EBC Leadership Program

Infrastructure and Environmental Developments at the MWRA
Welcome

Daniel K. Moon

President & Executive Director
Environmental Business Council
Introduction and Program Overview

Catherine Finneran

Program Co-Chair and Moderator

Vice President
Sustainability and Environmental Affairs
Eversource Energy
Keynote Presentation

Fred Laskey

Executive Director
Massachusetts Water Resources Authority
Infrastructure and Environmental Developments at MWRA

Frederick A. Laskey
Executive Director

November 13, 2019
Why The MWRA Was Created

• In 1985, MWRA assumed responsibility for the water and sewer infrastructure serving greater Boston, and to end the pollution of Boston Harbor from obsolete treatment plants

• MWRA was created as an independent authority charged with raising its revenue from ratepayers, bond sales and grants

• MWRA had to establish wholesale water and sewer rates to cover all costs, including a massive capital program to repair and upgrade the systems

• MWRA was also charged with promotion and enforcement of water conservation and planning for the future

• In compromise with Western and Central Massachusetts, MDC retained watershed management, but MWRA covers costs
• MWRA provides wholesale water and wastewater services to over 3 million customers in 61 communities

• On average, MWRA delivers an average of 200 million gallons per day to its water customers

• MWRA collects and treats an average of 350 million gallons of wastewater per day, with a peak capacity of 1.2 billion gallons
Planned Water and Sewer System Improvements
MRWA's Capital Improvement Program

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Actual (Wastewater)</th>
<th>Actual (Water)</th>
<th>Projected (Wastewater)</th>
<th>Projected (Water)</th>
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<tbody>
<tr>
<td>FY90-98</td>
<td>$18</td>
<td>$84M/yr</td>
<td>$564</td>
<td>$80M/yr</td>
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<tr>
<td>FY99-01</td>
<td>$24</td>
<td>$92M/yr</td>
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<td>FY02-04</td>
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<td>FY05-07</td>
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<td>FY08-10</td>
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<td>FY11-13</td>
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<td>FY14-16</td>
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<td>FY17-19</td>
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<td>$89M/yr</td>
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<tr>
<td>FY20-22</td>
<td>$127</td>
<td>$117M/yr</td>
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<td>$117M/yr</td>
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<tr>
<td>FY23</td>
<td>$123</td>
<td>$64M/yr</td>
<td>$123</td>
<td>$64M/yr</td>
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</table>

Wastewater Improvements: $79M-$192M/yr
Waterworks Improvements: $84M-$800M/yr
Progress on Water System Redundancy

1. Chicopee Valley Aqueduct - 2007 Improvements
2. Quabbin Aqueduct - Inspection planned
3. Cosgrove Tunnel / Wachusett Aqueduct - 2019 Completed new Pumping Station
5. Metropolitan Tunnels - Project now underway
The MetroWest Water Supply Tunnel was brought on-line in November 2003.

By March 2004, the Tunnel was being fully utilized allowing the shutdown of the Hultman Aqueduct for repair.
Since 2013, for the first time since originally planned in the 1930s, the Metropolitan Water System has redundancy for the Hultman Aqueduct from Marlborough to Weston.
• Existing NIH Piping

• NIH Phase 1 work completed May 2018

• NIH Phase 2 work completed September 2018

• NIH Phase 3 work wrapping up
Southern Extra High Redundancy Project: Stantec Consulting Services

- Contract 1 – complete
- Contract 2 - 85% complete
- Contract 3 - 40% complete
• Provides redundancy for Cosgrove Tunnel bringing water from Wachusett Reservoir to Carroll Treatment Plant
Wachusett Aqueduct Pumping Station

- Substantially complete February 2019
- Provides redundancy from the Wachusett Reservoir to the Carroll Treatment Plant
To provide redundancy for Metropolitan Tunnels which deliver water to 60% of the system

- $1.5 billion
- Project duration 2018 – 2039

- Work ongoing on tunnel alignment and shaft locations
- Contract for Program Support Services awarded in March
• We received six qualifications statements, currently under review:
  – AECOM
  – Brierley Associates
  – CDM Smith
  – McMillan Jacobs Associates
  – Parsons
  – Stantec

