

Climate Change Coastal Flood Vulnerability Screening
of
MBTA Commuter Rail Facilities and Parking Lots

MIT Transit Lab

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Executive Summary

The MBTA Commuter Rail system relies on over 30 main maintenance and layover facilities to ensure continuous and reliable service to the Greater Boston area and its suburbs. Over 70 parking facilities across the system help ensure riders have access to commuter rail service, facilitating automotive first and last mile trips. This report outlines the vulnerability of 33 commuter rail maintenance facilities and 77 parking facilities, based on available flood risk data (describing both present conditions and future conditions with sea level rise). We identify 4 maintenance facilities with high vulnerability to coastal flooding (Commuter Rail, Widett Service and Inspection, West Cambridge, and Salem Maintenance Facilities). We recommend additional vulnerability assessments for each of these locations at this time. Additional attention is warranted for all commuter rail locations and assets in Salem, as they are presently vulnerable to coastal and precipitation-based flooding.

We also identify 3 high vulnerability parking facilities (Salem garage, North Quincy, and Newburyport surface lots), though except for Salem garage, no additional investigation is recommended at this time. The remainder of the report provides an overview of the coastal flood risk data used in this report, the commuter rail system and facilities of interest, the vulnerability assessment ranking system, maintenance facilities grouped by vulnerability, and parking facility vulnerabilities. The flood exposure of all locations mentioned in this report can be further explored via the [MBTA Commuter Rail Flood Vulnerability Viewer](#). Note that a geoDOT account and membership in the CRaVAT group within geoDOT are required to access the viewer. Please reach out to Mike McGill (or the current geoDOT Coordinator) to obtain access.

About the Coastal Flood Risk Data

The future flood projections shown within this report derive from the Massachusetts Coastal Flood Risk Model (MC-FRM; Bosma et al., 2021). As the name implies, the MC-FRM was created for MassDOT as an extension of the Boston Harbor Flood Risk Model (BH-FRM) to assess the coastal flood risk of the entire coastline of Massachusetts. Similar to its predecessor, the MC-FRM considers dynamic shoreline processes, principally wind-induced storm surge, tidal fluctuations, wave run-up, and overtopping, resulting in a more accurate representation of coastal flood risk when compared to less sophisticated approaches (WHG et al., 2020).

It is worth repeating that the flood risk mapped by this model exclusively reflect anticipated coastal flood risk, meaning precipitation-based or drainage-based flooding is not reflected in this study. The model simulated coastal flood risk under 4 sea level rise (SLR) conditions: present day (2020), +1.2 ft SLR (possible as soon as 2030), +2.4 ft SLR (possible as soon as 2050), and +4.2 ft SLR (possible as soon as 2070). These sea level rise projections reflect an approximate upper bound of likely SLR conditions under RCP 4.5 and RCP 8.5 climate scenarios, as projected in 2017 (Bosma, 2020). Figure 1 below shows the sea level rise values used in the MC-FRM as compared to the probabilistic range of SLR projections for the aforementioned RCP scenarios, as well as those used previously in the BH-FRM.

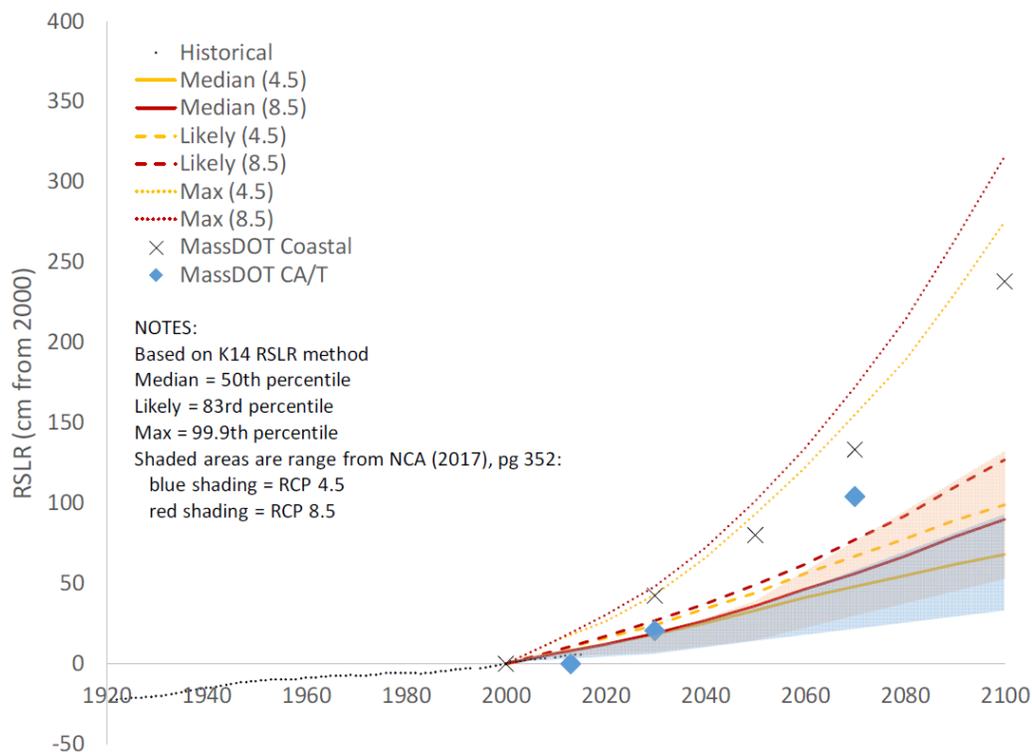


Figure 1: Sea level rise projections used in the MC-FRM compared to RCP projections (Miller, 2019)

While the coastal flood extents and flood risk data produced by the MC-FRM has a very high spatial resolution (at best 10 ft) this resolution may be insufficient in urban areas under certain circumstances. Specifically, some flood pathways that would likely arise in reality are not too small to be captured by the MC-FRM, such as the South Boston Bypass Road as show in Figure 2. Conversely, other

areas are shown to flood in the MC-FRM that in fact would not likely be flooded. For example, the bridge abutment at Wellington Yard along the Orange Line is shown to flood under MC-FRM flood projections, though is not expected to flood based on FEMA flood maps, as shown in Figure 2.

