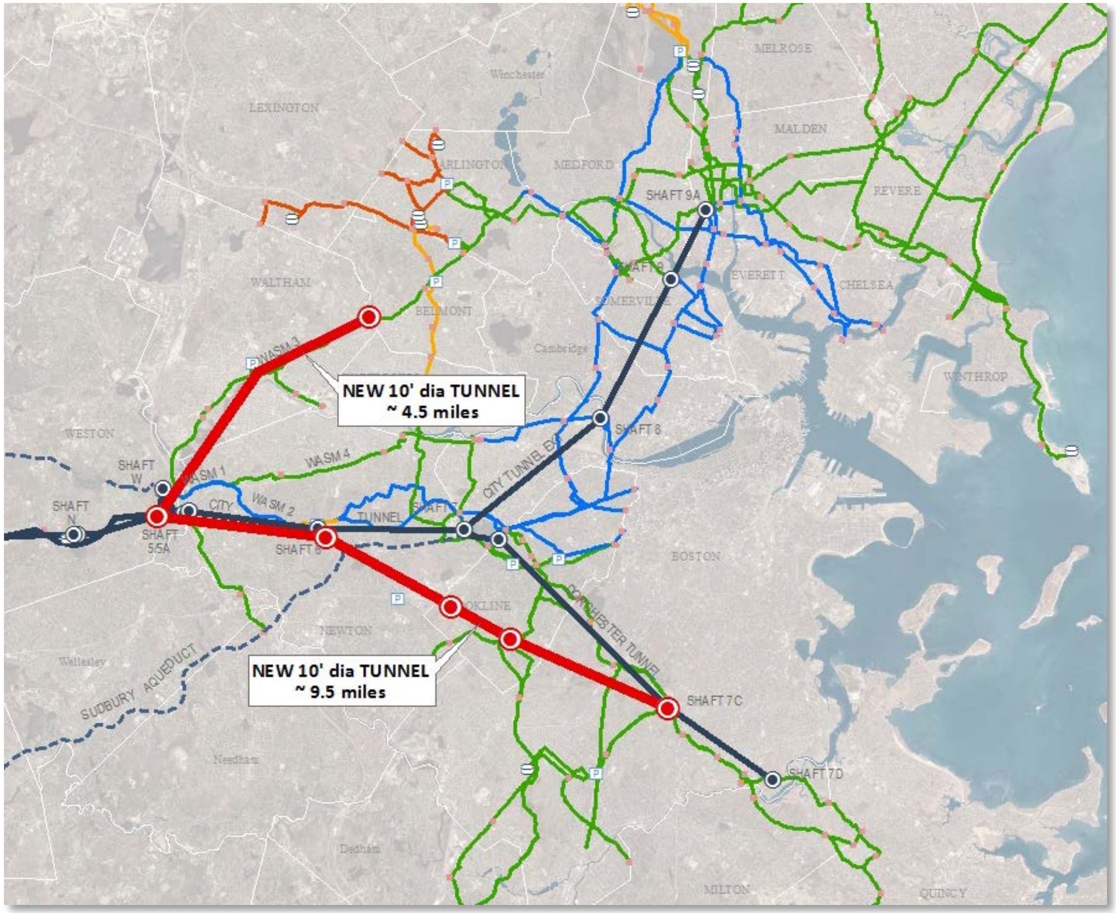
Two Tunnel Option was Recommended

- Tunnels begin at the Mass Pike/Route 128
- Northern Tunnel - 4.5 miles, connects to mid-point of WASM 3 in Waltham/Belmont area
- Southern Tunnel - 9.5 miles, connects to Shaft 7C and southern surface mains
- Time to Complete: 17 - 23 years

