destination 2040

Needs Assessment

to the Long-Range Tranportation Plan

Needs Assessment

for the Long-Range Transportation Plan of the Boston Region Metropolitan Planning Organization

destination 2040

July 2019

Prepared by
The Central Transportation Planning Staff
to the Boston Region Metropolitan Planning Organization

The Boston Region Metropolitan Planning Organization is composed of

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Metropolitan Area Planning Council
Massachusetts Bay Transportation Authority
MBTA Advisory Board
Massachusetts Port Authority
Regional Transportation Advisory Council
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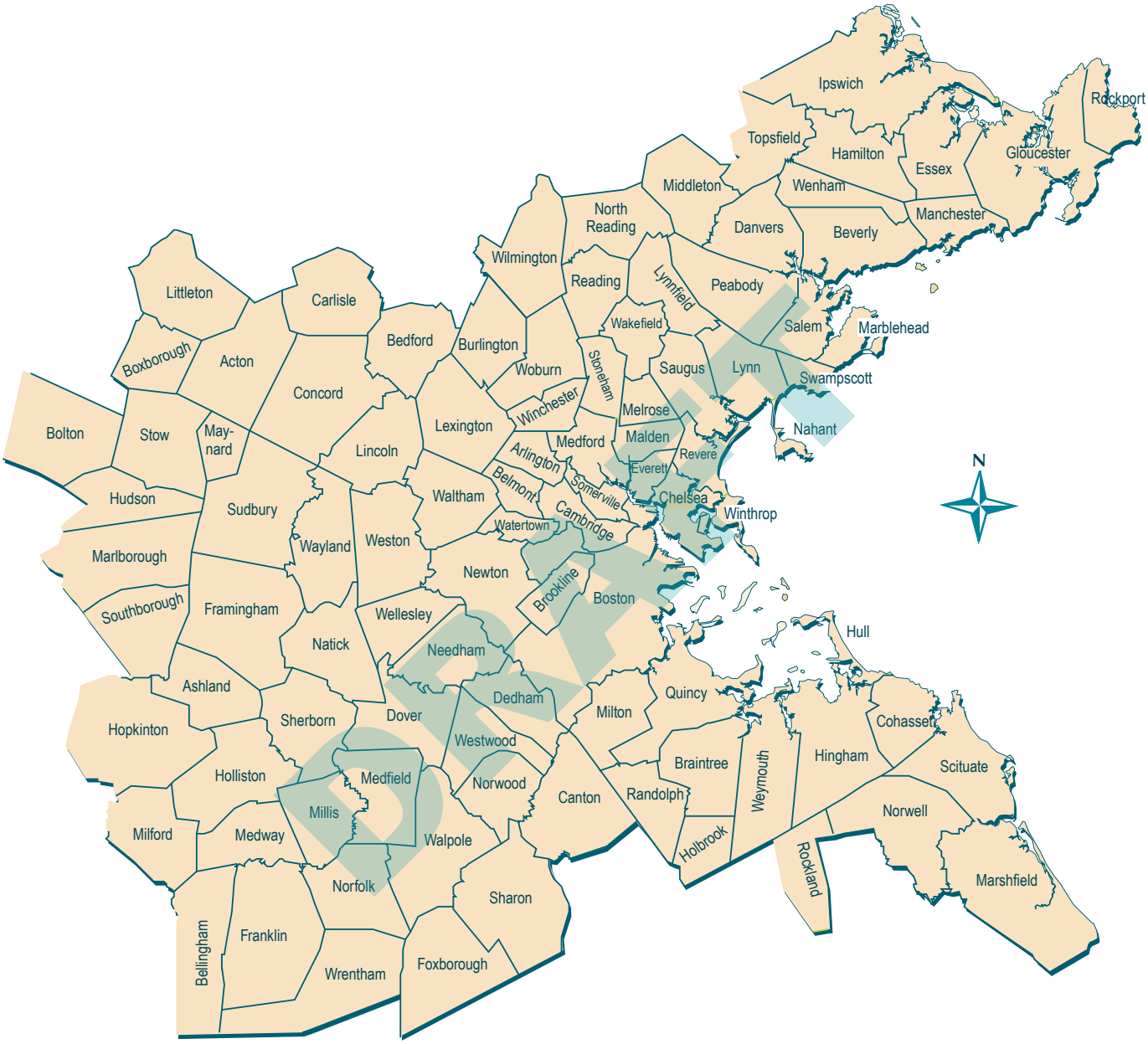
This document was funded in part through grants from the Federal Highway Administration and Federal Transit Administration of the US Department of Transportation. Its contents do not necessarily reflect the official views or policies of the US Department of Transportation.



BOSTON REGION METROPOLITAN PLANNING ORGANIZATION MUNICIPALITIES

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The Massachusetts Bay Transportation Authority, Cape Ann Transportation Authority, and MetroWest Regional Transit Authority, which are Federal Transit Administration Section 5307(c) applicants, have consulted with the MPO and concur that the public involvement process adopted by the MPO for the development of the Transportation Improvement Program satisfies the public hearing requirements that pertain to the development of the Program of Projects for regular Section 5307, Urbanized Area Formula Program, grant applications, including the provision for public notice and the time established for public review and comment.

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chapter 1

Introduction to the Needs Assessment

BACKGROUND

The Long-Range Transportation Plan and Needs Assessment

The Boston Region Metropolitan Planning Organization (MPO) develops a new Long-Range Transportation Plan (LRTP) every four years, as mandated by federal requirements and reaffirmed in the most recent federal transportation reauthorization legislation, *Fixing America's Surface Transportation (FAST) Act*. The LRTP establishes a vision for the Boston region's future transportation system, establishes goals and objectives to achieve the vision, and identifies transportation projects and programs that support the vision and goals.

The Needs Assessment was prepared during the development of the MPO's LRTP, *Destination 2040*. It documents the existing transportation, population, and employment conditions, and contains an analysis and projection of future conditions that indicate prospective transportation demand. It is a critical tool for planning the Boston region's future. This Needs Assessment report provides information about various components of the transportation system, the existing condition, how the system is used, and the projected future use of the system.

Performance-Based Planning and Programming

As required by the *FAST Act,* the MPO is integrating performance-based planning and programming (PBPP) into its practices to develop *Destination 2040* to achieve and document progress toward the MPO's goals. PBPP refers to the transportation agencies' application of performance management in their planning and programming processes to achieve desired outcomes for the multimodal transportation system.

For MPOs, PBPP is a comprehensive planning practice that reflects the MPO's continuing, cooperative, and comprehensive (3C) metropolitan transportation planning process. It involves undertaking a range of activities and producing a variety of products in coordination and consultation with all applicable agencies, organizations, and stakeholders—including the public. The PBPP is fully integrated into the MPO's 3C process, which includes developing:

- A LRTP
- Other plans and processes, including those that are federally required, such as Strategic Highway Safety Plans, Asset Management Plans, the Congestion Management Process (CMP), transit agency Asset Management Plans, and transit agency safety plans, as well as other plans that are not required
- Programming documents, including the Transportation Improvement Program (TIP)
- Studies conducted through the Unified Planning Work Program (UPWP)

The MPO is developing metrics used to monitor and report on transportation characteristics to assess the progress toward the MPO's goals. Through its PBPP practice, the MPO is working to base its transportation investment decisions, for both long-term planning and short-term programming, on the ability to meet the MPO's established goals.

THE BOSTON REGION MPO'S NEEDS ASSESSMENT PURPOSE AND PROCESS

Needs Assessment Purpose and Use

This Needs Assessment report will guide the MPO's decision making on how to address the Boston region's transportation needs through the LRTP, and will guide future decision making on which projects to fund in the TIP, and what studies to conduct through the UPWP. Authorities estimate that the cost of meeting all identified needs for the Boston region will exceed anticipated financial resources between now and 2040. Therefore, it is important to prioritize needs to guide investment decisions for the Boston region.

The information included in the Needs Assessment was used to establish a baseline for the MPO's performance measurement process and for tracking progress toward the MPO's goals and objectives for the transportation system.

Needs Assessment Process

Existing and Future Conditions

A critical first step in developing the LRTP and the MPO's PBPP practice is to gather, organize, and analyze available sources of data about the current transportation system and future conditions. The Boston region's assets system must be inventoried before decisions can be made on how to address problems within the constraints of future funding. This process allows the MPO to understand the many needs that must be addressed for all transportation modes.

Demographics

The forces of an aging population, growing diversity, and economic restructuring will intersect to create a region in 2040 that is markedly different from the one that exists today. Therefore, it is important to establish where people are living, working, and conducting everyday activities to determine how people use the transportation system.

MPO staff and the staff of the Metropolitan Area Planning Council (MAPC), the Boston region's land use planning agency, prepared detailed socioeconomic and land use projections for the year 2040 to support *Destination 2040,* and its Needs Assessment. The Massachusetts Department of Transportation (MassDOT) helped to lead the process by creating a projections committee with members from the Boston Region MPO, other MPOs in the state, MAPC, and other relevant government agencies. This committee oversaw the development of regional population, labor force, household, and employment projections for each MPO in Massachusetts.

Chapter 2 of this Needs Assessment describes the process for establishing the existing conditions and future 2040 socioeconomic projections. The existing and future socioeconomic projections are used in the MPO's regional travel demand model, which analyzes existing and future conditions of the transportation system.

Transportation System Analysis

Data for the Needs Assessment were drawn from a variety of sources to document existing conditions for the Boston region's transportation network. Sources included the MPO's CMP and various MassDOT-managed databases, such as the High-Crash Database, the Massachusetts Household Travel Survey, the Massachusetts Bay Transportation Authority's (MBTA) long-range capital plan, *Focus 40*, the MPO's transportation equity program, and other transportation studies.

Chapter 2 of this Needs Assessment also provides a description of the existing transportation system. Chapter 3 provides a description of the travel patterns in the region as forecasted by the MPO's travel demand model. The travel demand model provides analyses for both the

2016 base year and 2040 no-build conditions. The 2016 base year analysis is based on 2016 population estimates (established in the process described above) and includes projects that were completed and opened for service by the end of 2016. The 2040 No-Build analysis is based on 2040 population projections established in the process described above. In addition to the projects that were completed and opened for service by the end of 2016, the 2040 No-Build network reflects all other projects that were completed between 2016 and 2018, those that were under construction at the time of the analysis, and those that were programmed in the first year of the federal fiscal years 2019–23 TIP. Chapter 3 also provides information on highway, transit, freight, bicycle, and pedestrian travel modes, which use base year (2016) conditions and projects future travel patterns (2040). This information was used to identify transportation needs in the region as summarized in Chapters 4 through 9 by MPO Goal Area.

Public Outreach on Transportation Needs

MPO staff relied on public input to complement its own analyses about existing and future transportation needs in the Boston region. Staff conducted public outreach in 2017 and 2018 for the Needs Assessment. Between online and in-person outreach, MPO staff received a wide variety of feedback on transportation needs and opportunities for improvement.

Staff organized and summarized all of the public input received by goal area in the "Stakeholder/Public Input" sections included in Chapters 4 through 9. MPO staff incorporated this input into its recommendations to address the Boston region's transportation needs, which are summarized in Chapter 10. More detail on the public outreach process for the Needs Assessment is included in Appendix D.

The Boston Region MPO's Vision, Goals, and Objectives

The Boston Region MPO's vision, goals, and objectives are an important part of the Needs Assessment. As such, the Needs Assessment is set up by the MPO's goal areas to outline transportation needs in the region. In addition, the input collected during the Needs Assessment outreach process was used to revise the vision, goals, and objectives, adopted as part of the previous LRTP, *Charting Progress to 2040*. Staff found that most of the goals and objectives established in *Charting Progress to 2040* were broad enough to cover the topics and concerns identified from public comments as well as results from analyses conducted for the *Destination 2040* Needs Assessment. Changes that were warranted included those to

- Better align the objectives with the roles and responsibilities of the MPO;
- Incorporate additional feedback heard during outreach; and
- Incorporate new planning requirements.

The complete process of the revisions to the vision, goals, and objectives is included in Appendix E. The *Destination 2040* vision, goals, and objectives are shown in Figure 1.1.

Figure 1-1
Destination 2040 Vision, Goals, and Objectives

CENTRAL VISION STATEMENT

The Boston Region Metropolitan Planning Organization envisions a modern, well-maintained transportation system that supports a sustainable, healthy, livable, and economically vibrant region. To achieve this vision, the transportation system must be safe and resilient; incorporate emerging technologies; and provide equitable access, excellent mobility, and varied transportation options.

GOALS	OBJECTIVES
SAFETY	
Transportation by all modes will be safe	• Reduce the number and severity of crashes and safety incidents for all modes • Reduce serious injuries and fatalities from transportation • Make investments and support initiatives that help protect transportation customers, employees, and the public from safety and security threats
SYSTEM PRESERVATION AND MODERNIZATION	
Maintain and modernize the transportation system and plan for its resiliency	• Maintain the transportation system, including roadway, transit, and active transportation infrastructure, in a state-of-good repair • Modernize transportation infrastructure across all modes • Prioritize projects that support planned response capability to existing or future extreme conditions (sea level rise, flooding, and other natural and security-related man-made impacts)
CAPACITY MANAGEMENT AND MOBILITY	
Use existing facility capacity more efficiently and increase transportation options	• Improve access to and accessibility of all modes, especially transit and active transportation • Support implementation of roadway management and operations strategies to improve travel reliability, mitigate congestion, and support non-single-occupant vehicle travel options • Emphasize capacity management through low-cost investments; prioritize projects that focus on lower-cost operations/management-type improvements such as intersection improvements, transit priority, and Complete Streets solutions • Improve reliability of transit • Increase percentage of population and employment within one-quarter mile of transit stations and stops • Support community-based and private-initiative services and programs to meet first/last-mile, reverse commute, and other non-traditional transit/transportation needs, including those of people 75 years old or older and people with disabilities • Support strategies to better manage automobile and bicycle parking capacity and usage at transit stations • Fund improvements to bicycle/pedestrian networks aimed at creating a connected network of bicycle and accessible sidewalk facilities (both regionally and in neighborhoods) by expanding existing facilities and closing gaps • Increase percentage of population and places of employment with access to facilities on the bicycle network • Eliminate bottlenecks on freight network/improve freight reliability • Enhance freight intermodal connections
TRANSPORTATION EQUITY	
Ensure that all people receive comparable benefits from, and are not disproportionately burdened by, MPO investments, regardless of race, color, national origin, age, income, ability, or sex	• Prioritize MPO investments that benefit equity populations* • Minimize potential harmful environmental, health, and safety effects of MPO funded projects for all equity populations* • Promote investments that support transportation for all ages (age-friendly communities) • Promote investments that are accessible to all people regardless of ability *Equity populations include people who identify as minority, have limited English proficiency, are 75 years old or older or 17 years old or younger, or have a disability; or are members of low-income households.
CLEAN AIR/SUSTAINABLE COMMUNITIES	
Create an environmentally friendly transportation system	• Reduce greenhouse gases generated in Boston region by all transportation modes • Reduce other transportation-related pollutants • Minimize negative environmental impacts of the transportation system • Support land-use policies consistent with smart, healthy, and resilient growth
ECONOMIC VITALITY	
Ensure our transportation network provides a strong foundation for economic vitality	• Respond to mobility needs of the workforce population • Minimize burden of housing/transportation costs for residents in the region • Prioritize transportation investments that serve residential, commercial, and logistics targeted development sites and "Priority Places" identified in MBTA's *Focus 40* plan • Prioritize transportation investments consistent with compact-growth strategies of the regional land use plan

Source: Boston Region MPO.

Summary of Needs and Recommendations

MPO staff developed the Needs Assessment after following the steps described above and presented a summary of these findings by goal area, included in Chapters 4 through 9. As mentioned, recommendations to address transportation needs, based on data and analysis of the Needs Assessment, are presented in Chapter 10. Specifically, staff recommends programs, studies, and actions that the MPO should continue or implement for the first time. This summary was used to identify investment programs to include in *Destination 2040* and the TIP, and also identify studies that should be considered as part of the UPWP.

Next Steps in *Destination 2040* Development

The MPO used this summary of needs and recommendations in discussions for programming transportation funds for major infrastructure projects—those projects that cost more than $20 million and/or add capacity to the transportation system—and investment programs in *Destination 2040*. The next steps taken in the LRTP development process are outlined in the *Destination 2040* LRTP document and include:

- Establishing a Universe of Projects list
- Establishing a Universe of Programs list
- Evaluating projects and programs based on the MPO's vision, goals, and objectives
- Establishing finances available to the MPO for programming in the LRTP
- Reviewing alternative scenarios for projects and programs
- Selecting projects and programs
- Performing required analyses:
    - Systems Performance Report—discusses investments in LRTP and how they may relate to elements of the MPO's PBPP framework, including the MPO's goals, performance measures, and targets
    - Transportation Equity (TE) Analysis—ensures that the recommended set of projects and programs provides equitable benefits to both TE and non-TE populations
    - Air Quality Conformity Analysis—ensures that the LRTP is consistent with the Commonwealth's plans for attaining and maintaining air-quality standards
    - Greenhouse Gas Analysis—results in a report of the carbon dioxide emissions associated with the projects and programs being included in the LRTP, as required for implementing the Massachusetts Global Warming Solutions Act

ORGANIZATION OF THE NEEDS ASSESSMENT

The Needs Assessment is composed of two items, this written document and the Needs Assessment applications. The applications, created for the MPO's website, provide the data and information used in developing the Needs Assessment. The Needs Assessment is a critical tool that provides information about various components of the transportation system, including the system's existing condition, how the system is used, and the projected future use of the system.

Needs Assessment Document

As described above, the MPO's Needs Assessment is a compilation of existing transportation, population, and employment conditions, and analysis and projections of future conditions that indicate prospective transportation demand. MPO staff studied individual corridors and districts in the Boston region to understand current travel patterns and trends, projected future travel demand, and transportation conditions. Staff combined the information gathered to analyze the entire region. These corridors and districts are described in Chapter 3 along with information on travel patterns. Information about the transportation system helps the Boston Region MPO evaluate its performance relative to goals regarding safety, system preservation, capacity management and mobility, greenhouse gases and air pollutants, transportation equity, and economic vitality. Staff used information from previous and ongoing transportation planning work, including the *Charting Progress to 2040* LRTP, the MBTA's long-range capital plan, *Focus 40*, the MPO's CMP, public outreach, transportation equity outreach, MPO studies, and special studies to update the Needs Assessment.

Needs Assessment Applications

To provide the public with detailed information used in the development of the Needs Assessment, staff have created specific applications to illuminate data gathered in the process. These applications may be found on the MPO's website, and include:

- LRTP—Needs Assessment Application (https://www.ctps.org/maploc/www/apps/lrtpNeedsAssessmentApp/index.html)
- CMP Dashboards
    - Express Highway Performance Dashboard (https://www.ctps.org/maploc/www/apps/express_dashboard_2015_Final/index.html)
    - Arterial Performance Dashboard (https://www.ctps.org/maploc/www/apps/arterial_dashboard_2015_Final/index.html)
- Livable Communities Data Browser (https://www.ctps.org/dv/lcApp/index.html)

- All-Hazards Planning Application (https://www.ctps.org/map/www/apps/eehmApp/pub_eehm_index.html)
- Vehicle-Miles Traveled and Emissions Data Browser (https://www.ctps.org/dv/vmtApp/index.html)
- Performance Dashboard: Transportation in the Boston Region (https://www.ctps.org/dv/lrtp_dashboard/)

The MPO's travel demand model (updated with data from the most current (2011) Massachusetts Household Travel Survey) and demographic projections were also used in the Needs Assessment. Existing and projected socioeconomic information (population, housing, and employment data) and the existing and proposed transportation network were important factors in determining transportation needs. A base year of 2016 and a future year of 2040 were used in the modeling process for the transportation network and socioeconomic data.

A detailed description of the modeling process can be found at https://www.ctps.org/travel_modeling_101.

Information used in the updated *Destination 2040* Needs Assessment is documented on the MPO's website. It may be found by accessing the LRTP Needs Assessment webpage, and can be found at https://www.bostonmpo.org/lrtp_needs , or through the Data Catalog webpage, https://www.bostonmpo.org/data-catalog, under the LRTP category.

chapter 2

Land Use and the Transportation System

DEFINITION OF THE STUDY AREA

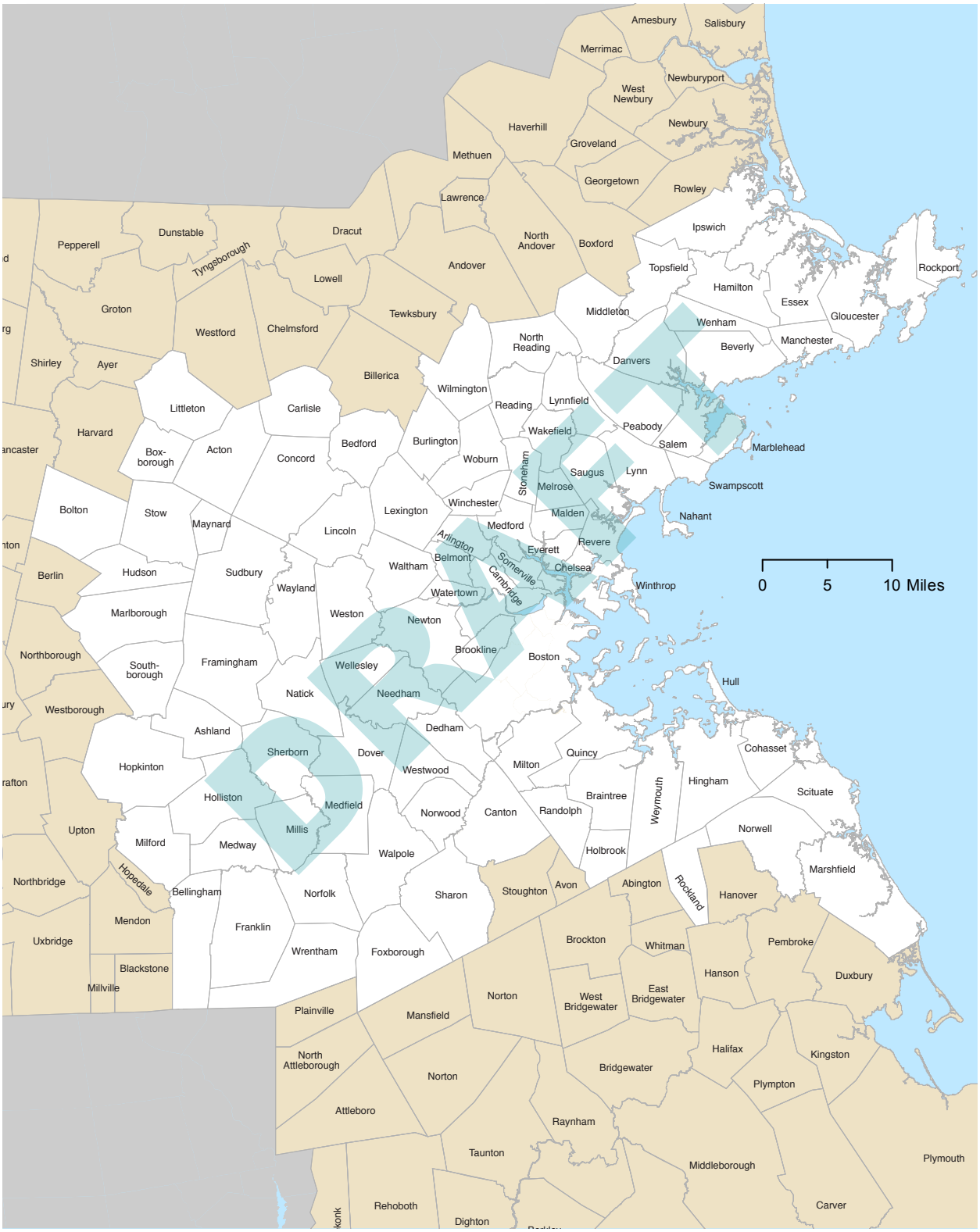
The Boston Region Metropolitan Planning Organization (MPO) encompasses 97 municipalities extending from Ipswich on the North Shore to Marshfield on the South Shore as shown in Figure 2-1. The region's outer circumferential highway, Interstate 495, passes through 11 MPO municipalities. In 2010, the population of the MPO was 3,086,000 making it the fifteenth most populous MPO in the country. The MPO's land area, however, is a comparatively small 1,381 square miles, the ninety-third largest MPO in geographical size.

The MPO's small land area has important implications for transportation planning. For example, out of the 139 stations in the Massachusetts Bay Transportation Authority's (MBTA) commuter rail system, 35 are located outside of the Boston Region MPO area. Also, many warehouses and logistic centers serving the Boston Region MPO are located in neighboring MPOs. Therefore, there is a heightened need for coordination with the Commonwealth and other MPO's across the state.

This chapter describes the existing land use as well as the land use projected for 2040 in the Boston Region MPO area. It also describes the existing transportation system including:

- Roadway Systems
- Public Transit
- Regional Rail
- Civil Air Space
- Navigable Waterways
- Multiuse Paths

Figure 2-1
Boston Region MPO Area



Source: Boston Region MPO.

EXISTING LAND USE IN THE BOSTON REGION MPO AREA

Background

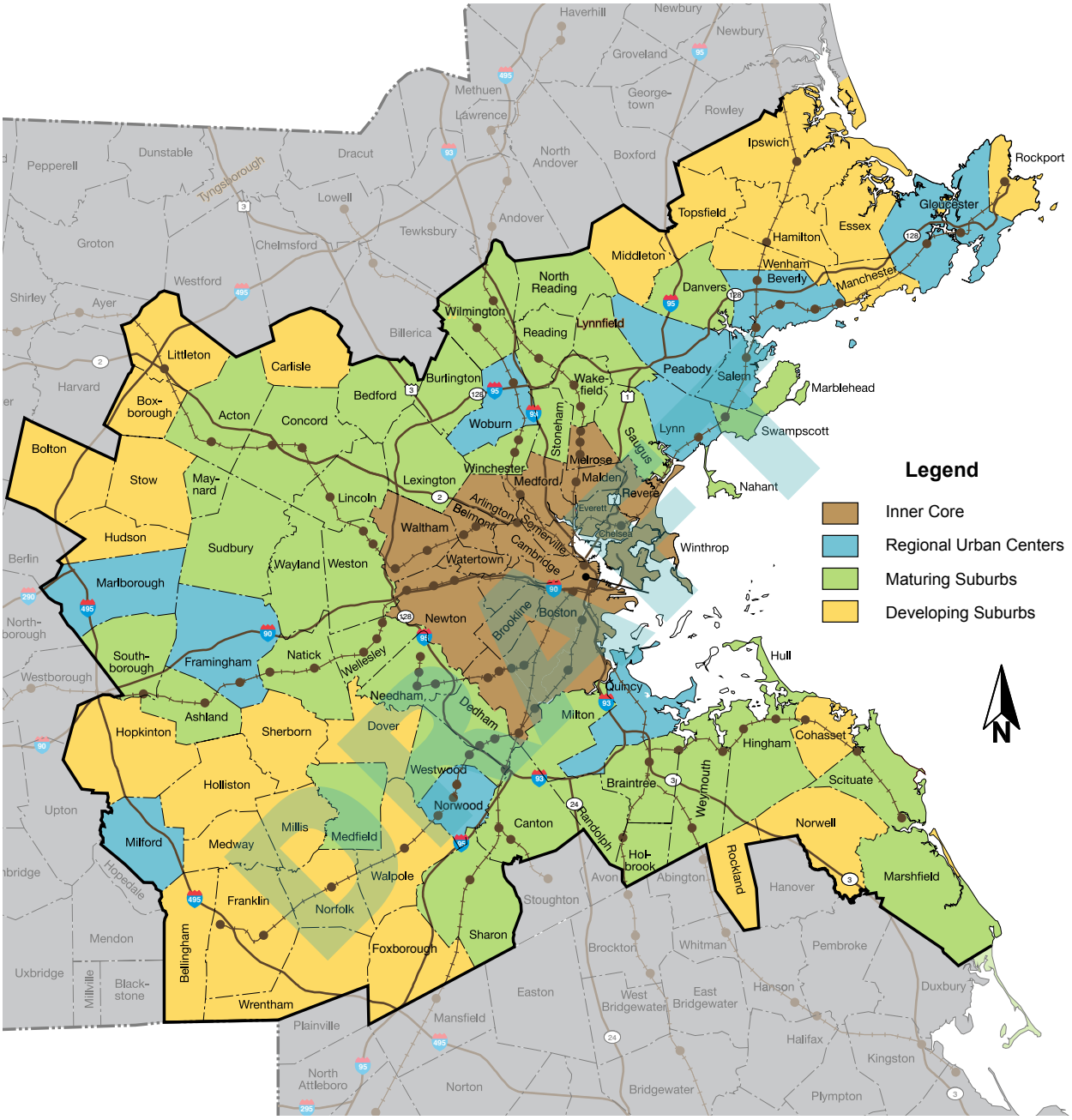
The Boston Region MPO area is a mature region with the majority of jobs and population located in a dense urban core. This region is composed of 97 cities and towns, each with its own land use regulatory authority.[1] These municipalities are connected by a diverse network of local roads, highways, rail lines, bus routes, and rapid transit services.

In order to understand how regional trends will affect the region's diverse communities over the coming decades, the Metropolitan Area Planning Council (MAPC) has identified four basic community types (shown in Figure 2-2) as the Inner Core, Regional Urban Centers, Maturing Suburbs, and Developing Suburbs. While each city and town is unique, communities within each community type share important characteristics that will influence their development in the coming decades. The criteria used to define community types include land use and housing patterns, recent growth trends, and projected development patterns.[2] The following sections describe the four basic community types in detail, along with Priority Development Areas, Priority Preservation Areas, and transit-oriented development in the Boston Region MPO area.

[1] Throughout this chapter, the term "Boston Region MPO area" and "Metropolitan Area Planning Council (MAPC)" both refer to the 97 municipalities in the Boston Region MPO area, which are the same as MAPC's 101 cities and towns excluding Hanover, Duxbury, Pembroke, and Stoughton, which are now members of the Old Colony Planning Council MPO.

[2] Please reference http://www.mapc.org/wp-content/uploads/2017/09/Massachusetts-Community-Types-Summary-July_2008.pdf for more documentation on Massachusetts community types.

Figure 2-2
Metropolitan Area Planning Council Community Types



Source: Metropolitan Area Planning Council.

The Inner Core

The Inner Core consists of the high-density cities of Boston, Cambridge, Somerville, Revere, Everett, and Chelsea, as well as more residential streetcar suburbs, such as Arlington and Brookline. There are 16 cities and towns in the Inner Core (within Route 128) that are classified as Streetcar Suburbs, which are built around village-scale commercial districts. The Inner Core has little vacant developable land, yet has experienced large gains in employment and residents in recent years as households shift to prefer dense, walkable areas. Virtually all recent development has occurred through infill and reuse of previously developed land. Multifamily housing is a significant component of the housing stock, as are rental and subsidized housing. Most employment is concentrated in downtown Boston and portions of Cambridge.

Regional Urban Centers

This community type includes urbanized municipalities (both cities and towns), located outside of the Inner Core. Eleven Regional Urban Centers are located in the Boston Region MPO area. These communities are characterized by an urban-scale downtown core with multiple blocks of multistory and mixed-use buildings. Moderately dense residential neighborhoods surround this core; in some cases, lower-density, single-family residential development surrounds these neighborhoods. Some of these communities are considered "built out," while other communities still have undeveloped but potentially developable land. Rental housing and multifamily structures compose a significant portion of the housing stock, and many of these communities have large or growing immigrant populations, such as Framingham and Lynn.

Maturing Suburbs

There are 43 towns classified as Maturing Suburbs in the Boston Region MPO area. These municipalities are moderate-density residential communities that have a very limited supply of currently undeveloped but potentially developable land (less than 25 percent of the land area). Most Maturing Suburbs are predominantly "bedroom communities" where less than 20 percent of the land area is devoted to commercial and industrial uses, although a few of these towns are significant job centers. More than half of the housing units are owner-occupied single-family homes.

Developing Suburbs

There are 27 towns in the Boston Region MPO area classified as developing suburbs. Most of these municipalities are located along Interstate 495 and on the North and South Shores. These are less-developed towns that have large expanses of currently undeveloped land that could be converted to developable uses. While the vast majority of housing is in single family

homes, some of these towns have a locally significant stock of rental units in larger complexes and in modestly sized multifamily structures. Many of these towns have a well-defined, mixed-use town center surrounded by moderately dense neighborhoods. Others areas are more rural, with sparse residential development and town or village centers that have historical and civic significance but little commercial or neighborhood function. The extent of economic development varies, but generally is quite limited.

Priority Development and Preservation Areas

Many cities and towns in the developing suburbs have planned ahead by identifying and prioritizing areas for growth and preservation. In many cases, identification of these priority areas has occurred through a subregional process involving multiple adjacent municipalities, the MAPC, and participating state agencies. This process entails

1. Identification of local priority areas;
2. Geographic information system-aided screenings of those areas to select regional priorities most consistent with MAPC's regional plan *MetroFuture*; and
3. In most cases, further refinement of priority areas by the Executive Office of Housing and Economic Development (for priority development areas) and the Executive Office of Energy and Environmental Affairs (for priority preservation areas)

Priority Development Areas (PDAs) may range in size from a single lot to many acres, and may include sites that are appropriate for housing, commercial development, industrial uses, or some combination of the above. PDAs may be considered "greenfield" sites,[3] major redevelopment areas, infill opportunities, or adaptive reuse of existing buildings to preserve a sense of place.

While localities generally identify a wide range of priority sites, the screening process for select regionally-significant PDAs is designed to identify those with the following features:

- Significant capacity to support additional development or redevelopment, even if that development may first require additional investment in infrastructure
- Good transportation access, including transit and walkability for housing and commercial development, and highway access for industrial or office sites
- Existing infrastructure (primarily water and sewer)
- Low level of environmental constraints such as wetlands, flood plains, protected open space, and steep slopes
- Existing community plans for development and demonstrated real estate interest and market activity

[3] A greenfield site is an undeveloped site being considered for development.

In addition to PDAs identified through a subregional planning process, the MPO and MAPC also recognize areas designated under state programs such as Chapter 43D (expedited permitting), Chapter 40R (smart growth zones) or Economic Opportunity Areas.

Priority Preservation Areas' features include

- Significant environmental factors and/or natural features, such as endangered-species habitats, large blocks of high-quality intact habitat for natural communities and ecosystem diversity, areas critical to the water supply, scenic vistas, areas important to a cultural landscape, or areas of historical significance
- Currently protected land, for example, via a conservation restriction, municipal or state conservation land, and land trust ownership
  (In general, existing parks and new park facilities do not fall within this category.)
- Linked open space and trails within a community across municipal boundaries that are part of a larger, regional network

Transit-Oriented Development

Transit-oriented development (TOD) has been a large part of Boston's growth since the earliest horse-drawn railways, and many of the region's city and town centers reflect the influence of former streetcars that stretched throughout the area. The Boston Metropolitan area (Metro Boston) is also experiencing a new wave of growth near transit service with hundreds of residential and commercial developments under way and more on the horizon. MAPC's database of recent, current, and future development indicates that 60 percent of inventoried housing development and 71 percent of commercial development planned for 2018 and after are located within one-half mile of commuter rail or transit service.[4] Cities and towns are creating plans for developing areas near transit stations, and are also updating their zoning to unlock development potential. The MBTA is accepting proposals for major developments on MBTA-owned parcels; state agencies are using transit proximity as a criterion for prioritizing infrastructure or housing resources; and the development community is finding a strong market for residential and commercial space near MBTA stations and stops.

FUTURE LAND USE: FROM 2010 TO 2040

Background

The forces of an aging population, growing diversity, and economic restructuring will intersect to create a markedly different region in 2040 from the one that exists in the Boston Region MPO area today. The next section describes these differences by breaking them out into key trends.

[4] MassBuilds: A visual database for detailed information on real-estate developments in Massachusetts. www.massbuilds.com

The MAPC, the region's land use planning agency, is responsible for preparing detailed transportation analysis zone (TAZ)-level socioeconomic and land use projections to the year 2040 to support the Long-Range Transportation Plan (LRTP). The Massachusetts Department of Transportation (MassDOT) helped lead the process for this LRTP by creating a projections committee with members from each of the state's MPOs, MAPC, Central Transportation Planning Staff (CTPS), and other relevant government agencies. This committee oversaw the development of regional population, labor force, household, and employment projections for each MPO in the state. MAPC and the University of Massachusetts Donahue Institute (UMDI) were contracted as technical leads for the production of these projections. The UMDI developed population and employment projections while MAPC developed household and labor force projections. CTPS served as a member of the committee and contributed to the development of the methods as well as preparation of specific deliverables such as group quarters projections and auto availability estimates. To advise this process and the methods used for creating these projections, MAPC convened a projections advisory group with representatives from state agencies, academic experts, and staff from Boston and Cambridge.[5]

The process to create the regional projections relied on the consistency between population, households, labor force, and employment. UMDI relied on recent rates of births, death, and migration to create a future year population for each MPO region and municipality using a traditional cohort component method. These estimates were calibrated to match the 2015 municipal and regional population estimates. With those population projections as the input, MAPC relied on age-specific headship rates, and labor force participation rates specific to age, sex, and educational attainment to produce regional projections of workers and households for the forecast years.[6]

MAPC was then tasked with allocating the Boston Region MPO's projected population, households, workers, and employment to TAZs. First, the region's households were grouped into "agents" based on demographic characteristics such as age, income, and presence of children. MAPC then allocated these household agents and employment types based on four key inputs:

[5] Advisory group participants included representatives from the Federal Reserve Bank of Boston, Massachusetts Housing Partnership, Northeastern University's Dukakis Center for Urban and Regional Policy, City of Cambridge, UMDI, MassDOT, Executive Office of Labor and Workforce Development, City of Boston, Joint Center for Housing Studies at Harvard University, and the Executive Office of Energy and Environmental Affairs.

[6] Headship rates by age were derived from 2008–12 American Community Survey Public Use Microdata Sample (PUMS) data so that recent headship rates influenced by the tight housing market were not continued forward. Labor force participation rates were derived from 2012–16 PUMS data to reflect most recent trends in delayed retirement. Please refer to the technical documentation *Massachusetts Regional Labor Force and Household Projections Prepared for MassDOT Office of Transportation Planning* for more details.

1. Existing distribution of agents and jobs
2. A development pipeline inventory, MassBuilds, showing planned and proposed housing units and commercial space
3. Estimated development capacity
4. Access to employment, retail, and services based on existing travel attributes

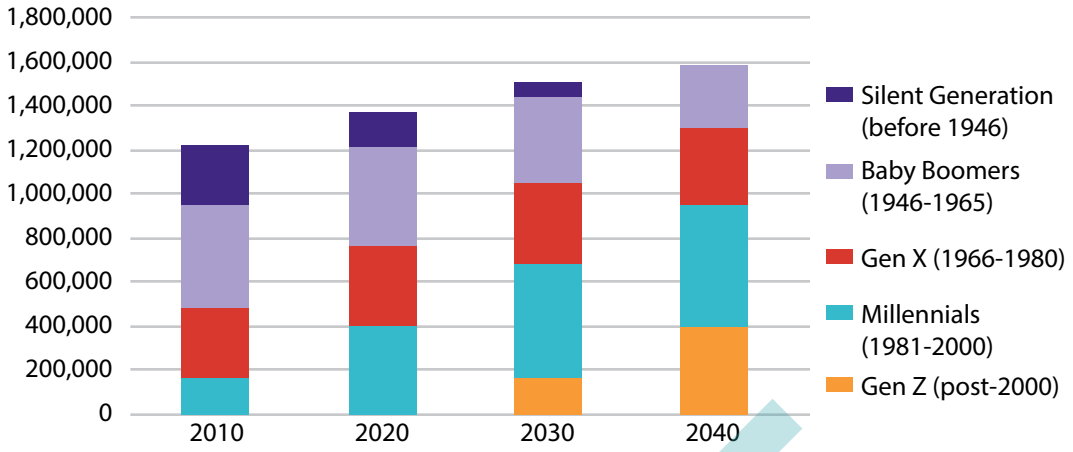
Overall, the land use scenario created for the LRTP, *Destination 2040,* involves key assumptions about the future and reflects large-scale, long-term land use trends in the region due to an aging population, a restructured economy, and the investment in development projects already planned. These key trends are described in the following sections.

Population and Housing Demand—Key Trends

1. Demographic shifts, even without changes in household formation preferences, will fundamentally change the type of households living in our region in 2040

The aging of the population will have large impacts, not just on the number of households in the future, but on the type of households that will exist. In 2010, the majority of households in the region were headed by someone born before 1965, with the baby boomers comprising the largest share of householder. As shown in Figure 2-3, as this generation ages, it will result in a large increase in senior households, and eventually outmigration and mortality will cause a steady decline in the number of baby boomer-headed households. Meanwhile, millennials (born 1981–2000) and generation Z (post-2000) will form new households in great numbers, and by 2040, the majority of the region's households will be headed by someone born after 1980. While it is hard to say exactly what location and travel preferences these households will exhibit, it is likely that the habits of these householders, shaped by a near-lifelong availability of the internet, mobile devices, and on-demand mobility, will differ substantially from their predecessors.

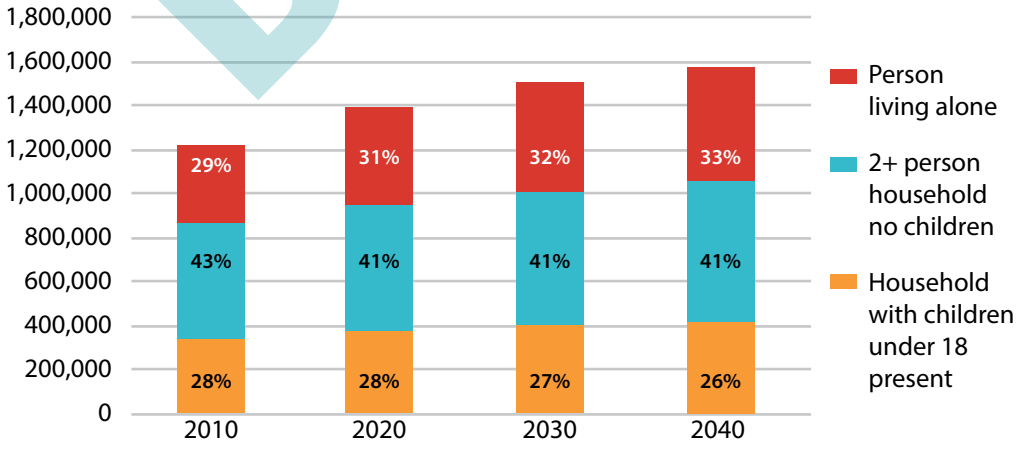
Figure 2-3
Households by Householder Year Born: 2010–40



Source: Boston Region MPO.

As this demographic transformation takes place, the projections suggest that the number of households with children under the age of 18 will remain relatively stable. However, families with children will comprise of a smaller share of total households (28 percent in 2010, 26 percent in 2040), and the average number of children per family will decline 15 percent from 1.8 to 1.6 across the same time period.

Figure 2-4
Households by Household Type: 2010–40

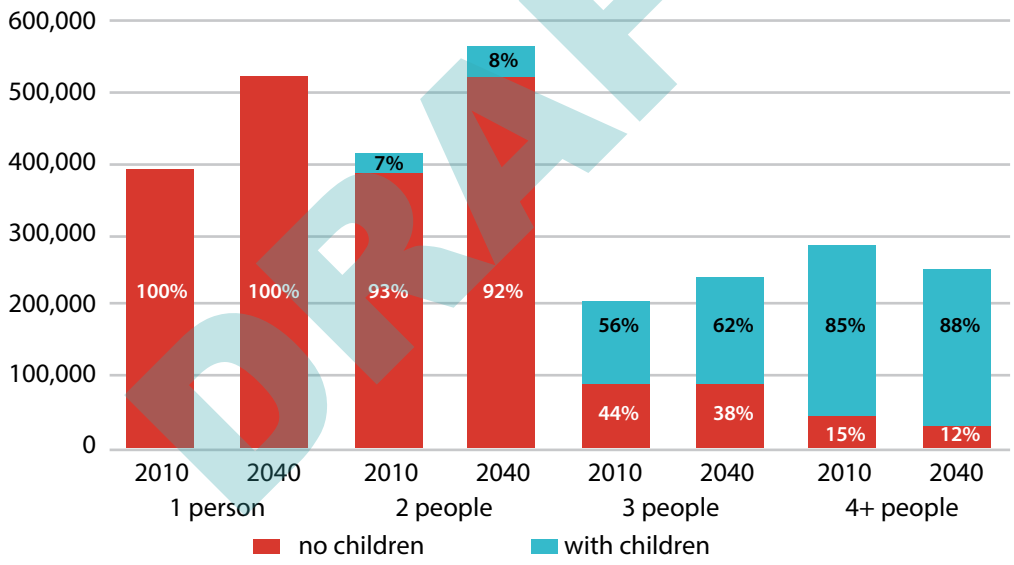


Source: Boston Region MPO.

2. New housing demand will outpace population growth due to declining household size

Since seniors comprise a larger share of households, the region's demand for housing units will outpace its population growth. A large part of this demand is due to the increase in single-person households, which are projected to grow from 362,000 in 2010 to 514,000 in 2040. Average household size would likely decline by 8.4 percent from 2010 to 2040 as the number of one- and two-person households increase by 41 percent and 48 percent, respectively. This change is driven largely by the growth in smaller senior households, which occur as baby boomers age out of their family-rearing years into their senior years. The region's population is projected to grow by 20 percent from 2010–40 while the number of households will grow by 30 percent. Statewide, the population is projected to grow 13 percent and households are projected to grow 24 percent over that same time period.

Figure 2-5
Households by Size and Type: 2010–40



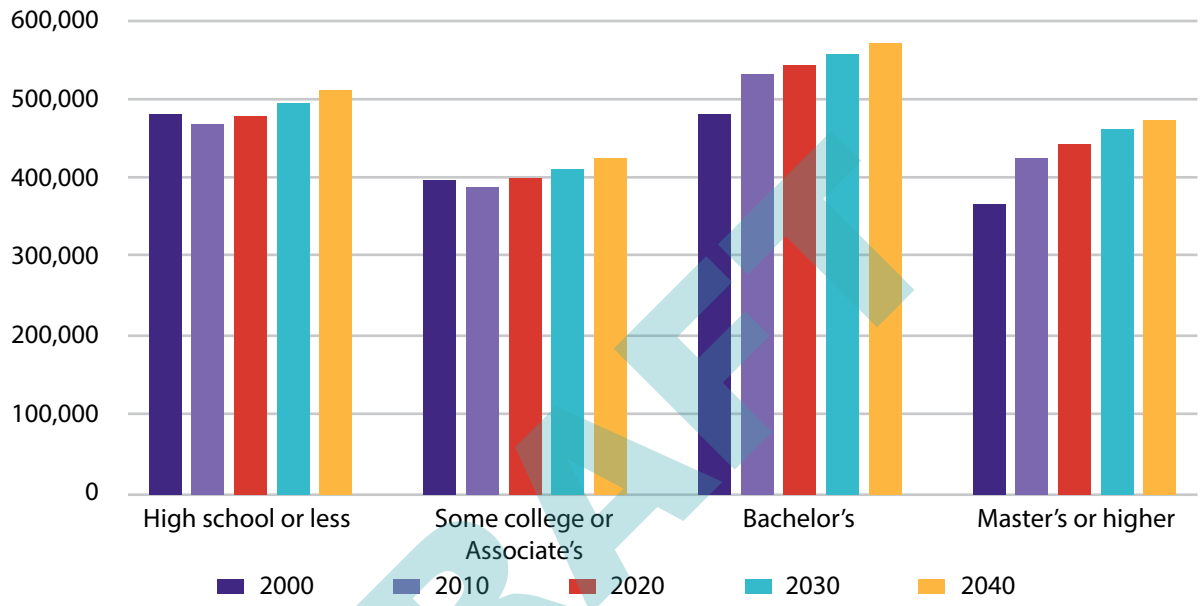
Source: Boston Region MPO.

3. The Boston region will have a labor force with more formal education than the labor force of today

Labor force projections for the region anticipate larger increases in those with a Bachelor's degree or higher (23 percent) than labor force participants with either an Associate's degree or less (7 percent). This could benefit the region as both retail and basic employment

opportunities shrink. These projections assume current rates of educational attainment level by age (while current rates of labor force participation by age, sex, and educational attainment), which means these numbers could be underestimating education levels of the labor force as millennials continue to accumulate more degrees than their parents.

Figure 2-6
Labor Force Projections by Educational Attainment



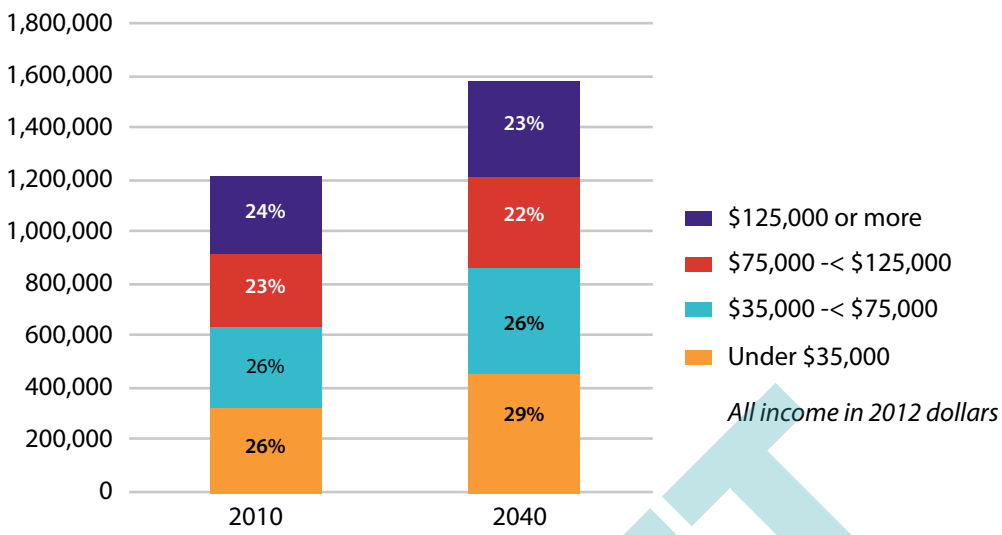
Source: Boston Region MPO.

4. A larger share of Metro Boston's households will be low income

Households earning less than $35,000 in 2012 dollars are projected to increase 41 percent from 2010 to 2040 while the total household growth is only projected to increase by 30 percent. This is largely due to the increase in senior-headed households, which are largely comprised of retired workers on a fixed income. These projections do not trend forward any continued wage polarization in the region, which could dramatically alter these projections and make the growth in low-income households even greater.[7]

[7] Economists refer to the polarization of the labor force when middle-class jobs (requiring a moderate level of skills) seem to disappear relative to those at the bottom, requiring few skills, and those at the top, requiring greater skill levels.

Figure 2-7
Projected Households by Income



Source: Boston Region MPO.

Regional Economic Growth—Key Trends

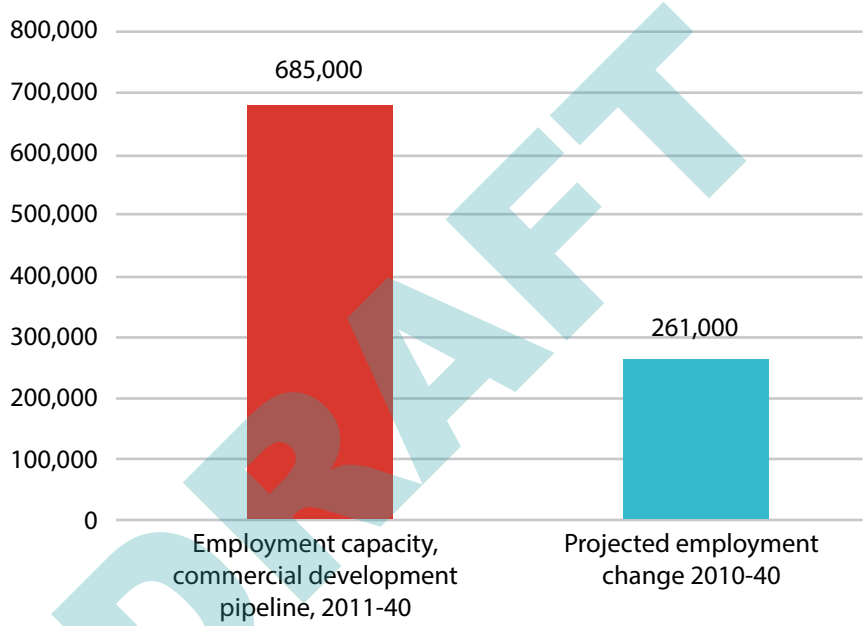
1. Availability of labor will be a fundamental constraint on job growth

Economic forecasts based only on recent growth rates suggest that the region's employment could grow by leaps and bounds over the coming decades. However, a limited supply of workers are likely to be a major constraint on growth. Even with labor force participation rates rising for older adults, the baby boomers will eventually leave the labor force, diminishing the supply of workers and the corresponding job growth potential. MAPC's labor force projections estimate a labor force growth of 15 percent over a 30-year period, averaging about 0.4 percent per year from 2020–30 and 0.3 percent per year from 2030–40. A statewide analysis indicates that the problem may be worse for other regions of Massachusetts than for the Boston MPO area, where seven out of 13 regional planning agencies show no growth or declines in their labor force over the coming decades. However, it is projected that jobs in the Boston MPO area will increase by 14 percent, or 261,000 jobs, from 2010 to 2040.

One way to compare these projections against market activity is by looking at MAPC's MassBuilds dataset. MassBuilds is a collaborative inventory of recently completed, in-construction, or planned commercial or residential development across Massachusetts. Projects in MassBuilds are inputted by municipal planning staff, regional planning agencies, and engaged residents. Most project information input is based on local news sources,

planning board documents, or local planning knowledge. MAPC's MassBuilds dataset shows that there is more commercial real estate development planned or envisioned for the region than there are projected jobs for the same area. This information suggests that the supply of commercial development in the pipeline may exceed demand. As a result, it is likely that some of the region's major planned office and commercial projects may not materialize or may not reach full occupancy; or that existing commercial real estate may experience higher vacancy rates, or some combination of the two scenarios.

Figure 2-8
MassBuilds Job Capacity vs. Projected Employment



Source: Boston Region MPO.

2. The economy will continue to experience significant restructuring and shifts between different sectors

Given the relatively slow pace of overall job growth projected for the coming decades, the growth and decline of certain sectors may have more impact on the region's economy than the absolute change in the number of jobs. Based on historical trends and national projections by sector, UMDI forecasted that certain sectors would most likely grow rapidly while others would experience continued declines. Specifically, the educational services sector, including colleges and universities, is projected to grow 44 percent in the Boston MPO

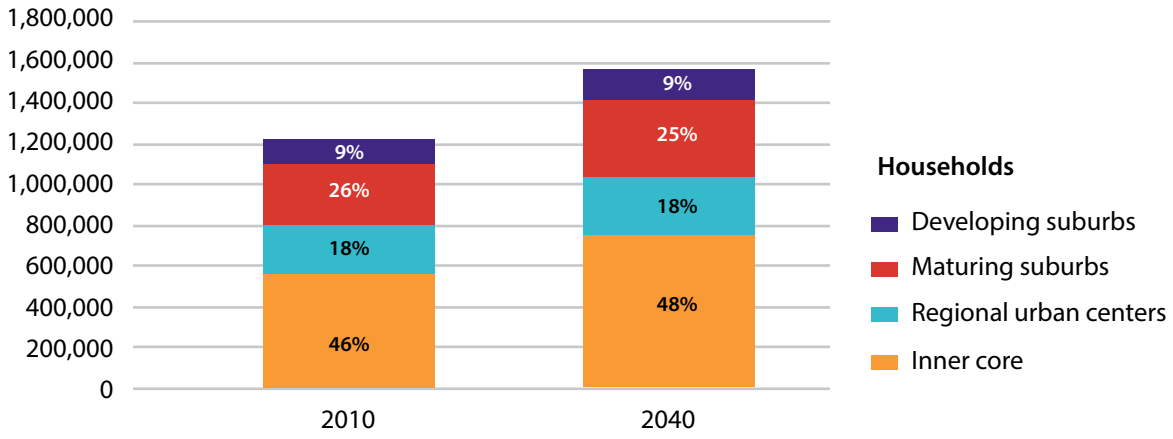
area and health care and social assistance jobs are projected to grow 40 percent. Together these sectors are projected to gain over 160,000 jobs. Meanwhile, the share of jobs in financial activities and insurance are expected to decrease, while the manufacturing, wholesale trade, retail trade, and utilities sectors are also projected to decline substantially. This reflects long-term trends in production and commerce, with more overseas manufacturing and online purchasing, and fewer labor-intensive retail operations. The slight declines in both basic and retail employment with a growth in service employment could result in the need to repurpose existing buildings and dramatically alter the land use in areas that have large employment centers in these sectors.

Location Choice—Key Trends

1. We anticipate a continued resurgence of urban communities

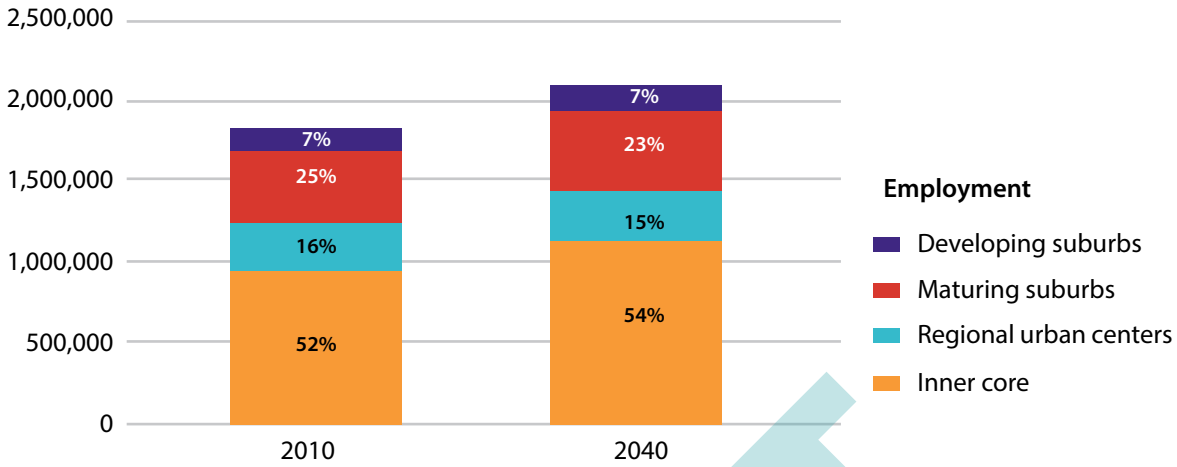
Past trends show that many urban municipalities—both in the Inner Core and outlying regional urban centers—experience a large influx of young people but lose them to suburban communities as those residents form families. However, those trends have changed in recent years. When compared to the 1990s, more young people have been moving to urban communities and only a slight number have moved out once they turn 20. An increasingly diverse population attracted by the job proximity, transit access, vibrancy, and cultural assets of urban areas will likely drive continued population growth. MassBuilds data collected since 2010 shows commercial development is more likely to be built near public transportation. From 2010 through 2014, 48 percent of commercial development was within half a mile of public transportation, and 57 percent from 2015 through 2018. Looking out to 2030, 68 percent of commercial development projects in the pipeline are located near public transit.

Figure 2-9
Households by Community Type



Source: Boston Region MPO.

Figure 2-10
Employment by Community Type



Source: Boston Region MPO.

2. It is difficult to predict winners and losers in the decline of basic and retail employment

As described above, losses are projected for both basic and retail employment in the region between 2010 and 2040. To both account for projected development in these sectors in MassBuilds and avoid any major municipal employment loss, MAPC allocated employment in both the basic and retail sectors based on the 2010 employment numbers and any proposed projects in the development pipeline. Due to the difficulties in predicting which industrial and retail centers are better positioned to weather the coming economic changes, and which are more likely to see substantial declines, MAPC adjusted basic and retail employment downward across the region. As a result, no specific employment center is projected to experience catastrophic decline or revival. Instead, this land use scenario reflects the thought that all retail and basic sites will experience slight declines with the overall decline in regional employment. It was projected that the declines in retail were more likely in Maturing Suburbs and Developing Suburbs than the Inner Core or Regional Urban Centers as online retail takes a larger share of purchases previously made at suburban malls and big-box stores. It was projected that the declines in basic employment (for example, manufacturing) were more likely in the Inner Core and Regional Urban Centers given the demand for land for other uses in these areas.

THE EXISTING TRANSPORTATION SYSTEM

The previous sections defined the Boston Region MPO study area and its existing and

projected land use and trends in population, housing, and economic growth in the region. The following section describes the existing transportation system in the MPO region.

Interconnected Systems of Routes, Terminals, and Travel Modes

Ground transportation systems in the MPO region include roads and associated bridges and tunnels, railroads, rapid transit and light rail lines, multiuse bicycle and pedestrian paths, sidewalks, and navigable waterways. Most of these routes are publicly owned and managed by agencies including MassDOT Highway Division, the MBTA, the Department of Conservation and Recreation (DCR), and individual municipalities. Some railroad lines within the MPO area are owned by freight railroads, and all railroads in Massachusetts connect with the national railroad system, most of which is also privately owned.

Entering, leaving, and transferring between these extensive and interconnected route networks takes place at millions of terminals, ranging in size from residential doorways and driveways at homes and businesses to North and South Stations and the Massachusetts Port Authority's (Massport) Logan Airport and Conley Container Terminal. These terminals are specialized based on the modes served and types of passenger trips or freight commodities. The simplest intermodal terminal is arguably a bus stop or a parking lot. Origin and destination terminals are publicly or privately owned. Passenger intermodal terminals tend to be publicly owned and freight distribution and consolidation centers are usually privately owned.

Passengers and freight use a mode or combination of modes to travel between origin and destination terminals using available routes. Providers of the transportation service fall into three broad groups:

- The traveler provides the service
- A private carrier such as an airline, bus company, taxi or transportation network company (TNC), or a truck company or freight railroad provides the service
- A public carrier such as the MBTA or Amtrak provides the service

The discussion of the transportation system in this chapter is organized generally around the major route systems, starting with the roadway system, for which the MPO has a major role in programming investments for improvement and reconstruction. The remainder of this chapter describes the elements of the existing transportation system in the Boston region, including:

- Roadway System
- Public Transit

- Regional Rail
- Civil Air Space
- Navigable Waterways
- Multiuse Paths

The Roadway System

Roadways as a Route System

The roadway system is the most extensive part of the regional transportation system. It connects with all the other route systems and allows them to operate as part of the overall transportation system. The roadway system consists of rights-of-way (ROW) (owned by MassDOT, local municipalities, independent agencies such as the DCR, or Massport), and a limited number of privately owned roads that allow general traffic.

Roadway system ROW contain roadway pavement, and may also contain medians, traffic islands, sidewalks, or protected paths designated for bicycles. The pavement can be striped for motor vehicle travel lanes of varying width and varying restrictions such as high-occupancy vehicle lanes, bus lanes, bicycle lanes, or parking. ROW pavement markings are reconfigured at intersections and interchanges to maximize safety while optimizing operations. The use of the curb and parking spaces can be regulated based on time of day or class of vehicle. The creation of curb cuts, small ramps built into sidewalks making it easier for strollers and wheelchairs to pass into the road, is governed by laws and regulations. Medians and other parts of ROW are often landscaped and the roadway is an important part of the public realm, with respect to appearance as well as transportation.

The modes and users traveling on the roadway system include

- Private two- and four-wheeled vehicles with one or more occupants;
- Taxis and TNC-associated vehicles;
- Private shuttle buses;
- Public transportation buses;
- Commercial regional and intercity buses;
- Commercial four-wheeled vehicles such as plumbers' vans;
- Trucks and heavy vehicles with six or more wheels;

- Emergency and official vehicles;
- Bicycles; and
- Pedestrians.

The design of each roadway system ROW determines the access, capacity, efficiency, and safety that members of these user groups will experience when using that part of the system.

Many trip origins or destinations are at facilities very close to or physically connected to a public transportation facility. This type of configuration dates back to the invention of modern rapid transit systems over 100 years ago. However, today new developments are actively encouraged to build in close proximity to fixed-guideway transit services, a practice commonly referred to as transit-oriented development (TOD). However, for the foreseeable future, the vast majority of trips, motorized or nonmotorized, will begin or end at some point on the roadway system.

Roadway Classification and Ownership

For purposes of planning and analysis, roadways are grouped into functional classes. Functional classes reflect the role that groups of roadways play in the overall transportation system rather than their physical attributes. The Federal Highway Administration and MassDOT define functional classes and subclasses slightly differently, however, there is congruence between the two systems at a higher classification level using four overarching groups; interstate highways, arterials, collectors, and local roads and streets.

Interstate highways are defined by United States statute that, as the name implies, forms a system whose components extend from state to state across the contiguous 48 states. At the opposite extreme are local roads and streets that can be as limited as a dead end cul-de-sac, or more likely, a street that goes for one or a few blocks. Collector roads may not be physically larger than local streets, but they are more important because they connect with arterials. Arterials are a broad class of roads that include express highways built to interstate standards that are not designated as part of the interstate system. These important distinctions are reflected in the various arterial subclasses used in federal or state level analyses.

The composition of the region's roadway system is summarized in Table 2-1. Federal recordkeeping guidelines require that roads be characterized by both lane-miles and centerline miles, which reflects the geographical distance that the roads cover. For the system as a whole, there are 10,966 centerline miles which comprise a total of 22,982 lane-miles in the Boston region. Most regional roads have two lanes. However, with a small number of one-lane roads and the added lanes of multi-lane roads and highways, the average is 2.1 lanes.

Table 2-1
Boston Region MPO Roadway Miles by Functional Class

Functional Class	Centerline Miles	Percent	Lane Miles	Percent	Average Lanes
All Functional Classes	10,966	100.0	22,982	100.0	2.1
Local	7,403	67.5	14,162	61.6	1.9
Collector	1,208	11.0	2,414	10.5	2.0
Arterial	2,179	19.9	5,252	22.9	2.4
Interstate	176	1.6	1,154	5.0	6.6

MPO = Metropolitan Planning Organization.
Source: Massachusetts Road Inventory Report, 2017.

More than half of the roadway miles in the region, whether measured by centerline or lane miles, are local streets and roads. Because there are very few local streets with more than two lanes, and a sizeable number with only one lane, the average local street averages 1.9 lanes. Collectors, the smallest group of non-interstate roadways, are almost entirely two-lane streets.

There are 2,179 miles of arterial roadways in the Boston Region MPO. The primary function of an arterial road is to deliver traffic from collector roads to freeways or expressways, and between urban centers at the highest level of service possible. Some arterial roadways are also limited-access roads.

There are only 176 centerline miles of interstate highways in the Boston region, 1.6 percent of the total, but these comprise of 1,154 lane miles, or 5.0 percent. This represents an average of 6.6 lanes, reflecting the mix of six- and eight-lane sections, plus the four-lane section of Interstate 90 through the Ted Williams Tunnel.

All of the interstate highways in Massachusetts are owned by MassDOT. However, MassDOT only owns 23 percent of the arterial centerline miles in the Boston Region MPO area, with the municipalities owning 72 percent and the DCR owning 5 percent. The municipalities own 98 percent of the collectors and 87 percent of the local roads and streets. The remaining 13 percent of local roadways are privately owned public ways. These public ways are often referred to as "unaccepted," because the municipality at some point declined to accept ownership of the roads and the associated maintenance commitment. Altogether, 84 percent of roadway miles in the MPO region are owned by local municipalities.

Connecting the Roadway System with Other Route Systems

It is possible to travel by different modes while staying entirely within the roadway system. Travelers can drive, walk, or ride a bicycle for the entire length of a trip. Travelers can also use transportation services such as taxis, TNCs, public transit buses or private shuttle buses that operate within the roadway system. For these trips, the terminals can be quite simple—the vehicle stops at a curb or parking lot, and the users enter or leave the vehicle.

Transferring between the roadway route system and another transportation system, such as transit, civil aviation, or navigable waterways, can be more complex and may include a variety of connections. The effectiveness of any transportation service is dependent on its connection with the roadway system.

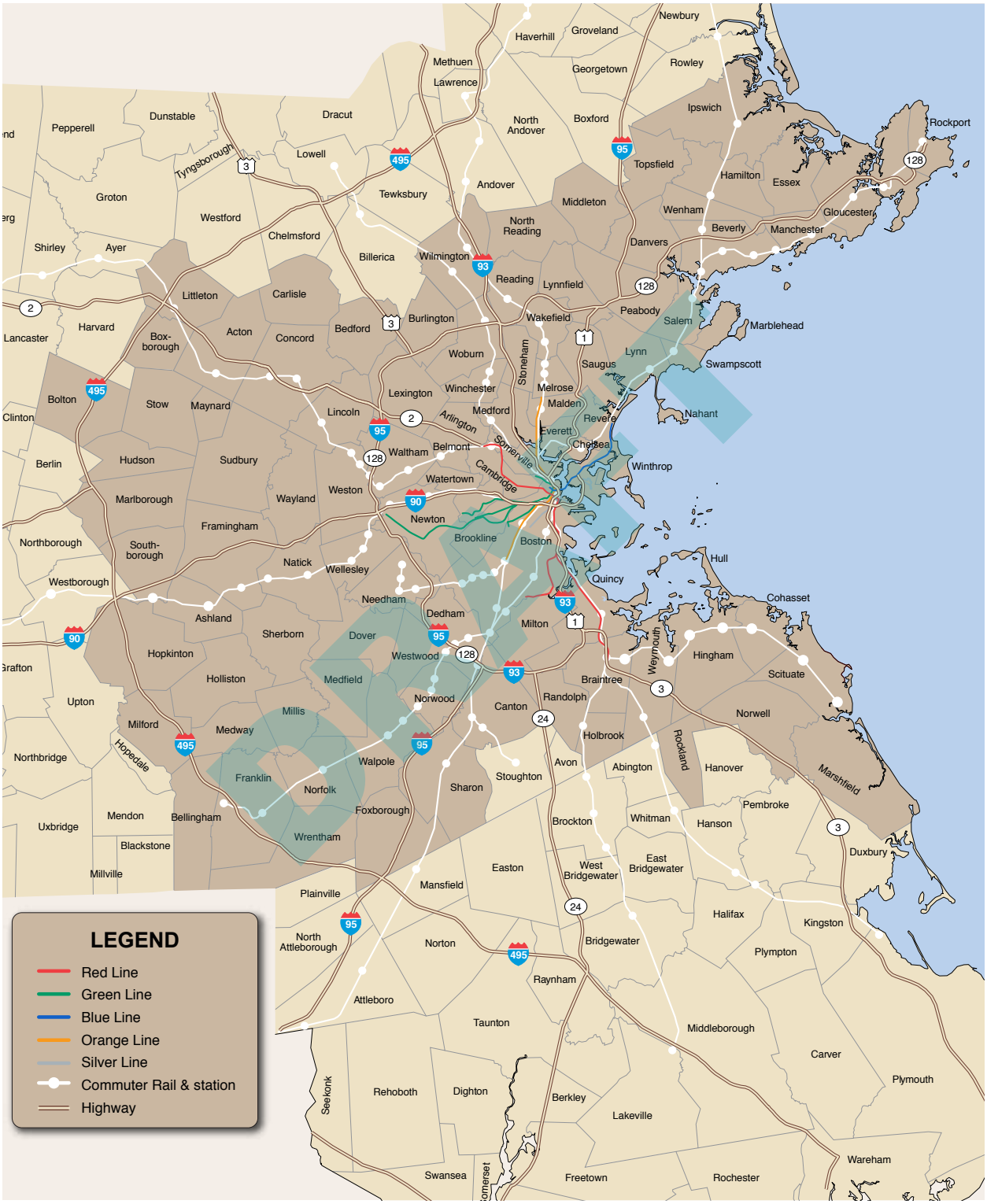
The Public Transit System

The Boston Region MPO's transit system includes three forms of rail transit: heavy rail, light rail, and commuter rail, as shown in Figure 2-11. Heavy rail and light rail are operated directly by the MBTA; the commuter rail is operated under contract for the MBTA, which owns the rolling stock and most of the fixed facilities. The transit system also includes a network of bus routes operated by or for the MBTA, and various regional transit authorities (RTAs) that also operate in the region, as well as passenger ferryboat service.

The present transit system has evolved over a span of nearly 200 years. Predecessors of most of the commuter rail lines were opened by 1850, and the histories of many present day bus routes can be traced to horse-drawn street railways built in the latter half of the nineteenth century. Although the system has always served passengers with a variety of trip purposes, the major focus has been to serve people traveling to and from work in downtown Boston.

At present, all of the commuter rail and heavy rail rapid transit lines, and all but one of the light rail lines serve downtown Boston directly. The majority of bus routes do not run into downtown Boston, but connect with one or more heavy rail, light rail, or commuter rail lines that do. All ferryboat routes funded by the MBTA serve terminals on the downtown Boston waterfront.

Figure 2-11
Rail Transit in the Boston Region



Source: Boston Region MPO.

Service frequency on all lines is greatest during the traditional commuting hours of Boston arrivals between 6:00 AM and 9:00 AM, and departures between 3:30 PM and 6:30 PM. Some commuter rail lines have intervals of more than two hours between off-peak trains, and some routes have no off-peak service.

MBTA Heavy and Light Rail Transit

The MBTA's heavy rail system has three lines: the Red, Orange, and Blue Lines. These operate over a mix of surface private ROW, subways, open cuts, embankments, bridges, and highway medians. All segments are fully separated from road traffic. South of downtown Boston, the Red Line divides into the Ashmont and Braintree Branches, while the Orange and Blue Lines have only one route.

All stations on these lines have off-train fare collection via electronic fare gates. Power for the Red and Orange Lines is supplied exclusively via third rail. Power for approximately one-third of the Blue Line is supplied via third rail and the rest via overhead catenary.

For historical reasons, the cars on the Red, Orange, and Blue Lines are not interchangeable, and there are no track connections between any of them. However, the stations in downtown Boston include one shared by the Orange and Blue Lines (State) and one shared by the Orange and Red Lines (Downtown Crossing), where free transfers can be made within the paid areas. The Red and Blue Lines have no stations in common.

The light rail system has five lines: the B, C, D, and E branches of the Green Line, and the Mattapan Trolley. Power for all five lines is supplied via overhead wires. The Green Line branches all operate through some portion of what is known as the Central Subway, but also include approximately 0.8 miles on viaduct and elevated structures.

All Central Subway stations (from Kenmore and Symphony to Lechmere) have off-train fare collection. One Central Subway station (Park Street) is shared with the Red Line and one (Government Center) with the Blue Line. Two stations (North Station and Haymarket) are shared with the Orange Line. A pedestrian tunnel within the paid station areas connects Park Street on the Green and Red Lines with Downtown Crossing on the Orange and Red Lines.

Outside the Central Subway, fares are collected on-board the cars at all stops except Riverside Station on the D Branch, which has fare gates. The surface portion of the D Branch runs on a private ROW of a former commuter rail line, with no vehicular grade crossings. The surface segments of the B and C Branches and approximately 60 percent of the E Branch operate in center-of-street reservations, with many at-grade crossings of other streets. The rest of the E Branch has in-street running with no separation from other traffic.

The Mattapan Trolley operates over the private ROW of a former commuter rail line. It has two grade crossings of streets. The inner terminal of the Mattapan Trolley is the Red Line Ashmont

Branch outer terminal. The fare system allows free transfers between the two lines, but not within a paid area. Unlike the Green Line, which uses modern light rail vehicles, the Mattapan trolley uses World War II era streetcars.

Commuter Rail

The MBTA commuter rail system has 14 lines that were all historically owned and operated by railroad companies that were part of the national rail network. The term commuter rail originated in the mid-1800s, in reference to railroad lines that offered discounted or "commuted" fares to frequent riders, especially those making daily trips between home and work. In recent years, commuter rail operating entities in some North American cities have switched to using terms such as regional rail to emphasize that their service is not just for people going to and from work.

After initially subsidizing commuter service run by railroad companies in the 1960s, the MBTA gradually took ownership of most of the ROW and stations, bought new rolling stock, and hired management companies other than the railroads to run the service. The current operator is Keolis Commuter Services. All trains are run with diesel-electric locomotives and coaches in push-pull configuration, with a control cab at the opposite end from the locomotive.

Five of the MBTA commuter rail lines were formerly part of the Boston and Maine (B&M) Railroad system, and terminate at North Station in Boston. These are the Newburyport and Rockport Lines, which share track south of Beverly Junction, and the Haverhill, Lowell, and Fitchburg Lines. A cross-connection called the Wildcat Branch links the Lowell Line at Wilmington with the Haverhill Line at Wilmington Junction.

Except for the Newburyport and Rockport Lines north of Salem Station, all of these lines also have some freight service, run by Pan Am Railways, successor to the B&M. Amtrak intercity Downeaster service between Boston and Brunswick, Maine uses the Lowell Line south of Wilmington, the Wildcat Branch, and the Haverhill Line north of Wilmington Junction.

The other nine commuter rail routes terminate at South Station in Boston. The Worcester Line was historically part of the New York Central Railroad system. The Needham, Franklin, Providence, Stoughton, Fairmount, Middleborough/Lakeville, Kingston/Plymouth, and Greenbush Lines were all historically part of the New York, New Haven and Hartford (New Haven) Railroad system.

The Providence and Stoughton Lines share tracks north of Canton Junction, and also share tracks with the Franklin Line, north of Readville and with the Needham Line, north of Forest Hills. The Middleborough/Lakeville and Kingston/Plymouth Lines share tracks north of South Braintree, and both also share tracks north of Braintree with the Greenbush Line.

From Memorial Day weekend through Labor Day weekend, the MBTA runs one round trip train per day, Friday through Sunday, between Boston and Hyannis on Cape Cod. This service, called the Cape Flyer, uses the route of the Middleborough/Lakeville Line between South Station and Middleborough/Lakeville Station.

An 11-month pilot program of commuter rail service to Foxborough is expected to begin in 2019. This service will be an extension of selected Fairmount Line trains, using the Franklin Line between Readville Station and Walpole Station, and a line between Walpole Station and Gillette Stadium in Foxborough that is used for special trains to football games and other events at the stadium.

CSX Transportation operates freight service on the Worcester, Franklin, and Stoughton Lines, the Providence Line between Readville and Attleboro, the Middleborough/Lakeville Line south of Braintree, and the line between Walpole and Gillette Stadium. The Providence and Worcester Railroad operates freight service on the part of the Providence Line in Rhode Island. The Fore River Railroad operates freight service on the Greenbush Line between Braintree and East Braintree. The Massachusetts Coastal Railroad operates freight service on the Cape Flyer route south of Middleborough/Lakeville Station. The other lines emanating from South Station have no freight service at present.

The Providence Line is also part of Amtrak's Northeast Corridor, which carries intercity passenger trains between Boston, New York City, Washington, D.C., and points in Virginia. Amtrak also operates one daily round trip on the Worcester Line as part of a route to Chicago.

Bus Rapid Transit

Six MBTA bus routes are classified as Bus Rapid Transit (BRT). These routes are branded as the Silver Line (SL) and are divided into two sub-groups.

The Silver Line Washington Street group includes Routes SL4 and SL5. Both routes use articulated hybrid diesel-electric buses. The outer terminal of Routes SL4 and SL5 is at Dudley Square in Roxbury. They share the same alignment, mostly on Washington Street, as far north as Essex Street. From there, Route SL5 continues to Temple Place and Route SL4 diverges to South Station. Most of the alignment outside downtown Boston has reserved bus lanes designated by pavement markings but with no physical barriers separating them from other traffic. The inbound segment unique to Route SL4 also has a reserved bus lane. Otherwise, within downtown Boston Routes SL4 and SL5 operate in mixed traffic.

The Silver Line Waterfront group includes Routes SL1, SL2, and SL3. These routes use articulated dual-mode vehicles that can run either on electric power supplied through overhead wires or with power from diesel engines. Buses on all three routes run in electric mode through a subway and open cut between South Station and Silver Line Way in South Boston, where they switch to diesel mode. From Silver Line Way, Routes SL1 and SL2 continue

in mixed traffic to their respective endpoints at Logan Airport and at the Boston Design Center. Route SL3 runs in mixed traffic from Silver Line Way to Eastern Avenue in Chelsea then continues on private ROW on a former freight railroad line to its endpoint at Everett Avenue.

MBTA Bus System

Excluding the Silver Line BRT routes, the MBTA bus network consists of 164 directly operated routes and five routes operated for the MBTA by private contractors. These routes operate in 44 of the 176 cities and towns in the MBTA district. Other RTAs provide bus service to some cities and towns in the MBTA district that do not have MBTA bus service.

Of the MBTA bus routes, all but seven have at least one direct connection to the heavy rail rapid transit or light rail system. The seven routes that do not have heavy- or light-rail connections have direct connections to commuter rail stations, and to bus routes that have rapid transit connections.

The MBTA classifies all non-BRT routes as either local or express. Of the 169 directly operated or contracted routes, 23 are classified as express. All but one of the express routes runs between a suburb and downtown Boston or Back Bay, and includes a segment on a limited-access highway. Some of the express buses can also be used for local travel on the suburban end.

Other Local Bus Services in the Boston Region

In addition to the five bus routes operated for the MBTA by private carriers, the MBTA provides partial funding for town-based fixed-route local bus systems in Bedford, Beverly, Burlington, and Lexington, and a community-based route in the Mission Hill neighborhood of Boston. A local bus system in Dedham was formerly funded by the MBTA but now operates with town funds.

Regional Transit Authority Bus System

Other than the MBTA, most of the RTAs in Massachusetts only serve cities and towns outside the Boston region, but there are a few exceptions. The state enabling legislation for the RTAs requires them to contract with private carriers to operate their services rather than running services directly.

The MetroWest Regional Transit Authority (MWRTA) is one of only two RTAs operating entirely within the Boston Region MPO area. The MWRTA currently provides fixed-route local bus service in Ashland, Framingham, Holliston, Hopkinton, Hudson, Marlborough, Milford, Natick, Sherborn, Southborough, Wayland, and Wellesley, and also provides service from Natick and Wellesley to Newton-Wellesley Hospital and the MBTA Woodland Station in Newton, and from Massachusetts Bay Community College in Wellesley to Riverside Station in Newton. The MWRTA is planning a trial service to Riverside Station from Marlborough and intermediate towns along Route 20.

The MWRTA also runs the MetroWest Ride, a shared-ride paratransit service for residents of Framingham, Natick, Wellesley, and Dover with disabilities that prevent them from using the MWRTA's fixed-route bus service. MetroWest Ride service includes connections at Riverside Station with the MBTA's THE RIDE service, discussed below. A separate MWRTA Dial-A-Ride system serves residents of Ashland, Marlborough, Southborough, and Wayland who have disabilities certified, according to the Americans with Disabilities Act.

The Cape Ann Regional Transit Authority (CATA) provides year-round weekday and Saturday bus service in Gloucester and Rockport, and Saturday-only service between Gloucester and shopping malls in Danvers and Peabody. CATA also provides summer weekend and holiday bus service between the Ipswich commuter station, Crane Beach in Ipswich, and the town of Essex. All of the CATA routes are entirely within the Boston Region MPO area.

CATA also operates Dial-A-Ride service in Gloucester, Rockport, Essex, and Ipswich for persons over 60 years of age and for adults with physical, mental, or cognitive disabilities. A separate CATA paratransit service, only in Gloucester and Rockport, is for individuals who are unable to use fixed-route service because of physical, mental, or cognitive disabilities.

The Merrimack Valley Regional Transit Authority provides bus service to cities and towns outside the Boston Region MPO area, but also provides weekday express bus service to downtown Boston during commuting hours on one route from North Andover, Methuen, Lawrence, and Andover.

The Lowell Regional Transit Authority provides bus service to cities and towns outside the Boston Region MPO area, but also provides service outside the Boston Region MPO area from Lowell and Billerica to the Burlington Mall and the Lahey Clinic in Burlington, and to other employment locations in Burlington and Bedford.

The Greater Attleboro Taunton Regional Transit Authority (GATRA) provides bus service primarily to cities and towns outside the Boston Region MPO area. However, GATRA also runs some local bus services in Bellingham, Franklin, Norfolk, Wrentham, Foxborough, Marshfield, and Scituate.

The Brockton Area Transit Authority provides bus service primarily to cities and towns outside the Boston Region MPO area, but has one route from Brockton to Ashmont Station with stops in Boston MPO communities, Randolph, and Milton.

THE RIDE

THE RIDE is a demand-responsive transit service operated by private carriers under contract with the MBTA that provides transportation to people who cannot use fixed-route public transportation because of a disability, either all or some of the time. THE RIDE operates sedans and lift-equipped vans within 58 municipalities in the MBTA district and small portions of six

other municipalities within three-quarters of a mile of MBTA fixed-route service. It is a shared-ride service provided 365 days a year from 6:00 AM to 1:00 AM. About 6,600 passengers use THE RIDE on an average weekday.

Public Transportation by Water

Passenger ferryboat service in the Boston Region MPO area includes a mix of year-round routes operated under contract for the MBTA or other public agencies, seasonal routes sponsored by municipalities, and unsubsidized routes run by for-profit companies.

At present, Nolan Associates, also known as Boston Harbor Cruises (BHC), is the largest ferry operator in the Boston area. BHC runs three year-round routes under contract with the MBTA: Route F1 from Hingham to Rowes Wharf, Route F2H from Hingham to Long Wharf via Hull and Logan Airport, and Route F4 from Charlestown to Long Wharf. For historical reasons, BHC owns the boats used on Routes F1 and F4 and the MBTA owns the boats used on Route F2H.

In January 2019, Bay State Cruise Company (Bay State) began running a route called the North Station/Seaport Ferry between Lovejoy Wharf near North Station and a wharf near the Institute of Contemporary Art (ICA) in South Boston. This service is a one-year demonstration under contract from the Massachusetts Convention Center Authority with funding from several large employers in the Seaport District. It replaces shuttle buses that previously ran between North Station and the Seaport. Bay State has leased two boats from a New York Harbor ferry operator for this service. The service is intended for employees of the sponsoring companies, but a few seats on each trip are available (by advance reservation) for members of the general public.

The Town of Winthrop runs a seasonal ferry service between a town-owned landing and Boston. Most recent service was run from mid-April to the end of November. The Boston stops have varied, but in 2019, the expected stops will be the Aquarium Wharf and the wharf at the ICA. Some trips also serve a wharf at Marina Bay in Quincy. The boat used for this service is owned by the town and was acquired partly with federal funds obtained by the state. The service is unusual in that it is run by permanent and seasonal town employees rather than by a ferry company.

BHC also runs a seasonal ferry service between Salem and Long Wharf in Boston by arrangement with the City of Salem, which owns the Salem terminal and the boat used on the route. These were funded partly with federal and state grants. BHC leases the boat from the city and does not receive any operating subsidy. One trip on weekdays in each direction is scheduled for commuting to and from work in Boston. Residents of Salem or nearby North Shore communities are eligible for discounted fares on these trips.

BHC and Rowes Wharf Water Transport, also known as Rowes Wharf Water Taxi, each run year-round on-demand water taxi service between several designated stops on the downtown

Boston waterfront and South Boston, East Boston, and Charlestown. The Logan Airport Ferry Terminal is the largest single source of ridership for these services.

From mid-May to mid-October, BHC runs unsubsidized seasonal ferry service from Long Wharf to Spectacle Island and Georges Island in the Boston Harbor Islands State and National Park. BHC also runs connecting service from Georges Island to Peddocks Island and Lovells Island, and service from Hingham to Bumpkin, Grape, Peddocks, Lovells, and Georges islands. During the months of service, BHC also adds an intermediate stop at Georges Island on MBTA ferry route F2H for passengers traveling between the island and Hingham.

The Thompson Island Outward Bound Education Center runs summer weekend ferry service for the general public from the EDIC Pier on the Reserved Channel at Summer Street in South Boston to Thompson Island. Year-round service on the same route is provided for staff and students of Education Center programs on the island.

The Regional Rail System—An Integral Part of a Nationwide Network

Passenger Services

As noted above in "The Public Transit System" section, the lines on which MBTA commuter rail trains currently run were historically owned and operated by railroad companies that were a part of the national rail network. When the MBTA bought these lines, the companies that sold them, and later successors to these companies, retained perpetual rights to operate freight service on them. However, much of the rail-dependent industry formerly located on these lines has given way to other kinds of enterprises for which shipping or receiving freight directly in carload volumes is not a consideration anymore. In response, the railroads have discontinued freight service on several of the MBTA-owned lines and have given up their rights to reinstate it.

Some of the lines on which freight service has been discontinued are now used exclusively for MBTA passenger service. Other lines have been converted to rail trails, with the MBTA retaining the right to convert them back to active rail lines if the need should arise in the future. Several cities and towns are in various stages of planning additional rail trails on MBTA-owned ROW. The MBTA has also sold a few parcels of former railroad property for redevelopment.

The National Railroad Passenger Corporation (Amtrak) was created by the federal government in 1971 to relieve the private railroad companies of the responsibility to operate intercity passenger trains. While Amtrak has statutory authority to run its trains over lines still owned by railroads, public agencies, or other parties, it must pay for the use of these lines.

In 1976, ownership of the segments of the Northeast Corridor rail line between Boston and Washington, D.C., not already owned by public agencies was transferred from private ownership to Amtrak. This excluded the section from Boston to the Rhode Island border, which the MBTA had bought previously. The MBTA also owns all the lines between Boston and the New Hampshire border used for Amtrak's Downeaster service, and the segment of Amtrak's Boston–Chicago route between Boston and Worcester. CSX transportation owns the rest of this line from Worcester to the New York border.

Freight Services

Rail is an important freight mode in the United States, New England, and the Boston Region MPO area. This importance is not immediately apparent, however, because of the widespread adoption of intermodal rail technology, where truck trailers and shipping containers are carried over long distances by rail, and then lifted from trains and hauled to customers by truck tractors. CSX Transportation operates a large intermodal lift facility in Worcester. Pan Am Southern, LLC, a joint venture of Pan Am Railways and the Norfolk Southern Corporation, operates the Ayer Intermodal Facility in the former Fort Devens space in Ayer. Both Worcester and Devens are outside the Boston Region MPO area, but many containers lifted at these facilities begin or end their journeys in the MPO region.

Some freight is still moved by freight cars delivered directly to shippers or receivers facilities. Carload rail is an especially competitive freight mode for bulk commodities such as cement, gravel, or chemicals, and construction materials such as lumber and steel. In some instances, boxcars are still competitive for moving manufactured goods. Freight cars are also picked up and dropped off for a number of MPO region industrial customers located near one of the regional rail lines, including both lines with passenger service and freight-only branches.

Civil Airspace

Civil Airspace as a Route System

Airspace forms a route system in two respects. First, commercial air carriers, both passenger and freight, operate flights according to published schedules to non-stop, multi-stop, and connecting destinations across the world. The second route system is the approach and departure corridors, conditions, and rules that govern the safe operation of an airfield. Different wind and visibility conditions require the use of specific runways by specific types of aircrafts for landing or takeoff. These runway and approach patterns are defined in advance in consultation with the Federal Aviation Administration and have the force of law, which means no tradeoff of safety for operational convenience is acceptable.

Under certain circumstances, light aircraft and helicopters are allowed to file flight plans where they can operate using what are called Visual Flight Rules (VFR). Near Logan Airport, an aircraft using VFR must avoid the active takeoff and approach corridors. The traffic helicopters

that frequent Boston's airspace during rush hour are operating under VFR. These small aircrafts are often collectively referred to as general aviation.

Logan Airport: New England's Ultimate Intermodal Hub

Logan Airport, located in East Boston, is owned and operated by Massport and is the sixteenth busiest airport in the United States for passenger travel, serving about 41 million passengers in 2018. It has a similar rank in terms of flight operations and air cargo handled.

Logan Airport operates on 1,700 acres of land. Within this area, less than 2.7 square miles, Logan has 8.8 miles of runways and paved overrun areas. These include four runways at least 1.5 miles in length and two shorter auxiliary runways. As the airport is surrounded by water and residential neighborhoods, Logan's owner, Massport, has been forced to use its limited real estate as efficiently as possible to accommodate growth in air travel.

Logan Airport is also acknowledged to have one of the most convenient locations with respect to the city center and other important local venues. It is within two miles of downtown Boston. To a large degree, public transportation access to Logan Airport utilizes the same fixed-guideway transit routes that are used by daily commuters. The rapid transit Blue Line Airport Station is located on the perimeter of the airport, with free Massport shuttle bus connections to all the airline terminals and to Massport offices. In downtown Boston, the Blue Line connects with the Green and Orange Lines in the Government Center area and the northern end of the financial district. The Silver Line SL1 route connects Logan Airport with the Boston Convention and Exhibition Center (BCEC) in the Seaport District, and also with South Station, which includes the Red Line, south side commuter rail lines, Amtrak Northeast Corridor and Chicago trains, and large employment centers at the southern end of the financial district.

Access to Logan Airport by employees via public transportation is also important. Massport and individual employers at the airport have considerable influence over the type of vehicle access that is available to the various classes of employees. Use of parking spaces at the airport by air travelers is viewed as a priority. The airport also has a ferry terminal served by MBTA ferries running between Hingham, Hull, and Long Wharf and by privately operated water taxis from points throughout the Inner Harbor.

The fixed-guideway transit route system plays an important role in the work travel market. The Blue Line extends to several residential neighborhoods in Revere, where it also connects with buses. The recently implemented SL3 route originates on a busway in Chelsea and connects with the Newburyport/Rockport commuter rail line at Chelsea Station. The SL3 does not stop at any of the airline terminals or Massport offices, but it connects with the Massport shuttle buses at Airport Station. Massport also runs an employee-only shuttle bus that shares some of the SL3 route from an off-airport garage it owns.

Logan Airport is not New England's only airport, but it is certainly the most important. From outside of the urban core, an extensive network of bus services brings passengers and employees from many points in New England directly to Logan Airport. Some of these buses also carry commuters to the Boston intercity bus terminal, located above the commuter and intercity rail platforms at South Station. Massport also funds Logan Express bus service to the airport from four terminals outside the Route 128 circumferential corridor in Peabody, Woburn, Framingham, and Braintree, where secure long-term parking is offered for travelers.

The necessary roadway system to support efficient operations at Logan Airport is complicated. Some of the transit services, mostly using buses, have already been described. A partial list of specific vehicle moves supported by Logan's roadway system helps illustrate the challenges facing the roadway system:

- Transit-type bus services
- Massport and hotel shuttle buses
- Long-distance coach-type bus services
- Car service, taxis, and TNC services
- Cars going to the arrival or departure levels
- Cars seeking low-cost parking
- Cars seeking convenient parking
- Rental cars arriving or leaving the airport
- Trucks accessing the air cargo area
- Official and airport-support vehicles using the public roadways

As previously described, because the physical constraints prevent the roadway and other access systems at Logan from growing outwards, alternatively, they must grow upwards. The circulation system is now two levels at all terminals and at the consolidated car rental facility. A third roadway level would be impractical, however, an automated on-airport fixed guideway system (to move passengers across terminals—also referred to as a people mover) is under consideration.

General Aviation

Hanscom Field, located 20 miles northwest of Boston, just outside of Interstate 95/Route 128 in the towns of Bedford, Concord, Lexington, and Lincoln, is the busiest general aviation airport in New England. With no scheduled commercial flights, Hanscom Field has attracted

office and light industrial development along nearby roads, appealing to firms that value access to convenient business, charter, private, and air-taxi flights. Massport operates Hanscom Field.

In addition to Logan Airport and Hanscom Field, the MPO region includes other public-use airports: three municipally owned in Beverly, Norwood, and Marshfield, and one privately owned in Stow. The business of these airports is supporting general aviation with facilities such as tie-down rentals and services such as flight instruction, fuel sales, and light repair.

Navigable Waterways

Navigable Waterways as a Route System

The locations of shipping channels are not as obvious as the locations of transportation arteries on land. However, to avoid running aground, waterborne vessels of all sizes must travel in designated lanes suitable for their dimensions, especially in port areas. The US Army Corps of Engineers (the Corps) is responsible for maintaining the major navigable waterways of the United States.

The basic structure of Boston Harbor has not changed since colonial times and is similar to other coastal port systems. There is a main shipping channel entering from the ocean that meets navigable tributary rivers. The ability of these channels to accommodate navigation gradually decreases as one moves father from the ocean. As described by the Corps, the Boston main channel is six miles long and 40 feet deep, extending from Massachusetts Bay, also referred to in the description as "the sea, to the entrance of the Mystic and Chelsea Rivers." The eastern end of the channel is near the eastern limit of the Boston Harbor Islands State and National Parks.

The history of navigation has been characterized by steady increases in vessel sizes. Improvements in metallurgy, propulsion, and construction practices have allowed larger ships to be built, carrying both passengers and freight. Larger ships generally reduce the unit costs or the cost per passenger or pound, an economic condition called economies of scale. To be a competitive port, Boston must accommodate vessels of all sizes that are currently operating in its target markets.

In July 2018, a project to increase the depth and width of the Boston main shipping channels between the sea and the Conley container terminal at Castle Island got underway, under a partnership between Massport and the Corps. The depth of the North Channel will be increased to 51 feet at mean low water. The depth of the main channel and the Reserved Channel at the Conley terminal will be increased to 47 feet. This $122 million project is expected to take three years. Future plans include increasing the depth of the Chelsea River channel to 38 feet, and the depth of the Mystic River channel to 40 feet.

Increasing the depth of the main channel to greater than the present 40 feet west of Castle Island is not feasible because of the depth of the Interstate 90 Ted Williams Tunnel under the channel. Before this tunnel was built, the channel depth was constrained farther upstream by the Blue Line rapid transit tunnel and the Sumner and Callahan highway tunnels. Consequently, there is limited potential for the Port of Boston to serve large modern container ships such as the "Post Panamax" class, which draw 51 feet of water.

Massport operates two modern terminal facilities on the Reserved Channel (described below): the Paul W. Conley Container Terminal and the Raymond L. Flynn Cruiseport Boston Terminal (formerly Black Falcon Terminal).

The shoreline of the inner harbor is now almost entirely nonindustrial, but Mystic and Chelsea River tributaries still host important ocean-going commerce. The existing Charles River Dam locks allow for industrial barges to enter the Charles River, but no remaining industries on the river use waterborne freight transportation. The water-dependent industries on the Mystic River are located between the Tobin Bridge and the Alford Street Bridge. The riverbanks farther upstream have been made into parks.