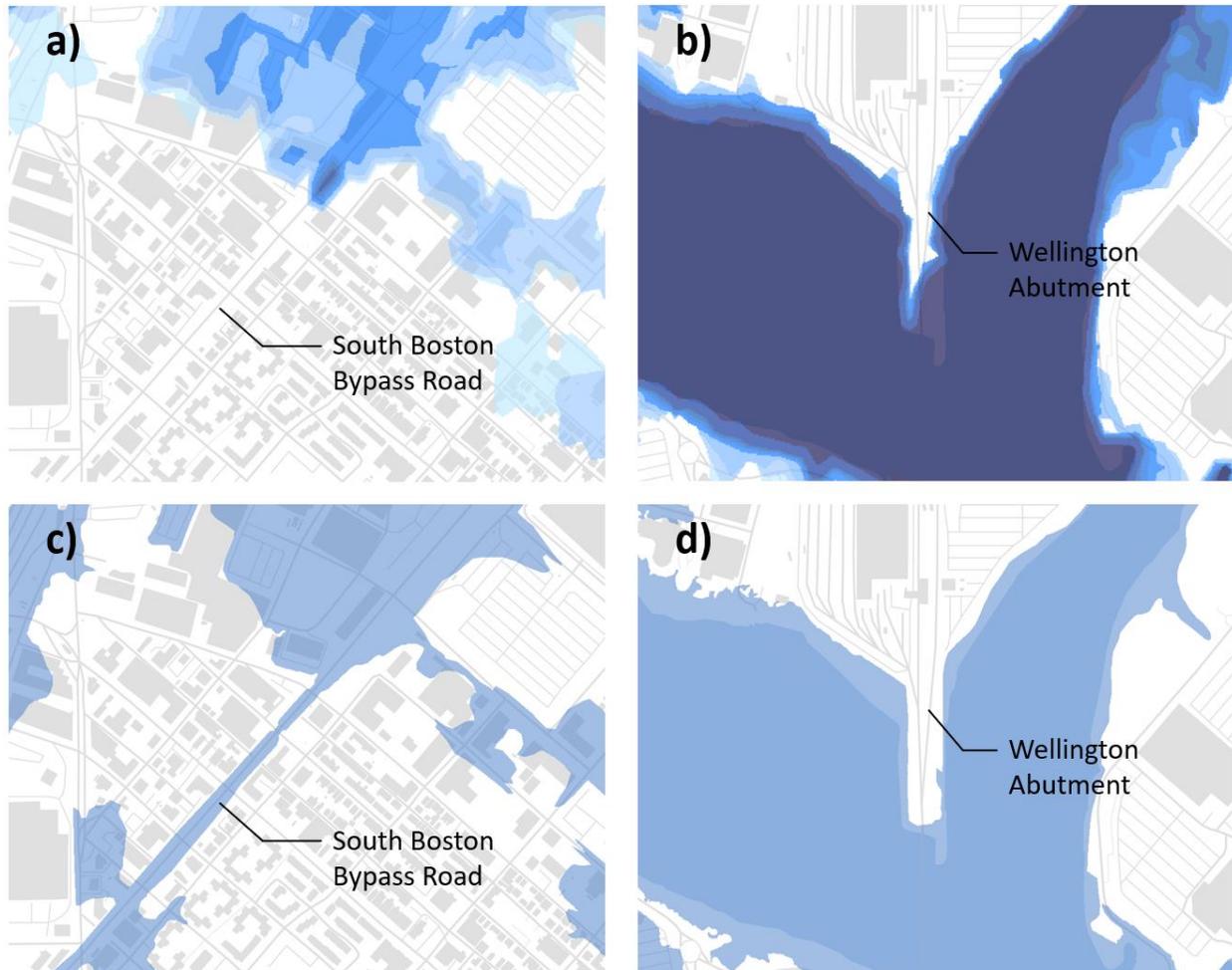


Figure 2: Minor discrepancies between the MC-FRM +1.2 ft SLR 1-100 year flood depths (a, b) and the FEMA 1-500 year floodplain (c, d). A flood path along the South Boston Bypass Road not captured by the MC-FRM (left). An area of inundation along the Orange Line ROW in Wellington shown in the MC-FRM that is slightly incongruent with historic FEMA data (right).

Aside from these moderate limitations, the MC-FRM provides very useful insights into coastal flood risks, particularly for long-term planning, climate change vulnerability assessment, and design guidance. As such we rely on the MC-FRM to screen Commuter Rail facilities for coastal flood vulnerability under both present and future sea level conditions. While there are local precipitation-based flooding projections at the municipality level that take climate change into consideration (most notably for the City of Cambridge, 2015; and Boston; BWSC, 2020) given that no such study exists that covers the entire study area (i.e., all Commuter Rail facilities and parking lots) we rely on the existing FEMA flood insurance rate map (FIRM) to characterize precipitation-based flood risks, acknowledging that these maps do not characterize all possible flood risk, as they do not account for the flooding of areas with poor drainage due to heavy downpours (e.g. urban or localized flooding).

MBTA Commuter Rail System and Facilities Overview

The MBTA commuter rail system consists of 12 lines connecting the suburbs and cities surrounding Greater Boston to Downtown, extending as far as Providence, Rhode Island. The system can be subdivided into northern and southern sections, with either North Station and South Station serving as the primary terminus of all commuter rail lines and no Commuter Rail service connection between the two sections. While there is no service interconnection between the two portions of the system, the Grand Junction railway allows for trains and nonrevenue vehicles to travel between the northern and southern portions of the system. Prior to the COVID-19 pandemic, serviced 10% of trips across all public transit modes in the Greater Boston area, with an average of 114,000 trips recorded during typical weekday service in February 2020, with ridership in April 2021 at 17,000 trips, just 15% of pre-pandemic levels (MBTA, 2021a). Figure 3 provides a relative breakdown of ridership across lines and terminus (i.e., North vs. South Station) based on 2018 weekly ridership data (MBTA, 2019a). Approximately 60% of passenger trips originate on one of the 8 southern lines and terminates in South Station, whereas 40% of trips originate on one of the 4 northern lines and terminates in North Station.

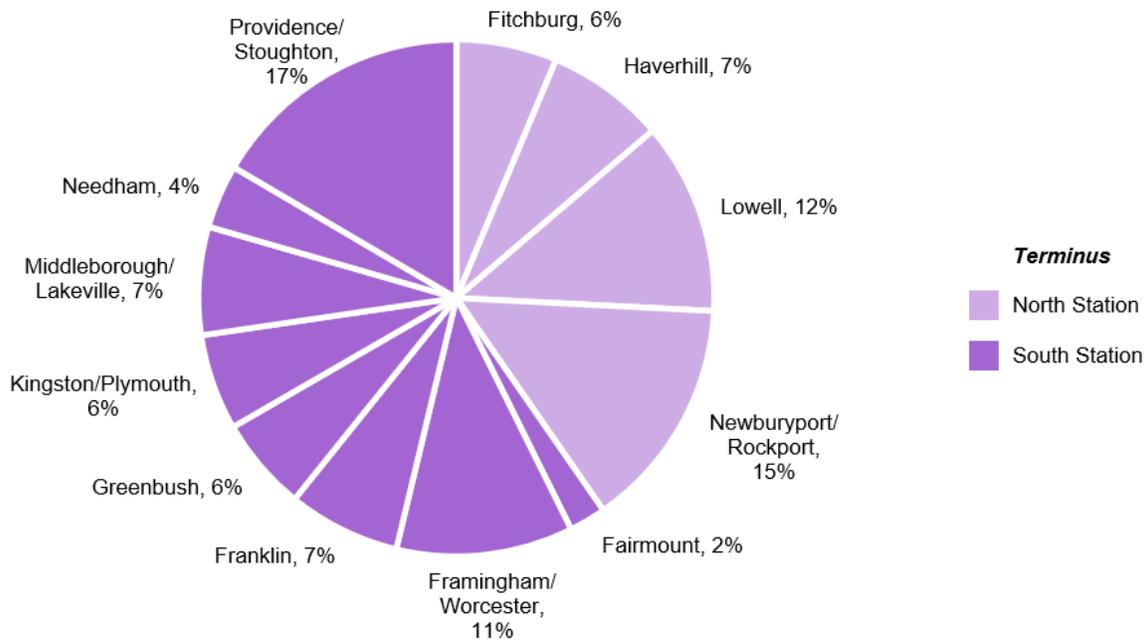


Figure 3: Relative ridership across the 12 MBTA Commuter Rail lines and 2 main system terminuses.

The Commuter Rail system is supported by 4 maintenance facilities, 4 support facilities, 13 layover yards, and 12 main maintenance of way (MOW) facilities, which are listed in Table 1 based on their perceived criticality, as provided by MBTA Railroad Operations (Ray, J., pers. comm., January 12, 2022). The Commuter Rail system also relies upon 75 parking locations adjacent to stations to enable easier customer access to stations; these lots also represent an additional revenue source for the MBTA. Additional information on these parking locations can be found in Appendix A.