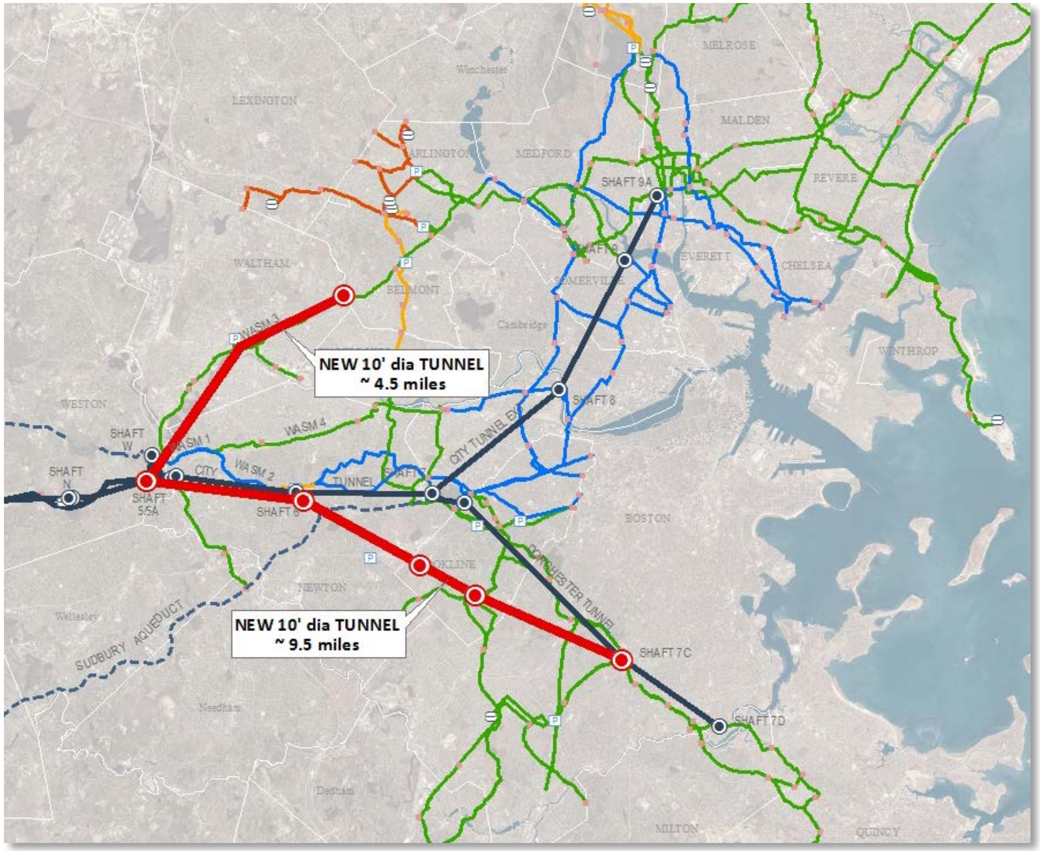


Recommended Alternative Meets Many Objectives

- Provides redundancy for entire metropolitan tunnel system
- Provides normal water service and fire protection if existing tunnel system is out of service
- Designed to meet high day demand. No seasonal restrictions
- Provides ability to perform maintenance on existing tunnels year-round
- Avoids activation of emergency reservoirs
- No boil order!
- It’s constructible