Boston's Maritime Markets

The working waterfront is lined with specialized wharves and terminals that support specific types of ships and cargoes. Several of these terminals are owned by Massport, and the rest are privately owned.

The Conley Terminal is a regional facility. All containers entering or leaving this terminal are hauled by truck to or from locations almost exclusively in eastern Massachusetts, Rhode Island, and southern New Hampshire and Maine. Use of the terminal has grown steadily, however, and programs to expand and improve the terminal have been ongoing. A recently completed truck access road has removed about 1,000 daily truck trips from South Boston residential streets.

With the completion of the dredging project, the Conley Terminal will be able to accommodate larger container vessels. Importantly, these vessels do not completely unload when they visit Boston. Containers are stacked on vessels in order to allow the Boston-bound containers to be easily removed, and then the ship can proceed on to its next port of call. The intent of the harbor dredging is to allow the major world shipping alliances to route most vessels in their fleets through Boston.

The Flynn Cruiseport shares the Reserved Channel with the Conley Terminal, and is designed to accommodate the largest cruise vessels. Modern cruise ships, used almost exclusively for leisure travel, would dwarf the great ocean liners of the pre-aviation travel era. Boston has enjoyed steady growth in cruise ship activity, both as a cruise stop and as an originating port.

Cruises originating in Boston provide a boost to the local hospitality industry as travelers typically arrive in the city a few days before the cruise.

Massport owns several other waterfront facilities. The Moran Terminal on the Mystic River is used for importing automobiles and light preparation before shipment to regional auto dealers. Massport also owns properties that support the fishing industry, including Boston's historic Fish Pier. Massport also owns land on the nearby North Jetty that has been leased to build modern seafood processing plants. These facilities are near the water but are served by refrigerated trucks.

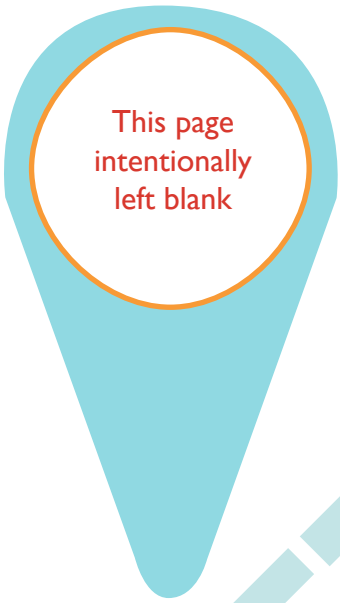
The private waterfront terminals mostly handle bulk cargoes. Terminals on the Chelsea River unload, store, and arrange to deliver road salt and refined petroleum products. Terminals on the Mystic River receive cement, fish, liquefied natural gas, and some refined petroleum products. There is also an export terminal on the Mystic River for scrap steel.

Multiuse Paths

The roadway system is the most important route system for pedestrians and bicyclists because it is a complete system reaching virtually any spot in Massachusetts that is possible to travel to. This is the case even if many parts of the roadway system are still substandard with respect to safely accommodating the nonmotorized modes.

There are a growing number of paths for nonmotorized users, some of which are on former railroad ROW. These have been improved to varying degrees but do not benefit from regular maintenance and upgrade programs because they are not generally part of the roadway system.

Few of these paths connect with each other directly, and most trips using these paths require travelers to use the roadway system for some portion of the trip. However, these paths are an important extension of the ubiquitous roadway system for the nonmotorized user. Some of the best known and most heavily used paths include the Minuteman Commuter Bikeway between Somerville and Bedford on a former railroad ROW, and the Dr. Paul Dudley White Bike Path, along the banks of the Charles River in Boston and Cambridge.



chapter 3

Travel Patterns in the Boston Region

BACKGROUND

An important part of understanding the Boston Region Metropolitan Planning Organization's (MPO) transportation needs is an understanding of the travel patterns in the region. The information used to analyze travel patterns for the Long-Range Transportation Plan (LRTP), *Destination 2040* Needs Assessment was obtained from several sources. Information on highway, transit, freight, bicycle, and pedestrian travel modes was derived from the MPO's travel demand model, which uses base year (2016) conditions and projects future travel patterns. In addition, information from MPO studies and activities, including freight studies and the 2011 Massachusetts Travel Survey, were used to obtain information on travel patterns in the region.

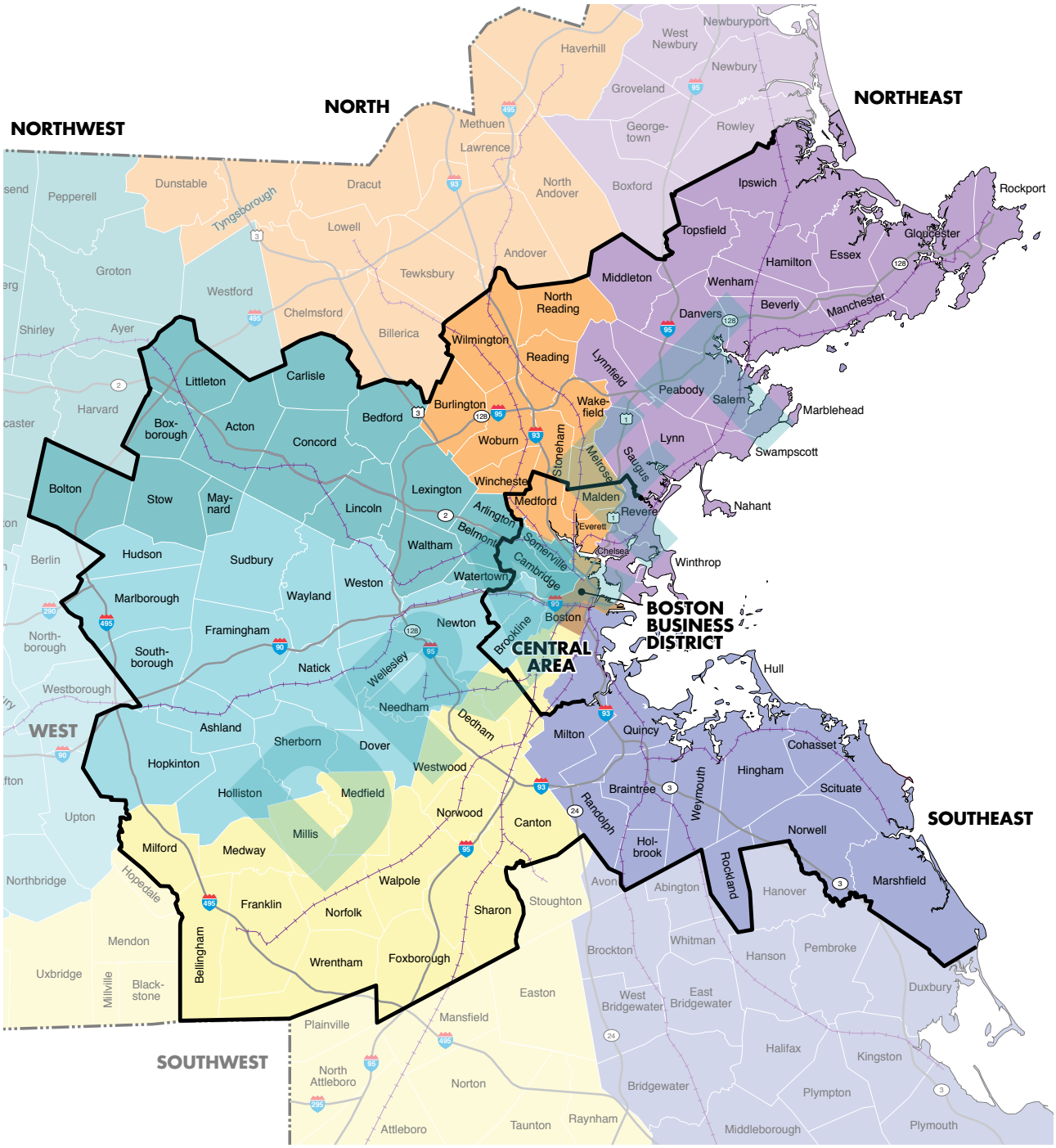
THE MPO AND TRAVEL DEMAND MODEL REGIONS

Radial Corridors

For transportation planning purposes, the MPO maintains a travel demand model set (referred to as the "model" throughout this report). Because the MPO region travel patterns are strongly influenced by travel demand outside the MPO, the MPO travel demand models have always included a number of neighboring municipalities. For *Destination 2040*, a newly developed statewide model is being used which includes all 351 Massachusetts municipalities, all of Rhode Island, and 56 municipalities in southern New Hampshire. A detailed description of the modeling process may be found here: https://www.ctps.org/travel_modeling_101.

For the purposes of this Needs Assessment, the MPO region has been divided into six radial corridors as shown in Figure 3-1. The municipalities in the Boston Region MPO are shown in darker colors, and adjoining municipalities are indicated with lighter shading of their associated sectors.

Figure 3-1
Radial Corridors, Central Area, and the Boston Business District within the Boston Region MPO Area



Source: Boston Region MPO.

The radial corridors are generally defined by the rail and highway facilities that connect them with Boston. Key infrastructure serving these corridors includes:

- **Northeast Corridor—**Key corridor highways include Interstate 95, US 1, and Route 128. The Rockport and Newburyport commuter rail lines also serve this corridor. There are two commuter rail stations in this corridor outside the MPO region. The Blue Line also serves this corridor.

- **North Corridor**—Corridor highways include Interstate 93 and US 3. The Haverhill and Lowell lines serve this corridor, and there are seven commuter rail stations outside the MPO region. The Orange Line also serves this corridor.

- **Northwest Corridor**—Route 2 is the major highway in this corridor. The Fitchburg Line serves this corridor, including five stations outside the MPO region. The Red Line also serves this corridor.

- **West Corridor**—Interstate 90 is the major highway in this corridor. The Worcester commuter rail line serves this corridor, including three stations outside the MPO region. Three of the Green Line branches serve this corridor.

- **Southwest Corridor**—Interstate 95 is the major highway in this corridor. The Franklin and Providence/Stoughton lines serve this corridor, including seven commuter rail stations outside the MPO region. This corridor is also served by the Orange Line and Amtrak's Northeast Corridor service.

- **Southeast Corridor**—Major highways in this corridor are Interstate 93 and Route 3. Commuter rail service is provided by the Middleborough/Lakeville, Kingston/Plymouth, and Greenbush lines, with 11 stations in this corridor outside of the MPO region. Both branches of the Red Line, including Mattapan trains, serve this corridor.

The Central Area

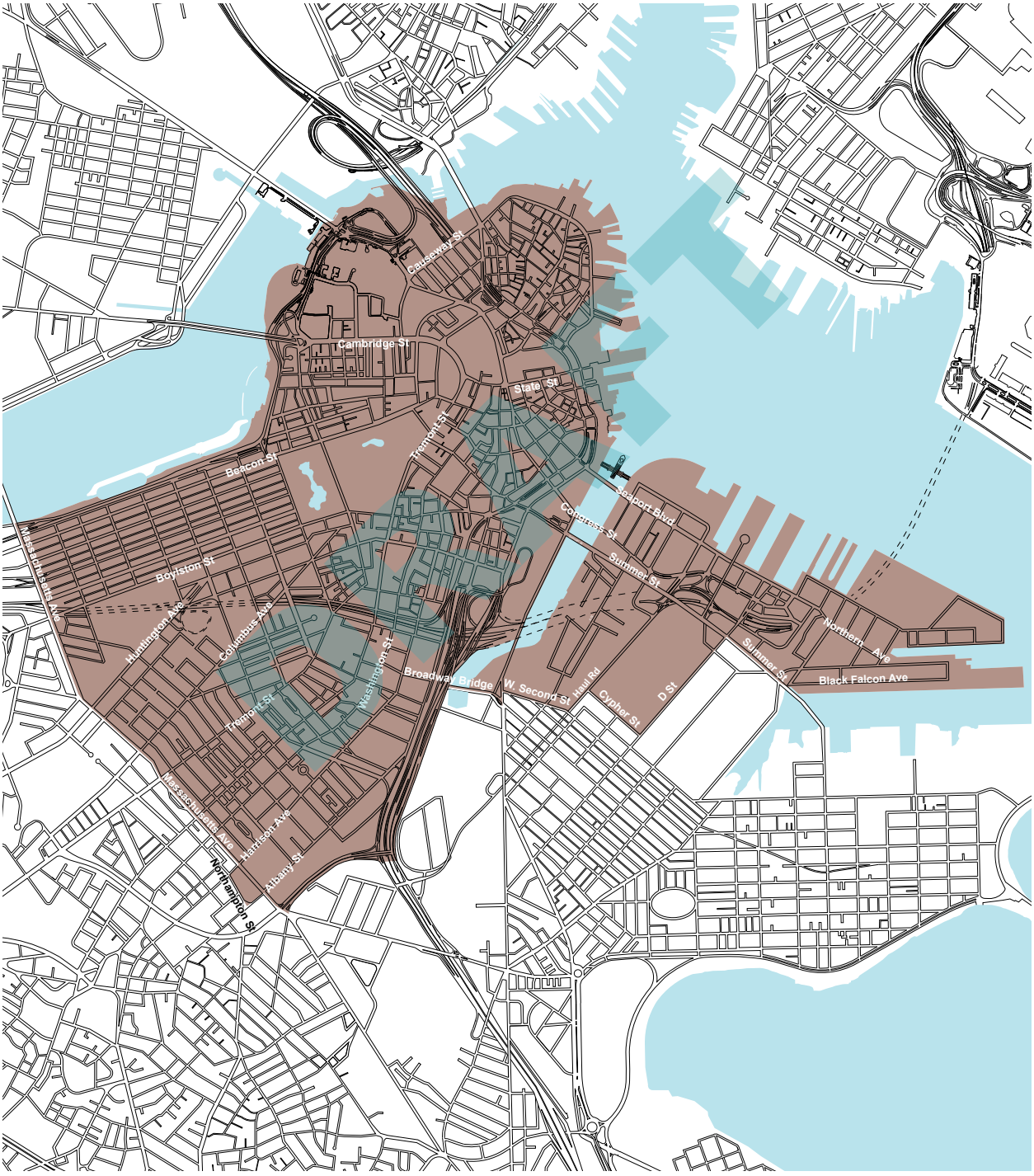
The MPO's model has always included a defined central area where the radial transit services meet and total employment in the area exceeds the total population. The Central Area, as shown in Figure 3-1, includes most of Boston and nine nearby municipalities: Brookline, Cambridge, Somerville, Medford, Malden, Everett, Revere, Chelsea, and Winthrop. Four Boston neighborhoods, Hyde Park, West Roxbury, Roslindale, and Mattapan are not included in the Central Area because their density and travel patterns more closely resemble the neighboring suburban communities.

The Boston Business District

At the heart of the Central Area is a very densely developed area designated as the Boston Business District (BBD); shown below in Figure 3-2. This area includes "Boston Proper" (as it is known) and the developing South Boston waterfront. More specifically, Boston Proper includes Boston south of the Charles River but bounded by Massachusetts Avenue and Interstate 93 on the west and southeast. The Fort Point Channel separates Boston Proper

from the South Boston waterfront. The line separating the South Boston waterfront follows Broadway from the Fort Point Channel to the South Boston Bypass Road, to Cypher Street, to D Street, and then Summer Street as far as the Reserved Channel.

Figure 3-2
The Boston Business District within the City of Boston



Source: Boston Region MPO.

BOSTON REGION MPO AREA TRAVEL PATTERNS DERIVED FROM THE TRAVEL DEMAND MODEL

Land use patterns, growth in employment and population, and trends in travel patterns will affect the demand on the region's transportation system in different ways. The model is used to assess potential projects and programs in terms of air quality benefits, travel-time savings, and congestion reduction.

The model was used to estimate 2016 base year travel conditions and project future-year 2040 No-Build travel conditions for the *Destination 2040* Needs Assessment. No-Build conditions assume that there are no new improvements to the existing transportation system other than those that are currently under construction, advertised for construction, or included in the first year of the Federal Fiscal Years (FFYs) 2019–23 Transportation Improvement Program (TIP) of the Boston Region MPO and TIPs of adjacent MPOs. Base- and future-year travel conditions were estimated for highway, transit, bicycle, and pedestrian travel into the Central Area and into the Boston Business District for an average weekday.

2016 BASE YEAR AND 2040 NO-BUILD PROJECTIONS

Demographic Assumptions

The 2040 socio-economic projections are based on the numbers of households, residents, workers, and available private vehicles in the Boston MPO area. Table 3-1 provides 2016 baseline demographic information and 2040 projections showing population, employment, and household vehicle ownership assumptions in the Boston Region MPO's 97 municipalities.

The locations and types of the region's jobs are important factors in regional transportation planning. The many types of professions are divided into three large groups for model development and transportation analysis. Current and projected employment in these three sectors—basic, retail, and service—are shown in Table 3-1. Employment characterized as basic includes manufacturing, warehousing, and transportation. Retail employment includes stores and restaurants. The service sector accounts for almost half of the workforce and includes education, health care, government, finance, and real estate, to name a few.

Table 3-1
Boston Region MPO Current and Projected Demographic Assumptions

Variable	2016 Base Year	2040 No-Build	2016 to 2040 Percent Change
Population	3,245,900	3,704,500	14.1%
Households	1,312,000	1,582,600	20.6%
Average Household Size	2.5	2.3	-5.4%
Total Employment	1,923,600	2,084,700	8.4%
Basic	365,400	344,600	-5.7%
Retail	308,700	297,600	-3.6%
Service	1,249,500	1,442,500	15.4%
Households with Vehicles			
0 Vehicle	15%	15%	0%
1 Vehicles	38%	40%	2%
2 Vehicles	31%	33%	2%
3+ Vehicles	16%	12%	-4%

Source: Boston Region MPO.

Person-Trips and Mode Choice

The Boston Region MPO area is an important center for employment and other activities and the area both influences and is influenced by travel activity over much of New England, even though it is a comparatively small MPO with only 97 municipalities. To understand the area, the extensive Massachusetts statewide travel demand model is used to project future travel. MPO-wide travel statistics developed using this model are summarized in Tables 3-2 and 3-3.

Table 3-2
Boston Region MPO Weekday Person-Trips by Travel Mode

Travel Mode	2016 Base Year	2040 No-Build	2016 to 2040 Percent Change
All Modes	13,960,900	15,861,700	13.6%
Auto	11,096,700	12,421,900	11.9%
Transit	1,021,900	1,183,700	15.8%
Nonmotorized	1,842,300	2,256,100	22.5%

Source: Boston Region MPO.

Table 3-3
Boston Region MPO Average Weekday Mode Shares

Travel Mode	2016 Base Year	2040 No-Build
All Modes	100%	100%
Auto Share	80%	79%
Transit Share	7%	7%
Nonmotorized Share	13%	14%

Source: Boston Region MPO.

As shown in Tables 3-2 and 3-3, person-trips for all modes in the Boston Region MPO are projected to increase. However, the auto share is projected to decrease slightly and the nonmotorized modes (for instance, walking and cycling) are projected to increase. The transit share is expected to change very little. Increasing congestion, especially in the inner core, likely contributes to this trend in mode shares.

This shift could also be a consequence of shifting demographics whereby people are moving into urban areas. This is consistent with the Metropolitan Area Planning Council's (MAPC) plan (entitled *MetroFuture*) for the region which suggests that younger households may be more inclined toward urban living and living closer to where they work. Another factor contributing to the decrease in auto mode share is the decrease in the share of three-plus vehicle households (see Table 3-1). Less access to automobiles along with increased usage of Transportation Network Companies (TNC) and car sharing services also contributes to a decrease in the auto share.

Current and Projected Use of the Roadway System

Recent and projected travel on the Boston MPO area's road system is summarized in Table 3-4. The number of auto and truck trips, vehicle-miles traveled, and vehicle-hours traveled are all projected to increase between 2016 and 2040. Average speeds are expected to decrease in the future because of the increase in the number of vehicles exacerbating congestion. Average trips lengths derived from this table show a slight decline from 6.8 miles in 2016 to 6.6 miles in 2040, with the average travel time staying steady at 17 minutes.

Table 3-4
Boston Region MPO Estimated Weekday Highway Use Statistics

Vehicle use Statistic	2016 Base Year	2040 No-Build	2016 to 2040 Percent Change
Vehicle Trips	10,834,400	12,119,600	11.9%
Auto	8,682,000	9,723,700	12.0%
Trucks	2,152,400	2,395,900	11.3%
Vehicle-Miles Traveled	73,688,400	80,496,600	9.2%
Auto	60,774,000	66,121,200	8.8%
Trucks	12,914,400	14,375,400	11.3%
Vehicle-Hours of Travel	3,004,700	3,372,400	12.2%
Auto	2,556,500	2,846,800	11.4%
Trucks	448,200	525,600	17.3%
Average Speed	24.5	23.9	-3.8%
Auto	23.8	23.2	-2.3%
Trucks	28.8	27.4	-5.1%

Note: Trucks include vehicles with at least six wheels except buses, plus some four-wheeled vehicles such as plumbers' vans.
Source: Boston Region MPO.

Air Quality

Table 3-5 details the results of the air quality analysis while considering the demographic projections with no additional transportation improvements other than those that are currently in place, under construction, advertised, or in the first year of the 2019–23 TIP. Even though there is an increase in vehicle-miles traveled, improvements are projected in all pollutants in 2040. Due to increased use of electric vehicles and more stringent emission standards for gasoline and diesel vehicles, the average car will be cleaner in the future.

Table 3-5
Boston Region MPO Current and Projected Air Quality Statistics

Variable	2016 Base Year	2040 No-Build	2016 to 2040 Percent Change
Volatile Organic Compounds (kg)	5,777	2,012	-65.2%
Nitrogen Oxides (kg)	28,805	5,087	-82.3%
Carbon Monoxide (kg)	220,344	84,675	-61.6%
Carbon Dioxide (kg)	38,666,496	25,271,965	-34.6%

Source: Boston Region MPO.

Current and Projected Use of the Transit System

Recent and projected transit ridership is summarized in Table 3-6 for the Boston Region MPO area. The number of transit person-trips is projected to increase about 15 percent by 2040, and the unlinked trips, or transit vehicle boardings, are projected to increase 18 percent as transit trips gradually become more complex and require more transfers.

Table 3-6
Current and Projected Weekday Transit Ridership Statistics

Transit Service	2016 Base Year	2040 No-Build	2016 to 2040 Percent Change
Transit Trips (linked)	1,172,200	1,346,400	14.9%
Transit Trips (unlinked)	1,473,500	1,739,200	18.0%
Local Bus	398,700	422,300	5.9%
Bus Rapid Transit	32,300	61,900	91.6%
Express Bus	12,700	14,200	11.8%
Non-MBTA Bus Routes	147,900	198,600	34.3%
Rail Rapid Transit	751,000	888,400	18.3%
Commuter Rail	126,000	145,200	15.2%
Ferry	4,900	8,600	75.5%
Average Transfer Rate	1.26	1.29	

Source: Boston Region MPO.

Rail rapid transit is expected to see about 18 percent more boardings while commuter rail ridership is projected to increase about 15 percent. Local buses have the lowest projected growth, possibly reflecting the impact of increased congestion. In contrast, bus rapid transit has the highest projected growth as it serves the growing Seaport District. The Seaport District was recently expanded to add the new SL3 route (added after 2016) and has key sections in dedicated rights-of-way. Non-MBTA services include buses operated by regional transit authorities, Logan Express and airport shuttle services, private regional bus services, and selected employee shuttles that allow use by the general public.

CHARACTERIZING REGIONAL TRAVEL PATTERNS

Understanding Regional Travel Begins at the Urban Core

Travel and traffic are seemingly everywhere in the region, moving in all directions simultaneously. The traditional notion of radial commuting into city centers during typical rush hour periods is always an over-simplification. It is even more so today with the spread of jobs throughout the region, the increased interest in urban living, and the flexible work schedules of knowledge-based industries.

It is possible, however, to identify and estimate the size of important regional travel flows. The MPO's model is informed by broad-based travel surveys and can generate plausible estimates of current travel activity at a fine level of detail. By applying demographic growth assumptions, it enables the model to estimate future travel activity at a comparable level of detail.

Some of the strongest travel patterns are observed in the travel network with the greatest concentration of travel activity which include the major employment centers of the urban core, specifically, the Boston Business District (BBD) and nearby parts of the Central Area, such as Kendall Square and the Longwood Medical area. This section begins with an analysis of travel in the BBD, followed by a discussion of the significantly larger Central Area. It concludes with descriptions of travel in the outer parts of the region, as well as the specialized movement patterns characteristic of freight and trucks.

The analysis of regional travel begins by dividing the entire travel market into four geographical realms.

- **The BBD**
  This section of Boston is described above and is shown in Figure 3-2.
- **The Central Area**
  This area is also described above and includes the rest of Boston and nine nearby municipalities. Its extent is shown in Figure 3-1.
- **All other MPO corridors**
  The 87 MPO municipalities outside of the Central Area and BBD are considered here as a single group. These are shown in Figure 3-1.
- **Outside the MPO area**
  All travel beginning or ending outside of the MPO area is included in this group, regardless of distance.

The analyses of BBD and Central Area travel will use these four geographical realms to show how travel patterns can be discerned based on the distance from the dense urban core.

Travel in the BBD

Travel is a major function dependent on the numbers of residents, workers, and available private vehicles. In addition, the locations and types of jobs are important factors in establishing travel patterns. The BBD is a very densely developed mixed-use area and is a major destination for the Boston region. Figure 3-3 shows the numbers of trips ending in the BBD in 2016 and 2040 by three major mode groups: auto, transit, and nonmotorized. In the figure, auto refers to private passenger vehicles owned by households traveling with one or more occupants. Transit refers to services operated by the MBTA plus selected private fixed-route shuttles that allow use by the general public. Nonmotorized travel includes walking and bicycling.

The 2016 and 2040 trip estimates in Figure 3-3 are shown as pairs of columns. Each pair of columns shows current and projected trips between the BBD and one of the four geographical realms. The first pair of columns are trips that both begin and end within the BBD, and the last three column pairs show trips of increasing distance to the BBD—from the Central Area, from the rest of the MPO region, and from outside of the MPO region. The vertical scales are the same for each of the modes.

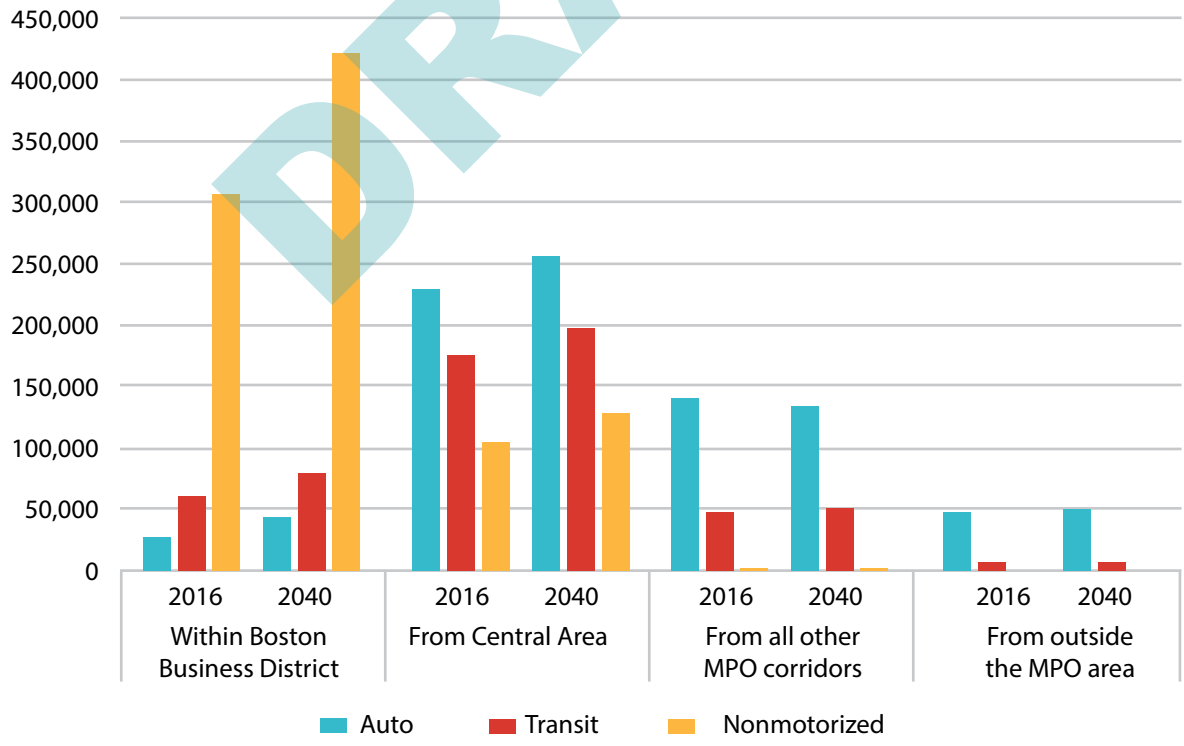
Travel within the BBD

Within the BBD, the nonmotorized modes are dominant. The density and mixture of land uses in the BBD reflects a rich variety of housing, jobs, stores, schools, and recreation opportunities in very close proximity. Projections show 117,000 more nonmotorized trips in 2040 (a 38 percent increase) compared with 18,400 more transit trips (29 percent) and 14,800 more auto trips (49 percent).

It is expected that TNCs will accommodate much of the increase in auto trips within the BBD. It should not be assumed, however, that TNCs will accommodate all of the growth. Given the congestion, parking scarcity and cost, and relatively short distances, many people do not drive between two points within the BBD unless the trip is part of a more extensive itinerary. The driver may need to make a midday trip or go someplace after work. In some cases, a person could get a ride from a friend or family member within the BBD, and after dropping the passenger off, the driver leaves the BBD for a more distant destination.

The projected percent increase in auto trips (49 percent) is significant and may mean that much of the new development will be in the less accessible parts of the South Boston waterfront, where use of an auto, especially as part of a trip chain, may be an attractive mode choice. Growth in TNC use will also contribute to this increase.

Figure 3-3
Travel Mode Projections for the Boston Business District



Source: Boston Region MPO.

Travel between the Central Area and the BBD

The second set of column pairs in Figure 3-3 detail travel between the Central Area and the BBD. The Central Area is roughly 10 miles across; and for about 45 percent of people making an up to six-mile journey to reach the BBD, a private auto is the primary mode of choice, sometimes in conjunction with a chained trip. Most of the fixed guideway transit routes are within the Central Area and transit accounts for 34 percent of the trips to the BBD. For trips between the Fenway and Back Bay, Lower Roxbury and the South End, South Boston and the South Boston waterfront, and Charlestown and Government Center, the nonmotorized modes are very practical and are used for 21 percent of trips between the Central Area and the BBD.

For trips between the Central Area and the BBD, each of the mode groups is projected to increase between 22,000 and 27,000 users in 2040. Because the nonmotorized modes have the fewest users today, they show the largest increase—about 20 percent. This is understandable because much of the current development activity is mixed use near the boundary of the BBD (such as near North Station and in the South Boston waterfront) and attracts trips from the neighboring parts of the Central Area.

Travel between the rest of the MPO Region and the BBD

The next column pair is travel to the BBD from the rest of the MPO region. The use of nonmotorized modes is almost non-existent for these trips. Walking from Watertown or Quincy to the BBD is not practical, but some people do ride bicycles from the inner suburbs outside of the Central Area to the BBD. Transit service for this market would include the Riverside Branch of the Green Line, the Braintree Branch of the Red Line, and most of the commuter rail system. Transit is also expected to take some market share from auto by 2040.

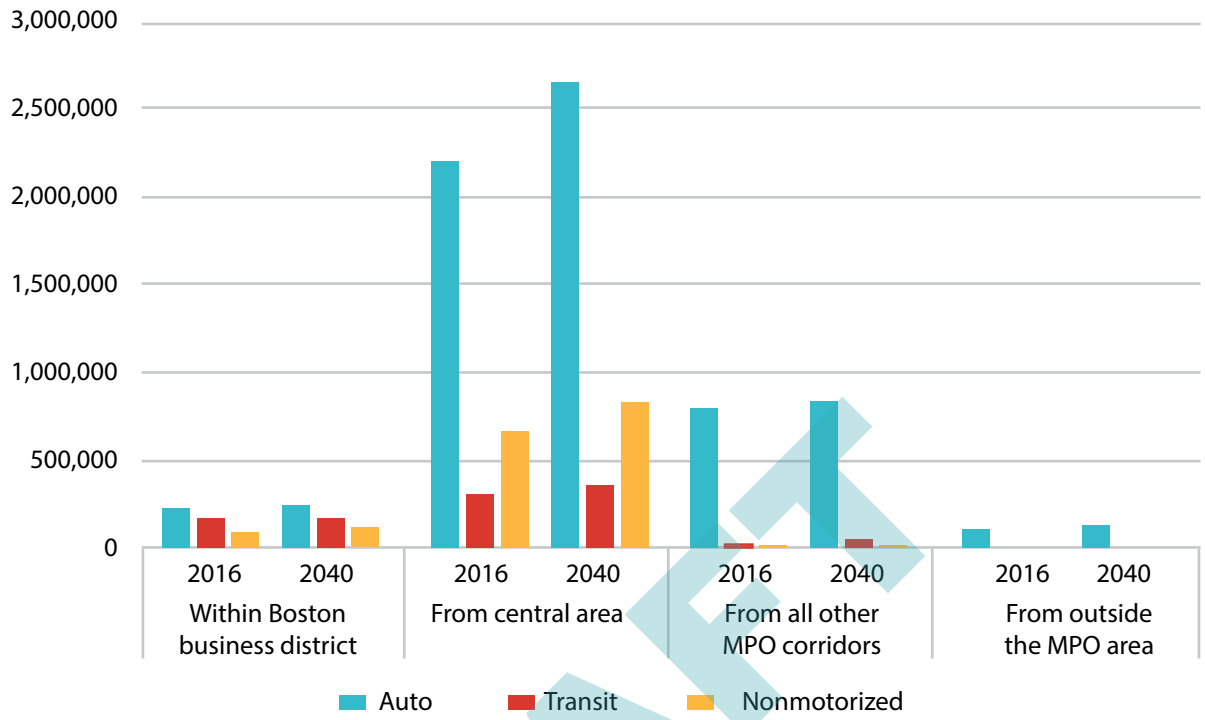
Travel between outside the MPO Region and the BBD

The last column pair is for trips to the BBD from outside the MPO. Auto is the dominant mode, with a small amount of travelers using one of the 35 commuter rail stations outside the MPO area, or one of the regional bus services.

Travel in the Central Area

Figure 3-4 shows the numbers of trips ending in the Central Area in 2016 and 2040 by the three major mode groups. This figure is organized in the same manner as Figure 3-3 except that the scale extends to 3,000,000 instead of 450,000 to accommodate the larger number of trips. While the BBD is much denser than the Central Area, the Central Area is geographically far more extensive and includes major employment centers—notably Kendall Square, the Longwood Medical Area, and Logan Airport.

Figure 3-4
Travel Mode Projections for the Central Area



Source: Boston Region MPO.

Travel between the BBD and the Central Area

The values are the same for the trips from the Central Area to the BBD, shown in the second set of column pairs of Figure 3-3, and the trips to the Central Area from the BBD, shown in the first set of column pairs of Figure 3-4. The differences in the column heights between the two figures are solely attributable to the differences in the figure scales. This difference illustrates that the flow of trips between the BBD and the Central Area, which is so important to the BBD (Figure 3-3), is only a very small part of travel in the Central Area, as illustrated in Figure 3-4.

Travel within the Central Area

As Figure 3-4 shows, the most important Central Area travel market is trips that both begin and end within the Central Area. Auto is used for about 69 percent of these trips, while transit is used for only 10 percent. The nonmotorized modes account for 21 percent of trips, reflecting the relative density and the abundant nearby destinations of the diverse Central Area neighborhoods.

Transit use is actually much more important in the Central Area than Figure 3-4 implies. The travel estimates in Figures 3-3 and 3-4 are for all trips over the entire day, which includes trip purposes and time periods where autos may offer advantages. However, many of the transit trips are made by commuters and students traveling during the peak periods. Peak-period traffic congestion and the need to pay for parking for an entire work shift makes transit an

attractive alternative to driving for commuters. Transit use by commuters frees up roadway and parking capacity use by vehicles for which transit might not be a practical option.

Travel between the MPO Region both outside the Central Area and in the Central Area

The third column pair in Figure 3-4 shows trips between the Central Area and areas of the MPO region outside the Central Area and BBD. Most of these trips are by auto. This number exceeds the amount of trips to the BBD by all modes.

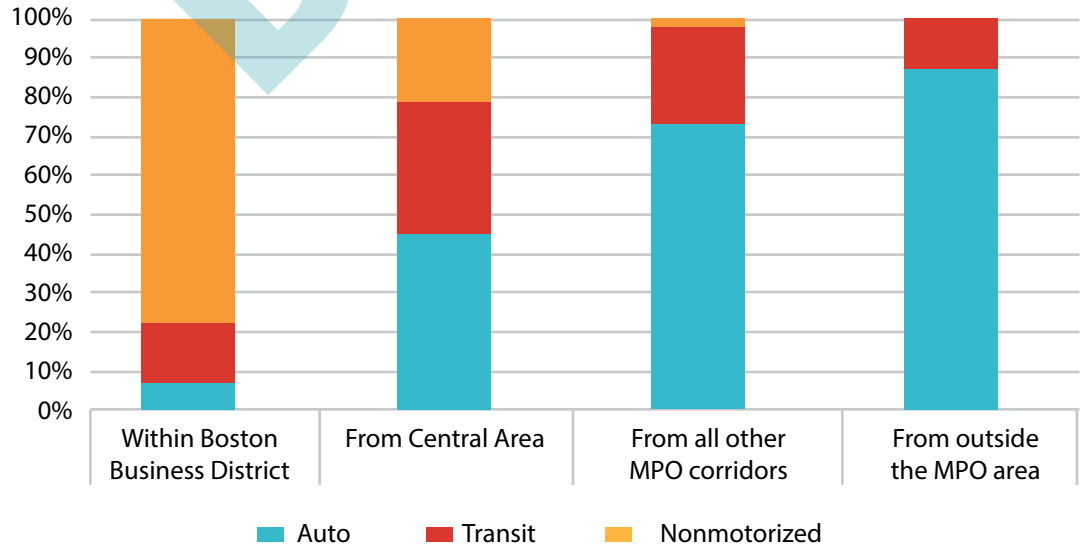
Travel between outside the MPO Region and the Central Area

The last column pair in Figure 3-4 shows that the smallest Central Area travel market is trips outside the Boston MPO area, and these are almost exclusively by auto.

Summary of Travel in the Urban Core

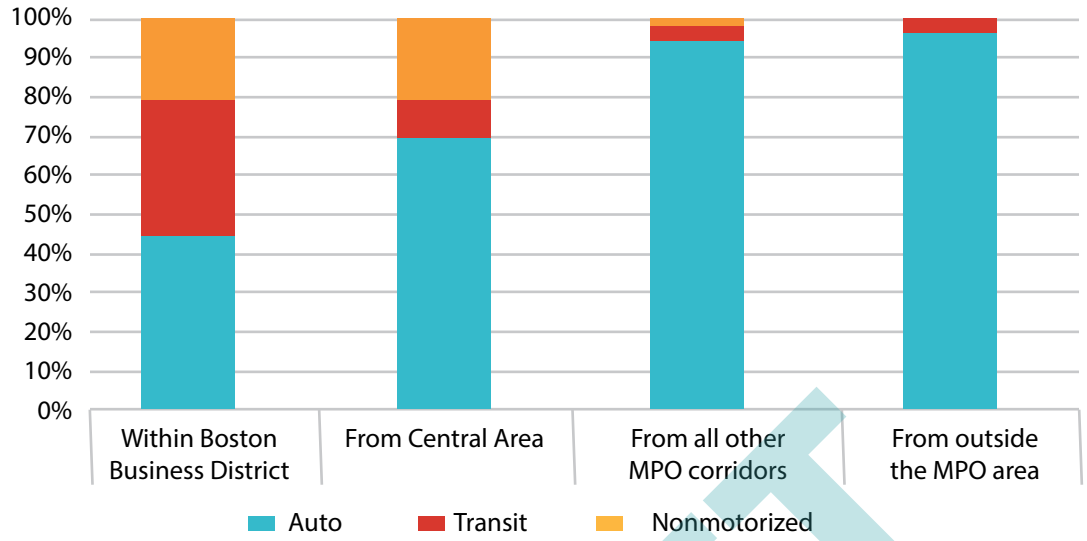
The attractiveness of the nonmotorized modes depends largely upon the proximity of useful destinations. Walking and bicycling can be used within the outer areas of the MPO region, but to reach Boston's urban core from the outer areas, auto or transit is usually required. Reverse commuting from a Central Area or BBD residence to a suburban workplace is growing, however, unless the workplace happens to be convenient to a transit service, auto will continue to be the commuting mode of choice. Figures 3-5 and 3-6 summarize the mode shares for travel to the two parts of Boston's urban core.

Figure 3-5
Mode Share Comparisons to the Boston Business District



Source: Boston Region MPO.

Figure 3-6
Mode Share Comparisons to the Central Area



Source: Boston Region MPO.

Travel in the MPO Region Outside of the Urban Core

Travel patterns for trips that both begin and end outside of the urban core are much less clearly defined. Workers with a primary workplace outside their residence travel on average 10 miles to work. Unlike commuting to the urban core, with its high-capacity radial transportation route systems, traveling from a suburban residence to a suburban workplace might be in any direction. There are about three times as many non-work as work trips, but these trips are often shorter than work trips. In addition to frequent and necessary shopping trips, non-work trips include trips for medical appointments, taking children to school or other activities, or going to social or recreational activities.

However, it is possible to discern some interesting suburban travel patterns, and the MPO's statewide model is the key tool for quantifying these flows. The model region has been divided into subareas referred to as districts, which (outside the urban core) consist of groups of municipalities. The projected trip flows between districts presented in this section have been derived from the calibrated model.

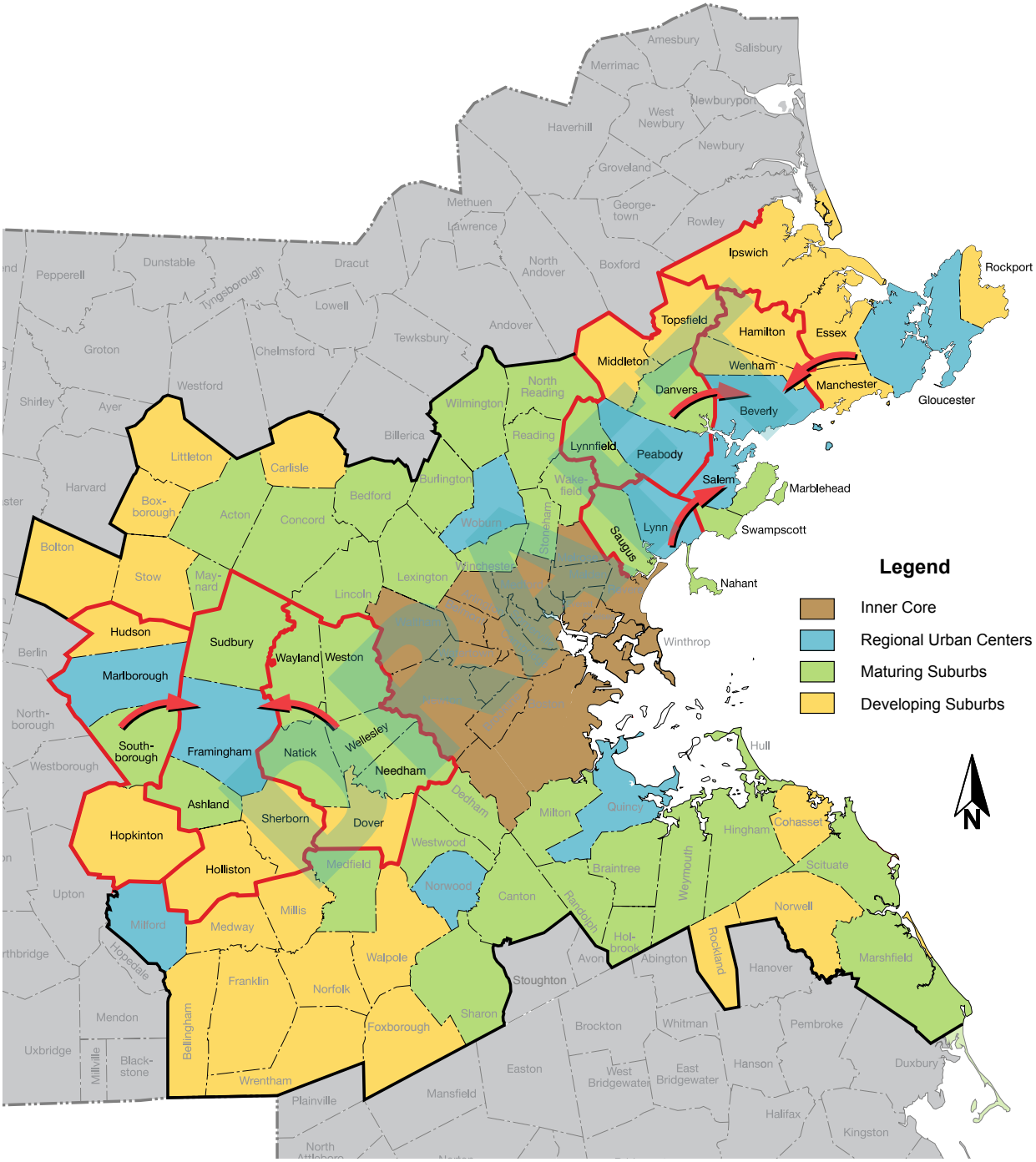
The results indicate that the districts with the largest trip flows to other districts outside the urban core were areas containing the important non-core area cities, Beverly, Salem, and Framingham. These areas and their strongest trip flow partners are shown in Figure 3-7, and also includes the MAPC community types. The community type depiction shows the Inner Core which includes the Central Area plus several adjacent municipalities. Outside of the inner core, the municipalities are characterized as Regional Urban Centers, Maturing Suburbs, or Developing Suburbs.

A major finding of this analysis is that the Regional Urban Centers function as suburban mini-downtowns, generating a significant amount of travel with adjacent areas. Table 3-7 summarizes some of the region's largest suburb-to-suburb trips flows. Travel to the Beverly/Salem area from the adjacent Peabody area (75,600 person-trips by auto) and to the Framingham area from the Natick area (78,900 auto trips) had the greatest numbers of trips between them in the suburban districts.

Trip flows from the Lynn, Gloucester, and Marlborough areas are also shown in Table 3-7 to provide a clearer picture of the importance of the Beverly/Salem and Framingham areas as regional trip generators. Other regional urban centers, notably Woburn and Quincy, also attract large numbers of trips from nearby suburbs. However, the proximity of Beverly/Salem and Framingham to other regional urban centers results in a larger number of trip flows to these areas.

Also presented in Table 3-7 are the intra-area trips for the Beverly/Salem and Framingham areas. These intra-area trips far exceed the trips to neighboring areas—a disparity that is even more pronounced for the non-auto modes. The comparative size of intra-area trips is largely attributable to the design of the districts used for model calibration. By grouping together several municipalities, many residents simply find that many of their daily destinations are located within these multi-municipality areas.

Figure 3-7
Metropolitan Area Planning Council Community Types with Notable 2040 Suburban Trip Flows



Sources: Boston Region MPO and Metropolitan Area Planning Council.

Table 3-7
Notable Suburban Trip Flows

Suburban Area-Pairs	Auto	Transit	Bicycle	Walk
Trips to Beverly/Salem Area from:				
Peabody area	75,600	300	700	800
Lynn area	51,200	1,100	800	1,300
Gloucester area	31,600	200	100	NM
Neighboring areas total	158,400	1,600	1,600	2,100
Beverly/Salem area (intra-area)	283,700	9,700	5,000	47,100
Trips to Framingham Area from:				
Natick area	78,900	1,000	800	1,700
Marlborough area	56,500	200	NM	100
Neighboring areas total	135,400	1,200	800	1,800
Framingham area (intra-area)	250,300	6,500	3,600	20,600

NM = Not meaningful
Source: Boston Region MPO.

Table 3-8 shows the mode shares of the Table 3-7 trip flows. Auto is the most dominant mode for travel from one suburban area to another, even for the adjacent area-pairs described above. For trips entirely within a suburban area, the walk mode is used for a significant number of trips—14 percent in the Beverly/Salem area and seven percent in the Framingham area. Even in the less-dense suburban communities, there will always be a large number of origins and destinations in close enough proximity to each other that use of a nonmotorized mode is feasible.

The suburban trip flows shown in Table 3-7 are expected to increase about nine percent by 2040, with the intra-area trips increasing slightly more than trips from the neighboring areas. The mode shares are expected to change only slightly. The auto share between Beverly/Salem and the neighboring areas is projected to decrease from 97 to 96 percent and within Beverly/Salem from 82 to 81 percent. Within the Framingham area, the auto share is expected to drop from 89 to 88 percent, but will stay at 97 percent for trips to neighboring areas.

Table 3-8
Selected Suburban Mode Shares

Suburban Area-Pairs	Auto	Transit	Bicycle	Walk
Mode shares between Beverly/Salem Area and:				
Peabody area	98%	0%	1%	1%
Lynn area	94%	2%	1%	2%
Gloucester area	99%	1%	0%	0%
Neighboring areas combined	97%	1%	1%	1%
Beverly/Salem area (intra-area)	82%	3%	1%	14%
Mode shares between Framingham Area and:				
Natick area	96%	1%	1%	2%
Marlborough area	99%	0%	0%	0%
Neighboring areas combined	97%	1%	1%	1%
Framingham area (intra-area)	89%	2%	1%	7%

Source: Boston Region MPO.

Freight, Heavy Vehicles, and Light Commercial Vehicles

The travel patterns described in previous sections have been those of individuals conducting their personal lives around their primary residence, often a primary workplace, and other travel destinations of their choosing. However, a significant fraction of traffic consists of vehicles traveling for a commercial reason. These components of traffic are sometimes referred to generically as trucks or freight. This section divides these vehicles into four subgroups and suggests some broad travel patterns to help to understand this diverse traffic mix. The four subgroups are:

- Long-distance freight
- Local pickup and delivery
- Other heavy vehicles
- Light commercial vehicles

Long-Distance Freight

Long-distance freight almost exclusively uses the tractor and semi-trailer combination. This is true whether or not the cargo was hauled from a distant origin or was transferred off a rail car or ship at one of the major intermodal terminals in or near the Boston Region MPO area. (Most air cargo is consolidated into trailers and hauled out of the airport to distribution centers.)

Trailers and containers have the advantage of being suitable for intermodal movements. For long-distance highway-only shipments, using the largest allowable equipment reduces the unit cost of transportation.

The destination of these long-distance shipments is usually a large customer, warehouse, or distribution center. These facilities tend to be located near major highways and at locations farther from the urban center where large industrial parcels are available. Long-distance shipments can reach the MPO area at any time of day or night and it may be necessary for drivers to find a place to park while waiting for the terminal to open or for a pre-arranged customer delivery time.

Local Pickup and Delivery

The trucks that the public are most likely to notice in an urban area are making deliveries, and to a lesser extent, picking up packages or freight. These trucks range in size from the maximum allowed 53-foot semi-trailer to four-wheeled delivery vans.

Smaller, single-unit delivery vehicles come in several configurations. A common type has six wheels, with the wheels on the rear axle doubled. This six-wheel configuration meets the common definition of a truck, and these vehicles are not permitted to use roads that do not allow for trucks. Some trucks have a second rear axle with doubled wheels, making 10 wheels altogether. These trucks are useful for heavy loads such as beverages or home heating oil.

The four-wheel delivery van is becoming a more common sight in residential neighborhoods with the increasing popularity of online shopping. The automakers have responded by developing new generations of larger, four-wheeled delivery vehicles.

The distribution centers of several supermarket chains are located outside the Boston Region MPO area, and every supermarket in the area is visited by several semi-trailers daily. Semi-trailers also deliver to restaurants and convenience stores, delivering only a part of the load at each stop. Commercial deliveries tend to begin early in the day, continue through the midday, and tail off as the evening peak-period builds. Consequently, most trucks tend to travel more during the midday.

Other Heavy Vehicles

Many vehicles with six or more wheels are not carrying freight. This is especially true in urban areas where vehicles such as garbage trucks, cement trucks, dump trucks, and bucket trucks (for servicing above-ground utilities) are common sights. Many of these have the 10-wheel configuration characteristic of especially heavy loads.

These vehicles are often dispatched from motor pools closer to the urban core than the large distribution centers. The motor pool only needs to be large enough to store the vehicles and

does not need to be near a large warehouse-type facility. However, similar to the practices of commercial distribution, these vehicles tend to begin their routes early and finish up before the evening peak.

Light Commercial Vehicles

Four-wheeled vans and pickup trucks are mainstays of utility motor pools and the distribution fleets mentioned above, often emblazoned with the corporate logo. They are also popular with self-employed people in trades such as contractors, plumbers, and electricians. Many of these tradespeople stencil their company name on the vehicle, but the vehicle is garaged at home and at the end of the work day, is often used as a family car. Conversely, some pickup trucks observed in traffic are going to the day's building site, but there is no indication of its business purpose directly on the vehicle.

Taken altogether, light commercial vehicles are usually more numerous than the heavier trucks with six or more wheels. These vehicles also tend to get started early and avoid the evening peak, if possible.

Estimated Truck Trips

For road and traffic planning purposes, MPO staff considers vehicles involved in logistic and commercial activities in five broad groups generally based on the types of roadways they are allowed to use. Trips by these groups are summarized in Table 3-9, along with applicable road restrictions. Altogether these vehicles make up almost 20 percent of regional traffic.

Table 3-9
Estimated Weekday Truck Trips in the Boston Region MPO Area

Truck Groups	Road Use Prohibitions	Trips
Vans and pickup trucks	None	1,510,000
Single-unit trucks with six or more wheels	DCR Parkways and local restrictions	373,000
Semi-trailers	DCR Parkways and local restrictions	119,000
Single-unit trucks with hazardous cargo	Parkways, local restrictions, and tunnels	11,000
Semi-trailers with hazardous cargo	Parkways, local restrictions, and tunnels	4,000

DCR = Department of Conservation and Recreation
Source: Boston Region MPO.

CONCLUSION

The information presented in this chapter helped to inform MPO staff of the various travel patterns in the region. Information on each of the modes—auto, transit, freight, bicycle, and pedestrian travel modes—was considered when staff identified the transportation needs by goal area (Chapters 4–9) and recommendations presented in Chapter 10 of this Needs Assessment. Travel patterns were important to consider when identifying transportation needs in each of the MPO goal areas but particularly important in the capacity management and mobility, transportation equity, and economic vitality goal areas. This information was used to identify issues throughout the region, such as congestion on roadways, access to and the reliability of the transit system, and access to households and employment by transportation equity populations.[1]

[1] MPO staff uses 2010 United States Census and 2010–14 American Community Survey (ACS) data to identify Transportation Equity (TE) populations as follows:

- People considered as a minority are those who identify as Hispanic or Latino/a/x and/or Black or African American, Asian, American Indian or Alaska Native, or Native Hawaiian or other Pacific Islander.
- Staff tabulates Limited English Proficiency (LEP) for the population aged five and older, and tabulates disability status for the noninstitutionalized population. A person with LEP is defined as a person who speaks English less than "very well," as reported in the ACS. All other TE populations are tabulated for the universe of total households or people, as appropriate. A low-income household is one whose annual household income is less than or equal to $45,392, or 60 percent of the region's median household income of $75,654.
- A transit-dependent household is one that does not have access to at least one personal vehicle.

chapter 4

Safety Needs

THE BOSTON REGION MPO'S SAFETY GOALS AND OBJECTIVES

Goal:

Transportation by all modes will be safe.

Objectives:

- Reduce the number and severity of crashes and safety incidents for all modes
- Reduce serious injuries and fatalities from transportation
- Make investments and support initiatives that help protect transportation customers, employees, and the public from safety and security threats

INTRODUCTION

Issue Statement

People who travel by car, truck, bus, rail, bicycle, or on foot in the Boston region seek to travel safely, but often these modes compete for space and priority on the roadways. While roadway crashes overall have declined over time, recent increases in bicycle and pedestrian crashes and in serious injuries to pedestrians attest to the challenge of ensuring safety for all modes. Changes to travel patterns, caused in part by increased use of transportation network company (TNC) services (e.g., Uber and Lyft) and deliveries from online retail businesses, add to the many factors that affect safety on the region's transportation system. Meanwhile, advancements in connected and autonomous vehicle (CAV) technology have the potential to generate safety benefits, but this technology may also change travel patterns and influence traveler behavior in ways that introduce new concerns.

Background

Safe travel on the region's transportation system is a top priority at the federal, state, and regional level. The federal *Moving Ahead for Progress in the 21st Century Act* (MAP-21) established a goal to achieve significant reduction in traffic fatalities and serious injuries on all public roads, which is also included in the *Fixing America's Surface Transportation (*FAST*) Act*. To support improvements in transportation safety, the US Department of Transportation has required states, transit providers, and metropolitan planning organizations (MPO) to implement a performance-based approach to making investments to improve safety, which includes setting performance targets and monitoring safety outcomes. Similarly, the Massachusetts' Strategic Highway Safety Plan (SHSP) includes a long-term goal to "Move toward Zero Deaths" by eliminating fatalities and serious injuries on the Commonwealth's roadways.

While the MPO shares the federal and state goals of reducing crash severity for all users of the transportation system, the MPO is also taking steps to reduce the number of crashes, serious injuries, and fatalities at the regional level.

SAFETY NEEDS SUMMARY

Reducing the number of transportation-related accidents, injuries, and fatalities as well as related property damage, pain, and suffering, is the Boston Region MPO's highest priority. This focus is in line with federal goals and Vision Zero policies that are being implemented by the Commonwealth of Massachusetts and municipalities. Potential projects that improve transportation safety in the region will need to account for all modes and employ a variety of strategies. Effective solutions will also require collaboration between the MPO, the Massachusetts Department of Transportation (MassDOT), other Commonwealth executive agencies, including the region's transit providers, municipalities, and other stakeholders.

Over the last several decades, the MPO has built a practice of analyzing roadway crash trends and crash locations. The MPO helps address key safety issues by recommending roadway design solutions for specific locations; creating tools and guidance to help municipalities address local safety issues; and investing in capital projects through the Long-Range Transportation Plan (LRTP) and Transportation Improvement Program (TIP) to improve safety.

Going forward, the MPO must continue to enhance practices of analyzing data, collecting public feedback, and applying staff expertise to recommend safety solutions. The MPO must also continue to apply LRTP and TIP evaluation and development processes that help identify and support projects likely to have safety benefits. The MPO should also continue to monitor the potential impacts that CAV technology will have on roadway user behavior and safety.

There are also areas where the MPO can expand activities to address transportation safety. The MPO will need to consider transit safety issues, data requirements, and needs when coordinating with the region's transit providers to set federally required transit safety performance targets. The MPO should analyze transit safety trends on an ongoing basis, consider the potential safety benefits of projects for the Massachusetts Bay Transportation Authority (MBTA), Cape Ann Transportation Authority (CATA), MetroWest Regional Transit Authority (MWRTA), and MassDOT that are programmed in the TIP, and explore opportunities to support transit agencies' safety initiatives and investments. The MPO should also continue to collaborate with safety practitioners, transportation agency representatives, municipalities, and others to identify both infrastructure and non-infrastructure approaches (such as education and awareness campaigns) to reduce fatalities, injuries, incidents, and other safety outcomes across all transportation modes and systems.

Table 4-1 summarizes key findings about safety needs that MPO staff identified through data analysis and public input. It also includes staff recommendations for addressing each need. Chapter 10–Recommendations to Address Transportation Needs in the Region provides more detail on each of the recommendations. The MPO board should consider these findings when prioritizing programs and projects to receive funding in the LRTP and TIP, and when selecting studies and activities for inclusion in the Unified Planning Work Program (UPWP).

Table 4-1
Safety Needs in the Boston Region Identified through Data Analysis and Public Outreach and Recommendations to Address Needs

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Fatalities and serious injuries from roadway crashes	Average number of fatalities and serious injuries from roadway crashes have declined over the past five years. However, a multi-strategy approach will be needed to eliminate roadway crash fatalities and injuries in the Boston region.	Identify crash factors and countermeasures Consider capital investment, education, enforcement, and other approaches to improve roadway safety	*Existing Initiatives* • Coordinate with partner agencies to collect data that supports safety research and analysis • Participate in road safety audits for roadway improvement projects • Continue to collect and analyze safety data and monitor performance measures *Proposed Studies* • Study factors that may contribute to fatal and serious injury crashes on the region's roadways • Conduct TIP before-after studies to evaluate safety impacts of funded projects *Proposed Initiatives* • Publicize transportation safety-oriented education and awareness material through the MPO's communication and public involvement channels • Coordinate with other agencies and stakeholders on their approaches for addressing education, enforcement, and other factors that influence safety

Emphasis Area	Issue	Needs	Recommendations to Address Needs
High crash locations	The number of all crashes should be reduced. Crash cluster locations with high EPDO values indicate locations with high crash frequencies and/or where crashes are severe.	Address the region's top-ranking crash cluster locations. Address MassDOT-identified Top 200 high crash intersections in the Boston region (66 total), such as those on Route 9 in Framingham, Route 107 in Lynn and Salem, and Route 16 in Chelsea, Everett, and Medford.	*Existing Program* Fund projects to improve safety at these locations through the MPO's Intersection Improvements, Complete Streets, and Major Infrastructure investment programs *Existing Study* Recommend solutions for specific locations through the Community Transportation Technical Assistance, Addressing LRTP Priority Corridors, Addressing Subregional Priority Roadways, and Low-Cost Solutions for Express Highway Bottlenecks studies *Proposed Study* Recommend solutions for specific locations through Safety and Operations at Selected Intersections studies *New Initiative* Publicize transportation safety-oriented education and awareness material through the MPO's communication and public involvement channels
Pedestrians	In the Boston region, the number of pedestrian-involved crashes is increasing. Pedestrians were involved in a disproportionate share of roadway crashes resulting in fatalities (27 percent) and serious injuries (12 percent), based on a 2011–15 rolling annual average. Pedestrian safety was a top concern mentioned during the MPO's outreach events.	Address top-ranking pedestrian crash cluster locations, including those in downtown areas in Chelsea, Lynn, Quincy, Boston, and Framingham. Provide well-maintained, connected sidewalk networks. Improve pedestrian connections at intersections. Develop separated shared-use paths.	*Existing Program* Fund projects to improve safety for pedestrians through the MPO's Intersection Improvements, Complete Streets, and Bicycle and Pedestrian investment programs *Existing Studies* • Recommend solutions for specific locations through Community Transportation Technical Assistance, Addressing LRTP Priority Corridors, Addressing Subregional Priority Roadways studies • Use the MPO's Pedestrian Report Card Assessment tool to analyze pedestrian safety and walkability *Proposed Studies* • Recommend solutions for locations with high pedestrian crash rates or pedestrian fatalities or injuries • Recommend safety solutions for people traveling to transit stops or stations

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Bicyclists	In the Boston region, bicyclists account for a disproportionate share of roadway crash fatalities (four percent) and serious injuries (five percent) based on a 2011–15 rolling annual average. Bicycle safety was a top concern mentioned during the MPO's public outreach events.	Address top-ranking bicycle crash cluster locations, including those in Boston, Cambridge, and Somerville. Develop separated shared-use paths and protected bike lanes. Develop a connected bicycle network.	*Existing Program* Fund projects to improve safety for bicyclists through the MPO's Intersection Improvements, Complete Streets, and Bicycle and Pedestrian investment programs *Existing Studies* • Recommend solutions for specific locations through Community Transportation Technical Assistance, Addressing LRTP Priority Corridors, Addressing Subregional Priority Roadways studies • Use the MPO's Pedestrian Report Card Assessment tool to analyze pedestrian safety and walkability *Proposed Study* Recommend solutions for locations with high bicycle crash rates or bicycle fatalities or injuries
Trucks	Truck-involved crashes account for approximately six percent of total motor vehicle crashes in the Boston region; however truck and large vehicle crashes account for 10 percent of roadway fatalities according to a 2011–15 rolling annual average.	Address top truck crash cluster locations. Modernize obsolete interchanges, such as the I-90 and I-95 interchange in Weston and the I-95 and Middlesex Turnpike interchange in Burlington.	*Existing Program* Fund projects to improve safety for trucks through the MPO's Intersection Improvements, Complete Streets, and Major Infrastructure investment programs *Proposed Program* Fund projects to improve truck safety through an MPO Interchange Modernization investment programs *Existing Study* Recommend solutions for specific locations through Low-Cost Solutions for Express Highway Bottleneck studies
Multimodal roadway usage	Cars, trucks, buses, bicyclists, pedestrians, and others compete for space and travel priority in constrained roadway environments. Delivery vehicles transporting online purchases and TNC vehicles picking up or dropping off passengers also compete for curb space and create conflicts. Both of these factors can create unsafe conditions for travelers.	Incorporate Complete Streets design and traffic calming principles in roadway projects. Identify strategies to manage roadway user priority, parking, and curb space.	*Existing Study* Apply or support safety- relevant findings from the MPO's Future of the Curb study (FFY 2019 UPWP)

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Transit safety	The MBTA reported recent increases in fatalities on its system, particularly on the commuter rail. The MBTA and the RTAs in the Boston region must continue to monitor and reduce bus collisions, derailments, and other accidents that may contribute to negative safety outcomes.	Collect and analyze safety data and monitor transit safety performance measures. Identify and invest in priority state-of-good-repair and modernization projects (e.g. positive train control and rapid transit vehicle upgrades). Coordinate with transit providers and partner agencies on safety education and awareness initiatives.	*Proposed Program* Fund projects to improve transit safety through an MPO Transit State of Good Repair and Modernization investment programs
Connected and Autonomous Vehicles	CAV technology is advancing. While CAV applications may reduce instances of human driver error, limiting factors such as inclement weather and device inoperability, may reduce their safety effectiveness. Riskier driver, pedestrian, and other roadway user behavior may offset safety benefits.	Monitor advancements in CAV technology. Monitor and analyze safety impacts of CAV deployments, particularly in the Boston region.	*Proposed Study* Research safety outcomes of autonomous vehicle testing in Boston or other metropolitan areas.

CAV = Connected and Autonomous Vehicles. EPDO = Equivalent Property Damage Only. FFY= federal fiscal year. LRTP= Long-Range Transportation Plan. MassDOT = Massachusetts Department of Transportation. MBTA = Massachusetts Bay Transportation Authority. MPO = metropolitan planning organization. RTA = regional transit authority. TNC = transportation network company. UPWP = Unified Planning Work Program.
Source: Boston Region MPO.

UNDERSTANDING SAFETY NEEDS IN THE BOSTON REGION

This section presents the research and analysis MPO staff conducted to understand transportation safety needs in the Boston region, which have been summarized in the previous section. Supporting information that MPO staff used to understand safety needs is included in the Appendices of this Needs Assessment.

- Appendix A includes key plans and policies
- Appendix B includes MPO studies and reports
- Appendix C includes data resources

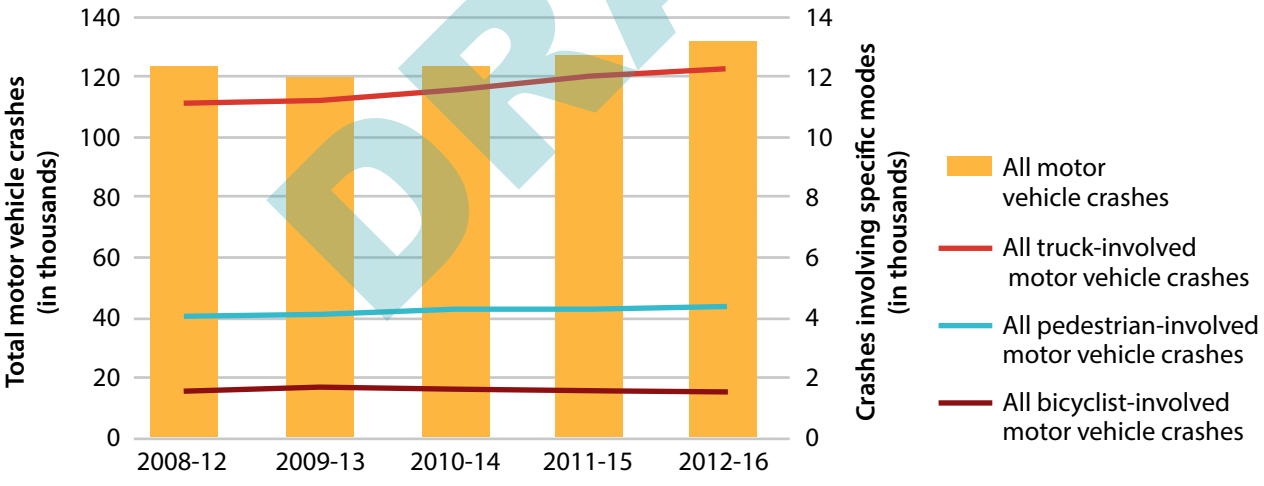
This section also includes a summary of input staff gathered from stakeholders and the public about transportation safety needs and proposed solutions to meet those needs. Staff considered this input when developing recommendations to achieve the MPO's safety goals and objectives.

Research and Analysis on Roadway Safety

Roadway Crash, Fatality, and Injury Trends

The Commonwealth of Massachusetts and the MPO track traffic crashes using information from the Massachusetts Crash Data System.[1] Figure 4-1 shows recent trends in Massachusetts for all motor vehicle crashes, along with those that involve bicyclists, pedestrians, or trucks. In this chart and the other roadway safety charts that follow, data is presented in rolling five-year annual averages for the years 2008 through 2016. As shown in the chart, the average number of total motor vehicle crashes in Massachusetts increased by 7.8 percent over the analysis period, those involving trucks increased by 12.4 percent, and those involving bicycles decreased by less than one percent. Meanwhile, the average number of crashes involving pedestrians increased by 14.2 percent.

Figure 4-1
Motor Vehicle Crashes in Massachusetts



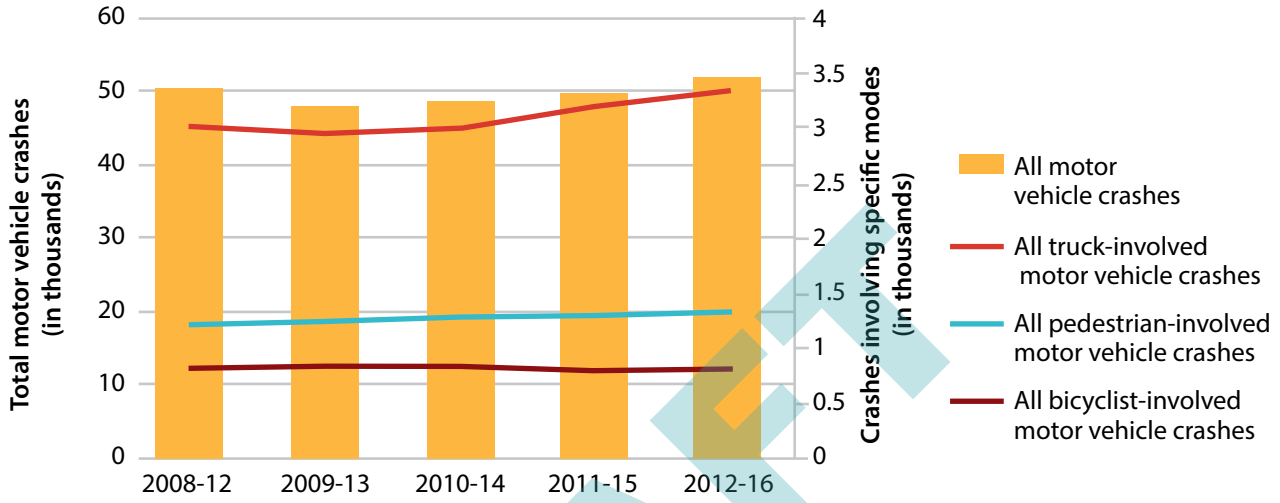
Sources: Massachusetts Crash Data System and Boston Region MPO.

Figure 4-2 provides crash data specific to the 97 municipalities in the Boston Region MPO. During the analysis period, the average number of total motor vehicle crashes increased by 3.2 percent, while Massachusetts as a whole experienced an increase of 7.8 percent. In

[1] The accuracy of the analysis results presented in this section depends on the accuracy of the crash information reported to the Fatality Analysis and Reporting System (FARS) and the Massachusetts Crash Data System.

the Boston region, the average number of truck-involved crashes increased by 10.4 percent, the average number of bicycle-involved crashes decreased by 1.1 percent, and the average number of pedestrian-involved crashes increased by 10.8 percent. These results indicate that the Boston region is experiencing similar trends in nonmotorized crashes compared to Massachusetts as a whole.

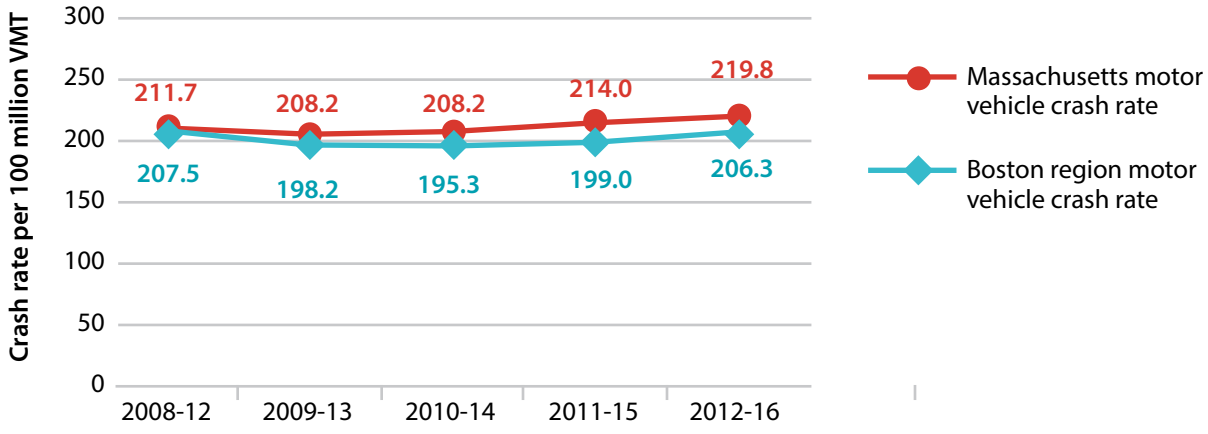
Figure 4-2
Motor Vehicle Crashes in the Boston Region MPO



Sources: Massachusetts Crash Data System and Boston Region MPO.

Figure 4-3 compares the crash rates per 100 million vehicle-miles traveled (VMT) for Massachusetts to the crash rate for the Boston region. Over the analysis period, the motor vehicle crash rate in Massachusetts as a whole increased by 3.8 percent, while the rate for the Boston region decreased by less than one percent.

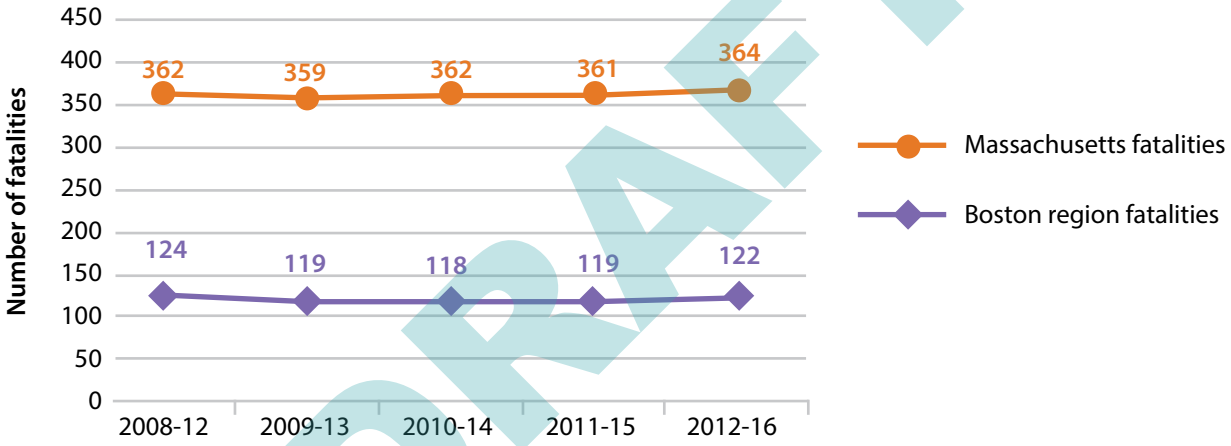
Figure 4-3
Motor Vehicle Crash Rates per 100 Million Vehicle-Miles Traveled



VMT = vehicle-miles traveled.
Sources: Massachusetts Crash Data System and Boston Region MPO.

The Commonwealth and the Boston Region MPO monitor crash outcomes, fatalities, and serious injuries, using information reported to the federal Fatality Analysis and Reporting System (FARS) and the Massachusetts Crash Data System. [2] Several of the charts describing crash outcomes below, including Figures 4-4 through 4-10, show information for federally required roadway safety performance measures, for which states and MPOs are required to set annual performance targets. More information about MPO performance targets is included in Table 4-8. Figure 4-4 shows recent trends in fatalities at the Massachusetts and MPO levels. At both the Massachusetts and Boston region levels, five-year annual rolling averages for fatalities have been relatively stable in recent years, with Massachusetts showing a less than one percent increase and the Boston region showing a 1.1 percent decrease.

Figure 4-4
Fatalities from Motor Vehicle Crashes

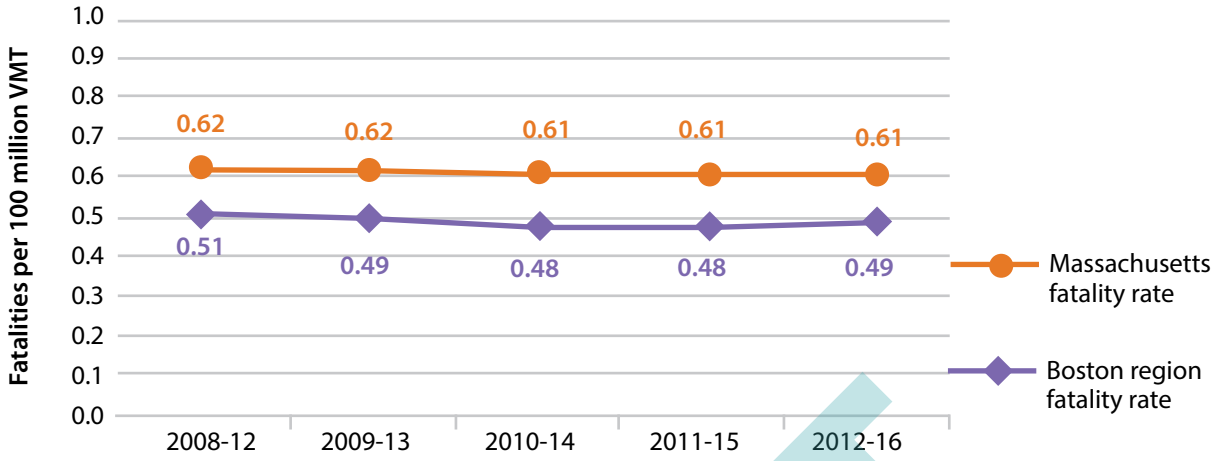


Note: States and MPOs monitor this roadway safety measure to meet federal performance requirements.
Sources: Federal Fatality Analysis Reporting System and MassDOT.

Figure 4-5 shows recent trends in the fatality rate per 100 million VMT for both Massachusetts as a whole and for the Boston region. At the Massachusetts and Boston region levels, average fatality rates have been declining over time, with the state showing a three percent decrease and the Boston region showing a 4.7 percent decrease. These declines may be partially attributed to a slight increase in VMT.

[2] MassDOT defines serious injuries as incapacitating injuries, which are identified through incident reporting by police and vehicle operators using the Commonwealth of Massachusetts Motor Vehicle Crash Operator Report. The Massachusetts Law Enforcement Crash Report Data Dictionary defines incapacitating injuries as non-fatal injuries resulting in severe lacerations, broken or distorted extremities, crush injuries, significant skull, chest, or abdominal injuries, significant burns, paralysis, or unconsciousness when taken from the crash scene. See Massachusetts Law Enforcement Crash Report Data Dictionary, pg. 100.

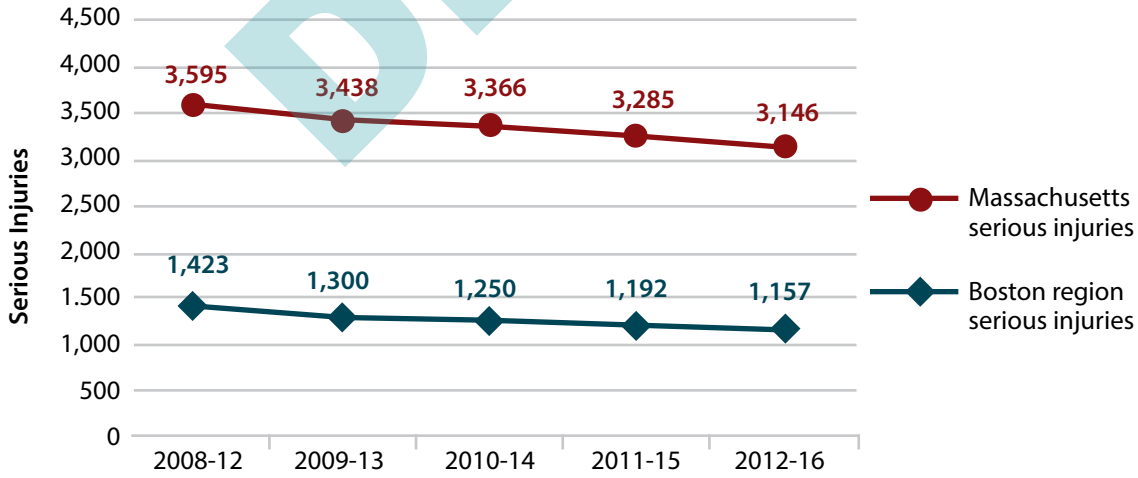
Figure 4-5
Fatality Rate per 100 Million Vehicle-Miles Traveled



Note: States and MPOs monitor this roadway safety measure to meet federal performance requirements
VMT = vehicle-miles traveled.
Sources: Federal Fatality Analysis Reporting System and MassDOT.

Figure 4-6 shows recent trends in serious injuries at the Massachusetts and Boston region levels.[3] The number of serious injuries from motor vehicle crashes declined between 2008 and 2016 both statewide and in the Boston region. It decreased by 12.5 percent statewide and by 18.7 percent in the Boston region.

Figure 4-6
Serious Injuries from Motor Vehicle Crashes

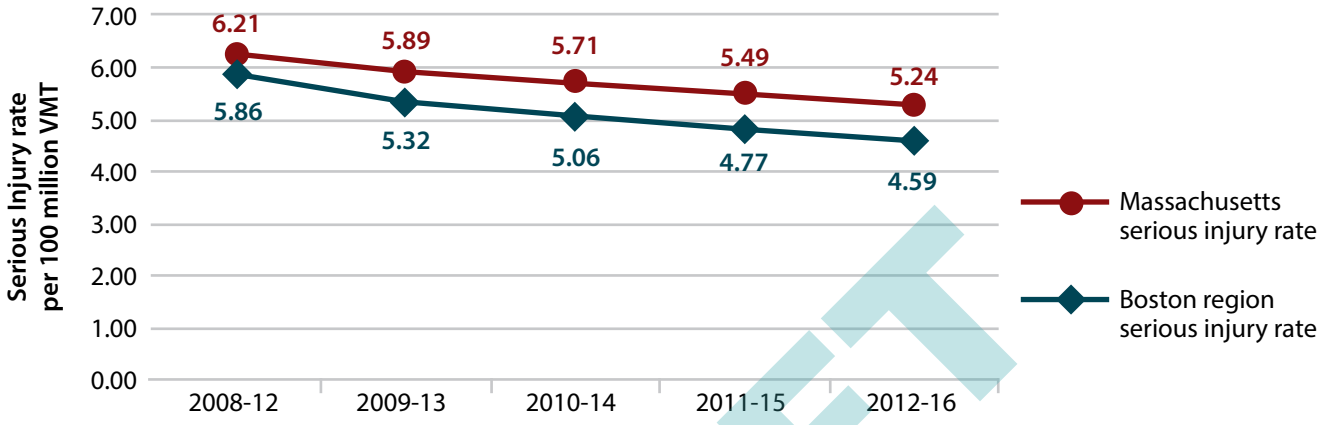


Note: States and MPOs monitor this roadway safety measure to meet federal performance requirements
Sources: Massachusetts Crash Data System and MassDOT.

[3] MassDOT defines serious injuries as incapacitating injuries, which are identified based on incident reporting by police and operators using the Commonwealth of Massachusetts Motor Vehicle Crash Operator Report. (See additional details in Footnote 2).

Figure 4-7 shows recent trends in the average serious injury rate per 100 million VMT for both Massachusetts as a whole and for the Boston region. These rates have been decreasing over time at both the state and Boston region levels; it decreased by 15.1 percent statewide and by 21.7 percent in the Boston region.

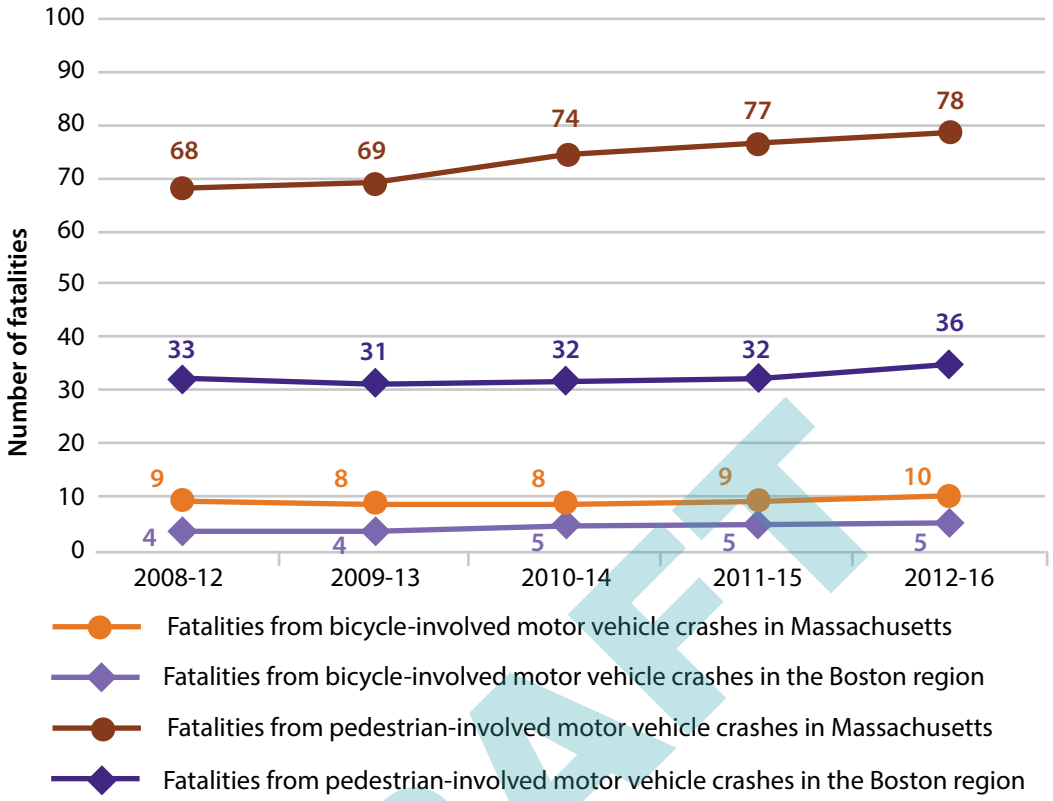
Figure 4-7
Serious Injury Rate per 100 Million Vehicle-Miles Traveled



Note: States and MPOs monitor this roadway safety measure to meet federal performance requirements.
VMT = vehicle-miles traveled.
Sources: Massachusetts Crash Data System and MassDOT.

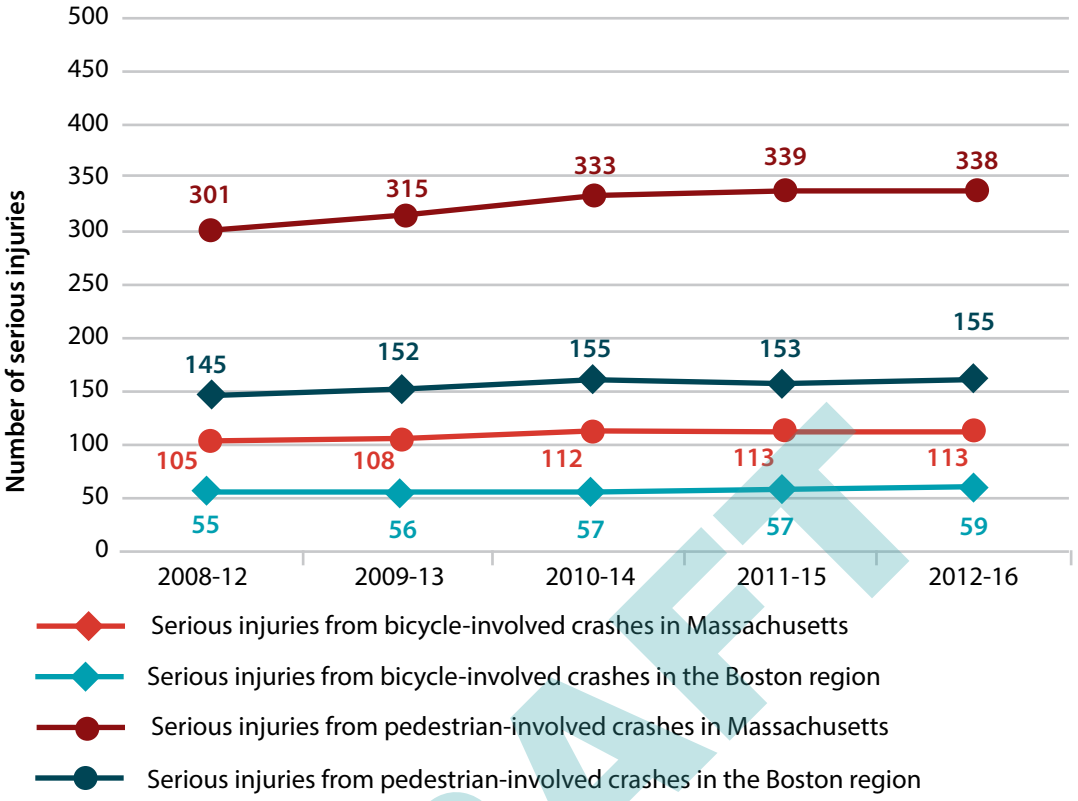
Figures 4-8 and 4-9 present data about fatalities and serious injuries from bicycle- or pedestrian-involved crashes. As noted in Figures 4-1 and 4-2, crashes involving pedestrians have been increasing over time at both the Boston region and statewide levels. Figure 4-8 shows that fatalities from bicyclist- or pedestrian-involved crashes have remained relatively stable at the Boston region level, but at the Massachusetts level, fatalities from pedestrian-involved crashes are increasing. Figure 4-9 shows changes in serious injuries from pedestrian- and bicyclist-involved crashes at both the Boston region level (6.8 percent and 7.3 percent, respectively) and Massachusetts level (12.4 percent and 7.6 percent respectively). Similar to pedestrian-involved crashes that resulted in fatalities, pedestrian-involved crashes that resulted in serious injuries are increasing at the state level.

Figure 4-8
Fatalities from Bicyclist- or Pedestrian-involved Crashes



Sources: Federal Fatality Analysis Reporting System, Massachusetts Crash Data System, and MassDOT.

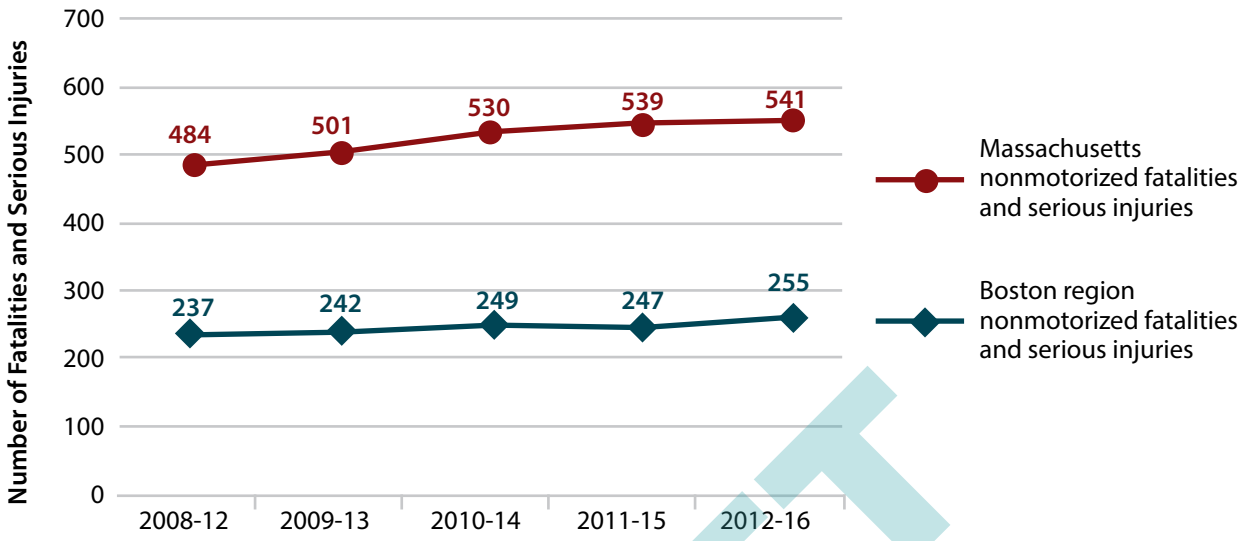
Figure 4-9
Serious Injuries from Bicycle- or Pedestrian-involved Crashes



Sources: Federal Fatality Analysis Reporting System, Massachusetts Crash Data System, and MassDOT.

Figure 4-10 presents nonmotorized fatalities and serious injuries for both Massachusetts and the Boston region. This measure includes fatalities and injuries from bicycle- or pedestrian-involved crashes as well as those from crashes involving other nonmotorized modes, such as skateboards, per federal requirements for highway safety performance measures. During the analysis period, nonmotorized fatalities and serious injuries increased by approximately 11.7 percent in Massachusetts as a whole and by approximately 7.6 percent in the Boston region.

Figure 4-10
Nonmotorized Fatalities and Serious Injuries



Note: States and MPOs monitor this roadway safety measure to meet federal performance requirements.
Sources: Federal Fatality Analysis Reporting System, Massachusetts Crash Data System, and MassDOT.

Roadway Crash Factors

When creating its 2013 SHSP, the Commonwealth identified safety emphasis areas by examining the factors that contribute to motor vehicle crashes that result in fatalities and serious injuries. The sections below discuss specific safety emphasis areas. In each emphasis area, the percentages of fatalities or injuries involving a particular crash factors are expressed in 2011–15 rolling averages.[4] Individual motor vehicle crashes can involve a number of different factors; tracking their prevalence can help inform strategies to improve transportation safety.

Roadway Features

Intersection Crashes

MassDOT reports that 32 percent of fatalities and 40 percent of serious injuries from motor vehicle crashes in the Boston region were related to crashes at intersections. These values are slightly higher than for Massachusetts overall, where 27 percent of fatalities and 39 percent of serious injuries were related to crashes at intersections. The Boston region includes 66 of the Top 200 Intersection Crash Locations identified in MassDOT's 2015 Top Crash Locations

[4] The Boston region crash factor information presented in this section is based on the MPO boundaries prior to October 2018, when the MPO region included Duxbury, Hanover, Pembroke, and Stoughton.

Report.[5,6] Corridors with multiple Top 200 Intersection Crash Locations include the following:

- Route 9 in Framingham (four locations)
- Route 18 in Weymouth (three locations)
- Route 107 in Lynn and Salem (six locations)
- Route 16 in Chelsea, Everett, and Medford (seven locations)
- Route 203 (Morton Street/Gallivan Boulevard) in Boston (three locations)
- Routes 2A and 3 in Cambridge (two locations each)
- Route 1 in Lynnfield and Peabody (two locations)
- Route 28 in Milton and Randolph (two locations)
- Route 20 in Waltham and Weston (two locations)
- Route 135 in Framingham and Natick (two locations)
- Route 16 in Milford (two locations)

The section of this chapter titled High Crash Locations discusses other MassDOT-identified high crash locations in detail.

Lane Departure Crashes

MassDOT describes a lane departure crash as one that occurs after a vehicle crosses a roadway edge or centerline or otherwise leaves the travel lane. MassDOT reports that in the Boston region, 50 percent of traffic fatalities occurred in roadway departure crashes, compared to 56 percent for Massachusetts as a whole. In particular, 41 percent of traffic fatalities occurred in roadway departures not near intersections, compared to 47 percent for Massachusetts. MPO staff analyzed the locations with various subtypes of lane departure crashes using 2013–15 crash data, and found that these crashes are prevalent on expressways along I-93 between I-90 and I-95 northbound; I-93 between I-90 and I-95 southbound; and I-90 in Boston, Newton, and Weston. For arterials, MPO staff noted that lane departure crashes were prevalent along Route 3 in Weymouth; Route 1 in Chelsea, Everett, and Revere; Route 16 in Everett; Soldiers Field Road in Boston; and Route 9 in Newton and Wellesley.

[5] MassDOT identified these top crash locations by examining clusters of motor vehicle crashes and ranking them based on their collective Equivalent Property Damage Only (EPDO) index value. (For more information on EPDO values, see the "High Crash Locations" section of this chapter.) MassDOT considered a crash cluster for inclusion in its Top 200 High Crash Location list if it was considered to be at an intersection. Clusters containing grade separated roadways or weaving sections, such as those located at rotaries or ramps, were excluded. Intersections located at the ends of off-ramps or traffic circles/rotaries were also generally excluded. See MassDOT 2015 Top Crash Locations Report, 2018, pg. 5.

[6] MassDOT 2015 Top Crash Locations Report, 2018, pg. 7-10.