Table 1: Commuter Rail support facilities

Perceived Criticality [10 = most critical]	Category	Name	Municipality	Owner	Line
10	Maintenance Facility	Commuter Rail Maintenance Facility	Somerville/ Boston/ Cambridge	MBTA	All Routes
10	Support Facility	Cobble Hill- 32 Cobble Hill Rd, Somerville, MA 02143	Somerville	MBTA	All North Side Routes
10	Support Facility	South Station	Boston	MBTA	All South Side Routes (includes Amtrak Dispatching)
10	Support Facility	Iron Horse Park Complex and Headquarters	Billerica	MBTA	All Routes
9	Maintenance Facility	Readville Yard and Maintenance Facility	Boston	MBTA	All South Side Routes
9	Maintenance Facility	Widett Service and Inspection Maintenance Facility	Boston	MBTA	All South Side Routes
9	MOW	West Cambridge Maintenance	Cambridge	MBTA	Fitchburg
9	Support Facility	Rochester Heavy Maintenance Shop	Rochester	MBTA	All South Side Routes
8	Maintenance Facility	Readville Track and Engineering	Boston	MBTA	All South Side Routes
8	Support Facility	Amtrak Southampton Street Yard	Boston	Amtrak	All South Side Routes
6	Layover	Franklin Layover and Trailers	Franklin	MBTA	Franklin
6	Layover	Greenbush Layover and Storage	Scituate	MBTA	Greenbush
6	Layover	Kingston Layover	Kingston	MBTA	Kingston
6	Layover	Middleborough Layover	Middleborough	MBTA	Middleborough/Lakeville
6	Layover	Newburyport Layover	Newburyport	MBTA	Newburyport
6	Layover	Rockport Layover	Rockport	MBTA	Rockport
6	Layover	Wamsutta Layover	New Bedford	MBTA	South Coast Rail
6	Layover	Weaver's Cove Layover	Fall River	MBTA	South Coast Rail
6	Layover	Westminster Layover Yard	Westminster	CSX	Fitchburg
6	Layover	Worcester Layover	Worcester	MBTA	Worcester
5	Layover	Bradford Layover	Haverhill	MBTA	Haverhill
3	MOW	Salem Maintenance Facility, Storage, and Offices	Salem	MBTA	Newburyport
3	Layover	Needham Layover and Storage	Needham	MBTA	Needham
3	MOW	Abington Maintenance Facility and Storage	Abington	MBTA	Kingston
3	MOW	Framingham Offices and Trailers	Framingham	MBTA	Worcester
3	MOW	Wilmington Storage and Office Complex	Wilmington	MBTA	Lowell
2	Layover	East Junction Layover	Attleboro	MBTA	Providence
2	MOW	Walpole Storage and Access Yard	Walpole	MBTA	Franklin
2	MOW	Ayer Staging Area and Maintenance Yard	Ayer	MBTA	Fitchburg
2	MOW	Fitchburg Maintenance Facility	Lunenburg	MBTA	Fitchburg
1	MOW	Adams Junction Yard and Storage	Braintree	MBTA	Middleborough/Lakeville, Kingston/Plymouth, Greenbush
1	MOW	Meadowcroft Yard and Storage Boxes	Lowell	MBTA	Lowell
1	MOW	Rosemount Trailers and Storage	Haverhill	MBTA	Haverhill
1	MOW	Worcester Maintenance Facility	Worcester	MBTA	Worcester

Vulnerability Assessment Ranking System

Using the MC-FRM coastal flood extent and flood depth information, as well as available FEMA flood insurance rate maps (FIRM) we perform a vulnerability screening of each of the 33 support facilities and 77 parking lots that support regular Commuter Rail operations. For the purposes of this analysis, we adopt the definition of vulnerability outlined in Martello et al. (2021) which is consistent with present MBTA policy and FHWA definitions (MBTA, 2021b). That is, we define vulnerability to be a function of internal system characteristics (i.e., sensitivity and adaptive capacity), as well as external exposure characterized by historic data and climate projections (Martello et al., 2021). We consider sensitivity to be informed by the exposure-specific robustness (i.e., fragility) and recovery speed (i.e., rapidity), whereas we consider adaptive capacity to be informed by the redundancy and resourcefulness (i.e., flexibility) of a facility. Figure 4 summarizes the definition of vulnerability used in this report.

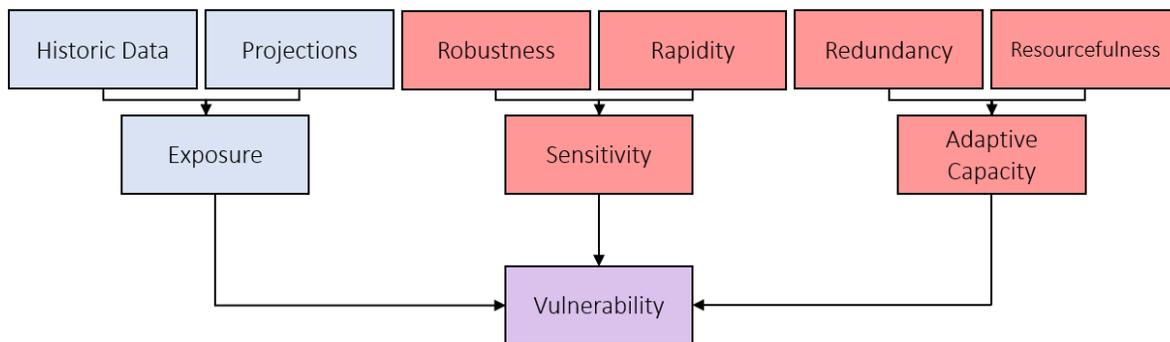


Figure 4: Definition of climate change vulnerability for infrastructure systems and facilities (adapted from Martello, 2020).

Rather than adopt a rigorous quantitative approach (e.g., Martello, 2020) or apply the scoring criteria outlined by the MBTA (2021b), given the relatively large scope and high level nature of this assessment, we instead adopt the qualitative vulnerability ranking system shown in Table 2. Vulnerability ranks are largely informed by qualitative descriptions of 1-100 year flood depths across all MC-FRM sea level conditions and the available FEMA FIRM data. Table 3 defines the flood conditions associated with each qualitative descriptor of flood severity.

The purpose of this report is to screen which facilities will require a more detailed vulnerability assessment. We recommend that all locations that score a high vulnerability rank receive an additional vulnerability assessment as early as possible, as these locations are presently exposed to flooding, highly sensitive to flood exposure, and are likely ill-equipped at present to properly adapt and respond to a flood event. Other locations should be prioritized in order of their assessed vulnerability, though do not require immediate action given the information available at this time. The following sections provide further information on the high, medium, and low vulnerability facilities. Locations that are not vulnerable based on presently available information as well as parking lots are listed separately.

The remainder of this report provides an overview of the vulnerability of commuter rail facilities and parking locations, grouping each by vulnerability ranking. For the sake of brevity, this report only provides figures detailing the coastal flood risk of facilities and parking locations ranked as high vulnerability. The flood exposure of these and all other locations mentioned in this report can be further explored via the [MBTA Commuter Rail Flood Vulnerability Viewer](#). Note that a geoDOT account and

membership in the CRaVAT group within geoDOT are required to access the viewer. Please reach out to Mike McGill (or the current geoDOT Coordinator) to obtain access. To locate each facility or parking location, simply type the name of the location into the search bar. Flood risk layers can be toggled on and off to further explore the flood risk associated with each location.

Table 2: Qualitative vulnerability ranking system used in this report

Rank	Factor	Description
Minimal	Exposure	No flooding identified across all SLR conditions, FEMA FIRM
	Sensitivity	N/A
	Adaptive Capacity	N/A
Low	Exposure	Minimal flooding for higher SLR conditions, FEMA FIRM
	Sensitivity	Low-Medium
	Adaptive Capacity	Medium-High
Medium	Exposure	Moderate-severe flooding under future SLR conditions, FEMA FIRM
	Sensitivity	Medium-High
	Adaptive Capacity	Low-Medium
High	Exposure	Severe-extreme flooding under any SLR conditions, FEMA FIRM
	Sensitivity	High
	Adaptive Capacity	Low

Table 3: Flood descriptors and associated depths and extents of flooding

Descriptor	Description
None	No flooding identified
Minimal	Flooding of 1 ft or less across site or at periphery
Moderate	Flooding of 3 ft or less across a portion of site
Severe	Flooding of 5 ft or less at any portion of site, complete inundation
Extreme	Flooding greater than 5 ft at any portion of site, complete inundation

High Vulnerability Facilities

The following locations are currently within the FEMA 1-100 year floodplain and/or are exposed to severe or extreme flooding under the 1-100 year coastal flood event for one or more of the 4 sea level conditions provided by the MC-FRM. Based on the vulnerability ranking system outlined previously, each of these locations has a high vulnerability to coastal or precipitation based flooding. For each of these locations, a more detailed vulnerability assessment is recommended. Facilities are listed in descending order based on perceived criticality:

- Commuter Rail Maintenance Facility
- Widett Service and Inspection Maintenance Facility
- West Cambridge Maintenance Facility
- Amtrak Southampton Street Yard
- Salem Maintenance Facility, Storage, and Offices

Commuter Rail Maintenance Facility (CRMF)

As shown in Figure 5, the Commuter Rail Maintenance Facility (CRMF) is subject to partial inundation in the northern portion of the adjacent tracks under a 1-100 year coastal flood event under present sea level conditions (a). More extensive flooding surrounding the maintenance facility is expected for a storm with the same return period and 1.2 ft of SLR (b). The facility is expected to flood with 2-3 ft of standing water under the 1-100 year flood event with 2.4 ft of SLR (c). With 4.2ft of SLR, the 1-100 year flood is expected to inundate the facility with 3-4 feet of standing water (d). The CRMF is a critical component of the entire commuter rail system, as it serves as the primary location for passenger car and locomotive maintenance. Extensive flooding at this facility is likely to result in significant damage to maintenance equipment, inventory of spare parts, and un-evacuated rolling stock (AECOM, 2018). Based on evaluations of similar coastal flood impacts on the Orient Heights Maintenance facility on the Blue Line, a similar level of inundation would result in complete loss of service for a two week period, with prolonged service impacts lasting for a year or more (MBTA, 2019b). A more comprehensive vulnerability assessment of this location, including a detailed review of immobile maintenance equipment locations and vulnerability is recommended.

