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Responding to Changes in Climate at MWRA

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Abstract

As an infrastructure-heavy water and wastewater utility with many of our facilities in coastal areas, Massachusetts Water Resource Authority's (MWRA) operations will be impacted by climate change. While the primary threat is sea level rise and coastal flooding, increased intensity and variability of precipitation and extreme heat will also affect our infrastructure and staff. MWRA's adaptation efforts began with the construction of the Deer Island Wastewater Treatment Plant (DITP). Priority sites for protection were identified based on the Authority's evaluation of coastal facilities' ability to withstand a 100-year storm with 2.5 feet of sea level rise (in line with 2050 conservative projections). To date, flood protection measures have been installed at most of these priority sites, through either short-term measures, including deployable flood barriers in doorways, or by more permanent solutions such as amending designs of facilities undergoing major rehabilitation. MWRA anticipates a modest increase in safe yield due to changes in intensity and frequency of precipitation, however, as locally supplied communities with much smaller water sources, might experience diminished yields, MWRA is anticipating and planning for increased use of the MWRA system by more communities. As part of MWRA's commitment to mitigate the impacts of climate change, the Authority has implemented many energy conservation programs to reduce the energy consumption and carbon emissions required to provide safe drinking water to its member communities. Since 2006, MWRA has reduced annual greenhouse gas emissions by 40% or nearly 58,000 metric tons of CO2 equivalent. This is the result of a multi-pronged approach, including investments in renewable energy, energy efficiency and optimization, and the electrification of both facilities and vehicles.

Keywords: climate change, resiliency, sea level rise

1. Deer Island: Our Resiliency Beginnings

The Deer Island Treatment Plant, which represents MWRA's single largest infrastructure investment, is extremely flood resistant due to its 1986 design that took into consideration sea level rise before it became a mainstay issue. In fact, Deer Island is designed to survive a direct hit from a Category 3 hurricane with minimal damage limited to support systems only with no flooding in the DITP process areas. The plant was designed back in 1998 to withstand a 100-year storm event plus nearly two feet of sea level rise. During design, plant process tanks were raised almost two feet, and the outfall was increased from 24 to 24.5 feet in diameter to accommodate sea level rise without reducing the plant capacity. In addition, the island is surrounded by a seawall that reflects incoming wave energy back to the ocean (see Figure 1).

In planning for the rising tide and storm surge effects on coastal infrastructure, MWRA has closely followed the evolving science of climate change over the past few years with the goal of fully understanding potential impacts to facilities and operations. MWRA has taken a pragmatic approach to climate change adaptation, and efforts have largely focused on the evaluation and implementation of measures to allow MWRA facilities to withstand a significant storm event that could occur in Eastern Massachusetts. Primary concerns for approaching sea level rise include the following:

Figure 1. Deer Island Treatment Plant is protected for 100-year flood, 1.9-foot sea level rise, and a wave run-up of 14 feet on its east side and 2 feet on its west side (MWRA, 2023).

- What are the most vulnerable facilities?
- How vulnerable are they and what are the potential service impacts?
- What can be done in the short-term or long-term to eliminate or mitigate the vulnerability?

Following Super Storm "Sandy" in October 2012, MWRA began an evaluation of coastal facilities to understand each one's ability to withstand such a storm were it to make landfall in the Boston area (MWRA, unpublished internal report, September 2013). The most current information available on climate change scenarios and sea level rise has been and will continue to be incorporated into design and construction contracts to ensure hardening against potential impacts.

MWRA recognizes that mitigation solutions must be approached as an ongoing effort. While there is no singular solution to a constantly changing issue, MWRA has formulated both short- and long-term strategies that address flooding concerns with the overall goal to limit damage, recover fully, and resume activity as quickly and efficiently as possible. Various adaptation strategies have been formulated on the basis of a pragmatic benchmark of 2.5 feet, added to the current 100-year flood elevation as set by the Federal Emergency Management Agency (FEMA) to account for sea level rise and intensified storm surges. This benchmark by no means depicts the "perfect" numerical value in planning for mitigation strategies. It does, however, represent a reasonable estimation of change for staff to utilize in evaluating the potential threat of sea level rise on coastal facilities, and allowed MWRA to move forward even while more detailed modeling of sea level rise was underway by other agencies. As research in climate change continues to advance, MWRA is aware of the potential for new scientific information to warrant re-evaluations of existing benchmarks and plans to act on these analyses accordingly.

While both short- and long-term strategies are imperative in developing emergency preparedness efforts, MWRA has placed particular emphasis on high-priority immediate actions to take in response to a severe weather event. Where major rehabilitation work is not occurring at facility in the short-term, MWRA has identified immediate needs for flood-proofing improvements (such as raising equipment up off floors and installing stop logs at doorways). Mapping out emergency response plans, training, and drilling staff on those actions, and evaluating MWRA's response after each major event have all been crucial initiatives in striving for preparedness.

Long-term initiatives include upgrading facilities on individualized rotation schedules and adding flood mitigation measures. Storm surge, together with anticipated sea level rise resulting from the changing climate, will affect several MWRA and communities' coastal collection systems and wastewater facilities. MWRA's 2018 Master Plan assumes any significant flood mitigation efforts will be undertaken as each MWRA facility is rehabilitated or upgraded, and that simpler measures will be implemented as maintenance efforts. Major rehabilitation projects at the Alewife Brook Pumping Station and the Chelsea Creek Headworks have already incorporated anticipated changes in sea level into the design criteria, and other coastal facilities have had flood mitigation measures implemented.