• The RFP will be released in early December

• Contract award is expected in the spring
Expert Review Panel

- 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
In the Meantime:
Top of Shafts Interim Improvements

Improve and protect critical facilities related to the existing tunnel system at nine shaft locations:

Shaft 5 – Weston
Shaft 9 – Somerville
**Shaft 6 – Newton**
Shaft 7 – Boston College
Shaft 7B – Chestnut Hill
Shaft 7C – Dorchester
Shaft 7D – Dorchester
**Shaft 8 – Brighton**
Shaft 9A – Malden

First contract will address Shafts 6, 8 and 9A
Top of Shafts Interim Improvements: Valve Reliability Concern

- Valves that don’t work
- Valves we can’t exercise
<table>
<thead>
<tr>
<th>Project Description</th>
<th>Contract #</th>
<th>Notice to Proceed</th>
<th>Substantial Completion</th>
<th>Total Contract Amount</th>
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<tr>
<td>Quabbin Admin Bldg. Rehab</td>
<td>7569</td>
<td>Oct-20</td>
<td>Oct-21</td>
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<td>QAB Concept Design Report</td>
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<td>Maintenance Garage/Wash Bay/Storage Bldg. Design/CA/RI</td>
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<td>River Rd Improvement - Wachusett (funded from FY19 Watershed Protection budget surplus)</td>
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<td>Land Acquisition</td>
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<td>Dam Improvements</td>
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<td>Dam Permits</td>
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<td>Quinapoxet Dam Removal - Design/ESDC/RI</td>
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<tr>
<td>Quinapoxet Dam Removal RELI</td>
<td>7690</td>
<td>Jul-21</td>
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<td>Sudbury/Foss Dam Design/CA/RI</td>
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<td>Sudbury/Foss Dam Construction</td>
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<td>Jul-20</td>
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## FY2020 Current Expense Budget

<table>
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<tr>
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<th>Amount</th>
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<td><strong>Watershed Protection Indirect Expense</strong></td>
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<tr>
<td>Clinton Crew Headquarters</td>
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<td>Quabbin/Ware road and drainage reconstruction</td>
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<td>Quabbin Admin Building interim roof repairs</td>
<td>$105,000</td>
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<tr>
<td>Quabbin Admin Building interim water system corrosion control</td>
<td>$150,000</td>
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<tr>
<td>New Salem restoration (gas tank &amp; garage design)</td>
<td>$75,000</td>
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<tr>
<td><strong>Maintenance Budget</strong></td>
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<tr>
<td>Quabbin Park Cemetery water spigot / irrigation</td>
<td>$15,000</td>
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<tr>
<td>Quabbin Park Cemetery lead abatement</td>
<td>$45,000</td>
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</table>
Quabbin Administration Building
• Recommend lead abatement and repairs
• The $900 million program included 35 separate construction projects

• Annual CSO volumes have already been reduced by nearly 3 billion gallons

• Since 2015, 93% of the remaining CSO flows are treated
Water Quality In Boston Harbor And Rivers Has Improved

- No beach closings at South Boston beaches in 5 years
- Boston has the cleanest urban beaches in the country
Dramatic Improvements In Water Quality – Even In Wet Weather

1987-1998 (Before Secondary Treatment and South System transfer)

1999 - 2018 (After Secondary Treatment and New Outfall)

Average Enterococcus counts in Boston Harbor in wet weather

The lighter the blue, the better
MWRA must meet the last federal court milestone – conduct a post-construction monitoring program and performance assessment to verify that the program achieves the required long-term levels of control by 2021.

In that time, MWRA must:
- Complete receiving water quality modeling
- Perform follow-up analyses to evaluate optimization alternatives
- Meet the terms of DEP’s 5-year Variance for Alewife and Charles rivers

Cambridge and Somerville must also meet the terms of the variance.

Cambridge has proposed a partial sewer separation project that will also help MWRA reduce activations.
How would system work with partial sewer separation?

