

To: Participants in Nor'easter Big Papi Functional Exercise
From: Resilient Mystic Collaborative Lower Mystic project team
Date: April 2021
Re: Vetted Findings of Lower Mystic Critical Infrastructure Exercise

EXECUTIVE SUMMARY

On October 26, 28, and 30, 2020, the Resilient Mystic Collaborative (RMC) hosted the "Nor'easter Big Papi" critical infrastructure virtual tabletop exercise involving 13 critical infrastructure agencies operating in the Lower Mystic Watershed region, six municipalities, state and federal emergency response agencies, and community organizations. The exercise was designed around a 2050 1% annual exceedance probability winter nor'easter storm with the following FEMA Core Capabilities and objectives:

FEMA Core Capabilities¹

- Risk and Disaster Resilience Assessment
- Long-Term Vulnerability Reduction
- Situational Assessment
- Community Resilience

Exercise Objectives:

- 1) Identify points of failure among Lower Mystic region critical infrastructure due to a severe weather event, including cascading impacts and recovery times.
- 2) Identify impacts of Lower Mystic region critical infrastructure failures on the business continuity of critical infrastructure operations and greater Boston residents' reliance on critical infrastructure.
- 3) Determine points of coordination and necessary data elements for information sharing before, during, and after a severe weather event to enable critical infrastructure to make informed decisions that support their agencies' and community's resilience.

The key regional issues and interdependencies highlighted through this exercise were the following:

- Power and flood vulnerabilities of the Amelia Earhart Dam
- Roadway access, in general, and flood vulnerability of MassDOT tunnel system, specifically
- Widespread reliance on emergency generators
- Environmental contamination potential of Chelsea Creek fuel terminals
- Flood vulnerability of MBTA routes and time to replace damaged assets
- Access to medical care during and immediately after a major event
- Water Management
- Communication with MEMA as a central point of information and coordination

The following memo provides more detail on each of these priority regional issues as well as more detailed notes from each of the participating organizations, included as an Appendix. Each of the participating facilities, MEMA, and DHS staff reviewed these findings to ensure they do not include security sensitive information.

¹ FEMA Mission Areas and Core Capabilities: <https://www.fema.gov/emergency-managers/national-preparedness/mission-core-capabilities>

BACKGROUND

On October 26, 28, and 30, 2020, the Resilient Mystic Collaborative (RMC) hosted the “Nor’easter Big Papi” critical infrastructure virtual tabletop exercise involving 13 critical infrastructure agencies operating in the Lower Mystic Watershed region, six municipalities, state and federal emergency response agencies, and community organizations. The exercise took place within the context of the larger RMC Lower Mystic Vulnerability Assessment which includes conducting infrastructure and social vulnerability assessments in order to identify regional priorities for storm hardening infrastructure in the region. At the direction of the exercise planning team, the exercise was designed around a 2050 1% annual exceedance probability winter nor’easter storm with the following FEMA Core Capabilities and objectives:

FEMA Core Capabilities²

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- 3) Determine points of coordination and necessary data elements for information sharing before, during, and after a severe weather event to enable critical infrastructure to make informed decisions that support their agencies’ and community’s resilience.
- 4) Identify and/or validate, if existing, worker support provisions in critical infrastructure emergency plans and greater Boston residents’ reliance on critical infrastructure.

The remainder of this memo is divided into two sections. The first is an analysis of potential issues that could be considered or further explored for inclusion on a list of regional priorities for storm hardening infrastructure. This information has not been verified but rather comes from the comments and notes of exercise participants. The second is a list of vulnerabilities, interdependencies, thresholds, and similar information recorded in exercise facilitator notes that may be useful for future planning activities of the Resilient Mystic Collaborative. The exercise situation manual as well as the facilitator notes and daily briefing memos developed during the exercise can provide additional detail to support this memo.

ISSUES TO CONSIDER OR FURTHER EXPLORE FOR REGIONAL PROJECTS

Issue: Power and flood vulnerabilities of the Amelia Earhart Dam

Community Lifelines: Transportation, Energy

FEMA Core Capabilities: Risk and Disaster Resilience Assessment, Long-term Vulnerability Reduction

The exercise scenario included overtopping the Amelia Earhart Dam (AED) and resulting structural damage that would cause the hydraulic lock system to fail. Mass DCR participants also shared that given the scenario, the dam would be flanked, experience power loss, and be vulnerable to downstream water flow. A mechanical backup system would

² FEMA Mission Areas and Core Capabilities: <https://www.fema.gov/emergency-managers/national-preparedness/mission-core-capabilities>

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allow DCR to close the locks manually. Pumps on emergency power would allow staff to lower the basin level. Upstream flooding associated with failure of the AED includes MBTA Orange Line/Assembly Row, and parts of Malden, Everett, Somerville (especially Rt. 38) and Medford.

Details:

- Mass DCR is currently conducting a Climate Change Vulnerability Analysis and storm hardening initiative. Will not raise height of dam but will ensure it is not damaged when overtopped to support quick recovery.
- Only 48 hours of fuel storage capacity at AED; would require fuel delivery mid-storm to maintain heat for onsite personnel and operation of pumps to lower basin level. However, flooding along Route 16 would threaten fuel deliveries to AED.
- If the switch gear in the locks were impacted, the pump station could still operate using the emergency generator.

