

**STAFF SUMMARY**

**TO:** Board of Directors  
**FROM:** Frederick A. Laskey, Executive Director  
**DATE:** October 16, 2019  
**SUBJECT:** Metropolitan Tunnel Redundancy Program Update




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**COMMITTEE:** Water Policy and Oversight

X  INFORMATION  
VOTE

Frederick O. Brandon, P.E., Director, Design and Construction  
Preparer/Title

  
Kathleen M. Murtagh, P.E.  
Director, Tunnel Redundancy

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**RECOMMENDATION:**

For information only.

**DISCUSSION:**

This staff summary provides an update on the following key ongoing activities to support the Metropolitan Tunnel Redundancy Program:

- Procurement of Preliminary Design Engineering Contract
- Hydraulic Analysis of the Proposed Tunnels
- Formation of an Expert Review Panel

**Procurement of Preliminary Design Engineering Contract**

The procurement process for Preliminary Design, Geotechnical Investigations, and Environmental Impact Report (Contract No. 7159) formally commenced on October 2, 2019. This contract will be procured under a two-step procurement process: a Request for Qualifications Statements (RFQ) followed by a Request for Proposals (RFP) issued to shortlisted firms. The Preliminary Design Engineering contract will have a duration of approximately three and a half years.

The Preliminary Design Engineering contract will include the preliminary geotechnical investigation (deep rock borings), evaluation of preliminary tunnel alignment and shaft site alternatives, preliminary design, preliminary contract packaging, preparation of the required MEPA filings and will establish a comprehensive list of the environmental permits needed. The tasks included in this contract require substantial amounts of coordination with environmental regulatory agencies in order to ensure that the data and documentation generated result in a robust alternatives analysis in the MEPA process. In addition, early interaction with regulators, will limit comments and concerns raised by agencies in the earlier MEPA phases.

While the Preliminary Design Engineering contract is underway, MWRA will simultaneously be implementing its communication plan to ensure that all stakeholders are informed as to the importance of this effort and what can be expected in the years ahead. This contract does not

have a direct communication task, however the work done under this contract will be utilized to support MWRA's communications efforts, which should in turn yield more informed comments during the MEPA process.

At the completion of the Preliminary Design Engineering contract, the goal is to have selected the alignment of the proposed tunnels and have identified the location of shaft sites for construction and interconnection with the existing water system, pending land acquisition and final permits.

The Preliminary Design Engineering contract will result in several significant project documents including:

- Preliminary Geotechnical Data and Design Reports
- Evaluation of Alternative Tunnel Alignments
- Draft and Final Environmental Impact Reports
- Preliminary Design Report and Drawings

The following is the schedule for procuring the Preliminary Design Engineering Contract:

Issue Request for Qualifications	10/2/2019
Qualifications Statements Due	11/1/2019
Issue Request for Proposals to Finalists	12/2/2019
Proposals Due	2/14/2020
Recommend Contract Award to Board of Directors	April 2020
Notice to Proceed	May 2020

After the completion of the preliminary design, consultants will be needed to support both final design and construction management of the Program. Future staff summaries will provide details on the structure of those contracts.

## **Tunnel Hydraulics**

### ***Water Use Projections***

It is expected that the proposed new tunnel system will be placed into service in or around 2037 (17 years after beginning Preliminary Design) and that the system will have a useful life of more than one hundred years. Therefore, the tunnel will be designed to accommodate future potential demands or have the ability for incremental increases in its capacity to address future water use.

Projecting the demand on the MWRA system into the future requires the acknowledgment of two competing trends: continuing increases in efficiency in the home and workplace and an increase in population and employment within the service area. Any projections must also include assumptions about the potential for partially supplied customers to turn toward the MWRA for an increased portion of their supply periodically or long term, and the possibility that new communities will opt to join the MWRA system. How all these assumptions are worked together can provide varying degrees of conservatism in the planning projections.

Staff have obtained population and employment projections for the metropolitan service area

extending to 2040 and population projections through 2060. These projections were used to develop a range of potential future water use taking into account varying degrees of increased water use efficiency.

Population and employment projections through 2040 prepared by planning agencies, primarily the Office of Transportation Planning in the Massachusetts Department of Transportation (MassDOT) and the Population Estimates Program of the Donahue Institute at the University of Massachusetts Amherst, were used as the starting point for developing future water demand projections.

Longer term population projections through 2060 were obtained from a private company (ProximityOne) that provides geographic, demographic and economic data to public and private sector organizations.

The above population and employment projections were used to develop high, medium and low average day water use projections as shown in Figure 1:

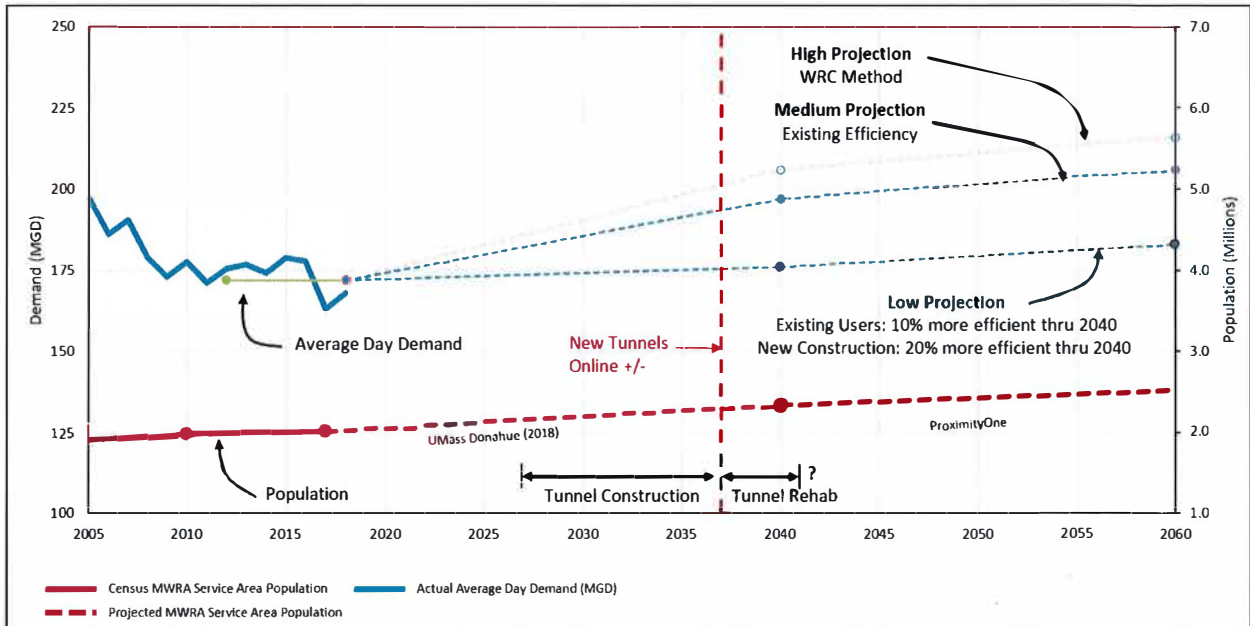


Figure 1. Average Day Water Use Projections - Metropolitan Area.

**High Projections:** The high water use projection utilized the Massachusetts Water Resources Commission state-wide water needs forecasting methodology, which assumes a residential gallons per capita per day use of 65 and an employment water use of 45 gallons per employee per day.

**Medium Projections:** The medium water use projection utilized the current community-specific residential and employment water use within the MWRA water service area. This results in an average residential water use of 53 gallons per capita per day and an employment water use of 30 gallons per employee per day.

**Low Projections:** The low water use projections assumed that existing residential water users will continue to become more efficient by ten percent through 2040 and that new residential

construction will be twenty percent more efficient than the average existing user (42 gallons per day per capita). Projected water use due to employment assumed that the existing average water use of 30 gallons per day per employee would continue into the future.