During smaller storm events the stormwater stays connected to the MWRA system; reducing the impact of phosphorous and other nutrients on the river.

During larger storm events, stormwater is diverted to the river; reducing the frequency and volume of CSOs.
Cambridgeport – Talbot Street Outfall

Consistently identified by the MWRA as critical to reducing the CSO volumes at Cottage Farm to under the LTCP of 6.30 MG. But the MWRA has not committed funding to this project.

The $12M to $15M+ partial sewer separation in the Cambridgeport area (Talbot Street outfall) is being constructed with no MWRA Funding.

With Partial Sewer Separation – stormwater during larger CSO storm events is directed to the Charles River, which is why the typical year CSO activations are the same under full sewer separation and partial sewer separation.
Somerville system – 3 major interceptors & MWRA connections

- Tannery Brook → Alewife Brook Conduit
- McGrath → Somerville Marginal
- Beacon-Washington-Somerville → Cambridge Branch
- Pipe-only outlets for southeast Somerville
<table>
<thead>
<tr>
<th>Area</th>
<th>MWRA Connection</th>
<th>Overflow</th>
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</thead>
<tbody>
<tr>
<td>Somerville Marginal Interceptor (SMI)</td>
<td>Mystic River</td>
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</tr>
<tr>
<td>Alewife Brook Conduit (ABC)</td>
<td>Alewife Brook</td>
<td></td>
</tr>
<tr>
<td>Cambridge Branch Sewer (CBS)</td>
<td>Interactions with SMI and McGrath system</td>
<td></td>
</tr>
<tr>
<td>Primary to CBS with overflows to ABC</td>
<td>Alewife Brook, plus interactions with CBS</td>
<td></td>
</tr>
</tbody>
</table>

- 60-percent of flows discharge to Cambridge Branch with overflows to Prison Point
• Three headworks screen sewage flow before it gets to Deer Island

• All built in the 1960s and in need of a complete rehab

• Rehabs include flood protection measures (more on that later)

• Total cost $230 million
Rehab Started with One Facility

- Rehab of Chelsea Creek Headworks ongoing

- Will apply lessons learned to other two facilities in future rehab

Columbus Park

Ward Street
MWRA’s Approach to Climate Change
Changing Precipitation Quantity and Patterns

- Currently, we average 104 rain events per year with an average of 44 inches of rainfall
- Models suggest we’ll see longer dry spells with shorter, heavier rain
- An overall modest increase in total rainfall
- Flooding during the January and March Nor’easters in 2018 impeded access to several MWRA facilities
Charlestown Navy Yard – March 2018
Preparing for Climate Change: Drinking Water System Is In Good Shape

- Quabbin Reservoir, Belchertown
  - 65 miles west of Boston
  - Elevation 528 feet

- Wachusett Reservoir, Clinton
  - 35 miles west of Boston
  - Elevation 395 feet

- Water treatment plant is in Marlborough

- 85% of water delivered by gravity

- Lowest elevation of a water tank is 192 feet above sea level
Significant Investment in Dams

- All MWRA dams, dikes, spillways and appurtenances are inspected routinely by licensed dam safety engineers and are rated “satisfactory” or “good” condition – the two highest ratings

- MWRA has spent over $23 million on dam safety projects

- Quabbin and Wachusett spillways have been improved to be able to discharge the probable maximum flood
Most these dams are classified as Large Size and High Hazard Class, meaning their failure could result in loss of life, property and infrastructure.
Quabbin Spillway Rehab: GZA Environmental
Adaptation for Sea Level Rise In The Design of Deer Island Treatment Plant

- Deer Island plant fully protected
  - 100-year flood
  - 1.9-foot (0.6 meter) sea level rise
  - Wave run-up of 14 feet (4.3 meters) on east side and 2 feet (0.6 meter) on west side
  - Nut Island headworks in Quincy similarly designed for sea level rise
On-site power plant ensures uninterrupted power supply to keep the plant operating for up to 90 days.
A Rising Sea Would Impact the Hydraulics of the Deer Island Outfall Tunnel