Issue: Roadway access, in general, and flood vulnerability of MassDOT tunnel system, specifically

Community Lifelines: Transportation, Energy, Safety and Security

FEMA Core Capabilities: Risk and Disaster Resilience Assessment, Long-term Vulnerability Reduction

Roadway access was identified by several infrastructure agencies as a priority during the storm to complete fuel deliveries for emergency generators and during recovery to allow access for essential workers and to resume normal economic activity. Several MassDOT tunnels serving the Lower Mystic region experienced flooding under the exercise scenario. Further, the estimated recovery timeline of the tunnels was long. Based on MassDOT staff and exercise participants with experience from Hurricane Sandy, it was estimated that anywhere from six weeks to three months would be required to pump and meet basic safety requirements to reopen the tunnels. Full effort to return the tunnels to state of good repair could take two or more years and would require periodic closures to complete. Some participants felt that prioritization of roadway/tunnel repair after a disaster should be directed by the Governor given the variety of stakeholders. Participants noted that installation of flood doors would mitigate tunnel flooding, but funding would need to be prioritized for this effort.

Details:

- Callahan Tunnel – floods from East Boston toll booth into pump room, closure would impact emergency services (e.g., fire) from reaching Logan Airport.
- Tip O’Neill Tunnel – floods from Aquarium shared egress tunnel; this connects to many other tunnels.
- Sumner & Callahan Tunnels are evacuation routes, do not have emergency generators.
- Route 1A, Route 16, and Seaport Boulevard would flood and impact several infrastructure organizations including access to fuel terminals and power substations.
- Flooded roads prevent access to MWRA Chelsea Screen House to refuel generators.
- Without electricity to vent rooms, air vents stop functioning and the tunnels must close.
- During recovery, standing water or road damage would prevent truck access and transfer of materials from ships in the port.
- Closed roads prevent access for MBTA personnel to inspect assets and clear them to resume service, compounding the region’s transportation challenges post-disaster.

Issue: Widespread reliance on emergency generators

Community Lifelines: All

FEMA Core Capabilities: Risk and Disaster Resilience Assessment, Long-term Vulnerability Reduction

Nearly all critical infrastructure organizations referenced rely on emergency generators to support life safety systems,

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at minimum, or support a higher level of sustained operations during a grid outage. Three issues threaten resupply of generator fuel: 1) flooding at fuel terminal prevents distribution, 2) street flooding around fuel terminals prevents delivery truck entry/exit, and 3) uncertainty around priority customers to receive resupply when available.

The scenario shows that several terminals will be open and able to distribute fuel supplies. Supply is unlikely to be an issue given the limited amount of fuel required to run the generators and supplies available throughout the Boston terminal network. The main vulnerability is sufficient road access to the generator locations. Prioritization may aid with logistics and help to ensure critical delivery routes can remain open.

Energy organizations noted some priority customers such as the Mass Pike gas stations and Logan Airport, assuming MEMA would assist with prioritization to customers if provided with a list of specific recommendations. Some participating organizations talked about planning fuel deliveries during low-tide intervals as well as increasing on-site fuel storage for emergency generators; however, more fuel storage requires proper maintenance, so fuel doesn't go bad. Facilities also need to ensure that generators are in good repair with spare parts and non-fuel fluids (e.g., oil) on hand.

Details:

- Energy Transfer would need to bring in additional generators in advance of storm to ensure continuous operation of pipeline that provides fuel from Energy Transfer to Logan Airport.
- Mass DCR (Amelia Earhart Dam) could not be refueled due to Route 16 flooding.
- Gulf Oil tanker rack would flood under this storm scenario and can't supply product (recovery time not given); however, South Portland and New Haven could assume Chelsea's product load for months.
- Global Companies' Revere terminal islanded by Route 1A flooding though equipment is elevated above flood waters. (Chelsea facility remains operational under scenario and is not impacted by AED failure).
- Hospitals in the Mass General Brigham (MGB) system have fuel for four days but would require resupply to prevent significant impacts to facilities, staff, and patients, including the need for evacuations. MGB needs to have an established process for resupply and prioritization as critical infrastructure.
- MWRA identified itself as a top priority for fuel deliveries to maintain drinking water and wastewater services.
- New requests for fuel (e.g., from cell tower operators, National Guard) may be received. These would need to be integrated into existing prioritization.
- MEMA does not maintain a regional priority list. The State Emergency Operations Center (SEOC) could prioritize customers with input from DPU & DPH. Life safety would be first priority, including hospitals and nursing homes.

Issue: Environmental contamination potential of Chelsea Creek fuel terminals

Community Lifelines: Hazardous Material, Energy, Health & Medical

FEMA Core Capabilities: Risk and Disaster Resilience Assessment, Long-term Vulnerability Reduction, Community Resilience, Situational Assessment

For the purposes of the exercise, the scenario included a fuel spill originating at one of the Chelsea Creek fuel terminals. **Please note that oil storage assets at the terminal would not actually be flooded or pose a significant vulnerability under the projected 2050 1% storm characteristics used in this exercise scenario.** Diking systems are in place and are designed to protect the bulk oil storage tanks for flood levels many feet above the levels in the scenario.