The results of the above water use projections were added to the existing baseline average day water use to develop a range of future water use. Average day water use fluctuates from year to year based primarily on the weather and the status of local water supplies in partially supplied communities. Therefore a baseline average day demand was developed by averaging the water use over five of the last seven years (2012 – 2018). Water use for the drought years of 2015 and 2016 was not used because these are considered atypical years. The effect of short term droughts on high day demands is included in the high day demand peaking factor discussed below. This baseline average day water use served as the starting point for water use projections into the future.

Since the proposed tunnels will be designed to supply high day demands, community-specific average day to high day water use peaking factors were developed based on historic water use in the MWRA system. These peaking factors include any additional water use by partially supplied communities during the drought of 2015-2016. These peaking factors were applied to the projected average day demands to develop high and medium projected high day demands (Figure 2). Since the low projection for average day demand has been experienced as recently as 2012, 2013, 2015 and 2016, the historic high day water use during this period was used for the 2040 low projection for high day demand.

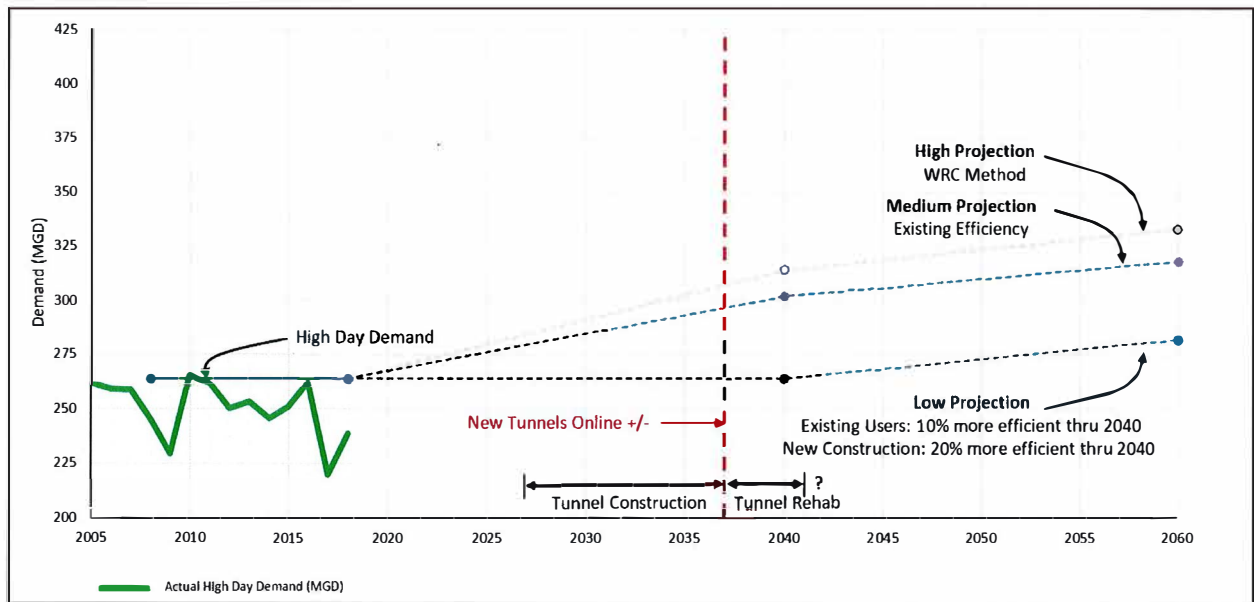


Figure 2. High Day Water Use Projections - Metropolitan Area.

The current two-tunnel concept will accommodate the low projection of high day demand through 2040. That is, the proposed tunnel can supply high day demands with the existing Metropolitan Tunnel System off line assuming the low projection. If the higher water use projections begin to materialize in the future, the ability of the proposed tunnel system to convey more water could be increased by extending it deeper into the distribution system as shown in Figure 3. For example, the northern tunnel could be extended further to the north as far as the Gillis pumping station and the southern tunnel could be extended further to the south as far as Shaft 7D on the Dorchester Tunnel to accommodate higher future demands. However, adding

more tunnel capacity to the water system also increases the residence time of water (water age) during normal demands. This longer residence time could increase the potential for water quality deterioration within the water system. The issue of water age is discussed further in the next section. At this time, staff believe the proposed tunnel configuration adequately meets projected needs. However, the tunnels should be designed in a manner which allows for future extension further to the north or south should higher future demand projections be validated. Staff will continue to monitor system water use during Preliminary Design and continue to analyze the hydraulics of the new tunnel with respect to potential increases in water demand.

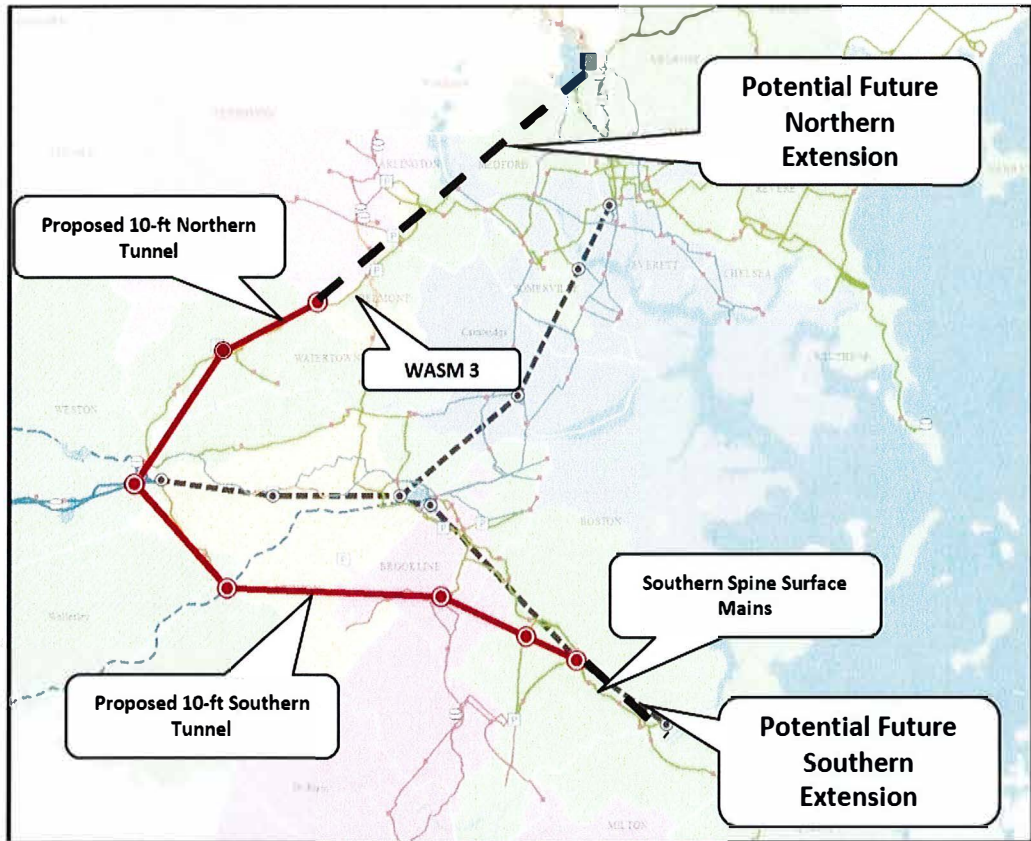


Figure 3. Potential future tunnel extensions.

### *Effect of the Proposed Tunnel on Water Age*

The addition of new tunnels to the water system increases the residence time of water (water age) during normal demands. Staff are carefully evaluating increases to residence time in order to protect against any water quality deterioration within the water system. For example, during the fall season when the water temperature is still relatively warm and water use is lower after the outdoor watering season is over, MWRA has seen occasional indications of nitrification (the conversion of ammonia in chloraminated water into nitrite and then nitrate) in both MWRA and local community distribution storage tanks. This phenomenon is usually addressed by increasing mixing and water turnover in the storage tanks.