Transportation Modes and Vehicles

Pedestrian- and Bicyclist-Involved Crashes

MassDOT reports that 23 percent of fatalities and 13 percent of incapacitating injuries occurred in pedestrian-involved crashes in the Boston region. These values are higher than Massachusetts-level values (21 percent and 10 percent, respectively). Meanwhile, four percent of fatalities and five percent of serious injuries occurred in bicycle-involved crashes, compared to three percent of fatalities and three percent of incapacitating injuries throughout Massachusetts. The section of this chapter titled Roadway High Crash Locations discusses MassDOT-identified high crash locations for pedestrians and bicyclists.

Large Vehicle and Motorcycle-Involved Crashes

MassDOT reports that 12 percent of fatalities occurred in crashes involving large vehicles, such as trucks or buses, in the Boston region. By comparison, 10 percent of motor vehicle crash fatalities in Massachusetts involved these vehicles. Six percent of serious injuries occurred in crashes involving large vehicles in both Massachusetts as a whole and in the Boston region specifically. The section of this chapter titled Roadway High Crash Locations discusses MassDOT-identified high-truck-crash locations. Meanwhile, 13 percent of fatalities and nine percent of serious injuries occurred in crashes involving motorcycles in the Boston region.

Other Roadway Safety Factors

The MPO spends federal transportation dollars primarily on capital transportation projects, such as intersection or Complete Streets roadway improvements. As a result, the MPO pays particular attention to the modes and infrastructure involved in crashes to determine how it may support safety improvements. However, other considerations and safety emphasis areas, such as those pertaining to driver characteristics and behaviors should also be considered when planning to improve highway safety. Table 4-2 shows the percent of fatalities or serious injuries in the Boston region and Massachusetts that involved driver-related crash factors. Table 4-2 also shows that some factors are more prevalent in motor vehicle crashes resulting in fatalities and serious injuries at the Boston region level than for Massachusetts as a whole, and vice versa. In particular, the involvement of young drivers or older drivers is a factor in a smaller share of Boston region fatalities than for fatalities in Massachusetts overall. Meanwhile, these drivers are involved in larger shares of crashes that result in serious injuries in the Boston region than serious injuries in Massachusetts overall.

Table 4-2
Share of Motor Vehicle Crash Fatalities and Serious Injuries Related to Crash Factors

Crash Factor	Percent of Massachusetts Fatalities	Percent of Boston Region Fatalities	Percent of Massachusetts Serious Injuries	Percent of Boston Region Serious Injuries
Lack of Occupant Protection (e.g., Seat belt use)[a]	49%	48%	12%	10%
Alcohol-impaired Driving	34%	34%	1%	1%
Speeding	28%	27%	3%	2%
Young Drivers[b]	11%	11%	3%	14%
Older Drivers[b]	20%	4%	16%	19%

Note: Percentages reflect 2011–15 rolling averages for the Commonwealth a 101-municipality Boston region that includes four towns that are no longer in the Boston Region MPO's planning area (Duxbury, Hanover, Pembroke, and Stoughton).
[a] Fatalities and serious injuries in this category only reflect those experienced by motorists.
[b] Young drivers are defined as those between 15 and 20 years old, while older drivers are defined as those ages 65 and older.
Sources: Federal Fatality Analysis Reporting System, Massachusetts Crash Data System, and MassDOT.

MassDOT accounts for these factors as well as the roadway characteristic and transportation mode factors (discussed earlier in this section) when it develops safety initiatives and coordinates with municipalities throughout the Commonwealth. Going forward, MassDOT will be putting increased emphasis on other factors, such as driver inattention, to address safety issues on the Commonwealth's roadways. The MPO can be attentive to these driver characteristics and behaviors when conducting its own safety planning, and can look for opportunities to publicize and otherwise support MassDOT initiatives that address these areas.

Roadway High Crash Locations

To address crashes, fatalities, and injuries on the Boston region's roadway network, the Boston Region MPO examines MassDOT-identified crash-cluster locations and uses these as indicators of where safety issues may be present. MassDOT creates these crash clusters using a procedure for processing, standardizing, matching, and aggregating crash data from the MassDOT Registry of Motor Vehicles by geographic location.[7] Crash severity is measured using the Equivalent Property Damage Only (EPDO) index, which weights crashes based on whether

[7] The crash cluster mapping process involves setting a 25 meter search radius around individual crash locations to find nearby crash locations and merging the areas around adjacent crash locations to create clusters. The search radius increases to 100-meters for bicycle- or pedestrian-involved crashes. For more information, see MassDOT's 2015 Top Crash Locations Report, 2018, pg. 4-5, and MassDOT's Top Crash Locations and Maps webpage at https://www.mass.gov/service-details/top-crash-locations-and-maps (accessed January 22, 2019).

they resulted in property damage (weighted by one), injuries (weighted by five), or fatalities (weighted by 10). MassDOT establishes a set of high priority all-mode, bicycle, and pedestrian crash cluster locations by selecting the top five percent of each type of cluster for each regional planning area, using a ranking scheme that accounts for EPDO index values. Projects that aim to address areas where these clusters are located are eligible for federal Highway Safety Improvement Program (HSIP) program funding, which supports roadway safety improvements. When evaluating TIP projects, MPO staff notes where projects are located with respect to each of these types of clusters. This information helps the MPO identify whether projects are addressing locations that have relatively high crash incidences and/or high fatality and injury incidences.

The following sections discuss top-ranked crash-cluster locations in the Boston region. The tables in these sections provide details about crash cluster locations; however these locations are best viewed spatially to understand the area encompassed by the crash cluster. Details on these crash clusters are available in the MPO's LRTP Needs Assessment application at (https://www.ctps.org/maploc/www/apps/lrtpNeedsAssessmentApp/index.html). Details on HSIP-eligible all-mode, bicycle, and pedestrian crash clusters are available using MassDOT's interactive crash cluster map at (https://gis.massdot.state.ma.us/topcrashlocations/). Chapter 8, on transportation equity needs, provides more information on where these crash clusters are located with respect to MPO-defined transportation equity zones (TEZs). These TEZs reflect areas where specific populations (including minorities, people with disabilities, youth, the elderly, and people with limited English proficiency) or types of households (including low-income and transit dependent households) exceed regional thresholds. Understanding where these populations are located with respect to high crash locations helps the MPO to address transportation safety needs in equitable ways.

All-Mode Crash Clusters

MassDOT created its most recent set of all-mode HSIP clusters using 2013–15 crash data. There are 993 crash clusters in the Boston region that are eligible for HSIP funding. Table 4-3 presents all-mode crash clusters with an EPDO index value greater than 150, along with information about the other cluster types these clusters intersect. These top-ranked all-mode clusters are also discussed in Chapter 8, which provides information about whether these all-mode clusters are located in MPO-identified TEZs. Table 4-3 shows that many, but not all, of these locations are on interstate segments or at interchanges. Many of these locations are in Inner Core municipalities, although these all-mode crash cluster locations exist throughout the Boston region.

Table 4-3
Top-Ranked HSIP Eligible All-Mode Crash Clusters

All-Mode Crash Cluster Location	Municipality	Cluster EPDO Value	Intersects Expressway	Intersects Arterial Route	Intersects HSIP Bicycle Crash Cluster(s)	Intersects HSIP Pedestrian Crash Cluster(s)	Intersects MPO Staff-identified Truck Crash Cluster(s)	Intersects Massachusetts Top Crash Location(s)	Included in Charting Progress to 2040 Top 25 Highway Crash Locations
Interstate 93 at Columbia Road (north of Exit 15)	Boston	638	X				X		X
Middlesex Turnpike at Interstate 95	Burlington	577	X	X			X		X
Interstate 93 at Interstate 95	Reading	496	X				X		X
Interstate 93 at North Washington Street	Boston	491	X			X	X		X
Interstate 93 near ramps to Furnace Brook Parkway (north of Exit 8)	Quincy	405	X				X		X
Interstate 95 at Route 4 (Bedford Street)	Lexington	399	X	X			X		X
Interstate 93 at Route 3A (Gallivan Boulevard/ Neponset Avenue)	Boston	391	X				X		X
Interstate 93 at Granite Avenue (Exit 11)	Milton	391	X				X		X
Route 9 at Interstate 95	Wellesley	374	X	X			X		X
Interstate 93 (northbound) near Exit 23 (Government Center)	Boston	349	X				X		
Interstate 95 at ramps to Neponset Street	Norwood	348	X				X		
Route 62 (Elliot Street) near Route 128	Danvers	326	X	X			X		
Interstate 93 near ramps for Furnace Brook Parkway (south of Exit 8)	Quincy	315	X				X		
Interstate 93 at Montvale Avenue	Woburn, Stoneham	310	X				X		

All-Mode Crash Cluster Location	Municipality	Cluster EPDO Value	Intersects Expressway	Intersects Arterial Route	Intersects HSIP Bicycle Crash Cluster(s)	Intersects HSIP Pedestrian Crash Cluster(s)	Intersects MPO Staff-identified Truck Crash Cluster(s)	Intersects Massachusetts Top Crash Location(s)	Included in Charting Progress to 2040 Top 25 Highway Crash Locations
Interstate 93 at ramps to Victory Road (south of Exit 13)	Boston	305	X				X		
East Street Rotary at East and Canton streets	Westwood	294							X
Interstate 93 at Columbia Road (south of Exit 15)	Boston	290	X				X		
Interstate 93 (northbound) at ramp to Interstate 95	Stoneham	281	X						
Route 3 at ramps to Route 18 (Main St) (Exit 16)	Weymouth	273	X				X		X
Interstate 93 at Morrissey Boulevard	Boston	266	X				X		
Interstate 93 (northbound) at Route 37 (Granite Street)	Braintree	265	X				X		X
Interstate 95 at Route 3	Burlington	262	X	X			X		
Interstate 93 (southbound) near East Berkeley Street	Boston	260	X				X		
Interstate 93 at Leverett Connector	Boston	251	X				X		X
Interstate 93 (southbound) at Exit 23 (I-90 to Purchase Street)	Boston	240	X				X		
Interstate 495 at Route 2	Littleton	233	X				X		
Route 18 (Main Street) at West Street	Weymouth	229		X			X	X	X
Route 37 (Granite Street) at Forbes Road	Braintree	228		X			X	X	
Interstate 93 (northbound) at ramps to Route 3	Braintree	227	X				X		

All-Mode Crash Cluster Location	Municipality	Cluster EPDO Value	Intersects Expressway	Intersects Arterial Route	Intersects HSIP Bicycle Crash Cluster(s)	Intersects HSIP Pedestrian Crash Cluster(s)	Intersects MPO Staff-identified Truck Crash Cluster(s)	Intersects Massachusetts Top Crash Location(s)	Included in Charting Progress to 2040 Top 25 Highway Crash Locations
Interstate 93 (near ramps to Granite Avenue)	Milton	225	X				X		
Route 28 at Route 3 (Leverett Circle)	Boston	221	X	X			X		
Route 28 at Route 16	Medford	220	X	X		X	X	X	
Route 3A (Southern Artery) at Broad Street	Quincy	218		X		X		X	
Interstate 93 south of Exit 20 (Massachusetts Avenue Connector)	Boston	218	X				X		
Route 28 (Embankment Road) at Route 3 (near Longfellow Bridge)	Boston	215	X			X			
Route 1 at Route 129	Lynnfield	213	X	X			X	X	X
Interstate 95 at Route 30 (north of Exit 24)	Weston	203	X				X		
Route 1 at Salem Street	Malden, Revere	200	X				X		
Interstate 93 near Upton Street	Quincy	198	X				X		
Interstate 95 at Totten Pond Road	Waltham	198	X				X		
Interstate 93 (southbound) at Route 37 (Granite Street)	Braintree	197	X				X		
Morton Street at Harvard Street	Boston	195		X				X	
Interstate 93 near Long Wharf	Boston	194	X				X		
Interstate 95 at Route 2	Lexington	193	X	X			X		X
Interstate 90 near Oak Street	Weston	191	X				X		
Massachusetts Avenue near Memorial Drive	Cambridge	190	X	X	X		X	X	
Route 1 (Newburyport Turnpike) at Route 1 Connector	Peabody	189	X				X	X	

All-Mode Crash Cluster Location	Municipality	Cluster EPDO Value	Intersects Expressway	Intersects Arterial Route	Intersects HSIP Bicycle Crash Cluster(s)	Intersects HSIP Pedestrian Crash Cluster(s)	Intersects MPO Staff-identified Truck Crash Cluster(s)	Intersects Massachusetts Top Crash Location(s)	Included in Charting Progress to 2040 Top 25 Highway Crash Locations
Condon Circle at Salem Street	Lynnfield, Lynn	187		X			X		
Interstate 95 (northbound) at Route 20	Waltham	185	X				X	X	
Route 85 (Cedar Street) at Fortune Boulevard	Milford	181		X			X	X	
Interstate 93 at Massachusetts Avenue Connector	Boston	180	X	X			X	X	
Interstate 93 (near Zakim Bridge)	Boston, Cambridge	179	X	X			X		
Interstate 95 at ramps to Route 16	Newton	178	X				X		
Interstate 95 (southbound) at Route 20	Waltham	176	X				X		
Interstate 93 at Route 138 (Washington Street)	Canton	172	X	X			X		X
Union Street Rotary at ramp to Route 3 (southbound)	Braintree	171					X		
Route 2 at Reformatory Circle	Concord	170	X	X			X		
Hammond Pond Parkway at Route 9 (Boylston Street)	Newton	167		X			X		
Route 126 (Hartford Avenue) at Deerfield Lane	Bellingham	166		X				X	
Interstate 95 at Route 135	Dedham	164	X	X			X		
Route 18 (Main Street) at Pond and Pleasant streets	Weymouth	164		X				X	

All-Mode Crash Cluster Location	Municipality	Cluster EPDO Value	Intersects Expressway	Intersects Arterial Route	Intersects HSIP Bicycle Crash Cluster(s)	Intersects HSIP Pedestrian Crash Cluster(s)	Intersects MPO Staff-identified Truck Crash Cluster(s)	Intersects Massachusetts Top Crash Location(s)	Included in Charting Progress to 2040 Top 25 Highway Crash Locations
Interstate 93 at ramps to Frontage Road (southbound)/ SouthHampton Street	Boston	163	X				X		
Revere Beach Parkway at Webster Avenue	Chelsea	162		X			X	X	
Interstate 95 (northbound) at ramps to East Street	Westwood	160	X				X		
Interstate 93 northbound at ramp to South Main Street	Foxborough	159	X				X		
Route 3 northbound at ramp to Derby Street	Hingham	158	X				X		
Broadway at Route 129 (Lynnfield Street)	Lynn	158		X			X	X	
Route 3 southbound at ramp to Union Street	Braintree	158	X				X	X	
Route 9 (Worcester Road) at Cochituate Road	Framingham	155		X				X	
Interstate 95 northbound at ramp to Washington Street	Woburn	154	X						
Interstate 90 at ramps to Interstate 95	Weston	152	X				X		
Soldiers Field Road at North Harvard Street	Boston	152		X			X		
Route 1A at Premium Outlets Boulevard	Wrentham	151		X			X	X	
Route 9 (Worcester Road) west of Caldor Road	Framingham	150		X					
Interstate 93 at Derby Street	Hingham	150	X				X		

Note: Clusters were selected from Massachusetts 2013–15 HSIP-eligible All-mode Crash Clusters for the Boston region. Expressway and arterial routes are based on designations from the Boston Region's Congestion Management Process.
EPDO = Equivalent Property Damage Only. HSIP = Highway Safety Improvement Program.
Sources: Massachusetts Department of Transportation and Boston Region MPO.

Bicycle Crash Clusters

MassDOT has established a set of HSIP-eligible bicycle clusters using 2006–15 crash data and a 100-meter buffer around the locations of crashes involving bicycles. There are 54 bicycle crash clusters in the Boston region that are eligible for HSIP funding. Table 4-4 presents 10 bicycle crash cluster locations with an EPDO index value greater than 100, along with information about the other cluster types that these clusters intersect.

Table 4-4
Top-Ranked HSIP Eligible Bicycle Crash Clusters

Bicycle Crash Cluster Area	Municipality	Cluster EPDO Value	Intersects Arterial Route	Intersects HSIP Pedestrian Crash Cluster(s)	Intersects Other HSIP Bicycle Crash Cluster(s)	Intersects All-Mode HSIP Crash Cluster(s)	Intersects MPO Staff-Identified Truck Crash Cluster(s)	Intersects Massachusetts Top Crash Location(s)
Massachusetts Avenue (from Harvard Square to Memorial Drive)	Cambridge	989	X	X	X	X	X	X
Beacon and Hampshire streets and Broadway (Park Street to Galileo Galleli Way)	Cambridge, Somerville	942		X	X	X		
Massachusetts Avenue (near Porter Square)	Cambridge, Somerville	525	X	X	X	X	X	
Somerville Avenue, Summer Street, and Bow Street (near Union Square)	Somerville	213		X	X			
Cambridge Street (Quincy Street to Maple Avenue, near Harvard Square)	Cambridge, Somerville	139		X	X			
Broadway and Inman Street (near Central Square)	Cambridge	125		X	X			
Massachusetts Avenue near Cedar Street	Cambridge	123	X		X	X	X	
Massachusetts Avenue at John F Kennedy Street (near Harvard Square)	Cambridge	115	X	X	X	X	X	
Massachusetts Avenue near Commonwealth Avenue	Boston	114	X			X	X	
Cambridge Street and Broadway (near Harvard Square)	Cambridge	105		X	X			

Note: Clusters were selected from Massachusetts 2006-15 HSIP-eligible Bicycle Crash Clusters for the Boston region. Arterial routes are based on designations from the Boston Region's Congestion Management Process.
EPDO = Equivalent Property Damage Only. HSIP = Highway Safety Improvement Program.
Sources: Massachusetts Department of Transportation and Boston Region MPO..

Pedestrian Crash Clusters

MassDOT has established a set of HSIP-eligible pedestrian crash clusters using 2006–15 crash data and a 100-meter buffer around the locations of crashes involving pedestrians. There are 73 pedestrian crash clusters in the Boston region that are eligible for HSIP funding. Table 4-5 presents 22 locations with an EPDO index value of 100 or more, along with information about the other types of clusters that these pedestrian clusters intersect. As shown in the table below, many of these top-ranked crash clusters exist in downtown areas or intersect major arterial routes in the Boston region.

Table 4-5
Top-Ranked HSIP Eligible Pedestrian Crash Clusters

Pedestrian Crash Cluster Area	Municipality	Cluster EPDO Value	Intersects Arterial Route	Intersects Other HSIP Pedestrian Crash Cluster(s)	Intersects HSIP Bike Crash Cluster(s)	Intersects All-Mode HSIP Crash Cluster(s)	Intersects MPO Staff-identified Truck Crash Cluster(s)	Intersects Massachusetts Top Crash Locations(s)
Downtown Chelsea (Broadway, Everett Avenue, and surrounding streets)	Chelsea	916		X	X	X	X	
Downtown Lynn (Essex, Union, Liberty, and Central streets, and surrounding streets)	Lynn	733	X	X		X	X	X
Massachusetts Avenue (Hancock Street to Lansdowne Street, and neighboring streets, near Central Square)	Cambridge	432	X	X	X	X	X	X
Quincy Center (Hancock Street from Washington to School streets)	Quincy	305			X	X	X	X
Downtown Boston (near Court, Summer, Park and India streets)	Boston	264			X			
Davis Square	Somerville, Cambridge	257		X			X	
Downtown Framingham (Waverly, Concord, and Hollis streets)	Framingham	219	X	X		X	X	X

Pedestrian Crash Cluster Area	Municipality	Cluster EPDO Value	Intersects Arterial Route	Intersects Other HSIP Pedestrian Crash Cluster(s)	Intersects HSIP Bike Crash Cluster(s)	Intersects All-Mode HSIP Crash Cluster(s)	Intersects MPO Staff-identified Truck Crash Cluster(s)	Intersects Massachusetts Top Crash Locations(s)
Watertown Square (Main, Mt. Auburn, N. Beacon, and Galen streets)	Watertown	209	X	X		X	X	
Newton Centre (Beacon Street, Centre Street, and surrounding streets)	Newton	184	X	X		X	X	
Downtown Salem (Washington, New Derby, Lafayette, and surrounding streets)	Salem	173	X	X	X	X		
Main Street (approximately Grant to Banks streets)	Waltham	170	X	X		X	X	
Broadway (Mountain Avenue to Revere Beach Parkway) and Park Avenue	Revere	163	X			X	X	
Mt. Auburn Street and Massachusetts Avenue (Harvard Square)	Cambridge	158	X	X	X		X	
Boston Common and Downtown Crossing Areas (Tremont, Washington, Essex and Boylston streets)	Boston	156	X		X			
Prospect and Cambridge streets (Inman Square)	Cambridge	126		X		X		
Central Square	Waltham	124	X	X		X	X	
Cambridge Street (Sciarappa Street to East Street, near Route 28)	Cambridge	118		X				
Harvard Street (near Coodlidge Corner)	Brookline	115	X	X				
Western Avenue (Mall Street to Franklin Street)	Lynn	113	X		X	X	X	X
Hancock Street (Adams Street to Washington Street near Quincy Center)	Quincy	112	X		X	X	X	
Main Street, Downtown Woburn	Woburn	101	X			X	X	
Route 3A in Quincy (Sea Street to Brackett Street)	Quincy	100				X		X

Note: Clusters were selected from Massachusetts 2006-15 HSIP-eligible Pedestrian Crash Clusters for the Boston region.
Arterial routes are based on designations from the Boston Region's Congestion Management Process.
EPDO = Equivalent Property Damage Only. HSIP = Highway Safety Improvement Program.
Sources: Massachusetts Department of Transportation and Boston Region MPO.

Truck Crash Clusters

MassDOT does not specifically identify a set of clusters for truck-involved crashes, but MPO staff followed MassDOT's methodology for creating all-mode crash clusters to generate a set of truck crash clusters using 2013–15 crash data. Staff identified 329 truck crash clusters that accounted for the top five percent of clusters in the Boston region, ranked by EPDO. Table 4-6 presents locations with an EPDO index value greater than 30, along with information about the other cluster types that these clusters intersect. Many of these high-ranking truck crash clusters exist at expressway-to-expressway interchanges and expressway-to-arterial interchanges. A noteworthy exception is the truck crash cluster at Kosciuszko Circle in Boston, which is located near the JFK/UMASS transit station and also intersects HSIP-eligible bicycle and pedestrian crash clusters.

Table 4-6
Top-Ranked MPO-identified Truck Crash Clusters

Truck Crash Cluster Area	Municipality	Cluster EPDO Value	Intersects Expressway	Intersects Arterial Route	Intersects HSIP Pedestrian Crash Cluster(s)	Intersects Other HSIP Bicycle Crash Cluster(s)	Intersects All-Mode HSIP Crash Cluster(s)
Interstate 93 at Columbia Road (north of Exit 15)	Boston	68	X				X
Middlesex Turnpike at Interstate 95	Burlington	65	X				X
Route 9 at Interstate 95	Wellesley	53	X	X			X
Interstate 93 near ramps for Furnace Brook Parkway (north of Exit 8)	Quincy	52	X				X
Interstate 495 at Interstate 290	Marlborough	48	X				X
Interstate 93 (northbound) near ramps for Furnace Brook Parkway (south of Exit 8)	Quincy	48	X				X
Interstate 93 near ramps to Albany Street	Boston	39	X				X
Interstate 93 near Exit 20A (South Station)	Boston	38	X				X
Interstate 95 at Ramps to Neponset Street	Norwood	36	X				X
Interstate 95 at Route 4 (Bedford Street)	Lexington	35	X	X			X
Interstate 93 at North Washington Street	Boston	35	X				X

Truck Crash Cluster Area	Municipality	Cluster EPDO Value	Intersects Expressway	Intersects Arterial Route	Intersects HSIP Pedestrian Crash Cluster(s)	Intersects Other HSIP Bicycle Crash Cluster(s)	Intersects All-Mode HSIP Crash Cluster(s)
Interstate 93 at Interstate 95	Reading	35	X				X
Kosciuszko Circle	Boston	34		X	X	X	X
Interstate 495 at Route 2	Littleton	33	X				X
Interstate 95 at Route 20	Waltham	32	X				X
Interstate 90 at ramps to Interstate 95 (west of Exit 15)	Weston	31	X				X
Interstate 90 near Edgell Road	Framingham	30	X				X
Interstate 90 near Wood Street	Hopkinton	30	X				X

Note: Expressway and Arterial routes are based on designations from the Boston Region's Congestion Management Process. EPDO = Equivalent Property Damage Only. HSIP = Highway Safety Improvement Program. MPO = metropolitan planning organization.
Sources: Massachusetts Department of Transportation and Boston Region MPO..

Stakeholder and Public Input on Roadway Safety

During fall 2017 and winter 2018, MPO staff collected feedback on transportation issues, needs, and opportunities from municipal planners and officials, transportation advocates, members of the general public, and other stakeholders. During this outreach process, 118 participants commented on transportation safety needs. This section focuses on safety issues related to car, truck, bicycle, and pedestrian travel on the region's roadways. Public feedback on transit safety is discussed later in this chapter.

Those who participated in the MPO's outreach process identified a variety of concerns related to roadway safety.

- By a wide margin, the most frequently raised transportation safety concern was related to dangerous conditions for bicyclists and pedestrians, particularly at intersections, high crash locations, on major roadways and routes people use to commute to work or school, in the Boston region's urban core. Several participants noted that a lack of safe pedestrian conditions may compel people using wheelchairs or mobility aids to travel in roadway shoulders.

- The advent of smartphones and other mobile devices has increased instances of distracted driving, putting pedestrians, bicyclists, and motorists at risk.
- Increased use of ridehailing services and deliveries of online purchases has led to more frequent instances of cars and trucks double-parking or otherwise blocking travel lanes, including bike lanes. This poses safety hazards to other roadway users.
- Participants noted that increased through-traffic and roadway congestion in places experiencing increased residential and commercial development, such as Cambridge and Malden, has negative impacts on roadway safety.
- At least one participant expressed concern about the impact of autonomous vehicles on transportation safety.
- At least one participant expressed concerns about interactions between freight traffic and bicyclists.

Participants in the MPO's outreach process identified specific needs and solutions to address these and other safety concerns. Many of these needs and solutions may overlap with those mentioned in Chapter 5 through Chapter 8. The ideas are summarized below.

Roadway Design and Operation

- Continue to support roadway reconstruction projects that implement Complete Streets design principles. Participants noted that more of these types of projects are needed. Some participants proposed that Complete Streets design techniques—such as creating physically separated sidewalks, bike paths, or trails—be incorporated into all roadway improvement projects.
- Designate mandatory drop-off areas for TNCs that double as loading zones. Several participants made this suggestion.
- Implement traffic calming practices and design features. Multiple participants recommended lowering posted speed limits. Some suggested setting defacto 25 mile-per-hour speed limits, and others suggested providing municipalities with funds for new speed limit signs. Others recommended narrowing overwide roadways by implementing bike lanes. Other suggestions included incorporating traffic calming measures into bridges and tunnels and in residential areas; and increasing the number of projects completed through the City of Boston's Slow Streets program each year.
- Improve safety at intersections, particularly for bicyclists and pedestrians. Participants recommended improving pedestrian and bicyclist crossings, particularly at dangerous intersections. Suggestions for improving intersections include the following:
    - Installing more pedestrian countdown timers and ensuring compliance with the Americans with Disabilities Act (ADA) compliance

- Improving signal timing for pedestrian crossings, including audio signals; lengthening crossing times for pedestrians; creating more exclusive pedestrian crossing phases at intersections
- Restriping crosswalks more frequently, and using yellow stripes
- Upgrading curb ramps
- Increasing the use of no-turn-on-red signs
- Deploying low-probability-of-intercept radars for pedestrian detection

- Prioritize rights-of-way to avoid conflicts between trucks and bicyclists.
- Create or improve railroad grade crossings. Several participants mentioned improving conditions for bicyclists and pedestrians at these locations.

Bicycle and Pedestrian Safety

- Build new, safe shared-use paths that are located away from highways and congested arterials. Multiple participants mentioned this solution. These shared-use paths should provide connections to markets, schools, and public transit, and should support radial commutes. Implementing agencies could support these paths by dedicating funds for greenway design and construction, and by making use of abandoned rail rights-of-way.
- Create more protected bike lanes. Multiple participants suggested this solution. These lanes should enable families, children, elderly people, inexperienced riders, and others to feel safe biking.
- Connect bike path segments into a continuous, gap-free network. Multiple participants suggested this solution, with some noting that such a network should be extensive, separated from vehicular traffic, protected, and well-marked. Participants suggested that such a network should serve major roadways, commuter routes, and low-income neighborhoods. Related suggestions include repainting road markings more frequently, designing bicycle facilities consistently across municipal borders, and creating pop-up protected bike lanes.
- Build a safer pedestrian environment with connected and well-maintained sidewalks. Multiple participants suggested this solution, and many highlighted specific ways to create safe sidewalk environments.
    - Maintain smooth surfaces; remove sidewalk hazards such as tree roots and potholes; quickly respond to repair requests; and create uniform standards for sidewalk texture.
    - Widen sidewalks and curb radii.
    - Prevent driveway cuts that cause sidewalks to slope dangerously, which make travel more dangerous in icy conditions.

    - Improve sidewalk lighting so that it is low and even, and lights are closely spaced.
    - Construct more ADA-compliant sidewalks. Improve sidewalk accessibility, for example, by including more curb cuts, so that people with wheelchairs, scooters, and strollers can travel on sidewalks instead of in the street.
    - Quickly clear sidewalks of snow in winter, particularly at bus stops and at tactile strips at curb ramps. This makes travel safer for elderly people and people with disabilities.
    - Use signs to discourage bicycle parking in dangerous areas.
- Improve walking routes from neighborhoods to local schools.
- Prioritizing pedestrians. This includes giving pedestrian's right-of-way priority and creating pedestrian only zones in some locations.

Travel Education and Enforcement

- Enforce rules of the road for motorists. This includes increasing police enforcement of traffic safety. Such enforcement should protect pedestrians in crosswalks, promote travel at safe speeds, and address parking on sidewalks and in bicycle lanes.
- Educate motorists and require regular recertification for drivers. One participant made a related suggestion to encourage better driver behavior.
- Enforce rules of the road for bicyclists. This includes enforcement addressing wrong way biking and biking on sidewalks, improper bicycle parking (such as on handrails or in areas too narrow to accommodate this parking), and proper yielding at intersections. One participant suggested licensing bikes.
- Provide education for bicyclists. Such education could address traffic laws, how to ride bicycles, bicyclist responsibilities, and how to interact with others using the roadway. One participation proposed an education campaign for bicyclists to respect the needs of people with disabilities, for example, by parking their bikes in appropriate areas.

Other Safety Supporting Activities

- Continue to expand Vision Zero initiatives.
- Improve the collection of, access to, and use of data. Participants recommended measuring bicycle usage to improve safety analyses, using predictive analytics to prevent pedestrian and bicyclist crashes, and making crash data more available.
- Maintain roadways to improve safety. This includes maintaining roadway striping.

- Discourage driving. This can include limiting car access or excluding cars.
- Ensure safety in the deployment of autonomous vehicles.

Feedback from Other Outreach Processes

MPO staff also reviewed feedback from other public gathering processes, including the 2017 *MassMoves* public workshops and outreach conducted for the *GoBoston 2030* transportation plan. Several interest areas in common with the MPO's outreach emerged and are included below.

- Design streets to be accessible for ages eight through 80, and for people of all abilities. Participants in the *GoBoston 2030* process applied this principle to the transit system as well.
- Prioritize bicycle and pedestrian safety by installing smarter signals for pedestrians and bicyclists, and adding protected bicycle lanes.
- Connect neighborhoods with better sidewalks and bicycling and walking trails.
- Increase funding for Vision Zero and Complete Streets initiatives.
- Prioritize safety for people accessing transit.

These outreach processes also yielded other valuable themes to consider when planning to improve roadway safety.

- Reallocate street space to balance the needs of all roadway users.
- Improve roadway safety, including with the use of smart traffic management systems.

Current Strategies and Activities to Address Roadway Safety Needs

The Massachusetts SHSP provides an important foundation for the planning and investments for improving roadway safety. The current plan sets an overarching long-term goal to "Move Toward Zero" by eliminating fatalities and serious injuries on the [Commonwealth's] roadways, along with interim goals for fatalities, serious injuries, and fatality and serious injury rates.[8] As mentioned previously, Massachusetts SHSP identifies key safety issue areas, many of which are discussed in the "Roadway Crash Factors" section above. For each issue area, the SHSP identifies specific objectives as well as strategies to address the issue areas, which involve the "4 Es of Safety," Engineering, Education, Enforcement, and Emergency response. Table 4-7 summarizes these strategies and the roles that the MPO has and could play to support their implementation.

[8] Commonwealth of Massachusetts. Massachusetts 2018 Strategic Highway Safety Plan, 2019. Accessed January 22, 2019, at https://www.mass.gov/files/documents/2019/01/18/dot_SHSP_2018.pdf, pg. 5.

Table 4-7
General Safety Improvement Strategies and Current or Potential MPO Roles

General Strategy	Current or Potential MPO Role
Improve data collection, quality, and analysis	Fund safety data collection and management projects through the UPWP, and coordinate with other agencies to share data
Identify crash locations and causes and safety problems	Continue to analyze crash data, including for specific locations
Incorporate safety elements into roadway design and maintenance	Develop safety recommendations as part of corridor and intersection studies Continue to participate in project-level RSAs to identify safety-issues and improvement opportunities at potential project locations Fund safety improvement projects in the TIP
Conduct research to more effectively address crash frequency and severity	Continue to conduct safety-oriented research studies on crash factors, countermeasures, and other topics
Incorporate changes precipitated by new directives related to healthy transportation	Incorporate healthy transportation policies into MPO planning processes Incorporate healthy transportation guidance and recommendations into corridor and intersection studies
Integrate safety issues into planning documents	Continue to account for various safety needs in TIP, LRTP, and UPWP development Incorporate MassDOT, MBTA, and other safety plans into MPO planning processes
Develop infrastructure improvements that address the needs of different types of users	Develop safety recommendations as part of corridor and intersection studies Fund safety improvement projects in the TIP
Improve design and engineering of facilities	Research design best practices in the UPWP
Develop education and training for safety practitioners on best practices for design	Fund safety-related technical assistance and guidebook and tool development through the UPWP Publicize training and educational opportunities through MPO public involvement channels
Provide alternative transportation	Analyze opportunities to provide alternative transportation in UPWP studies, and fund alternative transportation projects in the TIP
Improve communication and collaboration among entities, including municipalities, that are working to address transportation safety	Consider opportunities to use MPO meetings or events to support discussions on transportation safety issues
Create public education and awareness campaigns	Provide information through MPO public involvement channels
Enhance safety enforcement for relevant safety factors, and develop collaborative enforcement efforts	Not applicable
Improve motor carrier systems	Not applicable
Consider enhancements to driver licensing	Not applicable
Improve processes for setting roadway speed limits	Not applicable

General Strategy	Current or Potential MPO Role
Continue to develop and implement practices, policies, and procedures to improve work zone and traffic incident set-ups to maximize safety	Not applicable
Prevent alcohol service to underage youth and intoxicated persons by enforcing alcoholic beverage control laws	Not applicable

LRTP = Long-Range Transportation Plan. MassDOT = Massachusetts Department of Transportation. MBTA = Massachusetts Bay Transportation Authority. MPO = metropolitan planning organization. RSAs = Road Safety Audits. TIP = Transportation Improvement Program. UPW = Unified Planning Work Program
Sources: Massachusetts Strategic Highway Safety Plan and Boston Region MPO.

Federally required roadway safety performance measures and associated targets also help shape approaches to address roadway safety. These performance measures pertain to fatalities and serious injuries from traffic incidents, apply to all public roads, and are expressed as five-year rolling annual averages. The Commonwealth examined historic data and projected five-year rolling average values for these measures and set targets for calendar year (CY) 2019 that represent 2014–19 rolling annual averages. The Boston Region MPO voted to adopt these targets in February 2018 and has agreed to plan and program projects so that they contribute to the Commonwealth's highway safety targets.

Table 4-8 displays the highway safety targets set by the Commonwealth. For all measures, except the nonmotorized fatalities and serious injuries measure, the Commonwealth considered the general downward trend lines in the historic data as its CY 2018 targets. MassDOT recognizes that its initiatives to increase nonmotorized travel throughout the Commonwealth have posed a challenge to concurrent activities to reduce nonmotorized fatalities and injuries. Rather than adopt a target that reflects an increased amount of nonmotorized fatalities and serious injuries, MassDOT has set a CY 2019 target that is approximately equal to the 2011–15 rolling average value for nonmotorized fatalities and serious injuries (see Figure 4-10). The Commonwealth and the Boston Region MPO are required to update these targets on an annual basis.

Table 4-8
2019 Massachusetts Statewide Highway Safety Performance Targets

Highway Safety Performance Measure	2019 Safety Measure Target (Expected 2015–19 Rolling Average)
Number of fatalities	353.00
Rate of fatalities per 100 million VMT	0.58
Number of serious injuries	2,801.00
Rate of serious injuries per 100 million VMT	4.37
Number of nonmotorized fatalities and serious injuries	541.00

VMT = vehicle-miles traveled.
Source: Commonwealth of Massachusetts.

MassDOT's five-year Capital Investment Plan (CIP) plays a key role in implementing the strategies in the SHSP and for addressing the performance targets listed in Table 4-8. The CIP describes how the federal HSIP funds that Massachusetts received are assigned to programs and projects. The FFYs 2019–23 CIP supports these roadway safety improvement strategies through a variety of different reliability and modernization oriented programs, including those relating to bridges, intersections, roadways, bicycle and pedestrian facilities, and intelligent transportation systems. In particular, the CIP includes a highway-oriented Safety Improvements program, which supports repairs to traffic signals, highway lighting systems, impact attenuators, traffic signs, and pavement markings. Federally funded investments made through the aforementioned programs that affect the Boston region appear in the Boston Region MPO's TIP.

Transportation projects that address location-specific safety issues and opportunities begin with project designs and later become candidates for safety-related funding programs. Many types of MPO-funded UPWP studies recommend safety improvements for intersections and corridors, as noted in Appendix B, MPO Studies and Reports. Both MassDOT and the Boston Region MPO's project selection processes include safety-oriented criteria. MassDOT stakeholders also assess safety issues and opportunities by conducting RSAs at candidate project locations. MPO staff typically participate in RSAs conducted in the Boston region. A project becomes eligible for HSIP funding when an RSA is completed, and recommendations from these RSAs, along with those from UPWP studies, can be incorporated into the MassDOT-managed project design process.

Other transportation agencies in the region, including those at the municipal level, support roadway safety through their own activities. In particular, Boston, Cambridge, and Somerville address roadway safety using the same Vision Zero approach that informs the Commonwealth's "Move Toward Zero" goal. These cities have analyzed and publicized data

to better understand safety issues and crash locations, and have or are in the process of developing Vision Zero action plans. Examples of municipal level initiatives to advance Vision Zero include:

- Lowering speed limits and/or establishing slow zones;
- Addressing safety issues related to trucks and other large vehicles; and
- Creating education and engagement campaigns.

The City of Boston has integrated Vision Zero planning with its *GoBoston 2030* transportation plan and has created Priority Corridors and Safe Crossings, Walk and Bike Friendly Main Streets, Neighborhood Slow Streets, and Walkable Streets and ADA Improvements programs to support Vision Zero investments. The Boston Region MPO should continue to monitor these efforts and coordinate with these and other municipalities to identify ways that the MPO can support Vision Zero initiatives.

Research and Analysis on Transit Safety

Transit Safety Trends

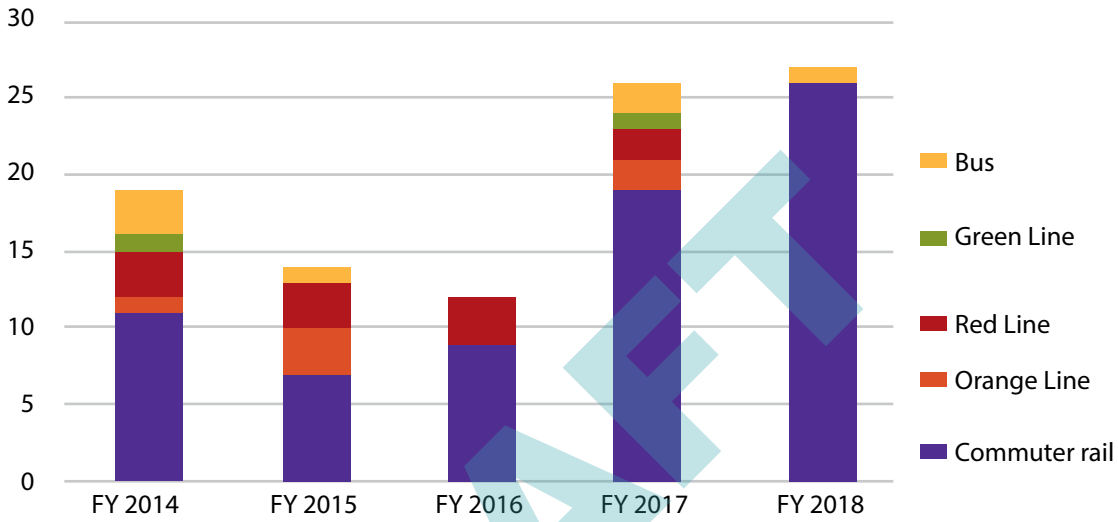
As with roadway safety, a number of factors affect the safety of the Boston region's transit systems, including infrastructure and vehicle condition as well as customer, employee, and general public practices and behavior. Likewise, the region's public transit providers must balance a number of considerations—including safety, operations, expansion needs and opportunities, and maintaining assets with in a state-of-good repair—when deciding how to invest in their systems. By understanding transit safety trends as well as system preservation and modernization, capacity management, and mobility considerations discussed later in this Needs Assessment, the MPO can make better decisions about how to improve the Boston region's transit infrastructure and service.

MBTA

The MBTA is the major transit provider in the Boston region, providing heavy and light rail, commuter rail, bus, ferry, and paratransit service in a complex, wide-reaching transit system. MBTA staff monitors a variety of performance measures to understand, respond to, and proactively plan safety needs on the system. For example, Figure 4-11 displays fatalities for the MBTA's bus and rail systems for the past six state fiscal years (SFYs). As the figure illustrates, most fatalities occurred on the commuter rail system. The number of fatalities on these MBTA systems more than doubled from SFY 2016 to SFY 2017, an increase attributed to growth in person/train collisions on the commuter rail network. This increase in fatalities on the commuter rail system continued into SFY 2018. MassDOT's annual Tracker Performance report notes that a committee of federal and MBTA experts has been created to analyze and address

emerging trends related to person/train conditions.[9] The MBTA has also partnered with Operation Lifesaver to prevent collisions, fatalities, and injuries near railroad tracks and has collaborated with Samaritans, which addresses suicide prevention.

Figure 4-11
Fatalities as a Result of Transit Incidents by MBTA Line



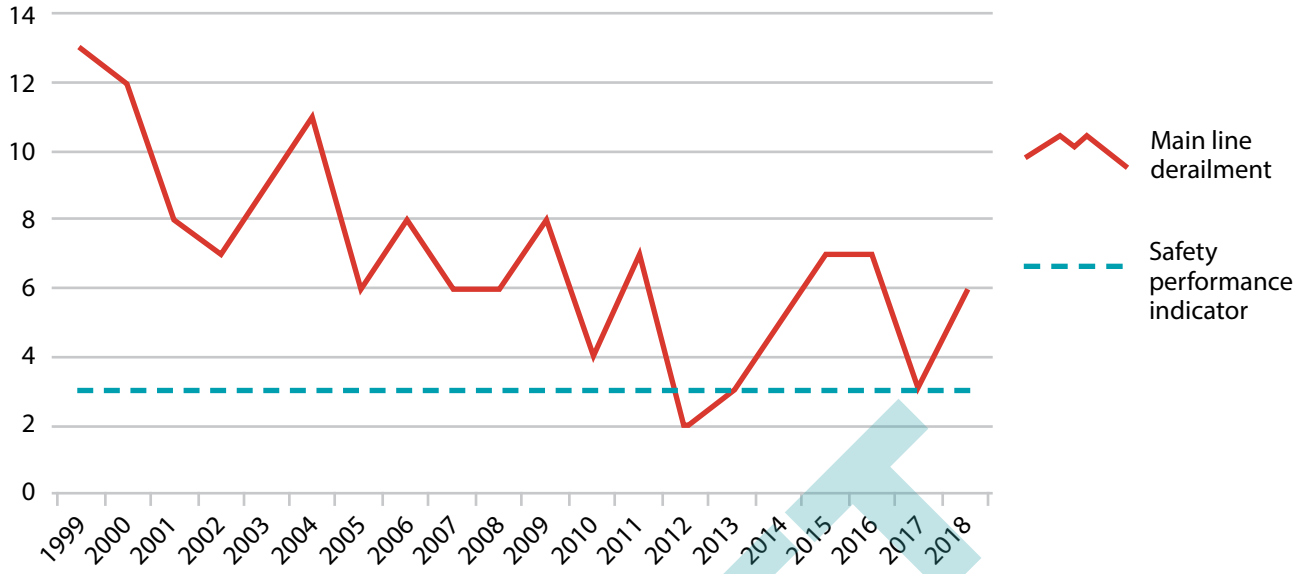
Note: These figures include intentional and unintentional fatalities.
MBTA = Massachusetts Bay Transportation Authority.
Sources: MBTA Safety and MassDOT Office of Performance Management and Innovation.

Other safety-relevant measures include derailments, which are defined as non-collision incidents in which one or more wheels of a transit vehicle unintentionally leaves the rail. Derailments can take place in rail yards or on mainlines. Figure 4-12 focuses on main line derailments, which have been trending downward over time. MBTA staff continues to work to eliminate derailments on its rail systems, and is specifically focused on eliminating human factor derailments, which were identified as the probable cause of 45 percent of 2017 derailments and 50 percent of 2018 derailments. Common human factor derailment causes include improperly setting switches and violating the red phases of signals.[10]

[9] Massachusetts Department of Transportation. Tracker 2017: MassDOT's Annual Performance Report. 2017 (revised March 2018). Accessed December 10, 2018, at https://www.mass.gov/files/documents/2018/04/20/Tracker2017.pdf, pg. 69. See also Tracker 2018: MBTA Performance at https://massdottracker.com/mbta/, accessed January 22, 2019.

[10] Nickle, Ron and Durso, Holly, Massachusetts Bay Transportation Authority (MBTA). MBTA Quarterly Safety Report. January 14, 2019. Accessed January 23, 2019, at https://cdn.mbta.com/sites/default/files/fmcb-meeting-docs/2019/01-january/2019-01-14-fmcb-safety-update-original.pdf, pg. 14.

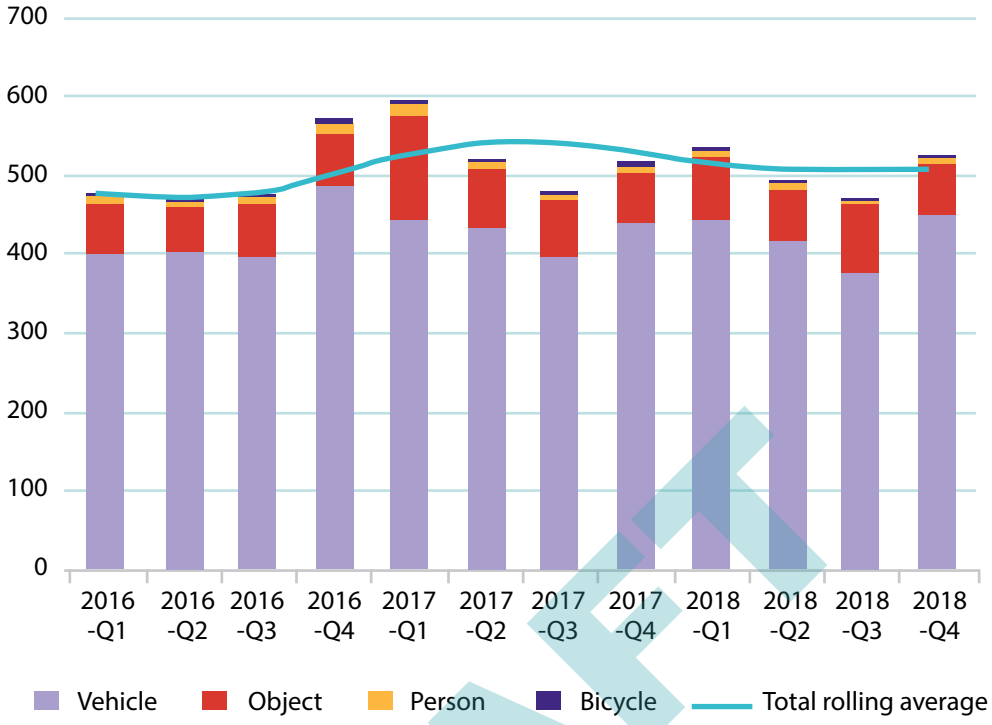
Figure 4-12
MBTA Yearly Main Line Derailments 1999-2018 (Light and Heavy Rail)



Note: This chart reflects mainline derailments occurring as part of both revenue (passenger) and nonrevenue service. The safety performance indicator is established by the MBTA's Chief Safety Officer. Derailment numbers above the safety performance indicator goal signify a need for greater focus on the examination of causal factors and mitigation
MBTA = Massachusetts Bay Transportation Authority.
Source: MBTA Quarterly Safety Report, January 14, 2019.

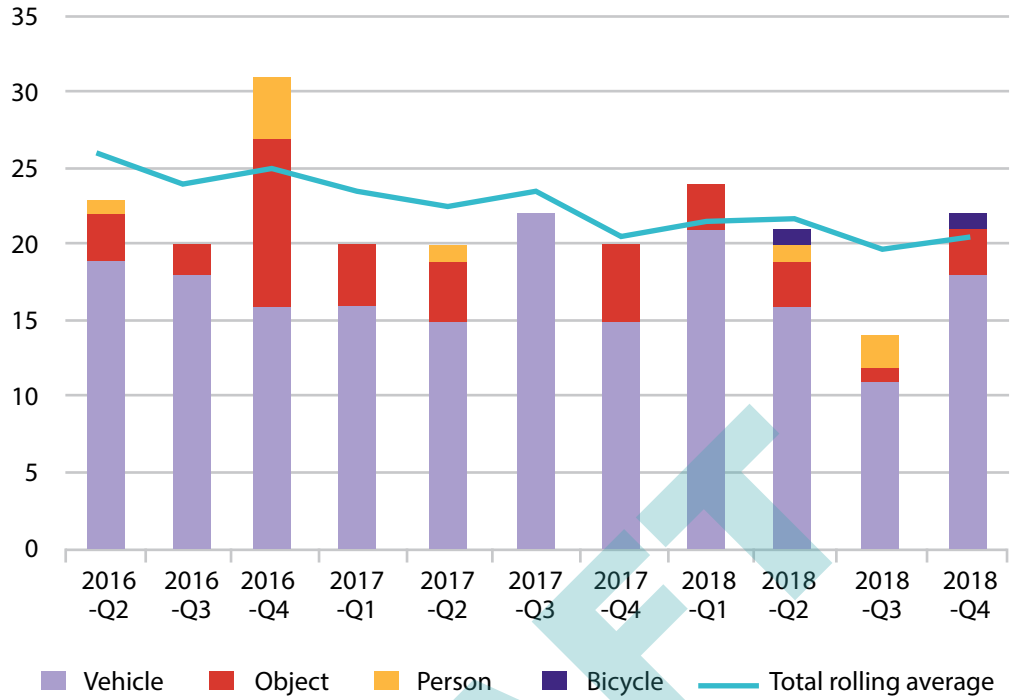
Figures 4-13 and 4-14 show data pertaining to MBTA bus collisions from mid-2016 through 2018, categorized by factor. Figure 4-13 focuses specifically on total bus collisions, estimates for which are based on incidents where there is a report or alleged contact with an MBTA bus, regardless of severity. These counts are based on MBTA operations logs and incidents reported to MBTA Safety. Figure 4-14 focuses on reportable bus collisions, which are those that involve a person requiring transport to a medical facility, any collision involving three or more transports for medical treatment, or any collision resulting in property damage equal to $50,000 or more. These figures highlight that people or vehicles are often factors in these collisions. Since buses generally share roadways with other vehicles, bicyclists, and pedestrians, many of the roadway safety concerns discussed earlier in this section may affect bus travel as well. MBTA staff notes the agency has formed a Bus Accident Reduction committee to address issues related to collisions.

Figure 4-13
MBTA Total Bus Collisions



Note: These counts of total bus collisions are based on incidents where there is report or alleged contact with an MBTA bus regardless of severity. These counts are based on MBTA operations logs and incidents reported to MBTA Safety.
MBTA - Massachusetts Bay Transportation Authority.
Source: MBTA Quarterly Safety Report, January 14, 2019.

Figure 4-14
MBTA Reportable Bus Collisions



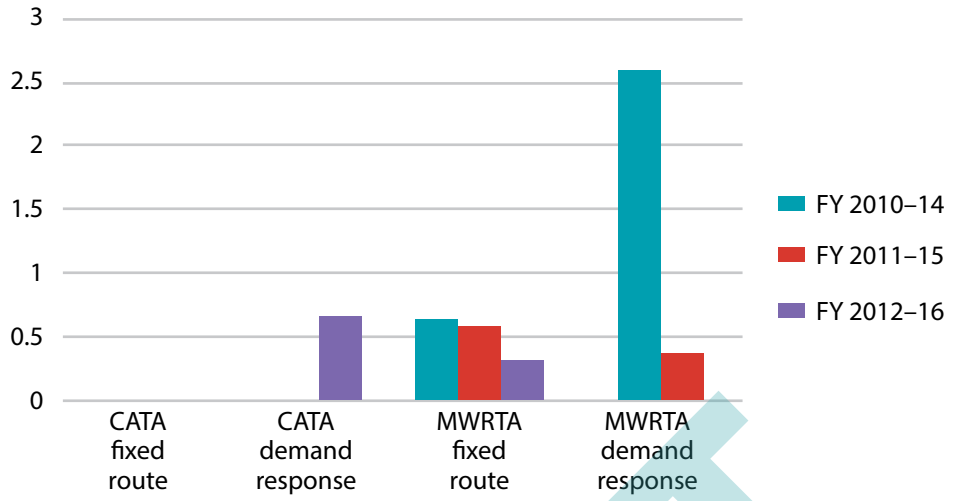
Note: Reportable bus collisions are those that involved a person requiring transport to a medical facility, any collision involving three or more transports for medical treatment, or any collision resulting in property damage equal to $50,000 or more.
MBTA = Massachusetts Bay Transportation Authority.
Source: MBTA Quarterly Safety Report, January 14, 2019.

Regional Transit Authorities (RTAs) in the Boston Region

The RTAs in the Boston region similarly monitor safety data. MassDOT's Office of Performance Management and Innovation reports several RTA safety metrics in its annual Tracker Performance report. The CATA and the MWRTA are of particular interest to the Boston Region MPO area, because they report their investments in the Boston Region MPO's TIP.

Figure 4-15 shows injuries per 100,000 unlinked passenger trips for RTA fixed-route bus or demand response service. These normalized injury values are presented in five-year rolling annual averages. CATA reported no injuries occurring on its fixed-route service during the three periods, and it only reported a positive average number of injuries per 100,000 unlinked person trips for its demand response service for the SFYs 2012–16 period. MWRTA reports declining injury rates for both its fixed route and demand response services. Neither of these transit providers reported fatalities for any of the three analysis periods.

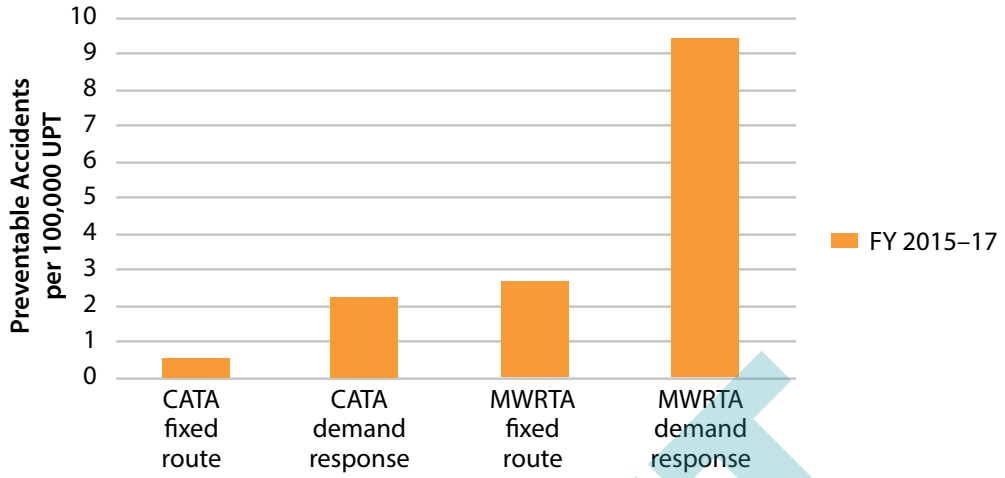
Figure 4-15
Regional Transit Authority Service: Injuries per 100,000 Unlinked Passenger Trips



Note: Injuries reflect the annual number of injuries that resulted from unintentional contact with transit vehicles or property. An injury is recorded for each person who received medical attention on the premises or was transported away to receive medical care.
CATA = Cape Ann Transportation Authority. MWRTA = MetroWest Regional Transit Authority.
Source: National Transit Database: Safety and Security Time Series Module.

Figure 4-16 shows preventable accidents per 100,000 unlinked passenger trips for RTA fixed-route bus service and demand response service. Preventable accidents are those in which the driver of the transit vehicle is normally deemed responsible or partly responsible for the occurrence of the accident. These normalized preventable accident values are presented in three-year rolling annual averages.

Figure 4-16
Regional Transit Authority Fixed-Route Bus Service: Preventable Accidents per 100,000 Unlinked Passenger Trips



CATA = Cape Ann Transportation Authority. MWRTA = MetroWest Regional Transit Authority. UPT = unlinked passenger trips.
Source: MassDOT Rail and Transit National Transit Database: Safety and Security Time Series Module.

Stakeholder and Public Input on Transit Safety

Participants in the MPO's outreach process noted that there are safety issues at bus stops and stations and identified ways to improve transit safety.

Some of these solutions may overlap with those mentioned in Chapter 5, System Preservation and Modernization Needs, Chapter 6, Capacity Management and Mobility Needs, and Chapter 8, Transportation Equity Needs. Suggestions to improve transit safety included the following:

- Publicize emergency protocols on buses and subways.
- Ensure that transit drivers are experienced and avoid privatizing transit vehicle operations.
- Hold bus drivers accountable for infractions that endanger pedestrians and bicyclists.
- Use consistent bridge plates across transit stations, ensure that plates are strong, and avoid using single, flat plates (such as those used at Back Bay and South Station).
- Reduce the gap between train cars and station platforms, and make the distance consistent across stations.

- Provide warnings about the steep entrances to Green Line cars, and invest in cars that are more accessible.
- Invest in rapid transit cars with sliding protective doors, such as those used in Paris.
- Widen station platforms and improve station lighting (which includes keeping lights clean) to aid people with low vision.
- Invest in buses with smaller turning radii.

Current Strategies and Activities to Address Transit Safety Needs

Activities to improve transit safety may range from data management and capital investment to new protocols and employee training. In its 2017 Strategic Plan, the MBTA highlights several specific needs, mandates, and initiatives pertaining to safety, which include workforce safety planning and programming, and the rail and bus system items outlined below.

- **Positive Train Control (PTC) Technology:** PTC systems are integrated command, control, communications, and information systems designed to prevent train-to-train collisions and derailments by tracking train movements and triggering brake systems if unsafe situations occur.[11] The MBTA is implementing a $459 million PTC program that will be implemented on all of the MBTA's commuter rail lines (about 394 miles of service), with the goal of having the system fully operational by 2020.
- **Green Line Safety:** The Green Line faces some unique safety challenges, given its age, signal system, street-running design, and the fact that it relies upon line of sight operation.[12] The MBTA also notes that the accessibility-required construction of the low-floor center truck on Green Line vehicles has resulted "in a declining but still significant" number of derailments.[13] To improve Green Line safety, the MBTA is continuing preventative maintenance, including vehicle, track, and operating improvements to prevent derailments. It also highlights the need for measures to promote pedestrian and traffic safety and to procure and implement Green Line train protection systems/collision avoidance technology.
- **Heavy Rail Maintenance:** While the MBTA prepares for the delivery of new Red and Orange Line vehicles, it recognizes the importance of short-term preventative

[11] US Department of Transportation Federal Railroad Administration (FRA). "Positive Train Control (PTC) Legislation & Regulations. https://www.fra.dot.gov/Page/P0564. Accessed August 13, 2018.

[12] "Line of sight" refers to a railway industry mode of operation that requires trains to operate under speed restrictions so that train operators can come to a stop within half the range of their vision. See City of Edmonton. "Metro Line: Fact Sheet–Operations." 2015. Accessed January 22, 2019, at https://www.edmonton.ca/transportation/Metro_Line_Operations_Fact_Sheet_August_2015.pdf pg. 1.

[13] Massachusetts Bay Transportation Authority. Fiscal Management and Control Board: MBTA Strategic Plan, 2017, accessed January 22, 2019, at https://cdn.mbta.com/sites/default/files/fmcb-meeting-docs/reports-policies/2017-mbta-strategic-plan.pdf, pg. 18.

maintenance of existing Red and Orange Line fleets to ensure safe and reliable service.

- **Bus Safety:** MBTA priorities in this area include developing a program to reduce collisions and ensure the safety of pedestrian traffic at modal stations and crosswalks. Implementation steps may include vehicle engineering improvements, technology solutions, and continued emphasis on driver training.

The needs of transit agencies pertaining to transportation safety are, and will continue to be, shaped in part by federal mandates established under MAP-21 and continued under the FAST Act. The National Public Transportation Safety Plan (2017) creates a guiding framework for agency-level safety planning by establishing safety performance criteria for public transportation systems, and recommending minimum safety performance standards for transit operations and the procurement of transit vehicles. Under the proposed Public Transportation Agency Safety Plan rule, public transportation providers receiving federal financial assistance would be required to develop an agency safety plan.[14] These plans would include methods for identifying and evaluating safety risks throughout transit systems, strategies to minimize the exposure of people and property to hazards, targets for National Public Transportation Safety Plan performance, and other features.

The MPO will have a more integrated role in transit safety through the monitoring of transit safety performance measures and the development of targets for those measures. The MBTA, CATA, MWRTA, MassDOT, and the MPO will need to coordinate on setting targets for established measures pertaining to transit-related fatalities, serious injuries, safety events, and system reliability, which are described in Table 4-1. These measures will help transportation agencies decide how to invest in "safety, reconstruction, or rehabilitation of existing assets in order to achieve and maintain a state of good repair."[15] Transit providers will establish targets for their respective systems, and the MPO will be responsible for setting targets for the Boston region.

MassDOT and transit agencies will work towards achieving these targets in part through capital investments, which are captured in MassDOT's CIP. Federally funded investments made through the aforementioned programs that affect the Boston region appear in the Boston Region MPO's TIP. Many of the CIP's reliability and modernization programs, including those pertaining to MBTA and RTA facilities, stations, vehicles, and systems, relate to transit safety because they help to keep transit in a state of good repair. Examples of CIP programs with specific transit safety components include:

[14] The Public Transportation Agency Safety plan Safety Plan rule would not apply to MBTA Commuter Rail, which is overseen by the Federal Railroad Administration (FRA). However, the System Safety Rule (49 CFR 270), most recently stayed till December 4, 2018, would require the development of a Commuter Rail system safety plan.

[15] US. Department of Transportation Federal Transit Administration. National Public Transportation Safety Plan. 2017, accessed January 22, 2019, at https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/National%20Public%20Transportation%20Safety%20Plan_1.pdf, pg. 30.

- **MBTA—Risk Management and Mitigation:** Implements risk management initiatives and proactive efforts to improve workplace safety and system security.
- **MBTA—Commuter Rail Safety and Resiliency:** Supports Positive Train Control and Automatic Train Control implementation, among other activities to support commuter rail safety and resiliency.

Often, transit system investments that address safety also address system preservation considerations. The Federal Transit Administration (FTA) notes that transit providers would consider the results of asset condition assessments, which are required for the development of the agency's Transit Asset Management Plan, when performing safety risk management and safety assurance activities.[16] In the future, the combination of transit providers' Agency Safety Plans and their Transit Asset Management plans (discussed in Chapter 5) will help identify and prioritize initiatives that will improve the safety of the transit systems operating in the MPO region. These plans will provide valuable information to the MPO as it considers transit agencies' proposed investments for the LRTP and TIP, as well as potential opportunities to provide support with MPO funds.

Future Transportation Safety Issues and Needs

Looking ahead to 2040, advancements in CAV technology will have implications for transportation safety. Connected vehicle technology supports communication from vehicle to vehicle or from vehicles to transportation infrastructures, which may also support the transmission of data about vehicle speed, brake status, and other safety-relevant information. Autonomous vehicle technology transfers the role of monitoring and responding to the travel environment from humans to automated systems. These deployments can range from driver assistance to full automation of the vehicle.

Equipping passenger, freight, and transit vehicles with CAV technology could generate safety benefits. The National Highway Traffic Safety Administration analyzed crash data nationwide for 2015 and attributed about 94 percent of the critical reasons for motor vehicle crashes to drivers.[17] CAV technologies could address human driving errors, such as those caused by fatigue, distraction, limited situational awareness, or under- or over-reaction to the travel

[16] US Department of Transportation Federal Transit Administation, "Fact Sheet: Public Transportation Agency Safety Plans Notice of Proposed Rulemaking (NPRM)." Accessed January 22, 2019, at https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/Fact_Sheet_Public_Transportation_Agency_Safety_Plans_Notice_of_Proposed_Rulemaking_NPRM.pdf, pg. 2.

[17] US Department of Transportation National Highway Traffic Safety Administration. "Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey." *Traffic Safety Facts: Crash Stats.* February 2015. Accessed January 22, 2019, at https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812115, p. 2.

environment.[18] These improvements could increase not only driver safety, but the safety of other roadway users, such as bicyclists and pedestrians. CAV technology may also improve the way vehicles operate in hazardous or constrained areas, such as tight parking spots or work zones. Also, real time provision of traffic signal phase and timing (SPaT) information could transmit warnings and advisories to vehicles approaching signalized intersections.[19]The types of benefits could result in saved lives, reduced health care costs, improved productivity, and reduced need for emergency response.

However, it is also possible that increased deployment of CAV technology may have neutral or negative effects on transportation safety. An evaluation of crash data by the Casualty Actuarial Society's Automated Vehicles Task Force found that 49 percent of crashes involved a limiting factor (such as inclement weather, inoperable traffic control devices, vehicle deficiencies, or driver behavior issues) that might reduce the effectiveness of or disable CAV technology.[20] Vehicle passengers or other roadway users could be inclined to engage in riskier behaviors, such as not using seatbelts or jaywalking, which may offset the benefits of CAV technology. Questions about how highly automated vehicles (HAV) may account for other roadway users persist, such as whether computing algorithms are likely to perform better than experienced human drivers, as do questions about non-HAV users may perceive or anticipate HAV actions. Planners and regulators will have to be attentive to how safety benefits and costs could vary depending on the market penetration of HAVs in the overall vehicle fleet.

Response to developments in CAV technology can happen at multiple levels of government. The Commonwealth's Commission on the Future of Transportation recommends that the Massachusetts governor should "consider proposing legislation to establish statutory and regulatory structures that would enable the safe and reliable deployment of CAVs."[21] In the MPO staff report, *Connected and Autonomous Vehicles and the Boston Region MPO—A First Look,* staff recommend actions for the MPO to stay current on CAV advancements and to plan for and respond to these technologies. Safety-relevant actions include the following:

[18] Central Transportation Planning Staff. Connected and Autonomous Vehicles and the Boston MPO—A First Look. December 2017. Accessed January 22, 2019, at https://www.ctps.org/data/pdf/studies/other/Connected_and_Autonomous_Vehicles.pdf pg. 10.

[19] California PATH Program Institute of Transportation Studies University of California, Berkeley. Investigating the Potential Benefits of Broadcasted Signal Phase and Timing (SPaT) Data under IntelliDriveSM. 2011. Accessed January 22, 2019, at http://www.cts.virginia.edu/wp-content/uploads/2014/04/PFS_SPAT99_Final.pdf, pg. 17.

[20] Casualty Actuarial Society Automated Vehicles Task Force. Restating the National Highway Transportation Safety Administration's National Motor Vehicle Crash Causation Survey for Automated Vehicles. 2014. Casualty Actuarial Society E-Forum, Fall 2014–Volume 1. Accessed January 23, 2019, at https://www.casact.org/pubs/forum/14fforum/CAS%20AVTF_Restated_NMVCCS.pdf, pg. 1 and 16. See also Smith et al. Benefits Estimation Framework for Automated Vehicle Operations, 2015. Volpe National Transportation Systems Center. Accessed January 23, 2019, at https://rosap.ntl.bts.gov/view/dot/4298/dot_4298_DS1.pdf, pg. 13-14.

[21] Commission on the Future of Transportation in the Commonwealth. Choices for Stewardship: Recommendations to Meet the Transportation Future. Volume 1. Accessed January 22, 2019, at https://www.mass.gov/files/documents/2019/01/10/FOTCVolume1.pdf, pg. 48.

- Identifying the potential of CAV technology to collect data for both movement and infrastructure conditions
- Monitoring and supporting CAV testing efforts, and becoming an active stakeholder in these efforts, seeking opportunities to participate in ongoing and upcoming processes related to CAV technology, such as serving on research panels or being involved in deployment efforts
- Conducting periodic assessments of CAV market penetration to keep CAV program costs and strategies up to date
- Fostering research ties with educational institutions to keep current with CAV technology

Security, Emergency Management, and Transportation Safety

The transportation safety issues discussed in this chapter have focused on fatalities, injuries, and other negative outcomes arising from typical travel on the region's roadways and transit systems. These negative outcomes may result from the design or condition of roadway or transit assets; from unintended consequences of driver, customer, or other behaviors; from weather, or from other factors. However, ensuring a safe transportation system also involves protecting the system from security incidents, such as a terrorist attack, and from natural disasters. These considerations will continue to be important, particularly for new transportation technologies and networks, such as those that may be implemented to support CAV travel.

Preventing and responding to security needs can involve capital investment, such as in new facility designs or in sensing, monitoring, or surveillance equipment. It can also involve operations planning and management to support communication and emergency response. Surface transportation agencies such as MassDOT, the MBTA, and the Massachusetts Port Authority have responsibilities in both capital investment and operations planning and management. MassDOT's five-year CIP includes programs designed to support security initiatives across MassDOT divisions. Programs in the FFYs 2019–23 CIP include:

- **Highway/Intelligent Transportation Systems:** Supports innovative and new communication equipment and information technology systems, such as signs, cameras, and sensors, to improve MassDOT's communication tools to communicate with drivers about travel options.
- **Information Technology/Cyber Information and Security:** Supports information technology infrastructure and software, in compliance with best practices and security standards, to protect agency and customer data.

- **MBTA/Risk Management and Mitigation:** Implements risk management initiatives and proactive efforts to improve workplace activity and system security.

- **MBTA/System Upgrades:** Supports upgrades to MBTA systems, including but not limited to communications, security, and computer technology systems, and rehabilitates nonrevenue vehicles and equipment.

With respect to transportation security, the Boston Region MPO relates most closely to capital investment processes that support security and communications assets. Federally funded investments made through the aforementioned programs that affect the Boston region appear in the Boston Region MPO's TIP. The MPO can also serve as a forum for transportation agencies and other stakeholders to discuss transportation security concerns and identify ways to incorporate them into the transportation planning process.

The MPO also expects that climate change may affect transportation safety, specifically through its impacts on transportation infrastructure. More details about this are discussed in Chapter 5, System Preservation and Modernization.

UPDATES SINCE *CHARTING PROGRESS TO 2040* NEEDS ASSESSMENT

Since the MPO last updated its Needs Assessment in 2014, there have been several planning and policy changes that affect the content of this chapter:

- Starting in 2015, the Cities of Boston, Cambridge, and Somerville became Vision Zero municipalities. These cities have committed to eliminating traffic fatalities and serious injuries, and are implementing strategies to achieve that goal.

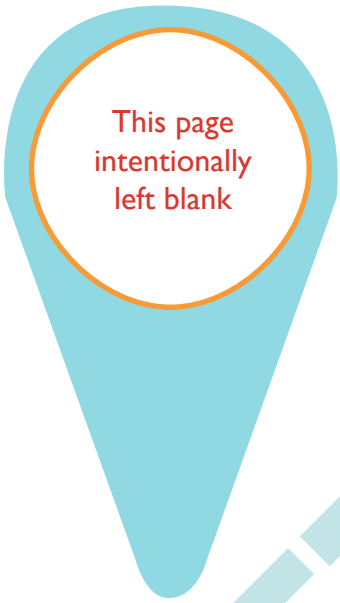
- In 2016, The United States Department of Transportation (USDOT) finalized rules and requirements for states and MPOs related to roadway safety performance measures (see Title 23 Code of Federal Regulations (CFR) Parts 490 and 494). States and MPOs must monitor and set performance targets related to motor vehicle fatalities and serious injuries, and incorporate this information into its performance-based planning and programming process.

- In 2016 and 2018, the USDOT finalized rules and requirements for public transportation providers, MPOs, and states, related to transit safety performance measures (see Title 49 CFR Parts 670 and 673). Federal Transit Administration (FTA) also published its National Public Transportation Safety Plan, which defines transit safety performance measures related to fatalities, injuries, safety events, and mechanical failures on transit systems and incorporates these activities into their performance-based planning and programming process.

- In 2017, the MBTA released its Strategic Plan. Both this document and the MBTA's Focus40 investment plan inform safety initiatives and capital investment for the MBTA system.
- In 2018, the Commonwealth of Massachusetts released an updated Strategic Highway Safety Plan, which identifies safety emphasis areas and strategies to achieve them.

MPO staff have also made several updates to this chapter, based on these planning and policy changes, data availability, and other factors.

- Updated trend data related to motor vehicle crashes, fatalities, and injuries in response to new federally required performance measures and newly available data.
- Refreshed the rankings of high crash locations in the Boston region.
- Incorporated the MPO's federally required roadway safety performance targets.
- Added information related to transit safety performance trends.
- Added information about the relationship between transportation safety and CAV technology as well as transportation security issues.



chapter 5

System Preservation and Modernization Needs

THE BOSTON REGION MPO'S SYSTEM PRESERVATION AND MODERNIZATION GOALS AND OBJECTIVES

Goal:

Maintain and modernize the transportation system and plan for its resiliency.

Objectives:

- Maintain the transportation system, including roadway, transit, and active transportation infrastructure, in a state of good repair
- Modernize transportation infrastructure across all modes
- Prioritize projects that support planned response capability to existing or future extreme conditions (sea level rise, flooding, and other natural and security-related man-made impacts)

INTRODUCTION

Issue Statement

The Boston region's transportation infrastructure is aging and the demands on roadway and transit facilities have stressed the infrastructure to the point that routine maintenance is insufficient to keep up with necessary repairs. As a result, there is a significant backlog of projects required to maintain the transportation system and assets in a state of good repair, including projects that address bridges, roadway pavement, transit rolling stock and infrastructure, and traffic and transit control equipment. In addition, parts of the transportation system may be compromised if climate change trends continue as projected.

Background

System preservation is a priority for the Boston Region Metropolitan Planning Organization (MPO) because the region's transportation infrastructure is aging. The demands placed on highway and transit facilities have stressed the system to the point that routine maintenance is insufficient to keep up with the need. As a result, there is a significant backlog of maintenance and work to maintain the system in a state of good repair on the highway and transit systems, including on bridges, roadway pavement, transit rolling stock, and other infrastructure. It is also important to improve the resiliency of the region's transportation system to prepare for existing or future extreme conditions, such as sea level rise and flooding. In addition, the movement of freight is critical to the region's economy, so it is important to protect all freight network elements, including port facilities that are vulnerable to climate change impacts.

To support preservation of the transportation system, the United States Department of Transportation (USDOT) requires states, metropolitan planning organizations (MPOs), and public transit providers to implement a performance-based approach to making investments to bring and keep transportation infrastructure in a state of good repair. This approach includes developing asset management plans, setting performance targets, and monitoring preservation outcomes for these assets, which include pavement, highway and transit bridges, and transit infrastructure and rolling stock.

SYSTEM PRESERVATION AND MODERNIZATION NEEDS SUMMARY

The transportation system must be brought into a state of good repair, maintained at that level, and enhanced to ensure mobility, efficient movement of goods, and protection from potential sea level rise and storm-induced flooding. Financial constraints require the Boston Region MPO, the Massachusetts Department of Transportation (MassDOT), and the region's transit agencies to set priorities, considering the most crucial maintenance needs and the most effective ways to program their funding. At the same time, infrastructure that could be affected by climate change must be made more resilient.

The MPO's understanding of system preservation and modernization needs are informed by various planning processes conducted by transportation agencies in the region. MassDOT has developed a Transportation Asset Management Plan (TAMP), a risk-based asset management plan for bridge and pavement assets on the National Highway System (NHS) in Massachusetts, which will help MassDOT plan to improve NHS asset condition and performance.[1] Similarly, the transit agencies in the Boston region—the Massachusetts Bay Transportation Authority (MBTA), the MetroWest Regional Transit Authority (MWRTA), and the Cape Ann Transportation Authority (CATA)—have produced Transit Asset Management (TAM) plans, which will help

[1] MassDOT's Transit Asset Management Plan is scheduled to be finalized in July 2019.

them prioritize investments to maintain state of good repair in transit vehicles, facilities, and other infrastructure. These agencies, along with the MPO, monitor changes in asset condition over time using federal established performance measures for NHS bridges, pavement, and transit assets.

The MBTA's Strategic Plan and 25-year investment plan, *Focus40*, complement the asset management plans by specifying state of good repair and modernization programs and projects, both for individual MBTA services and the system as a whole. Likewise, MassDOT's annual Capital Investment Plan (CIP) development process places top priority on investments that support transportation state of good repair and reliability. In addition, the report recently released by the Commission on the Future of Transportation in the Commonwealth, *Choices for Stewardship: Recommendations to Meet the Transportation Future*, includes recommendations to modernize existing state and municipal transit and transportation assets to more effectively and sustainably move more people throughout the Commonwealth and make transportation infrastructure resilient to a changing climate. MassDOT and the MBTA track performance over time both through annual reporting conducted by the Commonwealth's Performance and Asset Management Advisory Council and through MassDOT's Tracker.

To address identified needs, the MPO can invest its discretionary funds also known as Regional Target dollars to and coordinate with its partners to support transportation infrastructure preservation and modernization. The MPO can use information from the aforementioned planning processes to consider and provide feedback on projects and programs that agencies bring forward for inclusion in the MPO's Long-Range Transportation Plan (LRTP) and Transportation Improvement Program (TIP). The MPO may also choose to support some of these or other system preservation investments directly with its Regional Target funds. When spending its Regional Target funds, the MPO uses current system preservation-related TIP evaluation criteria to determine whether a project improves substandard pavement, bridges, sidewalks, signals or transit assets, or otherwise improves emergency response or the transportation system's ability to respond to extreme conditions. The MPO may be able to use information from MassDOT and transit agency planning processes to supplement its existing project evaluation process.

Table 5-1 summarizes key findings regarding system preservation and modernization needs that MPO staff identified through data analysis and public input. It also includes staff recommendations for addressing each need. Chapter 10 provides more detail on each of the recommendations. The MPO board should consider these findings when prioritizing programs and projects to receive funding in the LRTP and TIP, and when selecting studies and activities for inclusion in the Unified Planning Work Program (UPWP).

Table 5-1
System Preservation and Modernization Needs in the Boston Region Identified through Data Analysis and Public Outreach and Recommendations to Address Needs

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Bridges	Bridge condition: Currently, of the 2,811 bridges in the region 151 (five percent) are structurally deficient. Approximately 12 percent of the National Highway System (NHS) bridges in the Boston region are considered to be in poor condition.	Meet MassDOT's performance measure to prevent the number of structurally deficient bridges from exceeding 300 statewide. Maximize the number of bridges in the region considered to be in good condition, and minimize the number of bridges considered to be on poor condition.	*Existing Programs* • Complete Streets Program • Major Infrastructure Program *Proposed Program* Interchange Modernization Program
Bridges	Bridge Health Index scores: Currently, as measured on this index, 33 percent of bridges in the region are in good condition, 35 percent are in poor condition, and 32 percent have not been rated because of missing data.	Meet MassDOT's performance measure to maintain a systemwide Bridge Health Index score of 92 (measured on a scale of zero to 100) in calendar year 2020 and a score of 95 in the long-term.	*Existing Programs* • Complete Streets Program • Major Infrastructure Program *Proposed Program* Interchange Modernization Program
Pavement Management	Condition of MassDOT-maintained roadways: Of the roadways in the region maintained by MassDOT, 69 percent are in good condition, 25 percent are in fair condition, and six percent are in poor condition.	Monitor the MassDOT Pavement Management program. MassDOT-maintained arterial roadways make up 55 percent of monitored roadways, however 86 percent of the arterial roadways are in poor condition; lengthy arterials in poor condition are located in Arlington, Boston, Brookline, Cambridge, Chelsea, Lynn, Malden, Medford, Newton, and Salem.	*Existing Programs* • Intersection Improvement Program • Complete Streets Program • Major Infrastructure Program *Proposed Program* Interchange Modernization Program

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Pedestrian Facilities	Sidewalk location and condition: Of the sidewalks in the state, 81 percent are municipally owned. Neither the MPO nor MassDOT maintain pedestrian facility data. Knowing where sidewalks are located or absent, and their condition, is a key element in planning.	Identify the location of sidewalks and their condition; identify those around transit stations.	*Existing Programs* • Bicycle Network and Pedestrian Connections Program • Study issues through the Bicycle and Pedestrian Support Activities program (UPWP) *Existing Studies* • Addressing Priority Corridors from the LRTP Needs Assessment (FFY 2019 UPWP) • Addressing Safety, Mobility, and Access on Subregional Priority Roadways (FFY 2019 UPWP) *Proposed Study* Regionwide Sidewalk Inventory
Transit Asset State of Good Repair	State of good repair for the transit system: The region's transit systems include vehicles, facilities, and fixed guideway that do not meet state of good repair thresholds defined by the federal government. Other transit assets, such as track signals and power systems, need maintenance and upgrades to support safe, reliable service.	Identify and invest in priority transit state of good repair projects, as identified in *Focus 40*, TAM plans, and other prioritization processes.	*Proposed Program* Transit Modernization Program
Transit Asset Modernization	Obsolete infrastructure: Even if in a state of good repair, obsolete infrastructure inhibits transit systems' abilities to adapt to change and serve customers. Examples of necessary upgrades include increasing the resiliency of transit system power supplies, incorporating modern doors and platforms into subway services, and making transit stations—such as Oak Grove Station and Natick Center Commuter Rail Station—fully accessible to people with disabilities.	Support investments that improve the accessibility of transit stations, bus stops, and paratransit services, such as those identified through the MBTA's Plan for Accessible Transit Infrastructure (PATI) process. Support investments that upgrade transit fleets, facilities, and systems to provide more efficient, reliable, and sustainable service. Support climate vulnerability assessments and invest in projects and programs resulting from these processes.	*Existing Programs* • Bicycle Network and Pedestrian Connections Program • Study issues through the Bicycle and Pedestrian Support Activities program (UPWP) • Support MassDOT's Climate Adaption Vulnerability Assessment and invest in recommended projects *Proposed Program* Transit Modernization Program *Proposed Study* Research climate change resiliency options for transportation infrastructure

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Freight Network	Many express highways are built to outdated design standards for trucks. Roads connecting to major freight facilities and routes need to support trucks as well as other types of vehicles.	Maintain and modernize the roadway network. Improve connections between intermodal facilities and the regional road network. Maintain truck access on roadways designed to Complete Streets standards.	*Existing Programs* • Intersection Improvement Program • Complete Streets Program • Major Infrastructure Program • Research strategies to improve bottleneck locations through the Bottleneck Program *Proposed Program* Interchange Modernization Program
Climate Change Adaptation	Some transportation facilities and infrastructure, including tunnels, are located in places vulnerable to flooding and other hazards.	Retrofit or adapt infrastructure, including the Central Artery, to protect it from the impacts of hazards and climate change.	*Existing Programs* • Intersection Improvement Program • Complete Streets Program • Major Infrastructure Program • Support to MassDOT's Climate Adaption Vulnerability Assessment *Proposed Program* Interchange Modernization Program *Proposed Study* Research climate change resiliency options for transportation infrastructure *Other Actions* • Coordinate with municipalities and state and regional agencies on ways that the MPO can support resiliency planning • Emphasize TIP resiliency and adaptation criteria

UPWP = Unified Planning Work Program.

Source: Boston Region MPO.

UNDERSTANDING SYSTEM PRESERVATION AND MODERNIZATION NEEDS IN THE BOSTON REGION

This section presents the research and analysis MPO staff conducted to understand transportation system preservation and modernization needs in the Boston region, which have been summarized in the previous section. Supporting information that MPO staff used to understand preservation and modernization needs is included in the appendices of this Needs Assessment:

- Appendix A includes key plans and policies
- Appendix B includes MPO studies and reports
- Appendix C includes data resources

This section also includes a summary of input staff gathered from stakeholders and the public about transportation system preservation and modernization needs and proposed solutions to meet those needs. Staff considered this input when developing recommendations to achieve the MPO's system preservation and modernization goals and objectives.

Roadway Network Assets

This section focuses on the condition of the region's roadway network, which includes pavement, bridges, and pedestrian facilities.

Pavement

Regional Pavement Conditions

According to MassDOT's 2017 Year-End Roadway Inventory Report, the Boston region includes 1,154 lane miles of interstate highways, 5,252 lane miles of arterial roadways, 2,414 lane miles of collector roadways, and 14,162 lane miles of local roads.[2] MassDOT regularly monitors the region's interstate highways and a portion of the region's arterial and collector roadways to assess pavement condition. MassDOT's pavement management program assigns roadway segments a pavement condition value based on the International Roughness Index (IRI), which evaluates pavement roughness using a mathematical method.[3]

The Boston Region MPO currently does not maintain an independent pavement management tool, but relies on MassDOT's pavement management program to understand the condition of interstate, arterial, and access-controlled arterial roadways in the Boston region. MPO

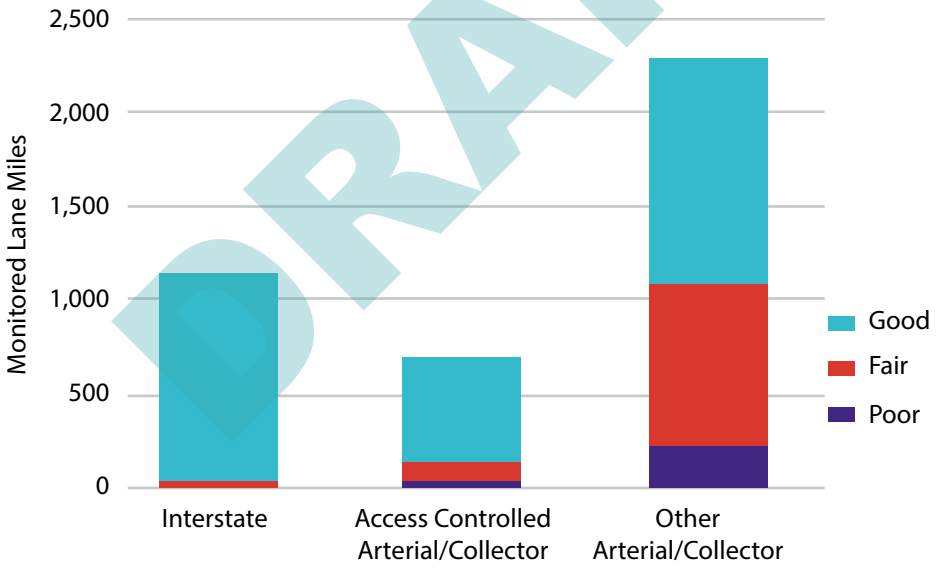
[2] Massachusetts Department of Transportation. 2017 Massachusetts Road Inventory Year End Report. March 2018. pg 58. Lane mile values exclude shoulders and auxiliary lanes.

[3] MassDOT continues to measure pavement quality and to set statewide short-term and long-term targets in the MassDOT Performance Management Tracker using the Pavement Serviceability Index (PSI), which is a different index than IRI.

staff used geographic information system (GIS) software to join 2017 data from MassDOT's pavement management system and roadway characteristics from the 2017 Roadway Inventory file to estimate the current condition of monitored roadways in the region. MPO staff was able to estimate pavement data for nearly 100 percent of interstate lane miles in the region, 96 percent of access-controlled arterials and collector lane miles in the region, and 33 percent of non-access controlled arterial and collector lane miles in the region. MPO staff categorized IRI values for segments on this network as *good*, fair, or poor using the classification scheme in its TIP evaluation criteria.[4]

Figure 5-1 shows the number of lane miles of monitored roadways, by roadway type, that are in good, fair, or poor condition.[5] Approximately 69 percent of all monitored roadway lane miles are in good condition, 25 percent are in fair condition, and six percent are in poor condition. However, MassDOT-monitored arterial and collector roadways without access controls account for a disproportionate share of monitored lane miles that are considered substandard, or in fair or poor condition. This roadway type accounted for 55 percent of the total monitored roadway lane miles in 2017, but about 86 percent of those lane miles that are in substandard condition.

Figure 5-1
Pavement Condition by Roadway Classification



Note: MPO staff selected pavement data collected during the last five years for analysis. While most of the data presented in this chart was collected in 2017, data for some roadways was collected in 2013, 2015, and 2016.

Source: Massachusetts Department of Transportation's Pavement Management System, 2017 data set.

[4] The MPO's TIP evaluation criteria considers pavement to be in good condition if its IRI rating is less than 190, in fair condition if its IRI rating is between 191 and 320, and in poor condition if its IRI rating is greater than 320.

[5] Local roads are not monitored under MassDOT's Pavement Management Program.

The most recent pavement data indicates that the majority of these arterial roadways are located in urban centers. MPO staff analysis of pavement condition in the region shows larger expanses of arterial roadways with poor pavement condition in the urban centers of Arlington, Boston, Brookline, Cambridge, Chelsea, Lynn, Malden, Medford, Newton, and Salem. Many of these urban centers are the same ones that MPO staff identified as having poor pavement condition in the last Needs Assessment. Since that time, pavement conditions on more roadways in Arlington, Brookline, and Salem have deteriorated. However, pavement conditions in Everett, Revere, and Somerville have improved.

Federal Pavement Condition Performance Measures and Targets

The USDOT performance management framework requires states and MPOs to monitor and set targets for the condition of pavement on NHS roadways, a network that includes the Interstate Highway System and other roadways of importance to the nation's economy, defense, and mobility. Massachusetts has 3,204 lane miles of interstate roadways, 1,154 lane miles (or 36 percent) of which are in the Boston region. The state's non-interstate NHS network is made up of 7,319 lane-miles of roadways, and the Boston region contains 2,559 (or 35 percent) of those lane miles. Applicable federal performance measures include the following:

- Percent of pavements on the Interstate System in good condition
- Percent of pavements on the Interstate System in poor condition
- Percent of pavements on the non-interstate NHS in good condition
- Percent of pavements on the non-interstate NHS in poor condition

The interstate performance measures classify interstate pavements as in good, fair, or poor condition based on their IRI value and one or more pavement distress metrics (cracking and/or rutting and faulting) depending on the pavement type (asphalt, jointed concrete, or continuous concrete). The Federal Highway Administration (FHWA) sets thresholds for each metric that determine whether the metric value is good, fair, or poor, along with thresholds that determine whether the pavement segment as a whole is considered to be in good, fair, or poor condition.[6] Non-interstate NHS pavements are subject to the same thresholds for IRI values. States will be required to collect data for the complementary distress metrics starting in 2020, and those data will be incorporated into future performance monitoring.

MassDOT uses information from its Pavement Management program to track the condition of Massachusetts' NHS network. In 2018, MassDOT established performance targets for these NHS pavement condition performance measures, which are shown along with baseline data in Table 5-2. As with the NHS bridge condition performance targets, the two-year target reflects conditions as of the end of calendar year (CY) 2019, and the four-year target reflects

[6] FHWA's IRI thresholds for good, fair, and poor condition differ from those currently used by the MPO. For federally required NHS pavement condition performance measures, IRI values considered good are those less than 95; those considered fair are between 95 and 170; and those considered poor are greater than 170.

conditions as of the end of CY 2021. While MassDOT has collected IRI data in past years, these federally required performance measures also require other types of distress data that have not previously been required as part of pavement monitoring programs. Setting targets for these pavement condition measures has been challenging given the lack of complete historic data. MassDOT's approach has been to use past pavement indicators to identify trends and to set conservative targets. MassDOT will revisit its four-year target in in 2020 when more data is available.

Table 5-2
Massachusetts NHS Pavement Condition Baselines and MassDOT NHS Pavement Condition Performance Targets

Federally Required Pavement Condition Performance Measure	2017 Measure Value (Baseline)	Two-Year Target (CY 2019)	Four-Year Target (CY 2021)
Percent of Interstate Highway System pavements that are in *good* condition[a]	74.2%	70.0%	70.0%
Percent of Interstate Highway System pavements that are in *poor* condition[a]	0.1%	4.0%	4.0%
Percent of non-interstate NHS pavements that are in *good* condition	32.9%	30.0%	30.0%
Percent of non-interstate NHS pavements that are in *poor* condition	31.4%	30.0%	30.0%

[a] For the first federal performance monitoring period (2018–21), the Federal Highway Administration has only required states to report four-year targets for pavement condition on the Interstate Highway System. MassDOT has developed both two-year and four-year targets for internal consistency.

CY = calendar year. NHS = National Highway System.

Source: MassDOT.

MPOs are required to set four-year interstate pavement condition and non-interstate NHS pavement condition performance targets by either supporting state targets or setting separate quantitative targets for the region. The Boston Region MPO elected to support MassDOT's four-year targets for these NHS pavement condition measures in November 2018. The MPO will work with MassDOT to meet these targets through its Regional Target investments.

Bridges

Regional Bridge Conditions

MassDOT and the MBTA prioritize resources for bridge preservation, as well as repair and replacement, and fund this work through the Statewide Bridge Program and MBTA bridge initiatives. MassDOT and the MBTA maintain a bridge management software tool (PONTIS) for recording, organizing, and analyzing bridge inventory and inspection data. PONTIS is used to guide the Statewide Bridge Program, which prioritizes resources for bridge preservation, repair, and replacement.

As of calendar year 2017, there were 2,811 bridges located within the Boston region. Some are in substandard condition because they have been deemed by MassDOT bridge inspectors to be structurally deficient or weight restricted (posted). Structurally deficient bridges are those that are not necessarily unsafe, but that have deteriorated in ways that reduce the load-carrying capacity of the bridge. A bridge may be posted as weight restricted to ensure traveler safety. Of the 2,811 bridges located in the Boston Region MPO, 151 (five percent) are considered structurally deficient and 102 (four percent) are posted as weight restricted.

The Bridge Health Index (BHI) is an important tool for monitoring bridge conditions. This index provides a comprehensive overview of the condition of all bridge elements across the network. This measure, reported on a scale of zero to 100, reflects inspection data in relation to the asset value of a bridge or network of bridges. A value of zero indicates that all of a bridge's elements are in the worst condition. A value of 85 or more indicates that the condition of a bridge is good. One-third of bridges in the Boston region (931 bridges) have health indices with a score 85 or greater; 35 percent (972 bridges) have health indices of less than 85; and 32 percent (864 bridges) do not have core element data needed to calculate this value. An additional 44 bridges have health indices of zero. These include railroad bridges, pedestrian bridges, and closed bridges.

The Commonwealth instituted the Accelerated Bridge Program in 2008 to reduce the number of structurally deficient bridges in Massachusetts by funding bridge replacement, rehabilitation, and preservation projects. The program's goal was to reduce this backlog to below 450 structurally deficient bridges by September 30, 2016. As of that date, the program exceeded its goal, reducing the number of structurally deficient bridges to 432, a 20 percent decline from the initial total of 543 structurally deficient bridges. As of September 1, 2018, the Accelerated Bridge Program had completed 191 bridge projects, 53 of which were in municipalities in the Boston region. Seven bridge projects are still under construction, including four in the Boston region:

- Washington Street Bridge over the Fore River in Quincy and Weymouth
- Cradock Bridge over the Mystic River in Medford
- Casey Overpass in Boston
- Bridge replacements on Revere Beach Parkway over the Malden River, the MBTA, and Rivers Edge in Medford and Everett

Over the course of the Accelerated Bridge Program, over 270 bridges will have been rehabilitated or replaced throughout Massachusetts, and many more will have been improved to address safety needs or support preservation. MassDOT will continue to address structurally deficient bridge projects and other bridge needs outside of the Accelerated Bridge Program.

Federal Bridge Condition Performance Measures and Targets

As of 2018, Massachusetts contains approximately 5,218 bridge structures that are included in the National Bridge Inventory (NBI), and 1,613 (31 percent) of them are located within the Boston region. NBI bridge structures are those that serve vehicular traffic and are more than 20 feet in length.[7] More than half of the bridges in the Boston region meet the NBI criteria. As of 2018, the Boston region included 151 NBI bridge structures deemed structurally deficient (about nine percent of all NBI bridge structures in the Boston region). Eighty-two NBI bridge structures were posted as weight restricted (about five percent of all bridge structures in the Boston region). By comparison, Massachusetts had 470 NBI bridge structures deemed structurally deficient and 438 bridge structures posted as weight restricted (nine and eight percent of the state's bridge structures, respectively).[8]

To meet federal performance monitoring requirements, states and MPOs must track and set performance targets for the condition of bridges on the NHS. FHWA's bridge condition performance measures include the following:

- Percent of NHS bridges by deck area classified as in *good* condition
- Percent of NHS bridges by deck area classified as in *poor* condition

These performance measures classify NHS bridge condition as good, fair, or poor based on the condition ratings of three bridge components: the deck, the superstructure, and the substructure.[9] The lowest rating of the three components determines the overall bridge condition.[10] The measures express the share of NHS bridges in a certain condition by deck area, divided by the total deck area of NHS bridges in the applicable geographic area (state or MPO).