The participating fuel terminals (Energy Transfer, Gulf Oil, Global Companies) all participate in the Chelsea Creek Co-Op and share response equipment and clean up responsibilities. They discussed robust plans to assess and address a spill. However, it was clear that weather conditions would not allow an effective spill response until the storm passed.

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In the scenario, the unattended spill spread overland with each tide cycle contaminating neighborhoods. Terminal representatives indicated that leaks could originate from damage to the tank roof, hull, or floor. Pump seals could also fail if submerged or frozen and cracked. Tank repair could take hours to weeks depending on the specific issue.

Terminals are required under federal law to implement Spill Prevention Containment and Countermeasure Plans (SPCC) and Facility Response Plans to prevent and respond to spills. It may be worthwhile to further explore vulnerabilities of the terminals/tanks to projected storm surge, temperature and wind extremes and solutions to mitigate the potential for environmental contamination in a severe weather event. The exercise did not explore the public health response to the contamination, since the agencies responsible for this work were not participating in the exercise.

Details:

- Only under hurricane-force winds would workers be prevented from assessing tanks for leaks.
- Wave action could render containment booms ineffective.
- Global Oil has steel and/or earthen dikes around tanks to contain product if there is a leak (Chelsea – 20 ft, Revere – 8-10 ft).
- MWRA was concerned about contaminated water (from individual homes and the jet fuel leak) entering the sewer and stormwater systems and the potential for explosions. There are controls in place to prevent explosions but need to maintain awareness and monitoring.
- BWSC was concerned about contamination of facilities and the need to clean facilities impacted by spill. Petroleum has a 10-year contamination lifespan.

Issue: Flood vulnerability of MBTA routes and time to replace damaged assets

Community Lifelines: Transportation

FEMA Core Capabilities: Risk and Disaster Resilience Assessment, Long-term Vulnerability Reduction, Community Resilience

Central to the MBTA's discussion was the importance of protecting most assets (e.g., by moving to higher ground and away from fallen trees) while running some level of service for essential workers during the storm event. The definition of essential workers wasn't explicitly explored, though MBTA stated they would look to the Governor for direction. It is important that the idea of essential workers is broad enough to capture all essential workers, not just those who have traditionally been recognized such as doctors and nurses. DHS CISA has published a non-binding [Guidance on Essential Critical Infrastructure Workers](#) that elaborates on this issue.

MBTA personnel commented that early implementation of a Governor-issued travel ban allows them to execute on this strategy. At the height of the storm, it is likely that all MBTA service would be shut-down with the goal to recover as quickly as possible.

Bus service could be resumed fastest provided it has fuel and facilities. Bus service is also flexible and temporary routes could operate depending on the region's recovery needs. MBTA buses include diesel, compressed natural gas, overhead catenary wires, and hybrid vehicles. Compressed natural gas (CNS) buses can only be fueled at specific sites, catenary wires could come down in a storm, Silver Line double-long buses slip on ice and aren't run in bad weather.

To resume train service, everything needs to be inspected (all track, all components, check for erosion under bridges, etc.) and all water needs to be pumped out of tunnels. Challenges to recovery include: corrosive saltwater affecting signals and power assets, damage from fallen trees, time and travel access for inspectors, time to pump out assets given available equipment, and time to replace damaged parts. Many MBTA parts are not "off-the-shelf" and have an average lead time of four to six months with some taking more than a year. These lead times could be lengthened

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given higher than usual demand by MBTA and other affected organizations. It is expected that temporary repairs would occur first followed by permanent repairs later on.

Details:

- Expect flooding at:
 - Subway & Commuter Rail: Orange line, Blue line, portions of Cabot yard, Silver Line 5, Newburyport/Rockport Commuter Rail, main line through Back Bay
 - North Station and South Station impacts: might strand non-residents in the city
 - Maintenance facilities: Cobble Hill, Everett, Orient Heights – generators only a couple feet off the ground
 - Bus Service: Lynn bus garage, Medford and Charlestown are questionable. Could retreat to Square One Mall. Bus Facility Modernization efforts include decreasing risk of flood damage and bus electrification.
 - Communications/Operations: 45 High Street central operations, dispatch, service planning.
- Might be able to use Fairmont and Old Colony for evacuation to Worcester and Middleborough.
- Expect that a significant amount of signal and electrical equipment would need to be replaced, taking months. Storing extra equipment is a challenge given sensitivity of assets. Not realistic to expect stored assets would function properly after long storage time.
- MBTA has some workarounds to provide reduced/modified service if switches, signals and other equipment are damaged and not operational.
- Electric buses cannot go nearly as far on a charge as diesel buses; if the grid is down in a storm event, these buses are stranded after they run out of charge.
- Communications network (> 20 radio frequencies) is extensive and complicated. Some parts have emergency generator backup but not all. Maintaining control of the signal system is most important. Some of this is in the process of being evaluated around current and projected flood risks.
- MBTA has robust plans for snow & ice, hurricanes, and heavy rain operations with specific triggers and corresponding actions. They are already aligned with MEMA ESF 1 Desk Notifications, which go out to all Infrastructure Managers; it would be good to review this coordination with the MBTA Security & Emergency Management Department.
- MBTA did not specifically mention other essential workers not labeled “first responders” such as hospital food service staff and others. It is important that we define “first responders” broadly in order to develop accurate considerations on where to provide service.