Staff have evaluated the effect of the proposed new tunnels on water age within the MWRA water system. Water age was calculated using the hydraulic model of the water system with typical fall day demands under existing conditions and future conditions when both the existing and new tunnels would be in operation. The water age was calculated from the finished water of the Carroll Water Treatment Plant to key locations within the metropolitan water system. The water age with existing and proposed tunnels on line ranges from 2.3 days to 5.8 days at key locations. Based on staff experience with water quality monitoring throughout the distribution system water quality issues related to increased water age are not anticipated with the current tunnel concept.

### **Expert Review Panel**

The use of an independent expert panel is a common practice for large programs in the tunnel engineering and construction industry. An expert panel can provide an important contribution to overall quality control, program accountability and risk mitigation strategies through all phases of a program. The Program Support Services consultant contract (7655) awarded in March 2019 includes an allowance for the establishment of such a panel.

The Expert Review Panel for the Metropolitan Tunnel Program will participate in regularly scheduled full-panel workshops, which will be focused on key elements of the Tunnel project such as risk mitigation, communication, program management and tunnel design and construction. From time to time individual panel members may be asked to provide input and advice on specialty subjects related to the panel member's expertise.

#### *Composition of the Expert Review Panel*

The composition of the Expert Review Panel may need to adapt as the Program advances through its various phases. However, maintaining a certain level of continuity in the composition of the Expert Review Panel to ensure efficient and consistent advisory support as the Program advances is also important. At this initial Preliminary Design phase of the Program, the Expert Review Panel is proposed to include experts with experiences and perspectives on a variety of specialties, including:

- Public agency, large infrastructure program implementation and administration
- Rock pressure tunnel design
- Geotechnical and Geologic investigations for deep underground projects
- Deep rock tunnel and shaft construction

The Expert Review Panel will include individuals with national expertise as well as individuals with expertise in local projects including MWRA's Boston Harbor Project and the Integrated Water Supply Program. Considering the desire for expertise in the above specialties, the following panel members are proposed:

- Richard Fox, Boston Harbor Cleanup Program – Perspective: Large Program; Past MWRA Experience
- Michael McBride, MetroWest Water Supply Tunnel Project – Perspective: Past MWRA Tunnel Program and Construction Manager

- Erika Moonin, Southern Nevada Water Authority, Lake Mead Intake Tunnel Program – Perspective: Large Program; Public Agency Project Manager
- Gary Brierley, Rock Tunnel and Shaft Design – Perspective: Tunnel and Shaft Designer
- Gaylin Rippentrop, Rock Tunnel Construction – Perspective: Tunnel and Shaft Contractor

Biographies of each of the above panel members are included in Attachment A.

### *Panel Implementation*

The members of the Expert Review Panel will be under contract with the Program Support Services consultant to provide advice and consultation for the Tunnel Redundancy Program on an as-needed basis. The Panel will likely be utilized during all phases of the program, however it will initially be established to provide advisory support through the Preliminary Design phase. Panel sessions are proposed to be held at key program milestones that may include: pre-submission drafts of the various environmental reports (DEIR, FEIR); Preliminary and Final Design deliverables; and other key decisions points such as prior to the start of major geotechnical investigation phases. These sessions will be held in a workshop format and each workshop will take place over the course of two days. It is anticipated that the Expert Review Panel will convene five times over the course of the Preliminary Design Phase.

### **BUDGET/FISCAL IMPACTS:**

The FY12 CIP includes a budget of \$16,000,000 for Contract 7159 Preliminary Design, Geotechnical Investigations and Environmental Impact Report.

### **MBE/WBE PARTICIPATION:**

The MBE and WBE participation requirements for Contract 7159 Preliminary Design, Geotechnical Investigations and Environmental Impact Report have been established at 7.18% and 5.77% respectively.

### **ATTACHMENTS:**

Attachment A: Proposed Expert Panel Biographies

Attachment A  
Proposed Expert Panel Biographies

Richard Fox

Mr. Fox currently serves as an adjunct Professor at Merrimack College teaching Project Management Masters course. In his role as Program Director for the MWRA's Program Management Division (PMD) he managed and directed the planning, design and construction of the Boston Harbor Project. This project involved, among other elements construction and commissioning of the Boston Harbor Outfall Tunnel; Inter-Island Tunnel and Deer Island Wastewater Treatment Plant. Mr. Fox was responsible for assembling and directing the management team responsible for this \$3.8 billion dollar construction program to clean up Boston Harbor.

Prior to retiring from CDM Smith, in his roles, including Chairman and CEO, Mr. Fox was responsible for all operations outside of North America including large offices in Cairo, Singapore, Hong Kong, Chennai and Germany, and directing CDM Smith's program management projects worldwide.

Michael McBride

Mr. McBride is a Professional Engineer with over 40 years of industry experience on Water/Wastewater, Transportation, Tunnel and Higher Education projects. His experience comes both from an owner's perspective and from a consulting perspective. He has led or been part of planning, development, design and construction management teams on mega projects including the \$ 3.8 billion Boston Harbor Project and \$2 billion for water treatment and transmission infrastructure with the Massachusetts Water Resources Authority. Serving as Chief Engineer and Deputy Chief Operating Officer at MWRA, he played a key role on several large infrastructure programs, including: the \$200 plus million Braintree-Weymouth Tunnel/Relief Facilities Program; the \$280 million South Boston CSO Tunnel project; the Blue Hills Covered Storage design/build project; and the \$1.7 billion Integrated Water System Improvement Program, which included the 17.6-mile, 14-foot-diameter hard rock MetroWest Water Supply Tunnel.

Erika Moonin

Ms. Moonin is currently serving as Engineering Project Manager for the Southern Nevada Water Authority, Engineering Department. As the Engineering Project Manager she is responsible for leading, organizing and directing an integrated team to plan, design, and construct large and complex projects as part of the Authority's \$2.2 billion Capital Improvement Program and \$1.3 billion Major Construction Capital Program. Ms. Moonin's expertise comes from her experience as a lead manager for complex underground tunnel construction and water supply capital programs. She has proven team leadership experience for the successful planning, design, construction and commissioning of multiple large and complex/high risk projects.

Recent accomplishments include her lead role planning, organizing and directing the planning, engineering design and construction of the large complex Lake Mead Intake No. 3 project, totaling approximately \$1.35 billion. Responsible as Project Manager from early planning phase, design, construction through commissioning. The project includes the construction of a 20-foot-diameter



3-mile-long tunnel beneath the lake to a new intake structure, connector tunnels, and new pumping station.

Dr. Gary Brierley

Dr. Brierley has more than 50 years of experience with both the technical and nontechnical aspects of underground engineering and construction management. Dr. Brierley began his career with the Bachelor of Science degree in Engineering from Tufts University in 1968 and the Master's and Doctor's degrees from the University of Illinois in 1970 and 1975, respectively. Dr. Brierley has worked on more than 500 major soil and rock tunneling projects involving design, construction management and consultation for owners, contractors, engineers, public agencies, and attorneys. He served as President of Brierley Associates. Dr. Brierley has provided his technical and professional support on many tunnel projects in Massachusetts including: MWRA's South Boston CSO Tunnel; MWRA's Braintree-Weymouth Tunnel; MWRA's Deer Island Outfall Tunnel; Army Corp's Quincy Town Brook Tunnel; MBTA's Red Line Extension Tunnels; and MWRA's (MDC) Dorchester Tunnel;

Galyn "Rip" Rippentrop

Mr. Rippentrop is a nationally recognized expert for underground construction elements on large tunnel and CSO projects. He has over 40 years of experience, most recently focused on advising clients on their large-scale tunnel construction projects and has managed major tunnel projects across the nation and internationally, including Puerto Rico, Washington DC, South Carolina, Colorado, Virginia, Washington and Denmark. He served as President and Chief Executive Officer for Frontier-Kemper Constructors, Inc. a nationally renowned underground construction company, after a career of 23 years with Peter Kiewit Sons.