- The effluent from the sewage treatment plant is discharged by gravity to the 9.5-mile outfall tunnel.
- To maintain hydraulic capacity, plant process tank elevation raised 1.9 feet and tunnel diameter was up-sized from 24 feet to 24.25 feet.
• Most of our staff and equipment is at our Chelsea Facility off of Eastern Avenue, across from the Chelsea Creek.
Back-up water and wastewater operations control center created at Carroll Treatment Plant in Marlborough
Plans to Pre-deploy Staff and Equipment to Higher Ground
Benchmarks For Evaluating Facilities

- 100 year flood as determined by FEMA
- 100 year flood + 2.5 feet (NYC DEP, BHA)
- Hurricane flooding levels as determined by FEMA’s SLOSH model (current evacuation planning recommendation) were reviewed
- Wave action (for facilities adjacent to FEMA Hazard Zone VE) was reviewed
MWRA’s Approach

• Short-term
  – At-risk buildings are being fitted with temporary flood barriers
  – Expanding fuel storage at wastewater stations

• Long-term
  – Facility rehabilitation on a 20-year cycle
  – Future rehabilitation contracts will include protection measures

• May have to speed things up
Flood Elevations At Chelsea Screenhouse: Dewberry Engineers

Southwest Facility View

Backup Generator
Flood Elevations At Chelsea Creek Headworks:

116.43ft 100yr Flood Elevation

First Floor Elevation 117.12ft

MA-231-0014 40000.Flood Elevation
New Flood Control Measures Are Being Added
Chelsea Headworks
Alewife Brook Pump Station: Stantec Consulting Services

Flood logs (exterior)

Flood logs (interior)

Watertight hatch

Flood logs (interior)
Alewife Brook Pump Station
Infiltration and Inflow Funding for Member Communities

- 191 miles of sewer Cured-In-Place Pipe liner installed
- 160 miles of sewer replaced
- 6,804 manholes rehabilitated/sealed
Water Conservation and System Expansion
Water Usage Is Down Over 100 Million Gallons A Day

Safe Yield

Million Gallons Per Day

And the City of Boston’s Usage Is At A 110-Year Low
Communities that Have Joined the MWRA Water System

STOUGHTON
BEDFORD
BURLINGTON
ASHLAND
Peabody, North Reading and Tri-Town (Braintree, Holbrook and Randolph have taken specific actions not to join the MWRA water system
During the most recent drought, MWRA provided emergency water to several communities:

<table>
<thead>
<tr>
<th>Community</th>
<th>Amount Supplied (Million Gallons)</th>
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<tbody>
<tr>
<td>Worcester</td>
<td>847.3</td>
</tr>
<tr>
<td>Cambridge</td>
<td>515.2</td>
</tr>
<tr>
<td>Burlington</td>
<td>7.9</td>
</tr>
<tr>
<td>Ashland</td>
<td>3.2</td>
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Renewable Energy
Renewable Energy at MWRA

Renewable generation in FY18 = 28% of total MWRA total electricity usage

Renewable generation totaled 52.4 million kWh in FY18, dropping for the third consecutive year due to hydro and wind assets being off-line for maintenance.
Deer Island is one of the largest electricity users in the Northeastern United States

Deer Island currently self-generates 26 - 28% of its electricity needs and over 60% of it’s total energy demand (including heat at hot water)
Methane Utilization at Deer Island

- Deer Island utilizes 98% of the methane generated to power a steam turbine generator and backpressure turbine for plant heat and hot water
- Avoid purchase of about 5 million gallons in fuel oil annually
- Approximately 31 million kWh per year electricity production
- Approximately $3.3 million per year electricity savings and revenue
Hydroelectric Power

- Oakdale, Cosgrove, Loring Road, Brutsch and Deer Island
- Over 8 MW capacity
- Approximately 16.5M kWh per year in electricity production
- Over $1.3 million in annual savings and revenue
Hatchery Pipeline and Hydrogenerator: Stantec Consulting Services Provides Multiple Benefits