The Metropolitan Tunnel Redundancy Program



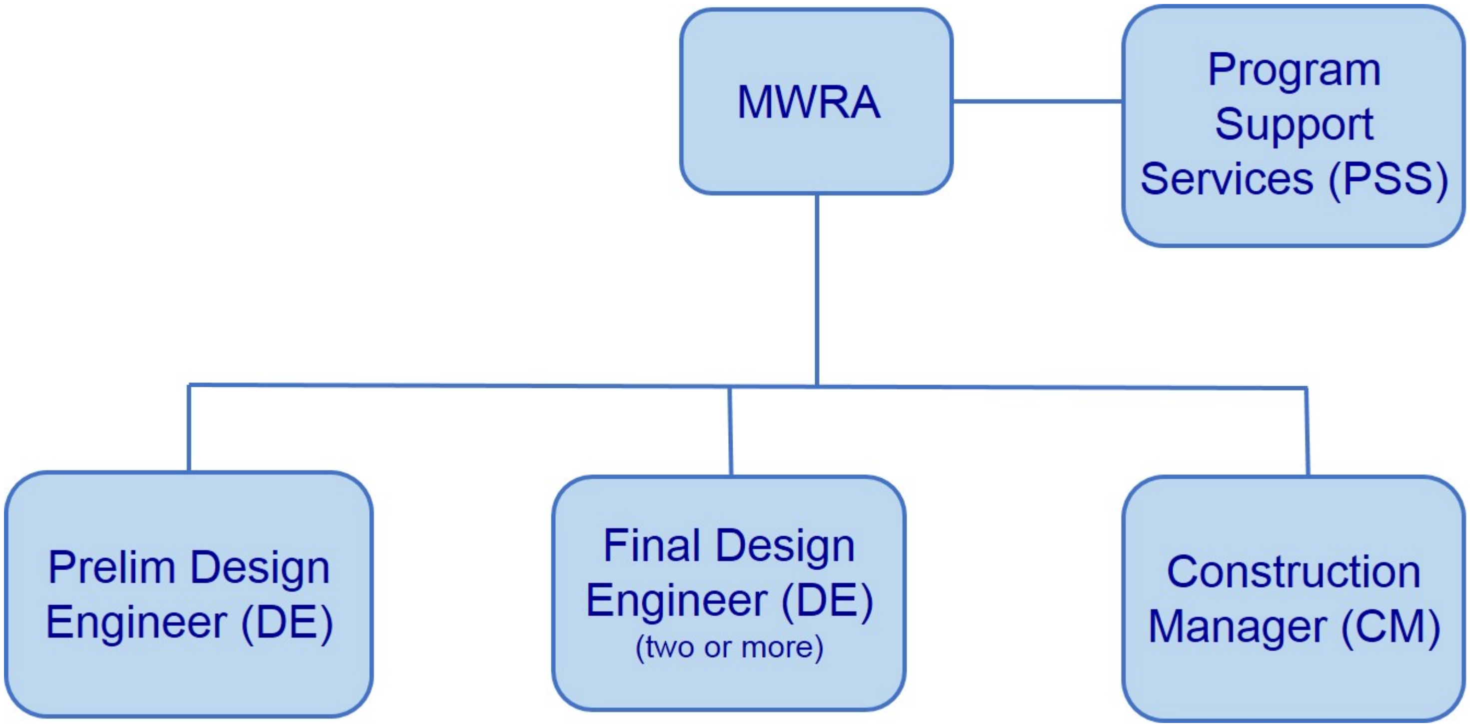
The Tunnel Project Basics

- ~ 14 miles of deep rock tunnel
  - ~4.5 miles to the north / WASM3
  - ~9.5 miles to the south / Shaft 7C
- 10' finished diameter pressure tunnel
- Expect it to be 200' – 500' below ground (well into bedrock)
- Mined using Tunnel Boring Machines (TBMs)
- There will be several shafts (# & location TBD)
- No consent decree (this is a water distribution redundancy program)

The Metropolitan Tunnel Redundancy Program

- The Program will be managed by the MWRA Tunnel Redundancy Department (similar to PMD for BHP)
- The Program is funded in our Capital Improvement Plan
- FY19 CIP Budget
  - Preliminary Design/Phase 1 Geotech/MEPA Review
  - Final Design
  - Construction Management
  - Tunnel Construction
  - Surface Connections Construction
  - Administration, Legal and Public Outreach
- Have Identified the Need for Program-Wide Support Services
- FY20 CIP Budget will include modifications to the Program budget – draft issued in December