Mr. Rippentrop currently serves as a tunnel construction expert for the DC Water's Clean Rivers Program, where Mr. Rippentrop has been providing technical expertise on the Project Review Board since 2009 during which DC Water has been implementing a program to construct 18 miles of soft and hard rock tunnels beneath Washington DC.



***Metropolitan Tunnel Redundancy Program  
Update***

October 16, 2019



## Procurement Schedule – Preliminary Design Engineering

- Issued Request for Qualifications 10/2/2019
- Qualifications Statements Due 11/1/2019
- Issue Request for Proposals to Finalists 12/2/2019
- Proposals Due 2/14/2020
- Recommend Award to Board April 2020
- Notice to Proceed May 2020
  
- Contract Duration: 3.5 years



## Major Tasks Associated with the Preliminary Design and Engineering Contract

- **Project Management, Regulatory Agency, and Stakeholder Coordination**
- **Evaluation of Alternatives - Massachusetts Environmental Policy Act**
  - Review Existing Information
  - Alternatives Screening Report - Environmental Notification Form
  - Tunnel Alignment Alternatives Evaluation – Draft Environmental Impact Report
- **Environmental Impact Report – Massachusetts Environmental Policy Act**
  - Environmental Analysis
  - Section 61 Findings
  - Wetlands Delineations

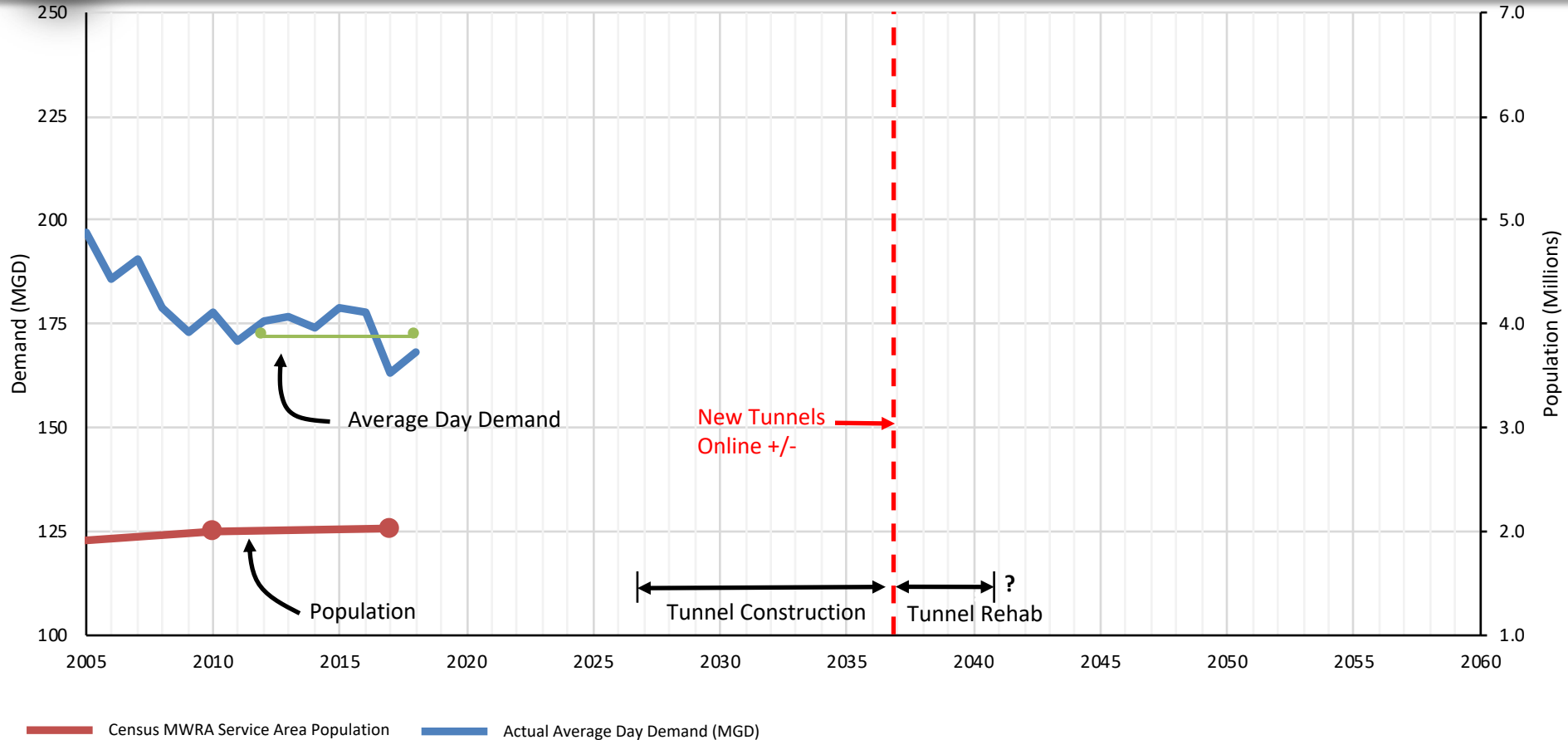


# Major Tasks Associated with the Preliminary Design and Engineering Contract

- **Geotechnical and Hazardous Materials Investigation and Evaluation**
  - Subsurface investigation
  - Geotechnical Database
  - Geotechnical Material Storage Management
- **Base Mapping and Survey**
  - Base Map Technical Memorandum
  - Easement and Records Research
  - Geotechnical Borings
- **Preliminary Design**
  - Hydraulic analysis of preferred alternative
  - Preliminary Design report and drawings
  - Program guide specifications