Table 5-3 shows performance baselines for the condition of bridges on the NHS in Massachusetts and the Boston region. As of 2017, MassDOT had analyzed the 2,246 bridges on the NHS in Massachusetts to understand their current condition with respect to the federal bridge condition performance measures. In 2018, the Boston Region MPO performed a similar analysis on the 859 bridges on the NHS in the Boston region. According to these baseline values, the Boston region has a larger share of NHS bridge deck area considered to be in good condition, and a slightly smaller share of NHS bridge deck area considered to be in poor condition, compared to Massachusetts overall.

[7] Federal Highway Administration. "Tables of Frequently Requested NBI Information." Bridges and Structures. Accessed May 27, 2019 at https://www.fhwa.dot.gov/bridge/britab.cfm.

[8] These 2018 values are based on bridge inventory data provided by MassDOT on December 31, 2018. Multiple bridge structures may serve a particular crossing.

[9] National Bridge Inventory data is used to rate these components on a scale of zero (worst) to nine (best). The FHWA has classified these bridge ratings into *good* (seven, eight, or nine on the scale), *fair* (five or six), or *poor* (four or less).

[10] Culverts are assigned an overall condition rating.

Table 5-3
Massachusetts and Boston Region NHS Bridge Condition Baselines

Geographic Area	Total NHS Bridges	Total NHS Bridge Deck Area (square feet)	Percent of NHS Bridges in *Good* Condition	Percent of NHS Bridges in *Poor* Condition
Massachusetts[a]	2,246	29,457,351	15.2%	12.4%
Boston Region[b]	859	14,131,094	19.2%	11.8%

[a] Massachusetts baseline data is based on a MassDOT analysis conducted in 2018.

[b] Boston region comparison data is based on a Boston Region MPO analysis conducted in 2018.

NHS = National Highway System.

Sources: MassDOT and Boston Region MPO.

USDOT has established 10 percent as a threshold for statewide NHS bridge deck area that is in poor condition, and departments of transportation for states that exceed that threshold must direct a defined minimum amount of National Highway Performance Program (NHPP) funding toward improving NHS bridges. Because more than 10 percent of Massachusetts NHS bridge deck area is in poor condition, MassDOT programs this minimum amount.

States must set performance targets for these NHS bridge performance measures at two-year and four-year intervals. Table 5-4 shows MassDOT's NHS bridge performance targets, which it established in 2018. The two-year target reflects conditions as of the end of CY 2019, and the four-year target reflects conditions as of the end of CY 2021. These targets reflect anticipated conditions based on historic trends and planned bridge investments. As shown in the table, MassDOT expects there will be a small increase in the share of NHS bridge deck area in good condition by the end of CY 2021, while it expects that the share of NHS bridge deck area in poor condition in CY 2021 will be slightly lower than the baseline.

Table 5-4
MassDOT's NHS Bridge Condition Targets

Federally Required Bridge Condition Performance Measure	2018 Measure Value (Baseline)	Two-Year Target (CY 2019)	Four-Year Target (CY 2021)
Percent of NHS Bridges [by deck area] that are in *good* condition	15.2%	15.0%	16.0%
Percent of NHS Bridges [by deck area] that are in *poor* condition	12.4%	13.0%	12.0%

CY = calendar year. NHS = National Highway System.

Source: MassDOT.

MPOs are required to set four-year bridge performance targets by either electing to support state targets or setting separate quantitative targets for the MPO area. The Boston Region MPO elected to support MassDOT's four-year targets for these measures in November

2018. The MPO will work with MassDOT to meet these targets through its Regional Target investments.

Pedestrian Facilities

An inventory of the location and condition of the region's sidewalks and walkways is limited, therefore this inventory must be supplemented through ongoing data collection and analysis. Currently, sidewalk inventory data is stored within the Massachusetts Road Inventory File, which is maintained by the MassDOT Office of Transportation Planning (OTP), however data about sidewalk condition is not included.

According to data gathered for MassDOT's *Massachusetts Pedestrian Plan*, 81 percent of sidewalks in the state are municipally owned, and MassDOT does not maintain data for these pedestrian facilities.[11] Knowing where sidewalks are located or absent, and their condition, is a key element in planning. Collection of these data could contribute to numerous other planning efforts, such as MAPC's Access Score application, MassDOT's Safe Routes to School program, and MPO Safe Routes to Transit initiatives.[12] A model for such an effort is the sidewalk inventory recently completed by the Capital District Transportation Committee, the MPO serving the Capital District of New York State.[13]

In addition, MassDOT has implemented a program to reconstruct substandard curb ramps on state-owned roads to meet the obligation of the development of its *ADA Transition Plan*. In 2012, MassDOT inventoried all 26,000 curb ramps throughout the Commonwealth; almost 6,700 were found to be failing or missing. As of 2017, the number of failed or missing curb ramps had been reduced to 5,200. Additional projects are scheduled for advertisement through 2021.[14]

Public outreach and data collection from other planning efforts, such as *Go Boston 2030*, the City of Boston's transportation plan, identified the need to maintain and upgrade sidewalks throughout the city and especially in and around transit stations.

Current Activities and Strategies to Address Roadway System Preservation and Modernization Needs

MassDOT identifies system preservation and modernization needs using an array of asset management systems and planning efforts, including the development process for its

[11] Massachusetts Department of Transportation. Massachusetts Pedestrian Transportation Plan. May 2019. Accessed May 27, 2019 at https://massdot.maps.arcgis.com/apps/MapJournal/index.html?appid=96339eb442f94ac7a5a7396a337e60c0.

[12] Metropolitan Area Planning Council. "Local Access Score by MAPC." Accessed May 27, 2019 athttp://localaccess.mapc.org.

[13] Capital District Transportation Committee. CDTC Regional Sidewalk Inventory. Accessed May 27, 2019 at http://www.cdtcmpo.org/images/bike_ped/CDTC_Regional_Sidewalk_Inventory_Report.pdf.

[14] Massachusetts Department of Transportation. Annual Report of the Performance and Asset Management Advisory Council. December 2018. Accessed May 27, 2019 at https://www.mass.gov/files/documents/2018/06/25/2017%20Annual%20PAMAC%20Report.pdf, pg 6.

Transportation Asset Management Plan for NHS bridge and pavement assets. These processes inform how MassDOT develops it's rolling five-year Capital Investment Plan (CIP). This plan is focused on three major priorities: system reliability, modernization, and expansion, with reliability being the top priority. For each priority area, MassDOT has established investment programs, which fund relevant capital improvement projects. The Reliability and Modernization Programs relate most directly to the MPO's system preservation and modernization goal.

- **Reliability investments** include projects that provide routine maintenance and keep the system in a state of good repair. These investments currently support MassDOT's bridge and tunnel, interstate and non-interstate pavement, roadway, and safety improvement programs, among others.

- **Modernization investments** help the Commonwealth meet federal safety and accessibility mandates for transportation infrastructure, substantially modernize transportation assets, and help expand capacity to accommodate current or expected demand on existing transportation facilities. These investments currently support MassDOT's Americans with Disabilities Act (ADA) retrofits, intelligent transportation systems, roadway reconstruction, and intersection improvement programs, among others. Resiliency projects would fall under this category of investments.

The Boston Region MPO TIP reflects federally funded investments MassDOT makes through these programs that affect the Boston region, along with investments that the MPO makes with its Regional Target funds. MassDOT's and the MPO's project selection processes complement one another to the extent possible to ensure transportation system preservation and improvement needs are met. Traditionally, MassDOT's reliability and modernization investments have addressed the vast majority of bridge and NHS pavement maintenance needs in the Boston region, along with other roadway and intersection improvement needs.

The MPO has focused its investments on intersection improvements and roadway reconstruction activities that support Complete Streets or address bottlenecks. The MPO follows a policy of not funding projects that are only for resurfacing pavement and typically does not fund bridge projects, although the MPO does address bridge pavement condition needs through Complete Streets or bottleneck improvement projects. The MPO's project evaluation process awards points if a proposed project will improve substandard bridges, pavement, sidewalks, or traffic signals. The MPO can use its performance-based planning and programming (PBPP) process to monitor bridge and pavement condition—and potentially the condition of other assets. Finally, the MPO can fund studies and data collection initiatives through its Unified Planning Work Program to inform its understanding of system preservation needs and opportunities to address these needs.

The Chapter 90 Program (named for Chapter 90 of the Massachusetts General Laws), which is administered by MassDOT, also contributes to the Commonwealth's strategy of preserving existing transportation facilities. This program supports construction and maintenance of local roadways, which are owned and maintained by the cities and towns of the Commonwealth. Typically, the majority of Chapter 90 allocations are allocated for road resurfacing and reconstruction.

Transit Network Assets

As with the roadway network, it is crucial to achieve and maintain the Boston region's transit systems in a state of good repair to ensure that transit service is safe and reliable. The region's largest transit provider is the MBTA, which maintains an extensive portfolio of transit assets. These assets are documented in the MBTA's Transit Asset Management (TAM) plan and related documents and in MassDOT's Performance and Asset Management Advisory Council 2018 annual report:[15]

- **Rolling Stock:** The MBTA owns and maintains 1,022 buses, 432 heavy rail cars, 209 light rail vehicles, 426 commuter rail coaches, 94 commuter rail locomotives, four ferries, and 763 paratransit vehicles.
- **Service Vehicles:** The MBTA owns an estimated 1,676 service vehicles, including the general-purpose fleet, operations and support equipment (such as cranes and portable signs), operations and support vehicles (such as tow trucks and fuel trucks), and the fleet of the Transit Police.
- **Track and Right-of Way:** The MBTA operates on and maintains 948 miles of track for its transit and commuter rail systems.
- **Signals:** The MBTA owns and maintains more than 38,000 pieces of individual train control and signaling equipment.
- **Power Equipment:** The MBTA owns and maintains over 5,000 pieces of power equipment, which generate and provide power to subway, light rail, and trackless trolley systems, and to commuter rail and maintenance facilities.
- **Bridges and Tunnels:** The MBTA owns and maintains approximately 46.2 miles of tunnels, 459 bridges, 1.81 miles of retaining walls, and 1,303 culverts, among other assets.
- **Passenger Facilities:** The MBTA owns and maintains 137 subway stations, 138 commuter rail stations, nine garages, nearly 100 parking lots, and 176 bus shelters. (There are an additional 487 shelters on the bus network that are not owned or maintained by the MBTA.)
- **Maintenance and Administrative Facilities:** The MBTA owns and maintains over 150 maintenance and administration buildings.

Other MBTA assets include its communication systems and automated fare collection system, the latter of which is made up of more than 3,000 assets, including fareboxes, vending machines, and fare gates.

[15] Annual Report of the Performance and Asset Management Advisory Council, pg. 14. See also: Massachusetts Bay Transportation Authority. MBTA Transit Asset Management Plan. Accessed May 27, 2019 at https://www.ctps.org/data/calendar/pdfs/2019/MPO_0321_MBTA_TAM_Plan_2018.pdf.

The Cape Ann Transportation Authority (CATA) and the MetroWest Regional Transit Authority (MWRTA) also own and maintain assets to provide service in the Boston region. As of June 2019, CATA and MWRTA expect to have approximately 33 and 102 revenue service vehicles, respectively, and each agency also owns and maintains several equipment vehicles. Each agency also owns and maintains an administrative facility. As with the MBTA, these agencies strive to maintain their assets in a state of good repair.

Federal Transit System Asset Condition Performance Measures and Targets

The MBTA, CATA, and MWRTA regularly receive funds from the Federal Transit Administration (FTA) to provide service. These agencies are responsible for meeting planning and performance-monitoring requirements under FTA's TAM rule, which focuses on achieving and maintaining a state of good repair for the nation's transit systems. Each year, they must submit progress reports and updated performance targets for TAM performance measures. Transit agencies develop these performance targets based on their most recent asset inventories and condition assessments, along with the capital investment and procurement expectations that are informed by their TAM plans. MBTA, MWRTA, and CATA share their asset inventory and condition data and their performance targets with the Boston Region MPO so that the MPO can monitor and set TAM targets for the Boston region.

The TAM rule specifies four performance measures, which apply to four asset categories: rolling stock (vehicles that provide passenger service), equipment (nonrevenue service vehicles), facilities, and infrastructure (rail fixed guideway systems). Table 5-5 describes these measures.

Table 5-5
Transit Asset Management Performance Measures by Asset Category

Asset Category	Relevant Assets	Measure	Measure Type	Desired Direction
Rolling Stock	Buses, vans, and sedans; light and heavy rail cars; commuter rail cars and locomotives; ferry boats	Percentage of revenue vehicles that have met or exceeded their ULB	Age-based	Minimize percentage
Equipment	Service support, maintenance, and other nonrevenue vehicles	Percentage of vehicles that have met or exceeded their ULB	Age-based	Minimize percentage
Facilities	Passenger stations, parking facilities, administration and maintenance facilities	Percentage of assets with condition rating lower than 3.0 on FTA TERM Scale	Condition-based	Minimize percentage
Infrastructure	Rail fixed guideway systems	Percentage of track segments with performance (speed) restrictions, by mode	Performance-based	Minimize percentage

FTA = Federal Transit Administration. TAM = Transit Asset Management. TERM = Transit Economic Requirements Model. ULB = Useful Life Benchmark.

Sources: FTA and the Boston Region MPO.

Transit agencies may supplement these federally required performance measures with other measures and indicators to monitor and address the condition of their assets.

The following subsections discuss the MPO's current performance targets (adopted in March 2019) for each of the TAM performance measures. These performance targets reflect MBTA, CATA, and MWRTA state fiscal year (SFY) 2019 TAM performance targets (for July 2018 through June 2019). MPO staff has aggregated some information for asset subgroups. The tables in this section highlight whether transit agencies expect to see performance for specific asset subgroups get better or worse compared to the SFY 2018 baseline (June 30, 2018).

Rolling Stock and Equipment Vehicles

FTA's TAM performance measure for the state of good repair for rolling stock and equipment vehicles (service support, maintenance, and other nonrevenue vehicles) is the percent of vehicles that meet or exceed their useful life benchmark (ULB). This performance measure uses vehicle age as a proxy for state of good repair (which may not necessarily reflect condition or performance), with the goal being to bring this value as close to zero as possible. FTA defines ULB as "the expected lifecycle of a capital asset for a particular transit provider's operating environment, or the acceptable period of use in service for a particular transit provider's operating environment." For example, FTA's default ULB value for a bus is 14 years. When setting targets, each agency has discretion to use FTA-identified default ULBs for vehicles or to adjust ULBs with approval from FTA. The MBTA has used FTA default ULBs for its rolling stock targets; however the MBTA defined its own ULBs, which are based on agency-specific usage and experience, for its equipment targets. CATA and MWRTA have selected ULBs from other sources.[16]

Table 5-6 describes SFY 2018 baselines and the MPO's SFY 2019 targets for rolling stock, which refers to vehicles that carry passengers. As shown below, the MBTA, CATA, and MWRTA are improving performance for a number of rolling stock vehicle classes. Transit agencies can make improvements on this measure by expanding their rolling stock fleets or replacing vehicles within those fleets.

[16] CATA adopted useful life criteria as defined in FTA Circular 5010.1E (Award Management Requirements). MWRTA adopted useful life criteria as defined in MassDOT's Fully Accessible Vehicle Guide and in FTA Circular 5010.1E.

Table 5-6
SFY 2018 Measures and SFY 2019 Targets for Transit Rolling Stock

Agency	Asset Type	SFY 2018 Baseline (as of June 30, 2018)		SFY 2019 Targets (as of June 30, 2019)		
		Number of Vehicles	Percent of Vehicles Meeting or Exceeding ULB	Number of Vehicles	Percent of Vehicles Meeting or Exceeding ULB	Target Compared to Baseline
MBTA	Buses	1,022	25%	1,028	25%	Same
MBTA	Light Rail Vehicles	205	46%	229	41%	Better
MBTA	Heavy Rail Vehicles	432	58%	450	56%	Better
MBTA	Commuter Rail Locomotives	94	27%	104	24%	Better
MBTA	Commuter Rail Coaches	426	0%	429	0%	Same
MBTA	Ferry Boats	4	0%	4	0%	Same
MBTA	THE RIDE Paratransit Vehicles[a]	763	35%	763	9%	Better
CATA	Buses	9	11%	8	0%	Better
CATA	Cutaway Vehicles[b]	23	13%	23	0%	Better
CATA	Trolleys (simulated)[c]	2	100%	2	100%	Same
MWRTA	Cutaway Vehicles[b,d]	89	6%	93	0%	Better
MWRTA	Automobiles[d]	9	0%	9	0%	Same

[a] The MBTA's THE RIDE paratransit vehicles data and targets reflect automobiles, vans, and minivans.

[b] The National Transit Database defines a cutaway vehicle as a vehicle in which a bus body is mounted on a van or light-duty truck chassis, which may be reinforced or extended. CATA uses nine of these vehicles to provide fixed-route services, and 14 of these vehicles to provide demand response service.

[c] Simulated trolleys, also known as trolley-replica buses, have rubber tires and internal combustion engines, as opposed to steel-wheeled trolley vehicles or rubber-tire trolley buses that draw power from overhead wires.

[d] MWRTA uses cutaway vehicles to provide fixed route and demand response service, and uses autos to provide demand response service.

CATA = Cape Ann Transportation Authority. MBTA = Massachusetts Bay Transportation Authority.
MWRTA = MetroWest Regional Transit Authority. SFY = State Fiscal Year. ULB = Useful Life Benchmark.
Sources: MBTA, CATA, MWRTA, and the Boston Region MPO.

Table 5-7 shows SFY 2018 baselines and the MPO's SFY 2019 targets for transit equipment vehicles. MPO staff has aggregated targets for nonrevenue vehicle subtypes for each of the three transit agencies. Similar to transit rolling stock, transit agencies can make improvements on these measures by expanding their fleets or replacing vehicles within those fleets.

Table 5-7
SFY 2018 Measures and SFY 2019 Targets for Transit Equipment Vehicles

	SFY 2018 Baseline (as of June 30, 2018)		SFY 2019 Targets (as of June 30, 2019)		
Agency	Number of Vehicles	Percent of Vehicles Meeting or Exceeding ULB	Number of Vehicles	Percent of Vehicles Meeting or Exceeding ULB	Target Compared to Baseline
MBTA[a]	1,676	20%	1,676	22%	Worse
CATA	4	25%	3	0%	Better
MWRTA	12	50%	12	50%	Same

[a] MBTA equipment includes both commuter rail and transit system nonrevenue service vehicles.

CATA = Cape Ann Transportation Authority. MBTA = Massachusetts Bay Transportation Authority.

MWRTA = MetroWest Regional Transit Authority. SFY = State Fiscal Year. ULB = Useful Life Benchmark.

Sources: MBTA, CATA, MWRTA, and the Boston Region MPO.

Facilities

FTA assesses the condition for passenger stations, parking facilities, and administrative and maintenance facilities using the FTA Transit Economic Requirements Model (TERM) scale, which generates a composite score based on assessments of facility components. Facilities with scores below three are considered to be in marginal or poor condition (though this score is not a measure of facility safety or performance). The goal is to bring the share of facilities that meet this criterion to zero. Infrastructure projects focused on individual systems may improve performance gradually, while more extensive facility improvement projects may have a more dramatic effect on a facility's TERM scale score.

Table 5-8 shows SFY 2018 measures and the MPO's SFY 2019 targets for MBTA, CATA, and MWRTA facilities. The MBTA measures and targets only reflect those facilities that have undergone a recent on-site condition assessment. The number of facilities that the MBTA has not yet assessed is shown to provide a more comprehensive count of the MBTA's assets.

Table 5-8
SFY 2018 Measures and SFY 2019 Targets for Transit Facilities

Agency	Facility Type	SFY 2018 Baseline (as of June 30, 2018)		SFY 2019 Targets (as of June 30, 2019)		
		Number of Facilities	Percent of Facilities in Marginal or Poor Condition	Number of Facilities	Percent of Facilities in Marginal or Poor Condition	Target Compared to Baseline
MBTA	Passenger–Assessed[a]	96	13%	96	11%	Better
MBTA	Passenger– Not Assessed[a]	285	In progress	286	TBD	N/A
MBTA	Administrative	156	68%	156	63%	Better
MBTA	Maintenance–Assessed	38	In progress	38	TBD	N/A
CATA	Administrative	1	0%	1	0%	Same
MWRTA	Maintenance–Not Assessed	1	0%	1	0%	Same

Note: Facilities are classified as being in marginal or poor condition based on FTA's Transit Economic Requirements Model (TERM) scale. Facilities assigned a rating of less than 3 are considered to be in marginal or poor condition.

[a] Passenger facilities include stations and parking facilities.

CATA = Cape Ann Transportation Authority. MBTA = Massachusetts Bay Transportation Authority.

MWRTA = MetroWest Regional Transit Authority. N/A = Not applicable. TBD = To be determined.

Sources: MBTA, CATA, MWRTA, and the Boston Region MPO.

Fixed Guideway Infrastructure

Table 5-9 describes SFY 2018 baselines and SFY 2019 targets for the condition of rail fixed guideways. The MBTA is the only transit agency in the Boston region with this type of asset. The performance measure that applies to these assets is the percentage of track that is subject to performance, or speed, restrictions. The MBTA samples the share of track segments with speed restrictions throughout the year. These performance restrictions reflect the condition of track, signal, and other supporting systems, which the MBTA can improve through maintenance, upgrades, and replacement and renewal projects. Again, the goal is to bring the share of MBTA track systems subject to performance restrictions to zero.

Table 5-9
SFY 2018 Measures and SFY 2019 Targets for MBTA Transit Fixed Guideway Infrastructure

Agency	Track Type	SFY 2018 Baseline (as of June 30, 2018)		SFY 2019 Targets (as of June 30, 2019)		
		Directional Route Miles	Percent of Miles with Speed Restrictions	Directional Route Miles	Percent of Miles with Speed Restrictions	Target Compared to Baseline
MBTA	Transit Fixed Guideway[a]	130.23	11%	130.23	10%	Better
MBTA	Commuter Rail Fixed Guideway	663.84	1%	663.84	1%	Same

Note: The term "directional route miles" represents the miles managed and maintained by the MBTA with respect to each direction of travel (for example, northbound and southbound), and excludes nonrevenue tracks such as yards, turnarounds, and storage tracks. The baseline and target percentages represent the annual average number of miles meeting this criterion over the 12-month reporting period.

[a] The MBTA's Transit Fixed Guideway information reflects light rail and heavy rail fixed guideway networks.

MBTA = Massachusetts Bay Transportation Authority. SFY = State Fiscal Year.

Sources: MBTA, CATA, MWRTA, and the Boston Region MPO.

Current Activities and Strategies to Address Transit System Preservation and Modernization Needs

Similar to MassDOT's Highway Division, the MBTA, CATA, and MWRTA identify transit system preservation and modernization needs using asset management systems, by developing their TAM plans, and by monitoring federally required performance measures relating to asset condition. Other processes also inform these agencies' understanding of these needs. In its 2017 Strategic Plan, the MBTA acknowledged its existing backlog of projects and set a goal to bring all of the MBTA's assets, including fleets and facilities, to a state of good repair within 15 years; the Strategic Plan also included a spending plan and other action steps to achieve this goal.[17] Meanwhile, the MBTA's *Focus40* plan establishes several systemwide programs that address MBTA modernization needs:

- The **Accessibility and Paratransit Program** identifies projects and initiatives to improve the accessibility of MBTA stations and stops.
- The **Customer Experience Program** includes the implementation of the MBTA's next automated fare collection system, as well as other station and system upgrades to modernize lighting, communications, and other infrastructure.

[17] https://cdn.mbta.com/sites/default/files/fmcb-meeting-docs/reports-policies/2017-mbta-strategic-plan.pdf, page 23.

- The **Resiliency Program** implements identified resiliency projects, such as those to protect the Blue Line, the Green Line portal at Fenway, and the Charlestown sea wall. It also supports MBTA vulnerability assessments and the implementation of recommendations from assessments.

Focus40's mode-specific programs include other planned projects to modernize transit infrastructure and make it more reliable, including initiatives to improve bus fleets and stops, upgrade infrastructure in Silver Line tunnels, upgrade the Green Line's fleets, infrastructure, and maintenance facilities, and other initiatives.

These various planning processes identify the projects that may be funded through MassDOT's CIP, which includes investments made by the MBTA as well as the Commonwealth's regional transit authorities (RTAs), including MWRTA and CATA. Programs that address these agencies' system preservation and modernization needs also fall into the CIP's Reliability and Modernization priority areas.

- The **Reliability** priority area currently focuses on the MBTA's Bridges and Tunnels, Revenue Vehicles, Facilities, Stations, System Upgrades, and Track, Signal and Power programs. It also focuses on RTA facility and vehicle maintenance and RTA vehicle replacement programs.

- The **Modernization** priority area currently focuses on programs and projects that support the MBTA's accessibility improvements, modernize the system and enhance customer experience, improve Red Line and Orange Line service, support implementation of the MBTA's next fare collection system (AFC 2.0), and address commuter rail safety and resiliency. This priority area also focuses on upgrades to RTA fleets and facility and system modernization.

The Boston Region MPO TIP reflects federally funded investments that the MBTA, CATA, and MWRTA make with their federal dollars, along with investments that the MPO makes with its Regional Target funds. While historically the MPO has not flexed its highway Regional Target funds to support transit reliability or modernization projects, it could work with the MBTA and the region's RTAs to do so through a transit modernization investment program.

Freight Infrastructure

The physical condition of the regional roadway network influences the health of the freight transportation system. For freight to move effectively, transportation agencies must consider and make improvements to various components of the network, including roadways, intermodal connection points, interchanges, and truck stops.

Roadway Maintenance and Modernization

Maintaining and modernizing the roadway network directly benefits freight transporters and the customers who receive goods conveyed by trucks. While many express highways

were designed in the 1950s, modern highways are designed to higher standards that accommodate the larger-sized trucks of today. One the other hand, the system of arterial roadways that connect regional express highways with local businesses that require freight delivery is undergoing gradual transformation as sections are rebuilt to Complete Streets standards. The emerging practices of arterial roadway design may pose challenges for truck movements if accommodation for modern trucks is not addressed at the outset. The viability of local merchants is key to supporting livable neighborhoods and reversing overdependence on the retail mall concept. However, the ability of "Main Street" merchants to receive deliveries by truck needs to be understood as a requirement for their viability.

When making improvements to the freight network, transportation agencies must recognize the following freight-related concerns:

- Reconstruction and modernization of the express highway system must continue.
- Reconstruction or improvements to arterial roadways must be explicitly vetted for truck compatibility.
- Growth of truck traffic serving regional intermodal terminals must be accommodated.

Intermodal Freight Connections

Intermodal freight connections in the Boston region are almost all between rail and truck or between ship and truck. These intermodal terminals—whether publicly owned, such as the Conley Container Terminal in South Boston, or privately owned, such as the bulk commodity terminals on the Mystic and Chelsea Rivers—finance their terminal investments outside of the MPO's planning process. However, the MPO may identify opportunities to improve connections between these intermodal terminals and the regional road network. Alternatively, MPO analyses undertaken as part of the UPWP process may identify intermodal freight roadway improvements that could be implemented by others.

Interchanges

The problems of system preservation and capacity management intersect at the issue of obsolete interchanges. The highway interchanges designed in the 1950s are less safe for trucks than modern interchanges, and they lack sufficient capacity to efficiently accommodate today's traffic. Their ability to accommodate future freight and passenger traffic levels is questionable. Merely reconstructing these interchanges might extend their physical life, but it would extend the use of highway designs unsafe for trucks and inadequate for all traffic. The recently completed Massachusetts Freight Plan recognizes this issue and lists several obsolete interchanges in the MPO region as major freight bottlenecks.

Truck Stops

Another freight-related issue is the need for truck rest locations. Rest requirements for truck drivers have become more rigorous in recent years, even as the volume of trucking has increased. There is now national consensus that there is not sufficient parking at useful locations to accommodate trucks during required rest periods. Even if an interstate highway is in excellent physical condition, the system is fundamentally inadequate if truck drivers cannot find suitable rest locations. The MPO staff studied this problem and the findings and recommendations have been incorporated in the Massachusetts Freight Plan.

Addressing Freight Needs

System preservation needs identified in the Massachusetts Freight Plan can be addressed by the Reliability and Modernization Programs included in MassDOT's CIP, as discussed previously in the Roadway Network Assets section. The MPO also seeks opportunities to fund freight-supporting projects through its investment programs. The project selection criteria in the MPO's TIP includes a criterion that examines whether a proposed project will protect freight network elements. Criteria that support other MPO goal areas examine whether proposed projects will improve truck movement and access.

Climate Change and Resiliency

When seeking to maintain the region's transportation system, the Boston Region MPO will not only have to consider existing challenges related to maintaining a state of good repair and existing environmental risk factors, but also threats posed by a changing climate. There are two aspects of climate change planning—mitigation and adaption. Climate change mitigation generally involves reducing human-caused (anthropogenic) emissions of greenhouse gases. Mitigation is addressed under the Clean Air/Sustainable Communities goal area. Adaptation is a response that reduces the vulnerability of the transportation system to a relatively sudden change and thus offsets the effects of climate change. This System Preservation goal area addresses adaptation.

The effects of climate change include increased days of extreme temperatures (causing asphalt deterioration, and the buckling of pavements and rail lines), sea level rise (causing inundation of transportation systems along the coastline and more severe flooding from storm surges), extreme precipitation (overwhelming storm water drainage systems that may also be compromised by sea level rise and river flooding), and more intense storms (such as Nor'easters that bring snow, flooding, and storm surges).

Transportation infrastructure that is susceptible to climate change and extreme weather includes roadways, bridges, tunnels, subways, commuter and freight rail, ferries, bus facilities, airports, and ports. Much of the key infrastructure in the Boston region is located along

coasts and near major rivers and was sited and designed based on historic weather, sea level, and flooding patterns. Adaptation to climate change can take the form of large-scale improvements—such as building infrastructure to protect against sea level rise and more intense and frequent extreme storm events, or improving the quality of road surfaces to withstand hotter temperatures.

Given the MBTA's central role in the region's transportation system, increased vulnerability to its infrastructure warrants particular attention. Climate change impacts can also present a number of planning challenges for the freight industry, which in the Boston region relies heavily on the functioning of the surface roadway system. (Hazardous cargo is prohibited in tunnels.) In addition, operators of regional port facilities are anticipating more severe storm surge conditions than found in the historical record, and associated MPO planning efforts can build on these new planning assumptions.

The MPO agrees that if climate trends continue as projected, the conditions in the Boston region likely would include a rise in sea level coupled with storm-induced flooding, and more days with extreme temperatures that would affect the region's infrastructure, economy, human health, and natural resources. While municipalities, MassDOT, and the MBTA oversee the design process for transportation infrastructure improvements in the region, the MPO has integrated resiliency into its scoring criteria used to evaluate projects for the LRTP and TIP.

The MPO developed an all-hazards planning application that shows the region's transportation network in relation to natural hazard zones. This tool is used in conjunction with the MPO's database of LRTP and TIP projects to determine if proposed projects are located in areas prone to flooding or at risk of seawater inundation from hurricane storm surges, or, in the long term, sea level rise. Transportation facilities in such hazard zones might benefit from flood protection measures, such as enhanced drainage systems, or adaptations for sea level rise.

Other actions that could be undertaken by the MPO and other transportation agencies to incorporate adaptation into the planning process include the following:

- Determine infrastructure needs in terms of asset type and location. This could include planning for vulnerable areas of the community and impacts on specific population groups.
- Undertake vulnerability and risk assessments to inventory the most at-risk facilities and systems, and identify the expected consequences.
- Design new infrastructure to anticipate changing environmental and operational conditions.
- Establish an asset management program that responds to current and anticipated conditions for existing infrastructure and operations, including changes to maintenance practices and retrofits.
- Anticipate expected disruptions from extreme weather events, and develop emergency response capability.

State Transportation-Related Climate Adaptation Actions

Executive Order 569: Establishing an Integrated Climate Change Strategy for the Commonwealth

Through Executive Order 569, the Secretary of Energy and Environmental Affairs is required to work with the Secretary of Transportation and others to publish a statewide adaptation strategy. Both MassDOT and the MBTA are developing policies to implement this executive order. These agencies will identify the vulnerabilities within their systems and then identify resiliency measures to reduce their vulnerabilities. These actions will include embedding resiliency into all project development. The MPO can use this information when evaluating projects for funding in its LRTP and TIP.

Central Artery/Tunnel (CA/T) Vulnerability and Adaptation Assessment

The CA/T Vulnerability and Adaptation Assessment was completed in 2015 and created the Boston Harbor Flood Risk Model. This model is being expanded to cover the entire Massachusetts coast and will be renamed the Massachusetts Coastal Flood Risk model. This model will be used to evaluate impacts associated with the current year, 2030, 2050, and 2070/2100 climate scenarios.[18]

In addition, MassDOT and the coordinating agencies are exploring ways to make climate data more accessible to municipalities.

Municipal Vulnerability Grant Program

The Commonwealth established a Municipal Vulnerability Preparedness (MVP) grant program to support cities and towns as they identify climate change vulnerabilities, prioritize critical actions, and build community resiliency. The MVP Program provides funding and technical support to complete a community-led planning process that

- defines extreme weather and natural and climate change related hazards;
- identifies existing and future community vulnerabilities and strengths; and
- develops and prioritizes actions and opportunities to reduce risk and build resilience.

When municipalities complete the planning process they become eligible for follow-on funding opportunities, including MVP action grants, and advanced standing in other grant opportunities.[19]

[18] Massachusetts Department of Transportation. "Central Artery and Tunnel Pilot Project." Climate Change Resiliency. Accessed May 27, 2019 at https://www.mass.gov/info-details/climate-change-resiliency#central-artery-and-tunnel-pilot-project-.

[19] Commonwealth of Massachusetts. "Municipal Vulnerability Preparedness." Resilient MA. Accessed May 27, 2019 at http://resilientma.org/mvp#resources.

As of October 2018, designated communities in the MVP Program were Boston, Cambridge, Salem, Somerville, and Swampscott. Designated communities receive advanced standing in Massachusetts Office of Energy and Environmental Affairs grant programs. Participating communities include Acton, Arlington, Cohasset, Essex, Everett, Gloucester, Littleton, Manchester-by-the-Sea, Marblehead, Medford, Melrose, Milford, Natick, North Reading, Rockport, Norwood, Peabody, Sherborn, Stow, Weymouth, Winthrop, and Wrentham.

Stakeholder and Public Input on System Preservation and Modernization

During fall 2017 and winter 2018, MPO staff collected feedback on transportation issues, needs, and opportunities for action from municipal planners and officials, transportation advocates, members of the public, and other stakeholders. During this outreach process, 78 respondents commented on maintenance and resiliency of the transportation system. This section summarizes comments by theme.

Maintenance

Respondents felt that it was important to maintain significant portions of the transportation network that are currently in disrepair. This interest was highlighted by state and municipal officials, transportation advocates, and residents. Maintenance concerns focused on the need to invest in the maintenance of MBTA infrastructure and the repair of roadway and pedestrian facilities.

Resiliency

Respondents felt that it was important to create a resilient transportation network that can evolve to mitigate the impacts of climate change, population growth, and inequality on the region. This interest was highlighted by state and municipal officials, transportation advocates, transit providers, and residents. Resiliency concerns centered around the need to plan for the impacts of climate change, particularly on public transit and in vulnerable communities, by promoting transit as an alternative to single-occupancy vehicles (SOVs) and by preparing facilities for extreme weather events.

Solutions Proposed through the Public Outreach Process

Respondents also offered proposed solutions that focused on improvements to public transit, pedestrian and bicycling infrastructure, and roadway and bridge maintenance. These ideas are summarized below.

Public Transit Maintenance

- Invest in maintaining MBTA infrastructure and equipment to reduce signal problems and delays and to improve capacity and reliability on the subway and commuter rail.

- Promote better use, management, and oversight of publicly owned transportation facilities, equipment, and infrastructure.
- Regularly maintain escalators, elevators, and stairs in stations for usability, safety, cleanliness, and accessibility.
- Provide and maintain seating for riders on transit vehicles and for those waiting for transit, particularly at bus stops.
- Maintain the pedestrian environment in and around transit stations (for example, by ensuring even pavement for paths and sidewalks, and maintaining clean and functioning lights).
- Complete major infrastructure upgrades to the Red and Green Lines.
- Replace the 114 year-old Blue Line tunnel.
- Maintain dedicated bus lanes, bus rapid transit markings, and infrastructure.
- Build a permanent MBTA Arborway Yard bus maintenance facility elsewhere and develop affordable housing on the facility's current plot.

Roadway Maintenance

- Invest in bridge and road repair prioritizing Complete Streets principles and road diets.
- Perform regular maintenance of road facilities (restriping, etc.).
- Do not spend money on expanding the road network, only on maintenance.

Pedestrian and Bicycle Infrastructure Maintenance

- Provide more funding for basic maintenance of pedestrian and bicycle facilities
- Improve the condition of the sidewalk network by maintaining even surfaces; removing cobblestones, bricks, and tree roots; and fixing potholes, particularly in environmental justice communities.
- Improve pavements for bikes throughout the Emerald Necklace.
- Regularly maintain faded crosswalks.
- Coordinate with municipalities and the state for better maintenance across jurisdictional boundaries.
- Improve municipal response times to calls and requests for maintenance.

- Improve coordination to accommodate pedestrians and people with disabilities during construction.
- Incorporate sidewalk upgrades into roadway projects.
- Complete the network of bike paths on Department of Conservation and Recreation parkways and rehabilitate paths in poor condition.

Public Transit Resiliency

- End the MBTA maintenance backlog by upgrading or replacing insufficient hardware, particularly signal equipment and cold-weather gear.
- Prioritize improvements to buses (including bus rapid transit) to support the agile nature of bus network, and provide for resiliency in cases of major storms, disabled vehicles, or other maintenance issues.
- Install better heating and cooling systems in transit stations and at bus stops.
- Create more protected bus stops.
- Plan for, coordinate, and prioritize snow clearance at bus stops and transit stations.
- Consider implementing new water transportation in Boston and coastal communities.
- Plan for sea level rise and flooding, particularly at transit stations near the ocean.
- Train operators in bad weather protocol and safety.

Pedestrian Infrastructure Resiliency

- Plan for, coordinate, and prioritize snow clearance and removal of debris after storms from sidewalks, curb cuts, crosswalks, and other pedestrian infrastructure.
- Create more green space.

Climate Change Adaptation

- Promote transition to carbon-neutral forms of transportation.
- Prepare for impacts of sea level rise, increased storm intensity, heatwaves, and flooding on existing transportation network (roads, bridges, and transit).
- Study climate impacts of delayed investment in transportation infrastructure, estimate increased carbon outputs if the region fails to invest in public transit system, and promote high-occupancy travel.
- Increase access to electric vehicle charging stations.

UPDATES SINCE *CHARTING PROGRESS TO 2040* NEEDS ASSESSMENT

Since the MPO last updated its Needs Assessment in 2014, there have been several planning and policy changes that affect the content of this chapter:

- In 2016, the USDOT finalized rules and requirements for states and MPOs related to National Highway System bridge and pavement performance measures (see Title 23 of the Code of Federal Regulations [CFR], Part 490). States and MPOs must monitor and set performance targets related to bridge and pavement conditions, and incorporate this information into their performance-based planning and programming processes. States must also create Transportation Asset Management Plans that monitor the condition of NHS bridges and pavements and identify investment strategies to improve those assets.

- In 2016, the USDOT finalized rules and requirements for states and MPOs related to transit asset measures (see Title 49 CFR Part 625). Transit agencies are responsible for monitoring and reporting on the condition of the vehicle, facility, and fixed guideway assets, creating Transit Asset Management Plans, and setting performance targets for established measures. MPOs must coordinate with transit agencies to set transit asset condition performance targets for their regions. In October 2018, The MBTA, CATA, and MWRTA completed their first TAM plans under the new TAM rule.

- Governor Charlie Baker signed Massachusetts Executive Order 569: *Establishing an Integrated Climate Change Strategy for the Commonwealth*, which will influence future state transportation policy related to climate change.

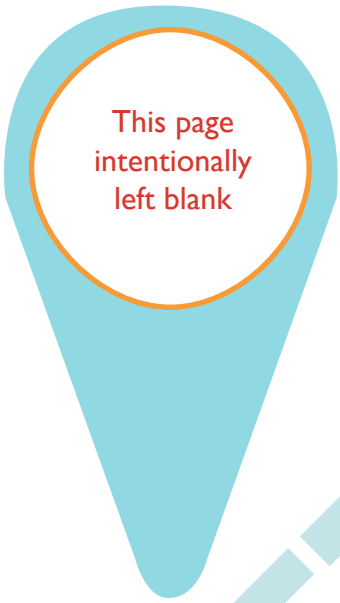
- The MBTA has completed its *Focus40* 25-year investment plan, which includes recommended projects and programs to modernize the system.

MPO staff updated this chapter, based on these planning and policy changes, data availability, and other factors:

- Bridge and pavement analyses have been updated with more recent data from MassDOT inventories, as well as information about the MPO's NHS bridge and pavement condition performance targets.

- MPO staff have expanded the discussion of transit asset condition by incorporating information from transit agencies' TAM planning processes. Staff have also expanded this chapter's discussion of transit modernization, based in part on content from the finalized *Focus40* plan.

- The MPO has strengthened its goals and objectives to include resiliency in its planning activities, which reflects its increased focus on addressing climate-vulnerable elements of the transit system.



chapter 6

Capacity Management and Mobility Needs

THE BOSTON REGION MPO'S CAPACITY MANAGEMENT AND MOBILITY GOAL AND OBJECTIVES

Goal:

Use existing facility capacity more efficiently and increase transportation options.

Objectives:

- Improve access to and accessibility of all modes, especially transit and active transportation
- Support implementation of roadway management and operations strategies to improve travel reliability, mitigate congestion, and support non-single-occupant vehicle travel options
- Emphasize capacity management through low-cost investments; prioritize projects that focus on lower-cost operations/management-type improvements such as intersection improvements, transit priority, and Complete Streets solutions
- Improve reliability of transit
- Increase percentage of population and employment within one-quarter mile of transit stations and stops
- Support community-based and private-initiative services and programs to meet first-and-last-mile, reverse commute, and other non-traditional transit/transportation needs, including those of people 75 years old or older and people with a disability
- Support strategies to better manage automobile and bicycle parking capacity and usage at transit stations

- Fund improvements to bicycle/pedestrian networks aimed at creating a connected network of bicycle and accessible sidewalk facilities (both regionally and in neighborhoods) by expanding existing facilities and closing gaps
- Increase percentage of population and places of employment with access to facilities on the bicycle network
- Eliminate bottlenecks on freight network/improve freight reliability
- Enhance freight intermodal connections

INTRODUCTION

Issue Statement

The transportation system in the Boston region is, to a certain extent, increasingly stressed by the overall growth and success of the region's economy. Congestion on the region's roadways is reducing vehicular speeds, while the transit system is strained by high ridership and an aging infrastructure. Usage of the transportation network, both the roadway and transit systems, is projected to increase more during the time period covered by the Boston Region Metropolitan Planning Organization's (MPO) next Long-Range Transportation Plan (LRTP), *Destination 2040*. In pursuit of the MPO's core goals, the MPO and other stakeholders must find a way to manage the network's capacity with limited capital funding to maximize mobility for all residents and users of the transportation network, including bicyclists and pedestrians.

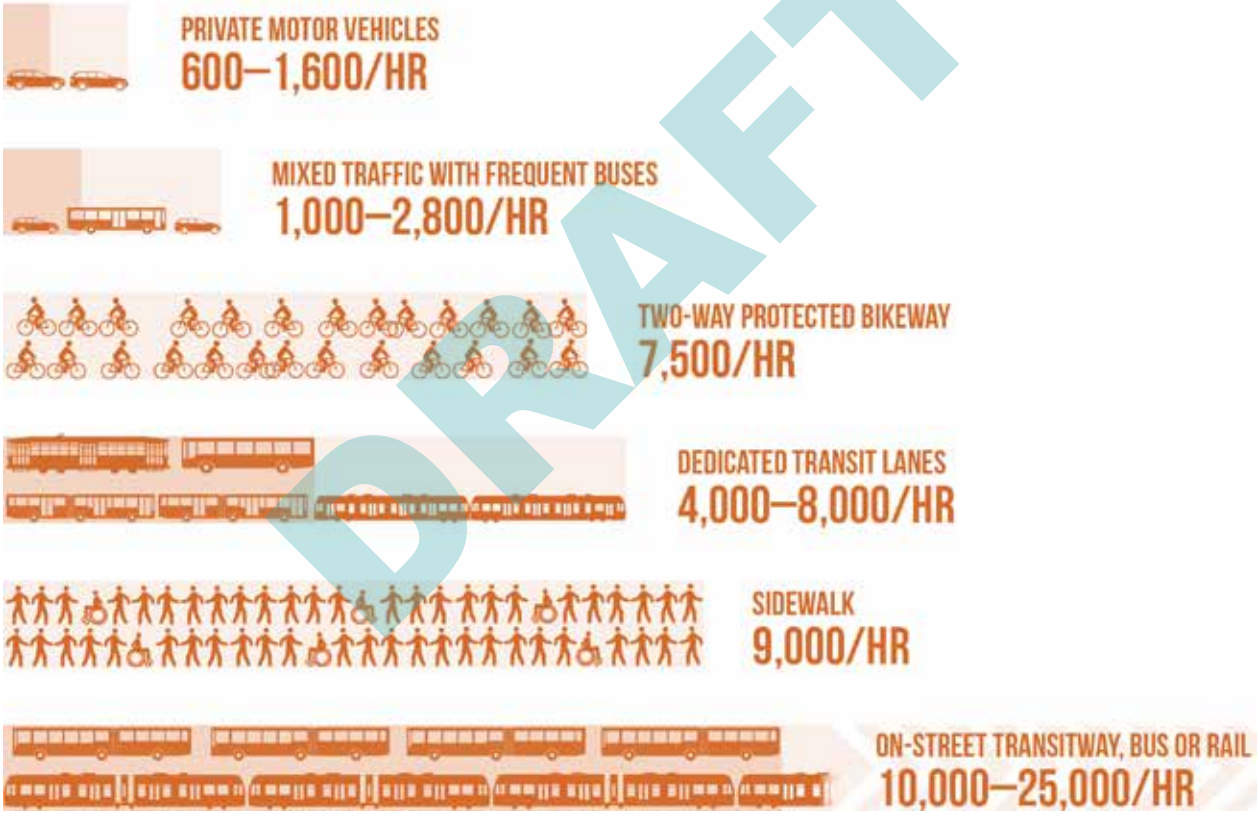
Background

Transportation capacity in a metropolitan region has important ramifications for the region's economic health and quality of life, both in the present and the future. As the data and analysis presented in this document demonstrate, the Boston region confronts a sort of policy paradox: a booming economy and a rapid population growth—especially in the core of the region—paired with increasing congestion and a public transit system that is aging and unreliable. These factors combine to stress the transportation network's overall capacity, creating significant challenges to convenient mobility across all modes for the residents and users of the MPO area's transportation network. Awareness of the stress on the system appears to be rising among the media and the public, and pressure on policymakers to restore mobility may be on the rise.[1]

[1] Representative articles in the Boston Globe include, "It's not your imagination. Your Boston commute is getting worse," (https://www.bostonglobe.com/metro/2018/03/25/not-your-imagination-your-boston-commute-getting-worse/J7SdMk5wwwLa3oQWplqGHN/story.html?event=event25) and "Your commute stinks because Greater Boston can't fathom its own growth." (https://www.bostonglobe.com/opinion/2018/03/28/your-commute-stinks-because-greater-boston-can-fathom-its-own-growth/9FMkxTCN2oT8nldJ8TRXeO/story.html).

The MPO's capacity management and mobility goal and objectives seek to expand users' travel options to reach principal destinations. They respond to federal, state, and regional policies and activities to increase transit, bicycle, and pedestrian travel, and to the increasing demand for transit, bicycle, and pedestrian connections by communities throughout the region. With limited finances for expansion, the MPO needs to work with other responsible agencies and entities to address the challenge of setting policy and priorities to create as much capacity as possible from the existing system. As studies and analyses by the MPO and other agencies have shown, in many situations, the least technically complex and least capital-intensive path to creating additional overall network capacity is to reallocate space on the existing road network to the modes that have the capacity to move the highest possible number of users in a given space. Figure 6-1 demonstrates this dynamic for a typical city street.

Figure 6-1
Overall Person Throughput Capacity of a Typical Lane by Mode



Source: National Association of City Transportation Officials (NACTO) Transit Street Design Guide, https://nacto.org/publication/transit-street-design-guide/introduction/why/designing-move-people.

Key Factors Affecting this Goal Area

MPO staff identified the following key factors that will affect the MPO's Capacity Management and Mobility goal area in the future. These factors are consistent with key challenges that have been identified in the report, *Choices for Stewardship: Recommendations to Meet the Transportation Future*, released in December 2018 by the Commission on the Future of Transportation in the Commonwealth—a high-level report intended to guide the future of transportation policy and planning in Massachusetts. These key factors include:

- Regional growth in population and economic activity resulting in greater demands on the transportation network and greater regional congestion
- Changing land use and real estate market trends, including increasing pressure on Inner Core markets and potential movement of transit-dependent populations to suburbs
- Transitions in commute and trip patterns, including growth in commutes outside of a 9-to-5 schedule, longer commutes, and reverse commute
- Rapid transit and buses face reliability, capacity, and crowding challenges
- Growth in demand for safe, convenient options for biking and walking
- The growth in usage of transportation network companies (TNCs) and the need to generate data on their effects
- Potential introduction of automated vehicles (AVs) and connected vehicles (CVs), and the need to plan for their effects on the network

CAPACITY MANAGEMENT AND MOBILITY NEEDS SUMMARY

One of the major challenges facing the MPO and other policymaking stakeholders and agencies is the preservation and enhancement of mobility options when economic growth and trip-making are concentrated in a limited geographic area. Economic growth in the Boston region outpaces that in the rest of the state, and growth in the Inner Core subregion is projected to continue at a faster rate than in the rest of the Boston region. The increase in the number of trips made in the Boston region is increasing congestion on a network that is either at capacity or nearing it. In an area where adding roadway capacity for vehicles is challenging, the MPO and other policymaking entities have the opportunity to work with municipalities to reallocate road space to accommodate all modes of travel.

The regional transit system has also been stressed over the past several years, and continues to struggle by some measures. The Massachusetts Bay Transportation Authority (MBTA) has plans and capital projects underway to modernize and increase capacity on much of the rapid transit system. The MBTA recently conducted the Better Bus Project which proposed changes

to bus service based on research and partnerships with municipalities. This project and potential MPO and municipal projects and programs provide an opportunity to improve the reliability, capacity, and quality of the bus network with a relatively low capital expenditure. The MBTA has also launched the Rail Vision study to examine the future of the commuter rail network, a topic which MPO staff heard discussed many times during public outreach events.

Table 6-1 summarizes key findings regarding capacity management and mobility needs that MPO staff identified through data analysis and public input. It also includes staff recommendations for addressing each need. Chapter 10—Recommendations to Address Transportation Needs in the Region—provides more detail on each of the recommendations. The MPO board should consider these findings and recommendations when prioritizing programs and projects to receive funding in the LRTP and Transportation Improvement Program (TIP), and when selecting studies and activities for inclusion in the Unified Planning Work Program (UPWP).

Table 6-1
Capacity Management and Mobility Needs in the Boston Region Identified through Data Analysis and Public Outreach and Recommendations to Address Needs

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Roadway	Congestion and slower speeds	Address congestion on expressways, interchanges, and arterials.	*Existing Programs* • Major Infrastructure Program • Bottleneck Program • Freight Program *Existing Studies* • Addressing Priority Corridors from the LRTP Needs Assessment • Addressing Safety, Mobility, and Access on Subregional Priority Roadways • Low-Cost Improvements to Express Highway Bottlenecks *Proposed Studies* • Congestion Pricing Research • Safety and Operations at Selected Intersections
Roadway	Bottlenecks	Reduce congestion at bottleneck locations on the regional roadway network.	*Existing Programs* • Major Infrastructure Program • Bottleneck Program *Existing Study* Low-Cost Improvements to Express Highway Bottlenecks *Proposed Study* Congestion Pricing Research

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Roadway	Connected and autonomous vehicles	Continue to monitor this technology because the schedule for its adoption and implementation, and its implications remain highly uncertain.	*Existing Study* Tracking of Emerging Connected and Autonomous Vehicle Technologies
Roadway	Ride-hailing and TNCs	Continue to monitor growth in TNC usage to determine if TNCs are diverting ridership and funds away from public transit, and contributing to congestion. The future of this mode is uncertain.	*Existing Program* Community Transportation Program *Proposed Program* Connect Elderly Adults with Transportation Options *Existing Studies* • Transportation Access Studies of Commercial Business Districts • New and Emerging Metrics for Roadway Usage • The Future of the Curb *Proposed Studies* • Congestion Pricing Research • Transit Revenue Analyses • Research on TNCs • Monitor TNC Adoption
Roadway	Car sharing	Continue to monitor car sharing; it is poorly integrated with other modes and not accessible in all areas. The future of this mode is uncertain.	*Existing Program* Community Transportation Program *Proposed Program* Coordinating Car Sharing and Transit
Roadway	Transportation demand management	Continue to monitor TDM services. There is no region-wide strategy for TDM and relatively few municipalities in the Boston region have TDM ordinances.	*Existing Program* Community Transportation Program *Proposed Study* Congestion Pricing Research

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Freight	Congestion	Reduce congestion on regional roadways to facilitate the movement of freight.	*Existing Programs* • Freight Program • Major Infrastructure Program • Bottleneck Program *Proposed Programs* Freight Database *Existing Studies* • Addressing Priority Corridors from the LRTP Needs Assessment • Addressing Safety, Mobility, and Access on Subregional Priority Roadways • Low-Cost Improvements to Express Highway Bottlenecks • New and Emerging Metrics for Roadway Usage • Updates to Express Highway Volumes Charts *Proposed Study* Congestion Pricing Research
Freight	Contested curb and arterial road usage	Reduce conflicts between automobiles and delivery trucks that are competing for curb space.	*Existing Studies* • Transportation Access Studies of Commercial Business Districts • The Future of the Curb
Freight	Lack of data	Develop reliable data sets on various freight topics.	*Existing Program* Freight Program *Proposed Program* Freight Database

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Transit	Access to transit	Improve access to transit service that runs frequently, and increase capacity at park-and-ride lots that are at or approaching capacity.	*Existing Programs* • Park-and-Ride and Bicycle Parking Programs • Regional Transit Service Planning Technical Assistance • Community Transportation Program *Proposed Programs* • Dedicated Bus Lane Program • Enhanced Park-and-Ride Program • Infrastructure Bank or Demonstration Materials Library • Coordinating Car Sharing and Transit *Existing Studies* • Transportation Access Studies of Commercial Business Districts • Reverse Commute Areas Analysis • The Future of the Curb) *Proposed Study* The role of dispatching and supervision in bus reliability and its application in the MBTA network
Transit	Bus speed and reliability	Improve the reliability of bus service. Bus speeds are projected to decline even further due to increasing congestion; the introduction of more dedicated bus lanes could be a potential solution.	*Existing Program* Regional Transit Service Planning Technical Assistance *Proposed Program* Dedicated Bus Lane Program *Existing Study* The Future of the Curb *Proposed Studies* • The role of dispatching and supervision in bus reliability and its application in the MBTA network • Assist the MBTA in locating new or improved bus garage locations • Congestion Pricing Research
Transit	Rapid transit reliability	Address increased delays resulting from the system's aging rapid transit infrastructure.	*Proposed Studies* • Analyze peak capacity of the MBTA rapid transit system • State and MPO Performance-based Planning Program

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Transit	Crowding	Address crowding on rapid transit lines and bus routes. According to a 2040 no-build scenario, crowding is projected to increase to unacceptable levels in some locations.	*Proposed Programs* Dedicated Bus Lane Program *Existing Study* The Future of the Curb *Proposed Studies* • The role of dispatching and supervision in bus reliability and its application in the MBTA network • Analyze peak capacity of the MBTA rapid transit system
Transit	Bus maintenance facilities	Address the need for sufficient MBTA garage space to fully modernize and/or expand the fleet.	*Proposed Study* Assist the MBTA in locating new or improved bus garage locations
Transit	Commuter rail schedules	Examine off-peak and reverse commute options. The commuter rail mostly serves commuter travel during the peak periods between the suburbs and the Boston Central Business District.	*Existing Study* Reverse Commute Areas Analysis
Transit	Commuter rail reliability	Address aging equipment and infrastructure challenges facing the commuter rail fleet. The reliability of the commuter rail system is not as good as it could be.	*Existing Program* State and MPO Performance-based Planning Program
Transit	First-mile and last-mile connections	Identify challenges to making first-mile and last-mile connections, which are major barriers to transit usage.	*Existing Programs* • Park-and-Ride and Bicycle Parking Programs • Regional Transit Service Planning Technical Assistance • Community Transportation Program *Proposed Programs* • Enhanced Park-and-Ride Program • Coordinating Car Sharing and Transit *Existing Study* Reverse Commute Areas Analysis

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Bicycle and Pedestrian	Access to infrastructure	Expand pedestrian and bicycle infrastructure so that residential areas and employment locations are close to good quality facilities conducive to regular usage.	*Existing Programs* • Bicycle and Pedestrian Program • Bicycle and Pedestrian Support Activities • Community Transportation Program *Existing Studies* • Pedestrian Report Card Assessment Dashboard • The Future of the Curb *Proposed Studies* • Locations with High Bicycle and Pedestrian Crash Rates • Region-wide Sidewalk Inventory
Bicycle and Pedestrian	Network construction	Connect the disjointed elements of the bicycle network to create a cohesive network.	*Existing Programs* • Bicycle and Pedestrian Program • Bicycle and Pedestrian Support Activities • Community Transportation Program *Existing Study* Pedestrian Report Card Assessment Dashboard
Bicycle and Pedestrian	Bike-sharing	Ensure that docked bike-share facilities are provided in all neighborhoods in the Inner Core, including low-income and minority areas. Monitor the future of dockless bike-share systems.	*Existing Programs* • Bicycle and Pedestrian Program • Bicycle and Pedestrian Support Activities • Community Transportation Program
Bicycle and Pedestrian	Lack of sidewalk data	Create a comprehensive inventory of existing sidewalk data, including sidewalk coverage and condition.	*Proposed Study* Region-Wide Sidewalk Inventory

FFY = federal fiscal year. LRTP = Long-Range Transportation Plan. TDM = transportation demand management. TNC = transportation network company. UPWP = Unified Planning Work Program.
Source: Boston Region MPO.

UNDERSTANDING CAPACITY MANAGEMENT AND MOBILITY NEEDS IN THE BOSTON REGION

This section presents the research and analysis MPO staff conducted to understand transportation capacity management and mobility needs in the Boston region for all modes of travel, which have been summarized in the previous section. The following sections present more detailed information on these needs by mode: first is roadway, followed by freight, then transit, and finally, bicycle and pedestrian needs.

Supporting information that the MPO staff used to understand capacity management and mobility needs is included in the Appendices of this Needs Assessment.

- Appendix A includes key plans and policies
- Appendix B includes MPO studies and reports
- Appendix C includes data resources

This section also provides a summary of input gathered from stakeholders and the public about transportation capacity management and mobility needs, and proposed solutions to meet those needs. Staff considered this input when developing recommendations to achieve the MPO's Capacity Management and Mobility goals and objectives.

Roadway

Background

The state of the region's roadways is perhaps one of the leading indicators of the state of the overall transportation network. As MPO staff's analysis indicates, congestion on the region's roadways has increased significantly since the last Needs Assessment, and it is expected to continue to do so over the course of the *Destination 2040* LRTP. This congestion and stress affects not only motorists but road users of all modes, including freight operators and bus passengers (detailed sections on freight and bus are included later in the chapter), and significantly impacts both capacity and mobility throughout the region.

MPO Research and Analysis

A number of different planning processes come together to address capacity management and mobility performance, issues, and needs on the roadway system. Through its Congestion Management Process (CMP), the MPO does extensive analysis of congestion and mobility constraints in the region and produces periodic performance plans that describe other congestion-oriented measures and targets. Along with data from the CMP, the following

section describes regional bottleneck locations identified using information from the MPO's travel demand model; crash data; and staff research on CVs and AVs, shared-use mobility and ride-hailing, car sharing, and travel demand management.

The MPO's CMP: Changes in Traffic Congestion, 2012–15

In order to determine how well the region's roadways are performing with respect to mobility, the MPO applies performance measures that gauge the duration, extent, intensity, and reliability (or regularity) of the occurrence of congestion. MPO staff analyze congestion in the region using its CMP Express Highway and Arterial Performance Dashboards, which apply the following measures[2]:

- Congested Time: Monitors duration of congestion (measured in minutes per peak-period hour). This is the average number of minutes that drivers experience congested conditions during the peak period. Limited-access roadways are considered congested when the average speed is less than 35 miles per hour (mph) and arterial roadways are congested when the average speed is less than19 mph.
- Speed Index: Monitors intensity; it is the average speed divided by the posted speed limit. When average speed matches the posted speed, the index equals one. Lower values indicate more congestion.
- Travel Time Index: Monitors reliability; it is the average peak-period travel time divided by free-flow travel time. When the average peak-period travel time equals free-flow travel time, the index equals one. Higher values indicate more congestion.
- Lane miles of Congestion: Monitors the extent of congestion. Lane miles of congestion are determined by the travel time index values of the region's roadways.

Regional Road Performance

Tables 6-2 and 6-3 show the duration, intensity, and reliability of congestion for the Boston Region MPO's expressways and arterials, comparing 2012 to 2015 (the most recent data available).

[2] The CMP and Arterial applications can be viewed at http://www.bostonmpo.org/applications.

Table 6-2
Regional Performance for Expressways

Expressway	2012	2015
AM Average Speed	57.81 mph	54.93 mph
AM Speed Index	0.99	0.95
AM Travel Time Index	1.12	1.17
PM Average Speed	58.53 mph	54.89 mph
PM Speed Index	1.01	0.95
PM Travel Time Index	1.11	1.17
Free Flow Speed	65.28 mph	64.09 mph
Average Congested Time per AM Peak-Period Hour	6 minutes, 49 seconds	8 minutes, 59 seconds
Average Congested Time per PM Peak-Period Hour	5 minutes, 55 seconds	9 minutes, 9 seconds

mph = miles per hour.
Source: Boston Region MPO Congestion Management Process.

Table 6-3
Regional Performance for Arterials

Arterials	2012	2015
AM Average Speed	31.57 mph	28.30 mph
AM Speed Index	0.86	0.77
AM Travel Time Index	1.09	1.30
PM Average Speed	31.92 mph	27.34 mph
PM Speed Index	0.87	0.75
PM Travel Time Index	1.07	1.35
Free Flow Speed	34.27 mph	36.87 mph
Average Congested Time per AM Peak-Period Hour	2 minutes, 57 seconds	8 minutes, 57 seconds
Average Congested Time per PM Peak-Period Hour	2 minutes, 20 seconds	11 minutes,10 seconds

mph = miles per hour.
Source: Boston Region MPO Congestion Management Process.

As shown above, congestion has increased across the region's roadways. Average travel times at peak have increased and average speeds decreased on both freeways and arterials. Of particular note is the marked increase—a tripling or quadrupling—in both AM and PM peak congestion time experienced by travelers on arterials. This is a special concern because, in addition to drivers, it also affects bus passengers (see analysis of the effects of the slowing of arterial traffic on buses below).

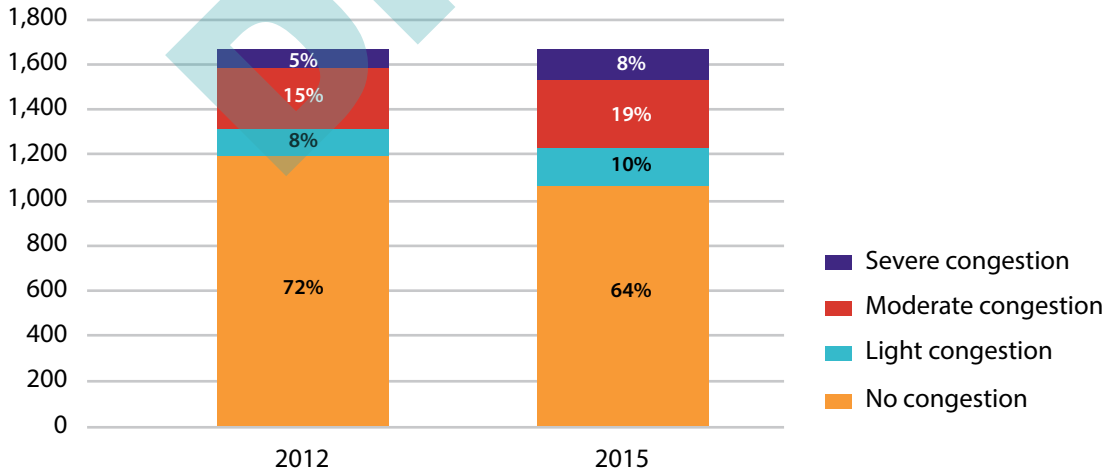
Lane Miles of Congestion

MPO staff established congestion thresholds for the region's express highways and arterial roadways based on travel time index (TTI), which is the average peak-period travel time divided by free-flow travel time. When the average peak-period travel time equals free-flow travel time, the index equals one; higher values indicate more congestion. The MPO's TTI-based congestion thresholds are:

- No congestion (TTI less than 1.15)
- Light congestion (TTI between 1.15 and 1.29)
- Moderate congestion (TTI between 1.3 and 2.0)
- Severe congestion (TTI greater than 2.0)

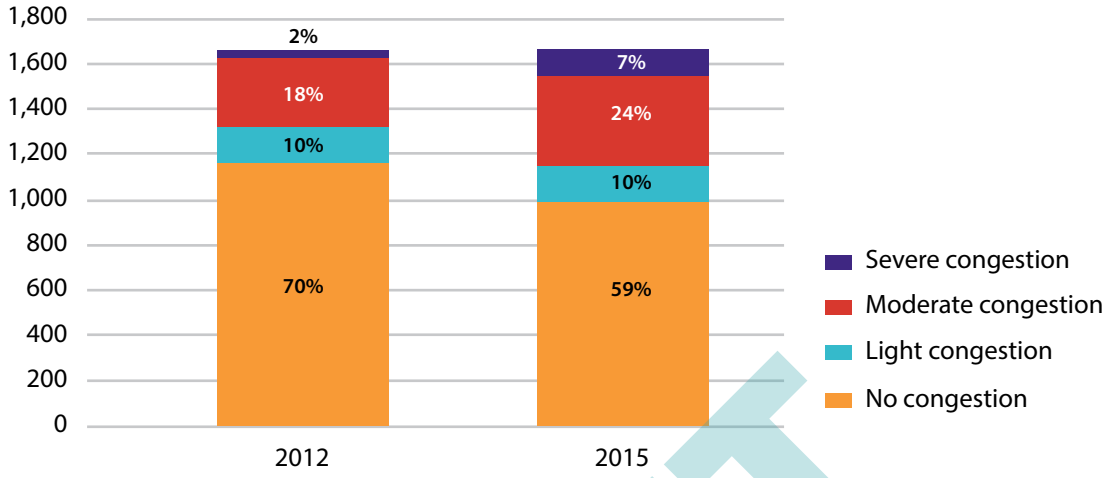
The Boston Region MPO obtains speed and travel time data to understand how congestion is changing on the region's express highways and arterial roadways. Figures 6-2 through 6-5 compare congestion levels based on data from 2012 to data from 2015. Each figure reflects a different combination of roadway type (expressway or arterial) and the time of day (AM or PM peak period). The figures also show both the total lane miles experiencing each level of congestion and the percent of CMP monitored roadways experiencing each level of congestion.

Figure 6-2
Lane Miles of Congestion on CMP Monitored Expressways in the AM Peak Period, 2012 and 2015



Note: This chart displays data for the 97 municipalities in the Boston Region MPO area. The AM peak-period time window for expressways is: 6:00 AM to 10:00 AM.
CMP = congestion management process.
Source: Boston Region MPO Congestion Management Process, 2012 and 2015 INRIX data.

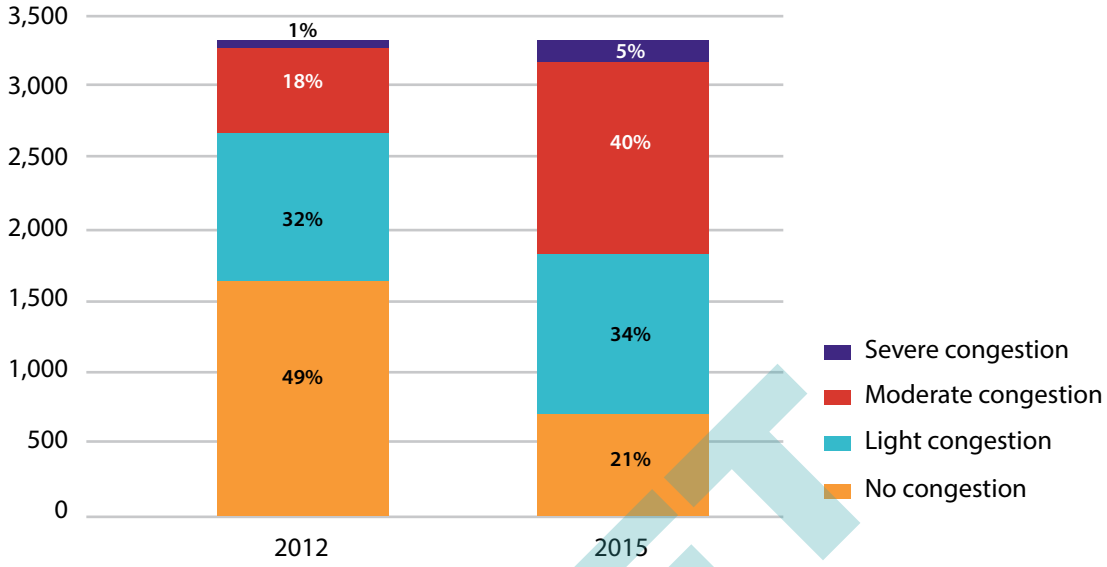
Figure 6-3
Lane Miles of Congestion on CMP Monitored Expressways in the PM Peak Period, 2012 and 2015



Note: This chart displays data for the 97 municipalities in the Boston Region MPO area. The PM peak-period time window for expressways is 3:00 PM to 7:00 PM.
CMP = congestion management process.
Source: Boston Region MPO Congestion Management Process, 2012 and 2015 INRIX data.

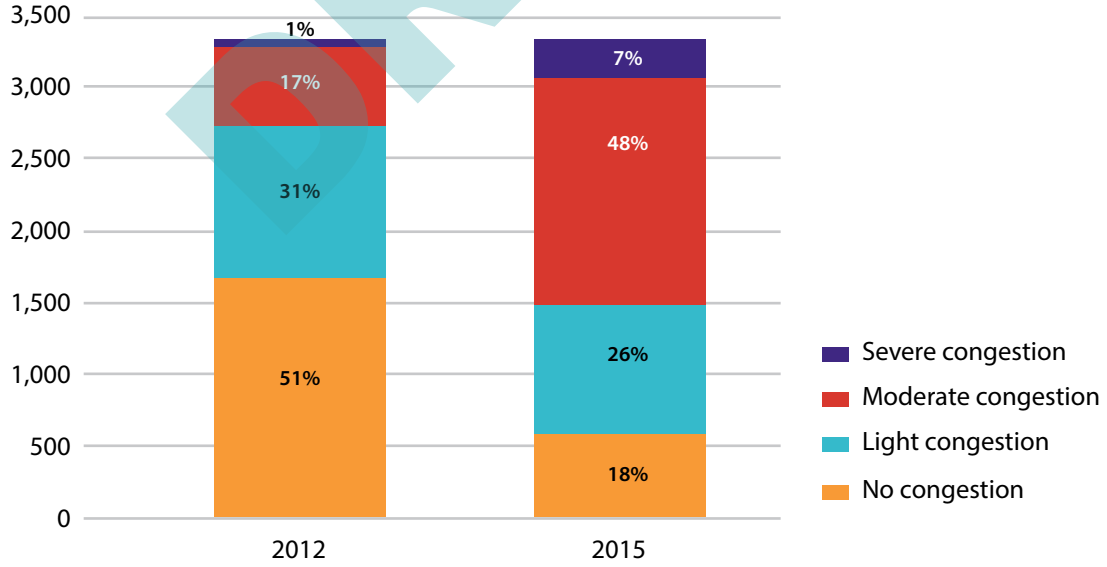
Figures 6-2 and 6-3 show that congestion is getting worse on the region's expressways. While 28 percent of CMP-monitored express highways experienced some congestion during the AM peak period in 2012, this share increased to 37 percent in 2015. The number of lane miles experiencing moderate congestion increased by 53 lane-miles (21 percent) between these two time periods, while the number of lane miles experiencing severe congestion increased by approximately 47 lane miles (60 percent). During the PM peak-period, 30 percent of monitored expressways experienced some level of congestion in 2012 and by 2015, this increased to 41 percent. The number of lane miles experiencing moderate congestion increased by 97 lane miles (33 percent), while the number of lane miles experiencing severe congestion increased by 83 lane miles (258 percent).

Figure 6-4
Lane Miles of Congestion on CMP Monitored Arterial Roadways in the AM Peak Period, 2012 and 2015



Note: This chart displays data for the 97 municipalities in the Boston Region MPO area. The AM peak-period time window for arterial roadways is 6:30 AM to 9:30 AM.
CMP = congestion management process.
Source: Boston Region MPO Congestion Management Process, 2012 and 2015 INRIX data.

Figure 6-5
Lane Miles of Congestion on CMP Monitored Arterial Roadways in the PM Peak Period, 2012 and 2015



Note: This chart displays data for the 97 municipalities in the Boston Region MPO area. The PM peak-period time window for arterial roadways is 3:30 PM to 6:30 PM.
CMP = congestion management process.
Source: Boston Region MPO Congestion Management Process, 2012 and 2015 INRIX data.

Figures 6-4 and 6-5 show that congestion was worse on arterial roadways than on expressways, even in 2012, and that congestion has also gotten worse based on 2015 data.

In the AM peak period, 51 percent of arterial roadways experienced congestion of some kind in 2012—this increased to 79 percent in 2015. The number of lane miles experiencing moderate congestion increased by approximately 742 lane miles (124 percent) between these two time periods, while the number of lane miles experiencing severe congestion increased by approximately 117 lane miles (287 percent). During the PM peak period, 49 percent of monitored expressways experienced some level of congestion in 2012—by 2015, this increased to 81 percent. The number of lane miles experiencing moderate congestion increased to 1,016 lane miles (179 percent), while the number of lane miles experiencing severe congestion increased by 224 lane miles (more than 1000 percent).

The increase in congestion in the MPO region could have numerous causes, among them the growing economy and population, the popularity of TNCs, displacement of workers to outer suburbs in search of affordable housing, and the customer-facing cost of driving being low—relative to the cost of using public transit. More work will be needed during the duration of *Destination 2040* to fully understand the causes and consequences of this congestion.

Regional Traffic Bottlenecks

The MPO has identified a priority set of congested locations on the region's express highways and arterials. These locations are shown in Table 6-4 and Figure 6-6, respectively. To identify the bottleneck locations, three measures were selected from various datasets for segments of the region's road network. The measures include:

- Volume/capacity ratios indicating congestion (2040 No-Build Regional Travel Demand Model run)
- Travel time and speed indices indicating travel delay (INRIX vehicle probe data)
- Crash history by crash severity (Massachusetts Crash Data System). The Equivalent Property Damage Only (EPDO) weights crashes based on whether they resulted in property damage (weighted by one), injuries (weighted by five), or fatalities (weighted by 10)

The information used to establish traffic bottlenecks is more advanced than what was used for the previous LRTP, *Charting Progress to 2040*. As a consequence of this improved data, the priority locations listed in Table 6-4 and Figure 6-6 focus more closely on the specific locations causing or exacerbating regional congestion. This new approach is illustrated in Table 6-4 with a column that shows how each congested location identified now compares to the assessment of the same location in the previous LRTP. Many locations are shown as shorter segments now, focusing on perhaps one or two especially problematic intersections and nearby roadways. Other problem locations are the same as before, larger, or in some cases, newly identified as priority locations. The MPO uses the data developed here to select locations for study through the UPWP, as well as to develop regional priorities for funding through the TIP. MPO activities and investments that increase the reliability of the roadway network benefit both light and heavy vehicles such as trucks and buses.

Table 6-4
Priority Bottleneck Locations

Municipality	Routes	Expressway Feature	Comparison with Previous LRTP	Number of HSIP Clusters	EPDO	Recent Study
Malden	US 1	Quarry bypass	shorter	2	325	MassDOT Project # 605012 - Route 1 Reconstruction and Widening: Preliminary Design
Boston	1A	Boardman Street flyover	new	na	na	none
Peabody	128	Exit 26	same	3	185	none
Woburn	I-93/I-95	Interchange	shorter	7	1,292	none
Everett	99-CUFC		shorter	3	181	2016: RSA: Broadway between Dexter Street and Beacham Street 2016: RSA: Santilli Circle and Sweetser Circle
Medford	60		longer	4	290	2018: CTPS: Priority Roadways - Medford Square
Burlington	3A		new	2	122	none
Wilmington	38/129		shorter	3	183	2012: CTPS: Safety and Operations Analysis at Selected Intersections: Main Street at Church Street and Burlington Avenue
Somerville	I-93	Embankment	shorter	4	633	none
Cambridge	2A/16		shorter	4	212	2009: CTPS: Alewife Studies, Phases One and Two
Arlington	2A/16		new	na	na	2009: CTPS: Alewife Studies, Phases One and Two
Arlington	60		longer	2	126	none
Bolton	117		new	3	145	2011: CTPS: Safety and Operations Analyses at Selected Boston Region MPO Intersections: Main Street (Route 117) at Still River Road (Route 110)
Newton	I-90	Exits 16–17	same	5	395	2006: CTPS: I-90 Interchange 17 (Newton Corner): Traffic Patterns and Operational and Safety Improvements 2009: CTPS: Newton Corner Rotary Study: Phase Two

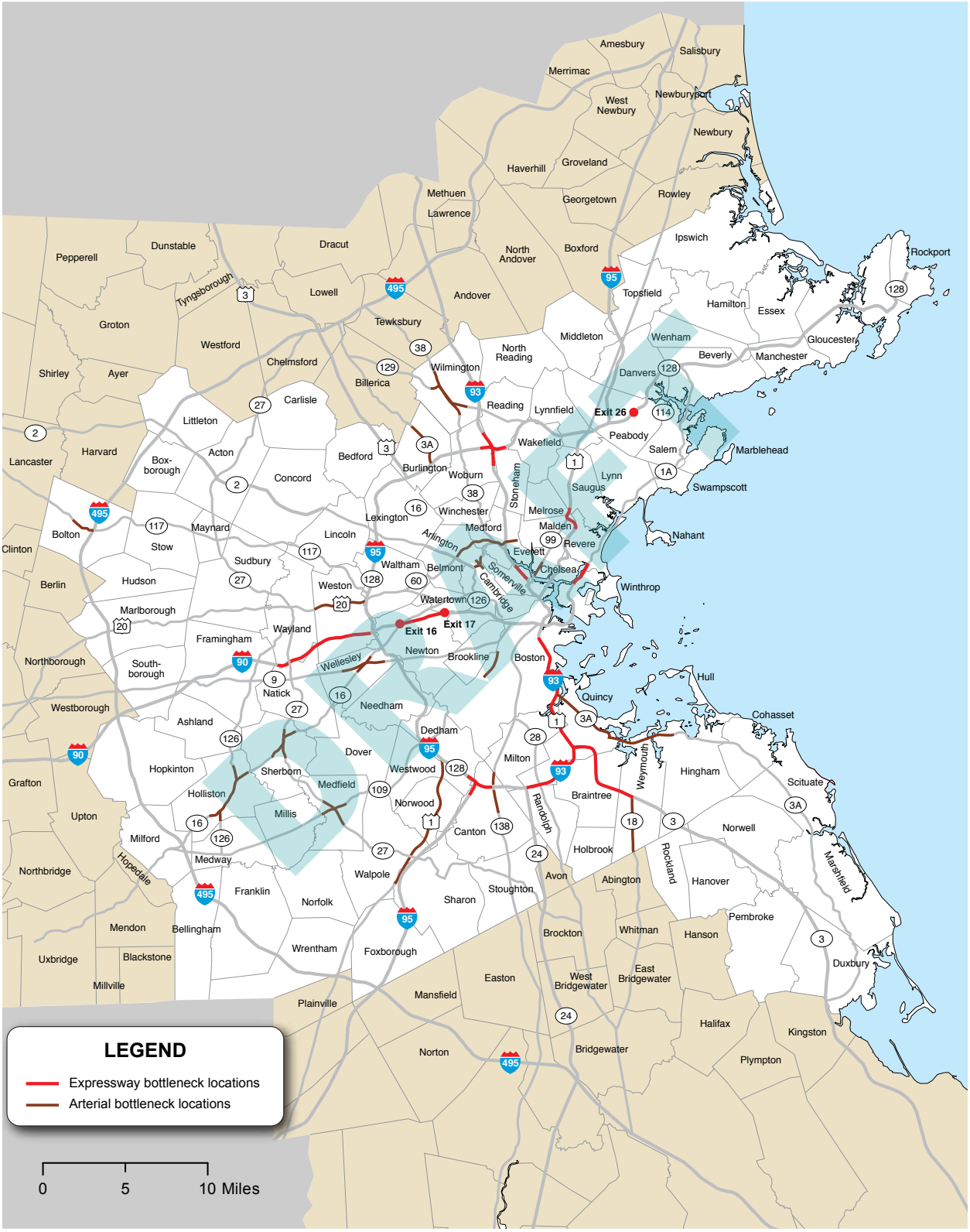
Municipality	Routes	Expressway Feature	Comparison with Previous LRTP	Number of HSIP Clusters	EPDO	Recent Study
Weston	I-90	Exits 13–14	new	4	485	2011: CTPS: Low-Cost Improvements to Express-Highway Bottleneck Locations: I-95 northbound, ramp merge area at interchange 24 in Weston 2015: CTPS: Low-Cost Improvements to Express-Highway Bottleneck Locations: I-95 southbound at the I-90 Interchange in Weston
Natick	I-90	Exits 13–14	new	2	97	none
Weston	US 20		same	3	211	2011: CTPS: Weston Community Transportation Technical Assistance: Boston Post Road, Church Street, and School Street Intersection
Wellesley	16/9		shorter	6	350	none
Sherborn	16/27		shorter	na	na	none
Holliston	16/126		shorter	2	107	2012: RSA: Washington Street
Canton	I-93/I-95	Interchange	new	5	356	2013: I-95 Northbound Off-Ramp to I-93 Northbound—Construction Completed 2015: Canton Street/ University Avenue Intersection—Construction Completed 2016: University Avenue Off Ramp—Construction Completed 2016: Dedham Street—Ongoing On-Hold (I-95/I-93 Interchange: 25% Design)
Boston	DCR		new	3	244	none
Canton	138		shorter	4	354	2016: RSA: Route 138 at Randolph Street 2017: CTPS: Route 138 Priority Corridor Study
Westwood	US 1		same	1	62	none

Municipality	Routes	Expressway Feature	Comparison with Previous LRTP	Number of HSIP Clusters	EPDO	Recent Study
Norwood	US 1		same	3	176	2014: RSA: Neponset Street Rotary/Pendergast Rotary 2017: RSA: Providence Highway (Route 1) at Morse Street 2014: Route 1 at Everett Street and University Avenue
Walpole	US 1		same	4	234	2017: Providence Highway (Route 1) at Coney Street 2013 - Providence Highway (Route 1) at High Plain Street (Route 27)
Medfield	109/27		new	na	na	2008: CTPS: Safety and Operations Analysis at Selected Intersections: Route 109 at Route 27
Boston	I-93	Southeast Expressway	same	9	2,267	2012: CTPS: Improving the Southeast Expressway—A Conceptual Plan
Milton	I-93	Southeast Expressway	same	3	745	2012: CTPS: Improving the Southeast Expressway—A Conceptual Plan
Quincy	I-93	Southeast Expressway	same	4	1,062	2012: CTPS: Improving the Southeast Expressway—A Conceptual Plan 2006: CTPS: I-93/ Southeast Expressway/ Route 3 (Braintree Split)—Operational Assessment and Potential Improvements
Braintree	I-93	Southeast Expressway approach	new	4	734	2006: CTPS: I-93/ Southeast Expressway/ Route 3 (Braintree Split)—Operational Assessment and Potential Improvements
Randolph	I-93	Southeast Expressway approach	new	4	265	2006: CTPS: I-93/ Southeast Expressway/ Route 3 (Braintree Split)—Operational Assessment and Potential Improvements
Braintree	3	Southeast Expressway approach	new	4	386	2006: CTPS: I-93/ Southeast Expressway/ Route 3 (Braintree Split)—Operational Assessment and Potential Improvements

Municipality	Routes	Expressway Feature	Comparison with Previous LRTP	Number of HSIP Clusters	EPDO	Recent Study
Weymouth	3	Southeast Expressway approach	new	2	138	2016: RSA: Route 3
Quincy	3A		same	10	778	2012: CTPS: FFY 2012 Safety and Operations Analyses at Selected Boston Region MPO Intersections: Southern Artery (Route 3A) at Sea Street/Coddington Street and at McGrath Highway/Field Street
Weymouth	3A		same	1	85	2016: RSA: Route 3A from Evans Street to Abigail Adams State Park
Hingham	3A		shorter	na	na	2016: CTPS: Summer Street/George Washington Boulevard Subregional Priority Roadway Study in Hingham and Hull
Weymouth	18		same	9	884	2011: RSA: Route 18 at Various Locations
Braintree	37-CUFC		new	5	425	2014: CTPS: Safety and Operations Analyses at Selected Intersections: FFY 2013: Franklin Street (Route 37) at West Street and Granite Street

Note: The Central Transportation Planning Staff (CTPS) is the staff to the Boston Region MPO. In addition to its work with the Boston Region MPO, CTPS works with and conducts studies for other transportation agencies in the state.
CTPS = Central Transportation Planning Staff. CUFC = Critical Urban Freight Corridor. DCR = Department of Conservation and Recreation. EPDO = Equivalent Property Damage Only. HSIP = Highway Safety Improvement Program. MassDOT = Massachusetts Department of Transportation. na = none available. RSA = roadway safety audit.
Source: Boston Region MPO.

Figure 6-6
Priority Bottleneck Locations



Source: Boston Region MPO.

Federal Performance Measures for Roadways

Highway System Reliability Performance Measures

In addition to the performance measures tracked as part of the MPO's CMP, described in the "Changes in Traffic Congestion" section above, the MPO is required to establish specific performance targets for federally required performance measures for travel reliability on the National Highway System (NHS) in the Boston region. These measures include

- Percent of the person-miles traveled on the Interstate System that are *reliable; and*
- Percent of the person-miles traveled on the non-Interstate NHS that are *reliable.*

These target measures capture whether travel times on an NHS segment are consistent (reliability), and the extent to which NHS users' travel may be affected by those conditions (percent of person-miles). Information on the development of these targets is described in more detail in the *Destination 2040* LRTP chapter on performance.

Both states and MPOs are required to set two-year and four-year targets for these measures. In 2018, the Massachusetts Department of Transportation (MassDOT) calculated baselines and established targets for these measures for the Massachusetts Interstate and non-Interstate NHS networks. Table 6-5 shows MassDOT's calendar year (CY) 2017 baselines and two-year and four-year targets for these measures. The Boston Region MPO (like all MPOs) was also required to establish four-year targets for these measures by either supporting state targets or setting its own quantitative targets for the MPO region. In 2018, the MPO voted to support the state's four-year targets. Table 6-5 also shows CY 2017 baselines for the Boston region's Interstate and non-Interstate NHS networks as a basis for comparison. As the table shows, Boston's share of reliable person-miles traveled on its Interstate and non-Interstate NHS networks is lower than those values for Massachusetts as a whole.

Table 6-5
Travel Time Reliability Performance Measure Baselines and MassDOT Performance Targets

Network	Measure	Cumulative Traffic Message Channel Length (Miles)	2017 Measure Value (Baseline)	Two-Year Target (CY 2019)[a]	Four-Year Target (CY 2021)[a]
Massachusetts—Interstate Highway System	Percent of person-miles on the Interstate Highway System that are reliable	1,150	68.0%	68.0%	68.0%
Massachusetts—Non-Interstate NHS System	Percent of person-miles on the non-Interstate NHS that are reliable	5,257	80.0%	80.0%	80.0%
Boston Region—Interstate Highway System	Percent of person-miles on the Interstate Highway System that are reliable	354	47.2%	na	See Massachusetts Target
Boston Region—Non-Interstate NHS System	Percent of person-miles on the non-Interstate NHS that are reliable	1,799	69.0%	na	See Massachusetts Target

[a]The two-year target reflects conditions as of the end of CY 2019, and the four-year target reflects conditions as of the end of CY 2021.
CY = calendar year. MassDOT = Massachusetts Department of Transportation. NHS = National Highway System. na = not applicable
Sources: National Performance Management Research Data Set, Cambridge Systematics, MassDOT, and the Boston Region MPO.

Congestion Mitigation and Air Quality Improvement Program Traffic Congestion Performance Measures

MassDOT and the Boston Region MPO also monitor traffic congestion to meet Congestion Mitigation and Air Quality Improvement (CMAQ) program requirements. The performance measures employed are designed to help states, the Federal Highway Administration (FHWA), and MPOs better understand the impacts of CMAQ investments, which are intended to contribute to air quality improvements and provide congestion relief.

CMAQ traffic congestion-related performance measures apply to urbanized areas that contain geographic locations designated as *nonattainment areas* or *maintenance areas* by the United States Environmental Protection Agency (EPA). A nonattainment area does not meet National Ambient Air Quality Standards (NAAQS) for monitored air pollutants; a maintenance area

is one with a history of nonattainment that now meets the standards and where air quality continues to be monitored. The EPA monitors common air pollutants, known as *criteria pollutants*, including carbon monoxide, nitrogen dioxide, ozone, particulate matter, sulfur dioxide, and precursors from mobile sources.[3]

States must be involved in setting targets for these measures if 1) they have mainline highways on the NHS that cross part of an urbanized area (UZA) with a population of more than one million; and 2) that UZA contains part of a nonattainment or maintenance area for relevant criteria pollutants. Similarly, MPOs must participate in target setting for the traffic congestion measures if they

- Have mainline highways on the NHS that cross part of an UZA with a population of more than one million; and
- If part of the MPO area that overlaps the UZA contains part of a nonattainment or maintenance area for relevant criteria pollutants.

Massachusetts and the Boston Region MPO each meet these respective criteria and must be involved in monitoring and setting targets for traffic congestion performance measures for the Boston UZA, which contains or overlaps several MPO areas in eastern Massachusetts, New Hampshire, and Rhode Island.

Peak Hours of Excessive Delay per Capita

The first of these CMAQ traffic congestion measures is *annual hours of peak hour excessive delay (PHED) per capita*, which estimates the excessive delays experienced by a UZA's population from travel on the NHS during peak-periods. Information on the development of PHED per capita targets is described in more detail in the *Destination 2040* LRTP chapter on performance.

To understand baseline performance and set targets for this measure, MassDOT and the New Hampshire Department of Transportation (NH DOT) worked with analysts at Cambridge Systematics. Using 2017 data, MassDOT and NH DOT calculated annual hours of PHED for travel on the NHS in their respective portions of the Boston UZA.[4] In 2018, the agencies in the Boston UZA that are subject to CMAQ performance monitoring requirements—MassDOT, NH DOT, the Boston Region MPO, and the Northern Middlesex Council of Governments (NMCOG)—established two-year and four-year targets that maintain this 2017 baseline value for the annual hours of PHED per capita measure, as shown in Table 6-6.

[3] A precursor is a chemical compound that reacts with other chemical compounds in the presence of solar radiation to form pollutants.

[4] Rhode Island was not included in the calculation of this measure because it does not include any portion of the Boston UZA's NHS network. See FHWA's *Applicability Determination CMAQ Traffic Congestion and CMAQ On-Road Mobile Source Emissions Measures* (23 CFR 490.707 and 490.807), and *Change Log: Applicability Determination for CMAQ Measures*, May 22, 2018.

Table 6-6
Baseline Value and Performance Targets for Annual Hours of Peak Hour Excessive Delay Per Capita for the Boston UZA

Geographic Area	Massachusetts and New Hampshire Annual PHED	Boston UZA Population (MA and NH only)[a]	2017 Measure Value (Baseline)	Two-Year Target (CY 2018-19)[a]	Four-Year Target (CY 2020-21)[a]
Boston Urbanized Area	80,053,183	4,371,476	18.30	18.30	18.30

[a] Cambridge Systematics aggregated 2012–16 American Community Survey population estimates at the block group level to estimate the population for the portion of the UZA in Massachusetts and New Hampshire. Cambridge Systematics then inflated this estimate for 2017 by applying information on expected population growth in the Boston Metropolitan Statistical area between 2016 and 2017.
CY =calendar year. MA = Massachusetts. NH = New Hampshire. PHED = peak hours of excessive delay. UZA = urbanized area.
Sources: National Performance Management Research Data Set, US Census, FHWA, MassDOT, the New Hampshire Department of Transportation, and Cambridge Systematics.

Percent of Non-Single Occupant Vehicle Travel

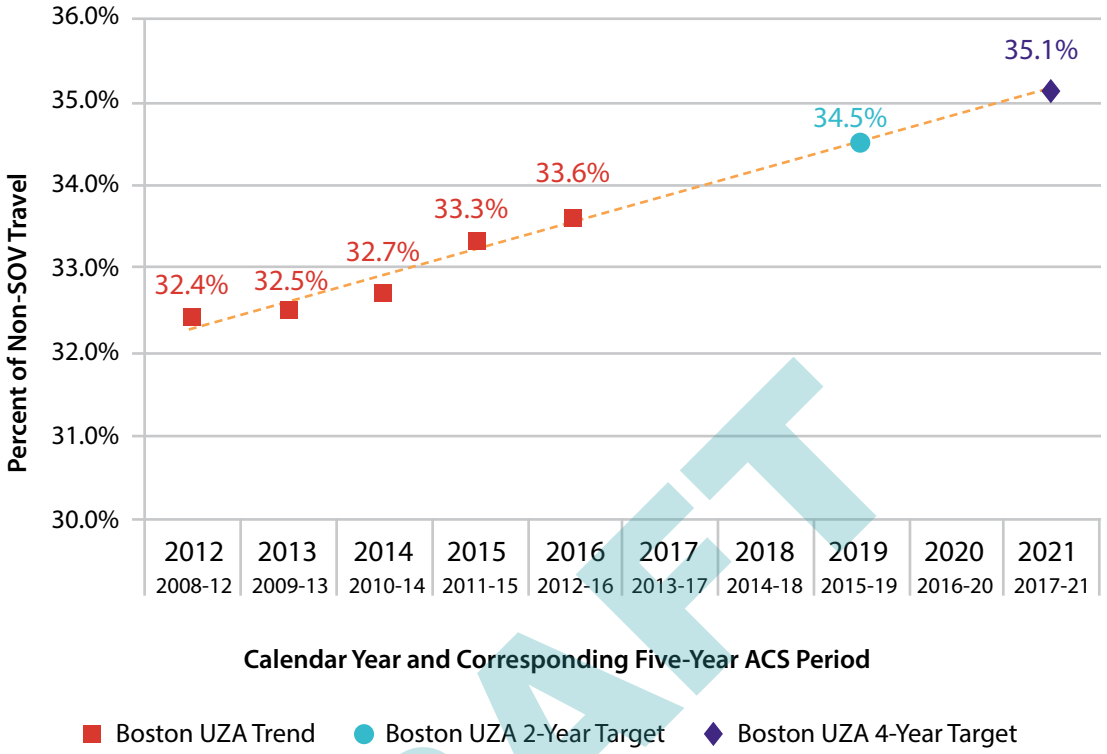
States and MPOs that meet applicability criteria for CMAQ performance requirements must also monitor and set targets for the share of non-single occupant vehicle (non-SOV) travel in the Boston region. Agencies calculate this measure at the UZA level. The percent of non-SOV travel performance measure describes the extent to which people are using alternatives to single-occupant vehicles (SOVs), as greater use of alternative SOVs may help reduce traffic congestion and air pollution from motor vehicles.

Collectively, MassDOT, NH DOT, the Boston Region MPO, and NMCOG used the US Census Bureau's American Community Survey (ACS) data[5] to estimate the percent of workers age 16 and older who commuted to work using an option other than driving alone.[6] Figure 6-7 shows how the percentage of workers using non-SOV commuting options in the Boston UZA has increased between 2012 (2008–12 ACS estimate) and 2016 (2012–16 ACS estimate). MassDOT calculated a linear trend line using these values for the Boston UZA and used that trend line to project expected values as of the end of CY 2019 (the expected 2015–19 ACS estimate) and CY 2021 (the expected 2017–21 ACS estimate). These agencies established these projected values as the Boston UZA targets for the percent of non-SOV travel. Table 6-7 also lists the recent baseline and performance target for this measure.

[5] US Census Bureau, American Community Survey, "Commuting Characteristics by Sex," American Community Survey Five-Year Estimates, https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_5YR_S0801&prodType=table; accessed September 2, 2018.

[6] FHWA allows States and MPOs to measure non-SOV travel using ACS estimates of the percentage of workers who commute to work using modes other than driving alone (such as taking a carpool, vanpool, or public transit; bicycling; walking; or telecommuting); travel surveys that reveal mode choices; or sample or continuous counts of travelers using different modes.

Figure 6-7
Historic Values and Performance Targets for the Percent of Non-SOV Travel in the Boston UZA



ACS = US American Community Survey. SOV = single-occupancy vehicle. UZA = urbanized area.
Sources: US Census Bureau, 2012–16 American Community Survey Five-Year Estimates; MassDOT; and NH DOT.

Table 6-7
Baseline Value and Performance Targets for Percent of Non-SOV Travel for the Boston UZA

Geographic Area	2017 Measure Value (Baseline)	Two-Year Target (CY 2018-19)[a]	Four-Year Target (CY 2020-21)[a]
Boston UZA	33.6%	34.5%	35.1%

ACS = American Community Survey. CY = calendar year. SOV = single-occupancy vehicle. UZA = urbanized area.
Sources: MassDOT, NH DOT, and ACS.