Issue: Access to medical care during and immediately after a major event

Community Lifelines: Health & Medical, Transportation

FEMA Core Capabilities: Long-term Vulnerability Reduction, Community Resilience

Mass General Brigham (MGB) community health centers in Chelsea and Revere would be impacted by flooding. Chelsea would experience flooding at the building, Revere might experience flooding at the building and would definitely be islanded by street flooding. Facilities in the Charlestown Navy Yard, including Spaulding Rehabilitation Hospital and key biomedical research facilities would also be affected. Emergency generators could run for four days with fuel on hand, but facilities could require evacuation or other emergency measures if fuel deliveries didn't occur. Water damage to specialized equipment and spaces would require months for full repair; however, phased reopening is possible beginning with use of upper levels of facilities while lower level repairs continue. Urgent care services would be first priority to restore at the community health centers.

MBTA assets in the same areas would be flooded, further challenging access for patients and staff to these facilities,

though buses could operate temporarily while trains are down. While individual building flood protection could be pursued, regional flood mitigation solutions might protect the medical facilities, transportation, and client homes in the surrounding areas. In the exercise “interdependencies” discussion, participants discussed making community health centers “resilience hubs” that could serve community health and more. There was some skepticism though, as municipalities note that people often don’t take advantage of centralized emergency facilities. It’s important to figure out how to get services/supplies to people where they are and/or where they already go. MGB was the only healthcare organization participating in the exercise; as a result, broader impacts to the healthcare system were likely not fully captured in the discussion. A larger regional-scale exercise would ideally include BMC, Tufts, Cambridge Health Alliance and others, as well as other MGB entities located outside the Lower Mystic watershed but vulnerable to the same regional infrastructure impacts.

Details:

- Repair to flooded healthcare facilities would take months due to replacement of complex medical equipment; equipment is heavy and could not be moved ahead of storm. Mobile imaging equipment could be brought in after the storm while permanent repairs take place.
- Clinical and operational staff support during a sustained emergency event warrants further consideration, for both on-site accommodation (food, lodging) and homecare coverage (dependents, property) during an extended absence.
- MGB’s Systemwide Resiliency Study undertaken with Arup identified both site-specific and district-wide flood vulnerability protection strategies for our dispersed research, teaching and healthcare campus in the Charlestown Navy Yard. A district-wide solution would offer clear advantages in terms of efficiencies, effectiveness and community collateral protections, but would require a partnership and shared funding mechanism with the City of Boston.
- Mobile healthcare services could be temporarily positioned in communities impacted by CHC closures.
- Many clinical and facility staff and patients rely on public transit to get to medical appointments.
- Important for community health centers and other medical practices to reopen quickly so patients don’t all go to the hospital. Want to preserve hospitals for higher level of care and emergencies.
- MGB community health centers are in leased facilities and therefore require significant coordination to flood proof. CHCs are also located in areas of greatest need. Age, condition, and non-ownership of these critical facilities is a serious constraint on the capital investment needed to upgrade for enhanced resilience and sustained access. This may require a public-private partnership for a regional flood protection solution.

Issue: Water Management

Community Lifelines: Food, Water, & Shelter, Transportation

FEMA Core Capabilities:

One participant commented: “It’s not always about keeping areas dry, it’s about managing the water.” MWRA, for example, manages stormwater damage with stop logs and gates to protect critical equipment and allow full functionality after the storm passes, but noted that it still takes weeks to fully recover after flooding.

A significant issue that came up for multiple facilities is the lack of functional tide gates on the ocean side of stormwater drains. Missing or corroded tide gates allow large volumes of seawater to back up stormwater systems during flood events, causing roads and buildings to flood, as well as to trigger combined sewer overflows. Many such outfalls are privately owned, sometimes by unknown entities. Without functioning tide gates, coastal flood barriers are ineffective. The group interdependency discussion included the potential for MWRA to serve as a regional manager to help communities manage floodwaters throughout the system.

Details:

- Tide gates at MBTA Aquarium can be problematic for MassDOT tunnels if not closed.
- Revere tide gate facility on the Town Line Brook causes flooding in Malden and Everett. Gates are inoperable.
- Lack of a functioning tide gate at the Island End River causes major flooding at the New England Produce Center.

Issue: Communication with MEMA as a central point of information and coordination

Community Lifelines: All

FEMA Core Capabilities: Situational Assessment, Community Resilience

MEMA's role as a source of information and coordinating prioritization of limited resources was recognized by many. Despite the challenges presented by Nor'easter Big Papi, most critical infrastructure organizations continued to have resources to offer to the larger regional response. This ranged from where to distribute available fuel, how to best utilize large workforces, where to direct transportation assets, and more. However, backup emergency communication systems/equipment varied between organizations. Many have satellite phones but not everyone. Several have interoperable radio communications with key partners or sister facilities. Some rely on landline and cell phones only, though have recently started using apps such as WhatsApp and Facebook messenger with success during emergencies.