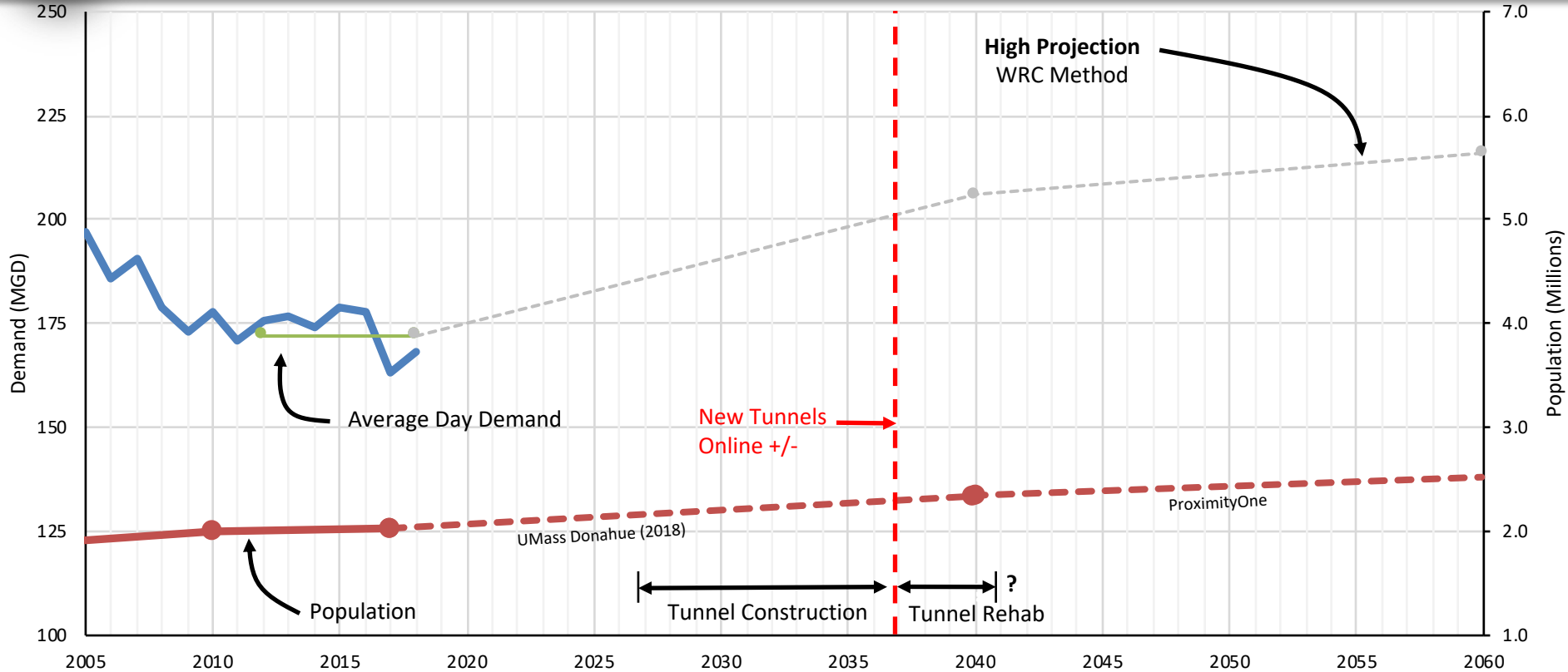


# Average Day Water Use Projections - East of Norumbega





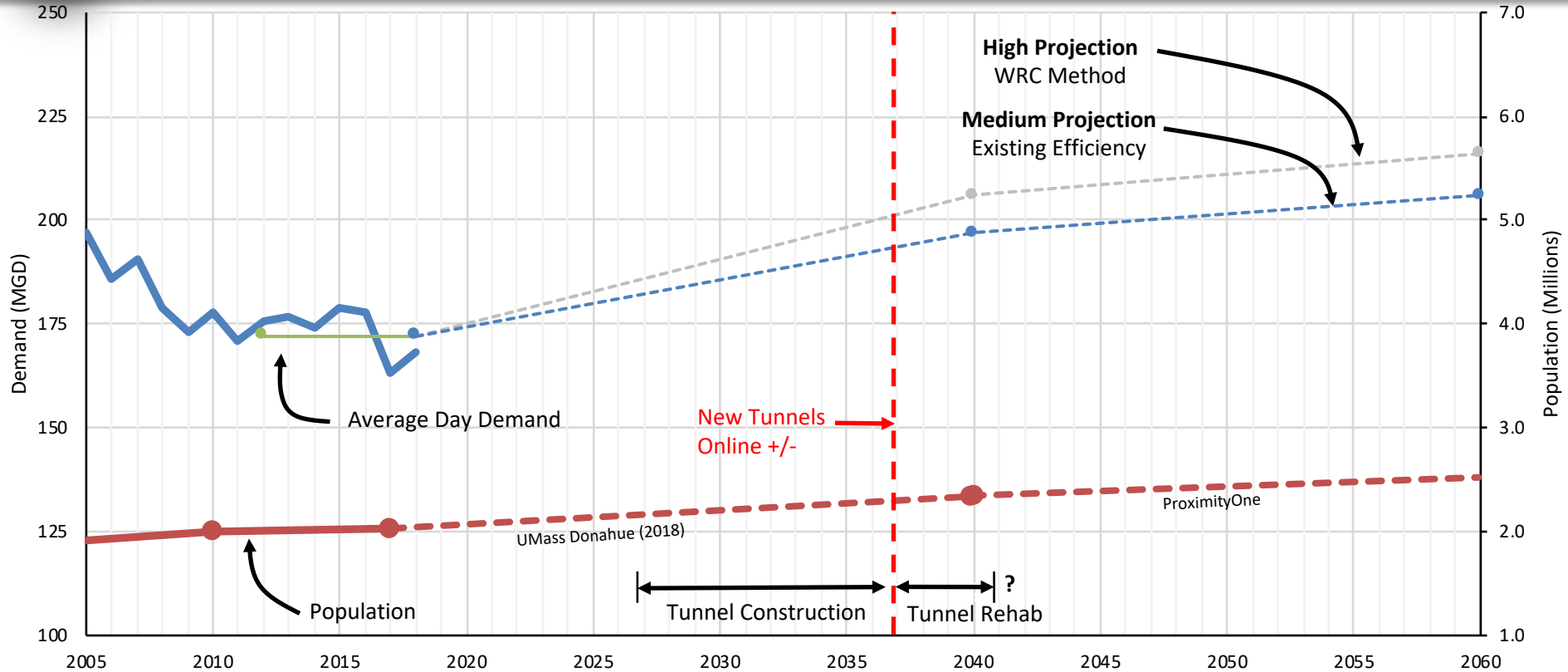
# Average Day Water Use Projections - East of Norumbega



— Census MWRA Service Area Population    — Actual Average Day Demand (MGD)  
- - - Projected MWRA Service Area Population



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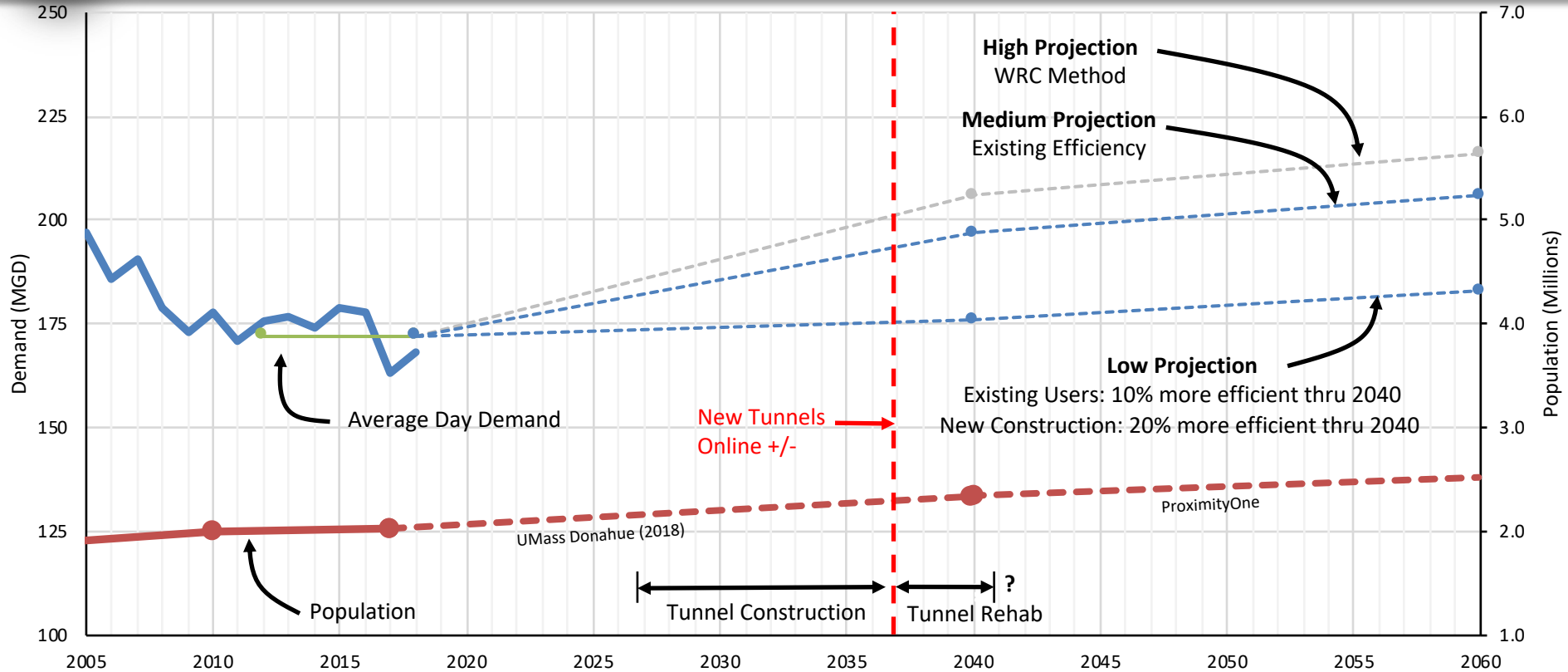