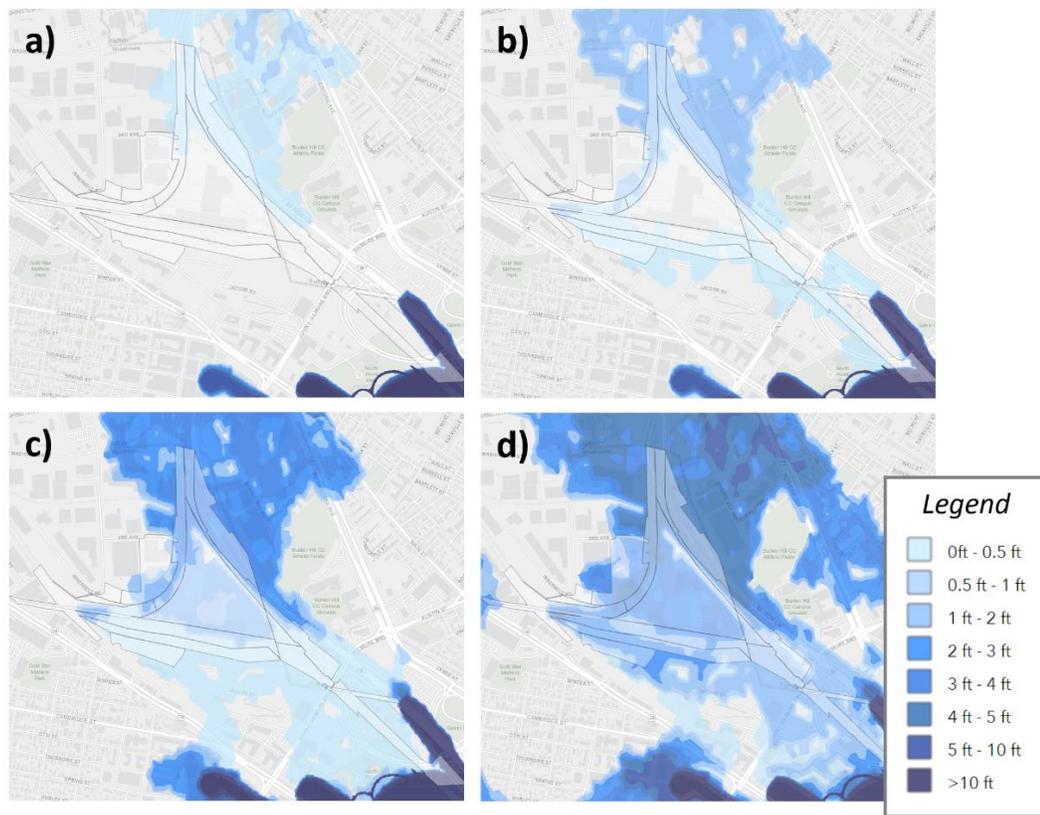


Figure 5: Projected 1-100 year flood depths at the Commuter Rail Maintenance Facility under: a) present sea level conditions, b) +1.2 ft of SLR, c) +2.4 ft of SLR, d) +4.2 ft of SLR

Widett Service and Inspection Maintenance Facility and Amtrak Southampton Street Yard

As shown in Figure 6, the Widett Service and Inspection Maintenance Facility and Amtrak Southampton Street Yard are both subject to significant flooding (3-5 feet) under a 1-100 year coastal flood event under more severe (i.e., +2.4 ft and +4.2 ft of SLR) sea level rise scenarios (c, d). Under present conditions and with 1.2 ft of SLR (a, b) these locations are not vulnerable to coastal flooding based on MC-FRM projections, though they are vulnerable to flooding with a 1-500 year return period based on the present FEMA FIRM. The Widett Service and Inspection Maintenance Facility services trains on the southern portion of the commuter rail system. Similar to the CRMF, extensive flooding at this facility is likely to result in significant damage to maintenance equipment, inventory of spare parts, and un-evacuated rolling stock (AECOM, 2018). Should this facility flood, it is likely that operations could be temporarily shifted to the CRMF, if that facility is still operable. While the MBTA does not own the Amtrak Southampton Street Yard, this yard is critical to operations along all south side routes and could therefore have significant implications for commuter rail service. Coordination with Amtrak for further assessment of the vulnerability of their Southampton Street Yard is recommended.

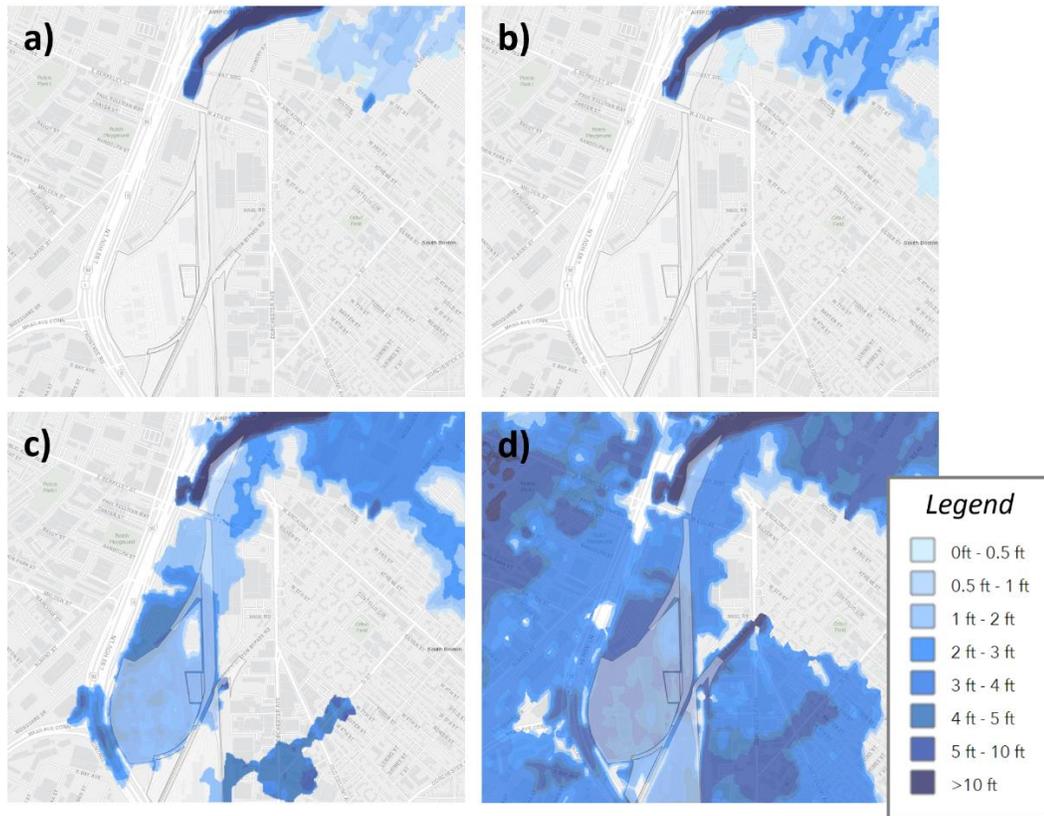


Figure 6: Projected 1-100 year flood depths at the Widett Service and Inspection Maintenance Facility under: a) present sea level conditions, b) +1.2 ft of SLR, c) +2.4 ft of SLR, d) +4.2 ft of SLR