It was not clear whether all infrastructure managers (via their chains of command, such as the local emergency management departments) would be able to connect with MEMA and other necessary partners if internet and cellular communications were impacted. Having a standardized backup communications system (e.g., Satellite phones) would require a commitment to the training, capital investments, and/or equipment maintenance needed to ensure that the backup works effectively during emergencies. Some participants had concerns re: security and reliability of using social media networks during emergencies.

Details:

- Several networks and sources for maintaining situational awareness were named, including the MEMA State Emergency Operations Center, National Weather Service, MA State Police, MA DOER Regional Winter Fuels Communication Network, and the US Coast Guard.
 - Of note, MWRA, Eversource, and National Grid need to communicate directly with all municipalities in the region. The importance of maintaining these direct connections in addressing problems and restoring service was emphasized.
- Mass General Brigham emphasized the importance of good and early information. Long lead times (24 hrs.+) are required to make decisions, such as evacuations. Moving critically ill patients can be dangerous and requires significant resources and personnel to transport one patient.
- MBTA's 1,200 buses could be redeployed from scheduled routes (requires State order) to transport non-critically ill patients and staff. Need information from MEMA, MDPH, and/or Boston Medical Intelligence Center on how to help. Large workforce could also be redeployed to support recovery.
- MWRA dump trucks, construction equipment, and pumps could be redeployed at MEMA's direction.
- Fuel terminals expect new, emergency customers (e.g., cell tower operators). Would require direction from MEMA on where to prioritize fuel deliveries especially to new customers. Would also request information on which gas stations have backup power and can be operational to prioritize delivery there.
- MEMA could work with communications companies (ATT & Verizon) to assist in getting critical communications systems set up via portable cell towers or two-way radios.

ADDITIONAL OBSERVATIONS, VULNERABILITIES, INTERDEPENDENCIES, AND THRESHOLDS

Preparedness

- Almost all organizations that participated have very strong preparedness plans and were able to clearly communicate how they would mobilize in advance of the storm.
- Things got a bit less certain as we moved into the actual storm impacts and recovery efforts.
- Regional coordination is needed around key flood thresholds that trigger putting emergency preparedness measures in place.

Regional recovery

- Top infrastructure priorities: transportation, energy (grid power and fuel deliveries for generators), and communications
 - Maintaining energy supplies (electricity and fuel) is dependent upon transportation – need clear roads to bring in emergency restoration crews and to reach impacted assets to repair them. While power grid is being repaired, need clear roads to make deliveries to fuel emergency generators.
- Personnel: Many support staff come from underserved communities/geographically flood-prone neighborhoods.
- Communications: clear and early communication is essential for everyone. Most organizations rely on MEMA and National Weather Service to communicate closures, evacuations, severity of storm.
 - Coordinated communications strategy is essential in all phases of storm – before, during, immediate response, and long-term recovery.
 - Most participants suggested that MEMA should be the one to own this regional coordination.
- External vendors and contractors: There was a lot of discussion on the need for skilled mechanical and electrical contractors, inspectors for MBTA and energy companies, local public health and building inspectors, fuel delivery suppliers, and others. Need to consider better regional coordination, information-sharing, and prioritization around these common contractors so that there is a clear regional strategy for deployment, which will allow for faster/more coordinated recovery efforts and also allow facilities that are lower on the priority list to make alternative plans if they are not likely to get serviced immediately following the storm.
 - This discussion also extends to pre-storm preparations for fuel deliveries, mobile generators, mobile pumps, etc.
 - Another critical need: “before” photos taken prior to storms and early activation of insurance adjusters and inspectors to document the damage before work is done to restore damaged facilities.

Snow disposal

- Prompt snow removal is critical for fuel deliveries to resume, for emergency personnel to get to/from work, and to provide access to utility repair crews.

Staff emergency support

- Plans, facilities, and supplies to support staff on-site for multiple days varied among critical infrastructure organizations. Some organizations lacked adequate sleeping spaces and stated they would rely on nearby hotels. Others, including Mass DCR (Amelia Earhart Dam), expressed concern that generators (or another power source) may be needed to provide heat for onsite emergency staff and lack of fuel deliveries could limit ability to maintain staff safety. Some organizations had food for on-site personnel for 1-2 days but not enough for the full time they expected to be cut-off from normal services.
- Follow up emergency planning support/peer-to-peer sharing of best practices would help.

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- Several participants discussed university dormitories and cruise ships as a solution to emergency personnel housing; MGB also suggested that universities could help with providing lab space for critical research that needs to be relocated out of flood-prone areas.
- Staff support discussion focused primarily on emergency personnel working and staying onsite. Need more exploration of the needs of staff and their families related to closure of schools and other community services or loss of housing or other personal property.
- Emergency information outreach should be expanded to non-English speaking media (e.g., Spanish-language radio).