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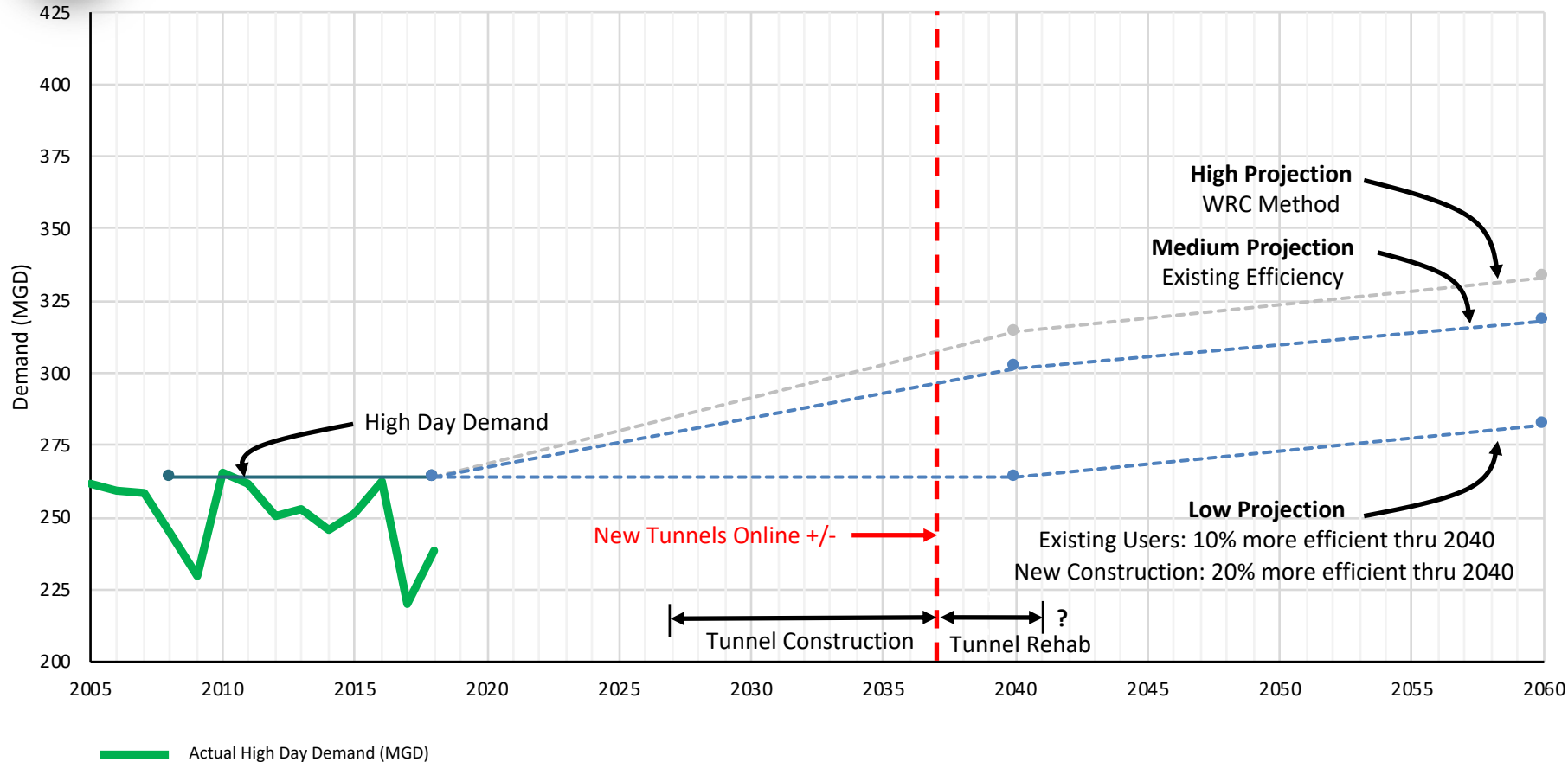
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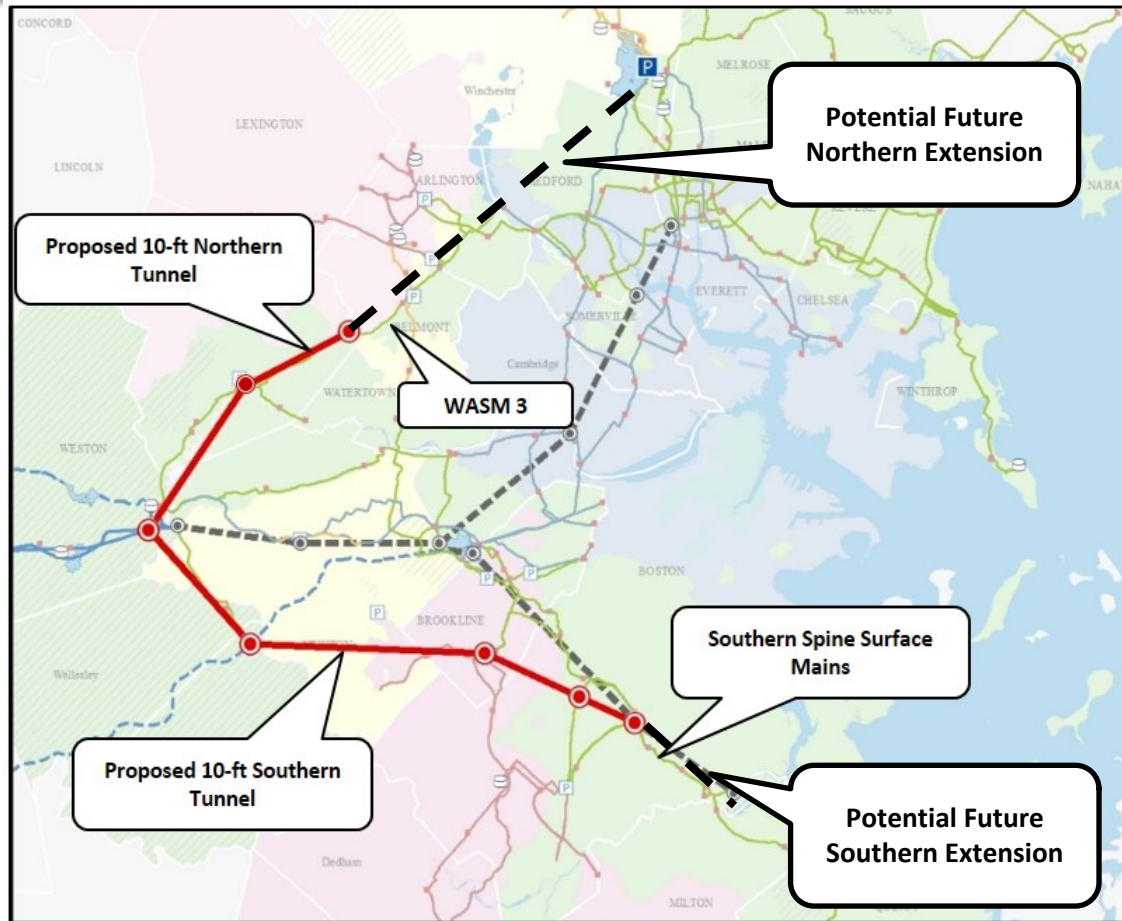