West Cambridge Maintenance Facility

As shown in Figure 7, the West Cambridge Maintenance Facility is not subject to coastal flooding under a 1-100 year coastal flood event given present sea level conditions (a). However, this location is within the FEMA 1-100 year flood plain, indicating a precipitation-based flood vulnerability under present conditions. With 1.2 ft of SLR, the MC-FRM projects the 1-100 year coastal flood event will result in 2-4 ft of standing water at this facility (b), with 5-10 feet of standing water expected with 2.4 ft or 4.2 ft of SLR (c, d). Coastal flood risk at this location is the result of the flanking and overtopping of the Amelia Earhart Dam (owned and operated by the Department of Conservation and Recreation; DCR) downstream on the Mystic River. Attenuation of future coastal flood risk is therefore dependent upon improvements to the dam and heightening of adjacent land. The West Cambridge Maintenance Facility maintains all on-track vehicles and equipment for the commuter rail system and is also the main storage location for essential non-revenue vehicles, including snow vehicles. Immobile equipment, materials, inventory, and vehicles on site at this facility would be significantly damaged under higher SLR scenarios. Further investigation into the vulnerability of this location and the systemwide implications of operations disruption at this facility is recommended.

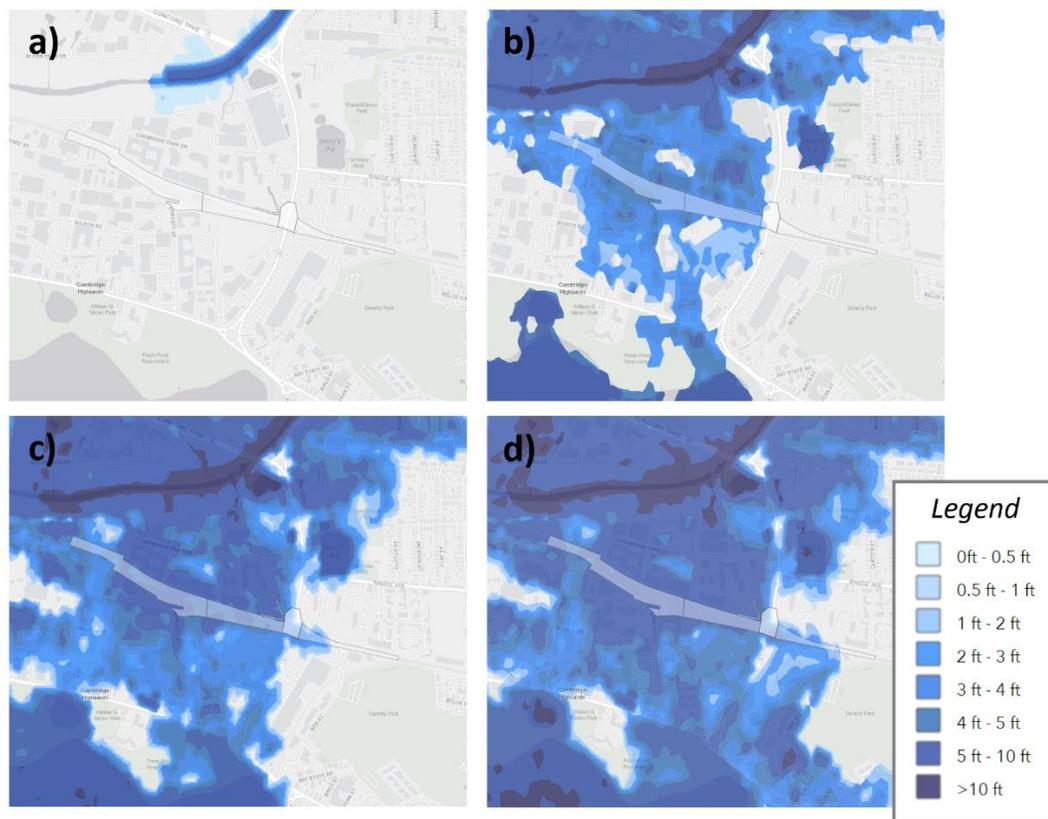


Figure 7: Projected 1-100 year flood depths at the West Cambridge Maintenance Facility under: a) present sea level conditions, b) +1.2 ft of SLR, c) +2.4 ft of SLR, d) +4.2 ft of SLR

Salem Maintenance Facility, Storage, and Offices

While the Salem Maintenance Facility, Storage, and Offices are minimally exposed to coastal flood risk for SLR conditions less than 4.2 ft based on MC-FRM results (Figure 8) the expected level of flooding under 4.2 ft of SLR (5-10 ft depth of standing water) is significant. Further, it appears likely that the MC-FRM neglects the presence of the tunnel under Washington Street in Salem. Given that the FEMA FIRM at present places this location and the other end of the tunnel (Salem Station) entirely within the 1-100 year floodplain, further review of the present-day coastal flood risk for this location is recommended. The MC-FRM estimates Salem Station (including the parking facility) and the tunnel entrance are exposed to coastal flooding under a 1-10 year event under present conditions. Given the exceptionally high vulnerability of Salem Station and the tunnel entrance, a detailed vulnerability assessment (and hydraulic model) of Salem Station and garage, the adjacent tunnel, and the maintenance facility is recommended.

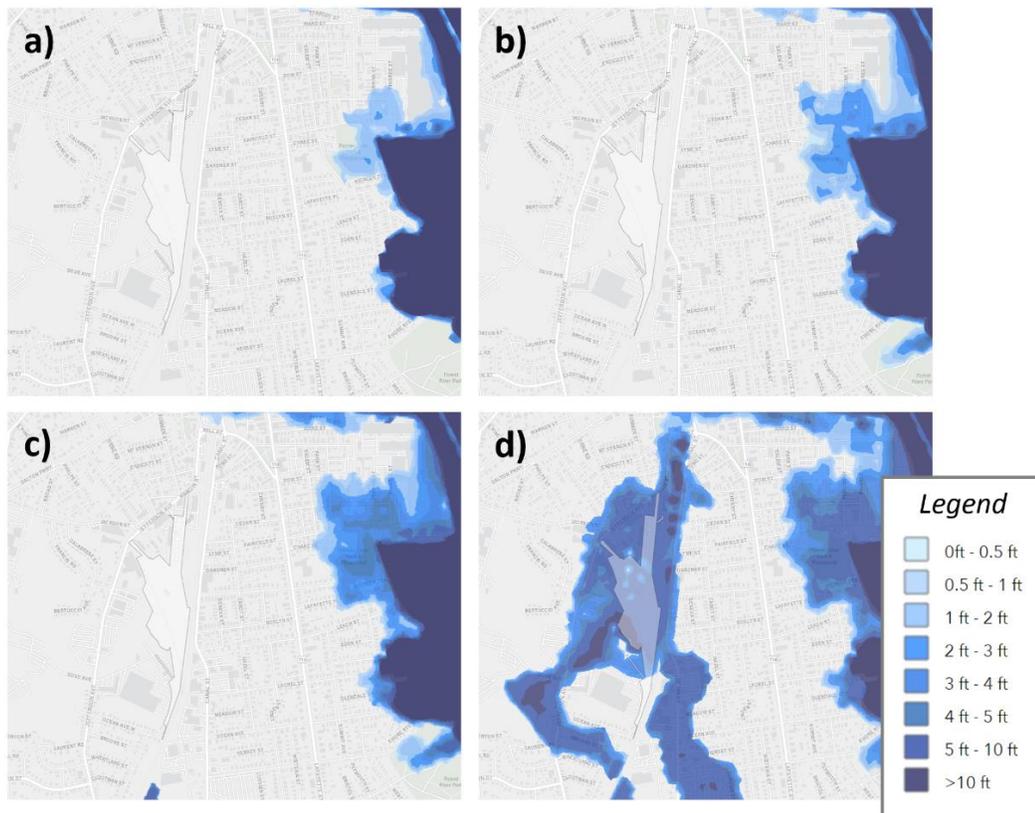


Figure 8: Projected 1-100 year flood depths at the Salem Maintenance Facility, Storage, and Offices under: a) present sea level conditions, b) +1.2 ft of SLR, c) +2.4 ft of SLR, d) +4.2 ft of SLR