Coordination with private landowners

- MBTA noted that it would be helpful to have partnerships with malls or other large landowners where buses and other vehicles could be stored to remove them from flood-prone areas.
- MassDOT noted that an emergency fueling station was set up at Home Depot after the Boston Marathon bombings – this sort of coordination and identification of key partners should be considered.

Additional stakeholders to bring to the table:

- ISO NE, universities, telecommunications providers – Verizon, cell tower and radio system operators, State Police, National Guard, BOSFuel (for Logan), public health agencies, DPU, coordination for key outside vendors that most facilities are relying on – pumps, mobile generators, electrical/mechanical contractors, key private landowners who could support, Boston Line (deploys boom)
- MEMA was observing/in the SimCell, but should be a player at the table next time
- Natural gas intake distribution centers (did not participate in exercise; ID need to engage)
 - Kinder Morgan, Algonquin, Tennessee Gas, Exelon do not appear to be affected by flooding
- New England Produce Center (NEPC) did not participate in the exercise, but participants familiar with the facility helped to identify critical impacts, and it appears the facility is extremely vulnerable. The entire site, including loading docks and buildings, is likely to be flooded; produce will be lost; truck-mounted generators and cooling trailers are likely flooded; mechanical, electrical, sewage, and phones are also likely to be down. Polluted flood waters from the oil spill would also reach the NEPC facility.
 - Food for emergency workers was highlighted often and long-term impacts of food supply to the region are a concern. Need to follow-up with NEPC and try to engage them more in this conversation.
- Consider expanding discussion to Greater Boston Metro Region and associated stakeholders, not just Lower Mystic; interdependencies stretch far beyond the boundaries of participants' constituencies. We should:
 - Highlight where possible those items we think are universal / systemic throughout the region; and those items we think are particular to this place.
 - Replicate this exercise in other sub-regions of Greater Boston building into a pan-regional workshop to address those items that participants have indicated are universal and systemic throughout the region and beyond.

APPENDIX: ADDITIONAL FACILITY-SPECIFIC OBSERVATIONS

MassDOT

- Ventilation system is required to operate tunnels. Power loss to ventilation, regardless of flood status, would require MassDOT to close tunnels. There are emergency generators for the Tip O’Neill and Sullivan Tunnels. There are no generators for the Callahan and Sumner Tunnels.
- Callahan, Tip O’Neill, and Sumner tunnels all likely to be closed for months if impacted by flooding; repairs could take more than two years for full operational recovery.
- Tobin Bridge needs to close with the 75mph winds given in the scenario; coordinate closure with the US Coast Guard
- MassDOT relies on communications services provided by Verizon – outage would disrupt communication with MEMA, MassDOT Headquarters, Districts, Municipalities, and Equipment Operators. Need for improved regional communications strategy.
- Street flooding would require MassDOT to move to backup highway operations center location.
- Biggest impacts: tunnel closures, road/highway erosion, physical/psychological long-term impacts on personnel.

Massport

- 35 mph winds shut down Conley (Fish Pier can remain open longer).
- Flood barriers installed at Conley and Fish Pier – lowest elevation of Massport assets.
- 15 ft. MLLW flood elevation is the trigger for flood operations protocols at Logan (13 ft MLLW for maritime assets; 14.5 ft MLLW is the threshold for damage to maritime assets).
- 90 mph is threshold for mandatory closing of airport/tower; flights would be diverted.
- First tier critical infrastructure and first responder assets are wet/dry flood proofed or able to be moved to higher ground if portable. Expect to recover these assets within 24 hours of storm passing. Second tier assets use Aquafence.
- Logan has onsite tanks with 3-days of jet-fuel supply. This would last longer if airport traffic is reduced or suspended.
- Recovery delays: closure of tunnels, roadway closures around ports, shortage of skilled electricians, mechanical and communications technicians.

MBTA

- Important to pump and dry out the system before it freezes.
- Need to construct a total of 10 miles of designated elevated track (not all in one place) to be able to move all trains out of harm’s way in case of a major flood event. Ensure trains are away from potentially falling trees.
- Increased reliance on bus service while rapid transit and light rail are repaired puts extra burden on bus service staff who are likely to have family members in shelters or otherwise personally affected; Will have to contract with private bus companies, as MBTA cannot replace all subways with existing buses.
- Many people use MBTA trains, buses, stations as shelter (warmth, restrooms). Storm scenario required closure/evacuation of these places meaning vulnerable people are left without these services. Need to coordinate with direct service providers.
- MBTA is reliant on Eversource’s 115kV lines that feed South Boston interconnection point and power the entire system – this would be key to protect if we want public transportation to get up and running quickly
- 45 High Street near South Station is likely to be evacuated - this is a major Operations Control Center that includes bus and subway dispatch and other critical parts of system. Ensuring that the backup OCC is operable and can communicate with decentralized bus and subway facilities is key.