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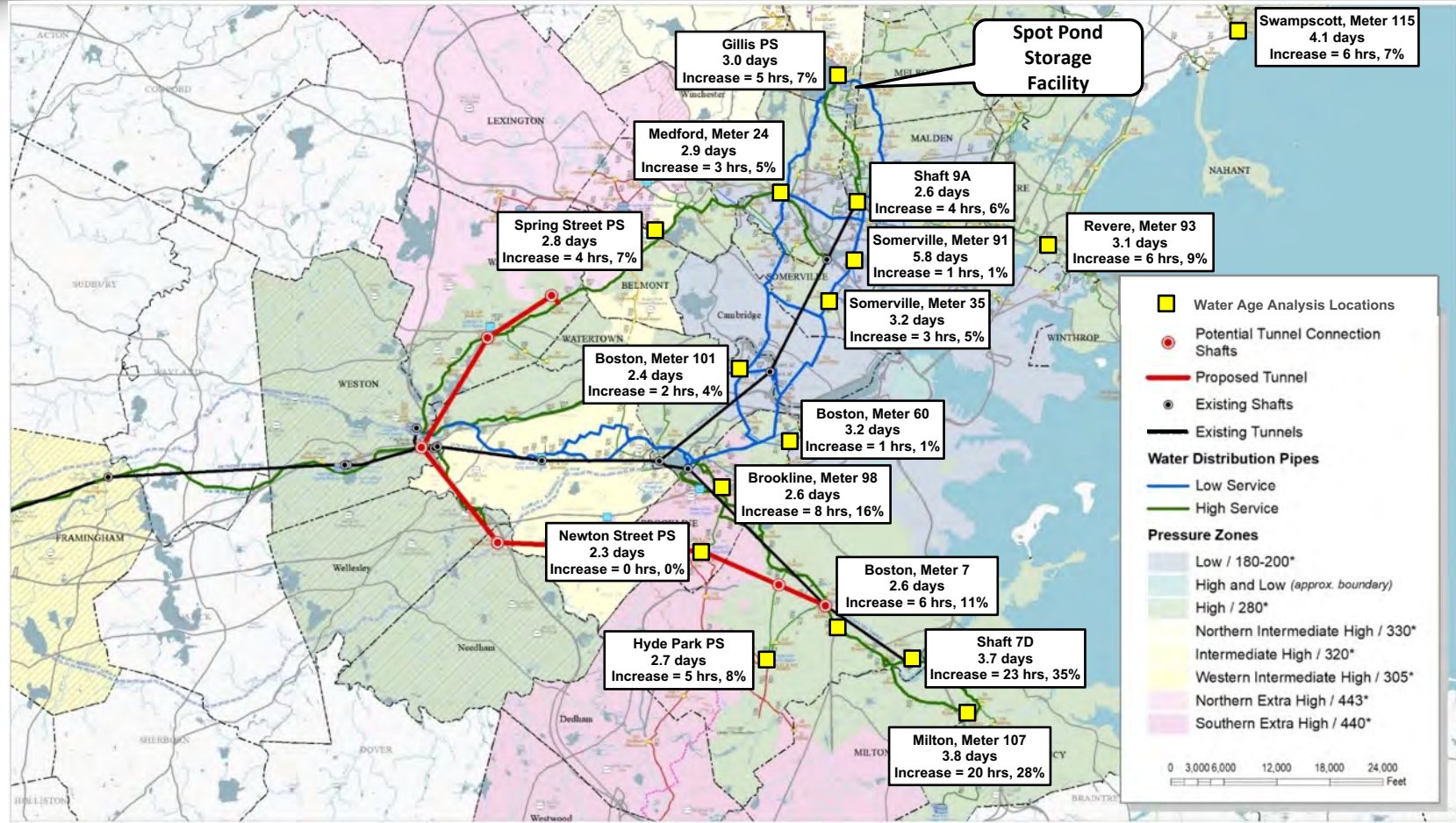
# Potential Future Tunnel Extensions