Medium Vulnerability Facilities

The following locations are currently within the FEMA 1-100 year floodplain and/or are exposed to moderate or severe flooding under the 1-100 year coastal flood event for one or more of the four sea level conditions provided by the MC-FRM. Based on the vulnerability ranking system outlined previously, each of these locations has a medium vulnerability to coastal or precipitation based flooding. For each of these locations, a more detailed vulnerability assessment is likely not required at this time, though flood resilient design criteria should be considered when planning facility upgrades. Facilities are listed in descending order based on perceived criticality:

- Cobble Hill Support Facility (Dispatching)
- South Station Support Facility (Dispatching)

Low Vulnerability Facilities

The following locations are currently within the FEMA 1-100 year floodplain and/or are exposed to minimal flooding under the 1-100 year coastal flood event for one of the higher sea level conditions provided by the MC-FRM. Based on the vulnerability ranking system outlined previously, each of these locations has a medium vulnerability to coastal or precipitation based flooding. For each of these locations, a more detailed vulnerability assessment is likely not required at this time, though flood resilient design criteria should be considered when planning facility upgrades. Facilities are listed in descending order based on perceived criticality:

- Newburyport Layover
- Bradford Layover
- Wamsutta Layover
- Weaver's Cove Layover
- Wilmington Storage and Office Complex
- Ayer Staging Area and Maintenance Yard
- Walpole Storage and Access Yard

Minimally Vulnerable Facilities

The following locations are not currently within the FEMA 1-100 year floodplain or exposed to flooding under the 1-100 year coastal flood event for and of the sea level conditions provided by the MC-FRM. Based on the vulnerability ranking system outlined previously, each of these locations is not vulnerable to coastal or precipitation based flooding based on presently available data. We note additional precipitation-based flood risks may still be present at these facilities, though all existing available information suggests any such flood risk has not been historically observed or projected at this time. For each of these locations, a more detailed vulnerability assessment is likely not required at this time. Facilities are listed in descending order based on perceived criticality:

- Iron Horse Park Complex and Headquarters
- Readville Yard and Maintenance Facility
- Readville Track and Engineering
- Franklin Layover and Trailers
- Greenbush Layover and Storage
- Kingston Layover
- Middleborough Layover
- Rockport Layover
- Westminster Layover Yard
- Worcester Layover
- Needham Layover and Storage
- Abington Maintenance Facility and Storage
- Framingham Offices and Trailers
- East Junction Layover

- Fitchburg Maintenance Facility
- Adams Junction Yard and Storage
- Meadowcroft Yard and Storage Boxes
- Rosemount Trailers and Storage
- Worcester Maintenance Facility

Commuter Rail Parking Locations

Of the 77 Commuter Rail station parking locations investigated as part of this study, 57 were found not vulnerable to coastal or precipitation-based flood risks. 14 parking locations were found to have a low vulnerability, 3 a medium vulnerability, and 3 were found to have a high vulnerability to coastal or precipitation-based flood risks. Given the relatively minimal infrastructure associated with most of the parking lots, we do not recommend additional investigation at this time, apart from the Salem parking garage, as noted above. Figure 9 provides a relation between overall parking facility exposure and SLR. Note that the FEMA FIRM does not consider SLR and therefore flood exposure remains constant with respect to SLR. Table 5 summarizes the flood exposure and vulnerability of all commuter rail parking facilities, sorted based on vulnerability ranking. Note that these facilities can be viewed and flood extents can be explored via the [MBTA Commuter Rail Flood Vulnerability Viewer](#).

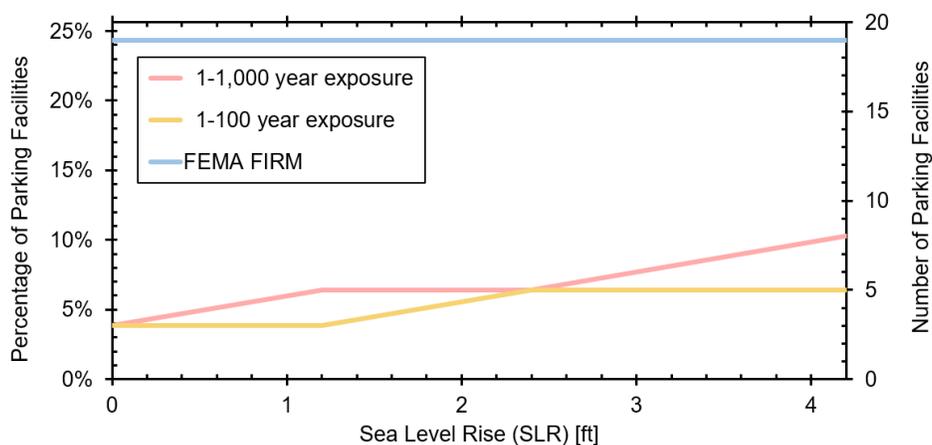


Figure 9: Percentage and number of commuter rail parking lots exposed to flooding vs. sea level rise (SLR)

Table 4: Summary of commuter rail parking facility vulnerability based on FEMA FIRM and MC-FRM flood exposure information

Station Name	Asset Type	Total Parking Spaces	MC-FRM 1-100 year exposure				FEMA FIRM Present	Vulnerability Rank
			Present	+1.2 ft SLR	+2.4 ft SLR	+4.2 ft SLR		
Salem	Garage	712	Severe	Severe	Extreme	Extreme	Severe	High
North Quincy	Surface Lot	613	None	None	Severe	Extreme	Severe	High
Newburyport	Surface Lot	680	None	None	Minimal	Moderate	Minimal	Medium
Holbrook/Randolph	Surface Lot	362	None	None	None	None	Moderate	Medium
Weymouth Landing	Surface Lot	290	Minimal	Moderate	Moderate	Moderate	Moderate	Medium
Wilmington	Surface Lot	198	None	None	None	None	Severe	Medium
Route 128	Garage	2578	None	None	None	None	Minimal	Low
Ashland	Surface Lot	693	None	None	None	None	Minimal	Low
Lynn	Garage	637	None	None	None	None	Minimal	Low

Station Name	Asset Type	Total Parking Spaces	MC-FRM 1-100 year exposure				FEMA FIRM Present	Vulnerability Rank
			Present	+1.2 ft SLR	+2.4 ft SLR	+4.2 ft SLR		
Campello	Surface Lot	552	None	None	None	None	Minimal	Low
Bridgewater	Surface Lot	497	None	None	None	None	Minimal	Low
Cohasset	Surface Lot	387	None	None	None	None	Minimal	Low
Southborough	Surface Lot	372	None	None	None	None	Minimal	Low
East Weymouth	Surface Lot	335	None	None	None	None	Minimal	Low
Braintree lots	Surface Lot	307	None	None	None	None	Minimal	Low
North Scituate	Surface Lot	249	None	None	None	None	Minimal	Low
West Hingham	Surface Lot	231	None	None	None	None	Minimal	Low
Whitman	Surface Lot	199	None	None	None	None	Minimal	Low
Malden Center	Surface Lot	193	None	None	None	None	None	Low
Plymouth	Surface Lot	96	None	None	None	None	None	Low
Kingston	Surface Lot	1030	None	None	None	None	None	Minimal
Greenbush	Surface Lot	1000	None	None	None	None	None	Minimal
Norwood Center	Surface Lot	781	None	None	None	None	None	Minimal
Middleborough/Lak eville	Surface Lot	769	None	None	None	None	None	Minimal
Canton Junction	Surface Lot	762	None	None	None	None	None	Minimal
Oak Grove	Surface Lot	727	None	None	None	None	None	Minimal
Forge Park/495	Surface Lot	718	None	None	None	None	None	Minimal
South Weymouth	Surface Lot	636	None	None	None	None	None	Minimal
Norfolk	Surface Lot	630	None	None	None	None	None	Minimal
South Attleboro	Surface Lot	579	None	None	None	None	None	Minimal
Dedham Corp Center	Surface Lot	497	None	None	None	None	None	Minimal
Beverly	Garage	494	None	None	None	None	None	Minimal
Nantasket Junction	Surface Lot	490	None	None	None	None	None	Minimal
Westborough	Surface Lot	448	None	None	None	None	None	Minimal
Hanson	Surface Lot	428	None	None	None	None	None	Minimal
Halifax	Surface Lot	412	None	None	None	None	None	Minimal
Abington	Surface Lot	404	None	None	None	None	None	Minimal
Grafton	Surface Lot	386	None	None	None	None	None	Minimal
Stoughton	Surface Lot	361	None	None	None	None	None	Minimal
Readville	Surface Lot	353	None	None	None	None	None	Minimal
Montello	Surface Lot	351	None	None	None	None	None	Minimal
Walpole	Surface Lot	345	None	None	None	None	None	Minimal
Hersey	Surface Lot	318	None	None	None	None	None	Minimal
Bradford	Surface Lot	300	None	None	None	None	None	Minimal
Framingham	Surface Lot	294	None	None	None	None	None	Minimal
Rowley	Surface Lot	283	None	None	None	None	None	Minimal
Littleton/Route 495	Surface Lot	222	None	None	None	None	None	Minimal
Norwood Depot	Surface Lot	219	None	None	None	None	None	Minimal
Forest Hills	Surface Lot	211	None	None	None	None	None	Minimal
Canton Center	Surface Lot	207	None	None	None	None	None	Minimal