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- Recovery priorities: getting water out of tunnels, updating old equipment that was not water resistant, getting more "off-the-shelf" products to speed up repairs

MWRA & BWSC

- Do not anticipate loss of drinking water service and fire protection – main challenges are wastewater backups and basement flooding. Backflow preventers keeps water from running from surcharged sewer back into building; if basements flood with stormwater (through windows, bulkheads, leaks), homeowners will often open cleanouts to allow it to go into the sanitary sewer, potentially adding to system capacity issues.
- Generally, pump stations would automatically go to back up power if they lose utility power. Deer Island goes to parallel use of on-site power in major storms to prevent the need for a black start of the plant if/when the grid goes down.
- Need to coordinate with Public Works on clearing catch basins.
- May need to open sanitary sewer overflows. Once open, would need to stay open throughout storm. In a major storm, we'd have to assume that flooded areas and near-shore ocean waters are contaminated regardless of whether communities allow additional drainage into sanitary sewers. Solution is to keep ALL clean water out of sanitary sewers, and to prevent any manholes from being opened to drain streets. Hard to ensure in an emergency and potentially not warranted, as tradeoff of local vs. distant environmental impacts comes into play.
- Clear roads and fuel deliveries are most important for recovery, which is estimated to take days, not weeks, once transportation and power are reestablished.
- Expect lots of residential flooded basements.
- If too much saltwater gets into the water treatment system at Deer Island, it could disrupt nitrogen cycle balance. The natural/biological secondary treatment cycle would be interrupted and take 1-2 months to recover. MWRA doesn't have a clear benchmark yet for this. Avoiding long term disruption would likely involve short term tradeoffs such as bypassing secondary treatment while salt levels were elevated. If that happened, the wastewater would be very diluted; it might be more of a regulatory issue than significant environmental concern.
- MWRA
 - Chelsea Admin building protected to 13.3 ft. NAVD88
 - Maintenance building protected to 14 ft. NAVD88
 - Screen House protected to 12.6 ft. NAVD88, but flooding around screen house prevents access; if facility loses power, staff would need to manually rake screens to keep solids (e.g. sticks, leaves, and other larger items) from entering the downstream system to protect the pumps and other equipment. Normally there is a powered system which periodically clears the material off the screen and moves it to a dumpster. Without power, the raking is done manually by staff.
 - Deer Island – extensive prior efforts to ensure this facility never goes offline; wastewater should continue to be able to move through here; treatment may not be as effective; ~1 month of fuel on-site
- BWSC
 - Alford Street Facility would take in significant water.

Mass General Brigham

- At risk of flooding: Spaulding Rehab Hospital, Charlestown Navy Yard research facilities, Assembly Row office building, and community health centers in Charlestown, Everett, Revere, and Chelsea – Chelsea facility flooded and likely closed for several months, whereas Revere and Everett may be safe from direct impacts but would be flooded around the facility
- Spaulding Rehab

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- Underground fuel storage tank and oxygen tanks at ground level impacted by > 1 ft of water
- Cafeteria on ground floor would be flooded; able to provide cold meals temporarily
- High winds present a significant threat to roofs and critical equipment on roofs (MGB is designing to Miami-Dade wind standards more often because of this)
- Much energy and attention is being focused right now on mobile, temporary healthcare facilities provision during the COVID surge. This work could be leveraged to develop mobile community healthcare service delivery strategies for other types of emergencies.
- Hospitals generally do a good job planning for staffing and staff accommodations during severe weather
- People on dialysis, where do they get services? Seven days post-power outage, will start to see major health impacts.
- There would be cascading impacts from long term power losses for those patients receiving treatments at home, and further concern for those patients during an outage when there are also limited transportation options. The Boston Medical Intelligence Center could help us understand these concerns and how to address them as part of the greater community impact.
- Concern about public health implications of sanitary sewer overflow, jet fuel leak, and flooding over multiple tidal cycles. Future exercises might also consider public health implications of other climate change-related events: extreme heat, drought, cloudbursts, food insecurity and pandemics.

Power Grid (National Grid, Eversource)

- #1 priority in recovery is the ability to get to impacted assets; flooded roads, downed trees, snow removal, and other obstructions delay access
- Mobilize contractors for response in advance of storm
- National Grid
 - Flood walls/gates around all substations within 100-year floodplain. If specific substation is at risk, have alternatives to serve customers. Some substations would be flooded by 2050 1% storm (did not indicate which substations or whether the flood protection was effective).
 - Power loss due to downed wires and poles from trees/ice and would take 1 week to recover
 - Crews cannot repair lines if winds over 35 mph
 - Dependencies – ferries to Martha’s Vineyard and Nantucket to send emergency crews, road closures prevent access, hotels to house 600-1000 out of town workers, Verizon for phones/internet, snow removal
 - Grocery stores not usually on priority list but could be with MEMA’s direction
 - Call Center is critical, but staff need power/internet to be able to work from home
 - Rely on liaison from each community to help direct restoration. System has been in place since 2012 and works well.
 - If basements and other areas are significantly flooded, will have to de-energize those areas to ensure public safety; cannot re-energize until every flooded location in a specific grid is inspected and confirmed okay to re-energize
 - Potential solutions: running new types of cables (e.g. Hedrix cables which are more resilient and expensive, in areas with lots of trees)
- Eversource
 - Concern for substation at Seafood Way & Fid Kennedy Ave, around Red Line, and Eversource Headquarters; current strategy involves sandbagging, with others possible depending on the facility and severity of the storm event.
 - Would require switching to back end power (supplying power from a two-way feed), and warning customers of potential outage. Recovery would span several months.
 - This is a critical asset for the MBTA system as well.