Connected and Autonomous Vehicles

The MPO and its staff will continue to monitor the implementation of CV and AV technology in the Boston region. It is commonly thought that the adoption of CV and AV technology will result in significant capacity gains on roadway networks, but the timeline for adoption of

this technology and its feasibility, remains highly uncertain, as do the second-order effects of any such boosts in capacity. The MPO has initiated its planning efforts through the report *Connected and Autonomous Vehicles and the Boston MPO—A First Look*, presented in 2018. This report chronicles the development of CV and AV technology up to the point of its publishing and recommends a number of planning and policy actions that the MPO can take to maintain a flexible, proactive stance toward CV and AV development and implementation. MPO staff have since made progress on incorporating CV and AV planning into ongoing MPO programs, and staff continue to familiarize themselves on CV and AV issues, since CV and AV planning could potentially play a role in future scenario planning.

The Commission on the Future of Transportation in the Commonwealth report, *Choices for Stewardship: Recommendations to Meet the Transportation Future* includes a recommendation to develop a strategy to support CVs and AVs. The MPO will coordinate with MassDOT to help implement this recommendation.

Shared-Use Mobility and Ride-Hailing

One of the biggest developments in the transportation planning world since the MPO's last LRTP has been the rapid growth of shared-used and for-hire car services, more commonly known as ridesourcing, ridesharing, and ride-hailing, among other terms. TNCs, such as Uber and Lyft, are the highest profile segment of the shared-use transportation field. This is a rapidly evolving industry, and it has already had a significant impact on transportation, however, the impact on existing transportation networks and on the future of transportation still remains unclear. MPO staff has documented the region's shared-use options through the March 2017 report, *Shared-Use Mobility Options—Literature Review*.[7] In a demonstration of the volatility of the field, several of the companies that were featured in the report have since gone out of business in Boston.

Public research and policy concern has largely focused on the highest-profile subsector of the shared-use field—TNCs. The State of Massachusetts Department of Public Utilities has begun collecting data on ridesharing/ride-hailing trips. The data is presented in Tables 6-8 and 6-9.[8] Table 6-8 shows the estimated person trips and ride-hailing activity for municipalities in the Inner Core area, where the vast majority of TNC trips in the region are taken. Boston and Cambridge have the largest number of trips and ridesharing activity with Somerville and Brookline following closely behind.

[7] To view this report, visit http://ctps.org/data/calendar/pdfs/2017/MPO_1019_Shared-Use_Mobility_LitReview.pdf.

[8] This information is also published at https://tnc.sites.digital.mass.gov/.

Table 6-8
Estimated Person Trips and Ride-Hailing Activity for Inner Core Subregion Municipalities

Municipality	Trips Started Per Person	Annual Trips (Origin)	Annual Trips (Destination)	Ride-hailing Trips (Origin)	Ride-hailing Trips (Destination)
Boston	57	967,288,818	895,499,530	34,911,476	35,221,885
Cambridge	64	189,847,847	179,109,006	6,782,366	6,454,440
Somerville	36	87,268,870	88,633,826	2,727,951	2,637,115
Brookline	35	70,797,608	76,026,259	2,074,425	1,963,570
Chelsea	19	43,285,073	42,986,266	656,686	632,627
Medford	17	66,409,699	67,903,947	966,710	966,364
Malden	15	62,232,358	64,944,230	906,043	867,169
Revere	14	54,481,061	57,125,847	722,136	714,901
Everett	19	61,619,596	56,293,077	775,773	753,268
Watertown	15	47,959,601	46,679,180	469,122	480,161
Newton	12	122,452,446	125,034,672	1,051,030	1,073,900
Quincy	10	118,837,779	116,245,809	957,311	963,069
Waltham	12	102,810,459	94,488,201	711,420	723,227
Belmont	8	29,546,032	30,494,233	195,807	201,636
Winthrop	6	16,736,781	17,819,225	103,750	103,862
Arlington	6	47,519,338	50,888,290	258,133	273,416
Lynn	6	106,210,599	104,907,612	549,822	511,532
Milton	5	29,705,413	33,198,745	138,761	142,492
Melrose	5	30,007,776	31,644,455	129,355	143,475
Saugus	6	40,654,204	39,434,253	147,714	162,887

Source: Data in this table courtesy of the Metropolitan Area Planning Council, originally published in *Share of Choices* report.

The Metropolitan Area Planning Council (MAPC) has also published two reports on the topic of ride-hailing: *Fare Choices*[9] *(February 2018) and Share of Choices*[10] *(May 2018). The Fare Choices* study collected data on trip origins and destinations, demographics, and transportation options through an in-vehicle survey of ride-hailing users, finding that ride-hailing users skew young (two-thirds of survey respondents were between 22 and 34 years old) but resemble the region at large in terms of income. Similar to the CTPS literature review,[11] the *Fare Choice* report also raised questions about whether ride-hailing trips are replacing trips made by more sustainable modes, and if that is diverting financial resources from providers such as the Massachusetts Bay Transportation Authority (MBTA). The *Share of Choices* report used newly

[9] To review this report, visit http://www.mapc.org/wp-content/uploads/2018/02/Fare-Choices-MAPC.pdf.

[10] To review this report, visit http://www.mapc.org/wp-content/uploads/2018/06/Share-of-Choices-PDF_Edited.pdf.

[11] As mentioned in Table 6-4, the Central Transportation Planning Staff (CTPS) is the staff to the Boston MPO. In addition to its work with the Boston MPO, CTPS works with and conducts studies for other transportation agencies in the state.

collected state-level data and modeling to estimate that one ride-hailing trip is taken for every five transit trips in the Inner Core, as shown in Table 6-9. It also notes that this dynamic may have cost the MBTA upwards of $19.3 million in 2017.

Table 6-9
Estimated Mode Shares of Ride-Hailing Activity and Public Transit for Inner Core Subregion Municipalities

Municipality	Ride-hailing (Origin)	Public transit (Origin)	Ratio (Origin)	Ride-hailing (Destination)	Public transit (Destination)	Ratio (Destination)
Somerville	3.13%	8.27%	0.38	2.98%	8.18%	0.36
Everett	1.26%	3.47%	0.36	1.34%	3.81%	0.35
Cambridge	3.57%	12.65%	0.28	3.60%	13.31%	0.27
Chelsea	1.52%	5.98%	0.25	1.47%	5.95%	0.25
Medford	1.46%	5.80%	0.25	1.42%	5.66%	0.25
Brookline	2.93%	13.06%	0.22	2.58%	12.21%	0.21
Malden	1.46%	6.59%	0.22	1.34%	6.31%	0.21
Boston	3.61%	18.19%	0.20	3.93%	19.54%	0.20
Winthrop	0.62%	3.47%	0.18	0.58%	3.24%	0.18
Arlington	0.54%	3.12%	0.17	0.54%	3.01%	0.18
Watertown	0.98%	5.65%	0.17	1.03%	5.82%	0.18
Waltham	0.69%	4.24%	0.16	0.77%	4.60%	0.17
Melrose	0.43%	2.68%	0.16	0.45%	2.56%	0.18
Revere	1.33%	8.80%	0.15	1.25%	8.44%	0.15
Quincy	0.81%	5.57%	0.14	0.83%	5.68%	0.15
Newton	0.86%	6.41%	0.13	0.86%	6.29%	0.14
Belmont	0.66%	5.17%	0.13	0.66%	5.00%	0.13
Milton	0.47%	3.80%	0.12	0.43%	3.44%	0.12
Saugus	0.36%	3.45%	0.11	0.41%	3.61%	0.11
Lynn	0.52%	7.66%	0.07	0.49%	7.77%	0.06
Inner Core	2.41%	11.78%	0.20	2.48%	12.14%	0.20

Source: Table courtesy of the Metropolitan Area Planning Council, originally published in *Share of Choices* report.

The growth in the field raises serious questions of how MPO and broader public policy should relate to shared-use services. While bike-sharing likely complements the MPO's goals of promoting growth in demand for nonautomotive travel options and mode shift, the effect of TNCs, car sharing and the like, is less certain.

As the MPO literature review documents state, there are serious equity-based concerns about access for people without bank accounts and/or smartphones; and disparities in service availability and accessibility for individuals with disabilities. Ride-hailing may also divert financial resources from public sector transportation providers and contribute to congestion on the region's roadways. MAPC's *Fare Choices* report estimated that "15 percent of all ride-hailing trips replaced a more sustainable mode during the morning and afternoon commutes." Although experiments are ongoing around the country, such services remain largely unintegrated with other modes of transit.

Car Sharing

Car sharing provides an alternative to both ride-hailing and traditional car ownership—users rent cars by the hour from a provider, but with more flexibility and automation than a traditional car rental business. Cars are physically located throughout communities rather than concentrated at a company facility. The dominant car sharing company in the Boston region is Zipcar. General Motors' Maven also has a small presence in the Inner Core, while Enterprise Car Share wound down its Boston-area operations in 2017. Like ride-hailing, the impact of car sharing and its role in future policy is an open question subject to further study. Table 6-10 provides information on the accessibility of jobs and housing to car sharing in the Inner Core of the MPO region (where the majority of car sharing locations are found) while Figure 6-8 shows the locations overlaid by population density. Although there are not as many car sharing locations, there are locations outside of the Inner Core in municipalities including Beverly, Framingham, Lynn, Salem, Wellesley, and Wenham.

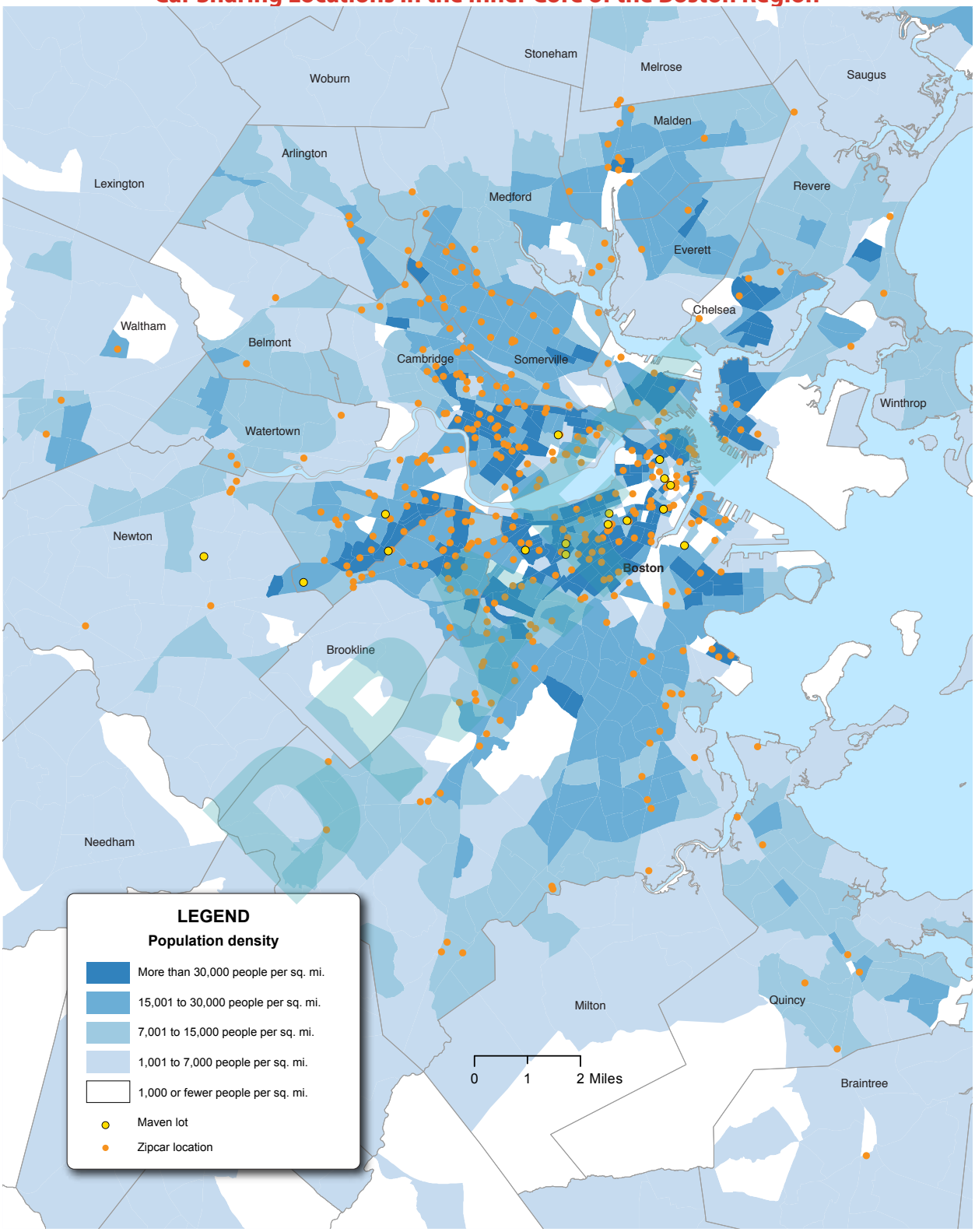
Table 6-10
Access to Car Sharing in the Boston Region

Car Share	Employment	Percent of Employment	Households	Percent of Households	Population	Percent of Population
Inner Core	1,006,000		616,800		1,487,900	
Within 1/4 mile	665,900	66%	287,300	47%	676,300	45%
Within 1/2 mile	814,200	81%	422,300	68%	1,011,000	68%
Regional Urban Centers	307,700		234,200		566,200	
Within 1/4 mile	19,900	6%	10,300	4%	23,200	4%
Within 1/2 mile	42,000	14%	30,200	13%	69,500	12%
Maturing Suburbs	470,200		339,800		871,900	
Within 1/4 mile	1,700	< 1%	800	< 1%	3,400	< 1%
Within 1/2 mile	5,800	1%	4,000	1%	12,700	1%
Developing Suburbs	139,700		121,200		319,900	
Within 1/4 mile	90	< 1%	20	< 1%	240	< 1%
Within 1/2 mile	310	< 1%	90	< 1%	900	< 1%

Note: Data includes car shares operated by ZipCar and Maven.
MPO = metropolitan planning organization.
Source: Boston Region MPO.

CTPS and MAPC have made progress toward quantifying the impact of ride-hailing on the Boston Region MPO's transportation network, but significant work remains to be done both in research and in shaping policy to respond to the emergence of TNCs, car sharing, and other shared-use modes. This will be an issue that the MPO will continue to discuss during the development of the *Destination 2040* LRTP, as new information becomes available.

Figure 6-8
Car Sharing Locations in the Inner Core of the Boston Region



Source: Boston Region MPO.

Travel Demand Management

In addition to analyzing current roadway capacity and potential for growth, some planning entities engage in policies and activities intended to decrease overall demand for roadway usage, especially by single-occupancy vehicles. These programs often fall under the broad title, "Travel Demand Management," or TDM. Several MPO member municipalities, including Cambridge, Watertown, and Arlington, have established TDM programs in one form or another. MAPC maintains a resource library on TDM at https://www.mapc.org/resource-library/parking-and-transportation-demand-management/.

The MPO region is home to a number of Transportation Management Associations, or TMAs, which are membership-based, often public-private partnerships of businesses, institutions, and municipalities. TMAs often operate their own shuttle services that supplement available transit service. A list of TMA-operated shuttle services in Massachusetts is available at http://www.masscommute.com/tma_directory/.

One important element of TDM programs is appropriate management of parking supply. Research incorporating data from MPO member municipalities, Cambridge and Somerville, has proposed a causal link between increased provision of parking and increased car travel,[12] while other research has estimated that drivers looking for parking comprise up to 30 percent of traffic in urban Central Business Districts.[13] MAPC's *Perfect Fit Parking* report has surmised that indeed, some demand for parking may be induced by the provision of parking, that is, that additional parking (and therefore additional travel and stress on the roadway network) is added by inefficient management of parking policy.[14] MAPC offers MPO member municipalities assistance with parking management and policy through its Parking Management Planning program, while CTPS offers traffic impact analysis through its Community Transportation Technical Assistance program. Given the growing congestion and stress on the regional roadway network, both agencies can continue to research and plan for parking management methods to reduce overall roadway travel demand.

Another potential new frontier for managing roadway demand is the possibility of pricing roadway usage. In the MPO region, the only tolled roadway is Interstate 90, also known as the Massachusetts Turnpike. Over the last several years, there has been increasing legislative interest in the possibility of using road pricing to manage the region's growing congestion. The MPO's UPWP committee discussed the possibility of a study on congestion pricing during the development process of the federal fiscal year (FFY) 2020 UPWP. Ultimately, the

[12] McCahill, Garrick, Atkinson-Palombo, and Polinski, 2015 (https://www.ssti.us/wp/wp-content/uploads/2016/01/TRB_2016_Parking_causality_TRB_compendium.pdf)

[13] Shoup, 2007 (http://shoup.luskin.ucla.edu/wp-content/uploads/sites/2/2015/02/CruisingForParkingAccess.pdf)

[14] Metropolitan Area Planning Council, 2017 (http://perfectfitparking.mapc.org/)

MPO decided not to fund the study, but plan to consider it again for the FFY 2021 UPWP. While the future of road pricing initiatives in the MPO region is unclear, the MPO and staff should continue to monitor developments and could potentially study the impacts of various paradigms for road pricing.[15]

Roadway Stakeholder/Public Input

During fall 2017 and winter 2018, MPO staff collected feedback on transportation issues, needs, and opportunities from municipal planners and officials, transportation advocates, members of the general public, and other stakeholders. The following sections focus on roadway capacity management and mobility issues by theme.

Roadway Congestion

- Respondents expressed frustration with frequent roadway congestion, especially at peak hours. Commuting times were noted to have increased over the past few decades. Many respondents also noted a perceived increase in traffic over the past few decades. Intersections, highway exits, and parkways, such as roads controlled by the Department of Conservation and Recreation, were highlighted as problem points.
- Many respondents discussed increasing congestion in the context of economic growth with new housing and residents.
- Congestion was thought to have worsened when growth did not coincide with improvements to public transit, and also when commuters' origins and destinations failed to align with the existing transit system.
- Some respondents connected increased congestion with the advent of TNCs, noting that many TNC trips replace transit trips but sometimes only transport one person.
- Respondents connected congestion with slow and unreliable bus service, specifically with the Silver Line where it lacks dedicated lanes. "Bus bunching" occurs regularly during rush hours, resulting in long headways and delayed trips.
- Respondents identified existing locations with severe roadway congestion and those locations where roadway congestion is increasing.

[15] FHWA's resource sheet on the topic lays out different options for congestion pricing, located here: https://ops.fhwa.dot.gov/publications/congestionpricing/sec2.htm.

Parking

- Suburban respondents noted that parking demand exceeds capacity at commuter rail stations in the North Shore, South Shore, North Suburban, and MetroWest subregions. Patrons arriving later in the morning find full lots and may need to travel to more distant stations. Meanwhile, commuters use parking spaces that downtown patrons would normally use. Respondents predicted that commuter parking demand would only increase as escalating housing prices continue to drive younger workers outside the urban core.

- Inner Core respondents described an increase in competition for curb space. Delivery trucks functionally decrease the street width or completely block roads. Increasing online retail will only increase off-peak hour deliveries. Meanwhile, TNCs also require curb space to drop off and pick up passengers. When curbside space is unavailable, TNCs are known to double-park and block traffic. Respondents also expressed concern about the future parking impacts of AVs.

- Respondents throughout the region noted the need for better parking management. Locations mentioned by name include Watertown and downtown Stoneham. One respondent felt that the parking impacts of increased housing and business density had not been thought through. A second respondent noted that neighborhood changes also impacted the availability of accessible parking spaces. A third felt that changes in zoning codes requiring less parking (or none at all) should be contingent upon increased transit capacity. Finally, some respondents remarked that a car-free lifestyle is not practical for people living with dependent children or older family members. For that reason, there will still be a need for affordable parking spaces at places like supermarkets and drugstores.

- A number of respondents remarked on the importance of parking for people with disabilities. Specifically, respondents mentioned by name the Boston Convention Center and Boston's Seaport, North End, and Back Bay neighborhoods as locations that are difficult to access. The existing placard system is prone to abuse and is inadequately enforced. Some handicapped spots are not well sited in relation to existing street conditions. For example, bike racks can interfere with the proper deployment of car ramps. In addition, cyclists often use handicap signs to lock bikes when designated bike parking is unavailable.

- Respondents expressed a desire to reduce on-street parking and parking garages, both to discourage driving and to free space for other uses. Frequently, parking was felt to be a less efficient and less beneficial use of valuable real estate. One respondent noted that the maneuvers involved in parking a car are dangerous for people parking and biking.

Land Use

Respondents have noticed an increased demand for dense urban living and auto-free lifestyles. The latter has been further enabled by increased ride-hailing options. They predicted continued interest in more "European" streets with sidewalk cafes and biking/pedestrian-only zones. One respondent felt that people should not expect to be able to park in downtowns. Others predicted an increase in "battles" over roadway space with increases in online deliveries, ride-hailing services, and demand for protected cycling infrastructure and dedicated bus lanes.

Proposed Solutions Identified by Public Comment

Generally, respondents expressed a desire for access to alternative modes of transportation to mitigate the impacts of congestion. Respondents wanted people to have the freedom to choose walking and biking and the infrastructure to encourage more to do so. In addition, respondents identified the need for more transportation options in the suburbs and for planners and policymakers to work with communities and regions to create first-and-last-mile connections. Many of the suggestions specific to transit and bicycling/walking are covered in the sections, below. Other proposed solutions included

- Make driving costs appropriate. Various approaches mentioned by respondents included tolls, congestion pricing, and parking pricing. Institute tolls on Interstate 93, Interstate 95, and other freeways.
- Align land use policies with transportation needs.
- Improve public transit as an alternative to driving. Specific ideas for improvement are covered in "Transit Stakeholder/Public Input" section below.
- Improve facilities for people walking and biking as an alternative to driving. Specific ideas for improvement are covered in the"Bicycle/Pedestrian Stakeholder/Public Input" section below.
- Improve roadway infrastructure.
- Manage parking policies through studies and policy changes.
- Regulate TNCs.
- Other suggestions include increasing opportunities for first-and-last-mile access to the commuter rail stations, studying AVs and smart infrastructure implementation to increase traffic efficiency, and working with large employers, developers, and institutions to mitigate traffic impacts.

Summary of Roadway Needs

The MPO and transportation policy-setting entities face a major challenge in regards to managing capacity and mobility on the region's roadway network. Congestion is increasing along with the region's population and economic activity, and the ability to add lane miles to the region's roadway network is limited.

The increasing congestion affects not only drivers but many surface transit riders as well, and policymakers face pressure to deal with it while also accommodating diverse needs and modes. Indeed, from the perspective of managing capacity of people, modes other than the single-occupancy vehicle may be more spatially efficient. The introduction of new technologies and paradigms such as ride-hailing and car sharing pose fresh challenges and an uncertain future, and may make the congestion situation worse.

While models such as TDM programs have considerable room to grow and may help take some stress off of the roadway network, they are currently limited in scope and require considerable additional research. The MPO must monitor all of these considerations carefully, while assisting municipalities to understand the challenges now and in the future. Additional research will help the MPO to monitor the performance of the region's roadway network in the future.

Freight

Background

The ability to move freight and heavy vehicles more efficiently is critical to economic vitality for both the state and region. The dominant freight transportation mode in the Boston region is trucks. While freight also enters or leaves the region via airfreight, railroad, or ocean shipping, in almost all instances, goods traveling by these other modes must use trucks to connect with local origins and destinations. A number of specialized terminals, both publicly and privately owned, enable freight to transfer between different modes, and critically, within the region's road network.

The MPO has a leading role in improving the region's road network, but it also supports, and where possible facilitates improvements to other freight modes and associated terminals. The MPO collaborates with freight service providers and terminal operators, both public and private, throughout the region in its ongoing efforts to ensure region-wide freight and logistic efficiency.

MPO Research and Analysis

The following section details freight-specific needs identified through MPO staff research and analysis. Specifically, those needs focused on

- Congestion in the Boston region specific to freight;

- Performance measures and targets as required by federal legislation; and
- Freight data.

Freight Congestion

Trucks, both commercial and private, share the regional roadway network with light vehicles. Measuring, managing, and reducing delay in the region's road network is an important and defined responsibility of the MPO and is the ongoing work of the MPO's CMP. In conjunction with population and economic growth, freight movements are expected to increase steadily between now and 2040. Growth in heavy vehicle traffic will contribute to traffic congestion, but should not be considered the cause of congestion. The primary source of peak-period congestion will continue to be the large numbers of light vehicles generated by regional commuting and discretionary travel by households.

Strategies to affect mode shift in the MPO region are less applicable to freight, since no practical alternatives to trucks exist for final distribution of consumer goods to retail locations, as well as for most industrial logistic needs. Railroads have been successful in increasing intermodal shipments using high-capacity double-stacked rail services to modern terminals, such as the one in Worcester, but have also concentrated local freight delivery on a smaller number of high volume customers. Strategies, such as moving the CSX Intermodal yard to Worcester from Beacon Park in Allston, slow the growth of trucks on the national interstate system, but also add increasing numbers of trucks, and truck vehicle-miles of travel (VMT), to roadways within the Boston Region MPO. The impacts of larger shipping vessels using the expanded Conley Terminal rather than New York area terminals are similar; less statewide truck VMT but more MPO VMT.

Federal Performance Measures for Freight

Truck Travel Time Reliability Performance Monitoring

The FHWA also requires states and MPOs to track truck travel reliability on the interstate system to better understand performance of the nation's freight system. The applicable measure in this case is the Truck Travel Time Reliability (TTTR) Index. This measure compares longer (95th percentile) truck travel times to average (50th percentile) truck travel times—the greater the difference between these two travel times is on an interstate segment, the less reliable truck travel on that segment is considered to be. Information on the development of these targets is described in more detail in Chapter 5 of the *Destination 2040* LRTP.

In 2018, MassDOT calculated baseline TTTR Index values and established performance targets using CY 2017 truck travel time data. As with the all-passenger travel time reliability targets, MassDOT set the two-year and four-year targets equal to the CY 2017 baseline. Table 6-11 displays these values. The MPO voted to support MassDOT's four-year TTTR Index target in 2018, and Table 6-11 also includes the Boston region's CY 2017 baseline index value. As the table shows, the Boston region's TTTR baseline value is higher than the one for Massachusetts,

indicating that truck travel on the region's interstate network is generally less reliable than on Massachusetts's interstates as a whole.

Table 6-11
Truck Travel Time Reliability Performance Measure Baselines and MassDOT Performance Targets

Network	Measure	Cumulative Traffic Message Channel Length (Miles)	2017 Measure Value (Baseline)	Two-Year Target (CY 2019)[a]	Four-Year Target (CY 2021)[a]
Massachusetts—Interstate Highway System	Truck Travel Time Reliability Index	1,150	1.85	1.85	1.85
Boston Region—Interstate Highway System	Truck Travel Time Reliability Index	354	2.55	n/a	See Massachusetts Target

[a]The two-year target reflects conditions as of the end of CY 2019, and the four-year target reflects conditions as of the end of CY 2021.
CY = calendar year. MassDOT = Massachusetts Department of Transportation. NHS = National Highway System.
Sources: National Performance Management Research Data Set, Cambridge Systematics, MassDOT, and the Boston Region MPO.

Freight-Related Data

Routine questions about numbers of trucks and their percent of traffic usually go unanswered because total traffic volumes are obtained more frequently than the more complex process of classifying vehicle types in those volumes. Although MPO staff has assembled a set of reliable truck data, for truck model estimation purposes, it is not sufficient and detailed enough to use for infrastructure project selection. With the completion of an envisioned truck model estimation effort, working estimates of truck traffic throughout the region's network will become available to support any regional planning effort.

The data that is available to staff suggests that the express highways which have been flagged as regional bottlenecks in the Roadway section of this chapter, are also sections of the road network with a large number of trucks. It is generally the case that the express highways will have a higher percentage of trucks than arterial streets in the region. However, the percent of trucks will vary from bottleneck to bottleneck. A safe assumption about addressing the needs of freight in 2040 is that improving the express highway bottlenecks as a group will likely be more beneficial than improving the arterial bottlenecks.

The analysis of truck traffic is further complicated by the fact that the temporal distributions of truck and light vehicle traffic are different. Trucks serving urban areas tend to start their day early, and often finish up their travel before the PM peak. However, this pattern of avoiding the evening rush hour is more pronounced for arterial traffic, and significant truck traffic on the express highways is experiencing both AM and PM congestion with light-vehicle commuters.

Consideration of the mobility needs of freight adds weight to the benefits of relieving congestion on the region's limited-access express highways. Estimating the truck traffic flows impacted at individual bottlenecks on both express highways and arterials will require further refinement of the MPO's truck modeling capabilities.

Freight Stakeholder/Public Input

Most public input relevant to the movement of freight in the MPO region and to the MPO's freight program is covered in the Roadway section above. However, specific freight-related comments are included below.

Needs and Challenges Identified by Public Input

- Increasing population means more trucks and deliveries, which is sometimes a burden
- Bellingham is seeing recent action on the development of warehouses in town, meaning increased truck activity
- Delivery trucks are increasingly blocking roads, posing safety hazards and decreasing the width of streets; Massachusetts Avenue was mentioned specifically
- Second Street in Everett is a key freight corridor that has also been identified as a potential Bus Rapid Transit alignment
- South Boston Waterfront has truck congestion issues

Proposed Solutions Identified by Public Input

- Designate more dedicated curb space for deliveries
- Ban large trucks
- Sort out prioritization of right-of-way between trucks and other uses
- Account for black carbon in state and regional policy around diesel fuel and trucking

Summary of Freight Needs

The growing congestion and delay in the region's roadway network affects freight operators like it does drivers and surface transit riders. Additionally, freight operators making deliveries in the Inner Core area increasingly face competition for scarce curb space, as bus lanes, bike lanes, and TNC dropoffs demand their share as well. For the most part, concerns about freight congestion can be addressed through the MPO's roadway actions, but policymakers should continue to consider the implications of freight transportation.

Transit

Background

The MPO region is served by a variety of transit services. These services include:

- **MBTA**—Provides rapid transit, bus and trackless trolley, commuter rail, commuter boat, and paratransit service to a network of 175 municipalities
- **The Cape Ann Transportation Authority**—Provides fixed-route and Dial-a-Ride transit service to the City of Gloucester and the towns of Essex, Rockport, and Ipswich
- **The MetroWest Regional Transit Authority (RTA)**—Provides fixed-route bus service in and between the municipalities of Ashland, Dover, Framingham, Holliston, Hopedale, Hopkinton, Hudson, Marlborough, Natick, Sherborn, Southborough, Sudbury, Wayland, Wellesley, and Weston; also operates paratransit service in Framingham and Natick
- **Additional RTAs**—Provide service in areas that overlap with municipalities in the MPO region (includes the Brockton Area Transit, Greater Attleboro Regional Transit Authority [GATRA], and Montachusett Regional Transit Authority
- **Massachusetts Port Authority**—Provides transit services that connect to Logan Airport
- **TMAs**—Serve member companies, developments, or institutions, and in some cases, the general public
- **Privately Operated Intercity Bus, Rail, and Ferry Services**—Includes Boston Harbor Cruises, Greyhound, Megabus, Concord Coach, Plymouth & Brockton, C&J, Amtrak, and others
- **Councils on Aging (COA)**—Social-service organizations, private non-profit organizations, and volunteer driver programs; collectively serve a range of clients including older adults, persons with disabilities, veterans, and others

Like the region's roadway system, the region's transit services and networks face reliability and capacity-management concerns. To date, most of the Boston Region MPO's target funding for capital projects goes to support the roadway network, bicycle, and pedestrian facilities; with the region's RTAs, the MassDOT Rail and Transit Division, and others supporting investment in the transit system. In the past, the MPO has flexed some of its highway funding to transit projects to support the construction of the Green Line Extension and Assembly Square Orange Line station.

In addition, the MPO has also made investments in the transit system through its Suburban Mobility Program, which evolved into the Clean Air and Mobility Program. The MPO currently has allocated CMAQ funds in the TIP for a new Community Transportation Program in FFYs 2021 through 2024, and conducted a study to determine the criteria for that program through the FFY 2018 UPWP. The Community Transportation Program is expected to fund and help plan fiscally sustainable mobility solutions with an emphasis on first-and-last-mile connections. The MPO also supports the distribution of federal transit grant funds by the Rail and Transit Division.

MPO Research and Analysis

A number of different planning processes come together to address capacity management and mobility performance, issues, and needs on the transit system. The MPO performs ongoing system-level and project-level analyses for the LRTP and for transit service operations and capital improvements for MassDOT and the MBTA. The following sections describe transit-specific needs identified through MPO research and analysis.

- Existing and Proposed Travel and Growth Patterns on Transit
- Access to Transit
- Priority Bus Corridors
- Changes in Bus Run Times
- Transit Reliability
- Transit Crowding
- Bus Maintenance Facilities

Existing and Proposed Travel and Growth Patterns

The following tables and figures show the current (2016) and projected (2040) daily boardings on the MBTA rapid transit and commuter rail networks, as projected by the MPO's travel demand model—assuming no additional transit projects are constructed. This is also known as No-Build conditions. The figures also show the projected change in population density in relation to transit usage in the Boston region.

Table 6-12
Rapid Transit Boardings, 2016–40

Rapid Transit Lines	2016 Daily Boardings	Projected 2040 Daily Boardings	Modeled Change in Daily Boardings (2016–2040)
Blue Line	78,360	88,794	13%
Green Line	210,469	264,593	26%
Green Line—Central Subway	147,521	171,783	16%
Green Line—B	18,094	21,005	16%
Green Line—C	9,754	11,022	13%
Green Line—D	19,055	37,505	97%
Green Line—E	16,045	23,277	45%
Orange Line	223,605	247,641	11%
Red Line	298,272	333,601	12%
Mattapan	3,370	3,804	13%
Silver Line	33,340	63,866	92%
Total	**847,416**	**1,002,298**	**18%**

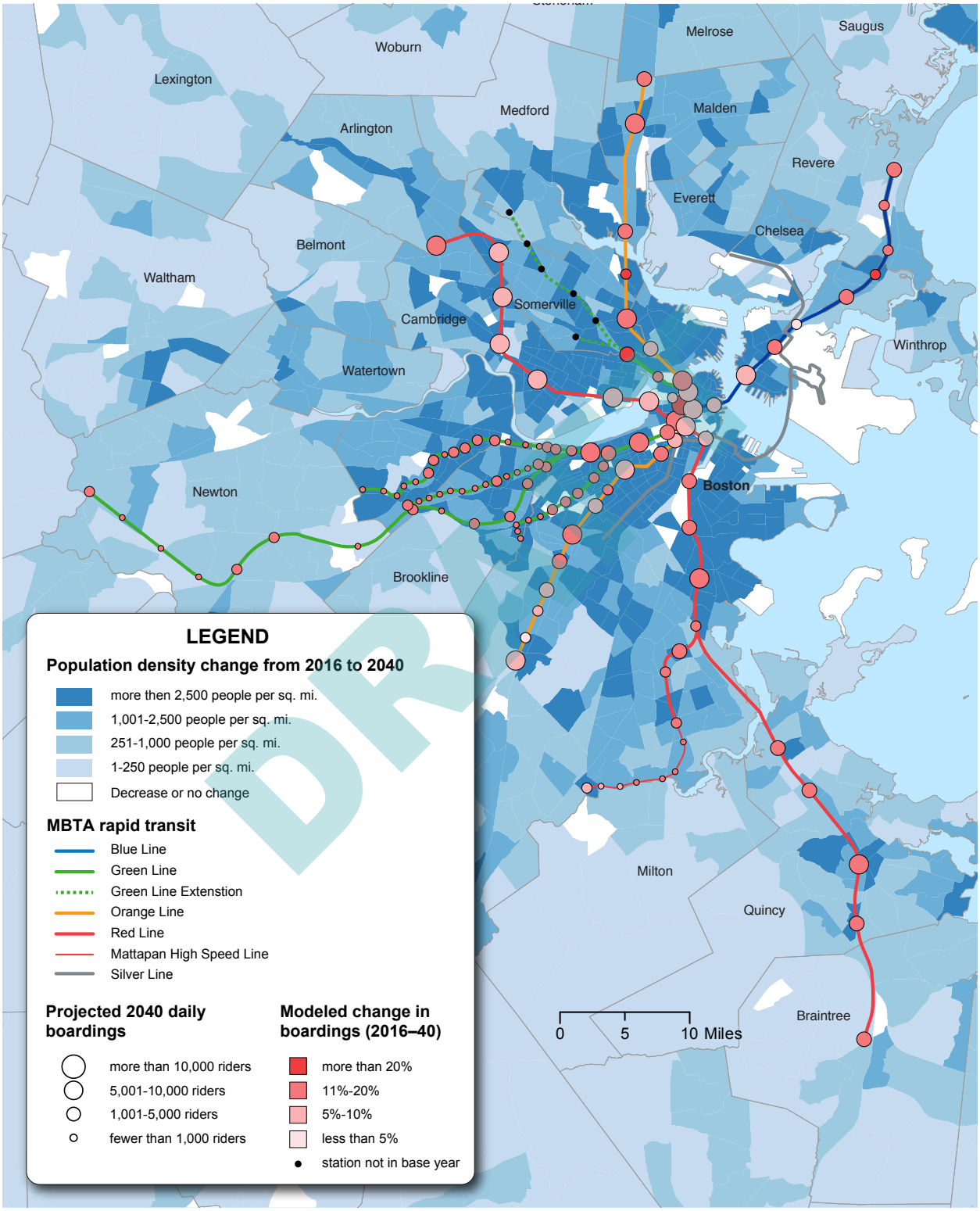
Source: Boston Region MPO.

Table 6-13
Commuter Rail Boardings, 2016–40

Commuter Rail Lines	2016 Daily Boardings	Projected 2040 Daily Boardings	Modeled Change in Daily Boardings (2016–2040)
Fairmount	2,652	3,030	14%
Fitchburg	9,302	10,535	13%
Franklin	11,671	13,673	17%
Greenbush	6,109	7,163	17%
Haverhill	7,112	7,910	11%
Kingston/Plymouth	6,095	7,283	19%
Lowell	10,925	11,971	10%
Middleborough/Lakeville	6,863	8,118	18%
Needham	6,672	7,705	15%
Providence/Stoughton	25,728	28,956	13%
Newburyport/Rockport	15,019	16,944	13%
Worcester	18,636	22,852	23%
Total	**126,784**	**146,139**	**15%**

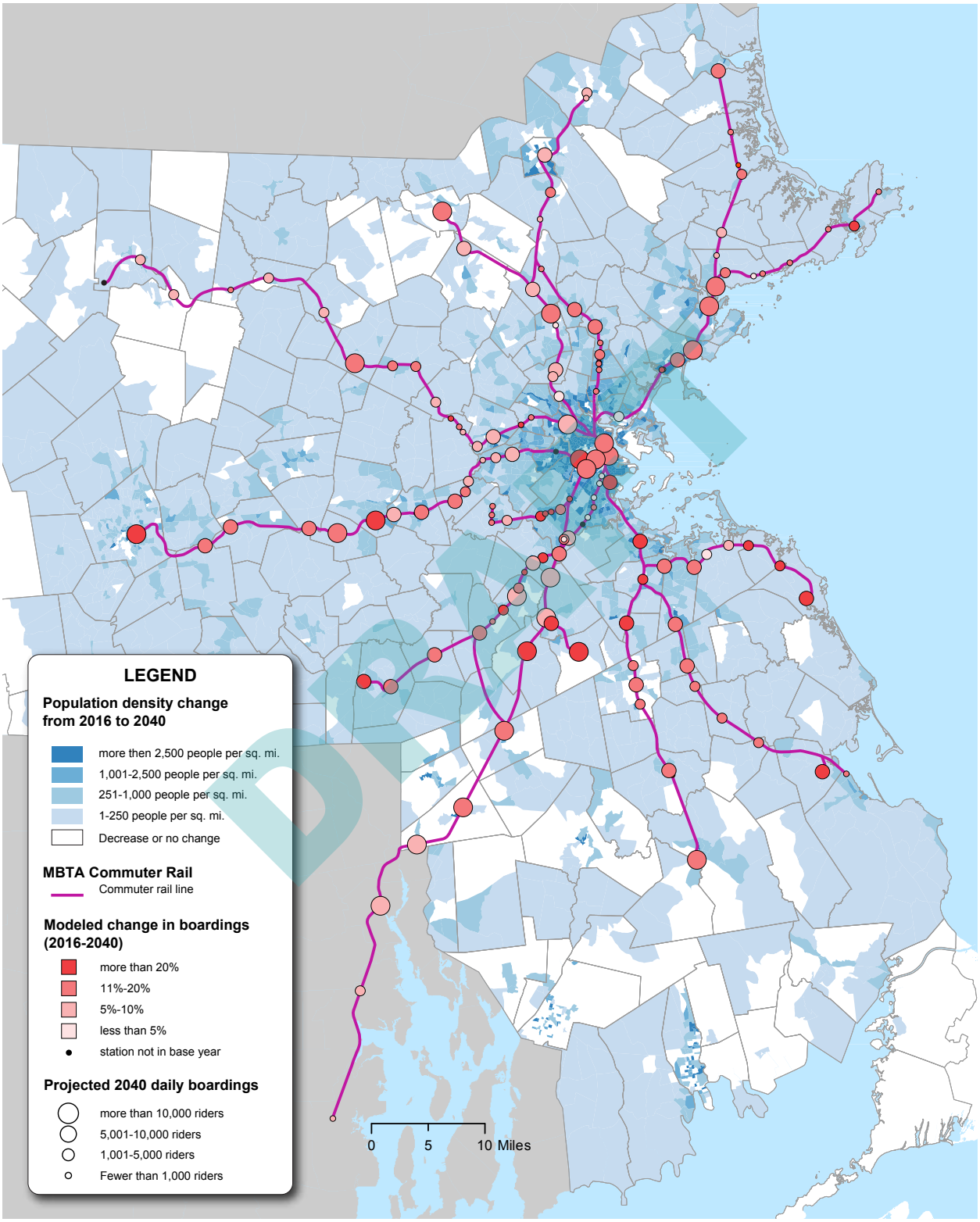
Source: Boston Region MPO.

Figure 6-9
Rapid Transit Boardings, 2016–40



Source: Boston Region MPO .

Figure 6-10
Commuter Rail Boardings, 2016–2040



Source: Boston Region MPO.

Rail rapid transit is expected to see about 18 percent more boardings while commuter rail ridership is projected to increase about 15 percent. The increase in boardings on the Silver Line Bus rapid transit serving the growing Seaport District is due to the recently added SL3 route (added after 2016) that has key sections in dedicated right-of-ways. The increase on the Green Line D and E branches are due to the extension of the Green Line to College Avenue in Medford and Union Square in Somerville.

Access to Transit

Land Use and Transit

One important element to improving the regional transportation system is the accessibility of transit to housing, employment, and other key destinations. Access to safe, reliable, frequent transit gives travelers options other than single-occupancy vehicles; but the provision of such service alone is insufficient. High-quality transit must be supported by appropriate land use around its stops. The following figures should thus be understood as describing a situation that can be shaped by future MPO and other public policy.

Tables 6-14 and 6-15 give an overview of the portion of the MPO's population and employment that fall within one-quarter and one-half mile of an MBTA or RTA bus or ferry stop or an MBTA rapid transit or commuter rail station. It is further broken down by provision of *frequent* transit service, according to the definition laid out for dense areas in the MBTA Service Delivery Policy—service no more than every 15 minutes during weekdays and 20 minutes on weekends. A map of the Inner Core, Regional Urban Centers, Maturing Suburbs, and Developing Suburbs was shown in Chapter 2, Figure 2-2.

Table 6-14
Access to All Transit: Households and Employment 2016

Transit Market Area	Employment (Number of Jobs)	Percent of Employment	Households	Percent of Households	Population	Percent of Population
Inner Core	1,006,000		616,800		1,487,900	
Within 1/4 mile	911,500	91%	562,200	91%	1,350,300	91%
Within 1/2 mile	989,200	98%	612,400	99%	1,475,200	99%
Regional Urban Centers	307,700		234,200		566,200	
Within 1/4 mile	176,600	57%	137,800	59%	326,900	58%
Within 1/2 mile	248,900	81%	185,200	79%	442,000	78%
Maturing Suburbs	470,200		339,800		871,900	
Within 1/4 mile	159,200	34%	91,800	27%	229,000	26%
Within 1/2 mile	265,200	56%	170,400	50%	428,600	49%
Developing Suburbs	139,700		121,200		319,900	
Within 1/4 mile	11,600	8%	7,600	6%	19,400	6%
Within 1/2 mile	27,500	20%	19,400	16%	50,000	16%

Source: Boston Region MPO .

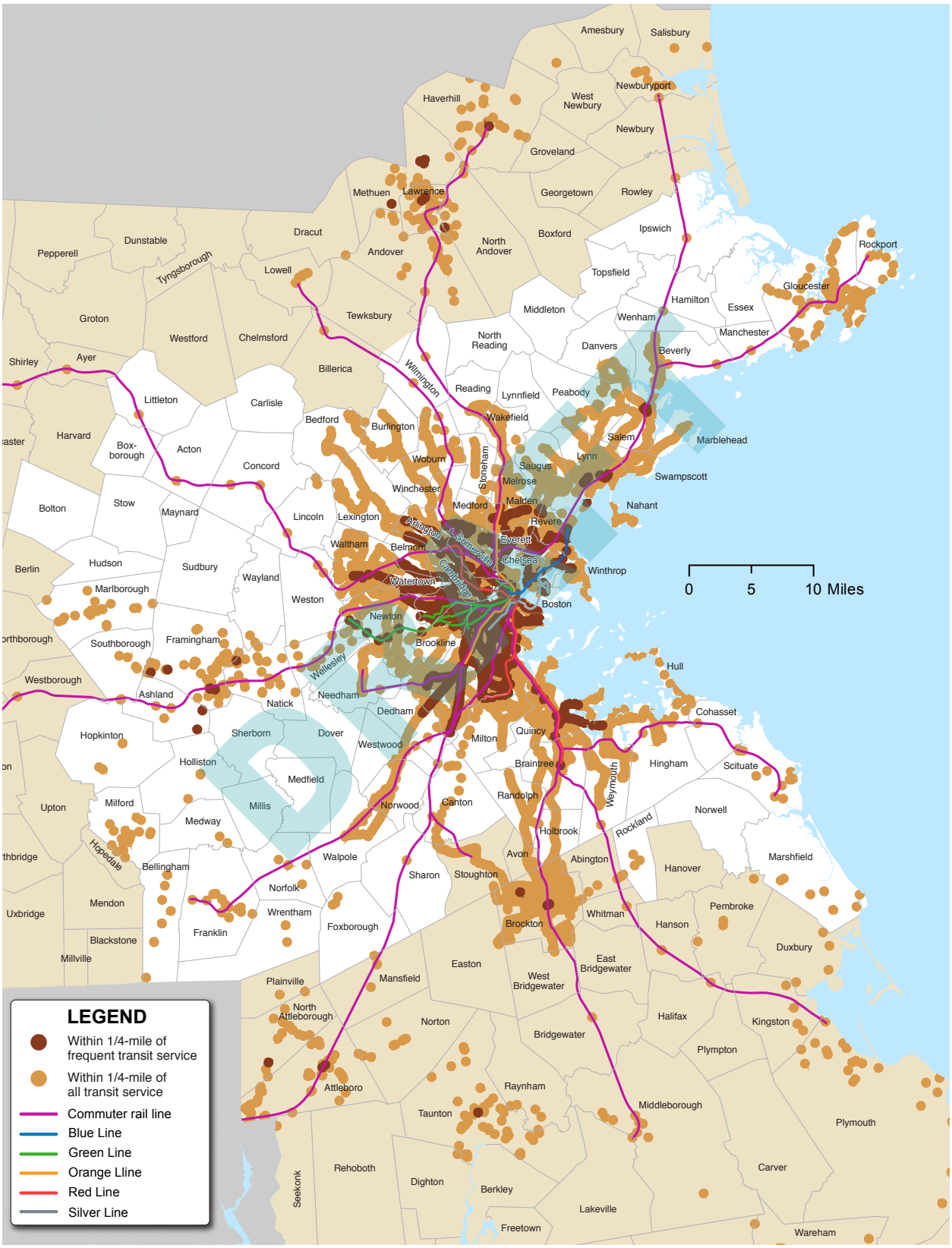
Table 6-15
Access to Frequent Transit: Households and Employment 2016

Transit Market Area	Employment (Number of Jobs)	Percent of Employment	Households	Percent of Households	Population	Percent of Population
Inner Core	1,006,000		616,800		1,487,900	
Within 1/4 mile	714,600	71%	369,400	60%	886,200	60%
Within 1/2 mile	866,900	86%	512,700	83%	1,231,900	83%
Regional Urban Centers	307,700		234,200		566,200	
Within 1/4 mile	31,300	10%	20,500	9%	46,400	8%
Within 1/2 mile	58,500	19%	48,400	21%	112,700	20%
Maturing Suburbs	470,200		339,800		871,900	
Within 1/4 mile	4,000	1%	2,500	1%	6,400	1%
Within 1/2 mile	11,100	2%	7,500	2%	18,500	2%
Developing Suburbs	139,700		121,200		319,900	
Within 1/4 mile	0	0%	0	0%	0	0%
Within 1/2 mile	30	< 1%	50	< 1%	120	< 1%

Source: Boston Region MPO .

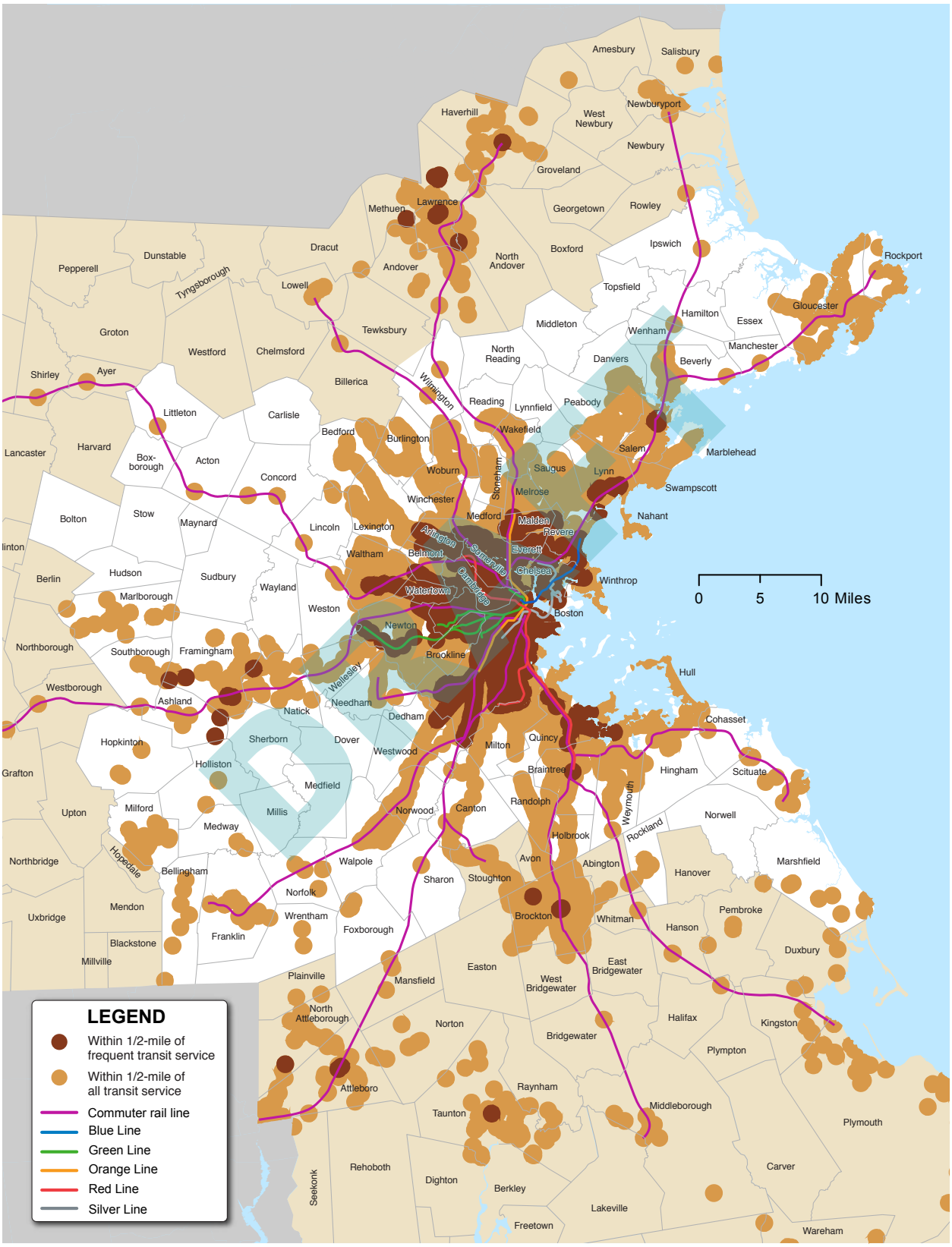
Figures 6-11 and 6-12 show the areas within one-quarter mile and one-half mile of any transit and/or frequent transit service in the Boston region. As these analyses show, there are several, potentially complementary or overlapping paths to increasing transit's share of the Boston region travel market in the coming years. Transit's coverage, already significant, can be expanded throughout the region; transit's frequency, high in some areas and not in others, can be increased to attract new riders; and land use can be planned to better align with transit. The MPO can support these efforts through planning, studies, and careful shepherding of available funds.

Figure 6-11
Areas within One-Quarter Mile of Transit and Frequent Transit in the Boston Region



Source: Boston Region MPO.

Figure 6-12
Areas within One-Half Mile of Transit and Frequent Transit in the Boston Region



Source: Boston Region MPO.

Park-and-Ride

Park-and-ride lots are an important way for many riders to access the MBTA transit network. Table 6-16 shows the results of the 2015–17 MBTA Systemwide Passenger Survey, conducted by CTPS (on behalf of the MBTA), indicating initial access to the commuter rail and rapid transit system. Demand for park-and-ride lots is therefore significant in some areas of the system, but uneven throughout the region.

Table 6-16
Access to Commuter Rail and Rapid Transit Stations

Mode	Commuter Rail (percent)	Rapid Transit (percent)
Walked or bicycled	53	88
Drove alone	31	4
Carpooled	2	1
Dropped off by personal vehicle	10	2
Dropped off by other vehicle	4	5

Source: 2015–2017 MBTA Systemwide Passenger Survey.

In order to take a closer look at the need for additional parking, staff analyzed parking demand at rapid transit and commuter rail stations for both the 2016 base year and the 2040 No-Build. When looking at parking demand, the travel demand model is normally constrained to existing capacity at park-and-ride locations. In order to determine actual parking demand at existing park-and-ride locations for the Needs Assessment, the 2040 No-Build scenario was run unconstrained, assuming an unlimited amount of parking at each existing park-and-ride location.[16]

The results showing the demand for parking at the commuter rail stations (by rail line) are detailed in Figure 6-13 and results for parking at rapid transit stations are detailed in Figure 6-14. Table 6-17 shows the assumptions used for parking demand at commuter rail and rapid transit stations. Tables 6-18 and 6-19 show the existing park-and-ride capacity on each commuter rail and rapid transit line, and the projected unconstrained demand in relation to capacity in 2040.[17] The existing park-and-ride capacity for 2012–13 shown in the table are the assumptions used in the travel model analysis. The park-and-ride capacity for 2017–2018 data is from the most recent inventory conducted by the Boston Region MPO, which is shown for information only.

[16] Constraints are based on 2012–13 Inventory of Park-and-Ride Lots at MBTA Facilities, conducted by CTPS. See full memo here: https://www.ctps.org/data/pdf/programs/cmp/Park_and_Ride.pdf. The model uses these numbers as inputs.

[17] Park-and-ride existing capacity numbers are taken from new counts conducted to update the 2012–13 Inventory of Park-and-Ride Lots at MBTA Facilities in 2018–2019; a memo including the full results has not yet been published.

Table 6-17
Assumptions for Demand at Commuter Rail and Rapid Transit Stations

Number of Parking Spots in Relation to Capacity	Demand in Relation to Capacity (2016–40)
Greater than 50 percent	High demand
26 percent to 50 percent	Medium demand
1 percent to 25 percent	Low demand
Less than 1 percent	No demand
N/A	No parking available

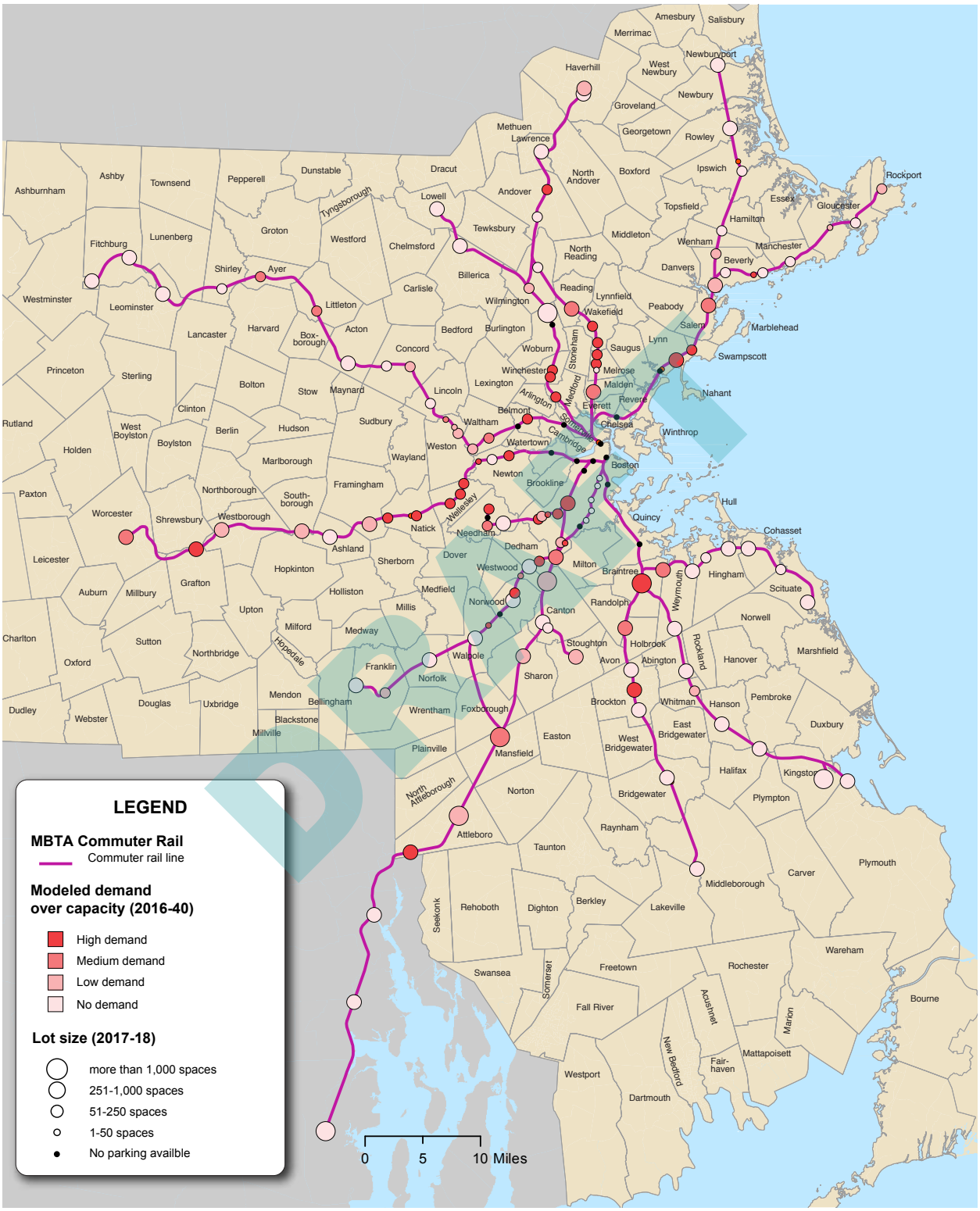
Source: Boston Region MPO .

Table 6-18
Commuter Rail: 2040 No-Build Parking Demand in Relation to Existing Capacity

Commuter Rail Lines	Existing PNR Capacity (2012–13)	Existing PNR Capacity (2017–18)	Unconstrained Demand in Relation to Capacity (2016–40)
Fairmount	408	406	Low demand
Fitchburg	2,774	2,807	Low demand
Franklin	4,312	4,164	Medium demand
Greenbush	3,007	2,982	No demand
Haverhill	2,589	3,581	High demand
Kingston/Plymouth	4,841	5,015	No demand
Lowell	3,287	3,273	Medium demand
Middleborough/Lakeville	4,164	4,043	Low demand
Needham	1,405	1,384	High demand
Providence/Stoughton	9,718	10,531	Low demand
Newburyport/Rockport	3,663	4,620	Medium demand
Worcester	3,880	4,439	High demand
Total	**44,048**	**47,245**	**Medium demand**

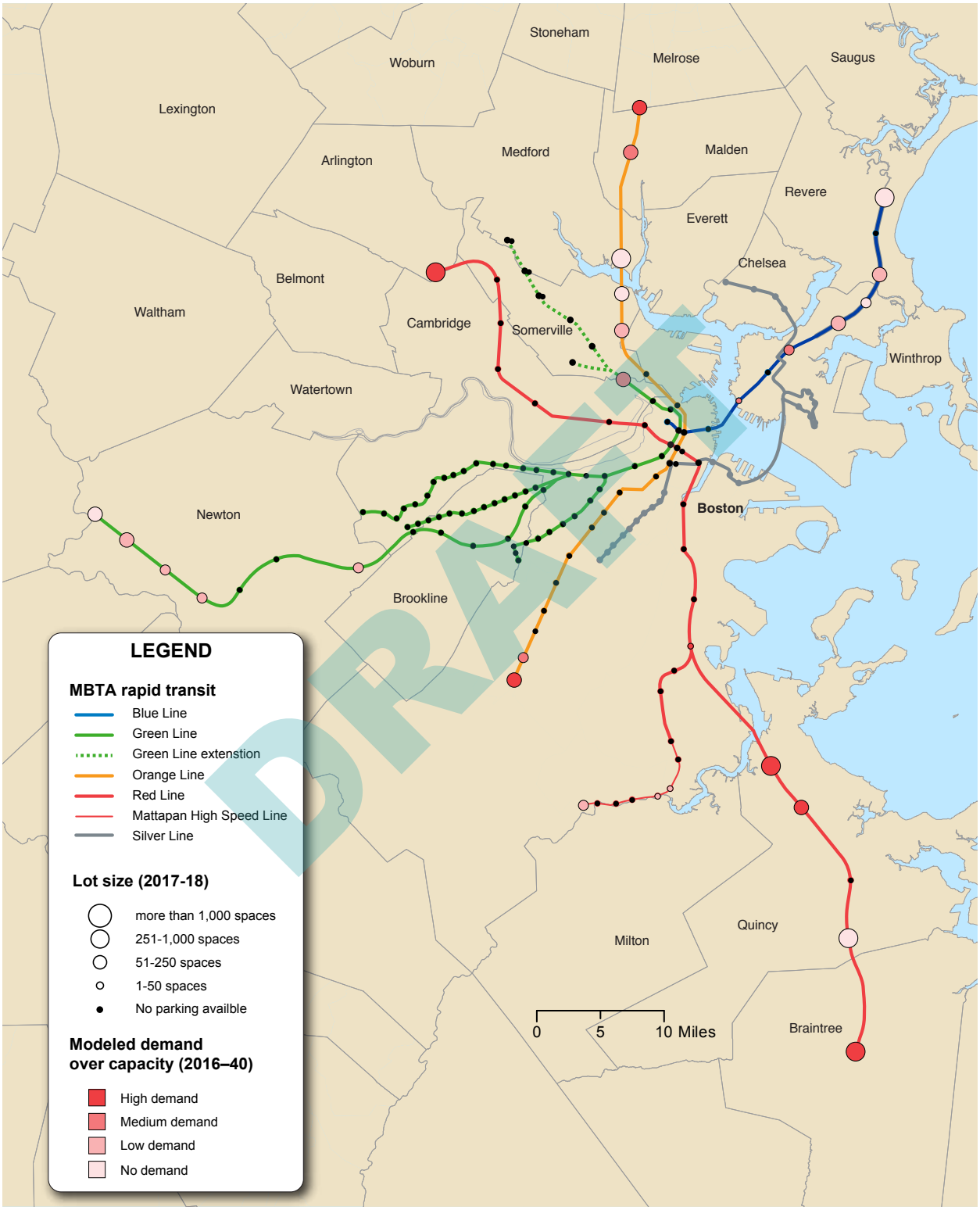
PNR = park-and-ride.
Source: Boston Region MPO.

Figure 6-13
Commuter Rail: 2040 No-Build Parking Demand in Relation to Existing Capacity



Source: Boston Region MPO.

Figure 6-14
Rapid Transit: 2040 No-Build Parking Demand in Relation to Existing Capacity



Source: Boston Region MPO.

Table 6-19
Rapid Transit: 2040 No-Build Parking Demand in Relation to Existing Capacity

Rapid Transit Lines	Existing PNR Capacity (2012–13)	Existing PNR Capacity (2017–18)	Demand in Relation to Capacity (2016–40)
Blue Line	3,459	3,346	Low demand
Green Line	2,171	2,092	Low demand
Green Line—Central Subway	377	374	Medium demand
Green Line—B	0	0	No parking available
Green Line—C	5	0	No parking available
Green Line—D	1,789	1,718	Low demand
Green Line—E	0	0	No parking available
Orange Line	4,676	5,309	Medium demand
Red Line	8,238	7,764	High demand
Mattapan	301	290	Low demand
Silver Line	0	0	No parking available
Total	**19,121**	**18,801**	**No demand**

PNR = park-and-ride.
Source: Boston Region MPO.

Based on the 2017–2018 inventory, there are approximately 47,000 park-and-ride spaces along the commuter rail lines. Results from the CTPS model (with unconstrained parking) show medium demand (26–50 percent) by 2040 for additional parking spaces beyond what is currently available. The highest demand is projected to be along the Haverhill, Needham, and Worcester lines, with the Greenbush, Kingston/Plymouth, and Fairmount lines projected to have excess capacity.

Currently, there are approximately 19,000 park-and-ride spaces along the rapid transit lines. CTPS analysis shows that there is low demand on the Blue and Green lines because large parking lots, such as those at Wonderland and Riverside stations, were not filled to capacity. The Orange and Red lines have higher demand for additional parking. Even with the model run assuming the demand for parking at commuter rail stations has no constraints, parking at shared commuter rail and rapid transit stations sustained high demand. In the North, stations such as Alewife and Malden were filled to capacity, despite "competing" trips on the Fitchburg and Haverhill commuter rail lines. And in the South, Braintree and Forest Hills stations had medium demand for additional parking, even with unconstrained park-and-ride lots near the Middleborough/Lakeville, Kingston/Plymouth, Providence/Stoughton, and Needham commuter rail lines.

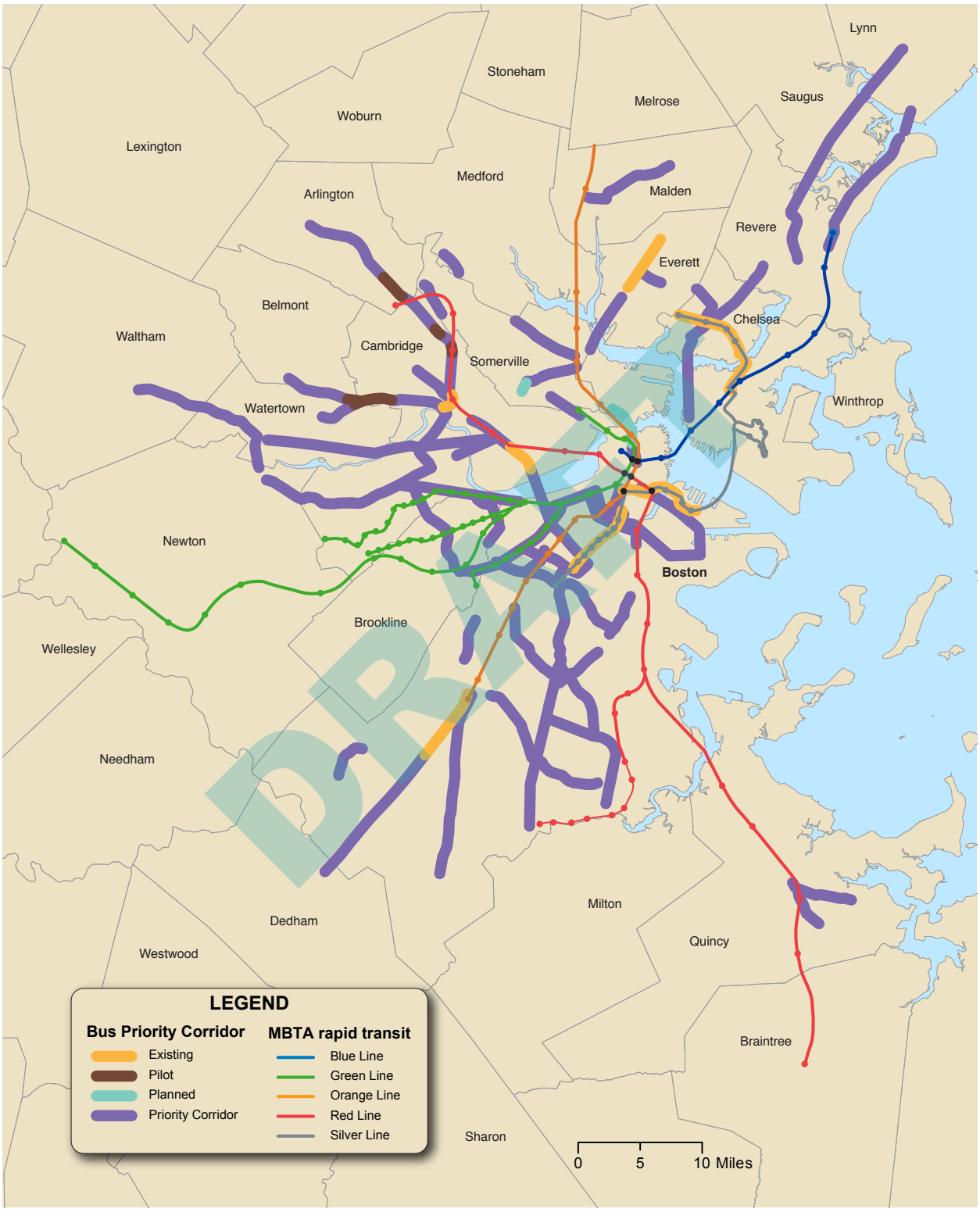
Further analysis and planning is needed before park-and-ride capacity is expanded. In 2018, the MBTA modified parking prices at its park-and-ride lots and garages in response to demand.[18] Close monitoring of that program, and others like it, can give a sense of the extent to which creative planning can mitigate the need for expansion of lots and garages. In addition, MassDOT is conducting its Rail Vision study which will identify key stations in which more frequent service may be provided. These key stations will take into account access to the stations with parking supply in relation to the current market and future growth potential. MPO programs such as the Community Transportation Program can also help with innovative ideas for reducing demand for car-based access to transit, as well as small capital projects that can increase capacity at parking lots.

Priority Bus Corridors

In 2017, CTPS performed a study to help MassDOT prioritize segments of Greater Boston roadways that might benefit from dedicated bus lanes. Existing traffic speed data and bus passenger load data was used to assess the average weekday rate of bus passenger delay over roadway segments that carry on average more than 1,500 weekday MBTA bus passengers in one direction. One result of the study was the identification of segments where the installation of dedicated bus lanes would provide the most effective benefit to bus riders. A map of priority bus corridors identified in the study is shown in Figure 6-15. It also identifies existing on-street and off-street busways, on-street priority corridors, and on-street planned pilot projects as of April 2019.

[18] For the MBTA update on parking prices, see https://www.mbta.com/projects/parking-prices-update.

Figure 6-15
Priority Bus Study Corridors in the Boston Region



Source: Boston Region MPO.

With this study as the basis, staff looked at the results of the 2016 Base Year and 2040 No-Build to analyze bus load information in the future. As discussed in Chapter 3, bus ridership is projected to increase by only six percent from 2016 to 2040 due to congested roadways increasing travel times. Dedicated bus lanes could help to decrease transit travel time along these congested corridors.

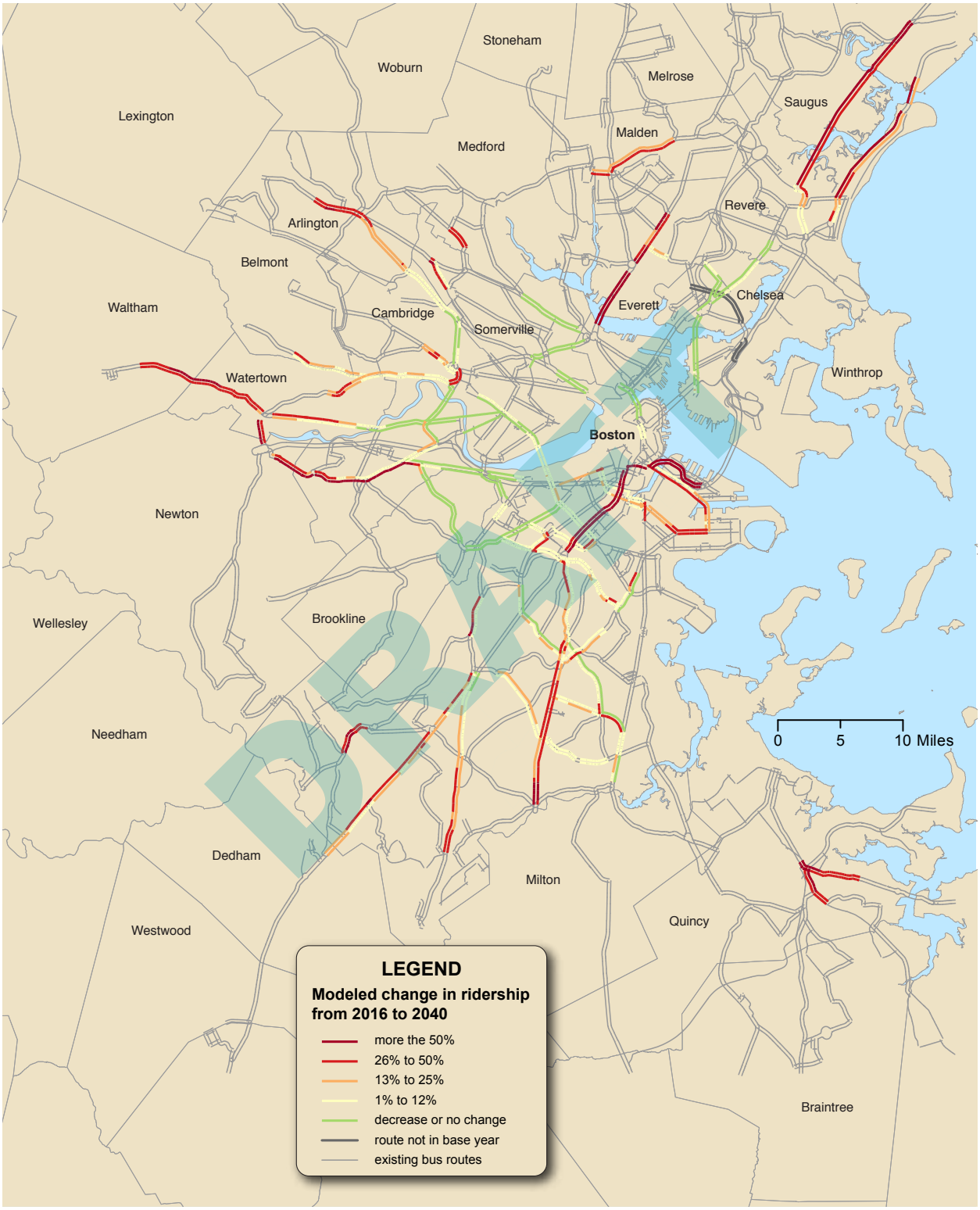
Figure 6-16 shows the modeled change in ridership from 2016 to 2040 along the priority bus corridors identified in the CTPS study, as well as existing busways and planned or dedicated bus lane pilots. The corridors that show a reduction in ridership are mostly due to increased congestion along the corridors in the future. The Somerville Union Square corridor ridership reduction is a result of the new Green Line service siphoning off some of the demand for transit trips in the area. Although there is a projected reduction in these corridors, a dedicated bus lane could be beneficial to providing feeder service into rapid transit stations (Union Square corridor into the Green Line, North Washington Street into Sullivan Square and North Station, etc.).

Changes in Bus Travel Times, 2016–40

As mentioned in the Priority Bus Corridors section above, bus travel times have increased as a consequence of the increasing congestion on the region's roadways. With the MPO's travel demand model projecting congestion to increase over the period of the next LRTP, buses are expected to see a corresponding decrease in speed which, in turn, increases run times.

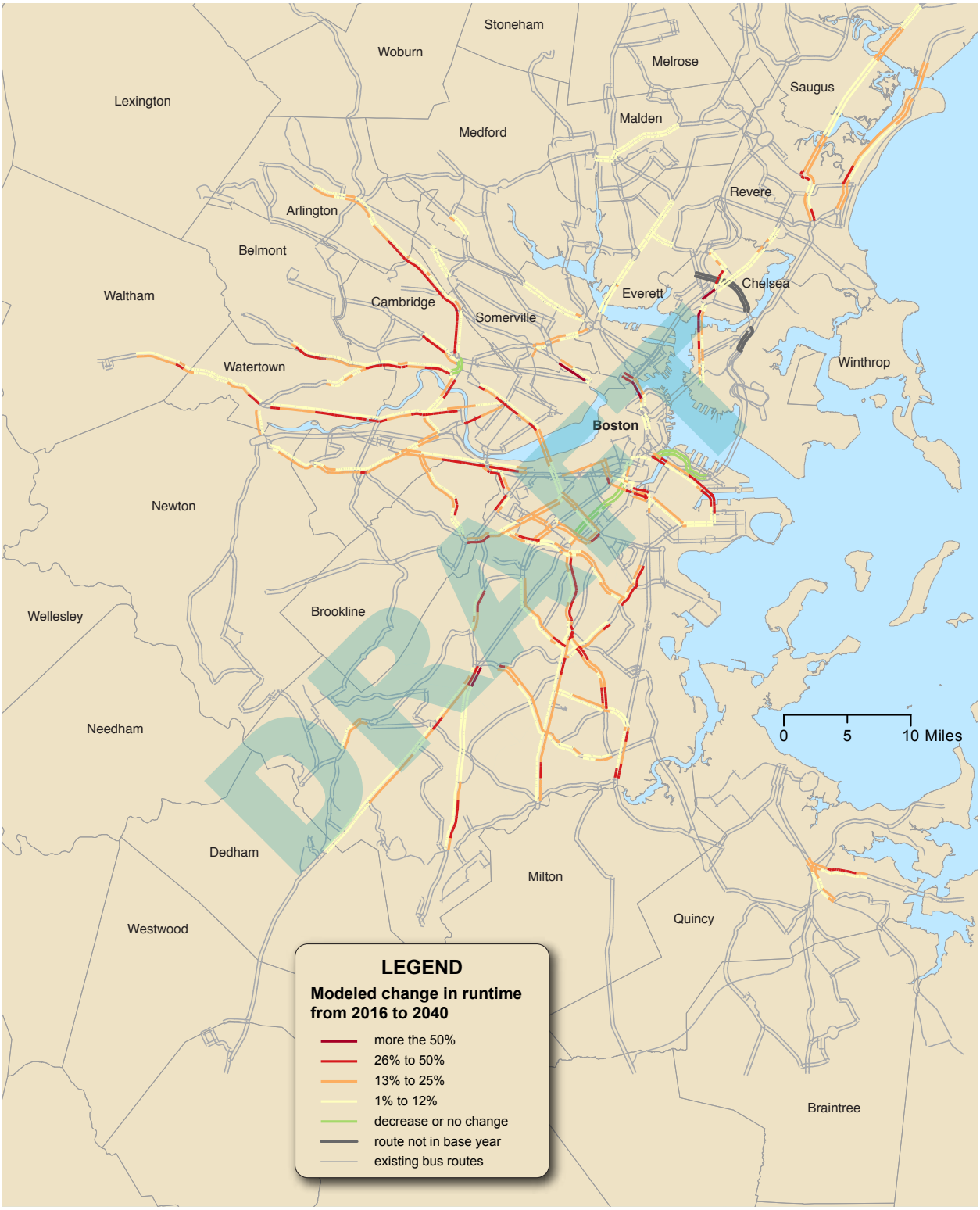
Studies and research by CTPS staff and other entities have identified the possibility of increasing the number and quality of dedicated lanes for buses on the region's roadways as a short-term transit priority improvement that can be implemented with relatively little capital expense. Everett, Cambridge, Arlington, Watertown, and Boston have (or are piloting) or have made permanent new dedicated bus lanes on different segments within the last several years. Figure 6-17 shows the modeled change in bus run times on Priority Bus Corridors, identified in the CTPS Study. The benefits of such lanes are shown in Figure 6-17, as buses traversing Washington Street in Roslindale and Broadway in Everett are expected to see decreased travel times over the period 2016–40 as a result of the implementation of dedicated bus lanes on those roads.

Figure 6-16
Modeled Change in Ridership on Priority Bus Corridors



Source: Boston Region MPO.

Figure 6-17
Modeled Change in Bus Run Times on Priority Bus Corridors



Source: Boston Region MPO.

The MBTA is also working with municipalities to roll out Transit Signal Priority (TSP) technology on many corridors; MPO staff has assisted in that effort through the FFY 2018 UPWP study *Review of and Guide to Implementing Transit Signal Priority in the MPO Region.*[19] The rollout of the MBTA's Automated Fare Collection (AFC 2.0) system in the coming years is expected to allow all-door boarding on bus routes, speeding up service. Such strategies hold significant promise for speeding up bus service and making it more reliable.

Transit Reliability

Much like the region's roadway system, the region's transit services and networks face reliability and capacity management concerns. Buses, trackless trolleys, and shuttles operating on roadways are affected by the increasing traffic congestion documented above. The size of vehicle fleets, the capacity of individual vehicles, and the condition of vehicles and infrastructure all have an impact on the number of passengers that can be moved and the ability of services to adhere to schedules. Transit planners and schedulers take into account poor reliability and adjust running times to be longer, meaning it takes more buses to make the same number or fewer scheduled trips; this can result in crowding.

As much of the MBTA's rapid transit infrastructure and rolling stock is aging, reliability has been poor in recent years, even as ridership demand increases. Bus reliability is also poor, in large part, because of overall roadway congestion. Regional bus ridership has fallen notably in recent years, potentially as a consequence of this unreliability.[20] TNCs may also play a role in decreasing bus ridership. However, as overall regional travel demand and congestion are increasing, transit—which is among the most efficient ways to use available road capacity—remains key not just to a sustainable regional future but to a future where mobility is preserved for regional residents.

Rapid Transit Reliability

The challenges facing the MBTA rapid transit system are well-documented, most notably in the *State of the System* materials accompanying the MBTA's *Focus40* planning process. Much of the system (including track infrastructure and rolling stock) is aging and as ridership has grown, and the capacity of the system has become strained, this has resulted in relatively poor reliability—especially on the Green Line.

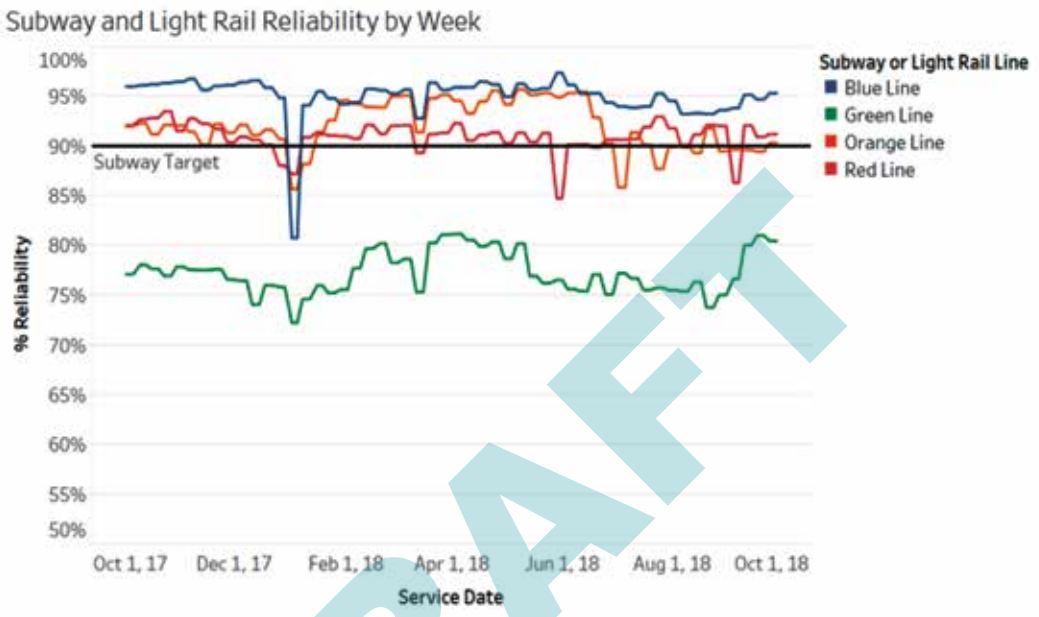
However, significant renewal processes are underway. New rolling stock and signals are due for the Orange and Red Lines within the next decade, and the MBTA has begun a Green Line Corridor Study, including the possibility of new, modern rolling stock and signals to determine the future of the Green Line system. The Blue Line has modern rolling stock and fewer capacity and reliability challenges than other lines. The coming implementation of a modern fare-collection system, known as AFC 2.0, should allow all-door boarding and thereby

[19] Transit Signal Priority in the Boston Region: A Guidebook (MPO, December 2018): https://www.ctps.org/data/calendar/pdfs/2018/MPO_1220_Report_Transit_Signal_Priority_Guide.pdf

[20] MBTA's Data Blog. "Investigating Bus Ridership using Regression Analysis," February 2018. http://www.mbtabackontrack.com/blog/79-bus-ridership-regression-model

improve boarding times and reliability on the surface sections of the Green Line. The MPO can continue to monitor the rapid transit system, contribute expertise to its planning, and study the possibilities for future expansion and further capacity enhancement as the region grows.

Figure 6-18
MBTA Rapid Transit Reliability, 2018



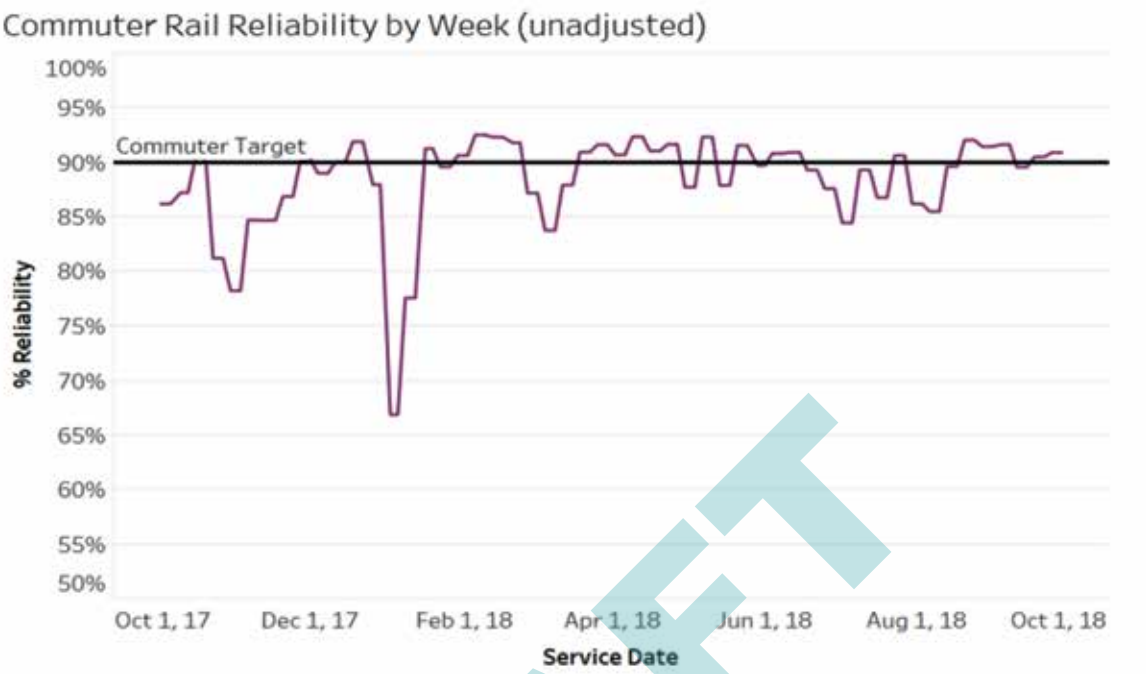
MBTA = Massachusetts Bay Transportation Authority.
Source: MBTA's Fiscal Management Control Board's Fourth Annual Report, https://cdn.mbta.com/sites/default/files/fmcb-meeting-docs/reports-policies/2018-12-17-fmcb-annual-report-original.pdf.

Commuter Rail Reliability

While MBTA commuter rail reliability has somewhat recovered since the winter of 2014–15, a number of physical and infrastructure factors must still be addressed. The rolling stock—both coaches and locomotives—is aging, and some coaches are not American Disabilities Act (ADA)-compliant. The signal system, while modern in some places, is many decades old and in need of improvement in others. Some lines lack layover capacity for midday or overnight train storage. Some bridges and other track structures are aging and maintenance-intensive as well. Platforms at 32 stations are "low" (track level) and are not ADA-compliant, while 58 stations have only a "mini-high" platform for minimal ADA compliance.[21] This means that most riders must climb stairs to enter or exit the train, a slow and complex boarding and alighting process that introduces significant variability in dwell time—and therefore in reliability—to the system.

[21] Plan for Accessible Transit Infrastructure presentation to the MBTA FMCB, 4/1/2019 https://cdn.mbta.com/sites/default/files/fmcb-meeting-docs/2019/04-april/2019-04-01-fmcb-pati-original.pdf

Figure 6-19
Commuter Rail Reliability, 2018



Source: MBTA FMCB Fourth Annual Report.

The MBTA is currently conducting a multiyear Commuter Rail Vision study to determine potential future scenarios for the system, including comparisons to international regional rail systems that provide frequent, modern service. At the same time, the MBTA's Fiscal Management Control Board (FMCB) is overseeing station improvements, fleet modernization, and general state of good repair projects. Over the next several years, the MPO and its staff can help provide input on potential best practices and operating and infrastructural scenarios, identify areas where the commuter rail system can be coordinated with RTAs and other transit services, and identify priorities for reliability and accessibility improvements—such as ensuring as many stations as possible receive high-level platforms.

Bus Reliability

Given the increased congestion on regional roadways, especially arterials (as mentioned in the Roadway section), it is not surprising that the reliability of the MBTA's bus system is poor. Maintaining a reliable bus system is especially important because buses can provide significant capacity for little capital investment. They are also disproportionately used by low-income and minority riders in Boston, as in many metropolitan areas around the United States. As Figure 6-20 shows, when evaluated in 2017, a clear majority of MBTA bus routes

failed the Service Delivery Policy's test for reliability.[22]

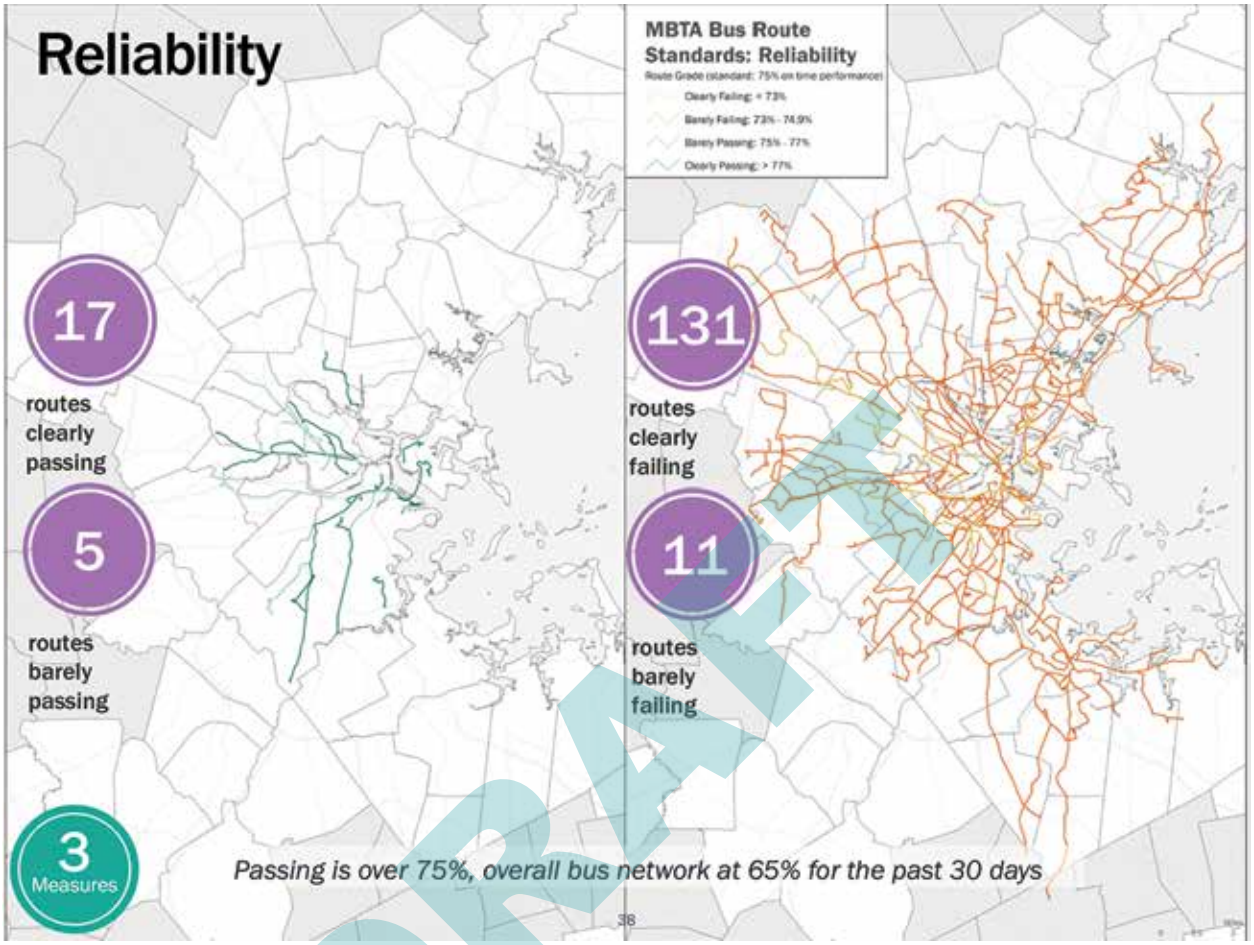
While MBTA service planners periodically adjust running times to address reliability issues, doing so frequently results in longer trips and more crowded vehicles which may not ultimately improve reliability. As data presented to the MBTA's FMCB at the end of 2018 showed, bus service reliability continues to be a significant challenge (see Figure 6.21).

The Priority Bus Corridors section above lays out one potential approach to improving the challenge of unreliable bus service. Several independent research reports have also suggested that modernizing dispatching and supervision practices could reduce bunching and improve overall reliability on the MBTA bus and rail networks.[23] Improvements such as transit signal priority and the MBTA's intended adoption of AFC 2.0, with riders being able to board buses at all doors, should have some positive impact on reliability in coming years, however, the extent of that impact remains to be determined. As congestion grows in the MPO region, a thoughtful approach to monitoring improvements (such as AFC 2.0 and using buses and other surface transit to maximize the capacity of the overall network) will become even more significant in the future.

[22] The MBTA measures reliability at timepoints, using two separate tests. **Scheduled-Departure Service**: A trip is considered to provide scheduled-departure service when it operates with a headway longer than 15 minutes. For scheduled-departure services, passengers generally time their arrivals at bus stops to correspond with the specific published departure times. **Frequent Service**: A trip is considered to provide frequent service when it operates with a headway of 15 minutes or shorter. For frequent service, passengers can arrive at a stop without looking at a schedule and expect a reasonably short wait. Key bus routes, whose passengers use the services as if they were frequent services despite occasional longer than 15 minute headways, are always evaluated using the frequent service definition even when their headways exceed 15 minutes.

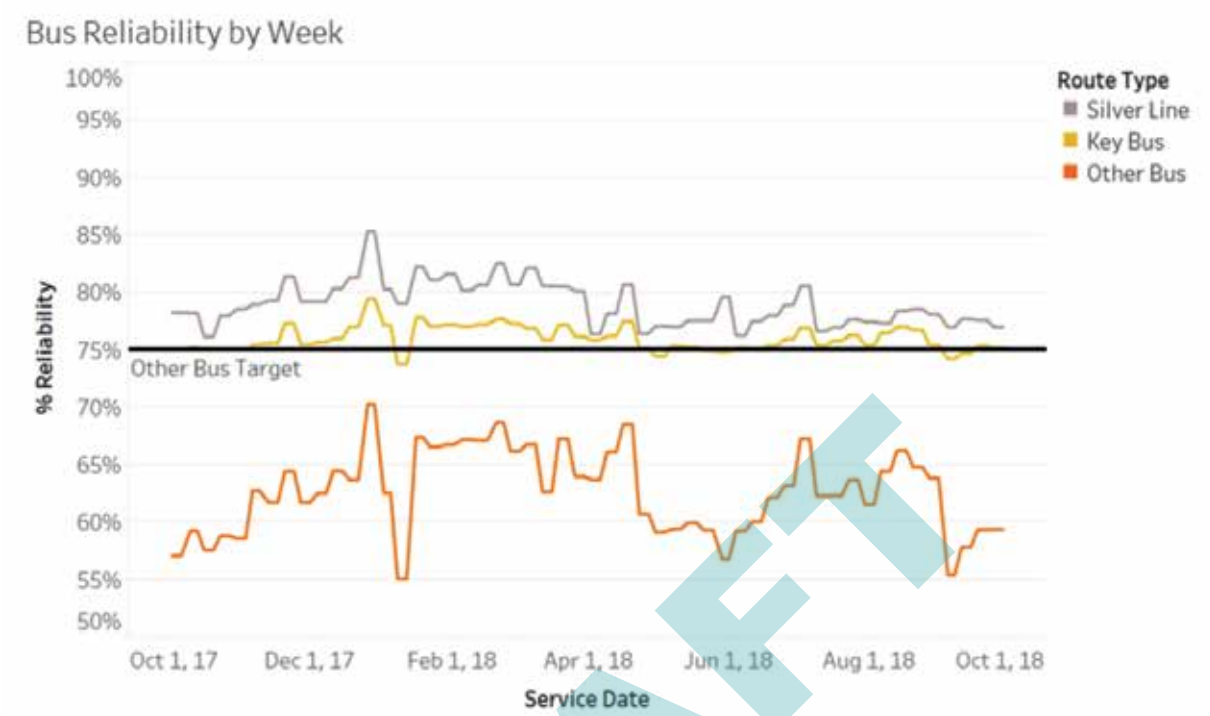
[23] For MBTA-specific research, see Maltzan (2015) and Fabian (2017); for examples from other U.S. transit systems, see Pangilinan, Wilson, and Moore (2007), Berrebi, Watkins, and Laval (2015), and Berrebi et al (2017).