Station Name	Asset Type	Total Parking Spaces	MC-FRM 1-100 year exposure				FEMA FIRM Present	Vulnerability Rank
			Present	+1.2 ft SLR	+2.4 ft SLR	+4.2 ft SLR		
Hamilton/Wenham	Surface Lot	194	None	None	None	None	None	Minimal
Franklin	Surface Lot	183	None	None	None	None	None	Minimal
West Natick	Surface Lot	178	None	None	None	None	None	Minimal
W Newton Webster St	Surface Lot	161	None	None	None	None	None	Minimal
Haverhill	Surface Lot	150	None	None	None	None	None	Minimal
Andover	Surface Lot	149	None	None	None	None	None	Minimal
Swampscott	Surface Lot	144	None	None	None	None	None	Minimal
Roslindale Village	Surface Lot	139	None	None	None	None	None	Minimal
Needham Junction	Surface Lot	129	None	None	None	None	None	Minimal
Ballardvale	Surface Lot	120	None	None	None	None	None	Minimal
Hyde Park	Surface Lot	118	None	None	None	None	None	Minimal
Montserrat	Surface Lot	117	None	None	None	None	None	Minimal
Wakefield	Surface Lot	116	None	None	None	None	None	Minimal
Highland	Surface Lot	115	None	None	None	None	None	Minimal
Gloucester	Surface Lot	100	None	None	None	None	None	Minimal
Needham Heights	Surface Lot	99	None	None	None	None	None	Minimal
North Beverly	Surface Lot	86	None	None	None	None	None	Minimal
Reading	Surface Lot	71	None	None	None	None	None	Minimal
West Roxbury	Surface Lot	60	None	None	None	None	None	Minimal
W Newton/ Washington St	Surface Lot	45	None	None	None	None	None	Minimal
West Gloucester	Surface Lot	43	None	None	None	None	None	Minimal
Bellevue	Surface Lot	37	None	None	None	None	None	Minimal
Fairmount	Surface Lot	37	None	None	None	None	None	Minimal
Auburndale	Surface Lot	35	None	None	None	None	None	Minimal
Islington	Surface Lot	33	None	None	None	None	None	Minimal
West Medford	Surface Lot	32	None	None	None	None	None	Minimal
Brandeis/Roberts	Surface Lot	24	None	None	None	None	None	Minimal

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Appendix A: Commuter Rail Parking Facilities Overview

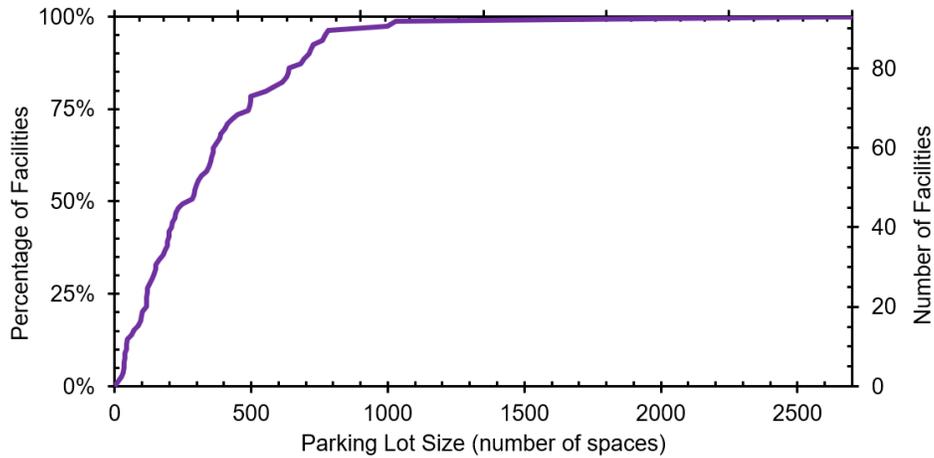


Figure 10: Cumulative percentage and number of Commuter Rail parking facilities vs. parking lot size (measured in number of parking spaces)

Table 5: List of all parking lots in the MBTA Commuter Rail system

Station Name	Asset Type	Total Parking Spaces	Ownership	LINE	Address
Abington	Surface Lot	404	MBTA	Kingston/ Plymouth Line	231 Centre Ave Abington, MA 02351-2278
Andover	Surface Lot	149	MBTA	Haverhill Line	17 Railroad St Andover, MA 01810-3516
Ashland	Surface Lot	693	MBTA	Framingham/ Worcester Line	Pleasant Street next to the restaurant off of Route 135 - west of Ashland High School, Ashland 01721
Auburndale	Surface Lot	35	MassDOT	Framingham/ Worcester Line	477 Lexington St Auburndale, MA 02466-1906
Ballardvale	Surface Lot	120	MBTA	Haverhill Line	195 Andover St Andover, MA 01810-5638
Bellevue	Surface Lot	37	MBTA	Needham Line	35 Colbert St West Roxbury, MA 02132-1239
Beverly	Garage	494	MBTA	Newburyport/ Rockport Line	100 Rantoul Street Beverly, MA 01915

Station Name	Asset Type	Total Parking Spaces	Ownership	LINE	Address
Bradford	Surface Lot	300	MBTA	Haverhill Line	10 Railroad Ave Bradford, MA 01835-7229
Braintree lots	Surface Lot	307	MBTA	Red Line	197 Ivory St Braintree, MA 02184-7139
Brandeis/Roberts	Surface Lot	24	MBTA	Fitchburg Line	1 Sawyer Rd Waltham, MA 02453-3427
Bridgewater	Surface Lot	497	MBTA	Middleboro/ Lakeville Line	85 Burrill Ave Bridgewater, MA 02324-2727
Butler	Surface Lot	42	MBTA	Mattapan Trolley	Butler St. and Branchfield St. off Adams Street, Dorchester, MA 02124
Campello	Surface Lot	552	MBTA	Middleboro/ Lakeville Line	30 Riverside Ave Brockton, MA 02301-6811
Canton Center	Surface Lot	207	MBTA	Providence/ Stoughton Line	710 Washington St Canton, MA 02021-3036
Canton Junction	Surface Lot	762	MBTA	Providence/ Stoughton Line	Beaumont St & Sherman St Canton, MA 02021
Cohasset	Surface Lot	387	MBTA	Greenbush Line	110 Chief Justice Cushing Hwy. Cohasset, MA 02025
Dedham Corp Center	Surface Lot	497	MBTA	Franklin Line	125 Allied Dr Dedham, MA 02026-6100
East Weymouth	Surface Lot	335	MBTA	Greenbush Line	1590 Commercial St, East Weymouth MA, 02189
Fairmount	Surface Lot	37	MBTA	Fairmount Line	Fairmount Ave & Truman Hwy Hyde Park, MA 02136
Forest Hills	Surface Lot	211	MBTA	Orange Line	Washington St & Hyde Park Ave Jamaica Plain, MA 02130, US