Planned Consultant Organization



Program Support Services

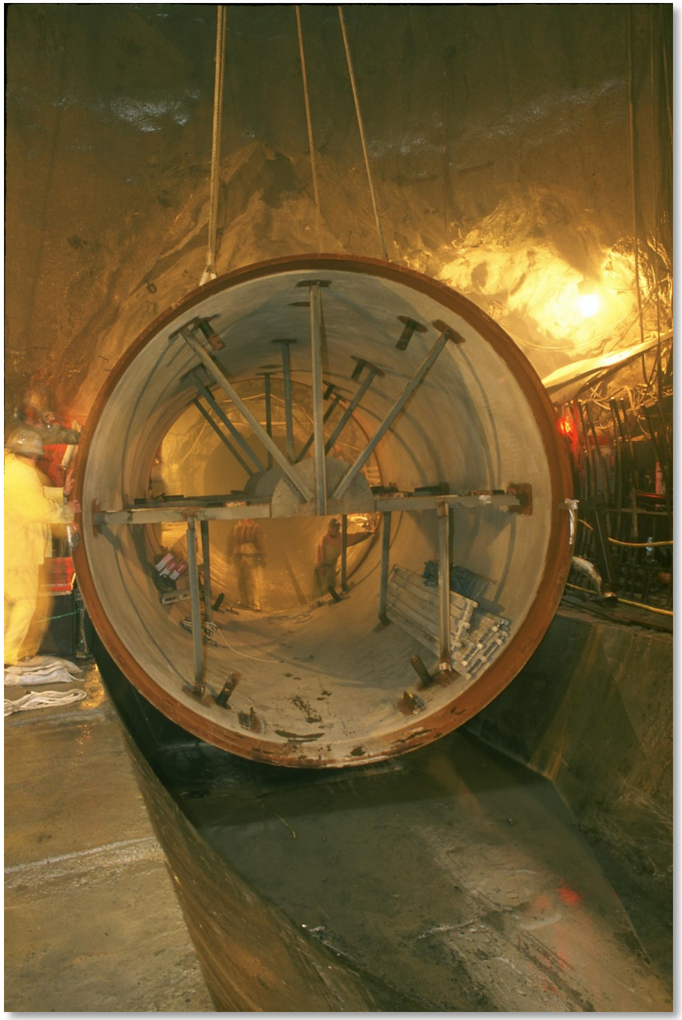
- Provide technical professional resources to the Tunnel Department
- Precluded from participating directly in the preliminary or final design, or construction phases
- Not envisioned to serve as E-O-R or CM
- One-step RFQ/P process for an initial contract duration of 5 years with up to two 2 year renewals (for a total of 9 years)
- Selection will follow our existing evaluative procurement process

Program-Wide Support Services

- Program-wide planning
- Risk management planning
- Quality management and health and safety planning
- Design criteria and standardization
- Independent technical review
- Work breakdown planning
- Procurement planning
- Construction package planning
- Critical path scheduling, and
- Budget planning and management

Program Support Services – Skills and Qualifications

- Senior professionals with significant tunneling experience
- Particular expertise in risk management/mitigation
- In-depth understanding of the state of the practice and current trends in the tunnel construction industry
- Key personnel will have necessary skills but would be difficult and not cost-effective for MWRA to hire as permanent staff