Figure 6-20
Routes Passing and Failing MBTA Service Delivery Policy Bus Reliability Test, 2016



MBTA = Massachusetts Bay Transportation Authority.
Source: MassDOT. "Service Delivery Policy Workshop," October 2016. https://cdn.mbta.com/uploadedfiles/About_the_T/Board_Meetings/Service%20Delivery%20Policy%20-%20Final%20To%20Upload(2).pdf.

Figure 6-21
MBTA Bus Reliability, 2018



MBTA = Massachusetts Bay Transportation Authority.
Source: MBTA's Fiscal Management Control Board's Fourth Annual Report.

Transit Crowding

Recent growth in population and employment has stressed the MBTA system. Adding capacity is never easy regardless of economic, fiscal, or political conditions. Capacity can be added by expanding or modernizing the rail network or the vehicle fleet, or sometimes by changing operating practices. This process begins with some type of needs assessment, such as this one.

Rapid Transit Crowding

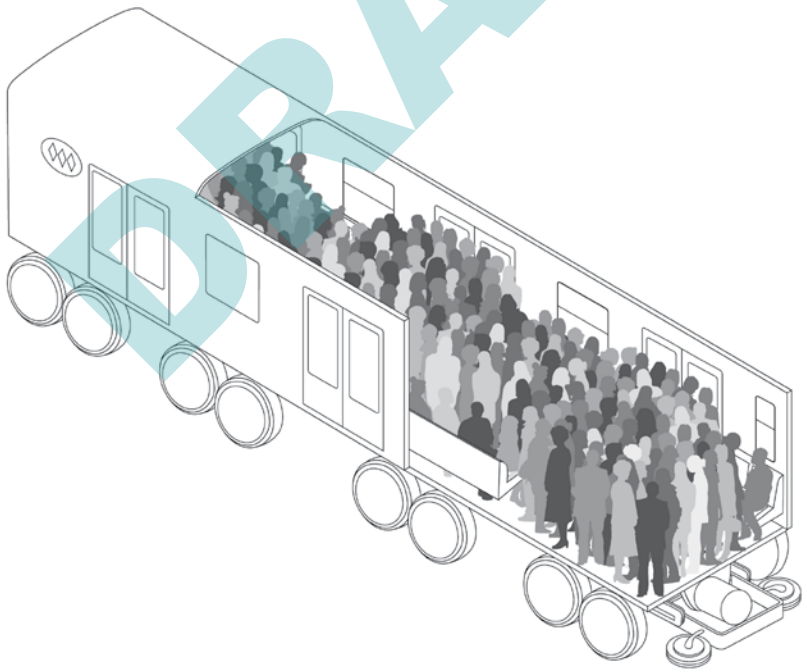
The MPO's recent report, *Core Capacity Constraints: Accommodating Growth on Greater Boston's Congested Road and Crowded Transit System,* specifically examined the problem of crowding in the rapid transit system, reaching the key conclusion that rapid transit crowding is a problem now and will be significantly more so in 2040.[24] Furthermore, the crowding problem impacts all other planning considerations. For instance, any proposal to extend an existing rapid transit line would exacerbate crowding on that line and throughout the rapid transit system.

[24] *Core Capacity Constraints: Accommodating Growth on Greater Boston's Congested Road and Crowded Transit System,* Boston Region MPO, August 2016. http://ctps.org/core-capacity-constraints

The "Core Capacity" report is briefly summarized below, presenting the general approach and several specific findings. Please refer to the report for a full account of locations, time periods, duration, and severity of crowding throughout the system that exists today or is forecasted in the future. References to the 2040 projections in this section refer to a modeling process done in support of the *Core Capacity* report, separate from the one carried out for the rest of the Needs Assessment.

The first phase of the "Core Capacity" study included a review of MBTA and international crowding standards, which is expressed as square feet per standing passenger, using a metric of 3.11 square feet per standing passenger as the smallest acceptable amount. The MBTA has different sizes and configurations of rapid transit equipment, and depending on the particular vehicle, this maximum level would imply that there are between 21 and 43 percent more standing passengers than seated passengers if all the seats are occupied. This maximum level of passenger crowding is illustrated in Figure 6-22.

Figure 6-22
Maximum Acceptable MBTA Load
(3.11 Square Feet per Standing Passenger)



Source: Batarce, Marco, Juan Carlos Muñoz, Juan de Dios Ortúzar, Sebastian Raveau, Carlos Mojica, and Ramiro Alberto Ríos Flores (2015) "Valuing Crowding In Public Transport Systems Using Mixed Sp/Rp Data: The Case of Santiago" *Transport Research Record.*

The "Core Capacity" study looked at every line segment between adjacent rapid transit stations, in each direction, for every 15 minute period between the peak-periods of 6:00 AM and 9:00 AM and 3:00 PM and 6:00 PM. These data were prepared for a base year of 2012, and two 2040 growth scenarios. These forecasts were based on project-based land use projections. The lower growth scenario was slightly below the official MPO demographic forecasts, and the higher growth scenario was slightly above the official forecasts. The forecasts were developed to test the impact on the transportation system on sets of individual projects rather than to replicate official MPO forecasts.

Table 6-20 presents selected results of this analysis. In 2012, every transit line except the Blue Line experienced unacceptable crowding at some point on the line on a regular basis. The Red and Orange Lines had some well-defined pinch points, but the Green Line, closely aligned with Boston's "High Spine" development plan, experienced unacceptable crowding throughout most of its tunnel system.[25]

Table 6-20 also indicates locations of unacceptable 2040 crowding, assuming the lower growth projection. The table indicates the additional locations in the rapid transit system where unacceptable crowding is anticipated. However, the duration and severity of crowding is expected to increase in the system segments shown as crowded in 2012. This is the case for the Green Line, where the central tunnel is almost entirely congested in both 2012 and 2040, but appreciably worse in 2040.

Table 6-20
Stations Adjacent to a Line Segment Experiencing Unacceptable Crowding on a Regular Basis during Peak Periods

Year	Red Line	Orange Line	Green Line	Blue Line
2012	Kendall/MIT	State	Park Boylston Arlington Copley Hynes Prudential Symphony	
2040 *(assuming lower growth scenario)*	Kendall/MIT Andrew JFK/UMass North Quincy	Sullivan Community College North Station Haymarket State Downtown Crossing Chinatown	Park Boylston Arlington Copley Hynes Prudential Symphony	State

Source: Boston Region MPO.

[25] A plan with origins in the 1960s to concentrate development in a spine of large towers from the Back Bay to the Financial District.

If the high growth scenario takes place throughout the MPO region, unacceptable crowding will be more extensive and more severe than indicated in this table. However, the MBTA is making investments in service and capacity that could relieve pressure, such as new rolling stock and signals on the Orange and Red Lines, and potentially a future Green Line Transformation program.

Bus Crowding

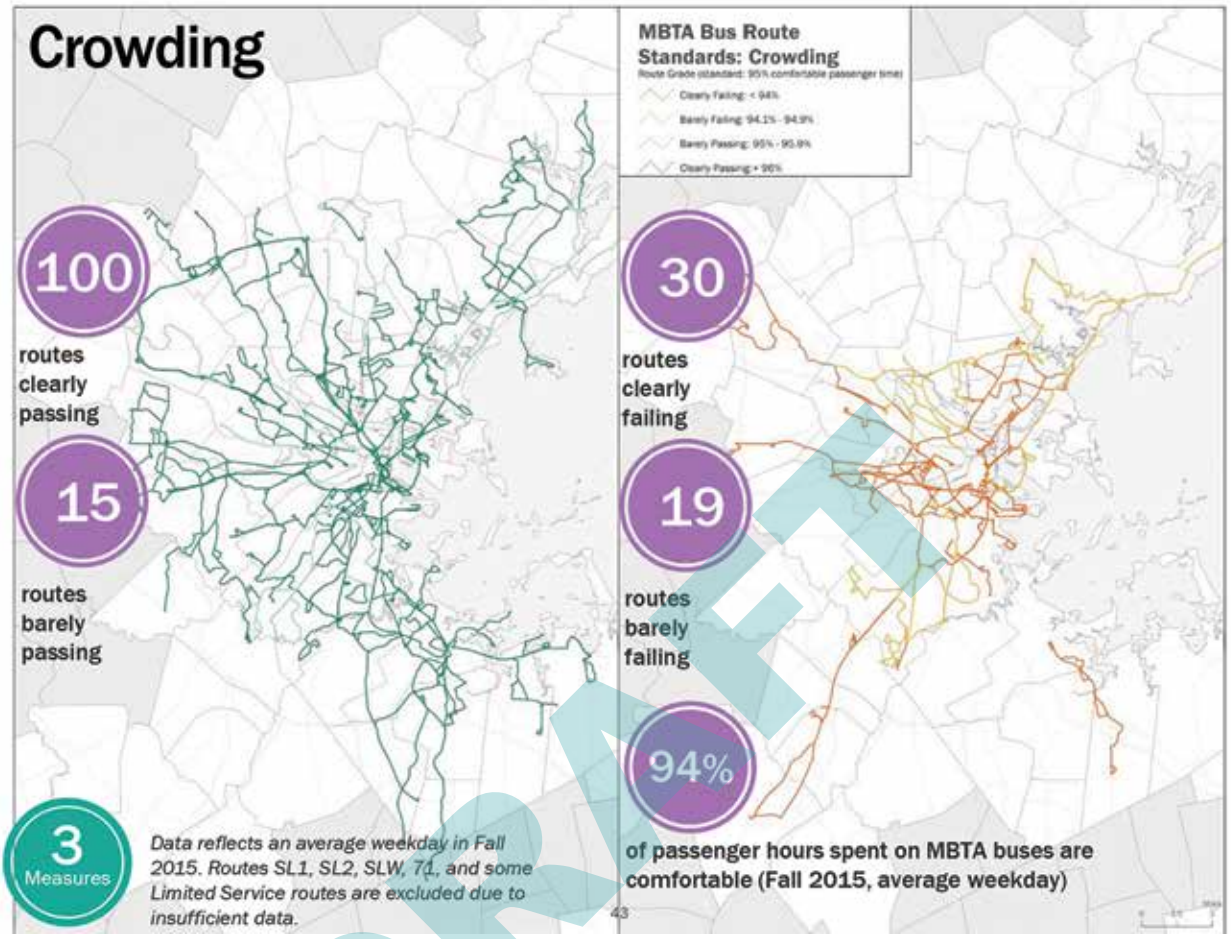
Despite recent losses in ridership, crowding remains a concern on parts of the regional bus network. The MBTA has identified crowding on buses as one of the elements most important to its riders and integrated metrics measuring it into the agency's new Service Delivery Policy.[26] Crowding remains a barrier to ridership and interacts in a negative cycle with unreliable service; crowding increases bus dwell times, which in turn causes bunching of buses, which decreases overall capacity on the line, and therefore the entire transportation network.

MBTA conducted a thorough review of crowding on its bus network as part of the process of developing the Service Delivery Policy. This review was presented to the MassDOT board and MBTA's FMCB in 2017[27]; Figures 6-23 and 6-24 demonstrate elements of the crowding analysis presented at that meeting. Figure 6-24 shows the different types of crowding on the Number 9, 66, and 111 bus routes.

[26] "Bus Crowding: Introduction" is located here: http://www.mbtabackontrack.com/blog/60-bus-crowding-introduction

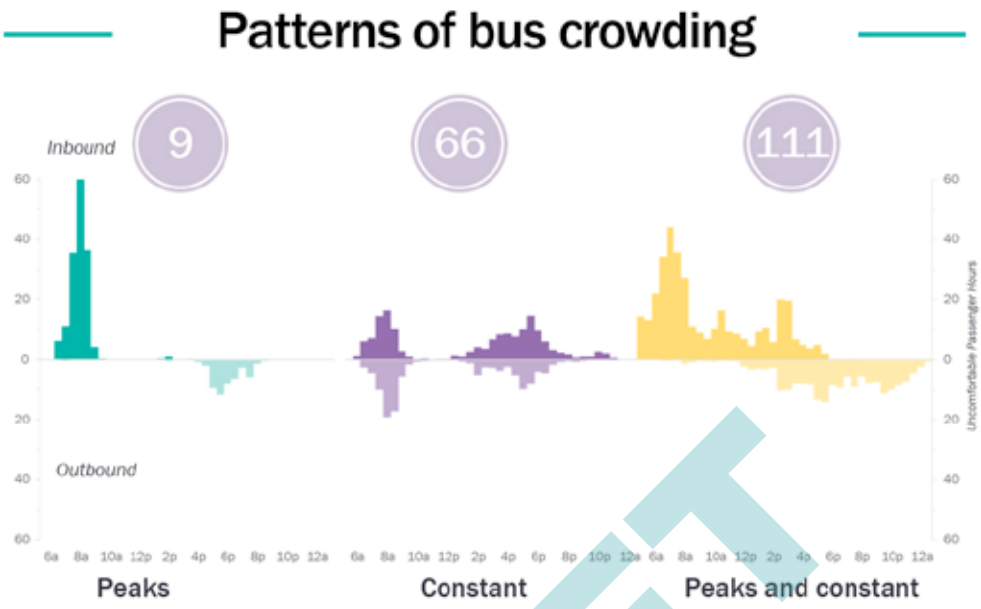
[27] "Service Delivery Policy Workshop," held October 20, 2016. More information is located here: https://cdn.mbta.com/uploadedfiles/About_the_T/Board_Meetings/Service%20Delivery%20Policy%20-%20Final%20To%20Upload(2).pdf.

Figure 6-23
MBTA Bus Route Crowding Analysis: Average Weekday, Fall 2015



Source: Massachusetts Bay Transportation Authority.

Figure 6-24
Different Types of Bus Crowding



Source: Massachusetts Bay Transportation Authority.

Table 6-21 shows the bus routes considered by the MBTA bus crowding standard to have above-average amounts of crowding as of fall 2017, the most recent data available at the time of publication.

Table 6-21
Most Crowded MBTA Bus Routes, Fall 2017

Route	Route Type	Percentage of Passenger Hours Spent in Uncomfortable Conditions
111	Key Bus	21.01%
65	Local	20.69%
57A	Key Bus	19.63%
7	Local	17.82%
109	Local	15.50%
9	Local	14.39%
34	Local	11.43%
117	Key Bus	10.73%
93	Local	10.73%
57	Key Bus	10.70%
47	Local	10.11%

Note: Data is provided by the MBTA Bus Crowding Model. Excludes privately operated routes: 710, 712, 713, 714, 716. Excludes routes operated as pay-on-exit: 71, 72, 73. This excludes routes accepting passengers at gated stations 741, 742, 746
Source: Massachusetts Bay Transportation Authority.

Crowding is generally not considered to be a problem on the bus systems of non-MBTA RTAs operating in the MPO region.

Crowding on Other Modes

While crowding has been identified by stakeholders as a concern on the commuter rail network, sufficient data to measure it accurately does not exist at this time. CTPS recently conducted commuter rail counts for MassDOT and the MBTA, which will (when sufficiently processed) allow for a crowding analysis. Crowding is not a concern on ferries because federal regulations prohibit the passenger load from exceeding the boat's seated capacity.[28]

Bus Maintenance Facilities

The *State of the System* reports undertaken by the MBTA as part of the *Focus40* process identify outdated and overcrowded bus garages and depots as a major need for the MBTA. Four of the MBTA's nine maintenance facilities are over 70 years old; most are at capacity and cannot expand to meet service demand and reduce crowding. Expansion will require new facilities, new land, or the intensification/layering of current land use.

Many facilities are obsolete and the ratio of buses to repair bays is too high. Those most in need of replacement are Fellsway, Lynn, and Quincy, while Albany and Arborway (which was intended to be a temporary facility) need major upgrades. The intention to trial and/or adopt battery electric buses, which are taller than diesel buses, is an additional challenge to the MBTA's garages and facilities; while some routes are already straining at the edges of capacity, few of the system's facilities can handle the 60-foot articulated buses that might help relieve crowding.

On the positive side, most transit systems do not have an asset like the central repair facility in Everett. Expansion of the MBTA's maintenance facilities or adding new facilities is a major need, but also financially and potentially politically challenging. The MPO can help reduce this need by working with municipalities to site new garages and providing technical support and data to the MBTA to help optimize garage siting and minimize deadhead travel for buses.

Transit Stakeholder/Public Input

MPO staff received comments during outreach on needs from fall 2017 through spring 2018 on the Capacity Management/Mobility goal area. The following is a summary of comments by transit mode and other themes.

Needs and Challenges Identified by Public Input

Respondents felt that it was important to improve the quality of service throughout the transportation network, but particularly on public transit. This interest was highlighted by state and municipal officials, transportation advocates, COAs, disability advocates, business

[28] To view commuter rail counts, visit: https://www.mass.gov/lists/2018-commuter-rail-counts.

and neighborhood development organizations, transit service providers, transit riders, and residents. Concerns centered on topics such as

- The need to improve the overall comfort and experience of MBTA services in order to encourage transit use;
- Reducing dependency on SOVs;
- Competing with TNCs;
- Improving the quality of bicycle and pedestrian accommodations throughout the region, specifically those that connect to transit;
- Improving congestion. Specifically, respondents connected congestion with slow and unreliable bus service, including the Silver Line where it lacks dedicated lanes;
- Reducing "bus bunching," which occurs regularly during rush hours, resulting in long headways and delayed trips; and
- Supplementing highly reliable transit with community transportation, paratransit, and on-demand options for older adults and people with disabilities.

Proposed Solutions Identified by Public Comment

General

- Improve quality of MBTA service across all modes (capacity, frequency, speed, reliability, maintenance, cleanliness, accessibility, affordability, and comfort)
- Reduce signal problems, breakdowns, and delays to comply with the ADA
- Increase capacity to match development in the Seaport and Kendall Square areas
- Expand service, prioritizing low-income and minority neighborhoods
- Expand off-peak, late night, all night, and weekend service across all modes
- Coordinate better schedules for buses and rapid transit
- Rethink fares (Unify fares across modes so riders pay per trip; yearly pass for the entire system; fare machines at Commuter Rail stations; lower fares; change to proof of payment with inspection)
- Provide better transit in rural areas, for instance, near Inner Core and connecting suburbs to Inner Core
- Build transit hub with bicycle and pedestrian access in Allston before 2040

- Include dedicated lanes for public transit in all future roadway projects
- Implement congestion pricing, dynamic tolling, raise gas tax and parking fees
- Install connected intelligent signal systems
- Improve enforcement at key intersections at peak times to prevent gridlock at intersections also referred to as "blocking the box"
- Increase system coverage:
    - To underserved/high-need areas and "transportation deserts"
    - To lower-income communities
    - To a wider housing market
    - To regional employment centers
    - To assisted living facilities
    - To neighborhoods further from Boston's core
    - To cultural and artistic activities
    - To grocery stores
    - To universities, colleges, and schools from more affordable areas within reach of the schools
- Provide more express options for long trips
- Better communicate planned delays due to construction and maintenance
- Provide and maintain fast, frequent, and reliable public transit (particularly in the Inner Core and in suburbs with significant employment and increasing housing stock) to reduce commute times, attract young people, and support the needs of elders and low-income populations

Coordination with Land Use

- Improve regional transit options to relieve housing pressure in Boston and revitalize neighboring towns and cities
- Provide improved reverse commute options with better scheduling and reduced pricing or financial incentives to companies in employment centers outside the Inner Core to change commuting habits of employees and draw more workers from the Inner Core

- Focus on the Inner Core to ensure transit capacity corresponds with demand
- Provide more connections from low-income areas, particularly outside of Boston, to regional employment centers
- Conduct origin-destination studies to better understand where to capture new riders
- Establish a standard state and city Development Transportation Impact Fee to support transit
- Work with communities to create first-and-last-mile connections to and from jobs and services, particularly in conjunction with planned development
- Overhaul land use policies to promote mixed-use development at transit hubs
- Replace surface lots or low density construction around transit stations and frequent bus lines
- Encourage infill housing and office development in the urban core to catalyze transit investment near dense housing and business clusters
- Build more affordable housing near transit
- Plan for connections to and from new affordable/senior housing in suburban communities (40B or otherwise) in geographically isolated areas

Rapid Transit

- Provide better connections to East Boston and the North Shore (Blue Line to Lynn, Red/Blue Line connector; repair Blue Line tunnels)
- Complete the Green Line Extension to Route 16
- Better manage the Green Line, especially at Lechmere; extend Green Line to Seaport
- Improve the Red Line—upgrade signals, address bunching
- Extend Orange Line—improve connections to Hyde Park, Mattapan, Roslindale, and West Roxbury
- Improve Silver Line—use the state police ramp at the Ted Williams Tunnel; light rail in Silver Line tunnel; service between Back Bay, North Station, and South Station; better protect bus-only lanes
- Provide safe, working, clean elevators and escalators at all stations
- Improve lighting in stations
- Improve cleanliness of vehicles and stations

- Reduce gap between train and platform (make consistent across the network)
- Provide more transit signage, materials, and outreach in languages other than English
- Expand service—Subway/light rail within 128 and Commuter/Regional Rail outside 128
- Build the "Urban Ring" project
- Convert existing rail right-of-ways and highway travel lanes into rapid transit
- Extend the Orange Line to the south
- Extend the Blue Line to the north

Buses

- Build bus rapid transit throughout the network
- Improve quality of service throughout the bus network
    - Implement TSP, all-door boarding, bus priority/dedicated lanes, queue jumps
    - Simplify fare collection
    - Offer frequent headways,and address bunching and overcrowding
    - Streamline fare collection (fare machines at more locations)
    - Announce stops
- Provide dedicated lanes, especially during peak hours
- Make bus stops more comfortable
    - Provide enclosed shelters, seating, heating/cooling
    - Label by location, post schedules within
    - Clear snow from bus stops faster, clean/maintain more often
    - Provide real-time arrival/departure information
    - Improve placement of bus stops (after intersections, more space between)
- Expand Key Bus Routes
- Provide more express buses (supplement the 86 39, 57, 66, 1, 77 and other key routes at peak)

- Improve bus service in specific areas/routes
- Build new/expand existing garages
- Assign appropriately sized vehicles (40 vs 60-foot buses) to routes based on demand
- Improve routes near senior and low-income housing (Example: #716 bus is infrequent and has no sheltered bus stops on Washington Street)
- Explore/implement hydrogen fuel cell bus technology
- Include school buses in plans for TSP
- Partner with TNCs on pricing when buses are unavailable or do not run late enough
- Provide more frequent service throughout the bus network, particularly in environmental justice (EJ) areas
- Provide more frequent off-peak (midday, weekend, evening, late night, 24-hour, NightBus) bus service, particularly in EJ areas
- Institute TSP for buses
- Acquire more vehicles
- Design bus routes to minimize total travel time
- Schedule buses to accommodate transfers to other modes
- Institute measures to compensate for Green Line Extension delay (buses every 15 min)
- Fund RTAs

Commuter Rail

- Improve service frequency, off-peak service, and ADA accessibility
- Build Regional Rail
    - Electrify the system and acquire Electric Multiple Units that run frequently and all day
    - Reinvigorate legacy rail network through electrification of existing tracks
    - Build high-level platforms at stations
    - Implement the "Indigo Line" on the Fairmount Line to provide rapid transit in Dorchester, Mattapan, and Roxbury

- Build the North/South Rail Link
- Build links to Fall River and New Bedford
- Fullly integrate fare with other modes, reduce fares, ensure fares are collected
- Build stations where new transit oriented development is likely (West Station)
- Provide more stations and frequent service within inner suburban stops (Zones 1A and 2)
- Provide real time train tracking data
- Provide more frequent service throughout the Commuter Rail network
- Improve service on specific existing Commuter Rail lines
- Improve schedules for reverse commutes
- Increase utilization of available commuter rail tracks for more frequent service
- Convert existing rail rights-of-way and highway travel lanes into more lines and connections through underserved areas
- Provide high speed rail infrastructure with Amtrak's new *Avelia Liberty* (220 mph) trains on MBTA-owned Northeast Corridor
- Improve scheduling frequency for reverse commutes

Paratransit, MBTA's The RIDE, and Community Transportation

- Improve crosstown, suburb-to-suburb connections
- Improve options for older adults to reach medical facilities in Boston
- Improve nonapplication-based ride-hailing options
- Improve customer service, and sensitivity of drivers and dispatchers at MBTA's The RIDE
- Improve MBTA's The RIDE scheduling
- Improve MBTA's The RIDE responsiveness and flexibility (day-of trip booking)
- Provide one customer service phone number for all paratransit options
- Better coordinate TNCs, MBTA's The RIDE, MBTA, and wheelchair accessible taxis
- Continue taxi partnerships, not just partnerships with TNCs
- Provide more accessible vehicles that can accommodate multiple wheelchairs and service animals

- Create an app for MBTA's The RIDE, like Lyft or Uber
- Streamline the eligibility process
- Expand MBTA's The RIDE coverage area
- Improve customer service, cleanliness, and disability sensitivity at TNCs
- Consolidate private shuttle buses and coordinate routes with MBTA
- Provide more readily available, frequent, on-demand, off-peak buses/shuttles
- Partner with TNC's (Uber, Lyft) and MBTA
- Form public/private taxi partnerships providing short notice options
- Plan more frequent regional use of COA vans, which are underutilized during commute hours, evenings, weekends, and holidays
- Promote cross-boundary cooperation/coordination between RTAs to address gaps in transit access
- Consider shuttle services for private schools to relieve congestion in residential neighborhoods
- Increase shuttle/van services for affordable housing/senior facilities to address needs created by Chapter 40B developments
- Increase options for seniors to allow aging in place with access to services
- Provide shuttle services to populations besides older adults: veterans, high school students, and town employees
- Provide senior transit outside of business hours
- Provide community transportation for non-drivers of all ages
- Partner with organizations and companies who can supply third-party transportation services (Example: Acton's Crosstown Connect)
- Create a community transit system in the North Shore
- Explore TNC partnerships with transit providers to connect commuters to rail stations
- Require university and private shuttles to accommodate underserved populations
- Use COA vans more efficiently

    - Use for employees during rush hours
    - Use for populations beyond seniors
    - Use on evenings, weekends, and holidays
- Provide shuttles to schools, commuter rail, local employers, and grocery stores
- Provide smaller off-peak buses and shuttles with flexible, on-demand schedules
- Provide demand responsive services

Ferries

- Provide more frequent ferry service from Hingham and Hull to Boston, including evenings and weekend
- Provide more frequent ferry service to and from Hingham and Hull and Logan airport, including evening and weekends
- Expand ferry service to Cape Cod

Coordination among Transportation Services

- Coordinate between agencies
- Use computer-based dispatching to eliminate missed transfers
- Use a mobility-as-a-service platform to integrate biking, ride-hailing, driving, and MBTA buses and trains into a single system
- Ease multimodal trips between rail, bus, paratransit, and TNCs
- Pursue partnerships between the MBTA and TNCs
- Coordinate schedules between rapid transit and buses
- Consolidate private shuttle buses and coordinate schedules with the MBTA
- Coordinate private and public funding to improve transportation options
- Coordinate different methods of transportation
- Create an online database of demand-based transportation options available to older adults and low-income people (ex: GATRA's Ride Match)
- Connect RTAs and TMAs across service borders
- Allow for interconnectivity among all transit and paratransit services, including fares "one card, one app"

- Coordinate existing transportation services for older adults, youth, people with disabilities, and people with lower incomes
- Create carpooling apps
- Establish transit nodes with easy transfers between bus and other modes
- Create multimodal transit centers at major commercial centers, including bikes, shuttles, TNCs, car sharing, and transit
- Provide a webpage application to map and publicize the availability of parking and accessible spots and parking rates near transit (Smart, connected parking sensors would communicate the availability of open spots)

Summary of Transit Needs

As this section has demonstrated, the needs of the region's transit system are extensive. They include the need to:

- Accommodate growing demand
- Repair aging infrastructure
- Modernize signals and rolling stock to increase capacity
- Consider competition from TNCs and other new transportation entities
- Address surface congestion and gain an appropriate share of road space to keep buses and the Green Line moving
- Collect sufficient data to appropriately analyze aspects of the system, such as crowding on the MBTA's Commuter Rail network
- Improve coordination between various operators, especially in suburban areas and on the fringes between multiple RTAs or other operators

Many of the MBTA's infrastructure needs are programmed for renewal or consideration under that agency's coming plans, but the MPO should continue to monitor developments and assist with planning and analysis as needed. The MPO can also serve as an important locus of coordination between municipalities, transit agencies, and state agencies—a need voiced frequently during public outreach.

Bicycle and Pedestrian

Background

The MPO has established objectives under its Capacity Management and Mobility goal to

- Improve access to and accessibility of all modes, especially active transportation (including bicycle and pedestrian improvements)
- Support strategies to better manage bicycle parking capacity and usage at transit stations
- Fund improvements to bicycle/pedestrian networks aimed at creating a connected network of bicycle and accessible sidewalk facilities (both regionally and in neighborhoods) by expanding existing facilities and closing gaps
- Increase percentage of population and places of employment with access to facilities on the bicycle network

This goal reflects the potential of both walking and bicycling to provide an efficient transportation network capacity and an environmentally sustainable mode of travel.

The potential for increasing walking and bicycling varies by geography and land use with the greatest room for growth existing in the maturing suburbs, regional urban centers, and developing suburbs of the region. When homes, jobs, and destinations are located in close proximity to each other, planners can create a robust, safe, and extensive network of pedestrian and bicycle infrastructure which could increase bicycle and pedestrian mode shares. When facilities are integrated into well-connected networks, they support trips both between and within the region's communities.

Federal, state, regional, and local initiatives supporting Complete Streets projects emphasize the collective interest in integrating and enhancing the role of bicycle and pedestrian modes in the transportation system. For example, MassDOT issued its Complete Streets design standards and related Healthy Transportation Policy Directive to ensure that MassDOT projects are designed and implemented so that all customers have access to safe and comfortable walking, bicycling, and transit options.

MPO Research and Analysis

The following section describes bicycle-specific and pedestrian-specific needs identified through MPO research and analysis.

Bicycle:

- Access to bicycle facilities
- Bike-sharing in the Boston region

Pedestrian:

- Collection of sidewalk and pedestrian facility data
- Examining network effects of safe infrastructure

Bicycle

Access to Bicycle Facilities

In 2019, MassDOT released its *Massachusetts Bicycle Transportation Plan* (Bicycle Plan) with the following vision: "Biking in Massachusetts will be a safe, comfortable, and convenient option for everyday travel." To that end, the Bicycle Plan lists two main goals:

1. Create high-comfort connected bike networks for people of all ages and abilities
2. Increase the convenience and attractiveness of everyday biking[29]

The type of bicycle facility at a given location greatly influences user comfort, which directly impacts the perceived convenience and attractiveness of biking for everyday travel.

MPO staff recognizes the importance of understanding the different levels of protections and comfort offered by bicycle infrastructure. Since high-quality protected or separated bicycle infrastructure garners considerably more usage and is much safer for all road users, staff explored how to define a "Bicycle Level-of-Service Metric" through a FFY 2018 UPWP study.[30] [31]In addition, staff sought to sharpen the analysis of residential and employment proximity to bicycle infrastructure contained in the last Needs Assessment (2015).

Using MAPC's continuously updated Trailmap application that maps and classifies active transportation infrastructure in the Boston region (located here: https://trailmap.mapc.org/), staff specifically mapped bicycle facilities in the MPO region and analyzed how many residents and jobs were located near high-quality infrastructure.[32] Figure 6-25 shows

[29] To view the Bicycle Plan, visit: https://massdot.maps.arcgis.com/apps/MapJournal/index.html?appid=c80930586c474a3486d391a850007694.

[30] See for example: https://www.citylab.com/transportation/2014/06/protected-bike-lanes-arent-just-safer-they-can-also-increase-cycling/371958/.

[31] "Development of a Scoring System for Bicycle Travel in the Boston Region," Boston Region MPO (November 8, 2018), https://www.ctps.org/data/pdf/studies/bikeped/bicycle-level-of-service.pdf

[32] High-quality bicycle infrastructure is defined as bicycle facilities that are physically separated (such as a vertical barrier between bicyclists), bicycle facilities at curb/sidewalk level that are accompanied by separation between bicyclists and pedestrians, or, in the case of shared-use paths, separate paths for bicyclists and pedestrians. Medium-quality bicycle infrastructure is defined as horizontally-separated bicycle facilities (such as paint-buffered bike lanes between motorists and bicyclists), bicycle facilities at curb/sidewalk level without a sidewalk buffer to separate bicyclists and pedestrians, or, in the case of shared-use paths, combined paths for bicyclists and pedestrians.

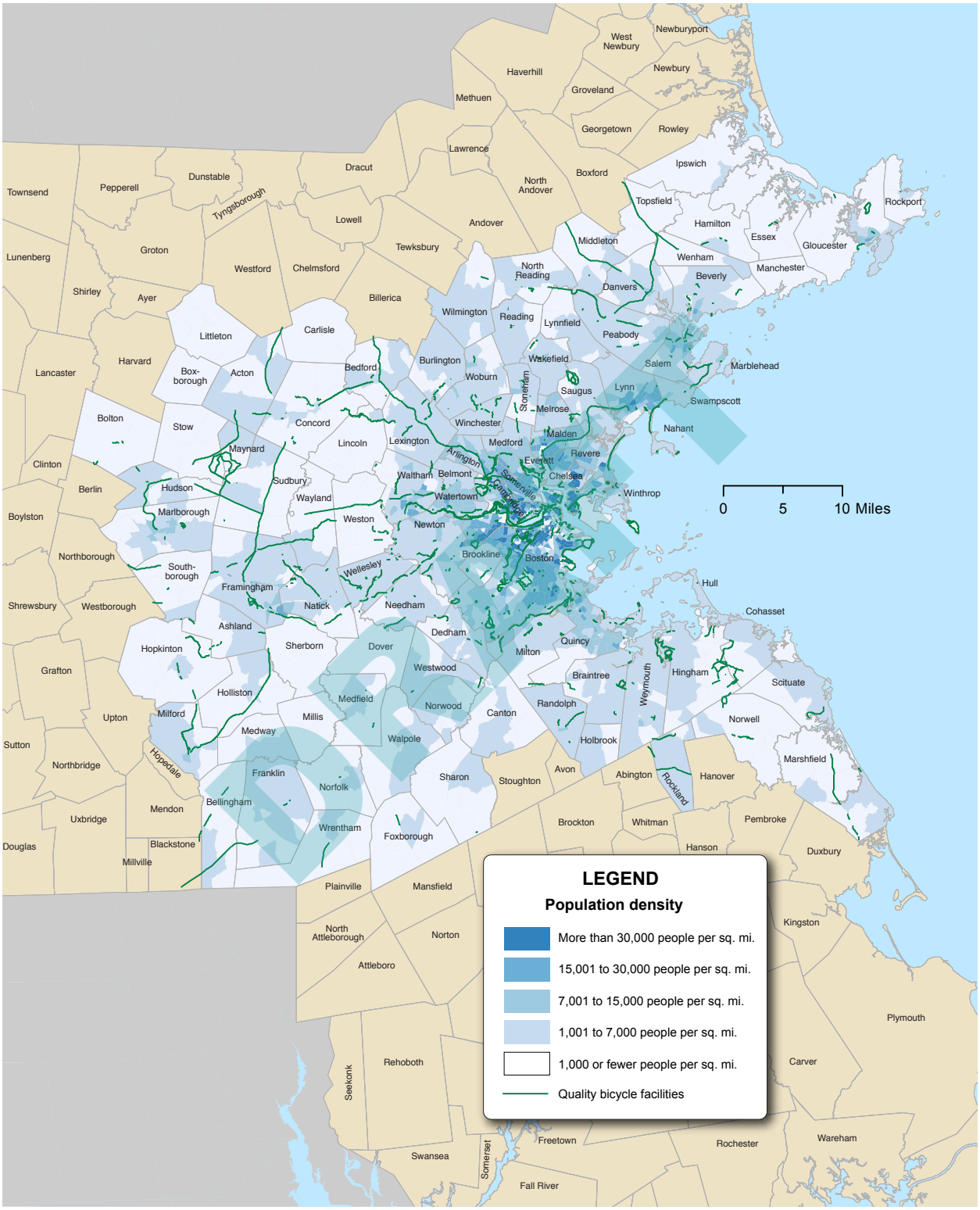
the locations of the high- and medium-quality bicycle infrastructure in the whole MPO region, while Figure 6-26 shows locations of bicycle infrastructure in the Inner Core in two categories: high- and medium-quality (roughly, infrastructure that offers physical separation from automobile traffic), and low-quality. Table 6-22 breaks down the access that high- and medium-quality bicycle infrastructure provides to residents and jobs in the region, while Table 6-23 shows access to all bicycle infrastructure in the MPO region.

Table 6-22
Access to High-Quality and Medium-Quality Bicycle Infrastructure in the Boston Region

High- and Medium-Quality Bicycle Infrastructure	Employment	Percent of Employment	Households	Percent of Households	Population	Percent of Population
Inner Core	1,006,000		616,800		1,487,900	
Within 1/4 mile	698,700	69%	320,600	52%	760,700	51%
Within 1/2 mile	896,200	89%	502,300	81%	1,207,300	81%
Regional Urban Centers	307,700		234,200		566,200	
Within 1/4 mile	72,600	24%	55,900	24%	134,500	24%
Within 1/2 mile	143,900	47%	114,300	49%	276,300	49%
Maturing Suburbs	470,200		339,800		871,900	
Within 1/4 mile	104,100	22%	62,600	18%	160,100	18%
Within 1/2 mile	198,500	42%	132,100	39%	338,700	39%
Developing Suburbs	139,700		121,200		319,900	
Within 1/4 mile	15,200	11%	11,100	9%	29,200	9%
Within 1/2 mile	29,900	21%	23,100	19%	60,600	19%

Source: Boston Region MPO.

Figure 6-25
High-Quality and Medium-Quality Bicycle Infrastructure in the Boston Region



Source: Boston Region MPO.

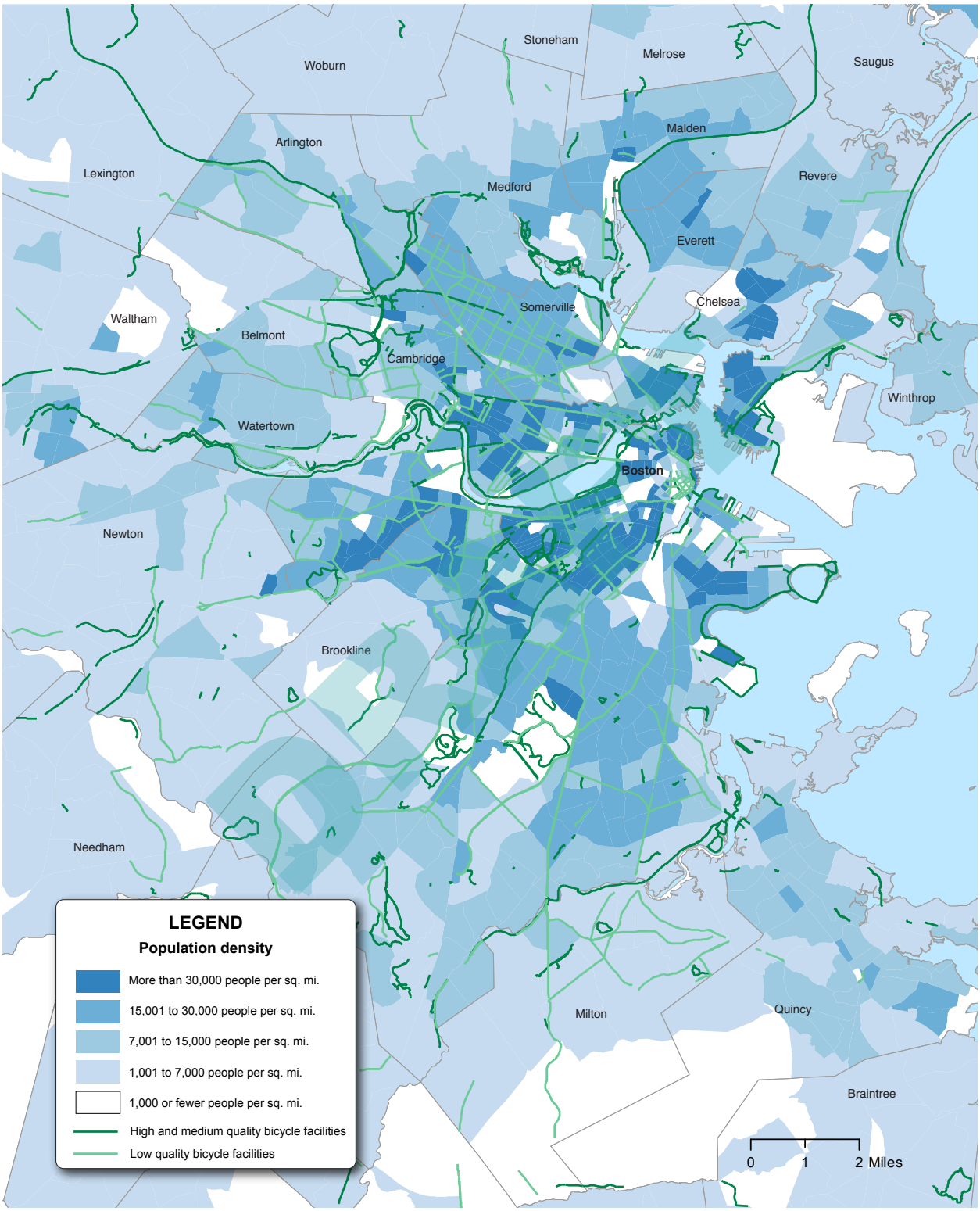
Table 6-23
Access to All Bicycle Infrastructure in the Boston Region

All Bicycle Infrastructure	Employment	Percent of Employment	Households	Percent of Households	Population	Percent of Population
Inner Core	1,006,000		616,800		1,487,900	
Within 1/4 mile	869,200	86%	474,500	77%	1,129,800	76%
Within 1/2 mile	955,500	95%	571,600	93%	1,374,700	92%
Regional Urban Centers	307,700		234,200		566,200	
Within 1/4 mile	88,400	29%	65,700	28%	157,100	28%
Within 1/2 mile	162,500	53%	126,600	54%	304,700	54%
Maturing Suburbs	470,200		339,800		871,900	
Within 1/4 mile	126,300	27%	75,400	22%	192,900	22%
Within 1/2 mile	237,100	50%	152,700	45%	391,400	45%
Developing Suburbs	139,700		121,200		319,900	
Within 1/4 mile	15,900	11%	11,900	10%	31,200	10%
Within 1/2 mile	31,200	22%	24,200	20%	63,400	20%

MPO = metropolitan planning organization.
Source: Boston Region MPO.

While bicycle, pedestrian, and shared infrastructure offers the promise of cheap, easy, and space-efficient capacity to the transportation network, there are still challenges remaining as to its implementation in the Boston Region MPO area. Rather than forming a coherent network, high-quality infrastructure has been built out project by project. This leads to trips that may begin or end on a comfortable path separated vertically or horizontally from other modes but may involve segments along on-street bike lanes or streets with sharrows (shared-lane markings) that many potential bicyclists regard as unsafe. Many underprivileged populations, such as low-income residents who could most benefit from inexpensive or free transportation, lack convenient access to bicycle infrastructure.

Figure 6-26
Map of All Bicycle Infrastructure in the Inner Core



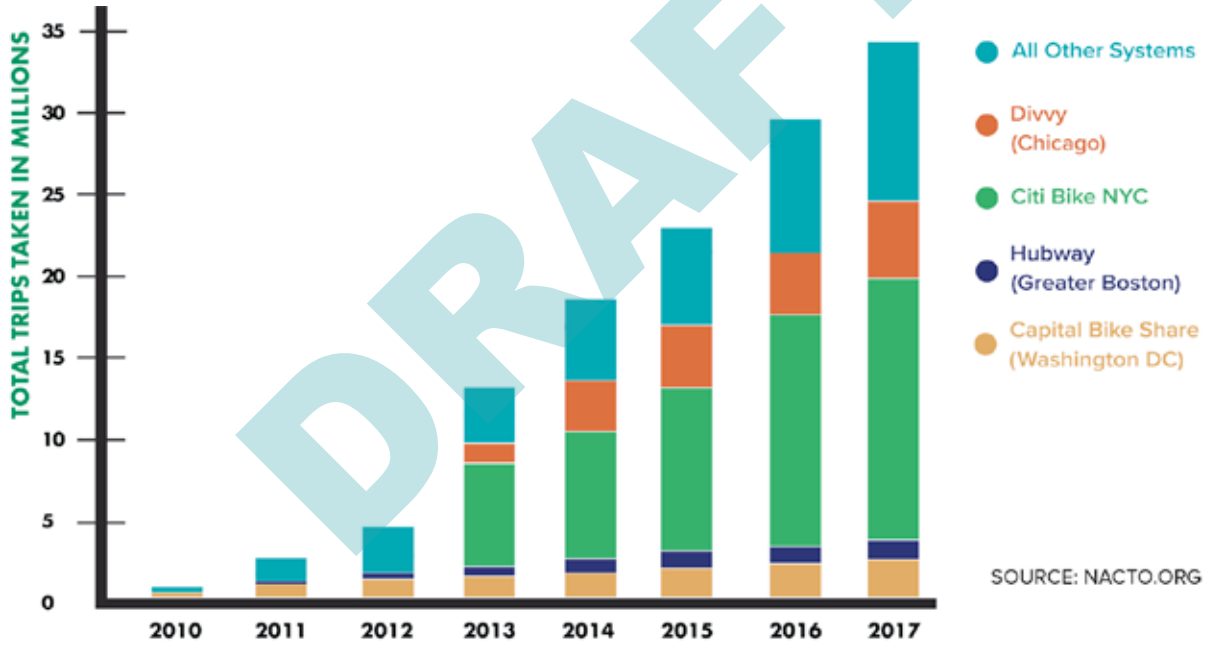
Source: Boston Region MPO.

In 2015, the MPO established a bicycle and pedestrian funding program as part of *Charting Progress to 2040*. This program provides an opportunity for the MPO to take the lead on creating a coherent network across multiple municipalities by prioritizing its own bicycle/pedestrian funding by network value; coordinating efforts between municipalities, state agencies, and other actors; and continuing to study and research best practices and the value of safe infrastructure.

Bike-sharing in the Boston Region

Since the last Needs Assessment, the Boston region and the entire country have seen dramatic growth in the popularity and prevalence of bike-sharing—a type of shared-use mobility where bicycles owned by a company or entity are made available for public use, typically for a small fee or subscription. This is also shown below in Figure 6-27.

Figure 6-27
National Growth of Bike-Share Usage



Source: National Association of City Transportation Officials (NACTO) Bike-Share in the U.S., 2017. https://nacto.org/bike-share-statistics-2017/.

The Boston region's major bike-share system, BLUEBikes (previously named Hubway) launched in 2011 and has enjoyed the support of Boston, Cambridge, Brookline, and Somerville. The system, operated by the major bike-share operating company Motivate, has continually grown its system of docks and is currently in the planning stages for major expansion throughout its member municipalities. Figure 6-28 shows the locations of the docks in the MPO area.

While BLUEBikes station locations are largely determined by member municipalities (with consultation provided by MAPC), the MPO continues to monitor system capacity and expansion, works to align the system with regional bicycle infrastructure, measures the impact of bike-share on the overall network, and addresses equity and access concerns. Table 6-24 analyzes proximity of employment, households, and population to BLUEBike docks in its member municipalities.

Table 6-24
Access to BLUEBikes (Docked Bike-Share) in Municipalities Served

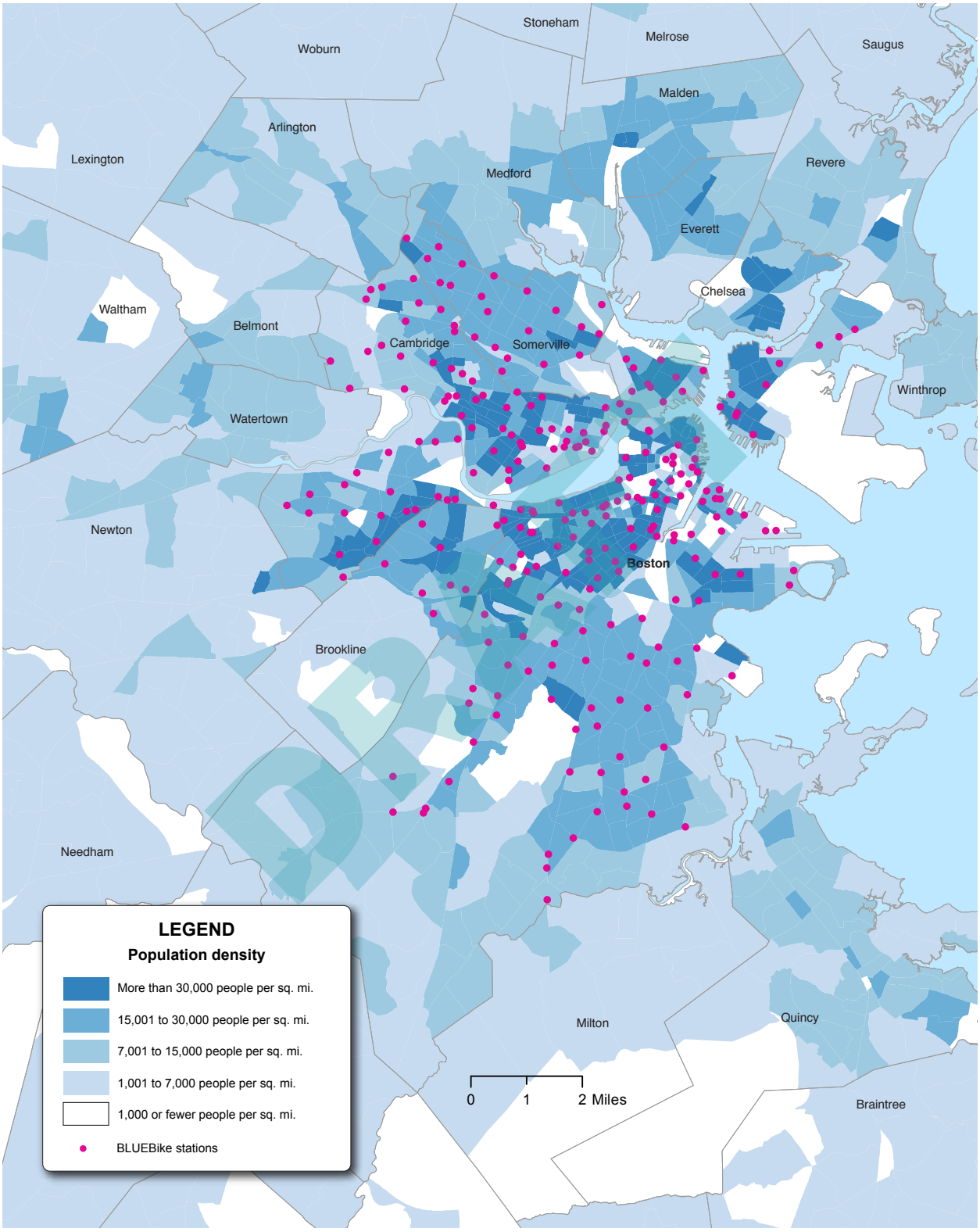
Bike-Share	Employment	Percent of Employment	Households	Percent of Households	Population	Percent of Population
Boston	613,300		281,300		676,400	
Within 1/4 mile	507,300	83%	178,800	64%	420,900	62%
Within 1/2 mile	567,000	92%	237,800	85%	567,000	84%
Brookline	21,100		26,700		60,400	
Within 1/4 mile	12,100	57%	13,600	51%	29,700	49%
Within 1/2 mile	17,600	83%	23,000	86%	50,300	83%
Cambridge	115,900		49,100		119,100	
Within 1/4 mile	102,100	88%	41,300	84%	101,700	85%
Within 1/2 mile	114,600	99%	48,700	99%	118,300	99%
Somerville	26,600		34,700		80,400	
Within 1/4 mile	18,300	69%	25,600	74%	59,100	74%
Within 1/2 mile	26,400	99%	33,600	97%	78,000	97%

Note: Only includes docked bike-share stations operated by BLUEBikes. The docked bike-share operated by Zagster in Marlborough and Salem was not included because data on the size and location of their fleet could not be found. Many other communities in the Boston Region MPO have dockless bike-shares (Figure 6-27) that could not be tracked as the locations of bicycles are not fixed.
Source: Boston Region MPO.

The past year has also seen rapid growth in a new bike-share paradigm, known as dockless bike-share. In this system, rather than returning bikes to a physical dock, users "unlock" bikes using a smartphone app and pick up or leave the bike anywhere within a predefined service area. Nationally, dockless bike-share operators installed around 44,000 dockless bikes in 2017, making up about 44 percent of the total number of bike-share bikes in the United States, and contributing to a doubling of the overall number of bike-share bikes available in the country.[33] However, the National Association of City Transportation Officials (NACTO) estimates that only four percent of bike-share trips were taken on dockless bikes in the United States in 2017.

33 NACTO Bike-Share in the U.S., 2017. https://nacto.org/bike-share-statistics-2017/

Figure 6-28
BLUEBike Dock Locations



Source: Boston Region MPO.

Dockless bike-share has also increased in the Boston region. MAPC has led a 16-community effort to bring bike-share to various suburban communities, and different municipalities have partnered with operators to provide dockless bikes. Figure 6-29 (below) shows the municipalities that have partnered with a dockless bike-share company as of November 2018.

While dockless bike-share is a new operating paradigm in the United States, its business model and future popularity appear uncertain at times. For instance, the October 2018 national publication, Streetsblog, published an article asking, "Is Pedal Dockless Bike-share Going Extinct?"[34] As of spring 2019, other dockless technologies, such as pedal-assist electric bikes and electric scooters, were becoming common in many cities, but the financial viability of the companies promoting them, and the regulatory framework that would allow them to continue to function, remained unclear. As of March 2019, Brookline was the first and only Massachusetts municipality to officially provide for electric scooter share, although the status of such vehicles in state law remained ambiguous.[35] The MPO will continue to monitor its development and coordinate with MAPC and regional communities to plan for increased adoption of dockless bike- and scooter-share and other such "micromobility" solutions as a benefit to regional mobility.

Pedestrian

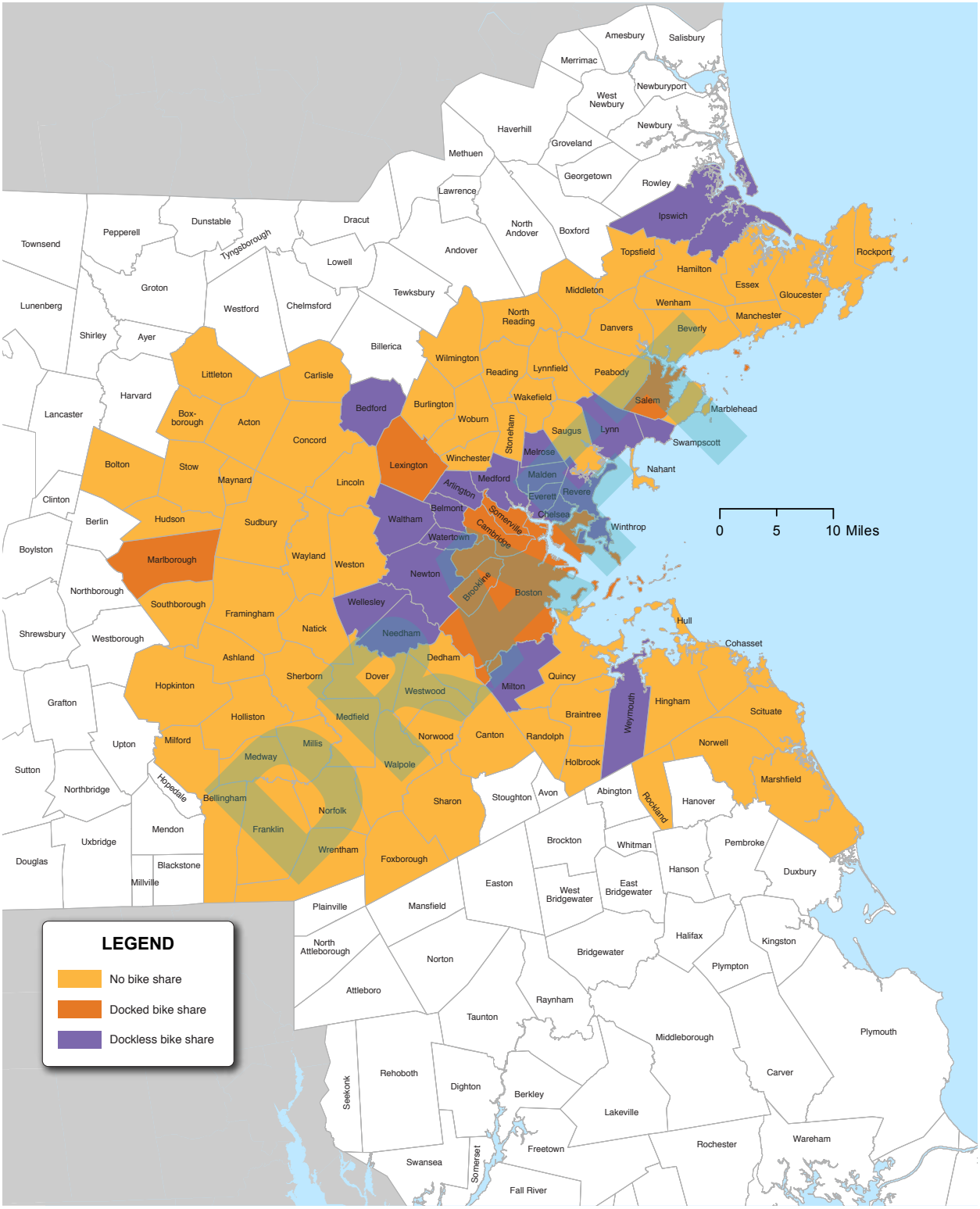
An inventory of the location, extent, and condition of the region's sidewalks and walkways is scarce, and there is a need to supplement this inventory with ongoing data collection and analysis. MassDOT released its Massachusetts *Pedestrian Transportation Plan* (Pedestrian Plan) in 2019, in which it lists several initiatives to meet the vision and goals defined in the Pedestrian Plan. The sixth initiative, "invest in data collection to inform Initiatives 1-5 and to track progress" is supported by MassDOT's commitment to inventory and collect condition information for sidewalks, roadway crossings, and off-street paths.[36] MassDOT further states that the information will be integrated into the MassDOT asset management database and geographic information systems or GIS, which should improve the current state of data available for sidewalks in the Boston region. Together, statewide and regional efforts to improve the quality and quantity of sidewalk data should facilitate the realization of MassDOT's vision for "all people in Massachusetts to have a safe and comfortable option to walk for short trips."

[34] "Is Pedal Dockless Bike Share Going Extinct?" StreetsBlog USA (2018), https://usa.streetsblog.org/2018/10/10/is-pedal-dockless-bike-share-going-extinct/.

[35] "Electric scooters will come to Brookline this spring" The Boston Globe (2019), https://www.bostonglobe.com/metro/2019/03/13/electric-scooters-will-come-brookline-this-spring/gsx17BynebY7EdM8Kkap1I/story.html

[36] Massachusetts Pedestrian Transportation Plan: https://massdot.maps.arcgis.com/apps/MapJournal/index.html?appid=96339eb442f94ac7a5a7396a337e60c0

Figure 6-29
Municipalities with Dockless Bike-Share Agreements



Source: Boston Region MPO.

Collection of Sidewalk and Pedestrian Facility Data

In preparation of this Needs Assessment, it became clear that no planning entity holds detailed data on the presence, absence or status of sidewalks in the MPO region. According to data gathered for MassDOT's Pedestrian Plan, 92 percent of sidewalks in the state are under municipal ownership, and MassDOT does not maintain pedestrian facility data of any type.[37] Knowing where sidewalks are located or absent, and their condition is a key element in planning. These data could be a springboard for numerous other planning efforts, such as MAPC's Local Access Score app, Safe Routes to School, and Safe Routes to Transit.[38] A model for such an effort was recently completed by the Capital District Transportation Committee (the MPO serving the Capital District of New York State).[39]

Examining Network Effects of Safe Bicycle and Pedestrian Infrastructure

There are several efforts underway to create a network of greenways (or bicycle and pedestrian infrastructure) serving parts of or the entire Boston region, including MassDOT's Bay State Greenways, MAPC's LandLine Network, and the Emerald Network, as proposed by the LivableStreets Alliance. The MPO will continue to monitor developments on greenways with the understanding that a potential greenway network would be a strong addition to the overall transportation network.

Bicycle and Pedestrian Stakeholder/Public Input

MPO staff received comments on the Capacity Management/Mobility goal area during outreach on needs from fall 2017 through spring 2018. The following is a summary of comments by theme.

Bicycle and Pedestrian Needs and Challenges Identified by Public Input

- A number of respondents noted an insufficient supply of safe, year-round bike parking in almost all locations.
- Respondents insisted on the need for safe routes to schools, jobs, commercial developments, and public transit. Intersections were noted as particularly dangerous.
- Respondents noted the need for improved connectivity of the sidewalk and bikeway networks and better access to bicycles or bike-sharing.

[37] Capital Planning Committee Meeting, June 5th, 2018, https://www.mass.gov/files/documents/2018/06/07/PedestrianPlanUpdate_060518.pdf.

[38] Local Access Score by MAPC: http://localaccess.mapc.org/

[39] CDTC's Regional Sidewalk Inventory: http://www.cdtcmpo.org/images/bike_ped/CDTC_Regional_Sidewalk_Inventory_Report.pdf

Proposed Solutions Identified by Public Input

Respondents overwhelmingly urged improvements to transit, biking, and walking infrastructure to serve equity populations (low-income and minority). People hoped to see a network of safe, connected, and well-maintained sidewalks and bikeways—both shared-use paths and on-road protected bike lanes. Intersections and timely snow clearance were noted as particularly important for safety.

Bicycle Improvements

- Construct safe, separated, on-road bicycle facilities on major roads, particularly in unsafe locations
- Construct safe off-road facilities
- Provide more bicycle parking
- Improve wayfinding
- Provide better bicycle education
- Provide a webpage application to map and publicize the availability of bicycle parking near transit (Smart, connected parking sensors would communicate the availability of open spots)
- Provide accessible parking along bicycle paths/cycle tracks
- Ensure access to safe, year-round bicycle parking in all locations
- Build additional bicycle infrastructure when developing new transit lines or stations
- Provide bike-share in the suburbs
- Reallocate lane usage from parking to bicycle lanes
- Build a gap-free network of safe, protected bicycle facilities that connect to transit

Pedestrian Improvements

- Improve safety for people walking (at sidewalks, crossings, signals)
- Build wider sidewalks to accommodate high pedestrian volumes from increased development
- Campaign with local businesses to offer discounts for customers who walk and bike
- Provide a network of safe and well-maintained sidewalks

- Provide crosswalks
- Design walking-friendly streets
- Provide more Complete Streets projects

Improved Connectivity

- Provide pedestrian improvements and traffic calming
- Implement pedestrian-only zones
- Construct more walkable developments
- Improve wayfinding
- Construct pass-over options (ex: walkway over Huntington at the Prudential Center)
- Connect Boston region bicycle/pedestrian paths to each other, to cycling infrastructure, and to public transit

Summary of Bicycle and Pedestrian Needs

As with other modes, the Boston region faces numerous policy and implementation challenges while planning for *Destination 2040* with respect to its bicycle and pedestrian networks. Demand for such accommodations, particularly for those that are of high-quality and safest for users, is growing. While many people within the MPO region, and especially in its densest areas, live near a section of high-quality bicycle infrastructure, the various elements have yet to be stitched into a network that enables widespread mobility since bicyclists and pedestrians sometimes compete for street space with cars, trucks, and buses.

Reliable region-wide data on the presence and condition of sidewalks is scarce—a key issue for safe routes to school and access to transit. The MPO and other policymakers must grapple with region-wide coordination on this issue, as well as with the growth of bike-share in both its docked and dockless forms. In addition to providing a region-wide forum for coordination on issues, such as creating a network of pedestrian and bicycle infrastructure, the MPO can also provide cutting-edge research and technical analysis to assist municipalities and others in the integration of bicycle and pedestrian accommodations into the transportation network.

UPDATES SINCE *CHARTING PROGRESS TO 2040* NEEDS ASSESSMENT

Since the MPO last updated its Needs Assessment in 2015, there have been several planning and policy changes that affect the content of this chapter:

- In March 2019, MassDOT and the MBTA released the *Focus40* plan which serves as a comprehensive playbook guiding all capital planning initiatives at the MBTA.
- In 2019, MassDOT announced the availability of its *Bicycle Plan* and *Pedestrian Plan.*
- The MBTA conducted the *Better Bus Project,* which proposed changes to bus service based on research and partnerships with municipalities.
- The MBTA has launched a study to examine the future of the commuter rail network, which reaches communities across the region.
- In August 2016, the Boston MPO completed its study on future growth in the region entitled, *Core Capacity Constraints: Accommodating Growth on Greater Boston's Congested Road and Crowded Transit System.*
- In 2016, US DOT finalized rules and requirements for states and MPOs related to roadway capacity management and mobility performance measures (see 23 CFR Parts 494 and 23 CFR Part 490). States and MPOs must monitor and set performance targets related to congestion reduction and transportation system reliability, and incorporate this information into its performance-based planning and programming process.

In addition, the MPO has witnessed new trends in the region since the last Needs Assessment, which have affected this update. These trends include:

- Changing land use and real estate market trends, including increasing pressure on Inner Core markets
- Transitions in commute and trip patterns including growth in commutes outside of a 9-to-5 schedule, longer commutes, and reverse commuting
- Growth in demand for safe, convenient options for biking and walking
- Growth in usage of TNCs and the need to generate data on the effects (TNCs include companies like Uber and Lyft)
- Potential introduction of AVs and CVs, and the need to plan for the effects on the network

- Rapid growth of shared-use and for-hire car services, also known as ridesourcing, ridesharing, and ride-hailing, among other terms
- Dramatic growth in the popularity and prevalence of bike-share in the Boston region and the entire country
- As of spring 2019, other dockless technologies, such as pedal-assist electric bikes and electric scooters, are becoming common in many cities
- As of March 2019, Brookline was the first and only Massachusetts municipality to officially provide for the electric scooter share

Updates have been made to this chapter based on these planning and policy changes, data availability, and other factors.

chapter 7

Clean Air and Sustainable Communities Needs

THE BOSTON REGION MPO'S CLEAN AIR AND SUSTAINABLE COMMUNITIES' GOALS AND OBJECTIVES

Goal:

Create an environmentally friendly transportation system.

Objectives:

- Reduce greenhouse gases generated in the Boston region by all transportation modes
- Reduce other transportation-related pollutants
- Minimize negative environmental impacts of the transportation system
- Support land use policies consistent with smart, healthy, and resilient growth

INTRODUCTION

Issue Statement

The Boston Region Metropolitan Planning Organization (MPO) acknowledges that greenhouse gas emissions (GHGs) contribute to climate change. If climate trends continue as projected, the conditions in the Boston region will include a rise in sea level coupled with storm-induced flooding and warmer temperatures that would affect the region's infrastructure, economy, human health, and natural resources.

The Commonwealth has made significant progress toward improving air quality in the region. The Boston Region MPO is meeting the national ambient air quality standards

(NAAQS) for ozone, particulate matter (PM), and carbon monoxide (CO). However, the MPO is required to continue monitoring its transportation activities to ensure that the region is continuing to meet the NAAQS, in particular, for ozone in the MPO area and CO for the City of Waltham. Continued vigilance is needed to keep emissions of these pollutants at acceptable levels. In addition, transportation infrastructure can negatively affect land use patterns and environmental resources. The MPO must continue to consult with the appropriate environmental agencies regarding transportation initiatives.

Background

Clean air and sustainable community issues related to the MPO's long range transportation planning include reducing greenhouse gas and other transportation-related emissions, minimizing the negative environmental impacts of the transportation system, and supporting land use policies consistent with smart, healthy, and resilient growth. With the acknowledgement that GHGs contribute to climate change, there are two aspects of climate change planning that the Boston Region MPO can move forward with—mitigation and adaption.

Climate change mitigation generally involves reductions in human (anthropogenic) emissions of greenhouse gases. Mitigation is addressed under the Clean Air and Sustainable Communities goal area. Adaptation is a direct response to climate change to reduce the vulnerability of systems, in this case, the transportation system, to a relatively sudden change to offset the effects of global warming. The changes can include large-scale changes, such as building infrastructure to protect against sea-level rise or improving the quality of road surfaces to withstand hotter temperatures. Adaptation is addressed under the System Preservation goal area.

Massachusetts is responding to the challenge of climate change by taking action to reduce the GHGs produced by the state—including those generated by the transportation sector. To that end, Massachusetts passed its Global Warming Solutions Act (GWSA), which requires reductions of GHGs by 2020, and further reductions by 2050, relative to 1990 baseline conditions. Reducing the use of single-occupant vehicles would scale back emissions of GHGs and other pollutants. Electrification of vehicles can also help reduce transportation-related emissions. The Boston Region MPO helps to implement the GWSA by analyzing proposed transportation projects for their impacts on GHG emissions.

The MPO also analyzes and monitors the presence of other air quality pollutants—volatile organic compounds (VOC), nitrogen oxides (NOx), CO, and $PM_{2.5}$ and PM_{10}—from transportation in the region. In 2012, the MPO region was classified as attainment for ozone (formed from VOC and NOx emissions). However, a recent court ruling requires that the MPO region continue to perform conformity determinations on new Long-Range Transportation

Plans (LRTP) to ensure that it is continuing to meet the NAAQS. The Boston Region MPO is in attainment with the PM standards, but remains in maintenance for CO for the City of Waltham.

Contributing to this improved air quality status is the MPO's attention to the State Implementation Plan Commitments from the Central Artery/Third Harbor Tunnel project, and other measures and projects funded in the LRTP and Transportation Improvement Program (TIP) to reduce congestion and improve transit and active modes of transportation. Although the MPO area is in attainment for certain pollutants and maintenance for others for specific air quality standards, the goal is to continue to reduce emissions of all pollutants. In addition, to support reductions in emissions from transportation, the United States Department of Transportation (US DOT) has required states and MPOs to implement a performance-based approach to making investments to reduce emissions, which includes setting performance targets and monitoring outcomes.

The MPO consults with agencies responsible for land management, natural resources, historic preservation, and environmental protection and conservation as related to transportation initiatives. Natural, environmental, and historic resources were mapped for the Boston region using information from the Commonwealth's Bureau of Geographic Information Systems (MassGIS).

In addition, the MPO considers environmental impacts that stem from transportation projects, including areas of critical environmental concern, special flood hazard areas, wetlands, water supply, protected open space, endangered species, and brownfield and superfund sites when considering and evaluating projects for funding. In the Boston region, environmental reviews for projects are conducted by the proponent transportation agency or municipality. The Massachusetts Department of Transportation (MassDOT) takes the lead on environmental reviews when each of the projects is in the design phase and prior to being funded for construction by the MPO. The MPO's land use agency, the Metropolitan Area Planning Council (MAPC), also submits comment letters on environmental documents for projects considered to be of significant regional impact. They also provide technical assistance to the member municipalities on other environmental issues including stormwater management, hazard mitigation planning, and climate mitigation and adaptation planning. The MPO supports land use policies that are consistent with smart, healthy, and resilient growth.

CLEAN AIR AND SUSTAINABLE COMMUNITIES' NEEDS SUMMARY

As mentioned above, Clean Air and Sustainable Communities' needs fall into three categories: reducing greenhouse gas and other transportation related emissions; minimizing the negative environmental impacts of the transportation system; and supporting land use policies consistent with smart, healthy, and resilient growth.

The reduction of GHG emissions is a priority for the MPO, not only to help implement the Commonwealth's GWSA, but to help alleviate impacts from climate change including flooding, sea-level rise, and warmer temperatures. The MPO should continue to evaluate and monitor carbon dioxide (CO_2) emissions from projects and programs funded through the LRTP and TIP. The MPO monitors CO_2 because it is the most significant GHG in the atmosphere. The MPO uses information from the Massachusetts Department of Energy Resources' Green Communities program to evaluate projects and programs for the LRTP and TIP, and MAPC works with municipalities on their Local Energy Action, Net Zero Communities 101, Energy-Use Baselines, and GHG Inventories programs. Continued updates of the MPO's Vehicle-Miles Traveled (VMT) and Emission Browser and All-Hazards Planning Application can provide additional information to municipalities that are creating GHG baseline information and GHG inventories.

Although the Boston region is meeting the air quality standards for most air pollutants, it is important to ensure that transportation projects funded by the MPO continue to help to reduce VMT, which in turn will continue to reduce air pollution in the region. The MPO should continue to evaluate and monitor VOCs and NOx—which are precursors to ozone—PM, and CO emissions from projects and programs funded through the LRTP and TIP. Updates to the MPO's VMT and Emission Browser will allow municipalities to monitor their transportation-related emissions of these pollutants as well.

The MPO does not engage in environmental planning, rather it relies on information from MassDOT, the Massachusetts Bay Transportation Authority (MBTA), and other planning agencies when evaluating projects and programs to be funded in the LRTP and TIP. MassDOT and the MBTA take the lead on environmental reviews during project design, and MAPC provides comments on environmental documents for regionally significant projects. Other sources of information used by the MPO include Massachusetts Geographic Information System (GIS) mapping, Massachusetts Department of Energy Resources' Green Communities program, and MAPC's stormwater management and hazard mitigation plans. The MPO should continue to coordinate with these agencies during its transportation planning activities.

Table 7-1 summarizes MPO staff-identified key findings about clean air and sustainable communities' needs through data analysis and public input. It also includes staff recommendations for addressing each need. More details on each of the recommendations are provided in Chapter 10 – Recommendations to Address Transportation Needs in the Region. The MPO board should consider these findings when prioritizing programs and projects to receive funding in the LRTP and TIP, and when selecting studies and activities for inclusion in the Unified Planning Work Program (UPWP).

Table 7-1
Clean Air and Sustainable Communities' Needs in the Boston Region Identified through Data Analysis and Public Outreach and Recommendations to Address Needs

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Greenhouse Gas	Reduce CO_2 emissions	Reduce CO_2 emissions from MPO-funded transportation projects and programs to help meet the requirements of the GWSA, particularly projects that help to reduce VMT	*Existing Programs* • Intersection Improvement Program • Complete Streets Program • Bicycle and Pedestrian Program • Major Infrastructure Program • Bottleneck Program • Community Transportation Program *Proposed Programs* • Enhanced Park-and-Ride Program • Dedicated Bus Lane Program • Interchange Modernization Program • Coordinating Car Sharing and Transit *Existing Studies* • Addressing Safety, Mobility, and Access on Subregional Priority Roadways (FFY 2019 UPWP) • Low-Cost Improvements to Express Highway Bottlenecks (FFY 2019 UPWP) • Reverse-Commute Areas Analyses (FFY 2019 UPWP) • Pedestrian Report Card Assessment Dashboard (FFY 2019 UPWP) *Proposed Studies* • Congestion Pricing Research • Safety and Operations at Selected Intersections
Greenhouse Gas	Reduce CO_2 emissions	Prioritize transportation projects and programs to assist municipalities in meeting or maintaining their Green Communities certification	*Existing MPO Action* Continue to use the MPO's evaluation criteria to assess projects seeking funding from the MPO
Greenhouse Gas	Reduce CO_2 emissions	Provide data and assistance to municipalities in developing their GHG inventories and energy reduction plans	*Existing MPO Action* Continue to provide CO_2 emissions data as part of the MPO's Vehicle-Miles Traveled and Emissions Data Browser

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Air Pollution	Reduce VOC, NOx, CO, and PM emissions	Reduce VOC, NOx, CO, and PM emissions from MPO-funded transportation projects and programs, particularly those that help to reduce VMT, to help maintain the air quality standards in the region	*Existing Programs* • Intersection Improvement Program • Complete Streets Program • Bicycle and Pedestrian Program • Major Infrastructure Program • Bottleneck Program • Community Transportation Program *Proposed Programs* • Enhanced Park-and-Ride Program • Dedicated Bus Lane Program • Interchange Modernization Program • Coordinating Car Sharing and Transit *Existing Studies* • Addressing Safety, Mobility, and Access on Subregional Priority Roadways (FFY 2019 UPWP) • Low-Cost Improvements to Express Highway Bottlenecks (FFY 2019 UPWP) • Reverse-Commute Areas Analyses (FFY 2019 UPWP) • Pedestrian Report Card Assessment Dashboard (FFY 2019 UPWP) *Proposed Studies* • Congestion Pricing Research • Safety and Operations at Selected Intersections
Environment	Protect the environment—wetlands, cultural resources, open space, and wildlife	Identify projects and programs that can meet criteria established to protect wetlands, cultural resources, open space, and wildlife	*Existing MPO Action* Continue to use the MPO's evaluation criteria to assess projects seeking funding in the MPO's LRTP and TIP
Environment	Protect the environment—water quality	Ensure that infrastructure to reduce storm water pollution is incorporated in project design	*Existing MPO Action* Continue to use the MPO's evaluation criteria to assess projects seeking funding in the MPO's LRTP and TIP
Environment	Protect the environment—hazard mitigation	Ensure that infrastructure to reduce impacts from natural hazard events (flooding, winter storms, etc.) is incorporated in project design	*Existing MPO Action* Continue to use the MPO's evaluation criteria to assess projects seeking funding in the MPO's LRTP and TIP

CO = carbon monoxide. CO_2 = carbon dioxide. GHG = greenhouse gas emission. GWSA = Global Warming Solutions Act. FFY = federal fiscal year. NOx = nitrogen oxides. PM = particulate matter. UPWP = Unified Planning Work Program. VMT = vehicle-miles traveled. VOC = volatile organic compound.
Source: Boston Region MPO.

UNDERSTANDING CLEAN AIR AND SUSTAINABLE COMMUNITIES' NEEDS IN THE BOSTON REGION

This section presents the research and analysis MPO staff conducted to understand transportation clean air and sustainable communities' needs in the Boston region, which have been summarized in the previous section. Supporting information that MPO staff used to understand clean air and sustainable communities' needs is included in the Appendices of this Needs Assessment.

- Appendix A includes key plans and policies
- Appendix B includes MPO studies and reports
- Appendix C includes data resources

This section also includes a summary of input staff gathered from stakeholders and the public about clean air and sustainable communities' needs and proposed solutions to meet those needs. Staff considered this input when developing recommendations to achieve the MPO's clean air and sustainable communities' goals and objectives.

Research and Analysis on Clean Air and Sustainable Communities

Greenhouse Gas and Air Pollution

Transportation-Related Emission Reductions

The MPO continues to monitor the estimated or projected levels of pollutants (VOC, NOx, CO, PM, and CO_2) at both the regional and project level. The MPO uses this information to guide planning and programming in its LRTP, TIP, studies or individual projects outlined in the UPWP, and project work for various transportation agencies. In both the LRTP and TIP project selection processes, the MPO reviews and rates projects on how well they meet criteria established to address climate change and reduce air pollution. Many of the projects funded by the MPO that reduce transportation related emissions are funded through the Congestion Mitigation and Air Quality (CMAQ) federal funding program in the TIP. The MPO reports CO_2 emissions of its programmed projects and programs to MassDOT, who in turn reports to the Executive Office of Energy and Environmental Affairs on its implementation of the GWSA.

In addition, many of the objectives established under the MPO's Capacity Management and Mobility goal help the MPO to meet the Clean Air and Sustainable Communities goal. The Capacity Management and Mobility goal encourages programs that help reduce VMT, which in turn helps to reduce emissions of VOC, NOx, CO, CO_2, and PM.

In December 2018, a report from the Commission on the Future of Transportation in the Commonwealth, *Choices for Stewardship: Recommendations to Meet the Transportation Future*, was released which identified recommendations to reduce GHG emissions from the transportation sector. One recommendation was specific to transportation electrification—to establish a goal that all new cars, light-duty trucks, and buses sold in Massachusetts be electric by 2040. For its part, the MPO can work with the state agencies to ensure that the appropriate infrastructure is available to power electric vehicles in the future.

The MPO consults with agencies responsible for environmental protection and conservation as related to transportation initiatives. The Massachusetts Department of Energy Resources (DOER) and MAPC provide resources that are used by the MPO in its project selection and transportation planning activities.

DOER administers a "Green Communities" program that helps municipalities to create a clean, affordable and resilient energy future. DOER offers cities and towns a range of energy initiatives and services to reduce GHG and to become clean energy leaders. To become certified as a Green Community, a community must

- Pass zoning in designated locations for the siting of renewable or alternative energy generating facilities, research and development facilities, or manufacturing facilities;
- Adopt an expedited application and permitting process of one year at most, under which providers interested in locating their facility in a designated renewable zone may be sited within the municipality;
- Establish an energy use baseline inventory for municipal buildings and facilities;
- Adopt an Energy Reduction Plan demonstrating a reduction of 20 percent of energy use after five years of implementation;
- Purchase fuel-efficient vehicles for municipal use, whenever such vehicles are commercially available and practicable, in all departments within a Green Community; and
- Minimize the life cycle cost of all newly constructed homes and buildings.

MAPC works with their member municipalities to attain this Green Communities certification. One of the MPO's evaluation criteria for funding in the LRTP and TIP is if the project is located in a certified Green Community. To date, there are 69 certified Green Communities in the Boston Region MPO area.

MAPC also provides technical assistance to municipalities to help reduce GHG emissions. These include

- Local Energy Action Program—Technical assistance program that helps municipalities plan for sustainable projects that reduce energy use and greenhouse gas emissions in the municipal, residential, and commercial sectors.

- Net Zero Communities 101—MAPC works with municipalities to develop climate and energy action plans including net-zero and energy reduction plans with specific steps for a city, town, or region to use to combat and mitigate the effects of climate change.
- Energy-Use Baselines and Greenhouse Gas Inventories—Technical assistance programs that help towns and cities build an energy-use and/or emissions profile of their communities, including the municipal, residential, commercial, and industrial sectors. Because residential, commercial, and industrial data is currently not available at the municipal level from utilities, MAPC helps build a more granular profile based on census data, labor statistics, and building energy survey analyses.

Federal Emission Reduction Performance Measures and Targets

To support reductions in emissions from transportation, the US DOT requires states and MPOs to implement a performance-based approach to making investments to reduce emissions, including setting performance targets and monitoring outcomes. There is one performance measure associated with emission reductions—total emissions reductions for applicable pollutants and precursors for CMAQ-funded projects in designated nonattainment and maintenance areas. Since the MPO is classified as maintenance for CO and must continue to do conformity determinations for ozone, the MPO is required to establish targets for this measure.

Table 7-2 identifies the federally required CMAQ emissions reduction measure, which is the total emissions reduction for applicable pollutants and precursors for CMAQ-funded projects in designated nonattainment and maintenance areas. The Federal Highway Administration (FHWA) requires states and MPOs subject to these CMAQ performance management requirements to establish a baseline for this measure by identifying emissions reductions associated with any CMAQ-funded projects programmed in air quality nonattainment or maintenance areas between FFY 2014 and FFY 2017. These states and MPOs were also required to set two-year and four-year targets for the emissions reductions they expect from CMAQ-funded projects programmed in nonattainment or maintenance areas.

In the Boston Region MPO's case, this CMAQ emissions performance measure would capture the anticipated CO emission reductions from any CMAQ-funded projects that the MPO has programmed specifically in the CO maintenance area in Waltham.[1] Table 7-2 also shows the Boston Region MPO's baseline and target values for this measure. Neither the MPO nor MassDOT programmed any CMAQ-funded projects in Waltham during FFYs 2014 to 2017. At the time of target setting, the MPO's TIP did not reflect any CMAQ-funded projects programmed in Waltham from FFY 2018 to 2021 either.

[1] FHWA assesses the CMAQ performance management requirements that apply to states and MPOs every two years. FHWA conducted its most recent assessment in August 2017, at which time the MPO was only subject to emissions performance management requirements for its CO maintenance area in Waltham. FHWA will conduct its next assessment by October 1, 2019, after which time the MPO may be subject to requirements for other pollutants or precursors.

Table 7-2
CMAQ Emissions Reduction Baseline and Targets for the Boston Region MPO

Performance Measure	FFYs 2014–17 Measure Value (Baseline)	Two-Year Target (FFYs 2018–19)	Four-Year Target (FFYs 2018–21)[a]
Daily kilograms of CO emissions reduction from CMAQ projects in Boston region nonattainment or maintenance areas	0	0	0

CMAQ = Congestion Mitigation and Air Quality. CO = carbon monoxide. FFY = federal fiscal year.
Source: Boston Region MPO.

Environment

One of the MPO's objectives is to minimize negative environmental impacts of the transportation system. The MPO addresses environmental impacts through its evaluation criteria, rating projects on how well they address impacts in these areas prior to programming projects in the LRTP and TIP. MassDOT takes the lead on environmental reviews when projects are in the design phase and prior to being funded by the MPO in its LRTP and TIP. MassDOT addresses the following environmental issues which are also considered in the MPO's evaluation criteria.

- Wetlands and Water Resources: MassDOT staff ensures all projects scheduled for construction receive the applicable Federal and State wetland permits. They prepare and/or review wetland permits and wetland/stormwater mitigation designs, delineate wetland boundaries in the field, conduct habitat evaluations, and determine wetland functions and values in accordance with the Department of Environmental Protection and U.S. Army Corps of Engineers methodologies. They also review proposed projects, provide technical and regulatory advice on wetland and water quality issues, recommend design changes where possible to avoid and minimize impacts, and determine the proper mitigation based on the extent of the impact relative to the feasibility of the mitigation.
- Cultural Resources: MassDOT staff reviews highway projects and files appropriate documentation to ensure that all projects comply with the applicable federal and state historic preservation laws and regulations.
- Hazardous Materials: MassDOT staff performs hazardous materials reviews on project designs for possible oil and hazardous waste/materials impacts, and if appropriate, recommends special provisions be included into the construction contract to address identified issues.
- Noise Abatement: MassDOT has programs in place to manage highway noise.

The MPO also considers the following environmental issues in its planning work; the information listed below can be accessed through the MPO's LRTP Needs Assessment tool. Users are directed to the Massachusetts GIS website to view maps of these areas.[2]

- *Areas of critical environmental concern (ACEC)*: Twelve ACECs are located at least partially in the Boston Region MPO area and are recognized for their unique, significant natural and cultural resources. The ACEC designation helps to ensure that any activities undertaken in or near the ACEC have minimal negative impacts.
- *Special flood hazard areas:* A simplified definition of these areas is that they are within 100-year floodplains. Proponents are directed to minimize construction and implement mitigation measures in areas categorized as being within a 100-year floodplain.
- *Wetlands:* Wetlands fall into the following categories: marsh/bog, wooded marsh, cranberry bog, salt marsh, open water, reservoir (with public water system identification), tidal flats, and beach/dune.
- *Water supply and wellhead protection areas:* These are surface water protection areas, classified according to the proximity to water. Wellhead protection areas, which include recharge areas for wells, are also classified.
- *Protected open space:* There are four levels of open-space protection—perpetuity, limited, term-limited, and none.
- *Natural heritage and endangered species program (NHESP) priority habitats:* Three categories are presented—NHESP certified vernal pools, NHESP estimated habitats of Rare Wildlife, and NHESP Priority Habitats of Rare Species.
- *Brownfield and Superfund Sites:* Brownfields are properties that may be complicated by the presence or potential presence of a hazardous substance, pollutant, or contaminant. A superfund site is an uncontrolled or abandoned place where hazardous waste is located.

In addition, the MPO's *All-Hazards Planning Application* shows the region's transportation network in relation to natural hazard zones. It works in conjunction with the MPO's database of TIP projects so that it can be used to determine if proposed projects are located in areas prone to flooding or at risk of seawater inundation from hurricane storm surges, or in the long term, sea level rise, which may be a result of climate change. Transportation facilities in such hazard zones might benefit from flood protection measures, such as enhanced drainage systems, or adaptations for sea level rise.

[2] To view maps of these areas, visit: https://www.mass.gov/service-details/massgis-data-layers.

MAPC provides technical assistance to municipalities to develop hazard mitigation plans. Hazard Mitigation planning is a proactive effort to identify actions that can reduce the impacts from natural hazard events, such as hurricanes, tornadoes, winter storms, and earthquakes. For the cities and towns in the Boston Metropolitan region, hazard mitigation planning tends to focus on flooding, the most common natural hazard to impact municipalities. The Federal Disaster Mitigation Act of 2000 requires that all municipalities that wish to be eligible to receive Federal Emergency Management Agency (FEMA) funding for hazard mitigation grants adopt a local multi-hazard mitigation plan and update this plan every five years. MAPC, with support from the FEMA Pre-Disaster Mitigation Program, provides assistance to cities and towns to develop and update their local Hazard Mitigation Plans. The plans and updates produced through this program are designed to individually meet the requirements of the Disaster Mitigation Act for each municipality and provide a resource for other local and regional planning efforts (e.g., Master Plans, Climate Change planning, Capital Improvements Programs, etc.). Similarly, MassDOT has its own Hazard Mitigation Plan, which is currently being updated.

MAPC also provides technical assistance to member municipalities on meeting federal requirements for stormwater management. Stormwater has become an issue in regards to water quality, which can be adversely impacted by chemical and biological materials if not directed to natural or man-made facilities designed to treat it. Runoff from roadways is of particular concern. The Environmental Protection Agency (EPA) requires that all large municipalities advance their Stormwater Master Plans and obtain a Municipal Separate Storm Sewer Systems general permit. Although these permits have been in place since 2003, the requirements have become more stringent as of July 1, 2018. The MPO can help to promote stormwater management by awarding points to highway projects that implement procedures for reducing stormwater pollution loads from runoff.

Environmental impacts of projects will continue to be reviewed and rated at the individual project level on how well they meet the MPO's criteria to protect the environment as they are submitted for funding consideration in the LRTP and TIP. Although a qualitative evaluation is done for projects in the conceptual design phase using the above-mentioned information, a more detailed evaluation is also possible for projects that are further along in design.

Land Use Policies

Land use decisions in Massachusetts are controlled directly by local municipalities through zoning. At the regional level, MAPC is the regional planning agency that represents the cities and towns in the metropolitan Boston area and the Boston Region MPO. MAPC created *MetroFuture* in 2008, a plan to make a "greater" Boston region—to better the lives of the people who live and work in metropolitan Boston, now and in the future. Some of *MetroFuture's* implementation strategies are to improve city life, conserve natural resources,

and support healthy families.[3] The MPO adopted this plan as its land use vision for the Boston Region MPO area. The MPO will continue to work with MAPC and municipalities to support these strategies and those that will be adopted as part of the new land use plan, *MetroCommon 2050*.

The *Choices for Stewardship: Recommendations to Meet the Transportation Future* report included recommendations to coordinate and modernize land use, economic development, housing, and transportation policies to support municipalities throughout the Commonwealth. The MPO can work with municipalities and state agencies to implement these recommendations.

Stakeholder and Public Input on Clean Air and Sustainable Communities

During fall 2017 and winter 2018, MPO staff collected feedback on transportation issues, needs, and opportunities from municipal planners and officials, transportation advocates, members of the general public, and other stakeholders. During this outreach process, 46 respondents commented on three different themes related to Clean Air and Sustainable Communities including greenhouse gas reduction, health and air quality, and noise. The following section is a summary of those comments by theme.

Greenhouse Gas Reduction

Respondents stated it is important to lessen the transportation system's contribution to global climate change by reducing carbon emissions. Respondents indicated a need to dramatically decrease GHG emissions from the transportation sector, which is the largest source of emissions. They also encouraged planning for a sustainable, carbon-neutral transportation system.

Respondents worried about the impact of storms and flooding on the region's aging transportation infrastructure, including roads, bridges, and rapid transit lines. Additionally, some respondents noted the climate impacts of transportation network companies (TNCs), which have increased single-occupancy trips. Others worried that autonomous vehicles (AVs) could have a similar climate impact, especially if AVs entering the market are not electric and not shared.

Respondents proposed solutions which focused on shifting mode share from single-occupancy vehicles into carbon-neutral forms of transportation (especially for local trips)

[3] In 2019 and 2020, MAPC will update the regional land use plan, and this new plan, *MetroCommon 2050* will be based on new development trends, housing needs, regional equity goals, and climate change impacts. *MetroCommon 2050* will not be completed until after the adoption of *Destination 2040*, however, the demographic projections and land use assumptions that will be used in *MetroCommon 2050* and in the *Destination 2040* LRTP and Needs Assessment have been developed.

and easing congestion on roadways. To accomplish this, respondents proposed funding improvements to public transit and infrastructure for people walking and biking. Respondents also encouraged electrification of the transit system.

Health/Air Quality

Respondents felt that the transportation system should support human health. This interest was highlighted by municipal officials, transportation advocates, Councils on Aging employees, and residents. Health concerns centered on pollution from congested roadways (especially at rush hour times) and the lack of active transportation options, which contributes to increased obesity. These concerns were noted as particularly prevalent in lower-income neighborhoods and communities of color. Additionally, respondents worried that TNCs have worsened congestion and increased pollution, due to increases in single-occupancy trips.

Noise

Respondents noted that noise can be a quality of life issue, particularly in areas neighboring rail lines. There is a desire for quiet zones in Ashland and Framingham. Respondents also felt that when additional commuter rail service is added, it should end before suburban communities (like Needham, for instance) to avoid noise concerns.

Solutions Proposed through the Public Outreach Process

Respondents also offered proposed solutions to reduce greenhouse gas emissions and noise, as well as improving air quality including:

- Improvements to public transit, such as investing in modernizing and expanding the public transit system to provide reliable, efficient, and cost-effective mass transit to riders in every neighborhood. This could include dedicated bus lanes, more frequent service, first mile/last mile shuttle services, developing more housing density around transit stations, and supporting community efforts to establish fixed-route services that connect transportation hubs to final destinations.
- Improvements to walking and biking, including
    - Shared roads for all modes;
    - Safer and better bike facilities including shared-use paths;
    - Education and enforcement to encourage local trips;
    - Linking the shared-use path network to public transit; and
    - Establishing safe walking and biking routes that are distant from highways and other polluted streets.

- Disincentives for driving including congestion pricing and tolling, requiring that AVs be shared, avoiding building new roads, and stopping prioritizing investments for the automobile

- Clean energy vehicles including electrifying the transportation system, running buses with hydrogen power, providing infrastructure for electric vehicles (EV) and introducing more EV charging stations, and encouraging partnerships between businesses and institutions

- Other proposed solutions including implement smart, connected parking sensors that communicate the availability of open spots, optimize traffic lights with sensors and communication with base in real time, study the climate impact of delayed investments in transportation, account for black carbon, preserve existing trees, and disaggregate transportation's impact on air quality to allow meaningful equity analyses of exposure to pollutants

Many of the proposed solutions above will also address the MPO's Capacity Management and Mobility goal.

UPDATES SINCE *CHARTING PROGRESS TO 2040* NEEDS ASSESSMENT

Since the MPO last updated its Needs Assessment in 2014, there have been several planning and policy changes that affect the content of this chapter.

- In 2016, the US DOT finalized rules and requirements for states and MPOs related to total emissions reductions for applicable pollutants and precursors for CMAQ-funded projects in designated nonattainment and maintenance areas (see 23 CFR Parts 494 and 23 CFR Part 490). States and MPOs must monitor and set performance targets related to this measure to improve air quality in the region.

- The MPO is now required to perform transportation conformity determinations on its LRTP and TIP. This is the result of the United States Court of Appeals ruling for the District of Columbia Circuit in *South Coast Air Quality Mgmt. District v. EPA* which stated that transportation conformity determinations must be made in areas that were either nonattainment or maintenance for the 1997 ozone NAAQS, and attainment for the 2008 ozone NAAQS when the 1997 ozone NAAQS was revoked. According to this ruling, the Boston Region MPO is now defined as an "orphan nonattainment area." Orphan nonattainment areas are areas that were designated as nonattainment for the 1997 ozone NAAQS at the time of its revocation (80 FR 12264, March 6, 2015) and were designated attainment for the 2008 ozone NAAQS in the EPA's original designations rule for this NAAQS. The ruling stated that orphan areas are required to continue to do conformity determinations even though they are in attainment with the new ozone

standard. A full description of the process is provided in the Air Quality Conformity chapter in the LRTP document.

MPO staff has made several updates to this chapter, based on planning and policy changes, data availability, and other factors. Staff has also updated the VMT and Emissions Data Browser application[4] with new demographic projections developed for *Destination 2040*, the travel model results of vehicle-miles of travel, and the resulting transportation emissions.

[4] To view the application, visit: http://www.ctps.org/geoserver/www/apps/vmtApp/index.html.

chapter 8

Transportation Equity Needs

THE BOSTON MPO'S TRANSPORTATION EQUITY GOAL AND OBJECTIVES

Goal:

Ensure that all people receive comparable benefits from, and are not disproportionately burdened by, MPO investments, regardless of race, color, national origin, age, income, ability, or sex.

Objectives:

- Prioritize MPO investments that benefit equity populations
- Minimize potential harmful environmental, health, and safety effects of MPO-funded projects for all equity populations
- Promote investments that support transportation for all ages (age-friendly communities)
- Promote investments that are accessible to all people regardless of ability

INTRODUCTION

Issue Statement

Over three million people live in the Boston region, representing a broad range of ages, abilities, incomes, races, ethnicities, and nationalities. Not all residents benefit equally from transportation investments, and some have been traditionally underserved by transportation

and underrepresented in the planning process. The Boston Region Metropolitan Planning Organization (MPO) considered the transportation needs of these underserved populations, referred to as transportation equity (TE) populations, in the development of this Needs Assessment.

Given the Boston region's demographics and the changing nature of travel patterns (induced, in part, by emerging new technologies and increasing interest in transit and non-motorized transportation options), sustaining a transportation network that serves all residents continues to present challenges. As a regional transportation planning agency, the MPO has an important role to play in addressing these challenges. The chapter reports on the current transportation needs facing TE populations. This information will help the MPO better allocate limited resources to address the most significant needs.