Station Name	Asset Type	Total Parking Spaces	Ownership	LINE	Address
Forge Park/495	Surface Lot	718	MBTA	Franklin Line	1000 W Central St Franklin, MA 02038-3108
Framingham	Surface Lot	294	MBTA	Framingham/ Worcester Line	417 Waverly St Framingham MA 01702
Franklin	Surface Lot	183	MBTA	Franklin Line	75 Depot St Franklin, MA 02038-1939
Gloucester	Surface Lot	100	MBTA	Newburyport/Rockport Line	75 Railroad Ave Gloucester, MA 01930-3540
Grafton	Surface Lot	386	MBTA	Framingham/ Worcester Line	1 Pine St North Grafton, MA 01536-1856
Greenbush	Surface Lot	1000	MBTA	Greenbush Line	247 Old Drifway (Driftway & Stockbridge Rd) Scituate, MA 02066
Halifax	Surface Lot	412	MBTA	Kingston/ Plymouth Line	6 Garden Rd Halifax, MA 02338-1020
Hamilton/Wenham	Surface Lot	194	MBTA	Newburyport/Rockport Line	Bay Rd & Walnut Rd Hamilton, MA 01982
Hanson	Surface Lot	428	MBTA	Kingston/ Plymouth Line	1070 Main St Hanson, MA 02341-1543
Haverhill	Surface Lot	150	MBTA	Haverhill Line	1 Washington Ave Haverhill, MA 01832-5420
Hersey	Surface Lot	318	MBTA	Needham Line	Great Plain Ave & Broad Meadow Rd, Needham, MA 02492
Highland	Surface Lot	115	MBTA	Needham Line	Corey St & Hastings St West Roxbury, MA 02132
Holbrook/Randolph	Surface Lot	362	MBTA	Middleboro/ Lakeville Line	Union St & Center St Randolph, MA 02368

Station Name	Asset Type	Total Parking Spaces	Ownership	LINE	Address
Hyde Park	Surface Lot	118	MBTA	Franklin Line	1 Pingree St Hyde Park, MA 02136-2751
Islington	Surface Lot	33	MBTA	Franklin Line	48 Carroll Ave Westwood, MA 02090-1444
Kingston	Surface Lot	1030	MBTA	Kingston/ Plymouth Line	194 Marion Dr Kingston, MA 02364-2249
Littleton/Route 495	Surface Lot	222	MBTA	Fitchburg Line	Grimes Ln & Foster St Littleton, MA 01460
Lynn	Garage	637	MBTA	Newburyport/Rockport Line	325 Broad St Lynn, MA 01901-1511
Malden Center	Surface Lot	193	MBTA	Orange Line	Commercial St & Pleasant St Malden, MA 02148
Middleborough/Lakeville	Surface Lot	769	MBTA	Middleboro/ Lakeville Line	125 Commercial Dr Lakeville, MA 02347-1661
Montello	Surface Lot	351	MBTA	Middleboro/ Lakeville Line	150 Spark St Brockton, MA 02302-1621
Montserrat	Surface Lot	117	MBTA	Newburyport/Rockport Line	180 Essex St Beverly, MA 01915
Nantasket Junction	Surface Lot	490	MBTA	Greenbush Line	190 Summer St Hingham, MA 02043
Needham Hts	Surface Lot	99	MBTA	Needham Line	95 Avery Sq. Needham, MA 02494-1320
Needham Junction	Surface Lot	129	MBTA	Needham Line	51 Junction St Needham, MA 02492-2919
Newburyport	Surface Lot	680	MBTA	Newburyport/Rockport Line	25 Boston Way Newburyport, MA 01950-4067

Station Name	Asset Type	Total Parking Spaces	Ownership	LINE	Address
Norfolk	Surface Lot	630	MBTA	Franklin Line	9 Rockwood Rd Norfolk, MA 02056-1409
North Beverly	Surface Lot	86	MBTA	Newburyport/Rockport Line	Enon St & Dodge St Beverly, MA 01915
North Quincy	Surface Lot	613	MBTA	Red Line	1 Newport Avenue Quincy, MA 02171
North Scituate	Surface Lot	249	MBTA	Greenbush Line	777 Country Way Scituate, MA 02066
Norwood Center	Surface Lot	781	MBTA	Franklin Line	164 Broadway Norwood, MA 02062-3404
Norwood Depot	Surface Lot	219	MBTA	Franklin Line	14 Hill St Norwood, MA 02062-3650
Oak Grove	Surface Lot	727	MBTA	Orange Line	Washington Street at Winter Street, Malden 02148
Plymouth	Surface Lot	96	MBTA	Kingston/Plymouth Line	385 Court Street, Plymouth, MA 02360
Reading	Surface Lot	71	MBTA	Haverhill Line	35 Lincoln St Reading, MA 01867-3133
Readville	Surface Lot	353	MBTA	Franklin Line	1800 Hyde Park Ave Hyde Park, MA 02136-2460
Roslindale Village	Surface Lot	139	MBTA	Needham Line	1 Belgrade Ave Roslindale, MA 02131-3025
Route 128	Garage	2578	MBTA	Providence/Stoughton Line	50 University Ave Westwood, MA 02090
Rowley	Surface Lot	283	MBTA	Newburyport/Rockport Line	70 Railroad Ave Rowley, MA 01969-1211

Station Name	Asset Type	Total Parking Spaces	Ownership	LINE	Address
Salem	Garage	712	MBTA	Newburyport/ Rockport Line	252 Bridge Street Salem, MA 01970
South Attleboro	Surface Lot	579	MBTA	Providence/ Stoughton Line	1315 Newport Ave Attleboro, MA 02703-8040
South Weymouth	Surface Lot	636	MBTA	Kingston/ Plymouth Line	89 Trotter Rd Weymouth, MA 02190-4100
Southborough	Surface Lot	372	MBTA	Framingham/Worcester Line	87 Southville Rd Southborough, MA 01772-2023
Stoughton	Surface Lot	361	MBTA	Providence/ Stoughton Line	45 Wyman St Stoughton, MA 02072-2908
Swampscott	Surface Lot	144	MBTA	Newburyport/Rockport Line	Burrill St & Railroad Ave Swampscott, MA 01907
W Newton Washington St	Surface Lot	45	MassDOT	Framingham/Worcester Line	1395 Washington St Newton, MA 02465-2003
W Newton Webster St	Surface Lot	161	MassDOT	Framingham/Worcester Line	770 Webster Street West Newton, MA 02465
Wakefield	Surface Lot	116	MBTA	Haverhill Line	225 North Ave Wakefield, MA 01880-2314
Walpole	Surface Lot	345	MBTA	Franklin Line	275 West St Walpole, MA 02081- 1608
West Gloucester	Surface Lot	43	MBTA	Newburyport/Rockport Line	290 Essex Ave Gloucester, MA 01930-2350
West Hingham	Surface Lot	231	MBTA	Greenbush Line	20 Fort Hill Rd, Hingham, MA 02043
West Medford	Surface Lot	32	MBTA	Lowell Line	481 High St. Medford, MA 02155- 6735

Station Name	Asset Type	Total Parking Spaces	Ownership	LINE	Address
West Natick	Surface Lot	178	MBTA	Framingham/Worcester Line	249 W Central St Natick, MA 01760-3714,
West Roxbury	Surface Lot	60	MBTA	Needham Line	450 Lagrange St West Roxbury, MA 02132-3226,
Westborough	Surface Lot	448	MBTA	Framingham/Worcester Line	Smith Pkwy & Fisher St Westborough, MA 01581
Weymouth Landing	Surface Lot	290	MBTA	Greenbush Line	121 Commercial St Weymouth, MA 02184
Whitman	Surface Lot	199	MBTA	Kingston/ Plymouth Line	383 South Ave Whitman, MA 02382-2033
Wilmington	Surface Lot	198	191	Lowell Line	405 Main St Wilmington, MA 01887-3630