- 500,000 kWh and ~$50,000 in savings expected annually
- Constant supply of cold water to Fish Hatchery
• About 85% of the drinking water is delivered by gravity
Solar Power - Deer Island Treatment Plant

- 736 kW capacity
- Over 824,000 kWh per year in electricity production
- Approximately $162,000 in annual savings and revenue
Solar Power – Carroll Water Treatment Plant

- 496 kW capacity
- Approximately 530,000 kWh per year in electricity production
- Over $106,000 in annual savings and revenue
New Solar Projects Under Consideration

- Deer Island Canopy
- Arlington Covered Storage
- Norumbega Covered Storage
- Loring Road Covered Storage
Wachusett Aqueduct Emergency Pump Station – “Net Zero”

- Geothermal Heating and Cooling System
- Solar Ground and Roof Mount Panels
- High Efficiency Lighting and Controls
- Water Efficient Fixtures
Wind Power – Deer Island Treatment Plant

- Two 600 kW turbines
- 1.4 million kWh per year in electricity production
- Approximately $266,000 in annual savings and revenue
Wind Power - Charlestown

- 1.5 MW capacity
- Over 2.3 million kWh per year in electricity production
- Approximately $309,000 in annual savings and revenue
MWRA has completed over 50 energy audits at most major facilities.

Implementation of audit recommendations and other process optimization efforts have saved over 25.4M kWh and $2.51 million annually.
From 2008 to 2018, MWRA’s purchases of electricity have been reduced by nearly 20.0%, or 37 million KWh.

Drop in FY17 reflects HEEC Cable work.
We Love Being Green!

- Of our $40 million annual energy budget, $22 million comes from renewable sources
What’s New at Deer Island
New Cross-Harbor Power Cable Installed and In Use
• Cross Harbor Electrical Cable
  (primary power)
• Fuel Oil
  (CTGs as backup power)
• Digester Gas from sludge
  (combined heat & power)
• Hydro
• Wind
• Solar
Energy Generation Equipment

Combustion Turbine Generators

Steam Boilers
Energy Generation Equipment

Back Pressure Steam Turbine Generator

Steam Turbine Generator
Existing On Site/Thermal Power Plant Schematic

Existing CHP electrical efficiency - 10%

Biogas Treatment → Biogas Booster Blowers → Gas Storage → Digesters

Exhaust → Boiler → Steam → Steam Turbine Generator (STG) → Steam to Hot Water

BP STG → Deaerator → Condensate

Boiler Feed Water

Plant Hot Water Loop

HW → HW Return
• Digester gas meets 95% of the plant’s thermal demand

• Produce 64% of thermal and electricity demand with renewable energy

• Produce 27% of electricity with renewable energy
Combined Heat and Power Study Underway: Black & Veatch

• Existing equipment is nearing end of useful life
• Increased energy efficiency (newer technology)
• Potential energy cost savings
• Plan for Deer Island’s energy supply future
MWRA Pelletizing Plant, Quincy

• Located in Fore River Shipyard

• Designed, constructed and owned by MWRA
  – Total cost - $133 million

• 15-year contract was extended by 5 years to 2021

• New contract to be bid next year
Contract Operations and Maintenance Since 1991

- Responsible for developing markets for pellets
  - Land Application
  - Fertilizer Blenders
  - Alternate Fuels
  - Bay State Fertilizer Program

- Maintain Facility and Equipment
  - Returning fully operable plant at the end of contract

MWRA Pellet Distribution - 2018

- Massachusetts, 27%
- Maine, 25%
- New York, 22%
- Virginia, 4%
- South Carolina, 3%
- Ohio, 3%
- Georgia, 1%
- Florida, 1%
- Vermont, 7%
- Connecticut, 4%
- Rhode Island, 1%
- Other, 1%
- Other, 1%
What Does the Future Hold?

- Nitrogen / Phosphorus
- PFAS
- Microplastics
- New NPDES Permit
Moderated Discussion

Fred Laskey
Executive Director, MWRA

Moderator: Catherine Finneran
Vice President, Eversource Energy