Background

As a recipient of federal funding, the Boston Region MPO is required to comply with various federal civil rights statutes, executive orders, and regulations that are intended to ensure that the transportation needs of traditionally underserved populations are considered in the MPO's planning and programming and that they have opportunities participate in MPO activities. Specifically, federal laws prohibit MPOs from discriminating on the basis of race, color, national origin, sex, disability, and age in all of their activities, policies, and programs. MPOs are further required to identify and address the disproportionately high and adverse effects of their activities on minority and low-income populations, as well as provide meaningful access to their services for those with limited English proficiency (LEP) as an extension of national origin protections.

The Boston Region MPO considers TE populations to include those protected by federal laws and regulations—such as people who identify as minority and people with disabilities—as well as those who have specific transportation needs (members of transit-dependent households, for example). Specifically, the MPO considers TE populations to include the following groups:

- People who identify as minority
- People with LEP
- People with disabilities
- People who are 75 years of age or older

- People who are 17 years of age or younger
- People who are members of low-income households or transit-dependent households[1]

The MPO's Transportation Equity Program ensures that the MPO complies with all federal Title VI, environmental justice (EJ), and other nondiscrimination regulations. As part of the program, staff supports the development of the Long-Range Transportation Plan (LRTP) Needs Assessment by ensuring that the transportation needs of the populations covered by those mandates are considered and by identifying the transportation needs of TE populations through data analysis and public outreach.

TRANSPORTATION EQUITY NEEDS SUMMARY

Input from public outreach and results from data analyses show that TE needs coincide with needs identified in all of the MPO's other goal areas. These needs include access to frequent, reliable public transit; more transit service to healthcare facilities; additional first- and last-mile connections to and from rail stations; more complete bicycle and pedestrian networks; safe bicycle and pedestrian transportation routes away from congested roadways in communities with high shares of TE populations; transit service during off-peak hours and for reverse commutes; transit service between suburbs, especially to and from job centers; bicycle routes to and from employment centers; bicycle facilities, sidewalks, and street crossings that are safe for children and elderly adults; and more sidewalks that are in compliance with the Americans with Disabilities Act (ADA). Outside of the existing goal areas, there is also a need to improve coordination across agency and political boundaries as many commenters said that poorly coordinated schedules and services can lead to long trips.

Table 8.1 provides more detail about the needs of TE populations, which were identified through public outreach and data analysis.

[1] MPO staff uses 2010 United States Census and 2010–14 American Community Survey (ACS) data to identify TE populations as follows:
- People considered as minorities are those who identify as Hispanic or Latino/a/x and/or Black or African American, Asian, American Indian or Alaska Native, or Native Hawaiian or other Pacific Islander.
- LEP status is tabulated for the population aged five and older. A person with LEP is defined as a person who speaks English less than "very well," as reported in the ACS.
- Disability status is tabulated for the noninstitutionalized population.
- The minority population, the population 75 years of age or older, and the population 17 years of age or younger are tabulated for the entire population.
- The low-income population and transit-dependent households are tabulated for all households.
- A low-income household is one whose annual household income is less than or equal to $45,392, which is 60 percent of the region's median household income of $75,654.
- A transit-dependent household is one that does not have access to any personal vehicle.

Table 8-1
Recommendations for Addressing Transportation Equity Needs in the Boston Region

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Capacity Management and Mobility	Serving non-traditional commutes	There is a lack of public transit service for reverse commutes and off-peak commutes.	*Existing Programs* • Community Transportation • Regional Transit Service Planning Technical Assistance *Existing Study (2019 UPWP)* Reverse-Commute Areas Analysis *Proposed Study (2020 UPWP)* Operating a Successful Shuttle Program
Capacity Management and Mobility	Gaps in transit service	Some TE populations lack transit service comparable to service available to non-TE populations.	*Existing Programs* • Community Transportation • Regional Transit Service Planning and Technical Assistance *Proposed Programs* • Bus Mobility • Connect Elderly Adults with Transportation *Proposed Study (2020 UPWP)* Operating a Successful Shuttle Program
Capacity Management and Mobility	Transit reliability	Rapid transit and bus service is unreliable for populations whose only option is transit.	*Existing Programs* • Major Infrastructure • Regional Transit Service Planning Technical Assistance *Proposed Programs* • Bus Mobility • Connect Elderly Adults with Transportation • Transit Modernization *Existing Studies (2019 UPWP)* • Transportation Access Studies of Commercial Business Districts • The Future of the Curb
Capacity Management and Mobility	First- and last-mile connections	First- and last-mile connections to transit (including pedestrian, bicycle, and transit routes) are lacking, causing barriers to transit usage.	*Existing Programs* • Bicycle Network and Pedestrian Connections • Community Transit • Regional Transit Service Planning Technical Assistance *Proposed Programs* • Bus Mobility • Connect Elderly Adults with Transportation *Existing Studies (2019 UPWP)* • Pedestrian Report Card Assessment Dashboard • The Future of the Curb • Transportation Access Studies of Commercial Business Districts *Proposed Studies (2020 UPWP)* • Operating a Successful Shuttle Program • Transportation Equity Areas Bicycle and Pedestrian Analysis

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Capacity Management and Mobility	Active transportation options	Elderly and youth populations have inadequate access to safe bicycle facilities.	*Existing Programs* • Bicycle and Pedestrian Connections • Complete Streets *Existing Study (2019 UPWP)* The Future of the Curb *Proposed Studies (2020 UPWP)* • Transportation Equity Areas Bicycle and Pedestrian Analysis • Locations with High Bicycle and Pedestrian Crash Rates in the Boston Region MPO Area
Capacity Management and Mobility	Active transportation options	Docked bike-share facilities in the Inner Core are not available to some communities with high shares of low-income or minority populations; the future of dockless bike-share systems is uncertain.	*Existing Program* Community Transit *Existing Study (2019 UPWP)* The Future of the Curb
Clean Air and Clean Communities	Auto emissions	More off-road active transportation routes are needed in communities with high shares of TE populations that live near congested roadways.	*Existing Program* Bicycle and Pedestrian Connections *Proposed Study (2020 UPWP)* Transportation Equity Areas Bicycle and Pedestrian Analysis
Coordination between municipalities and regions[a]	Coordination of services between towns and transportation agencies	Better coordination of schedules, routes, and services is needed between towns and between the MBTA and other regional transit authorities.	*Existing Program* Regional Transit Service Planning Technical Assistance *Proposed Study (2020 UPWP)* Operating a Successful Shuttle Program
Economic Vitality	Transit service during non-peak commuting times to job-rich centers	More transit service (late night, early morning, and reverse commute) is needed between job-rich centers—such as Longwood Medical Area, the Seaport, and suburban job centers—and underserved neighborhoods.	*Existing Programs* • Community Transportation • Major Infrastructure *Proposed Program* Bus Mobility *Existing Studies (2019 UPWP)* • Reverse-Commute Areas Analysis • Transportation Access Studies of Commercial Business Districts *Proposed Study (2020 UPWP)* Operating a Successful Shuttle Program

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Economic Vitality	Lack of transit routes between suburbs	New transit service is needed between low-income suburban residential communities and suburban job centers.	*Existing Programs* • Community Transportation • Major Infrastructure • Regional Transit Service Planning Technical Assistance *Proposed Program* Bus Mobility *Existing Study (2019 UPWP)* Transportation Access Studies of Commercial Business Districts *Proposed Study (2020 UPWP)* Operating a Successful Shuttle Program
Economic Vitality	Affordable housing	Transportation needs of TE populations could be met by building transit-oriented developments that provide affordable housing near transit hubs and employment centers, particularly in the inner core and suburbs.	*Existing Program* Transportation Equity Program—this can be coordinated with MAPC's work on land use issues, including housing and transportation *Existing Study (2019 UPWP)* Transportation Access Studies of Commercial Business Districts
Economic Vitality	Lack of safe bicycle routes to key destinations	The region needs good-quality bicycle infrastructure that connects homes and final destinations, such as jobs and other amenity-rich locations, especially in and between communities with high shares of low-income or transit-dependent households.	*Existing Programs* • Bicycle Network and Pedestrian Connections • Community Transportation Technical Assistance • Complete Streets *Existing Studies (2019 UPWP)* • The Future of the Curb • Transportation Access Studies of Commercial Business Districts *Proposed Studies (2020 UPWP)* • Transportation Equity Areas Bicycle and Pedestrian Analysis • Locations with High Bicycle and Pedestrian Crash Rates in the Boston Region MPO Area
Safety	Lack of safe bicycle routes within neighborhoods	Improve access to safe bicycle facilities within communities with high shares of TE populations.	*Existing Programs* • Bicycle Network and Pedestrian Connections • Complete Streets *Existing Study (2019 UPWP)* The Future of the Curb *Proposed Studies (2020 UPWP)* • Locations with High Bicycle and Pedestrian Crash Rates in the Boston Region MPO Area • Transportation Equity Areas Bicycle and Pedestrian Analysis

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Safety	Unsafe sidewalks and street crossings, and incomplete pedestrian networks	Improve sidewalks and street crossings, especially around schools, so that they are safe for children and elderly adults.	*Existing Programs* • Community Transportation Technical Assistance • Complete Streets • Intersection Improvements *Existing Studies (2019 UPWP)* • Pedestrian Report Card Assessment Dashboard • Safety and Operations at Selected Intersections
System Preservation	Non-ADA compliant sidewalks	Upgrade sidewalks to be compliant with the ADA.	*Existing Programs* • Community Transportation Technical Assistance Program • Complete Streets • Intersection Improvements *Proposed Program* Connect Elderly Adults with Transportation *Existing Study (2019 UPWP)* Pedestrian Report Card Assessment Dashboard
System Preservation	Climate change	Document potential exposure of TE populations to climate change impacts and determine how their ability to access transportation may be affected.	*Existing Program* Transportation Equity Program *Proposed Program* Climate Resiliency *Proposed Study (2020 UPWP)* Exploring Resilience in MPO-funded Corridor and Intersection studies

[a] Although this issue does not directly relate to the MPO's goal areas, this topic was voiced during public outreach.
ADA = Americans with Disabilities Act. MAPC = Metropolitan Area Planning Council. MPO = Metropolitan Planning Organization. TE = transportation equity. UPWP = Unified Planning Work Program.
Source: Boston Region MPO.

UNDERSTANDING TRANSPORTATION EQUITY NEEDS IN THE BOSTON REGION

This chapter discusses the transportation needs of TE populations identified through data analysis and public outreach. The information included in this chapter builds on information in previous LRTPs by identifying the needs of TE populations as they relate to each of the MPO's other existing goal areas: Safety, Economic Vitality, Clean Air/Sustainable Communities, Capacity Management and Mobility, and System Preservation. This approach better organizes the transportation needs of TE populations in relationship to the other areas that are of interest to the MPO. This chapter summarizes analysis results specific to TE populations for analyses that are included for all populations in the other goal area chapters. The full descriptions of the methodologies used to evaluate the needs of TE populations can be found in the respective goal area chapters.

The findings in the Needs Assessment informs *Destination 2040*'s new TE goal and objectives, which shape how equity is considered in project selection and performance analysis in the Transportation Improvement Program (TIP) and the LRTP. The recommendations will help the MPO identify ways in which the MPO can address the needs through the Transportation Equity Program.

Supporting information that the MPO staff used to understand capacity management and mobility needs is included in the Appendices of this Needs Assessment.

- Appendix A includes key plans and policies
- Appendix B includes MPO studies and reports
- Appendix C includes data resources

Research and Analysis

Demographics of the Boston Region

Transportation Equity Populations' Demographics

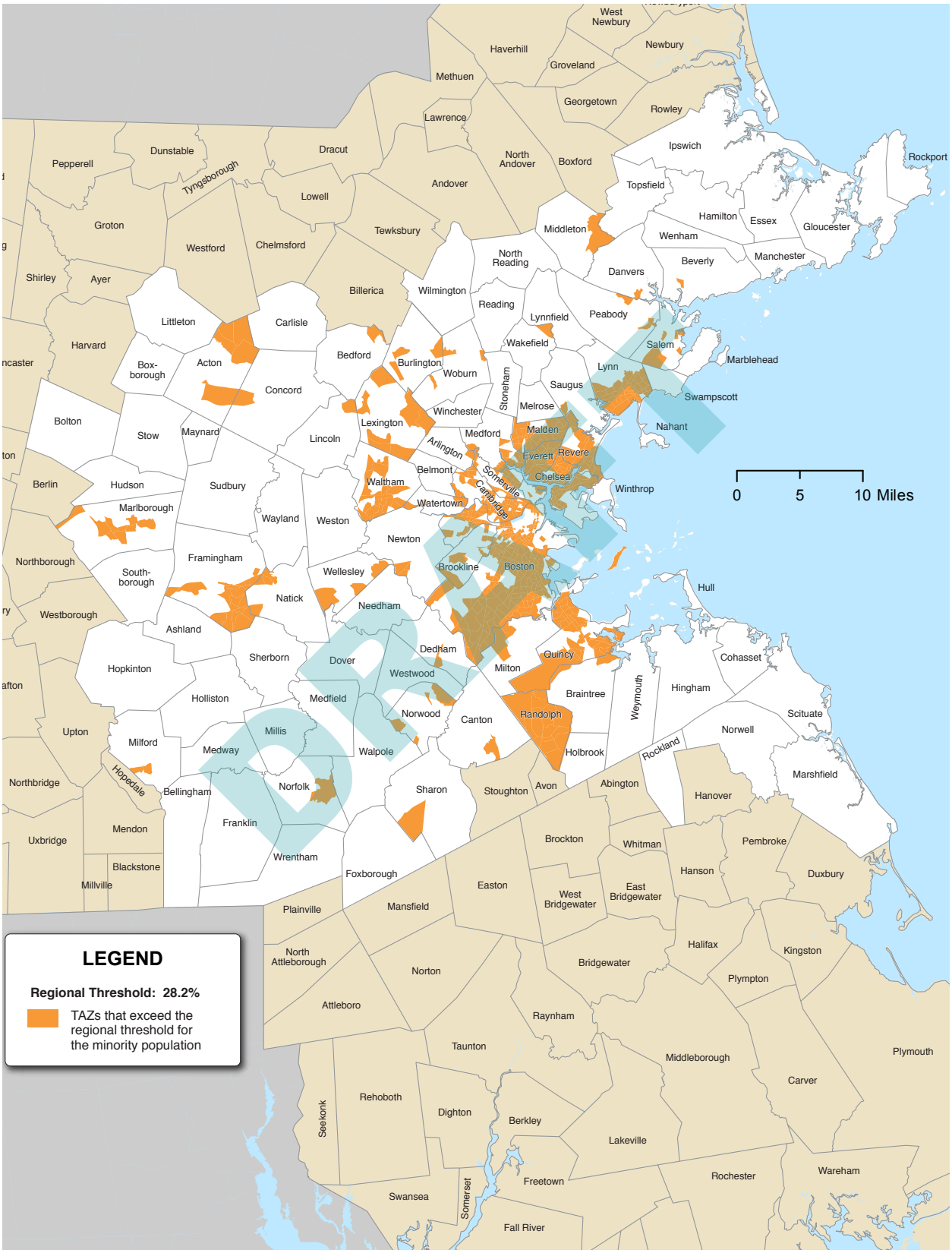
The MPO staff regularly collects and analyzes demographic data on TE populations in the region. The analyses that follow describe the demographic characteristics of TE populations living within the region. These data are derived from the 2010 United States Census and the 2010–14 American Community Survey (ACS). The MPO staff uses these data to determine how many people or households of each TE population live in the Boston region, identify where in the region they live, and identify communities where there is a high share of TE populations.

To identify communities in which there is a high share of TE populations, the MPO sets a regional threshold for each population. For all TE populations except low-income households the regional threshold is defined as the average number of people or households within the MPO region who meet the definition of a TE population.[2] For low-income households, the regional threshold is 60 percent of the region's median household income. Data from the 2010–14 ACS show that the regionwide median income is $75,654; therefore, the low-income threshold is $45,392. These thresholds are used to identify transportation analysis zones (TAZs) in which there are a high share of TE populations. TAZs that exceed these thresholds are referred to here as transportation equity zones (TEZs).[3] Figures 8.1 through 8.7 below show the TAZs that exceed regional threshold for each TE population.

[2] For people who identify as minority, have LEP, are 75 years old or older or 17 years old or younger, or who have a disability, the threshold is based on the number of people. For transit-dependent and low-income households, the threshold is based on the number of households.

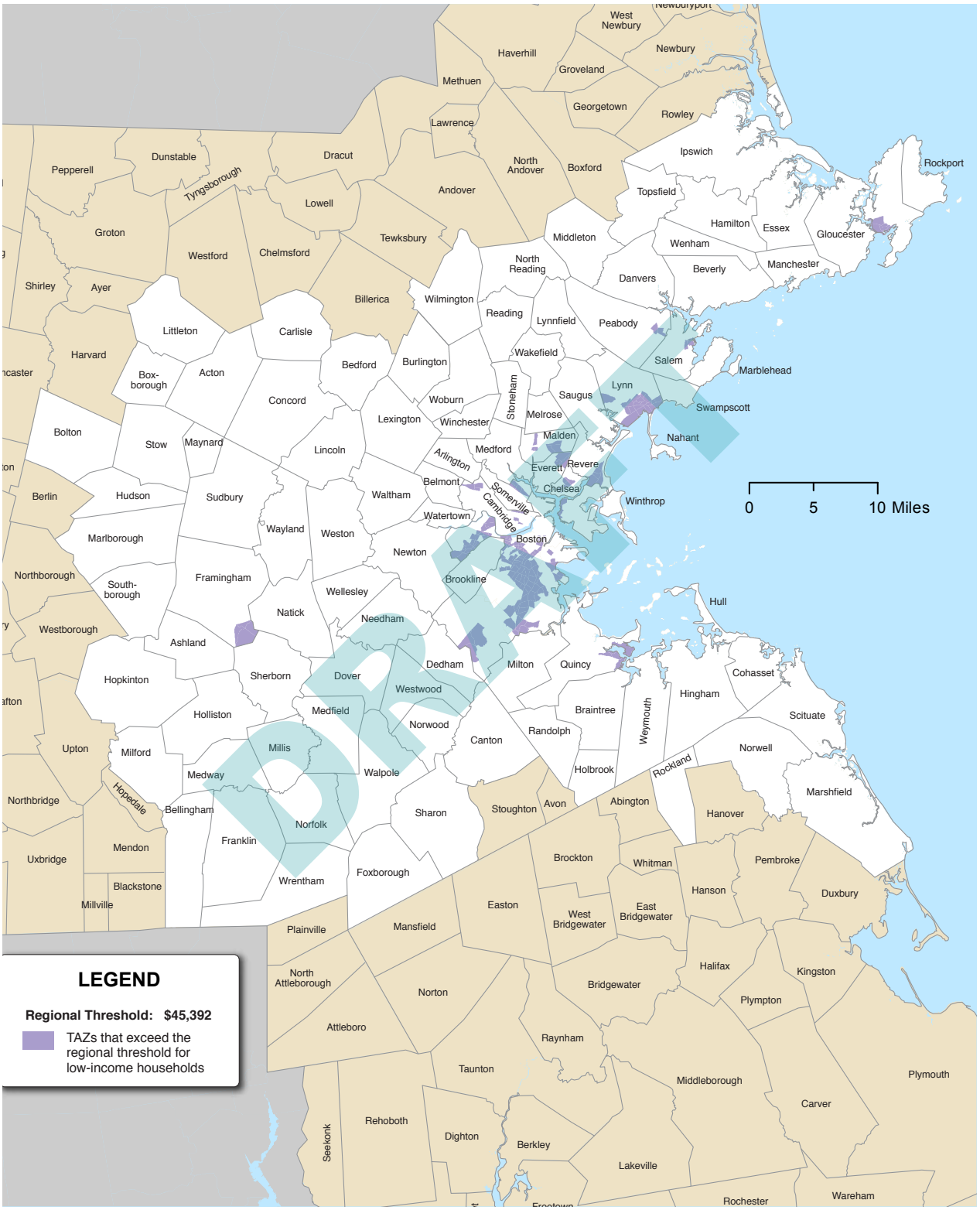
[3] A TAZ is a unit of geography used for travel demand modeling. The MPO region is divided into TAZs, which are approximately the size of census block groups; there are 1,901 TAZs in the region.

Figure 8-1
Transportation Equity Zones: Minority



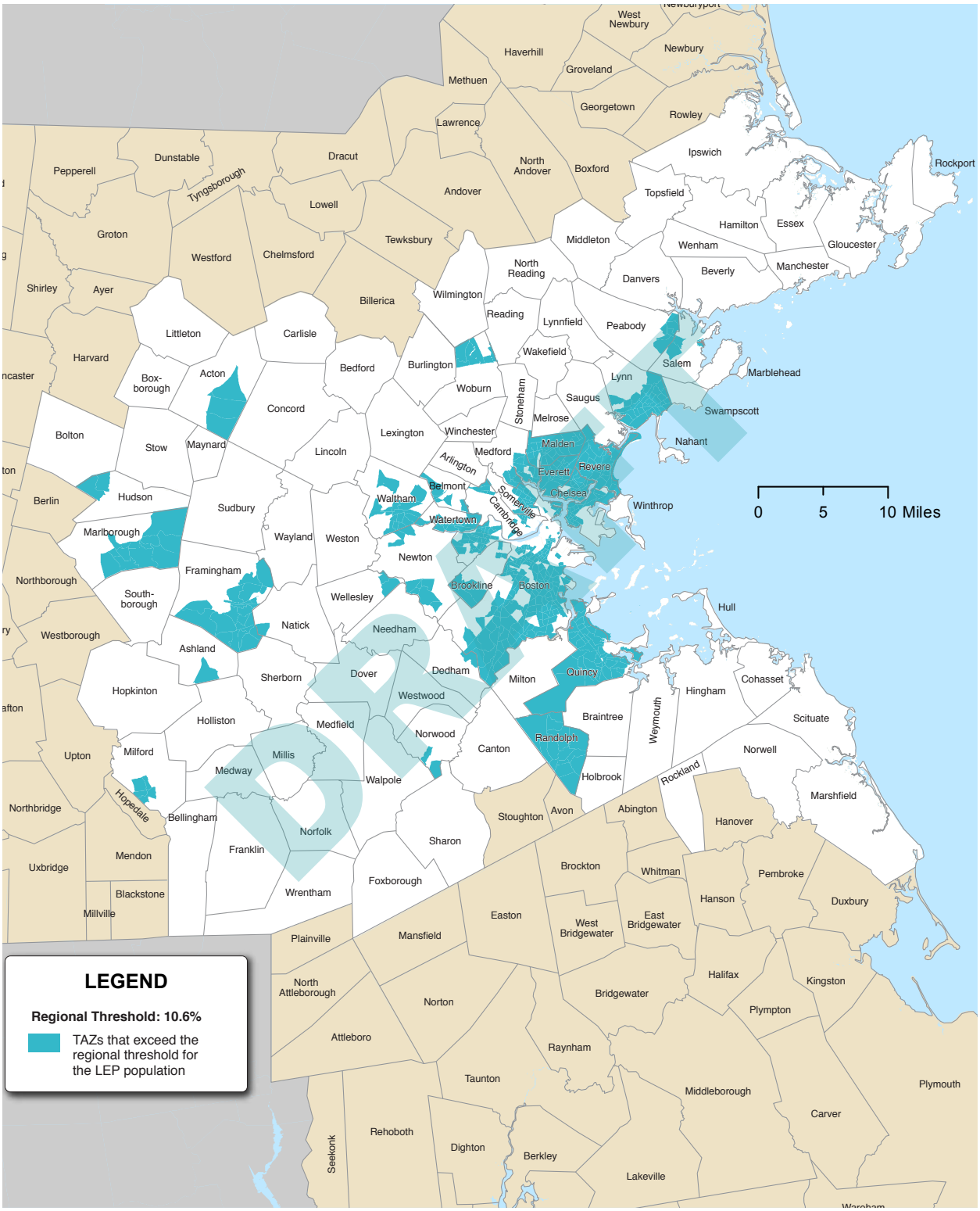
TAZ = transportation analysis zone.
Source: 2010 US Census.

Figure 8-2
Transportation Equity Zones: Low-Income



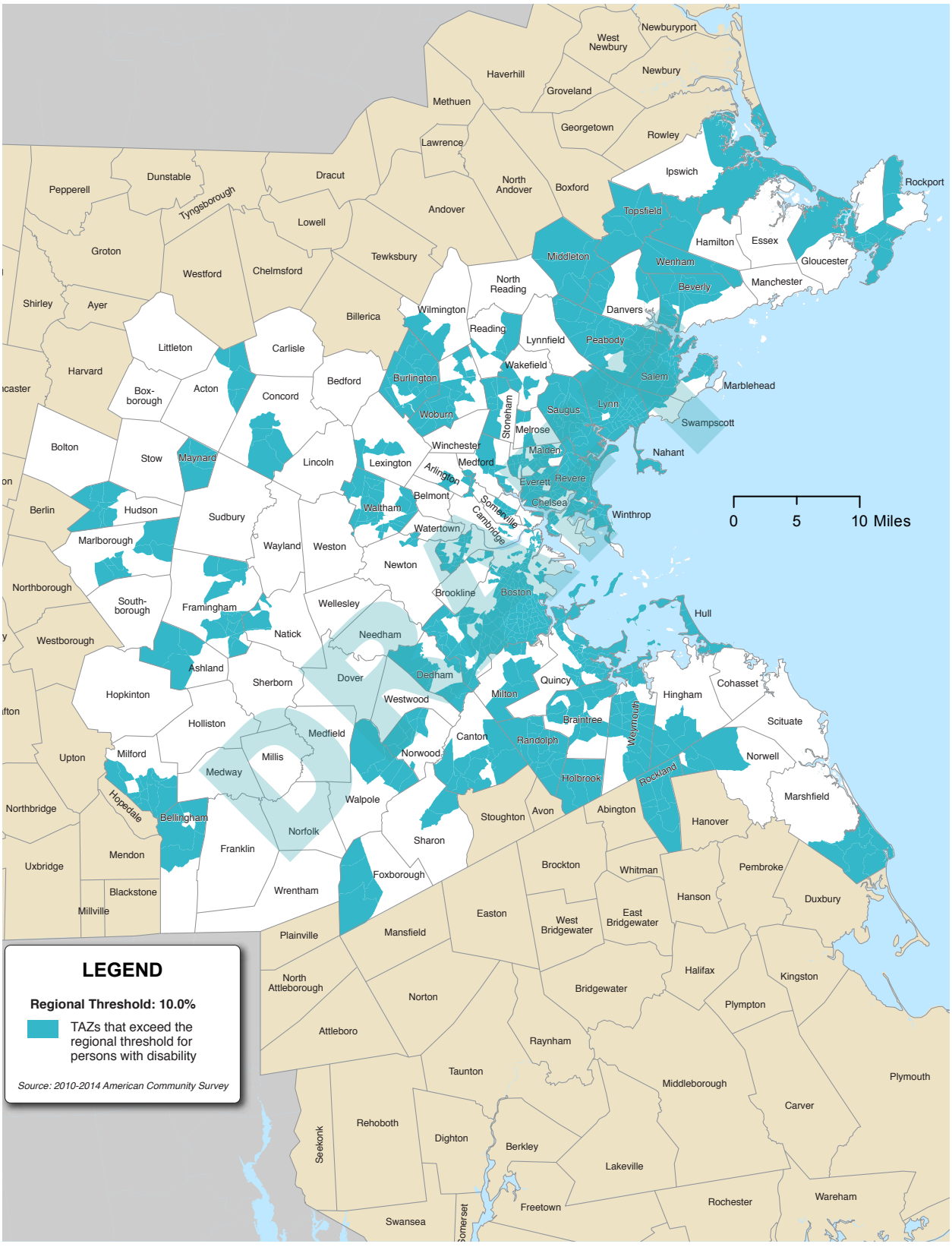
TAZ = transportation analysis zone.
Sources: 2010–14 American Community Survey and 2010 US Census.

Figure 8-3
Transportation Equity Zones: People with Limited English Proficiency



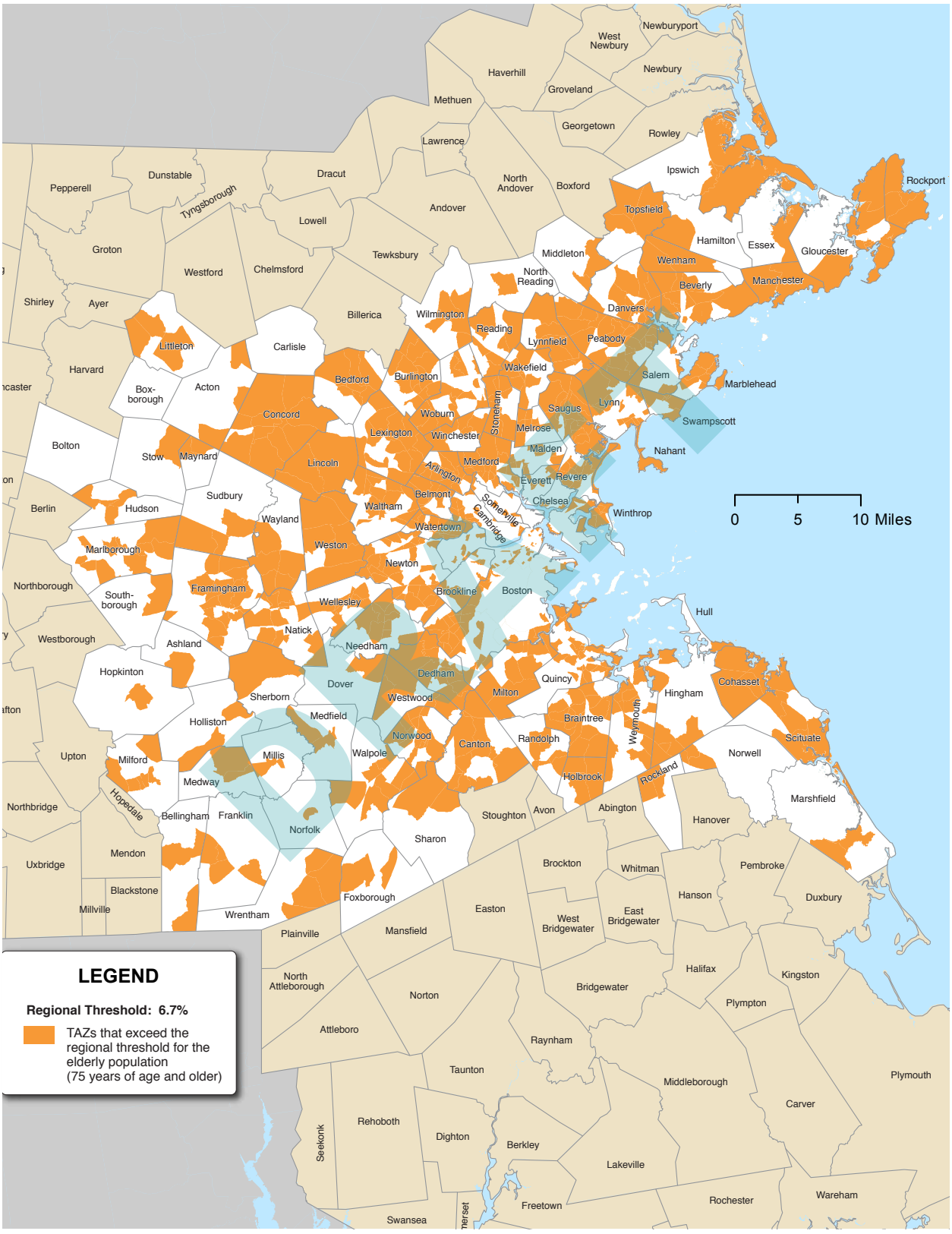
TAZ = transportation analysis zone.
Sources: 2010–14 American Community Survey and 2010 US Census.

Figure 8-4
Transportation Equity Zones: People with Disabilities



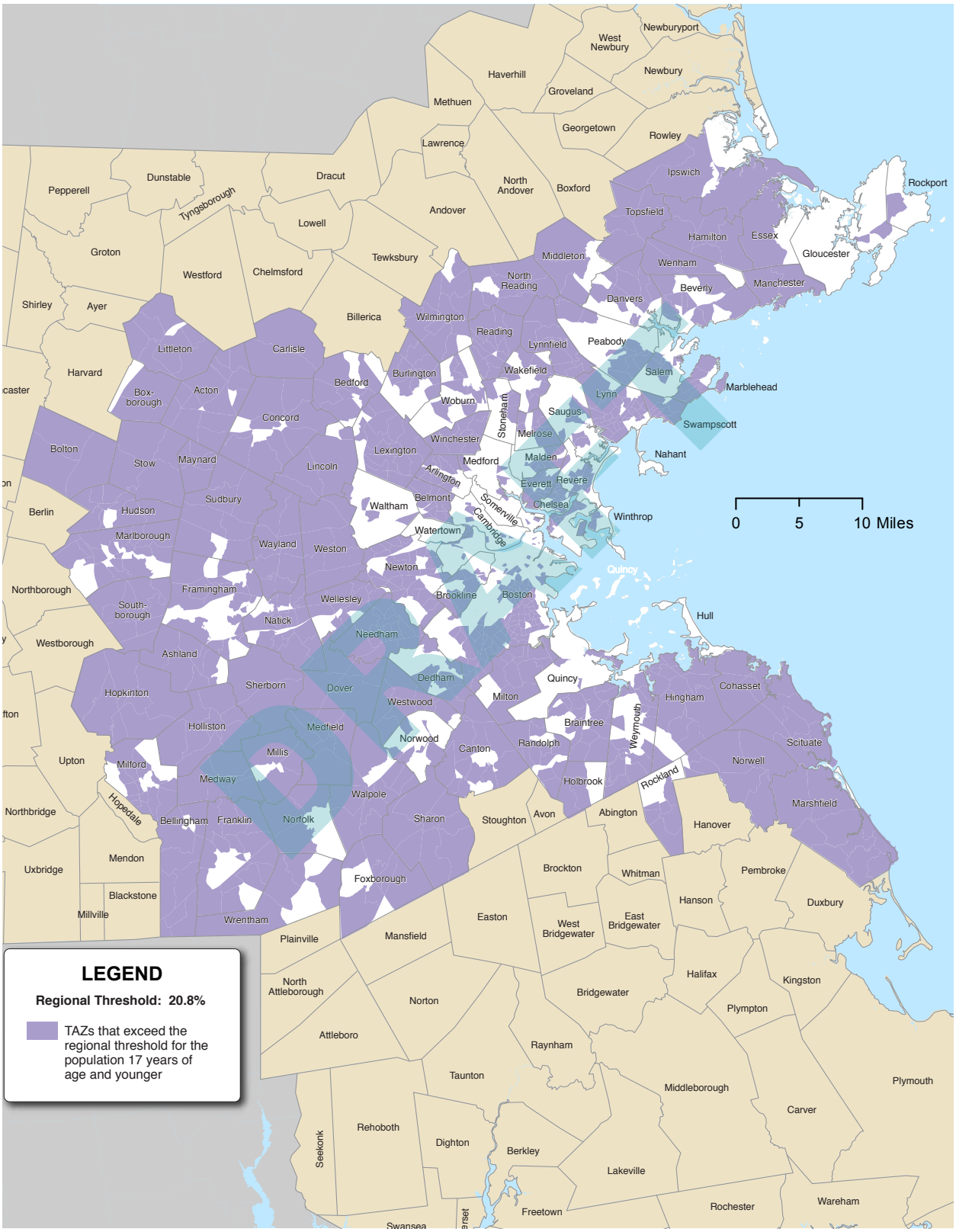
TAZ = transportation analysis zone.
Sources: 2010–14 American Community Survey and 2010 US Census.

Figure 8-5
Transportation Equity Zones: Elderly



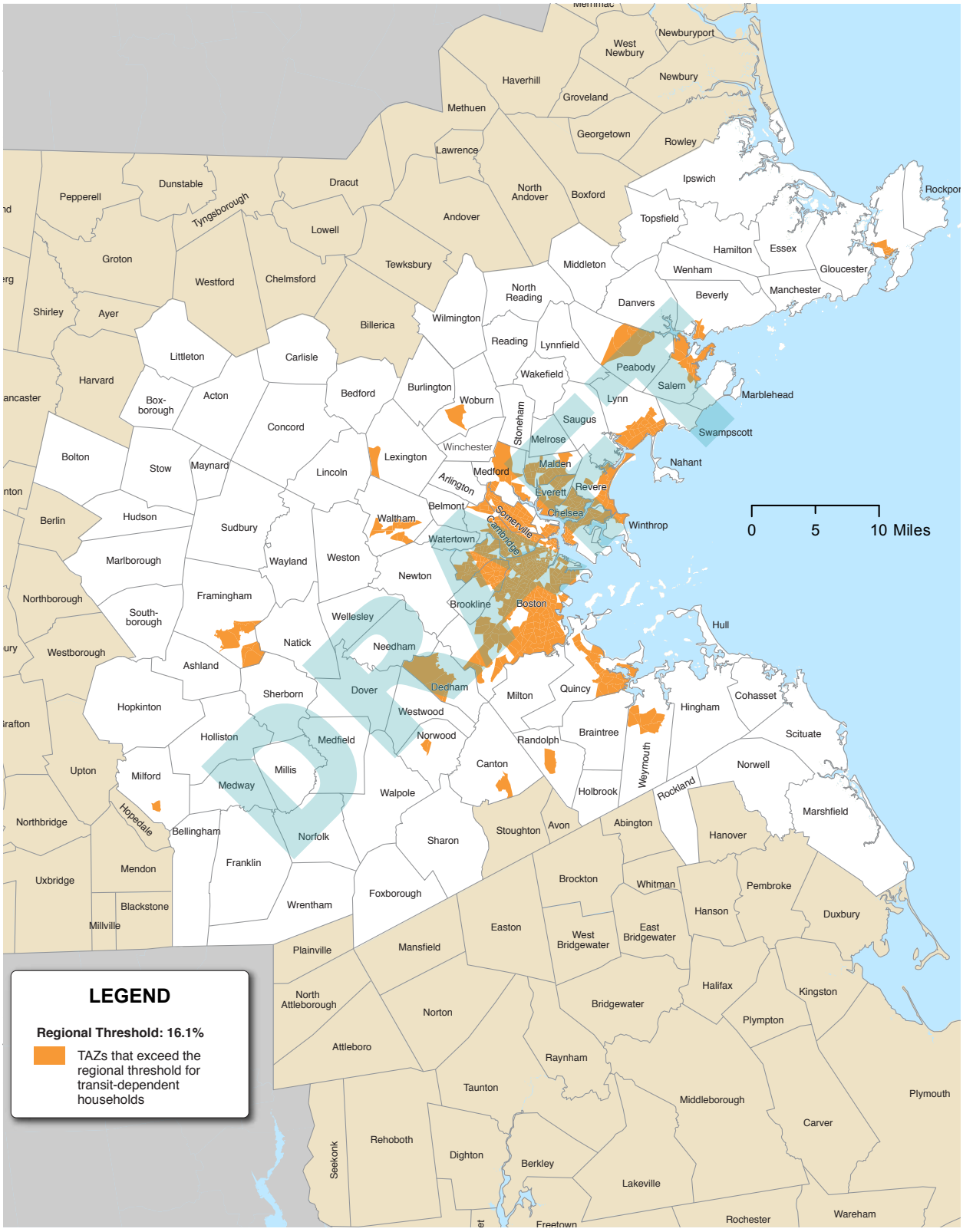
TAZ = transportation analysis zone.
Source: 2010 US Census.

Figure 8-6
Transportation Equity Zones: Youth



TAZ = transportation analysis zone.
Source: 2010 US Census.

Figure 8-7
Transportation Equity Zones: Transit-Dependent Households



TAZ = transportation analysis zone.
Sources: 2010–14 American Community Survey and 2010 US Census.

Table 8.2 shows the number of people or households that belong to each TE population, as well as the number of TAZs in which the regional thresholds are exceeded. (Thresholds for more than one TE population may be exceeded in a given TAZ.) If the regional threshold exceeds the percent of the TAZs that exceed the regional threshold, this indicates that the population is clustered geographically. Conversely, a bigger difference between the two columns indicates that the population is geographically dispersed throughout the region. Low-income households show the greatest clustering of all the TE populations, while the elderly population and people with disabilities are more evenly distributed throughout the region.

Table 8-2
Transportation Equity Populations in the Boston Region

Transportation Equity Category[a]	Population or Households	MPO Region Total Population or Households	Regional Threshold	Percent of TAZs that Exceed Regional Threshold (TEZs)
Minority population	870,459	3,087,796	28.2%	33.5%
Low-income households	393,192	1,216,550	$45,392 (32.3% of households)	10.1%
People with LEP	308,770	2,915,559	10.6%	31.3%
Elderly population (age 75 or older)	206,578	3,087,795	6.7%	38.4%
Youth population (age 17 or younger)	636,761	3,087,965	20.6%	46.7%
People with disabilities	306,776	3,056,697	10.0%	42.5%
Transit-dependent households	196,460	1,216,550	16.1%	34.5%

Note: Footnote 1 in this chapter describes the methods MPO staff uses to tabulate these transportation equity populations.
[a] For the minority, LEP, elderly, and people with disabilities categories, the amounts in the "Population or Households" and "MPO Region Total Population or Households" columns reflect numbers of people. For the low-income and transit-dependent households categories, the amount in these columns reflect numbers of households.
LEP = limited English proficiency. TAZ = transportation analysis zone. TEZ = transportation equity zone.
Sources: 2010 US Census and 2010–14 American Community Survey.

The State of Equity in Metro Boston

In 2011, the Metropolitan Area Planning Council (MAPC) released its first *The State of Equity in Metro Boston* report, which contained a quantitative assessment of interdisciplinary equity indictors for the MAPC region (an area which covers 101 municipalities in eastern Massachusetts, including the 97 municipalities in the Boston Region MPO's planning area). Subsequently, in 2017, MAPC published an updated report. The data in the report paint a broad picture of equity in the Boston region today, as pertains to transportation, housing, education, and employment.

The 2017 report's transportation data show that minority and low-income populations are often at a disadvantage when it comes to transportation. Minority commuters as a whole spend more time commuting than nonminority commuters, whether traveling by bus, subway, or car. Additionally, low-income households and minority-headed households are less likely to own a vehicle. Black and Latino households have an average of 1.1 vehicles per household, Asian households have an average of 1.4 vehicles, and White households have an average of 1.7 vehicles.[4]

Transportation challenges that minority and low-income populations face may be compounded by other socioeconomic and demographic factors. Over the past decade, between 2000 and 2010, the share of the population in the region that identifies as minority increased from 21 percent to 28 percent. The percent of the population born outside of the United States increased about two percent during that time, with Latin American-born residents comprising the largest share of the immigrant population.[5] Data also show that the number of elderly residents is increasing as the baby boomers age; this trend may also lead to an increase in the number of residents with disabilities, as people age 75 or older are the cohort most likely to have disabilities. While the region's population age 75 and older will be mostly those who identify as racially white in the near future, the region's younger residents are more racially and ethnically diverse which will eventually lead to a much more diverse elderly population.[6]

These demographic changes will affect the transportation needs of the region's residents. Baby boomers choosing to age in place will need ways to get around other than by single occupancy vehicles. This challenge may be particularly acute in the suburbs, where transit service is limited. Younger residents will continue to require options for access to education, employment, and recreational opportunities.

MAPC's report also shows that metropolitan Boston continues to have among the highest housing costs in the country, and that these costs are unevenly distributed among different demographic groups. About half of renters are considered housing cost-burdened, while about one-third of home owners are also considered housing cost-burdened. These rates

[4] *State of Equity in Metro Boston*, MAPC Regional Indicators, Metropolitan Area Planning Council, accessed December 14, 2018, http://www.regionalindicators.org/topic_areas/7.

[5] Ibid.

[6] Ibid.

are even higher for the elderly population. The burdens of housing costs are linked to transportation access and costs; the notion of "drive until you qualify" means that those who cannot afford housing near Boston look further out in the suburbs for affordable housing. This situation can impose significant travel times, induce stress, limit time available for other healthier activities (such as socialization with family or exercise), and inflict higher transportation costs on households.[7]

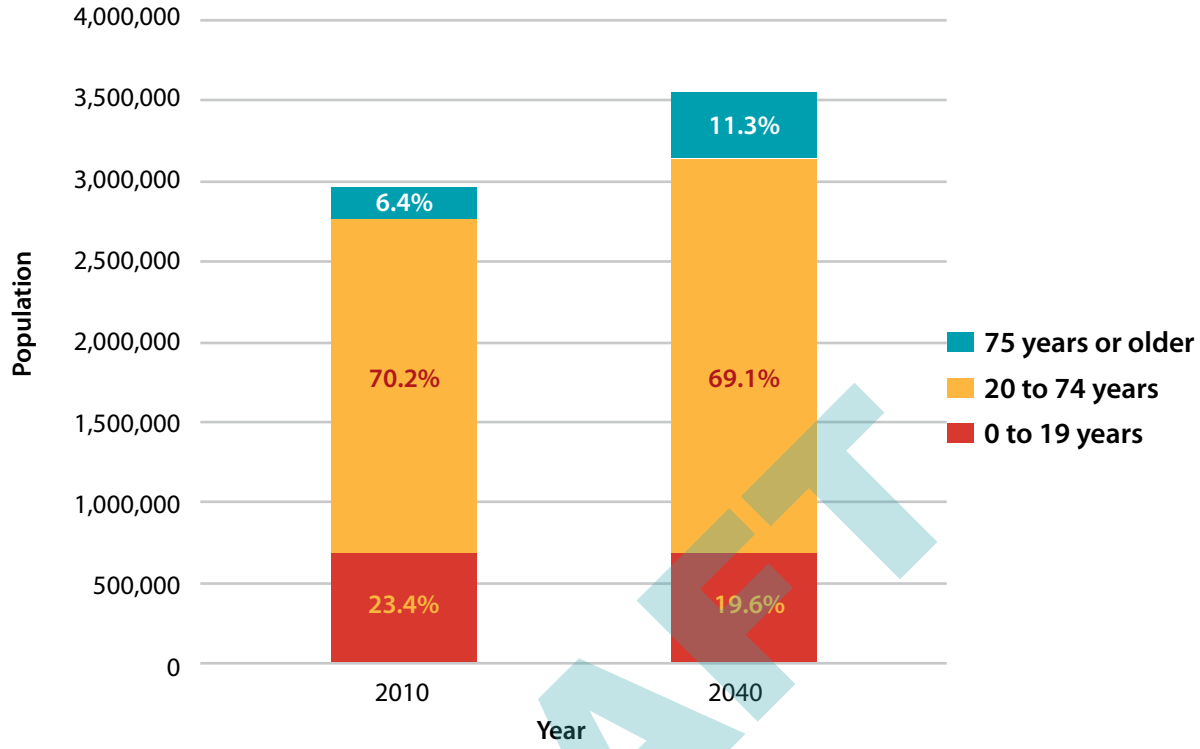
Demographic and Land Use Projections

MAPC has produced demographic projections for age cohorts and household income. Consistent with recent trends, the share of the population age 75 and older is expected to increase. The number of people in the lowest household income category is expected to increase, while those in the higher household income categories are expected to decrease. The repercussions of these trends mean the transportation providers and those that program funding—including the MPO—may increasingly have to address the transportation needs of elderly and low-income populations. Chapter 2 discusses in detail projections to 2040; those findings relevant to transportation equity are discussed here.

Figure 8.8 shows the age cohort breakdowns of the population in households for the baseline year of 2010 and projections to 2040. Between 2010 and 2040, the cohort of people age 75 years and older is projected to increase from six percent to 11 percent of the region's total population. The cohort between 20 and 74 years old is expected to decrease from 70 percent to 69 percent. And, the cohort of people age 19 years and younger is expected to decrease from 23 percent to 20 percent. All three age cohorts are projected to increase in total population size. In addition, average household size is expected to decline. The elderly population, in particular, is expected to experience a large increase in single person households. A smaller percentage of households are expected to have children, as well. The data suggest that the MPO will increasingly have to plan for the transportation needs of the elderly as they make up an increasing share of the region's population.

[7] MAPC, "State of Equity in Metro Boston."

Figure 8-8
Household Population Change in the Boston Region: 2010 to 2040

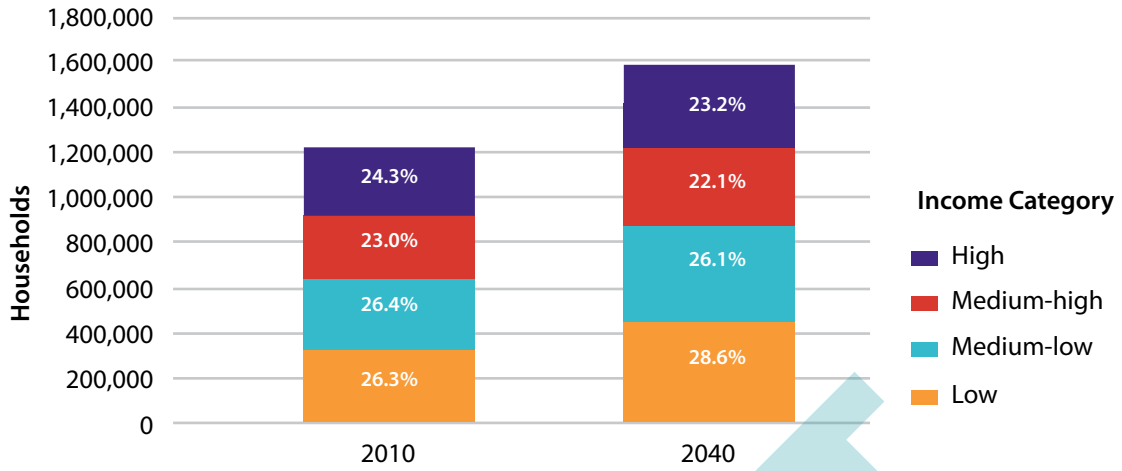


Note: These data include household population only; the group quarters population is excluded.
Source: Metropolitan Area Planning Council.

Figure 8.9 shows the number of households in 2010 and projections to 2040 broken out into four income groups: household income less than or equal to $35,000 (low); between $35,001 and $75,000 (medium-low); between $75,001 and $125,000 (medium-high); and greater than $125,000 (high).[8] The number of households in all four categories is expected to increase. The percent of households in the lowest income category is expected to increase the most, by two percent. Households in the highest income category are projected to decrease the most, by one percent. These data show that the share of lower-income households is expected to increase.

[8] These categories do not correspond with the MPO's definition of "low-income households" described earlier in the chapter. They are the income categories used in the models employed by MAPC and Central Transportation Planning Staff (CTPS) to project transportation, demographic, and landuse trends. Income is reported in 2010 dollars.

Figure 8-9
Household Income in the Boston Region: 2010 and 2040



Note: Low: household income <=$35,000; Medium-low: household income $35,001 <=$75,000; Medium-high: household income $75,001 <=$125,000; and High: household income >$125,000.
Source: Metropolitan Area Planning Council.

Safety Goal

The MPO's safety goal is to reduce the number and severity of crashes and safety incidents for all modes, reduce serious injuries and fatalities from transportation, and make investments and support initiatives that help protect transportation users, employees, and the public from safety and security threats. Safety of the users of the transportation network is a top priority for the MPO, as well as for the state and the federal government. The MPO's effort to address safety issues has largely been focused on taking steps to reduce the number and severity of crashes through programming projects in the TIP and LRTP. With those aims in mind, the analyses in this section mirror the analyses completed in the Safety Needs chapter, analyzing the distribution of crash clusters in communities with high shares of TE populations. The results show how many crash clusters are in TAZs with high shares of TE populations.

To address crashes in the region, the MPO examines crash cluster locations, identified by the Massachusetts Department of Transportation (MassDOT). MPO staff considers the number of crash clusters within the project area when evaluating TIP and LRTP projects. These clusters are only those on roadways that are eligible for federal Highway Safety Improvement Program (HSIP) program funding, which supports roadway safety improvements.

MassDOT identifies locations that are high-priorities for safety improvements by using the Equivalent Property Damage Only (EPDO) index to assess the severity of crashes. Weighted

values are assigned to each crash based on whether the crash resulted in property damage (unweighted), injury (weighted by 5), or a fatality (weighted by 10). Based on the EPDO values, MassDOT maps crash clusters and establishes the high-priority locations for safety improvements. These clusters represent crashes involving motor vehicles ("all-mode" crash clusters), bicycles, and pedestrians. These locations represent the top five percent of each crash cluster type in each regional planning agency's (RPA) area.[9] (A more detailed description of this method is described in the Safety Needs chapter.) As MassDOT does not identify crash clusters for crashes that involve trucks, MPO staff has developed a similar methodology to identify crash clusters for truck crashes in the Boston region. This section analyzes the distribution of each modal crash cluster in TEZs, as well as the locations of the top-ranked crash clusters. (Crash clusters can be viewed in the LRTP Needs Assessment application.)

Top-Ranked Crash Clusters

All-Mode Crash Clusters

All-mode crash clusters are those that involve a vehicle. The most recent set of crash cluster data from MassDOT is based on 2013–15 crash data. There are 993 crash cluster locations that are eligible for HSIP funding in the Boston region—which represent the top five percent of the all-mode crash clusters. Table 8.3 shows these 75 crash clusters with an EPDO index value of at least 150 and the location of those crashes. The table also identifies which types of TEZs the crash clusters are in. Of the 75 crash clusters, only one—Interstate 93 at the Leverett Connector in Boston—is not in a TEZ. None of the crash clusters are in all seven TEZ types. Five are in six TEZs types: Interstate 93 southbound near East Berkeley Street in Boston; Morton Street at Harvard Street in Boston; Interstate 93 at the ramps to Frontage Road (southbound) and Southhampton Street; Revere Beach Parkway at Webster Avenue in Chelsea; and Route 9 (Worcester Road) west of Caldor Road in Framingham.[10]

[9] MassDOT's identifies crash clusters by merging crashes that are within a 25 meter radius of each other. If two distinct clusters are found to share a common crash, the two clusters are merged into a single cluster. The full methodology can be found in MassDOT's *2015 Top Crash Location Report*, March 2018, https://www.mass.gov/files/documents/2018/05/31/15TopCrashLocationsRpt.pdf, pg. 4-5

[10] This does not necessarily mean the crash cluster is in one of each type of TEZ. It could be in one TAZ that exceeds that threshold for all seven TE populations.

Table 8-3
Top-Ranked 2013–15 All-Mode Crash Clusters within Transportation Equity Zones

Crash Cluster Location	Municipality	Cluster EPDO Value	Within Minority TEZ(s)	Within Low-income TEZ(s)	Within LEP TEZ(s)	Within Elderly TEZ(s)	Within Youth TEZ(s)	Within Transit- Dependent Household TEZ(s)	Within Disability TEZ(s)	Total TEZs Crash is Within
Interstate 93 (southbound) at ramp to Columbia Road	Boston	638	X		X			X		3
Middlesex Turnpike at Interstate 95	Burlington	577	X						X	2
Interstate 93 at Interstate 95	Reading	496				X	X			2
Interstate 93 at North Washington Street	Boston	491	X				X	X	X	4
Interstate 93 near ramps to Furnace Brook Parkway (north of Exit 8)	Quincy	405			X					1
Interstate 95 at Route 4 (Bedford St)	Lexington	399	X			X	X			3
Interstate 93 at Route 3A (Gallivan Boulevard/ Neponset Avenue)	Boston	391				X		X	X	3
Interstate 93 at Granite Ave (Exit 11)	Milton	391				X	X			2
Route 9 at Interstate 95	Wellesley	374	X		X		X			3
Interstate 93 (northbound) near Exit 23 (Government Center)	Boston	349				X		X	X	3
Interstate 95 at ramps to Neponset Street	Norwood	348				X	X			2
Route 62 (Elliot Street) near Route 128	Danvers	326				X	X		X	3
Interstate 93 near ramps for Furnace Brook Parkway (south of Exit 8)	Quincy	315	X		X					2
Interstate 93 at Montvale Avenue	Woburn, Stoneham	310				X			X	2
Interstate 93 at ramps to Victory Road (south of Exit 13)	Boston	305							X	1
East Street Rotary at East and Canton Streets	Westwood	294				X	X			2
Interstate 93 at Columbia Road (south of Exit 15)	Boston	290	X		X			X		3
Interstate 93 (northbound) at ramp to Interstate 95	Stoneham	281				X	X		X	3

Crash Cluster Location	Municipality	Cluster EPDO Value	Within Minority TEZ(s)	Within Low-income TEZ(s)	Within LEP TEZ(s)	Within Elderly TEZ(s)	Within Youth TEZ(s)	Within Transit- Dependent Household TEZ(s)	Within Disability TEZ(s)	Total TEZs Crash is Within
Route 3 at ramps to Route 18 (Main St) (Exit 16)	Weymouth	273				X			X	2
Interstate 93 at Morrissey Boulevard	Boston	266	X		X			X	X	4
Interstate 93 (northbound) at Route 37 (Granite Street)	Braintree	265	X				X		X	3
Interstate 95 at Route 3	Burlington	262				X			X	2
Interstate 93 (southbound) near East Berkeley Street	Boston	260	X	X	X	X		X	X	6
Interstate 93 at Leverett Connector	Boston	251								0
Interstate 93 (southbound) at Exit 23 (I-90 to Purchase Street)	Boston	240			X	X		X	X	4
Interstate 495 at Route 2	Littleton	233				X	X			2
Route 18 (Main Street) at West St	Weymouth	229					X		X	2
Route 37 (Granite Street) at Forbes Road	Braintree	228					X			1
Interstate 93 (northbound) at ramps to Route 3	Braintree	227	X				X		X	3
Interstate 93 (near ramps to Granite Avenue)	Milton	225				X	X			2
Route 28 at Route 3 (Leverett Circle)	Boston	221	X					X	X	3
Route 28 at Route 16	Medford	220	X		X	X		X	X	5
Route 3A (Southern Artery) at Broad Street	Quincy	218			X	X		X	X	4
Interstate 93 south of Exit 20 (Massachusetts Avenue Connector)	Boston	218	X		X				X	3
Route 28 (Embankment Road) at Route 3 (near Longfellow Bridge)	Boston	215						X		1
Route 1 at Route 129	Lynnfield	213				X	X			2
Interstate 95 at Route 30 (north of Exit 24)	Weston	203				X	X			2

Crash Cluster Location	Municipality	Cluster EPDO Value	Within Minority TEZ(s)	Within Low-income TEZ(s)	Within LEP TEZ(s)	Within Elderly TEZ(s)	Within Youth TEZ(s)	Within Transit- Dependent Household TEZ(s)	Within Disability TEZ(s)	Total TEZs Crash is Within
Route 1 at Salem Street	Malden, Revere	200	X		X		X		X	4
Interstate 93 at Upton Street	Quincy	198			X					1
Interstate 95 at Totten Pond Road	Waltham	198	X		X	X	X		X	5
Interstate 93 (southbound) at Route 37 (Granite Street)	Braintree	197	X				X		X	3
Morton Street at Harvard Street	Boston	195	X	X	X		X	X	X	6
Interstate 93 near Long Wharf	Boston	194	X					X	X	3
Interstate 95 at Route 2	Lexington	193	X			X	X	X	X	5
Interstate 90 near Oak Street	Weston	191				X	X			2
Massachusetts Avenue near Memorial Drive	Cambridge	190	X					X		2
Route 1 (Newburyport Turnpike) at Route 1 Connector	Peabody	189				X		X	X	3
Condon Circle at Salem Street	Lynnfield, Lynn	187				X	X		X	3
Interstate 95 (northbound) at Route 20	Waltham	185							X	1
Route 85 (Cedar Street) at Fortune Boulevard	Milford	181				X	X		X	3
Interstate 93 at Massachusetts Avenue Connector	Boston	180	X		X				X	3
Interstate 93 (near Zakim Bridge)	Boston, Cambridge	179	X					X	X	3
Interstate 95 at ramps to Route 16	Newton	178				X	X			2
Interstate 95 (southbound) at Route 20	Waltham	176	X		X	X		X	X	5
Interstate 93 at Route 138 (Washington Street)	Canton	172				X	X		X	3
Union Street Rotary at ramp to Route 3 (southbound)	Braintree	171							X	1
Route 2 at Reformatory Circle	Concord	170	X			X	X			3

Crash Cluster Location	Municipality	Cluster EPDO Value	Within Minority TEZ(s)	Within Low-income TEZ(s)	Within LEP TEZ(s)	Within Elderly TEZ(s)	Within Youth TEZ(s)	Within Transit- Dependent Household TEZ(s)	Within Disability TEZ(s)	Total TEZs Crash is Within
Hammond Pond Parkway at Route 9 (Boylston Street)	Newton	167				X				1
Route 126 (Hartford Avenue) at Deerfield Lane	Bellingham	166					X		X	2
Interstate 95 at Route 135	Dedham	164				X		X	X	3
Route 18 (Main Street) at Pond and Pleasant Streets	Weymouth	164					X		X	2
Interstate 93 at ramps to Frontage Rd (southbound)/Southhampton St	Boston	163	X	X	X		X	X	X	6
Revere Beach Parkway at Webster Avenue	Chelsea	162	X		X		X	X	X	5
Interstate 95 (northbound) at ramps to East Street	Westwood	160				X	X			2
Interstate 93 northbound at ramp to South Main Street	Foxborough	159				X	X			2
Route 3 northbound at ramp to Derby Street	Hingham	158				X	X		X	3
Broadway at Route 129 (Lynnfield Street)	Lynn	158					X		X	2
Route 3 southbound at ramp to Union Street	Braintree	158				X	X		X	3
Route 9 (Worcester Road) at Cochituate Road	Framingham	155	X		X	X		X	X	5
Interstate 95 northbound at ramp to Washington Street	Woburn	154			X				X	2
Interstate 90 at ramps to Interstate 95	Weston	152				X	X			2
Soldiers Field Road at North Harvard Street	Boston	152	X	X				X		3
Route 1A at Premium Outlets Boulevard	Wrentham	151				X				1
Route 9 (Worcester Road) west of Caldor Road	Framingham	150	X		X	X	X	X	X	6
Interstate 93 at Derby Street	Hingham	150				X	X		X	3

Note: Clusters were selected from Massachusetts 2013–15 HSIP-eligible all-mode crash cluster locations in the Boston region.
EPDO = equivalent property damage only. HSIP = Highway Safety Improvement Program. LEP = limited English proficiency. TEZ = transportation equity zone.
Sources: Massachusetts Department of Transportation; 2010 US Census; 2010–14 American Community Survey; and Boston Region MPO.

Pedestrian Crash Clusters

Pedestrian crash clusters involve at least one vehicle and one pedestrian. MassDOT has identified pedestrian crash clusters based on 2006–15 crash data and by mapping a 100-meter buffer around the crashes. Table 8.4 shows the top ranked pedestrian crash clusters in the Boston region—those with an EPDO index value of at least 100, of which there are 22—their locations, and the types of TEZs they are in. All of the clusters are within at least one TEZ. Three clusters are within all seven types of TEZs: Downtown Lynn (Essex, Union, Liberty, and Central Streets, and surrounding streets); Downtown Salem (Washington, New Derby, Lafayette, and surrounding streets); and Western Avenue (Mall Street to Franklin Street) in Lynn.

Table 8-4
Top-Ranked 2006–15 Pedestrian Crash Clusters within Transportation Equity Zones

Crash Cluster Location	Municipality	Cluster EPDO Value	Within Minority TEZ(s)	Within Low-income TEZ(s)	Within LEP TEZ(s)	Within Elderly TEZ(s)	Within Youth TEZ(s)	Within Transit- Dependent Household TEZ(s)	Within Disability TEZ(s)	Total TEZs Crash is Within
Downtown Chelsea (Broadway, Everett Avenue, and surrounding streets)	Chelsea	916	X	X	X		X	X	X	6
Downtown Lynn (Essex, Union, Liberty, and Central Streets, and surrounding streets)	Lynn	733	X	X	X	X	X	X	X	7
Massachusetts Avenue (Hancock Street to Lansdowne Street, and neighboring streets, near Central Square)	Cambridge	432	X		X	X		X		4
Quincy Center (Hancock Street from Washington to School Streets)	Quincy	305	X		X	X		X	X	5
Downtown Boston (near Court, Summer, Park and India Streets)	Boston	264	X		X	X	X	X	X	6
Davis Square	Somerville, Cambridge	257						X		1
Downtown Framingham (Waverly, Concord, and Hollis Streets)	Framingham	219	X	X	X		X	X	X	6
Watertown Square (Main, Mount Auburn, North Beacon, and Galen Streets)	Watertown	209			X	X				2
Newton Centre (Beacon Street, Centre Street, and surrounding streets)	Newton	184				X	X			2
Downtown Salem (Washington, New Derby, Lafayette, and surrounding streets)	Salem	173	X	X	X	X	X	X	X	7
Main Street (approximately Grant to Banks Streets)	Waltham	170	X		X	X		X	X	5
Broadway (Mountain Avenue to Revere Beach Parkway) and Park Avenue	Revere	163	X		X	X	X		X	5
Mt. Auburn Street and Massachusetts Avenue (Harvard Square)	Cambridge	158	X			X		X		3

Crash Cluster Location	Municipality	Cluster EPDO Value	Within Minority TEZ(s)	Within Low-income TEZ(s)	Within LEP TEZ(s)	Within Elderly TEZ(s)	Within Youth TEZ(s)	Within Transit- Dependent Household TEZ(s)	Within Disability TEZ(s)	Total TEZs Crash is Within
Boston Common and Downtown Crossing Areas (Tremont, Washington, Essex and Boylston Streets)	Boston	156	X	X	X	X		X	X	6
Prospect and Cambridge Streets (Inman Square)	Cambridge	126	X	X	X			X	X	5
Central Square	Waltham	124	X		X			X	X	4
Cambridge Street (Sciarappa Street to East Street, near Route 28)	Cambridge	118	X		X	X		X	X	5
Harvard Street (near Coolidge Corner)	Brookline	115	X		X	X		X	X	5
Western Avenue (Mall Street to Franklin Street)	Lynn	113	X	X	X	X	X	X	X	7
Hancock Street (Adams Street to Washington Street near Quincy Center)	Quincy	112	X		X	X		X	X	5
Main Street (Harlow Court to Pleasant Street)	Woburn	101				X			X	2
Route 3A in Quincy (Sea Street to Brackett Street)	Quincy	100	X		X	X		X	X	5

Note: Clusters were selected from Massachusetts 2006–15 HSIP-eligible pedestrian crash cluster locations in the Boston region.
EPDO = equivalent property damage only. HSIP = Highway Safety Improvement Program. LEP = limited English proficiency. TEZ = transportation equity zone.
Sources: Massachusetts Department of Transportation; 2010 US Census; 2010–14 American Community Survey; and Boston Region MPO.

Bicycle Crash Clusters

Bicycle crash clusters involve at least one vehicle and one bicyclist. MassDOT has identified bicycle crash clusters based on 2006–15 crash data and by mapping a 100-meter buffer around the locations of these crashes. Table 8.5 shows the top-ranked bicycle crash clusters in the Boston region that have an EPDO index value greater than 100 (of which there are 10), the locations of these crash clusters, and which types of TEZs they are in. All of these crash clusters are within at least one type of TEZ. One is within all seven types of TEZs—Beacon and Hampshire Streets and Broadway (Park Street to Galileo Galilei Way) in Somerville and Cambridge.

Table 8-5
Top-Ranked 2006–15 Bicycle Crash Clusters within Transportation Equity Zones

Crash Cluster Location	Municipality	Cluster EPDO Value	Within Minority TEZ(s)	Within Low Income TEZ(s)	Within LEP TEZ(s)	Within Elderly TEZ(s)	Within Youth TEZ(s)	Within Transit-Dependent Household TEZ(s)	Within Disability TEZ(s)(s)	Total TEZs Crash is Within
Massachusetts Avenue (from Harvard Square to Memorial Drive)	Cambridge	989	X		X	X	X	X		5
Beacon and Hampshire Streets and Broadway (Park Street to Galileo Galilei Way)	Cambridge, Somerville	942	X	X	X	X	X	X	X	7
Massachusetts Avenue (near Porter Square)	Cambridge, Somerville	525	X		X			X		2
Somerville Avenue, Summer Street, and Bow Street (near Union Square)	Somerville	213	X		X	X		X	X	5
Cambridge Street (Quincy Street to Maple Avenue, near Harvard Square)	Cambridge, Somerville	139	X		X	X		X		4
Broadway and Inman Street (near Central Square)	Cambridge	125	X		X			X	X	4
Massachusetts Avenue near Cedar Street	Cambridge	123	X	X	X	X		X	X	6
Massachusetts Avenue at John F. Kennedy Street (near Harvard Square)	Cambridge	115	X			X		X		3
Massachusetts Avenue near Commonwealth Avenue	Boston	114	X	X	X	X		X		5
Cambridge Street and Broadway (near Harvard Square)	Cambridge	105	X					X		2

Note: Clusters were selected from Massachusetts 2006–15 HSIP-eligible bicycle crash cluster locations in the Boston region.
EPDO = equivalent property damage only. HSIP = Highway Safety Improvement Program. LEP = limited English proficiency. TEZ = transportation equity zone.
Sources: Massachusetts Department of Transportation; 2010 US Census; 2010–14 American Community Survey; and Boston Region Metropolitan Planning Organization.

Truck Crash Clusters

Truck crash clusters represent crashes that involved at least one truck. MPO staff identified these crash clusters using MassDOT's methodology for identifying all-mode crash clusters. These truck crash clusters are based on 2013–15 crash data. Table 8.6 shows the top-ranked truck crash clusters—those in the Boston region that have an EPDO index value greater than 30. The table also includes information about the locations of the crash clusters and which types of TEZs they are in. All of the crash clusters are within at least one TEZ. None are within all seven types of TEZs, but two are within six types of TEZs: Interstate 93 near the ramps to Albany Street in Boston and Kosciuszko Circle in Boston.

Table 8-6
Top-Ranked MPO-Identified Truck Crash Clusters within Transportation Equity Zones

Crash Cluster Location	Municipality	Cluster EPDO Value	Within Minority TEZ(s)	Within Low-Income TEZ(s)	Within LEP TEZ(s)	Within Elderly TEZ(s)	Within Youth TEZ(s)	Within Transit-Dependent Household TEZ(s)	Within Disability TEZ(s)(s)	Total TEZs Crash is Within
Interstate 93 at Columbia Road (north of Exit 15)	Boston	68	X		X			X		3
Middlesex Turnpike at Interstate 95	Burlington	65	X						X	2
Route 9 at Interstate 95	Wellesley	53	X		X		X			3
Interstate 93 near ramps for Furnace Brook Parkway (north of Exit 8)	Quincy	52			X					1
Interstate 495 at Interstate 290	Marlborough	48	X		X					2
Interstate 93 (northbound) near ramps for Furnace Brook Parkway (south of Exit 8)	Quincy	48	X			X	X			3
Interstate 93 near ramps to Albany Street	Boston	39	X	X	X	X		X	X	6
Interstate 93 near Exit 20A (South Station)	Boston	38			X	X		X	X	4
Interstate 95 at ramps to Neponset Street	Norwood	36				X	X			2
Interstate 95 at Route 4 (Bedford Street)	Lexington	35	X			X	X			3
Interstate 93 at North Washington Street	Boston	35				X	X			2
Interstate 93 at Interstate 95	Reading	35	X				X	X	X	4
Kosciuszko Circle	Boston	34	X	X	X		X	X	X	6
Interstate 495 at Route 2	Littleton	33				X	X			2
Interstate 95 at Route 20	Waltham	32							X	1
Interstate 90 at ramps to Interstate 95 (west of Exit 15)	Weston	31				X	X			2
Interstate 90 near Edgell Road	Framingham	30					X			1
Interstate 90 near Wood Street	Hopkinton	30				X	X		X	3

Note: Clusters were selected from 2013–15 data. Expressway and arterial routes are based on designations from the Boston Region MPO's Congestion Management Process.
EPDO = equivalent property damage only. HSIP = Highway Safety Improvement Program. LEP = limited English proficiency. TEZ = transportation equity zone.
Sources: Massachusetts Department of Transportation; 2010 US Census; 2010–14 American Community Survey; and Boston Region MPO.

Distribution of Crash Clusters in TEZs

Table 8.7 shows, for each mode, the percent of crash clusters in the Boston region that are in TEZs, compared to the share of the TAZs in the region that belong to each TEZ type.

These data indicate that crash clusters are disproportionately more common in TEZs than in TAZs without TEZs. For all types of TEZs, the percent of all-mode crash clusters in TEZs exceed the percent of TEZs in the region. For example, minority TEZs represent approximately one-third of TAZs in the region, so one-third of crashes would be expected to occur in these areas; however, minority TEZs are the site of nearly 46 percent of all-mode crashes, a larger share of crashes than would be expected. TEZs also have a higher share of pedestrian and bicycle crash clusters, except for youth TEZs. Meanwhile, the percent of truck crash clusters in all TEZs types, except youth and transit-dependent TEZs, exceed the share of TEZs in the region. This indicates that most TEZ types bear a disproportionate share of crashes. This represents a potential safety need that could be addressed by MPO investments.

Table 8-7
Percent of Crash Clusters in Boston Region Transportation Equity Zones

Type of TAZ	Percent of all TAZs	Percent of All-mode Crash Clusters	Percent of Bicycle Crash Clusters	Percent of Pedestrian Crash Clusters	Percent of Truck Crash Clusters
Minority TEZs	33.5%	45.9%	77.8%	78.1%	39.0%
All other TAZs	66.5%	54.1%	22.2%	21.9%	61.0%
Low-income TEZs	10.1%	12.7%	40.7%	34.2%	9.2%
All other TAZs	89.9%	87.3%	59.3%	65.8%	90.9%
LEP TEZs	31.3%	42.7%	63.0%	72.6%	32.9%
All other TAZs	68.7%	57.3%	37.0%	27.4%	67.1%
Elderly TEZs	38.4%	57.2%	51.9%	63.0%	53.6%
All other TAZs	61.6%	42.8%	48.1%	37.0%	46.3%
Youth TEZs	46.7%	57.8%	37.0%	46.6%	62.5%
All other TAZs	53.3%	42.2%	63.0%	53.4%	37.5%
Disability TEZs	42.5%	58.2%	53.7%	76.7%	51.8%
All other TAZs	57.5%	41.8%	46.3%	23.3%	48.2%
Transit-dependent household TEZs	34.5%	35.6%	88.9%	80.8%	29.9%
All other TAZs	65.5%	64.4%	11.1%	19.2%	70.1%

Note: This table includes all HSIP-eligible crash clusters (all-mode, bicycle, and pedestrian) and all Boston Region Metropolitan Planning Organization-identified truck crash clusters in the Boston region. All-mode and truck crash clusters are based on 2013–15 crash data. HSIP bicycle and pedestrian crash clusters are based on 2006–15 crash data.
HSIP = Highway Safety Improvement Program. LEP = limited English proficiency. TAZ = transportation analysis zone. TEZ = transportation equity zone.
Sources: Massachusetts Department of Transportation; 2010 US Census; 2010–14 American Community Survey; and Boston Region MPO.

Summary of Safety Needs

The crash analyses discussed above assesses the location of various modal types of crash clusters—all-mode, bicycle, pedestrian, and truck—in relation to TEZs. The crash cluster tables show which specific crash clusters are in multiple TEZs, indicating that they are in areas where residents have multiple indicators of potential disadvantage. In general, bicycle and pedestrian crash clusters tend to be in TEZs where multiple indicators of potential disadvantage are present. On average there are 4.7 bicycle crash clusters and 4.3 pedestrian crash clusters in TEZs, and an average of 2.8 all-mode and truck crash clusters. Table 8.7 shows the types of TEZs in which crash clusters are more numerous. The share in bicycle and pedestrian crash clusters are significantly more in most TEZ types. These data indicate that there is a need to address bicycle and pedestrian crashes in TEZs.

Capacity Management and Mobility Goal

The MPO's Capacity Management and Mobility goal aims to use existing facility capacity more efficiently and increase healthy transportation options, such as bicycling and walking, for people in the region. Mirroring analyses done in the Capacity Management and Mobility chapter, this section examines these aims through an equity lens and describes the mobility needs of TE populations in the Boston region. It examines their access to public transit, bicycle infrastructure, and shared mobility options. Results from similar analyses completed for the entire population in the region are in the Capacity Management and Mobility Needs chapter.

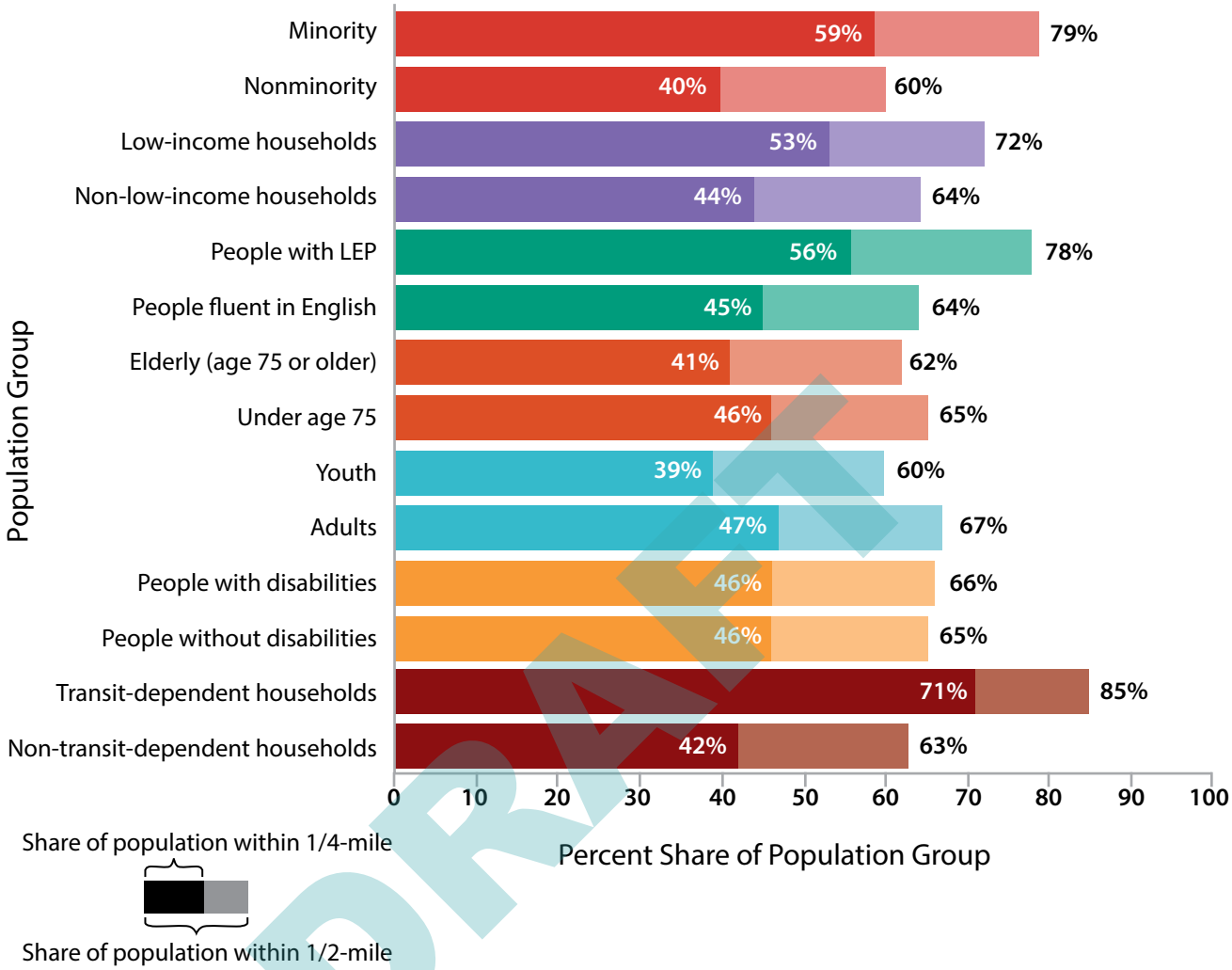
Bicycle and Pedestrian Mobility

Figure 8.10 shows the percent of each TE population within one-half and one-quarter mile of all types of bicycle infrastructure in the Boston region—out of the total TE population within the region.[11]

[11] The methodology involved calculating the TE population in each TAZ as a percentage of the population in each TAZ. For example, if a TAZ had 100 people and 30 percent were minority, then 30 people were considered minority in that TAZ. If a TAZ overlapped with the one-quarter or one-half mile buffer, the TE population was calculated based on the percentage of the TAZ within the buffer. For example, if 50 percent of a TAZ was within one-quarter mile of bicycle infrastructure, the calculations would be based on 50 percent of the total population of the TAZ. Using the example from above, this would mean that 15 people within one-quarter mile of bicycle infrastructure were considered minority.

The population of each TAZ was drawn from demographic projections produced by MPO staff for the year 2016. Because these projections do not include projections of each TE population, only of the total people and households, this methodology applies the share of each TE population as reported in the 2010 Census or 2010–14 ACS the MPO's projections.

Figure 8-10
Share of Transportation Equity Populations with Access to Bicycle Infrastructure



Note: Bicycle infrastructure includes facilities that provide bicyclists with their own space, including unprotected on-street bicycle lanes, on-street buffered bicycle lanes, and shared-use off-street paths. It does not include sharrows.
The share of the population group refers to the portion of the total TE or non-TE population living in the Boston region within one-quarter mile and one-half mile of the bicycle infrastructure.
LEP = limited English proficiency. TE = transportation equity.
Sources: 2010 US Census and 2010–14 American Community Survey; and Metropolitan Area Planning Council's TrailMap.

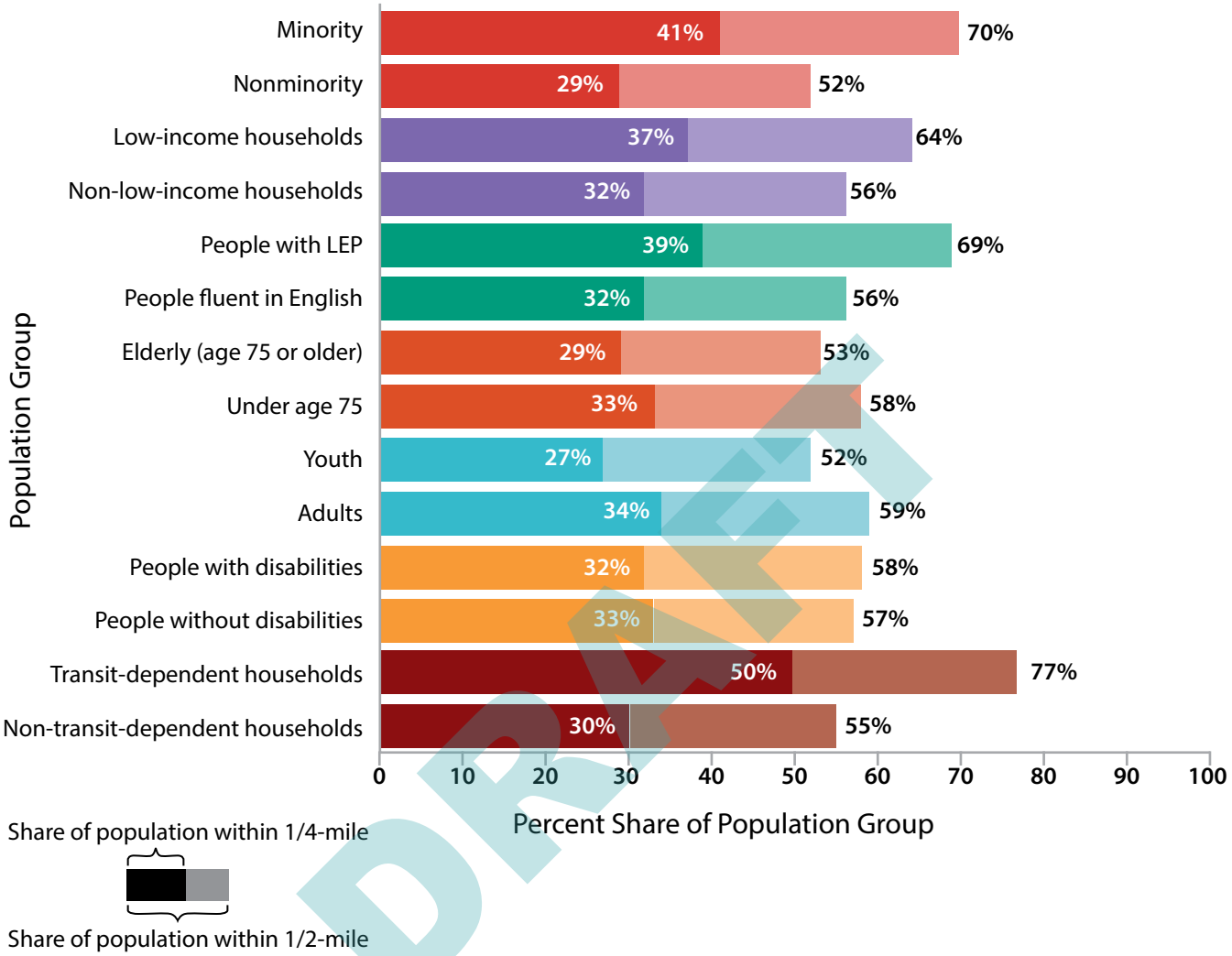
Overall, TE populations appear to be well-served by bicycle infrastructure in the Boston region relative to their comparison populations. Over half of minority, low-income, people with LEP,

and transit-dependent populations live within one-quarter mile of bicycle infrastructure, and about three-quarters live within one-half mile. Youth and elderly populations are the only TE populations where the share that is within one-quarter mile of bicycle facilities is less that their respective non-TE populations. For people with disabilities, the percent of the population within one-quarter or one-half mile of bicycle infrastructure is about the same as for people without disabilities. Future investments to the region's bicycle network could focus on improving access for the youth population and elderly populations. However, this analysis does not account for whether the bicycle infrastructure connects residents to where they want to go or whether residents want to or can bicycle. These concerns should be addressed during project development and evaluation.

Access to the safest types of bicycle infrastructure—those physically separated by vertical or horizontal buffers—provide the safest bicycle routes for all riders. Youth and elderly populations may in particular benefit from this type of bicycle infrastructure. In this Needs Assessment, these are called "high-quality infrastructure" and "medium quality infrastructure."[12] Figure 8.11 shows the percent of each TE population within one-quarter mile and within one-half mile of high- and medium-quality bicycle infrastructure in the Boston MPO region.

[12] High-quality bicycle infrastructure is that which physically separates bicyclists from the street, such as a vertical barrier between bicyclists and motorists, bicycle facilities at the curb or sidewalk level that allow for the separation of bicyclists and pedestrians, or, in the case of shared-use paths, separate paths for bicyclists and pedestrians. Medium-quality bicycle infrastructure has a horizontal separation between motorists and bicyclists, facilities at curb level without a sidewalk buffer to separate bicyclists and pedestrians, or, in the case of shared-use paths, combined paths for bicyclists and pedestrians.

Figure 8-11
Share of Transportation Equity Populations with Access to High- and Medium-Quality Bicycle Infrastructure



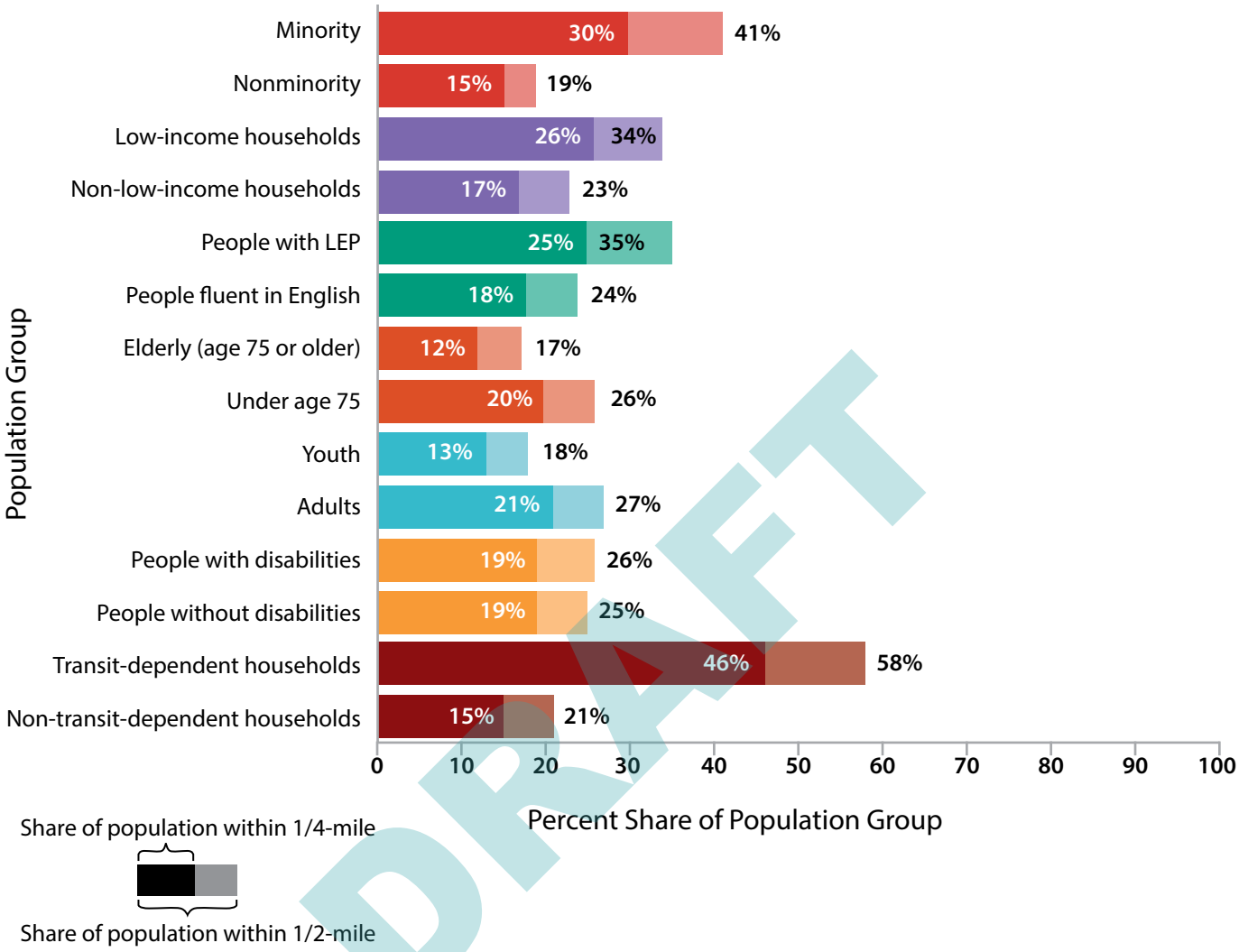
Note: The share of the population group refers to the portion of the total TE or non-TE population living in the Boston region within one-quarter mile and one-half mile of the bicycle infrastructure.
LEP = limited English proficiency. TE = transportation equity.
Sources: 2010 US Census; 2010–14 American Community Survey; and Metropolitan Area Planning Council's TrailMap.

Across the region, TE populations have at least as good access to medium- and high-quality bicycle infrastructure within one-quarter or one-half mile of their homes compared to their respective non-TE populations. Transit-dependent households and low-income households—have among the best access. On the other hand, youth, many of whom cannot drive, have among the least access, indicating that neighborhoods with families are underserved by high- and medium-quality bicycle infrastructure. Similarly, the elderly population has less access than the population under the age of 75. Again, however, this analysis does not account for whether these populations can or want to bicycle, or whether the infrastructure provides access to places they want to go. It also does not measure the connectivity of bicycle networks, which likely plays a role in the utility of a given bicycle facility.

Figure 8.12 shows the percent of each TE population within one-quarter mile and one-half mile of Bluebikes stations, a bike share that operates within Boston, Brookline, Somerville, and Cambridge.[13] The analysis does not indicate, however, whether Bluebikes stations are close to high- and medium-quality bicycle infrastructure. These percentages are out of the total TE population within these municipalities only. The analysis only includes docked bike share stations operated by Bluebikes. The docked bike share operated by Zagster in Marlborough and Salem was not included because data on the size and location of their fleet could not be found. Many other municipalities in the Boston MPO have dockless bike share (including Arlington, Bedford, Belmont, Chelsea, Everett, Malden, Medford, Melrose, Milton, Needham, Newton, Quincy, Revere, Swampscott, Waltham, Watertown, and Winthrop) that could not be tracked as the locations of bicycles is not fixed.

[13] This includes the Bluebikes expansion in the summer and fall of 2018.

Figure 8-12
Share of Transportation Equity Populations with Access to Bluebikes Stations



Note: The share of the population group refers to the portion of the total TE population living within the municipalities where Bluebikes operates (Cambridge, Somerville, Boston, and Brookline) within one-quarter mile and one-half mile of a Bluebikes station.
Sources: 2010 US Census; 2010–14 American Community Survey; and Bluebikes.

Most TE populations have greater or equal access to Bluebikes stations relative to their comparison non-TE populations, except for the youth and elderly populations. Transit-dependent households have the best access of any TE population, with 58 percent within one-half mile and 46 percent within one-quarter mile of a Bluebikes station. This compares with households that are not transit-dependent, of which 21 percent and 15 percent have access to a Bluebikes station, respectively. The elderly population has the least access to

Bluebikes stations of any TE population, with 12 percent of that population within one-quarter mile of a station and 17 percent within one-half mile of a station. This analysis does not factor in whether these populations want to or can use Bluebikes, but it does suggest that elderly and youth populations have less access to Bluebike stations than other age groups in the Bluebike service area.

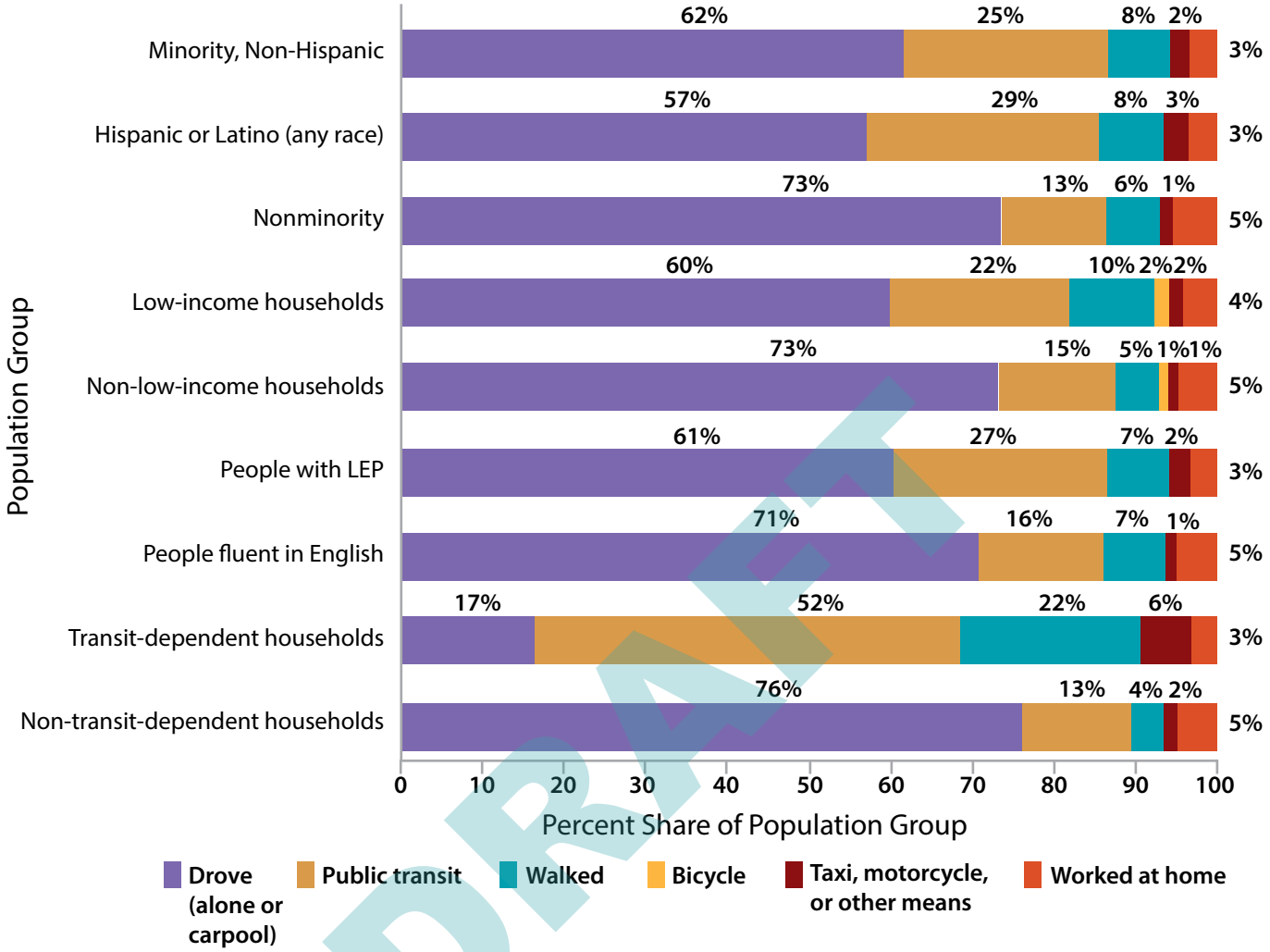
Public Transit

Census data show that, in general, TE populations in the Boston region rely on public transit to travel to work more than their non-TE population counterparts. Figure 8.13 shows the commute modes used by each population. (The youth population was omitted from this analysis; data for people with disabilities are not available.)

As expected, transit-dependent households have the highest public transit mode share, with 52 percent using this mode, followed by LEP and minority populations. (Because the ACS reports Journey to Work data for people who identify as a racial or ethnic minority but not for people who identify as both, mode shares for these two groups are reported separately here.) Transit-dependent households also have the highest walking mode share (22 percent) and the lowest driving mode share (16 percent).

These data show that TE populations generally rely on non-automobile transportation to get to work, especially walking and public transit. Therefore, these workers may most benefit from investments in transit, bicycle, and pedestrian infrastructure.