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- Triggers for preparing for outages: combination of winds over 40 mph, wet snow, and/or ice accumulation
- Estimate 150,000 customers would experience outages given scenario – downed wires will take 2-3 weeks to repair
 - Some areas may be serviced by a dual feed and could get service from a backup asset
- Gas lines usually not impacted by coastal inundation (it is a low pressure system with some potential to cause pressure changes/gaps)
- Goal is to maintain service by switching sources and backfeeding; they warn customers if possible to prepare to use backup generation if service levels drop (i.e., electrical capacity goes below designated levels) or are cancelled.
- Rely heavily on weather services (NWS, Storm GEO, DTN). They already contract with multiple service providers for this information; customized weather reports are delivered multiple times a day.
- They already coordinate with MEMA, hospitals, MBTA, and municipal emergency management directors

Fuel Terminals (Energy Transfer, Gulf Oil, Global Companies)

- Terminals often work with their competitors in times of crisis
- Regardless of other scenario components (bridges, etc.) these storm conditions would not allow vessels carrying product to access terminals
- Estimate one-week minimum to clear boats from under McArdle Bridge; then resupply could occur.
 - Worcester and Providence could supplement the jet fuel supply (Energy Transfer)
 - New Haven and South Portland could assume Gulf Oil product load for several months
 - Global Companies would typically have sufficient fuel supplies in inventory and could supplement with supply from NY, VT, and ME if roads are clear (eight terminals in New England area)
- Exxon facility in Everett and Global Oil facility in Chelsea are outside of the two bridges and would receive resupply first if there are remaining problems further up Chelsea Creek.
- If flooding were 3 feet higher, Global Oil would have more longer-term problems with buildings and transformers. However, there is still no concern for tank leaks given steel dikes that keep water out and fuel in.
- Concern about water quality under this scenario; drinking, sewage, and showers are important for emergency personnel health and morale.
- Concern for water pressure if major firefighting efforts are occurring in nearby areas.
- Backup generators power safety devices on tanks and pipelines, heat, water, and emergency fire suppression systems. Generators can run indefinitely given fuel on hand.

OTHER PARTICIPANT COMMENTS

- Academic input into this process would be ideal. These kinds of big questions could be an opportunity to spin off some research and gain from lessons learned from Sandy and tabletops like these (e.g., URI especially interested in port resiliency).
- We support an Infrastructure Coordinating Committee. Need more buy-in from public utilities to pursue resilient solutions.
- [Power utilities] are really seeing the effects of climate change and responding to them. Never saw storms like this years ago.
- We're puzzled by talking about individual protective actions rather than larger infrastructure projects.
- Strategic thinking and early retreat can reduce risk and speed up recovery. May shut down services preemptively to give better chance at recovery. For example, it may be important to shut down and seal off a

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pump station to prevent the pumps from being submerged and damaged. If not, it could take months of repair to get them back online depending on the damage. How to explain this to the public, though?

- Would be helpful for power companies to understand which substations and other infrastructure falls within the flood zone and have municipalities come to the table to discuss hazard mitigation plans - What are the redundancies in place? What are the potential impacts? How do we coordinate? MEMA used to have a day-long conference that brought together the utility providers with the municipalities. Request to please restart the conference, it was helpful.
- Biggest challenges to recovery: Recovering financial losses due to region wide storm impacts. These are associated with internal and external hard and soft costs. Repair of infrastructure, purchasing of new equipment otherwise compromised during the storm, shifting systems to endure damages and restore service, public health degradation, environmental hazard clean up and remediation. The biggest challenge will always be cost, which will certainly require massive amounts of federal intervention and financial programming.
- This exercise is just focused on physical impacts/infrastructure that services all populations. Being part of this exercise has shown that other sectors have more predictable impacts and outcomes in this scenario, but community impacts and outcomes are so much more unpredictable. It's good to focus on infrastructure, but also good that there will be a social resiliency exercise too.
- We need to have a hard conversation about discontinuing use of critical facilities that are inaccessible twice a day. It's so uncomfortable and uncertain, but really important to talk about. There are some parts of our cities that we won't be able to go to. We need to move them.
- This preparedness exercise demonstrates the need for coastal and adjacent communities to coordinate planning efforts to address coastal flood pathways and effect of flooding on transportation and access to resources including food and fuel, including first responder personnel.
- Another additional consideration for community support would be targeted training with the local [Community Emergency Response Teams](#). The CERT program educates volunteers about disaster preparedness which professional responders can then rely on during disaster situations, allowing them to focus on more complex tasks. It appears that Somerville has a robust program.
- I particularly agree with the call for broader coordination and the inclusion of academic input. The Global Resilience Center at Northeastern seems like it would align very succinctly with these goals.