2. Sea Level Rise and Coastal Storm Flood Risk: Evaluating Benchmarks

To determine site vulnerabilities, MWRA evaluated the potential impacts of sea level rise on 30 coastal or near coastal wastewater and administrative/operational facilities – of which 13 were determined to be within the most recent FEMA 100-year flood elevation (or to be conservative, within one foot above the 100-year elevation) (MWRA, unpublished internal report, September 2015). The record drawings for all MWRA coastal facilities were reviewed to identify their lowest flooding elevations. In many cases, this was the first-floor elevation. However, lowest flooding elevations could also include hatches or other access points on the exterior of the facility. Staff performed site-specific inspections of each facility and took note of any major exterior equipment (such as emergency power generators) that might be damaged during a major storm. Using specialized software, staff then performed an inundation analysis that used the three-dimensional elevation data that was recently collected by the Commonwealth through Light Detection and Ranging (LiDAR).

The critical flooding elevations were compared to two benchmarks. The first benchmark is the existing 100-year flooding elevation from the most recent FEMA flood maps. To be conservative, MWRA retrofitted any facilities whose first-floor elevation was within a foot above the 100-year flood.

The second benchmark is the 100-year flooding elevation with an additional 2.5 feet added. Some regional organizations, such as Boston Harbor Now and the NYC Department of Environmental Protection, had adopted this benchmark as a reasonable and

conservative estimate of mid-term sea level rise. These benchmarks can be seen on the photo of the Quincy Pump Station below. Climate models have varying estimates for the degree of rise anticipated by 2050 or 2100, and 2.5 feet generally falls in the middle of them. When compared to the recent Boston Research Advisory Group (BRAG) sea level rise projections, 2.5 feet appears to provide protection beyond 2070 - even for the highest C02 emissions scenarios. MWRA is using this benchmark as an appropriately conservative measure of vulnerability, addressing issues of both storm intensity and sea level rise. MWRA will continue to monitor the evolving science and consensus on sea level rise and change benchmarks as appropriate (see Figure 2).

Figure 2. Quincy Pump Station flood line scenarios drawn to represent water levels at two different benchmarks, FEMA 100-year and 100-year +2.5 ft (MWRA, 2016)

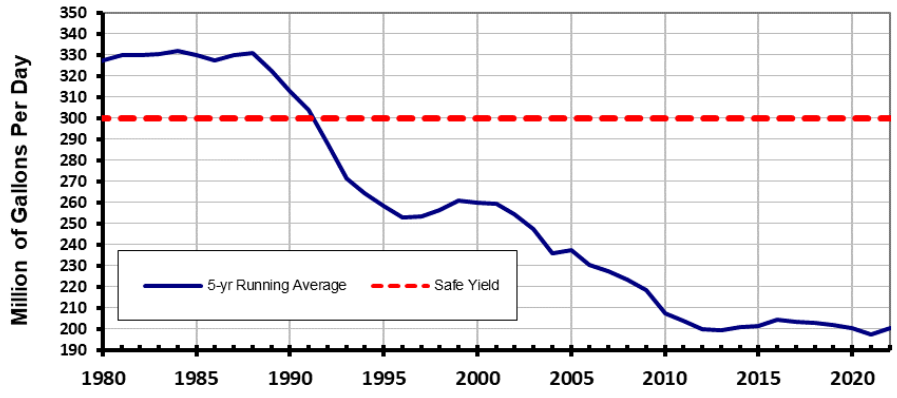

Figure 3. MWRA water demand vs. safe yield, 1980 – 2022 (MWRA, 2022)

3. Safe Yield: A Steady Supply for Future Extremes

MWRA's source reservoirs, the Quabbin and Wachusett, can safely provide around 300 million gallons of water per day - even during periods of extended drought. This number, or the safe yield, is a widely used measure for supply adequacy, and is defined as the quantity of water that can be supplied on a continuous basis during critical drought, without violating a defined operating objective (see Figure 3).

Cooperating with other partners that included the Water Research Foundation, the National Center for Atmospheric Research, the Stockholm Environment Research Institute, Tufts University and UMass, MWRA has evaluated the potential impact of a changing climate on our water system's safe yield. While many locally supplied communities can anticipate diminished yields of their sources, MWRA's system is likely to see a modest increase in its safe yield from the increased but more varied precipitation due to the sheer size of its reservoir storage, thereby setting the stage for MWRA to potentially provide water to these communities during periods of stress or more regularly. During the 2016 drought, for instance, MWRA was able to provide emergency water supply to Worcester, Cambridge, and Burlington (see Figure 4).

4. Next Steps: Energy-Forward Plans of Action

Implementation of initiatives to reduce energy demand and the continued assessment of sustainable cost-saving opportunities are long-standing goals of the MWRA. As part of MWRA's commitment to mitigate the impacts of climate change, the Authority has implemented a wide range of energy conservation programs to reduce the energy consumption and carbon emissions required to provide safe drinking water to its member communities.

Since 2006, MWRA has reduced annual greenhouse gas emissions by 40% or nearly 58,000 metric tons of CO2 equivalent. This success is the result of a multi-pronged approach, including investments in renewable energy, energy

efficiency and optimization, and the electrification of both facilities and vehicles.

5. References

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MWRA (Massachusetts Water Resources Authority). 2022. *MWRA water demand vs. safe yield, 1980-2022.*

MWRA (Massachusetts Water Resources Authority). 2023. *Stressed basins adjacent to MWRA-served communities.*

Figure 4. Stressed basins adjacent to MWRA-served communities (MWRA, 2023)