Preliminary Design Engineering

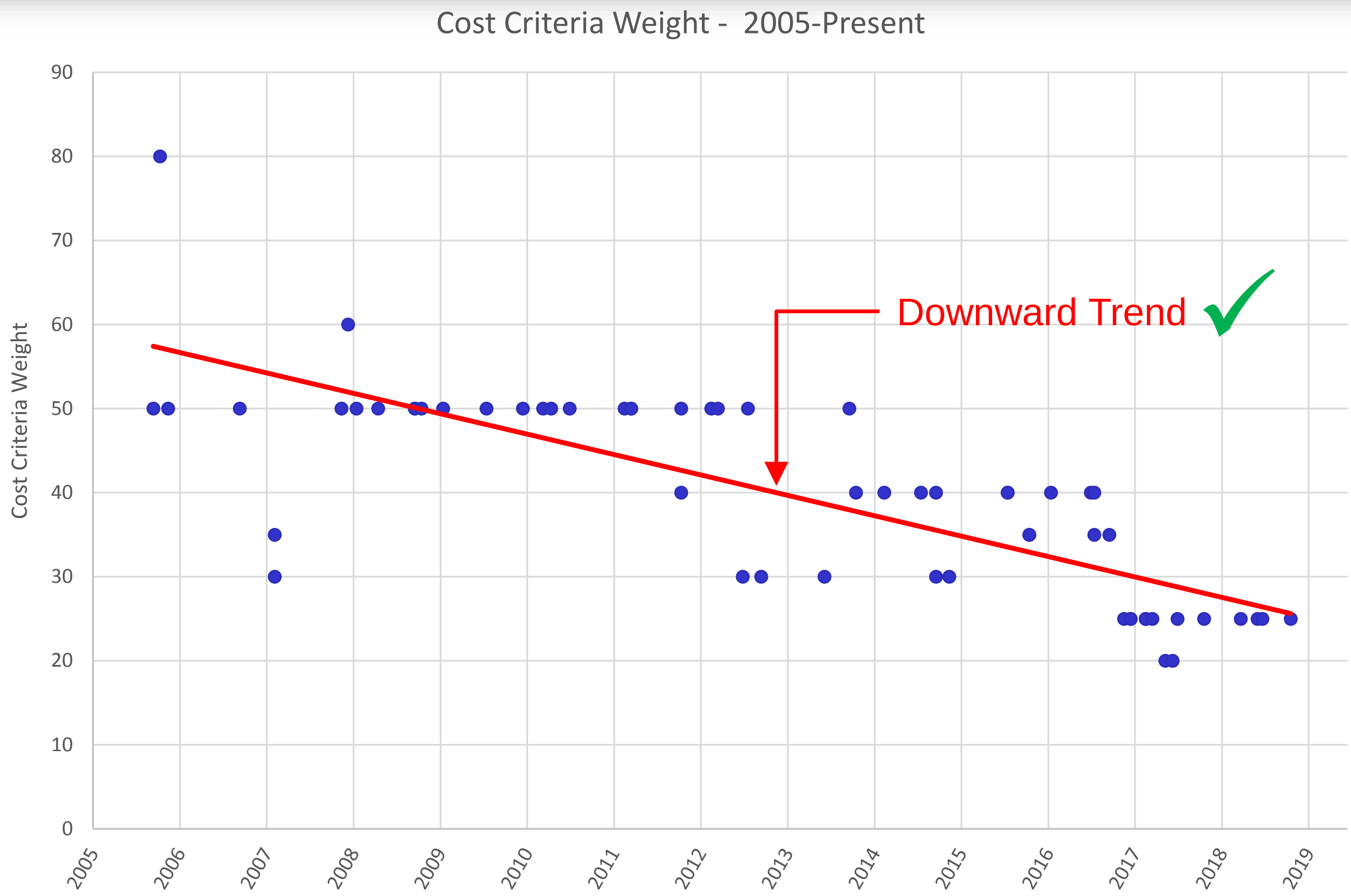
- Preliminary geotechnical investigation, preliminary route and shaft site evaluations, identify environmental permits needed and prepare required the MEPA review
- Produce significant project documents - Preliminary Geotechnical Data & Design Report, Alternatives Evaluation & Preliminary Design Report, Environmental Impact Report and preliminary design drawings
- Two-step RFQ and RFP process
- It is expected this work can be accomplished within 3 years
- Selection will follow our existing evaluative procurement process

Existing Evaluative Procurement Process = “Best Value”

Typical Proposal Evaluation Criteria

- Cost
- Qualifications
- Key Personnel
- Experience
- Past Performance
- Technical Approach
- Capacity
- Organization & Management
- M/WBE

Cost Criteria Weight is on a Downward Trend



Note: Includes A/E/CM consulting awards, not including TA contracts.

A/E/CM Consultant Awards

- Typical cost criteria weight is currently around 20-25 points
  - Cost criteria is evaluated based on the appropriateness, reasonableness, and competitiveness of the cost proposal, including level of effort, direct labor rates, indirect cost rates, other direct costs, fee percentages, etc.
- Since 2017, awards for A/E/CM consultant services go to the firm with….
  - Highest rank on qualifications/key personnel: nearly 100% of the time
  - Not lowest price: 2/3 of the time
  - Highest cost rank is not lowest price: 2/3 of the time

Planned Schedule

- Program Support Services
  - Issue RFQ/P: by early 2019 or sooner
  - Notice to Proceed: by mid 2019 or sooner

- Preliminary Design Engineering/MEPA Review
  - Issue RFQ: mid 2019
  - Notice to Proceed: early 2020

Thank You!