# Water Age Analysis from Carroll Treatment Plant

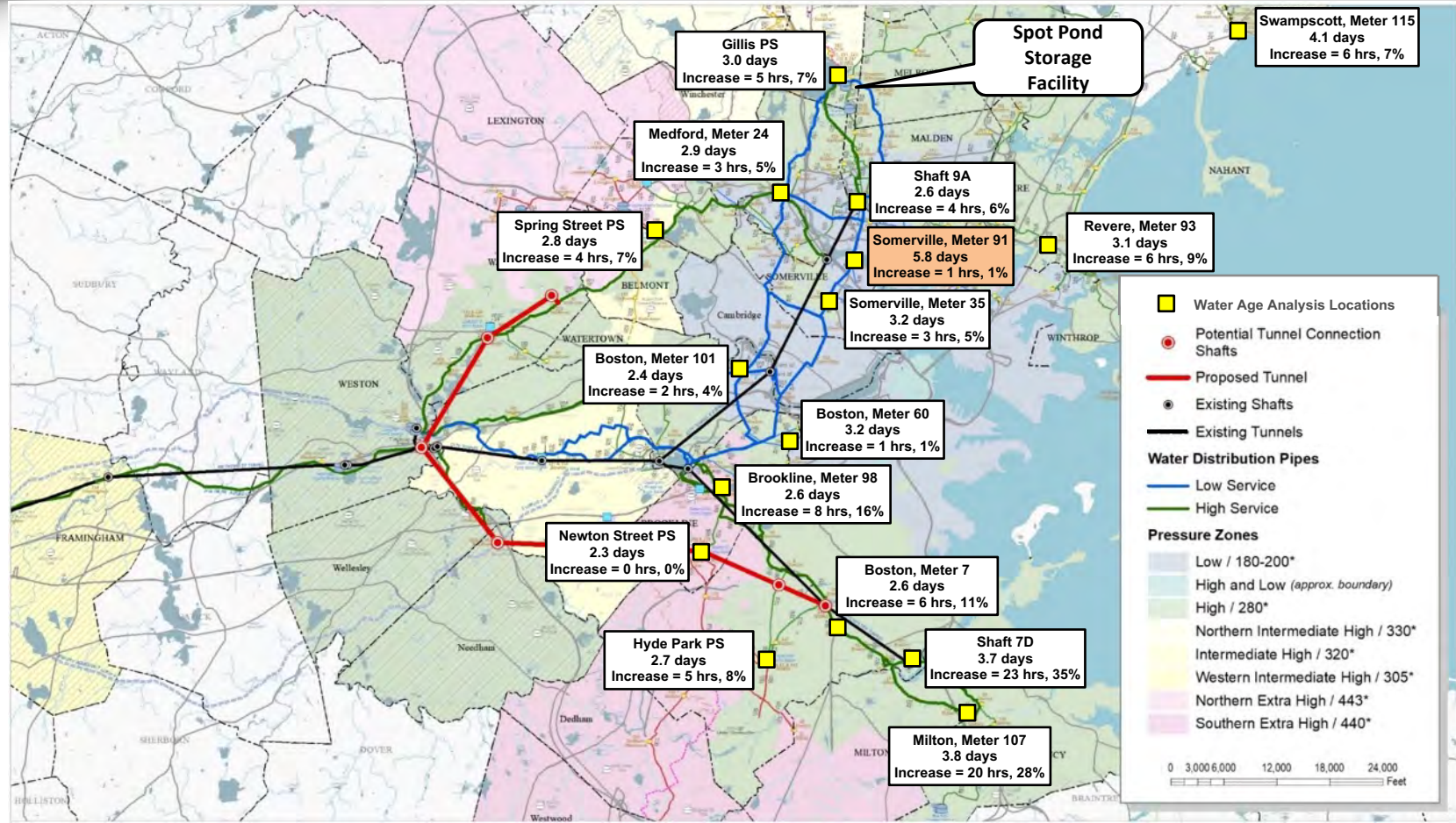
## Average Day Demand





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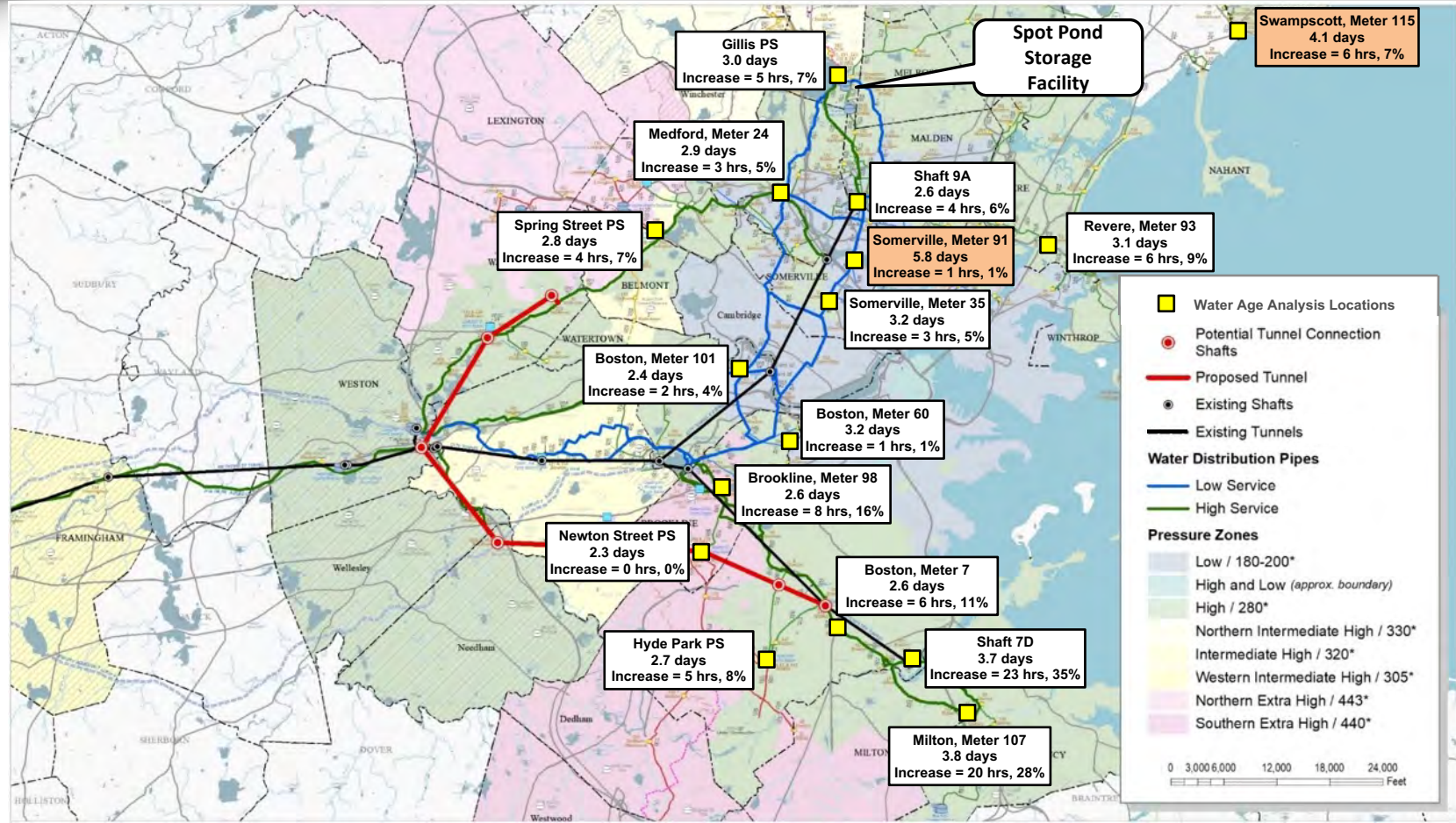
## Average Day Demand





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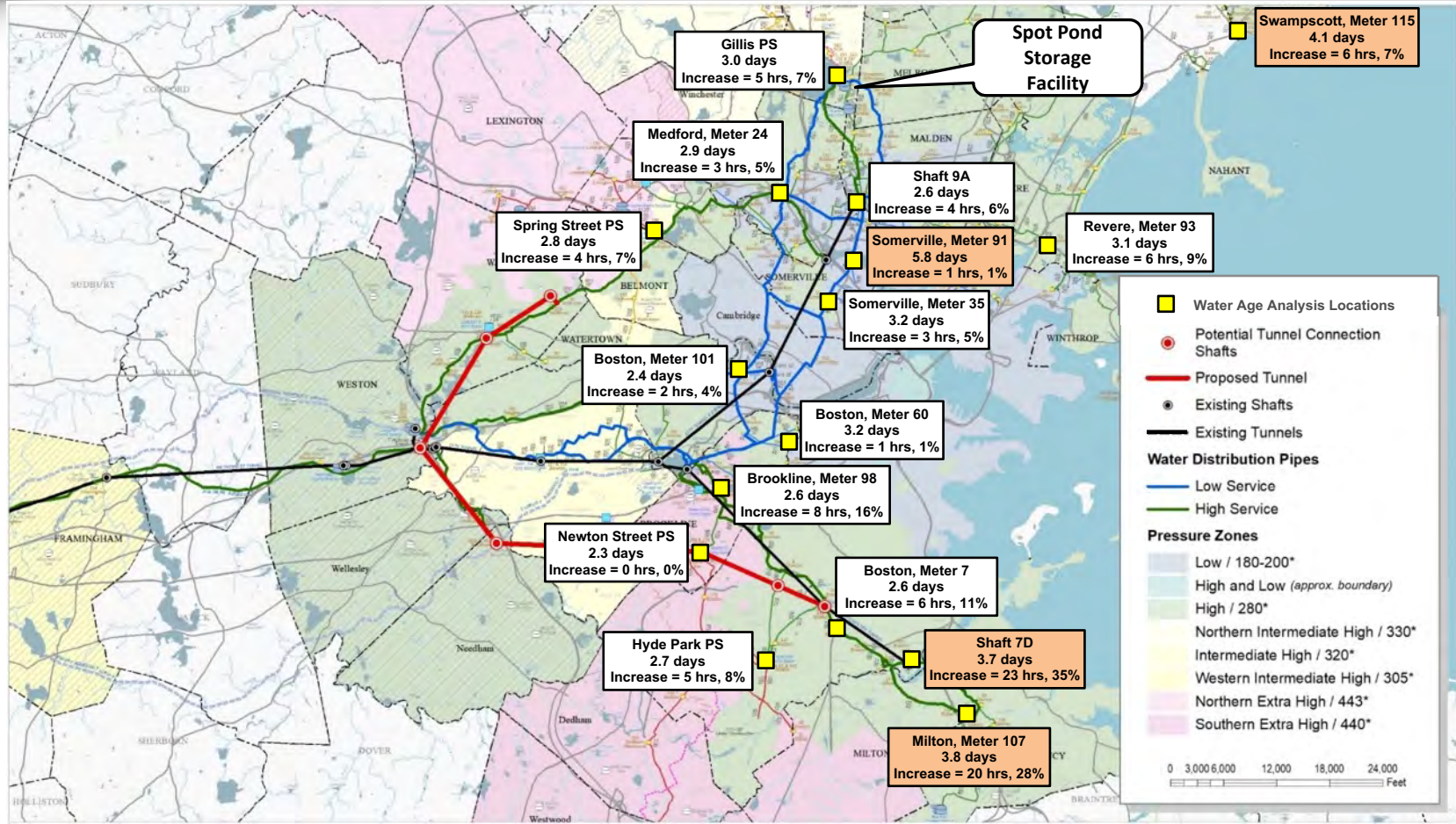
## Average Day Demand





# Water Age Analysis from Carroll Treatment Plant

## Average Day Demand





## Expert Review Panel

- Risk Mitigation
- Communications
- Program Management
- Tunnel Design and Construction
- National and Local Experts
- Panel Workshops at Key Program Milestones





# Expert Review Panel

- **Richard Fox – Owner, Mega Program Management, MWRA**
  - Adjunct Faculty, Merrimack College
  - CDM Smith
  - MWRA
- **Michael McBride – Tunnel Construction Management, MWRA, Owner**
  - Gilbane
  - HDR
  - Allston Development Group
  - MWRA
- **Erika Moonin – Owner, Mega Tunnel Program Management**
  - Project Manager – Lake Mead Intake No. 3, Southern Nevada Water Authority
- **Gary Brierley – Tunnel Boring Machine / Local Geology**
  - “Dr. Mole”
  - Brierley Associates
  - Haley & Aldrich
- **Gayln Rippentrop – Underground Construction / Tunnel Contractor**
  - Frontier-Kemper
  - Kewit