Figure 8-13
Commute Mode Share of Transportation Equity Populations



Note: The tabulation is for workers age 16 years and older. Journey to Work data collapses the bicycle mode with "motorcycle, taxi, or other means" for some populations due to the small sample sizes of those populations. The bicycle mode only is tabulated separately by income and sex. For all other TE populations, the "taxi, motorcycle, or other means" field includes the bicycle mode. The commute mode share data are available for people who identify as either a racial and ethnic minority, but not for people who identify as both.
LEP = limited English proficiency.
Source: 2010–14 American Community Survey.

Figure 8.14 shows the share of each TE population within one-quarter and one-half mile of frequent transit service with average weekday headways of 15 minutes or less.[14] Figure 8.15 shows the TE populations within one-quarter and one-half mile of any transit service in the Boston region, including service with longer wait times.[15] Overall, the minority populations, low-income households, people with LEP, people with disabilities, and transit-dependent households have better access to transit service, including frequent service, when compared to their respective non-TE populations. However, the percent of elderly and youth populations that live within one-quarter mile of frequent transit is lower than their respective non-TE populations. This is also true for those living within one-half mile of public transit. As the demographic profiles show, minority populations, low-income households, people with LEP, people with disabilities, and transit-dependent households tend to live in urban areas that have the most developed transit systems. Thus, these populations are more likely to rely on public transit as their main form of transportation. Meanwhile, elderly and youth populations tend to be more evenly distributed geographically through the Boston region. The analysis of access to transit, however, did not assess other factors such as reliability and connectivity. As many commenters said during public outreach, these factors are very important.

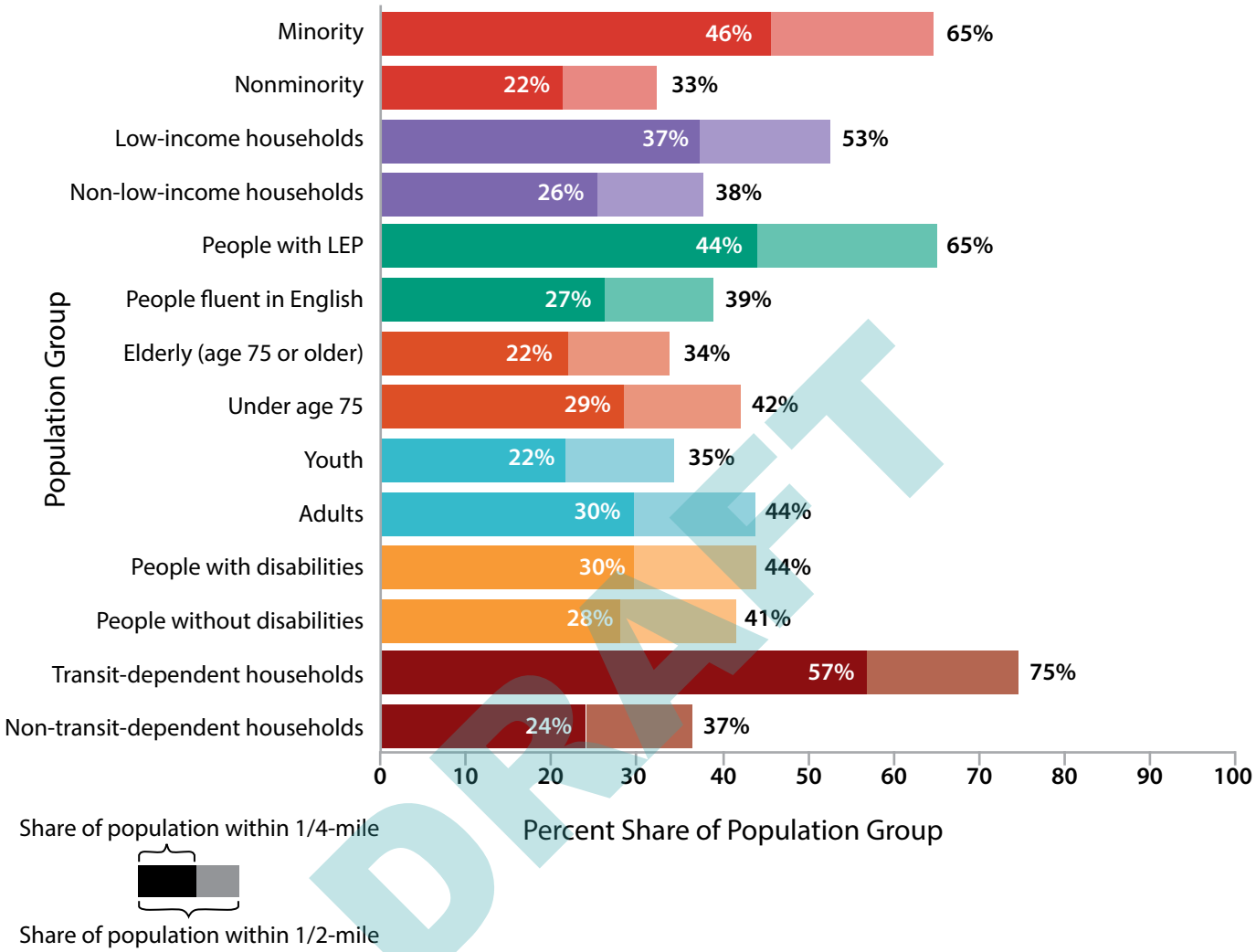
Transit-dependent households have the highest share of all TE populations with respect to access to transit service, with about 93 percent of all households living within one-half mile of service and nearly 74 percent within one-half mile of frequent transit service. Meanwhile, youth and elderly populations have the lowest share. Seventy percent of the youth and elderly populations live within one-half mile of transit service, but only one-quarter of both populations live within one-quarter mile of frequent service.

Overall, these data suggest that most TE populations have comparable access to transit service, including frequent service, relative to their respective non-TE populations. However, this does not factor in the quality and reliability of the transportation. Additional future analyses could look more in-depth into these trip characteristics to better understand if TE populations have transit service that meets their needs.

[14] Frequent transit service is defined as routes with an average weekday frequency of 15 minutes or less. Service includes all weekday public transit modes—bus, rapid transit, bus rapid transit, commuter rail, and ferry—operating within the Boston region.

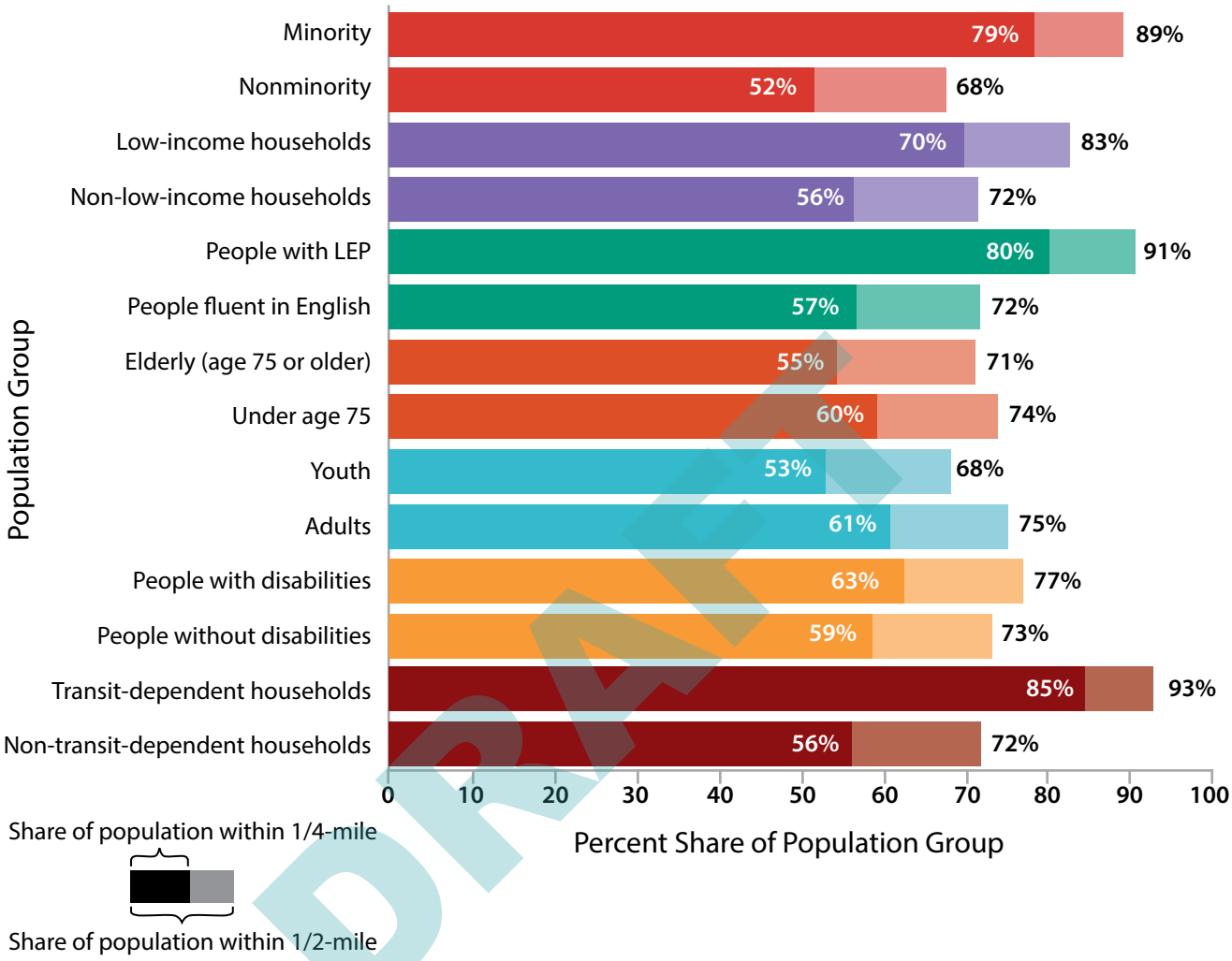
[15] Service includes all weekday public transit modes that operate within the Boston region: bus, bus rapid transit, rapid transit, commuter rail, and ferry.

Figure 8-14
Share of Transportation Equity Populations within One-Quarter and One-Half Mile of Frequent Transit Service



Note: Frequent service is defined as routes with an average weekday frequency of 15 minutes or less. Service includes all weekday public transit modes (bus, rapid transit, bus rapid transit, commuter rail, and ferry) operating within the Boston region. Operators include the BAT, CATA, GATRA, MBTA, MVRTA, and MWRTA. The share of transportation equity population refers to the portion of the total TE population living in the Boston region within one-quarter mile or one-half mile of bicycle infrastructure.
BAT = Brockton Area Transit. GATRA = Greater Attleboro Taunton Regional Transit Authority. LEP = limited English proficiency. MBTA = Massachusetts Bay Transit Authority. MVRTA = Merrimack Valley Regional Transit Authority. MWRTA = MetroWest Regional Transit Authority.
Sources: 2010 US Census; 2010–14 American Community Survey; Central Transportation Planning Staff; MBTA; CATA; BAT; GATRA; MVRTA; and MWRTA.

Figure 8-15
Share of Transportation Equity Populations within One-Quarter and One-Half Mile of Transit Service

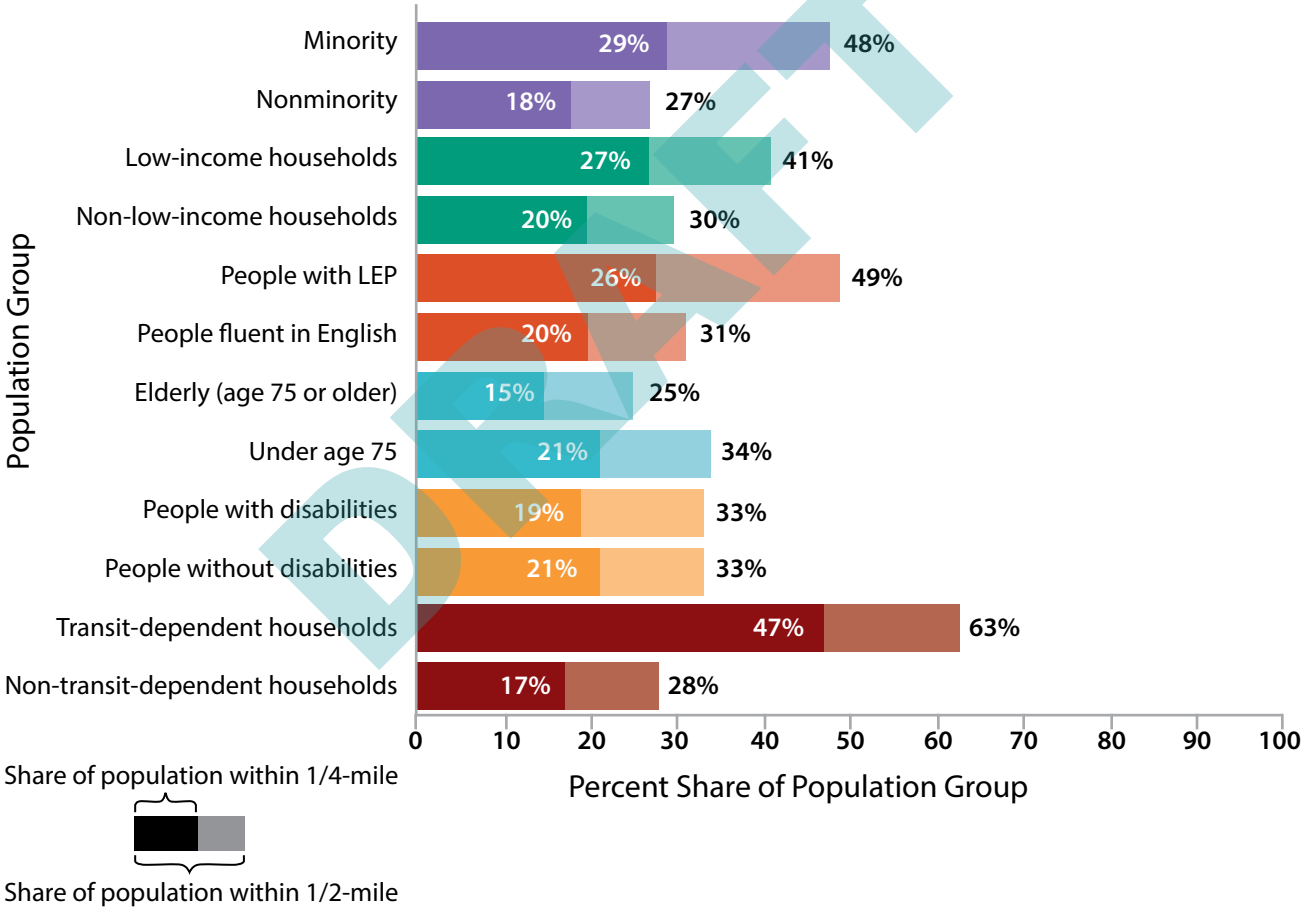


Note: Service includes all weekday public transit modes (bus, rapid transit, bus rapid transit, commuter rail, and ferry) operating within the Boston region. Operators include BAT, CATA, GATRA, MBTA, MVRTA, and MWRTA.
The share of transportation equity population refers to the portion of the total equity population living within the MPO region—within one-quarter mile and one-half mile of bicycle infrastructure.
BAT = Brockton Area Transit. GATRA = Greater Attleboro Taunton Regional Transit Authority. LEP = limited English proficiency. MBTA = Massachusetts Bay Transit Authority. MVRTA = Merrimack Valley Regional Transit Authority. MWRTA = MetroWest Regional Transit Authority.
Sources: 2010 US Census; 2010–14 ACS; CTPS; MBTA; CATA; BAT; GATRA; MVRTA; and MWRTA.

Other Shared Mobility Options

In addition to bicycle sharing companies, the other shared mobility options include car sharing. Several of these companies operate within the Boston region; data were available for two of them, ZipCar and Maven. Figure 8.16 shows the percent of TE populations within one-quarter and one-half mile of stations of the two car-sharing companies with available station data, Zipcar and Maven. The analysis assumes that living near a car share station improves one's transportation options and that all people are able and want to use a car share.

Figure 8-16
Share of Transportation Equity Populations with Access to Car Share Vehicles



Note: The youth population is not included in this table as the majority does not drive.
LEP = limited English proficiency.
Sources: 2010 US Census; 2010–14 American Community Survey; Zipcar; and Maven.

Most TE populations have a higher share that live within one-quarter or one-half mile of a Zipcar station than their respective non-TE populations. The exceptions are people with disabilities and elderly. Elderly populations have the lowest share of the population near car share vehicles, with 15 percent within one-quarter mile and 25 percent within one-half mile. (The youth population was not part of this analysis as most children under the age of 18 cannot drive.) These data reflect in part that the Zipcar stations tend to be located in denser areas, whereas the elderly and people with disabilities tend to be evenly distributed throughout the region. This analysis did not account for whether people can afford to use Zipcar or need to do so.

Summary of Capacity Management and Mobility Needs

The analyses in this section describe some of the mobility needs of TE populations. Some of the differences regarding access to transit are due to differences in geographical distribution of populations—for example, as described in the section on demographics, elderly and youth populations are fairly evenly distributed across the region, whereas minority and low-income populations tend to be more concentrated in Boston and neighboring municipalities. As transit also tends to be concentrated in these areas, the latter TE populations have better access.

However, these analyses assume that living near a transit station or infrastructure improves one's transportation options and that all people are able and want to use transit. They do not account for the ability of someone to access the infrastructure, whether someone has the need to use it, or the quality of the service or infrastructure. Future analyses could explore these questions.

Clean Air/Sustainable Communities Goal

The MPO's Clean Air/Sustainable Communities goal focuses on creating an environmentally friendly transportation system by reducing greenhouse gases and other transportation-related pollutants, minimizing other negative environmental impacts of the transportation system, and supporting land use policies that are consistent with smart, healthy, and resilient growth. Identifying and addressing the human health and environmental effects of transportation is a key component of the EJ Executive Order, and subsequently of EJ guidance from the Federal Transit Administration (FTA) and Federal Highway Administration (FHWA). As such, this section discusses the MPO's current and potential future work to identify transportation needs related to the environmental effects of transportation on TE populations.

Greenhouse Gas Emissions

The transportation sector is the leading cause of greenhouse gas emissions[16]—including methane, nitrous oxide, and hydrofluorocarbons, carbon dioxide (CO_2)—which contribute to climate change.[17] In Massachusetts in 2014, transportation was responsible for 39 percent of the state's greenhouse gas emissions.[18] Climate change affects human health and welfare directly as a result of more frequent and severe heat waves, extreme weather events, and sea-level rise. These events and related impacts are expected to affect certain vulnerable populations in the Boston region. Vulnerable populations are those that have comparatively few resources to cope with the stresses of climate change. In particular, children and the elderly are more susceptible to climate impacts, such as higher temperatures, while low-income communities near the coast may be vulnerable to the financial burdens associated with repeated flooding and stronger storms.[19] Other populations vulnerable to climate change include people with disabilities and people with limited English proficiency. These socioeconomic vulnerabilities may be compounded depending on where vulnerable populations live. Those who live in neighborhoods most likely to be affected by rising sea levels, heat waves, or extreme weather events (such as hurricanes) may find it more difficult to adapt to changes in the climate.[20]

The Boston Region MPO has interactive maps that show potential impacts related to climate change. The All-Hazards Planning application contains maps that show areas at high risk for 100-year and 500-year floods; at risk for seawater inundation during Category 1 through Category 4 hurricanes; and at risk for sea level rise during this century based on the range of levels predicted. Currently, the maps do not show which communities with high shares of TE populations would be affected. Adding map layers to show these communities is a possible next step for the MPO to better understand the potential impact of climate change on TE populations in the region. Additionally, the MPO's Vehicle Miles Traveled and Emissions Data Browser shows CO_2 emissions data for the cities and towns in the Boston region. In the future, these maps could be updated with layers that show communities with high shares of TE populations in the region to better understand where emissions are highest and therefore have the potential to cause the greatest health effects.

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16 US EPA, *Green Vehicle Guide,* "Fast Facts on Transportation Greenhouse Gas Emissions," https://www.epa.gov/greenvehicles/fast-facts-transportation-greenhouse-gas-emissions

17 US EPA, *Carbon Pollution from Transportation*, "Transportation and Climate Change," https://www.epa.gov/transportation-air-pollution-and-climate-change/carbon-pollution-transportation

18 State of Massachusetts, *MA GHG Emission Trends*, https://www.mass.gov/service-details/ma-ghg-emission-trends

19 Metropolitan Area Planning Council, 2014, *Metro Boston Regional Climate Change Adaption Strategy Report*. https://www.boston.gov/sites/default/files/metro_boston_regional_climate_adaptation_strategy_report.pdf

20 Schlegel, C., 2018, *Climate Justice for the City of Boston: Visioning Policies and Processes,* http://michelleforboston.com/wp-content/uploads/2018/02/CJ-Report.pdf

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Other Transportation-Related Emissions

Particulate matter ($PM_{2.5}$ and PM_{10}), nitrogen oxide (NO_x), carbon monoxide (CO), and volatile organic compounds (VOCs) are all emitted by vehicles and are harmful to human health. People who live near major roads have increased exposure to these pollutants; children, the elderly, people who have cardiopulmonary disease, and people with low incomes are especially vulnerable.[21] Ozone, which is formed by NO_x and VOC emissions in the presence of sunlight, can cause a variety of health problems. Ozone can make breathing more difficult, cause coughing, make the lungs more susceptible to infection, increase the frequency of asthma attacks, and cause chronic obstructive pulmonary disease.[22] Meanwhile, particulate matter—caused when chemicals emitted by cars interact with the atmosphere—is associated with aggravated asthma, coughing, difficulty breathing, heart attacks, and premature death in people with heart or lung disease.[23] The finer the particle—those less than 10 micrometers in diameter, such as $PM_{2.5}$—pose the greatest risk as they can get deep in the lungs and in the bloodstream.[24]

Tracking and documenting data about exposure of TE populations that are particularly vulnerable to the effects of emissions is one strategy the MPO could take to better ensure that MPO investments do not aggravate the health effects of vehicle emissions in vulnerable neighborhoods—especially those near highways or arterials—and promote alternative forms of transportation to reduce vehicle use and thus emissions. The MPO has several data resources that show transportation-related emissions in the Boston region. The 2015 Arterial Highway and Express Highway Performance Dashboards show congested highway segments and arterial segments, respectively, during peak travel times. In addition, the Vehicle Miles Traveled and Emissions Data Browser directly show VOC and NO_x emissions data. These maps do not currently provide information about the extent of congestion in TEZs, but they could be updated in the future to do so and to show where emissions are highest. High levels of congestion could indicate the presence of significant harmful pollutants caused by transportation.

Summary of Clean Air/Sustainable Communities Needs

Some people in TE populations are particularly vulnerable to the effects of climate change—whether because of their age, place of residence, income, or physical health. These effects may be compounded in communities where several of these demographic indicators overlap. Additionally, some populations, in particular youth and elderly, are more affected by

[21] US EPA, *How Mobile Source Pollution Affects Your Health*, https://www.epa.gov/mobile-source-pollution/how-mobile-source-pollution-affects-your-health.

[22] US EPA, *How Mobile Source Pollution Affects Your Health*, https://www.epa.gov/mobile-source-pollution/how-mobile-source-pollution-affects-your-health#smog.

[23] US EPA, *How Mobile Source Pollution Affects Your Health*, https://www.epa.gov/mobile-source-pollution/how-mobile-source-pollution-affects-your-health.

[24] US EPA, *Particulate Matter (PM) Basics*, https://www.epa.gov/pm-pollution/particulate-matter-pm-basics.

transportation-related emissions, such as particulate matter. These factors should be taken into consideration in the MPO's planning and programming process.

System Preservation Goal

The MPO's System Preservation goal focuses on maintaining the transportation system in a state of good repair, modernizing transportation infrastructure for all modes; prioritizing projects that support planned response capability to existing or future extreme conditions; and protecting freight network elements, such as port facilities, that are vulnerable to climate change impacts. Transportation infrastructure in the Boston region is aging and transportation agencies face a backlog of maintenance work for the highway and transit system. In addition, if climate change trends continue, the region can expect significant impacts to the transportation system due to rising sea levels, more frequent flooding, storm surges, and heat stress.

Climate Change Risk and Vulnerable Populations

Climate change poses significant risks to the region's transportation system. Impacts to the transportation network will also likely affect populations that rely on public transit. In the last few years, complete or partial shutdowns on the MBTA's system have occurred due to severe weather events—including flooding and nor'easters—affecting, among others, hourly wage earners who depend on public transit to get to work. Public transit networks will continue to be vulnerable to the effects of stormwater flooding from precipitation, hurricanes, nor'easters, and damaging storm surges. Major routes susceptible to flooding include Tremont Street in Boston, portions of Interstate 90 and Interstate 93, and some portions of the MBTA's subway lines in downtown Boston.[25]

The MPO's All-Hazards Planning application could be updated to identify those public transit routes that are widely used by the various TE populations and that could be affected by climate change-related impacts, such as sea-level rise, storm surges, and flooding. This analysis could identify the transit passengers most likely to be affected by an interruption of service due to the effects of climate change.

Pavement and Bridges

The MPO's Performance Dashboard shows pavement condition of interstates and MassDOT-owned non-interstate roads based on the present serviceability index (PSI), which is a measure of the road's roughness. The dashboard documents the change to PSIs between 2007 and 2014. In the future, the MPO staff could calculate the miles of roads in TEZs for each TE population type and determine, based on PSI scores, whether roads in those communities are maintained as well as those outside TEZs.

[25] Schlegel, C., 2018, *Climate Justice for the City of Boston: Visioning Policies and Processes,* http://michelleforboston.com/wp-content/uploads/2018/02/CJ-Report.pdf.

The Performance Dashboard also shows the condition of the bridges in the region that are listed in the National Bridge Inventory, which includes all bridges that are more than 20 feet long. In 2016, there were 1,622 such bridges in the Boston region. The dashboard shows how the structural integrity of the bridges in the region has changed between 2007 and 2016, based on bridge health index scores. While the information is currently sorted by municipality, in the future the MPO staff could sort the information according to TEZs and non-TEZs to see whether bridges in communities with high shares of TE populations are more likely to be structurally deficient.

Summary of System Preservation Needs

Some major transportation routes and transit lines in the Boston region are susceptible to flooding and storm surges from extreme weather events, such as hurricanes and nor'easters. Impacts to public transit, which TE populations often depend on more than non-TE populations, could adversely affect these populations in particular. These impacts are only expected to get worse as the effects of climate change intensify, leaving already vulnerable populations increasingly susceptible to the adverse effects of climate change.

Economic Vitality Goal

The MPO's Economic Vitality goal is to respond to the mobility needs of the workforce population; minimize the burden of housing and transportation costs for residents in the region; prioritize transportation investments that serve residential, commercial, and logistics targeted development sites and "Priority Places" identified in the MBTA's *Focus 40* plan; and prioritize transportation investments consistent with the compact-growth strategies of the regional land use plan. Over the past four years, the MPO's work has largely focused on prioritizing transportation investments that support a changing economy, encourage mixed-used development, accommodate emerging transportation services and non-auto modes, and serve new or planned development.

Boston's *Go Boston 2030: Imagining Our Transportation Future* identifies several emerging job centers that are currently underserved by public transportation. These include the Longwood Medical Center (LMA), Logan International Airport, and the Seaport. Boston neighborhoods with significant shares of TE populations—particularly low-income households and transit-dependent households—that could potentially benefit from improved or new transit service to these job centers include Roxbury, Mattapan, Dorchester, and Brighton. The report also identifies bicycle corridors that could improve access to jobs for these populations.[26] Future MPO work could build on these efforts to identify job centers within the region for which there is limited or no transit access for TE populations.

[26] Boston Transportation Department, 2017, *Go Boston 2030*, https://www.boston.gov/sites/default/files/go_boston_2030_-_full_report_to_download.pdf.

Summary of Economic Vitality Needs

As Boston area employment patterns change, transportation services and infrastructure must adapt. Job centers are becoming more spread out, with Boston neighborhoods outside of downtown emerging as job centers, as well suburban nodes. Additionally, more and more people are commuting between suburbs, instead of into and out of Boston, as well as commuting during off-peak hours. Many of these commuters who work in low wage jobs would benefit from transportation services geared to these non-traditional commutes. Also, increasingly services such as healthcare are being provided outside of Boston and a growing elderly population will necessitate improved transportation access to these services.

Stakeholder and Public Input

The MPO staff engaged local organizations who work with TE populations, which are the focus of federal Title VI, EJ, and other nondiscrimination laws, to gather input on the transportation needs and challenges of the people they represent. MPO staff also distributed a survey to organizations throughout the region to get greater input from TE populations for the Needs Assessment. The survey was also posted on the MPO's website and distributed through the MPO's regular email channels.

Safety Goal

Many commenters who discussed safety focused on building safe bicycle and pedestrian facilities (such as protected or off-street bicycle lanes) for people of all ages and abilities. Specifically, they recognized the need for safe routes to schools, jobs, commercial developments, and public transit, as well as sidewalks that are ADA-compliant. Commenters also identified a need for high- and medium-quality bicycle lanes, especially along well-traveled streets, which would help people who travel to or from work when there is no transit service running to arrive safely. They also pointed to the need for safe bicycle facilities in low-income neighborhoods, especially on major thoroughfares that lack safe infrastructure and pose risk to pedestrians and bicyclists.

Capacity Management and Mobility Goal

The transportation interests and needs of TE populations are largely focused on non-auto modes, especially public transit. Overall, commenters expressed interest in more frequent service during off-peak hours and extending service throughout the night. They also expressed interest in improving transit reliability, frequency, efficiency, accessibility, and connectivity.

Many commenters cited the need to provide late-night and/or 24-hour rapid transit service, and to increase the level of service on the commuter rail. Additionally, many saw the need for more off-peak bus service, including during the midday and on the weekends. These changes would particularly support those who do not have a standard nine-to-five workday. Commenters also saw a need for more reliable transit services, particularly for the Red Line, buses, and all services operating during rush hours.

Gaps in transit coverage were also cited. These gaps include transit from Boston to regional employment centers outside of the urban core, suburb-to-suburb service, service to healthcare facilities in Boston from the suburbs, east-west connections between Boston neighborhoods, service to Springfield, and service between outer suburbs and neighboring cities outside of the Boston region, such as Lowell.

Several commenters noted the slow transit service to some neighborhoods, such as Roxbury, Mattapan, and Hyde Park. Speeding up public transit service to these neighborhoods, to regional job centers, and for long-distance commuting could shorten commutes for lower-income individuals with non-traditional commutes.

Other commenters remarked on the need to improve connectivity of the sidewalk and bicycle networks and to provide better access to bike-sharing. Specifically, several commenters cited the need for bicycle and pedestrian infrastructure in low-income neighborhoods as this infrastructure would provide reliable, affordable, and healthy transportation options.

With regard to accessibility, commenters noted that many people with disabilities lack access to single occupancy vehicles, and therefore access to public transit is an essential for them. Several commenters also highlighted the importance of an accessible pedestrian environment with access to bus stops and rail stations. Also mentioned was the importance of investing in the public transit system—including bus routes—in outlying Boston neighborhoods and suburbs. Commenters also encouraged partnerships with transportation network companies, such as Uber and Lyft, in order to close the gaps in areas served by public transit.

Clean Air/Sustainable Communities Goal

Some commenters expressed concern about the impacts that climate change could have on the public transit system, especially the impacts that extreme weather and storms have had in the past and that could occur in the future. Some commenters expressed concern about the impacts of greenhouse gases and other pollutants at the local level on TE populations. Others brought up the importance of building non-motorized transportation infrastructure in TE neighborhoods along streets that are not major thoroughfares to help residents reduce their exposure to vehicle emissions.

System Preservation Goal

Several commenters identified the need to improve sidewalk conditions. Poorly-maintained sidewalks can be especially problematic for elderly adults and people with disabilities, so these commenters wanted more sidewalks to be ADA-compliant. Poorly-maintained sidewalks can also be dangerous to young children who walk to school. Poor street-level lighting and faded crosswalks were also identified as safety issues. Others identified the need for better maintenance of elevators and escalators in public transit stations, as well as the need for to address the safety and cleanliness of stations in general.

Economic Vitality Goal

Many commenters discussed the impacts that high housing prices have on commute times and on transportation costs as lower income individuals get pushed further from job centers in the urban core. Because of this trend, some commenters suggested improving connections by transit between low-income neighborhoods that are outside of the urban core and regional employment centers as a way to help reduce these burdens.

Many commenters said that current public transit schedules and routes—which largely serve traditional nine-to-five jobs and employees working in the urban core—do not serve commuting patterns of some low-income households and other TE populations. A lack of off-peak commute options—including overnight and early morning service—can make it challenging for some to get to work. People with LEP and low-income populations are particularly burdened. Commenters also identified the need for more reverse-commute options on public transit to job centers outside the urban core. Finally, others noted that long-distance commutes needed to be better accommodated with more direct express service and fewer transfers. Without these services, low-income households must invest in a car, adding to the financial burdens on these households.

In addition to schedule changes, some suggested that more first- and last-mile connections would help bridge transportation gaps between homes and workplaces and fixed-route transit stations. Others identified the need for new rapid transit lines in inner-core neighborhoods with limited or no fixed-route service, many of which have many low-income and other TE populations, including Roxbury, Mattapan, Hyde Park, and Roslindale, in order to connect them to job-rich neighborhoods, such as the Longwood Medical Area.

Beyond jobs, there was a desire for increased transit connectivity to schools, grocery stores, healthcare facilities, and amenities in lower-income communities. Commenters noted that elderly individuals and people with disabilities particularly need better and more affordable access to these locations. Safe, accessible bicycle and pedestrian connections were frequently cited as a way to improve connectivity within and between neighborhoods. These would also serve young people who cannot drive.

Other Topic Areas

Beyond the transportation needs identified in the goal areas, two cross-cutting transportation needs emerged from public outreach. One was improving the coordination between transportation and land use planning. Implementing many of these suggestions would be outside the jurisdiction of the MPO—such as building more affordable housing near transit stations and updating zoning to allow more mixed-use development near train stations. However, the MPO would have the ability to support transportation investments where, for example, mixed-use development or low-income housing is planned.

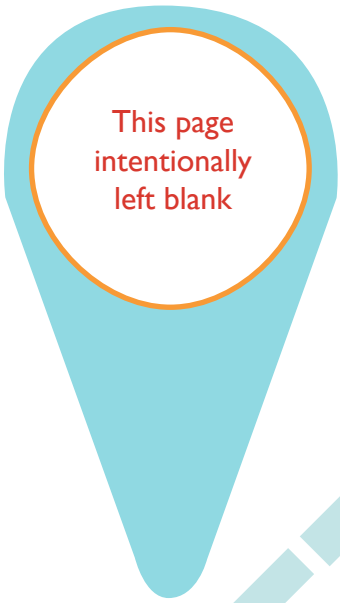
Commenters also mentioned the lack of coordination between transportation services, especially between public transit services. Many saw the need for schedules between transit providers, such as regional transit authorities (RTAs), to match more closely. Integration of fares between providers was also noted as a strategy to make traveling easier. Some commenters noted that the artificial boundaries between transit providers, including RTAs, transportation management associations (TMAs), and local paratransit services, make traveling across borders unnecessarily time consuming. This can be particularly problematic for people who rely on public transit to get to work, such as low-income individuals and people without access to a vehicle, as well as for those who rely on transit to travel to medical appointments, such as elderly adults and people with disabilities.

Changes since the Last Needs Assessment

The Transportation Equity section of the *Destination 2040* Needs Assessment has been significantly updated since the Needs Assessment for the prior LRTP, *Charting Progress to 2040*, was produced. Additional TE populations have been analyzed and new analyses have been completed to identify transportation needs. More data and other relevant information were available to complete these analyses. These changes and new data sources include the following:

- The TE populations analyzed were expanded from people who identify as minority and low-income households to include the following TE populations:
    - People with LEP
    - People who are 75 years or older
    - People who are 17 years or younger
    - People with disabilities
    - Transit-dependent households

- Several new resources were used to identify transportation needs, including the following:
    - MAPC's *State of Equity 2017 Update*
    - The MPO's update of socioeconomic projections (population, employment, and household)
    - *Go Boston 2030: Imagining Our Transportation Future*
    - New American Community Survey data from the US Census Bureau
- New analyses were undertaken to examine how TE populations are affected by the transportation network with regard to each goal area. These analyses addressed the following topics:
    - Distribution of bike share stations to TEZs
    - Distribution of car share vehicles to TEZs
    - Share of TE populations within one-quarter and one-half mile of frequent and non-frequent transit stops
    - Crash clusters within TEZs, by mode
    - High- and low-quality bicycle facilities in TEZs
    - Existing data resources and tools related to climate change risk, pavement and bridge quality, greenhouse gas emissions, and access to job centers, and next steps that the MPO could take to improve equity-related analyses related to these topics
    - New demographic profiles of TE populations



chapter 9

Economic Vitality Needs

THE BOSTON MPO'S ECONOMIC VITALITY GOALS AND OBJECTIVES

Goal:

Ensure the Boston MPO's transportation network provides a strong foundation for economic vitality.

Objectives:

- Respond to the mobility needs of the workforce population
- Minimize the burden of housing and transportation costs for residents in the region
- Prioritize transportation investments that serve residential, commercial, and logistics-targeted development sites and "Priority Places" as identified in the Massachusetts Bay Transportation Authority (MBTA)'s *Focus 40* plan
- Prioritize transportation investments consistent with the compact-growth strategies of the regional land use plan

INTRODUCTION

Issue Statement

Transportation is a key factor in the region's economic vitality. The transportation system makes economic activity possible by enabling the transport of goods and the delivery of services. The transportation sector also serves as a major economic engine itself—households, businesses, and government agencies directly consume transportation goods (e.g., vehicles and motor fuel) and services (e.g., public transit) to meet their travel needs.

Economic vitality issues related to the MPO's long-range transportation planning include land use and freight travel. Land use planning (including development of residential, commercial, and industrial areas) needs to be coordinated with investments in transportation improvements and expansion of transportation options. The locations of different land uses, as well as patterns of regional development, impact housing costs, mobility, and commute times. The region's economic health and growth potential is also influenced by freight movement in terms of goods and services reaching businesses and consumers. Overlaying these core issues are factors of congestion, both on roadways and transit, as well as access to housing, jobs, and transportation options.

Background

As described above, the main economic issues that tie into the MPO's planning process include land use and freight movement. The key to a prosperous region in the future is to coordinate development with transportation infrastructure investments. The relationship between freight transportation and economic vitality is broadly acknowledged. It is useful, however, to identify specific connections between freight and the economy which are relevant to the MPO's planning process. Two broad connections with freight transportation and economic vitality are added expenses caused by congestion and the provision of effective and appropriate access to retail and industrial sites.

Land use decisions and many economic development decisions in Massachusetts are directly controlled by local municipalities through zoning. At the regional level, the Metropolitan Area Planning Council (MAPC) is the planning agency that represents the cities and towns in the metropolitan Boston area and the Boston Region MPO area. MAPC created *MetroFuture* in 2008, a plan to make a "greater" Boston region—to better the lives of the people who live and work in metropolitan Boston, now and in the future. One of *MetroFuture's* implementation strategies is to coordinate economic development and transportation investments to guide economic growth in the region.[1] The MPO also adopted this plan as its land use vision for the Boston Region MPO area.

MAPC also works with state agencies to identify local, regional, and state-level priority development and preservation areas in municipalities in the Boston region. These areas can support additional housing, (including affordable and elderly housing) employment growth, creation and preservation of open space, and the type of continued economic vitality and future growth that the market demands, and which the communities desire. The MPO should continue to work with the MAPC and state agencies to understand the transportation

[1] In 2019 and 2020, MAPC will update the regional land use plan, and this new plan, *MetroCommon 2050* will be based on new development trends, housing needs, regional equity goals, and climate change impacts. *MetroCommon 2050* will not be completed until after the adoption of the MPO's *Destination 2040*, however, the demographic projections and land use assumptions for use in *MetroCommon 2050* and in the *Destination 2040* LRTP and Needs Assessment have been developed.

infrastructure needs in these communities. In addition, the MPO can coordinate with municipalities when they are considering local land use decisions, for example, changes in zoning to encourage higher density development around existing transportation options.

The MPO is able to prioritize funding for projects that improve freight travel through its project selection criteria. Roadway projects are given points during the project prioritization and selection process for improving truck safety, movement, and access to freight-reliant industrial or commercial areas.

Working to ensure that the region's transportation network provides a strong foundation for economic vitality is a key goal of the Boston Region MPO. In addition to prioritizing its investments on projects that improve access to priority development areas and activity centers, the MPO places importance on the equitable provision of multimodal transportation options throughout the region. These issues affect regional economic vitality and must be considered when the MPO is making decisions about both long-term and short-term transportation investments.

ECONOMIC VITALITY NEEDS SUMMARY

Economic vitality needs addressed in the Long-Range Transportation Plan (LRTP) fall into two main categories, land use and freight movement. These categories influence and are influenced by interrelated transportation issues in the Boston region including housing costs, roadway and transit congestion, and access to housing, commercial, business, and transportation/mobility options.

The ultimate goal of regional planning is to coordinate investments in housing and employment centers with investments in transportation infrastructure. This approach of linking land use and transportation can have the dual effect of guiding growth towards identified priority development areas and away from high quality natural preservation areas. In addition, making coordinated investments in affordable housing and transit infrastructure is key to responding to the needs of the workforce population. Traffic congestion, including time-consuming commutes and longer truck freight travel times, can contribute to slowing economic growth and a less competitive regional economy.

As indicated by data analysis and public outreach conducted during the development of the Needs Assessment for the new LRTP, *Destination 2040*, new infrastructure and upgrades to traffic and transit operations are needed to improve access to jobs and services. These include additional park-and-ride spaces, reverse-commute and off-peak services, and coordination among Regional Transit Authorities (RTAs). Regarding freight transport, there must be convenient access to the regional express highway system from warehouses and distribution centers. In addition, conflicts between automobiles (including Transportation Network

Companies (TNCs) drop-offs and pick-ups), bicycles, and delivery trucks competing for curb space in urban areas need to be addressed. Economic growth in the Boston region outpaces that in the rest of the state, and growth in the Inner Core subregion is projected to continue at a faster rate than in the rest of the Boston region. This growth is adding to an increase in the number of trips made in the region and increasing congestion on a network that is either at capacity or nearing it. Congestion reduction on expressways, interchanges, and arterials is needed to facilitate the movement of people and freight to ensure that the transportation network continues to provide a strong foundation for the economy.

Table 9.1 summarizes key findings about economic vitality needs that MPO staff identified through data analysis and public input. It also includes staff recommendations for addressing each need. Chapter 10 in this Needs Assessment—Recommendations to Address Transportation Needs in the Region—provides more detail on each of the recommendations. The MPO board should consider these findings when prioritizing programs and projects to receive funding in the LRTP and Transportation Improvement Program (TIP), and when selecting studies and activities for inclusion in the Unified Planning Work Program (UPWP).

Table 9-1
Economic Vitality Needs in the Boston Region Identified through Data Analysis and Public Outreach

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Land Use	Affordable housing	Address the transportation needs of low-income populations via dense, affordable housing near transit hubs and employment, particularly in the Inner Core and suburbs.	*Existing Program* Regional equity program, this can be coordinated with MAPC's work on land use issues including housing and transportation
Land Use	Access to a high-performing, multimodal transportation system	Infrastructure improvements are needed to support growth in the priority development areas, including improved equitable access to employment and housing via public transit, walking, and biking options.	*Existing Programs* • Intersection Improvement • Complete Streets • Bicycle and Pedestrian • Major Infrastructure • Freight Program *Proposed Programs* • Bus Mobility Program • Enhanced Park-and-Ride program • Interchange Modernization • State Freight and Rail projects

Emphasis Area	Issue	Needs	Recommendations to Address Needs
Land Use	Access to jobs through reverse-commute and off-peak service	There is a need for better commuter rail scheduling, more frequent service, and off-peak service to allow for commuters to access jobs outside of the Inner Core. Also, more frequent, reliable off-peak, late-night, and weekend service to support reverse commuting and service workers on all modes throughout the region is needed.	*Existing Study (2019 UPWP)* Reverse-Commute Areas Analysis
Access	RTA coordination	RTAs should coordinate service to address the needs of customers who travel between different RTA service areas; however, there are no funding sources to connect RTA services.	*Existing Program* Regional Transit Service Planning and Technical Assistance
Access	Park-and-ride	Additional parking is needed at park-and-ride lots that are at or approaching capacity.	*Existing Program* Community Transportation/ Parking program *Proposed Program* Enhanced Park-and-Ride program
Freight Movement	Congestion	Reduce congestion on regional roadways to facilitate the movement of freight. (Increases in the costs of products and services can result from congestion due to increased payroll and vehicle costs of truck operations.)	*Existing Programs* • Major Infrastructure • Bottleneck Program *Proposed Program* Freight Database *Existing Studies (2019 UPWP)* • Addressing Safety, Mobility, and Access on Subregional Priority Roadways • Various location-specific studies and technical analysis projects implemented through the existing Freight Program *Proposed Study* Congestion Pricing Research
Freight Movement	Contested curb and arterial road usage	Reduce conflicts between automobiles and delivery trucks that are competing for curb space.	*Existing Studies (2019 UPWP)* • The Future of the Curb • Transportation Access Studies of Commercial Business Districts • Various location-specific studies through Freight program
Freight Movement	Appropriate freight access to retail and industrial sites	Modern logistic operations, such as warehouses, distribution centers, and motor pools, require economies of scale and convenient access to the regional express highways system.	*Existing Studies (2019 UPWP)* • Transportation Access Studies of Commercial Business Districts • Various location-specific studies through Freight program

RTA = regional transit authority. UPWP = Unified Planning Work Program.

Source: Boston Region MPO.

UNDERSTANDING ECONOMIC VITALITY NEEDS IN THE BOSTON REGION

This section presents the research and analysis MPO staff conducted to understand transportation economic vitality needs in the Boston region, which have been summarized in the previous section. Supporting information MPO staff used to understand economic vitality needs is included in the Appendices of this Needs Assessment:

- Appendix A includes key plans and policies
- Appendix B includes MPO studies and reports
- Appendix C includes data resources

This section also includes a summary of input staff gathered from stakeholders and the public about economic vitality needs and proposed solutions to meet those needs. Staff considered this input when developing recommendations to achieve the MPO's economic vitality goals and objectives. As discussed earlier, the MPO is not directly responsible for land use and economic decisions but will continue to work with MAPC and the municipalities to focus on transportation infrastructure needs that will provide a foundation for economic vitality.

MPO Research and Analysis

Land Use Needs

Land use needs in the Boston region were identified through region-specific planning and analysis as well as efforts at the state level that currently impact development patterns and associated issues such as zoning, housing policy, and the prioritization of infrastructure improvements.

Regional Needs Identification

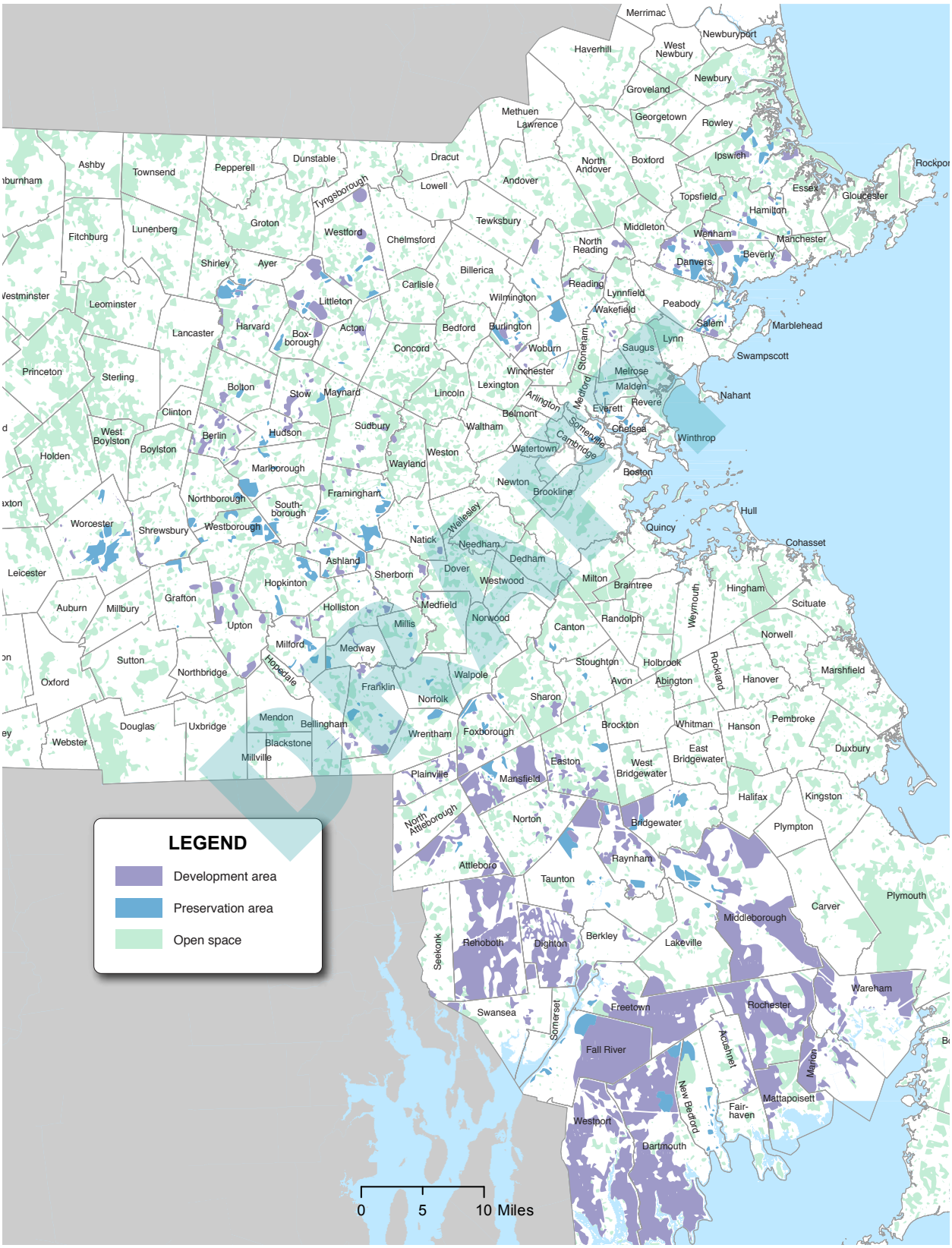
As mentioned above, MAPC created their 30-year regional plan in 2008, *MetroFuture*. The MPO adopted this plan as its land use vision for the Boston Region MPO area. One of *MetroFuture's* implementation strategies is to coordinate economic development and transportation investments to guide economic growth in the region. As mentioned previously, MAPC's new regional plan, *MetroCommon 2050*, will not be completed until after the adoption of the LRTP *Destination 2040*. However, the demographic projections and land use assumptions that will be used in *MetroCommon 2050* and in the *Destination 2040* LRTP and its Needs Assessment have already been developed.

Statewide Needs Identification

In 2012, under the Patrick administration, Massachusetts Department of Transportation (MassDOT), the Massachusetts Executive Office of Housing and Economic Development (EOHED), and the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA) joined together to highlight their common strategy and commitment to sustainable development and the "Planning Ahead for Growth" strategy. This strategy called for identification of priority areas where growth and preservation should occur. MAPC worked with EOHED and the EOEEA to develop a process to identify local, regional, and state level priority development and preservation areas in municipalities within the MPO area. MAPC staff worked with municipalities and state partners to identify locations throughout the region that are principal supporters of additional housing, employment growth, creation and preservation of open space, and the infrastructure improvements required to support these outcomes for each location. To date, 52 of 97 MPO municipalities have experienced this planning process, and MAPC continues to work with cities and towns to identify local priorities. Figure 9.1 shows the areas that have been identified as regionally significant priority development and preservation areas.

In 2015, Governor Baker created the Community Compact Program and Housing Choice Initiative to coordinate state and local economic development planning and to incentivize local efforts to adopt best planning practices and build more housing. MAPC staff work with EOHED and other state agencies to support these efforts. These processes help the Boston Region MPO, MAPC, and state agencies to understand both the infrastructure and technical assistance needed to encourage economic growth in order to prioritize limited regional and state funding.

Figure 9-1
Regionally Significant Priority Development and Preservation Areas



Source: Metropolitan Area Planning Council.

In 2018, the Massachusetts Commission on the Future of Transportation in the Commonwealth released their *Choices for Stewardship: Recommendations to Meet the Transportation Future* report. It acknowledges that land use, transportation, and economic development are linked and that many of the problems of the transportation system are not driven by transportation-based decisions but instead by land use and development patterns. They acknowledged that those issues need to be addressed as part of solving current and future transportation challenges. Recommendations offered in the report include steps that can be taken at both the municipal and state levels.

- Municipal: Adopt land use regulations that promote density and the use of shared and multi-passenger vehicles and active and shared transportation modes.
- State: Consider supporting local advancements (MassWorks Infrastructure Program, District Improvement Financing, and transit-oriented locations) through incentives and regulations and coordinate the reinvention of the MBTA commuter rail system with local, regional, and state land use and economic development strategies.

Also in March of 2019, the MBTA released its Program for Mass Transportation, *Focus 40,* which includes its recommendations to support higher quality transit to "Priority Places" including major employment districts. *Focus 40* includes recommendations on improvements to the system and place-based service additions that can support economic vitality in the region.

The MPO can coordinate with MassDOT, the MBTA, and municipalities to move the recommendations of these initiatives forward. Economic development effects are considered at the individual project level as projects are submitted for funding in the LRTP and TIP. Projects are evaluated based on their proximity to priority development areas, adoption of local zoning or other policies that support housing growth, and how well the transportation project or program would address existing and proposed economic development needs in the area. The MPO will also work with MassDOT as they implement the recommendations from the recently completed Statewide Economic Impact Evaluation Study.

Freight Needs

Regional traffic congestion can negatively affect the region's economy, making it less competitive. Truck drivers stuck in traffic need to be compensated for their time. The payroll and vehicle costs of truck operations are reflected in the costs of products and services.

Access to retail and industrial sites is an issue which is usually addressed in later stages of project planning and project design. However, good site access for heavy vehicles, including buses, is important and should to be addressed in long-range planning at the regional level. Modern logistic operations such as warehouses, distribution centers, and motor pools require economies of scale and convenient access to the regional express highways system. The MPO currently addresses these freight needs by continuing to study key freight issues through the

Freight Program. Additionally, impacts to freight movement including safe roadway design and improvements to access of key industrial and commercial areas are evaluated based on truck access to activity centers.

Stakeholder/Public Input

MPO staff received comments on the Economic Vitality goal area during outreach on transportation needs from fall 2017 through fall 2018. Over 140 respondents commented on two different themes including economic vitality and coordination with land use. The following is a summary of comments by theme.

Respondents felt that it was important to support continued regional economic vitality by improving the transportation system. This interest was highlighted by state and municipal officials, transportation advocates, business leaders and advocates, Transportation Management Associations (TMAs), transit providers, and residents.

Economic vitality concerns centered on the need to

- Match growth in the suburbs, Inner Core, and elsewhere in the region with improved equitable access to employment and housing via public transit, walking, and biking options;
- Shift from single occupancy vehicles (SOVs) by coordinating transportation planning with land use concerns in order to better support the long-term economic vitality of the region; and
- Coordinate improvements to the transportation network with regional trends in land use and demographics.

Land use coordination concerns centered on the need to

- Provide for population growth, demographic change, and housing affordability by promoting density without relying on single-occupancy vehicles (autonomous or otherwise), and
- Prioritize dense, affordable housing near transit hubs and employment, particularly in the Inner Core and suburbs for older adults, young people, and environmental justice populations to accommodate their needs.

Solutions Proposed During the Public Outreach Process

Respondents offered proposed solutions for a stronger foundation for economic vitality in the region. All input was considered when MPO staff developed its recommendations for achieving the MPO's Economic Vitality goals and objectives. The MPO could implement

many of these solutions by funding either infrastructure or operations and maintenance improvements through the LRTP or TIP or by conducting studies through the UPWP. In addition, all ideas will be shared with MassDOT and the MBTA for consideration.

Public transit

- Plan for, rather than react to growth and development and match this with increased capacity on public transit
- Establish better connections to employment hubs and growth areas, particularly in the suburbs
- Establish first-mile and last-mile connections with existing transit
- Provide more options for reverse commutes (Examples: Better commuter rail scheduling, more frequent service, off-peak service)
- Provide more frequent and reliable off-peak, late-night, and weekend service to support reverse commuting for service workers
- Improve coordination between RTAs. RTAs often have overlapping customers, but there are no funding sources to connect services between RTAs
- Provide support for TMAs (There is a need to provide fixed-route service between transportation hubs and final destinations; planning for this is difficult due to limited RTA planning staff)
- Study cost and benefits of personal rapid transit system
- Prioritize maintenance and modernization of equipment to reduce delays and get riders to work and school on time
- Keep transit fares affordable
- Provide more express options to help reduce commute times, bus rapid transit
- Implement regional rail and improved South Station operations as alternative to South Station Expansion
- Provide rapid transit options in Roxbury, Mattapan, Hyde Park, and Roslindale to increase opportunity and job access
- Implement transit signal priority
- Establish a standard state and city development transportation impact fee to support transit

- Create a true multimodal transit hub at Alewife Station
- Provide more bus service connecting major commercial/mixed-use development
- Include improved public transit and bicycle infrastructure in any plans to develop the Massachusetts Turnpike

Community Transportation

- Coordinate across municipal boundaries to reduce missed opportunities for collaboration
- Provide more shuttle services to jobs, particularly in the suburbs
- Establish first-mile and last-mile connections with existing transit
- Provide financial incentives for companies/employees to change the commuting habits from single-occupancy vehicles (SOVs)

Walking and Biking

- Provide bikeshare in the suburbs (also allows employees to get out during the day)
- Provide more safe walking/biking infrastructure
- Quantify impacts of bike/bus lanes and elimination of on-street parking on businesses
- Campaign with local businesses to offer discounts for customers who walk and bike

Coordination with Land Use

- Provide support for municipalities that encourage Transportation-Oriented Development by creating coherent strategies for development, rather than reacting to private development
- Support suburban employers in attracting millennials who want to live in the city and do not want to drive to work
- Support the growth of mixed-use development in suburbs with transit/walking/biking infrastructure
- Improve the transportation options available to the growing number of Chapter 40B[2], affordable, and senior housing developments in the suburbs to reduce risks of unemployment and lack of access to social services

[2] Chapter 40B is a state statute, which enables local Zoning Boards of Appeals to approve affordable housing developments under flexible rules if at least 20–25 percent of the units have long-term affordability restrictions.

- Provide strong support for new housing in urban core cities and many suburbs
- Promote infill housing and office development in the urban core to catalyze transit investment near dense housing and business clusters
- Build dense, affordable housing within walking distance of job centers
- Research how a state law to preempt local zoning to increase allowed density near transit could improve job access and housing affordability

Parking Management

- Create remote parking shuttle services to open parking spaces near commuter rail for patrons of local businesses
- Implement more pricing and peak hour parking restrictions
- Designate more live parking spaces and/or set off-peak hour delivery requirements for trucks
- Identify where parking and vehicle lanes can be upgraded to include bicycles, dedicated bus facilities, pick-up and drop-off zones
- Quantify and plan for the impact of TNCs on parking demand

Other

- Improve coordination between public agencies and private entities
- Find ways to manage increased freight activity
- Use Longitudinal Employer–Household Dynamics to track employment
- Assign more points for high growth areas in TIP criteria
- Quantify how businesses benefit financially from the MBTA and require them to contribute to funding
- Plan for a future where fleets of electric, shared, and autonomous vehicles reduce demand for parking, revenue from traffic violations, and the need for gas stations and auto repair businesses

UPDATES SINCE *CHARTING PROGRESS TO 2040* NEEDS ASSESSMENT

Economic vitality continues to be an important goal for the MPO, the Commonwealth, and municipalities. The Commonwealth continues to promote initiatives to improve the economic opportunities in the region and the MPO will continue to program infrastructure and conduct studies to advance its goal. Many of the needs associated with this goal were identified in previous Needs Assessments. New developments since the *Charting Progress to 2040* Needs Assessment are as follows:

- MPO's update of socioeconomic projections (population, employment, and household)
- MPO program established in *Charting Progress to 2040* and the 2019–23 TIP—Community Transportation/Parking and Clean Air and Mobility Program—which programs funding for first-mile and last-mile transportation services
- MPO studies in recent UPWP:
    - The Future of the Curb study concerning the use of curb spaces for purposes other than parking (including urban delivery zones)
    - Transportation Access Studies of Commercial Business Districts—collection of data on mode of arrival and travel behavior of patrons of commercial business districts
    - Reverse Commute Areas Analysis—identify reverse-commute options, where a significant number of workers commute from the Inner Core to suburban municipalities, and examine possibilities for encouraging these commuters to use transit
    - Various location-specific studies and technical analysis projects implemented through the existing Freight Program
- Commencement of the region's land use plan update, *MetroCommon 2050*
- Commonwealth's Community Compact Program and Housing Choice Initiative
- Massachusetts Commission on the Future of Transportation in the Commonwealth released their *Choices for Stewardship: Recommendations to Meet the Transportation Future* report along with recommendations
- Completion of MassDOT's Statewide Economic Impact Evaluation Study. The MPO can then coordinate with MassDOT to develop economic performance measures

The information presented in this chapter was used by the MPO to identify projects and programs for the MPO's LRTP, TIP, and studies considered for inclusion in the MPO's UPWP.

chapter 10

Summary of Recommendations to Address Transportation Needs

INTRODUCTION

As presented in previous chapters, the *Destination 2040* Needs Assessment establishes the transportation needs for the Boston region by the Metropolitan Planning Organization (MPO) goal area. Chapters 4 through 9 detail the transportation needs as follows:

- Chapter 4—Safety
- Chapter 5—System Preservation and Modernization
- Chapter 6—Capacity Management and Mobility
- Chapter 7—Clean Air and Sustainable Communities
- Chapter 8—Transportation Equity
- Chapter 9—Economic Vitality

Each chapter listed above includes a table that summarizes the transportation needs identified through data analysis and public outreach. Each of those tables also include recommendations to address each need. The recommendations listed in those tables are described below in more detail and were also used by the MPO to identify projects and programs for the MPO's Long-Range Transportation Plan (LRTP) and Transportation Improvement Program (TIP). The potential studies identified in each chapter were also considered for inclusion in the MPO's Unified Planning Work Program (UPWP). This chapter provides a summary of recommendations and details each of the recommendations outlined in Chapters 4 through 9.

SUMMARY OF RECOMMENDATIONS

This section summarizes the MPO staff's recommendations by type (existing or potential program, existing or potential study, or other action) and identifies the MPO goal areas that relate to each recommendation.

- Table 10-1 summarizes the existing investment programs in the MPO's current LRTP, *Charting Progress to 2040,* and TIP that were identified in each of the goal area chapters listed above to address specific transportation needs. It also includes existing technical assistance programs that are in the MPO's UPWP.
- Table 10-2 summarizes potential investment and technical assistance programs to be considered for implementation by the MPO in the *Destination 2040* LRTP.
- Table 10-3 summarizes the existing MPO studies that are currently underway or planned studies, research, and analyses included in the federal fiscal year (FFY) 2019 UPWP that address transportation needs identified in this Needs Assessment.
- Table 10-4 summarizes potential studies to be considered by the MPO in future UPWPs. These study ideas were included in the Universe of Studies used for the development of the FFY 2020 UPWP.
- Table 10-5 summarizes other actions that the MPO could take to address the identified needs in this document.

As previously mentioned, the recommendations identified were used to guide MPO discussions on the selection of projects and programs for *Destination 2040* LRTP, which will be implemented in future TIPs. It was also used to identify studies for the MPO's UPWP.

Table 10-1
Existing Programs in the LRTP, TIP and/or UPWP

Program	Safety	System Preservation	Capacity Management	Clean Air	Transportation Equity	Economic Vitality
Investment Programs in LRTP and TIP						
Intersection Improvement	X	X	X	X	X	X
Complete Streets	X	X	X	X	X	X
Bicycle Network and Pedestrian Connections	X	X	X	X	X	X
Major Infrastructure	X	X	X	X	X	X
Community Transportation/ Parking/Clean Air and Mobility			X	X	X	X
Planning Studies and Technical Assistance Programs in the UPWP						
Improvements to Highway Bottlenecks	X	X	X	X		X
Community Transportation Technical Assistance	X		X		X	
Regional Transit Service Planning Technical Assistance			X		X	
Bicycle and Pedestrian Support			X	X		X
Park-and-Ride/Bicycle Parking			X			
Other Projects and Programs Conducted by the MPO						
Evaluation of LRTP program benefits and burdens to transportation equity populations					X	
Evaluation of TIP program benefits and burdens to transportation equity populations					X	
Support to MassDOT's Climate Adaptation Vulnerability Assessment	X	X			X	
Freight Program			X			X

LRTP = Long-Range Transportation Plan. MassDOT = Massachusetts Department of Transportation. MPO = Metropolitan Planning Organization. TIP = Transportation Improvement Program. UPWP = Unified Planning Work Program.
Source: Boston Region MPO.

Table 10-2
Potential Programs Considered for Implementation by the MPO

Program	Safety	System Preservation	Capacity Management	Clean Air	Transportation Equity	Economic Vitality
Investment Programs						
Bus Mobility (Dedicated Bus Lanes and Infrastructure)			X	X	X	X
Transit Modernization	X	X		X	X	X
Interchange Modernization	X	X		X		X
Enhanced Park-and-Ride			X	X		X
Connect Elderly Adults with Transportation			X		X	
Coordinating Car Sharing and Transit			X	X	X	
Climate Resiliency		X		X		
Technical Assistance Programs and Projects						
Infrastructure Bank or Demonstration Materials Library			X			
Freight Database			X			X

MPO = Metropolitan Planning Organization.
Source: Boston Region MPO.

Table 10-3
Existing or Planned Studies, Research, and Analyses in the UPWP to Address Needs

Program	Safety	System Preservation	Capacity Management	Clean Air	Transportation Equity	Economic Vitality
Addressing Safety, Mobility, and Access on Subregional Priority Roadway (FFY 2019 UPWP)	X	X	X	X		X
Addressing Priority Corridors for LRTP Needs Assessment (FFY 2019 UPWP)	X	X	X			
Low-Cost Improvements to Express Highway Bottlenecks (FFY 2019 UPWP)	X		X	X		
The Future of the Curb (FFY 2019 UPWP)	X		X			X
Transportation Access Studies of Commercial Business Districts (FFY 2019 UPWP)			X			X
New and Emerging Metrics for Roadway Usage (FFY 2019 UPWP)			X			
Updates to Express Highway Volumes Charts (FFY 2019 UPWP)			X			
Tracking of Emerging Connected and Autonomous Vehicle Technologies			X			
Reverse-Commute Areas Analysis (FFY 2019 UPWP)			X	X	X	X
Pedestrian Report Card Assessment Dashboard (FFY 2019 UPWP)	X		X	X		
Location-Specific Freight Studies			X			X

FFY = federal fiscal year. LRTP = Long-Range Transportation Plan. UPWP = Unified Planning Work Program.
Source: Boston Region MPO.

Table 10-4
Potential Studies Considered for the UPWP by the MPO

Program	Safety	System Preservation	Capacity Management	Clean Air	Transportation Equity	Economic Vitality
Conduct safety and operations at selected intersections studies	X		X			
Identify locations with high bicycle and pedestrian crash rates	X		X		X	
Identify factors that may contribute to fatal and serious injury crashes on the region's roadways	X					
Conduct TIP before-and-after studies	X		X		X	
Research safety outcomes of autonomous vehicle testing	X					
Conduct safety studies for travel to and from transit stops and stations	X					
Create region-wide sidewalk inventory		X	X		X	
Explore opportunities to consider vulnerability and resilience in MPO-funded corridor and intersection studies	X	X				
Conduct congestion pricing research			X	X	X	X
Analyze revenue lost to transit services because of TNC usage			X			
Research effect of TNCs on other modes, especially transit			X			
Monitor travel habits of all age groups in response to TNC technology			X			
Research the role of dispatching and supervision in bus reliability and its application in the MBTA network			X			
Assist the MBTA in locating new or improved bus garage locations			X			
Analyze peak capacity of the MBTA rapid transit system			X			

Program	Safety	System Preservation	Capacity Management	Clean Air	Transportation Equity	Economic Vitality
Assess the impacts of changes to the transportation system on transportation equity populations					X	
Analyze commute patterns of low-income populations					X	
Support studies of state freight and rail projects						X
Support the recommendations of the Statewide Economic Impact study						X
Assess how the MPO can implement recommendations from the Commonwealth's Future of Transportation Report	X	X	X	X	X	X

MBTA = Massachusetts Bay Transportation Authority. MPO = Metropolitan Planning Organization. TIP = Transportation Improvement Program. TNC = transportation network company.
Source: Boston Region MPO .

Table 10-5
Other Potential MPO Actions Considered by the MPO

Program	Safety	System Preservation	Capacity Management	Clean Air	Transportation Equity	Economic Vitality
Coordinate with partner agencies to collect additional safety data	X					
Continue to participate in Road Safety Audits	X					
Consider publicizing transportation safety-oriented education	X					
Consider opportunities to support discussions on transportation safety issues	X					
Coordinate on ways staff can support climate vulnerability assessments and resiliency planning	X	X				
Emphasize the existing TIP resiliency and adaptation criteria		X				
Lead discussions on prioritization of surface roadway space for the automobile, transit, freight, and active transportation modes			X			
Coordinate between RTAs and other transit providers			X			
Establish additional performance metrics	X	X	X	X	X	X
Measure mode shift related to capital investment			X			
Develop demographic profiles for transportation equity populations					X	
Track transportation trends					X	
Identify transportation equity communities of concern underserved by transportation					X	

MPO = Metropolitan Planning Organization. RTA = regional transit authority. TIP = Transportation Improvement Program.
Source: Boston Region MPO.

DETAILED DESCRIPTIONS OF RECOMMENDATIONS

The following sections include detailed descriptions of the programs, studies, and other actions as summarized above in Tables 10.1 through 10.5.

Existing Programs

Investment Programs in Charting Progress to 2040 LRTP and TIP

Intersection Improvement

This program funds intersection projects that modernize existing signals, add signals, or otherwise update signal operations to improve safety, mobility, and reliability. Eligible improvements could also include the addition of turning lanes, shortened crossing distances for pedestrians, sidewalk improvements and curb cuts, and striping and lighting for bicyclists.

Complete Streets

This program modernizes roadways to improve safety and mobility for all users. Improvements can consist of continuous sidewalks and bicycle lanes, cycle tracks, and other bicycle facilities, as well as updated signals at intersections along a corridor. Improvements could also address other roadway infrastructure in the corridor, such as bridges, drainage, pavement, and roadway geometry. These improvements will reduce delay and improve bus transit reliability. Expanded transportation options and better access to transit will improve mobility for all and encourage mode shift.

Bicycle Network and Pedestrian Connections

This program expands bicycle and pedestrian networks to improve safe access to transit, school, employment centers, and shopping destinations. Bicycle and pedestrian connection projects could include constructing new, off-road bicycle or multiuse paths, improving bicycle and pedestrian crossings, or building new sidewalks. Improvements may also consist of traffic calming, sidewalk network expansion, enhanced signage and lighting, and upgrades similar to those in a Complete Streets program.

Major Infrastructure

This program includes all projects on roadway or transit systems that add capacity to the transportation network or cost over $20 million. Projects in this category could include large-scale Complete Streets projects, interchange modernizations, or transit expansion projects.

Community Transportation/Parking/Clean Air and Mobility

This program includes a combination of the following types of projects:

1. Transit Operations: Projects that close gaps in the transit network (first-mile/last-mile shuttles, partnerships with transportation network companies [TNCs], transit enhancements, and technology updates)

2. Parking Management: Additional parking for automobiles and bicycles, and leasing off-site parking near transit stations with shuttles connections

3. Bicycle and Pedestrian Improvements: Bicycle and pedestrian improvements for transit access, improvements to non-automotive transportation infrastructure for travelers with mobility impairments, and training and equipment for bicycles on transit

4. Education and Wayfinding: Projects could include travel instruction, training on new technologies, signage, and pilot or demonstration projects

Planning Studies and Technical Assistance Programs in the UPWP

Improvements to Highway Bottlenecks

Bottleneck locations identified as part of the Needs Assessment are studied to identify and prioritize short-term and long-term improvements that can reduce congestion and improve mobility on expressways and arterials. These improvements frequently address safety concerns and include maintenance and modernization improvements. Solutions to improve traffic operations and traffic flow can also lessen emissions by reducing the time that vehicles are emitting in congested conditions.

Community Transportation Technical Assistance

This program provides municipal officials with technical advice on local transportation concerns, such as traffic operations, safety, bicycle and pedestrian access, livability, parking, and bus stop locations.[1]

Regional Transit Service Planning Technical Assistance

Through this program, the MPO staff offers technical support to Regional Transit Authorities (RTAs) to promote best practices and address issues related to route planning, ridership, cost-effectiveness, and other service characteristics. The MPO staff also helps transportation management associations, municipalities, and the Metropolitan Area Planning Council's subregional groups to improve the transit services that they operate or fund.[2]

[1] For more information, visit the MPO's website here http://www.ctps.org/ctta.

[2] For more information, visit the MPO's website here http://www.ctps.org/regional_transit.

Bicycle and Pedestrian Support

MPO staff supports the Boston region's bicycle and pedestrian planning needs through ongoing data collection, analysis, and technical assistance. Specific examples include bicycle and pedestrian counts and various online resources.

Park-and-Ride/Bicycle Parking

Alongside the Congestion Management Process, these programs can increase transit ridership by expanding automobile and bicycle parking at commuter rail and rapid transit stations.

Other MPO Projects and Programs

Evaluation of LRTP program benefits and burdens to transportation equity populations

This project develops analysis methods to assess the potential benefits and burdens of the LRTP program of projects in the MPO region. Concurrently, a Disparate Impact and Disproportionate Burden policy is being developed to determine whether the LRTP program of projects is projected to cause disparate impacts (when they adversely affect minority populations) and disproportionate burdens (when they adversely affect low-income populations) by 2040.

Evaluation of TIP program benefits and burdens to transportation equity populations

This project develops analysis methods to assess the potential benefits and burdens of the TIP program in the MPO region.

Support to Massachusetts Department of Transportation's (MassDOT) Climate Adaptation Vulnerability Assessment

For this program, the MPO works directly with MassDOT to prioritize transportation assets that should be the focus of MassDOT's climate change adaptation efforts. This will help address the challenges resulting from climate change for the populations that are the most vulnerable.

Freight Program

This program monitors developments and analyzes changes in the region's freight systems.

Potential Programs

The following section provides detailed descriptions of potential programs to be considered by the MPO for implementation in the LRTP, *Destination 2040*. These programs were also summarized in Table 10-2.

Investment Programs

Bus Mobility (Dedicated Bus Lanes and Infrastructure)

A new program could be implemented through the LRTP and the TIP to provide funding for municipalities to construct dedicated bus lanes and otherwise support projects that improve bus mobility and reliability. The MPO may fund lane striping and other roadway geometry and infrastructure improvements to demarcate bus lanes. It may also fund installations or upgrades to signals to enhance transit signal priority. These types of improvements can help to alleviate congestion and allow faster and more reliable (or predictable) travel times for bus riders. The service improvements realized by bus lanes could also induce a mode shift from the single-occupant vehicle to transit, which would reduce emissions. This program would benefit transportation equity populations that rely on the bus system.

Transit Modernization

This program could address safety as well as system preservation needs on the transit system. Depending on the location and type of project, it could also address clean air, transportation equity, and economic vitality needs. The MPO would coordinate with MassDOT, the MBTA, and RTAs in the region to identify opportunities to flex the MPO's discretionary funding to modernization projects. This program could coordinate with the MBTA and the regions' RTAs to target specific types of modernization projects—such as station or facility improvements or climate resiliency projects—to improve transit infrastructure.

Interchange Modernization

This program would include modernization of interchanges on the region's roadway system. It would improve safety, reduce congestion, and improve mobility, which would reduce transportation-related emissions. Projects in this program could potentially be included in the Major Infrastructure Program.

Enhanced Park-and-Ride

This program would revisit the existing Community Transportation/Parking/Clean Air and Mobility program and consider allocating more funding for additional park-and-ride spots at transit stations for commuter rail and rapid transit customers. This program could help induce mode shift and reduce transportation-related emissions.

Connect Elderly Adults with Transportation

The MPO or another entity could take the lead on developing a program to connect elderly adults with transportation options, such as TNCs. This program would restore mobility to elderly adults who can no longer drive and who might not be familiar with the new technologies and transportation options. This could also be a part of the Community Transportation program.

Coordinating Car Sharing and Transit

Car sharing locations in the Boston region are currently concentrated in the Inner Core. Designating more spots for car sharing providers at key outlying rapid transit and commuter rail stations could improve mobility for travelers outside of the Inner Core. The MPO could play a key role in identifying potential locations and coordinating planning. This program could increase mode shift from single-occupant vehicles to transit and reduce transportation-related emissions. The program could also support the non-traditional commuting needs of transportation equity populations.

Climate Resiliency

This program could provide funding for transportation network resiliency improvements. It could be coordinated with the Commonwealth's Municipal Vulnerability Preparedness program which provides support for cities and towns in Massachusetts to plan for climate change resiliency and to implement priority projects. Projects funded through this program could include stormwater management projects or signal upgrades that might not fall under the MPO's Complete Streets or Intersection Improvement programs.

Technical Assistance Programs and Projects

Infrastructure Bank or Demonstration Materials Library

The MPO's discretionary funds could be used to build a reference library or bank of materials that could be used as a resource during roadway interventions and allow for quick tests of various roadway configurations and alternatives. This could also be a resource when testing new transit configurations, such as bus bump-outs, and other alternatives. This idea was inspired by the Northeast Ohio Areawide Coordinating Agency (NOACA), the Greater Cleveland area MPO.[3]

Freight Database

This project would involve collecting a full set of truck volume data for use in an updated truck model. The data collected could be used when selecting infrastructure improvement projects.

[3] More information on NOACA is located here: http://noaca.org/index.aspx?page=32&recordid=11702.

Existing Studies

The following section provides detailed descriptions of existing or planned studies, research, and analyses included in the MPO's UPWP, as outlined in Table 10-3.

Addressing Safety, Mobility, and Access on Subregional Priority Roadway (FFY 2019 UPWP)

These studies are conducted each year to identify and address operations and safety issues on priority arterial locations identified by relevant subregional groups concentrating on transit, nonmotorized modes of transportation, and truck activity. Recommendations from these studies may include maintenance and modernization improvements and improvements to operations resulting in reduced vehicle emissions.

Addressing Priority Corridors for LRTP Needs Assessment (FFY 2019 UPWP)

These studies are conducted each year to make recommendations for improving priority roadway corridors that have high levels of congestion and safety problems.

Low-Cost Improvements to Express Highway Bottlenecks (FFY 2019 UPWP)

These studies are conducted each year to address points in the highway system where traffic flow is restricted and to provide recommendations to increase safety, reduce congestion, and reduce vehicle emissions.

The Future of the Curb (FFY 2019 UPWP)

This planned study comprises of a literature review and an analysis of data to determine best practices concerning the use of curb space for purposes other than parking—including best practices for urban delivery zones, dedicated bus lanes, and bicycle lanes. Effective management of curb space can enhance traveler safety.

Transportation Access Studies of Commercial Business Districts (FFY 2019 UPWP)

This study will focus on the collection of data on the travel behavior (including the mode of arrival) of patrons in commercial business districts in the Boston region. The analysis of that data will be applied to address issues such as curb access and parking policy.

New and Emerging Metrics for Roadway Usage (FFY 2019 UPWP)

This study will focus on reviewing new performance metrics to measure roadway efficiency by different modes to express the needs of all travelers on the corridor.

Updates to Express Highway Volumes Charts (FFY 2019 UPWP)

This study will update estimates of traffic volumes on key regional limited-access highways and ramps. This is used as a basic tool for studying the express highway system.

Tracking of Emerging Connected and Autonomous Vehicle Technologies

The MPO staff continues to monitor the status of this new technology and the schedule for adoption and implementation of this technology in the Boston region.

Reverse-Commute Areas Analysis (FFY 2019 UPWP)

This study will identify reverse-commute pattern trends (where a significant number of workers commute from the Inner Core to suburban municipalities) and examine possibilities for encouraging these commuters to use transit.

Pedestrian Report Card Assessment Dashboard (FFY 2019 UPWP)

This project will create an online version of the Pedestrian Report Card Assessment (developed in a previous UPWP study) and an interactive website, both of which will be available to the public. These tools will allow municipalities to identify locations where improvements could address safety as well as to encourage walking and potentially reduce transportation-related emissions.

Location-Specific Freight Studies

Staff conducts location-specific studies and technical analysis projects implemented through the existing Freight Program.

Potential Studies

The following section provides detailed descriptions of potential studies to be considered by the MPO for implementation in the LRTP, *Destination 2040*. These studies were also summarized in Table 10-4.

Conduct safety and operations studies at selected intersections

These studies provide municipalities with recommendations and conceptual designs for potential short-term, low-cost solutions or long-term, high-cost solutions for intersections that need safety improvements. (These studies are typically done every other year. The last study was completed in 2018. A new study could be done in FFY 2020.)

Identify locations with high bicycle and pedestrian crash rates

This study, which was proposed during the development of the FFY 2019 UPWP, would identify intersections in the Boston region where a high number of pedestrian crashes have occurred and recommend improvements to those intersections. Locations with high shares of transportation equity populations in their communities could be identified.

Identify factors that may contribute to fatal and serious injury crashes on the region's roadways

As the title suggests, this study would identify factors that may contribute to fatal and serious injury crashes on the region's roadways.

Conduct TIP before-and-after studies

These studies would measure the success of roadway safety projects in all areas, including transportation equity areas. The studies could also measure the success of roadway operation improvement projects.

Research safety outcomes of autonomous vehicle testing

MPO staff would research safety outcomes of autonomous vehicle testing in Boston or other metropolitan areas.

Conduct safety studies for travel to and from transit stops and stations

As the title suggests, these studies would recommend actions to improve safety for people traveling to and from transit stops and stations.

Create region-wide sidewalk inventory

This project would create a region-wide sidewalk inventory documenting infrastructure condition, stored in a format such as a geographic information system or GIS, and similar to

the one created by the Capital District Transportation Committee (http://www.cdtcmpo.org/news/latest-news/307-regional-sidewalk-inventory). This inventory would fill a major gap identified by staff during the Needs Assessment development and complement numerous MPO programs and analyses. The inventory could also include a field identifying sidewalks located in communities with high shares of transportation equity populations.

Explore opportunities to consider vulnerability and resilience in MPO-funded corridor and intersection studies

As the title suggests, staff would explore opportunities to consider vulnerability and resilience in MPO-funded corridor and intersection studies.

Conduct congestion pricing research

The MPO could proactively plan to examine potential effects of different models for road congestion pricing proposed in the Massachusetts Legislature and advanced by members of the public. Congestion pricing schemes aim to reduce congestion by charging higher fees during peak travel times. If effective, congestion pricing can reduce transportation-related emissions. This study could also include the effects of congestion pricing on low-income populations.

Analyze revenue lost to transit services because of TNC usage

Staff would continue to analyze revenue lost to transit services because of TNC usage, such as Uber or Lyft, etc.

Research effect of TNCs on other modes, especially transit

Staff would continue to research the role of TNCs in the system and their effect on other modes, especially transit.

Monitor travel habits of all age groups in response to TNC technology

Staff would monitor how the adoption of TNCs by young people may modify travel habits in the future and how other age groups might respond to this technology.

Research the role of dispatching and supervision in bus reliability and its application in the MBTA network

Several independent research reports have suggested that modernizing dispatching and supervision practices could reduce bus bunching and improve reliability on the MBTA bus and rail networks.[4] The MPO could contribute its expertise and data resources to a comprehensive effort to address this question.

Assist the MBTA in locating new or improved bus garage locations

State of the system materials compiled as part of MassDOT's *Focus 40* planning process identified the need to modernize bus garages as a high priority for the MBTA. Modern garages would allow expansion of the bus fleet and acquisition of more articulated buses and battery-electric-powered buses. However, these garages are not easy to site, as they may increase traffic and noise in the neighborhood, and they must be as close as possible to major bus terminals to minimize deadhead time. As a regional agency, the MPO is in a position to assist in a regional effort focused on finding locations for new garages.

Analyze peak capacity of the MBTA rapid transit system

Historically, several of the MBTA's rapid transit lines operated with shorter peak headways (that is, with more frequent service) than they do today. Headways are expected to decrease with the delivery of new rolling stock and signal systems for the Orange and Red Lines in the coming years, however, the Orange Line's scheduled headways will still be longer than was historically the case. Members of the public suggested that the MPO analyze this situation and determine whether it is possible to return to historical headways without major capital investment, or if it is possible to run tighter headways given the currently available level of investment.

Assess the impacts of changes to the transportation system on transportation equity populations

This study would identify how changes to the transportation system affect the region's population, with a focus on transportation equity populations. For example, staff could research the effects of increases in carbon monoxide emissions, changes in commute times, or increases in congestion levels.

[4] For MBTA-specific research, see Maltzan (2015) and Fabian (2017). For examples from other U.S. transit systems, see Pangilinan, Wilson, and Moore (2007), Berrebi, Watkins, and Laval (2015), and Berrebi et al (2017).

Analyze commute patterns of low-income populations

This study would identify gaps in transit service to employment centers that have a significant concentration of jobs that employ low-income populations.

Support studies of state freight and rail projects

The MPO could consider recommendations from the MassDOT's State Rail Plan, MassDOT's Freight Plan, and the MBTA's Rail Vision study when programming projects for the LRTP and TIP.

Support the recommendations of the Statewide Economic Impact Study

The MPO could consider recommendations from MassDOT's 2018 Economic Impact study, which will include economic scoring criteria for transportation projects.

Assess how the MPO can implement recommendations from the Commonwealth's Future of Transportation Report

The Commission on the Future of Transportation in the Commonwealth released *Choices for Stewardship: Recommendations to Meet the Transportation Future* in December 2018. Staff will monitor the implementation of the recommendations included in the plan and determine if the MPO can help to move them forward.

Other Recommended Actions

As outlined in Table 10-5, the following section provides detailed descriptions of potential actions to be considered by the MPO.

Coordinate with partner agencies to collect additional safety data

Continue to coordinate with partner agencies to collect data that supports safety research and analysis.

Continue to participate in Road Safety Audits

Continue to participate in road safety audits for roadway improvements projects.

Consider publicizing transportation safety-oriented education

Consider publicizing transportation safety-oriented education and awareness material through the MPO's communication and public involvement channels.

Consider opportunities to support discussions on transportation safety issues

Consider opportunities to use MPO meetings or events to support discussions on transportation safety issues.

Coordinate ways MPO staff can support climate vulnerability assessments and resiliency planning

Coordinate with other municipalities and state and regional agencies to determine ways MPO staff can support climate vulnerability assessments and resiliency planning.

Emphasize the existing TIP resiliency and adaptation criteria

Emphasize the existing TIP resiliency and adaptation criteria and encourage municipalities to share information about how their proposed projects relate to their resiliency and adaptation planning.

Lead discussions on prioritization of surface roadway space for the automobile, transit, freight, and active transportation modes

As the title suggests, lead public discussions about how to prioritize the use of surface roadway space for the automobile, transit, freight, and active transportation modes.

Coordinate between RTAs and other transit providers

Encourage coordination between RTAs and other transit providers. During public outreach efforts, MPO staff documented the need for better coordination between various transit providers (for example, MBTA and MetroWest or Cape Ann RTA service), especially in municipalities that are located on the borders of provider service areas.

Establish additional performance metrics for the Boston MPO

Establish additional performance metrics that measure outcomes in the MPO's goal areas including those that measure:

- Safety of the transportation system
- Maintenance and modernization of the transportation system
- Congestion levels, degrees of mode shift, etc.
- Air quality and other environmental issues
- The transportation system specific to transportation equity populations
- Economic vitality in the region as it relates to the transportation system

Measure mode shift related to capital investment

An equivalent investment in the various transit services may not produce the same degree of mode shift to each service. The MPO should measure mode shift specific to capital investment. For example, commuter rail is capital-intensive but carries fewer riders, whereas buses are less capital-intensive but carry more riders.

Develop demographic profiles for transportation equity populations

The MPO should analyze demographic data from the US Census Bureau and its American Community Survey to identify transportation analysis zones (TAZs) in the Boston region that have a high share of each transportation equity population. This is determined using the threshold for each transportation equity population, which is equal to the population's region-wide median (except for low-income populations for which the threshold is 60 percent of the region's median household income).

Track transportation trends

Summarize key demographic, socioeconomic, health, transportation, and environmental data each year to provide further context for understanding the transportation challenges and needs of transportation equity populations in the Boston region, as well as the trends that emerge as these data are tracked over time.

Identify communities of concern

Identify TAZs that have high shares of more than one transportation equity population to better focus resources on communities that may be particularly vulnerable to being underserved by the transportation network.

CONCLUSION

The recommendations detailed in this chapter are a result of the data analyses and public outreach for the *Destination 2040* LRTP Needs Assessment. This information was used by the MPO to identify projects and programs included in the MPO's *Destination 2040* LRTP, which will also be implemented in future TIPs.

The accompanying LRTP document, based on this Needs Assessment, explains how the recommendations presented here were used to choose the projects and programs included in the recommended LRTP. This information was also an input into the Universe of Studies list which was used in the development of the MPO's FFY 2020 UPWP, adopted in summer 2019.

appendix A

Policies, Plans, Studies and Data that Inform the Needs Assessment

POLICY AND PLANNING FRAMEWORK

The Boston Region Metropolitan Planning Organization (MPO) operates under a variety of laws, regulations, guidance, policies, and plans that not only shape its activities but also inform its understanding of the region's transportation needs. This appendix presents information about the laws, regulations, guidance, policies, and plans that strongly influence the MPO's activities in the metropolitan transportation planning process and that contributed to the development of the Needs Assessment. Each item indicates which of the MPO's goal areas to which it relates, and when possible, describes how it influenced the Needs Assessment. More details are provided on the major laws, regulations, guidance, policy directives, and plans that guide MPO activities as they generally apply to three or more goal areas. The entries are organized by their geographic scope (federal, state, regional, or local). Those that cover one or two goal areas are summarized in Table A-5. As stated, the MPO's goals are as follows:

- **Safety:** Transportation by all modes will be safe
- **System preservation:** Maintain and modernize the transportation system and plan for its resiliency
- **Capacity management and mobility:** Use existing facility capacity more efficiently and increase transportation options
- **Clean air and sustainable communities:** Create an environmentally friendly transportation system
- **Transportation equity:** Ensure that all people receive comparable benefits from, and are not disproportionately burdened by, MPO investments, regardless of race, color, national origin, age, income, ability, or sex
- **Economic vitality:** Ensure our transportation network provides a strong foundation for economic vitality

FEDERAL LAWS, REGULATION, MANDATES, AND GUIDANCE

Fixing America's Surface Transportation (FAST) Act

Year Enacted: 2015

MPO Goal Areas Addressed: Safety, System Preservation, Capacity Management/Mobility, Clean Air/Sustainable Communities, and Economic Vitality

The FAST Act authorizes federal funding and establishes programs and requirements for surface transportation infrastructure, including roads, bridges, transit systems, and passenger rail. It also includes seven national goals for federal highway programs, which were first established under its predecessor, the Moving Ahead for Progress in the 21st Century Act (MAP-21). These goals include the following:

1. **Safety**—To achieve a significant reduction in traffic fatalities and serious injuries on all public roads
2. **Infrastructure condition**—To maintain the highway infrastructure asset system in a state of good repair
3. **Congestion reduction**—To achieve a significant reduction in congestion on the National Highway System
4. **System reliability**—To improve the efficiency of the surface transportation system
5. **Freight movement and economic vitality**—To improve the national freight network, strengthen the ability of rural communities to access national and international trade markets, and support regional economic development
6. **Environmental sustainability**—To enhance the performance of the transportation system while protecting and enhancing the natural environment
7. **Reduced project delivery delays**—To reduce project costs, promote jobs and the economy, and expedite the movement of people and goods by accelerating project completion through eliminating delays in the project development and delivery process, including reducing regulatory burdens and improving agencies' work practices

These national goals helped to shape the MPO's goals established in *Charting Progress to 2040*, which in turn informed the needs described in this Needs Assessment. Table A-1 shows the relationship between these national goals and the MPO's goals.

Table A-1
National Goal Areas and MPO Goal Areas

National Goal Area	MPO Goal Area
Safety	Safety
Infrastructure Condition	System Preservation
Congestion Reduction	Capacity Management/Mobility
System Reliability	Capacity Management/Mobility
Freight Movement/Economic Vitality	Capacity Management/Mobility and Economic Vitality
Environmental Sustainability	Clean Air/Clean Communities
Reduced Project Delivery Delays	N/A
N/A	Transportation Equity

N/A = not applicable.
Sources: Fixing America's Surface Transportation Act and the Boston Region MPO.

These national goals also relate to performance-based planning and programming (PBPP) provisions first established under MAP-21 and then continued under the FAST Act. PBPP refers to practices that apply performance-management principles to transportation system policy and investment decisions. PBPP employs a system-level, data-driven process and is used to make decisions about strategies and investments. The FAST Act requires states, MPOs, and public transportation operators to monitor progress and set targets for specific measures. The US Department of Transportation (USDOT) has promulgated several rules related to performance measures in response to the FAST Act:

- 23 Code of Federal Regulations (CFR) Part 490: National Performance Management Measures
- 23 CFR Part 924: Highway Safety Improvement Program
- 49 CFR Part 625: Transit Asset Management
- 49 CFR Part 673: Public Transportation Agency Safety Plan

The MPO must establish performance measures and targets that track progress toward the attainment of priority outcomes for the Boston region and coordinate the development of these targets with those of relevant state agencies and public transportation providers to ensure consistency. The MPO has begun to analyze data and establish baselines and targets for federally required performance measures, and information pertaining to these measures (if available) is included in the Safety, System Preservation, Capacity Management/Mobility, Economic Vitality, and Clean Air/Sustainable Communities goals. Tables A-2 and A-3 summarize these measures for transit and highway systems.

Table A-2
Federally Required Performance Measures for Transit Systems

National Goal	Relevant MPO Goal Area	Transit Performance Area or Asset Category	Performance Measure
Safety	Safety	Fatalities	Total number of reportable fatalities and rate per total vehicle revenue-miles by mode
Safety	Safety	Injuries	Total number of reportable injuries and rate per total vehicle revenue-miles by mode
Safety	Safety	Safety Events	Total number of reportable events and rate per total vehicle revenue-miles by mode
Safety	Safety	System Reliability	Mean distance between major mechanical failures by mode
Infrastructure Condition	System Preservation	Equipment	Percent of vehicles that have met or exceeded their ULB
Infrastructure Condition	System Preservation	Rolling Stock	Percent of revenue vehicles within a particular asset class that have met or exceeded their ULB
Infrastructure Condition	System Preservation	Infrastructure	Percent of track segments with performance restrictions
Infrastructure Condition	System Preservation	Facilities	Percent of facilities within an asset class rated below 3.0 on the FTA's Transit Economic Requirements Model scale

FTA = Federal Transit Administration. MPO = metropolitan planning organization. ULB = useful life benchmark.
Sources: National Public Transportation Safety Plan (January 2017), the Public Transportation Agency Safety Plan Rule (49 Code of Federal Regulations Part 673), and the final Transit Asset Management Rule (49 CFR Part 625).

Table A-3
Federally Required Highway Performance Measures

National Goal	Relevant MPO Goal Areas	Highway Performance Area	Performance Measure
Safety	Safety	Injuries and Fatalities	• Number of fatalities • Fatality rate per 100 million VMT • Number of serious injuries • Serious injury rate per 100 million VMT • Number of nonmotorized fatalities and nonmotorized serious injuries
Infrastructure Condition	System Preservation	Pavement Condition	• Percent of pavements on the Interstate System in good condition • Percent of pavements on the Interstate System in poor condition • Percent of pavements on the non-Interstate NHS in good condition • Percent of pavements on the non-Interstate NHS in poor condition
Infrastructure Condition	System Preservation	Bridge Condition	• Percent of NHS bridges by deck area classified as in good condition • Percent of NHS bridges by deck area classified as in poor condition
System Reliability	Capacity Management/ Mobility	Performance of the National Highway System	• Percent of person-miles traveled on the interstate system that are reliable • Percent of person-miles traveled on the non-interstate NHS that are reliable
System Reliability, Freight Movement, and Economic Vitality	Capacity Management/ Mobility, Economic Vitality	Freight Movement on the Interstate System	Truck Travel Time Reliability Index
Congestion Reduction	Capacity Management/ Mobility	Traffic Congestion	• Annual hours of peak hour excessive delay per capita (for travel on NHS roadways) • Percent of non-SOV travel
Environmental Sustainability	Clean Air/Clean Communities	On-Road Mobile Source Emissions	Total emissions reduction of on-road mobile source emissions (for applicable pollutants and precursors)[a]

[a] As of the Federal Highway Administration's 2017 Congestion Mitigation and Air Quality Improvement (CMAQ) Program performance requirements applicability determination, the Boston Region MPO area contains an area designated as in maintenance for carbon monoxide, so the MPO is currently required to comply with this performance measure requirement.
NHS = National Highway System. SOV = single-occupancy vehicle. VMT = vehicle-miles traveled.
Sources: Highway Safety Improvement Program Rule (23 CFR 924), National Performance Management Measures Rule (23 CFR 490).

The FAST Act also lists a set of transportation planning factors that must be considered in the transportation planning process. It continues and builds on a set of factors established in prior legislation—the *Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users*. Table A-4 lists these transportation planning factors along with the related MPO goal areas. These planning factors also informed the type of information that is included in the Economic Vitality, Capacity Management/Mobility, Safety, Clean Air/Clean Communities, and System Preservation chapters in this Needs Assessment.

Table A-4
Federal Planning Factors and Related MPO Goal Areas

Federal Planning Factor	MPO Goal Area
Support the economic vitality of the metropolitan area, especially by enabling global competitiveness, productivity, and efficiency	Economic Vitality
Increase the safety of the transportation system for all motorized and nonmotorized users	Safety
Increase the ability of the transportation system to support homeland security and to safeguard the personal security of all motorized and nonmotorized users	Safety
Increase accessibility and mobility of people and freight	Capacity Management/Mobility, Economic Vitality
Protect and enhance the environment, promote energy conservation, improve quality of life, and promote consistency between transportation improvements and state and local planned growth and economic development patterns	Clean Air/Clean Communities, Economic Vitality
Enhance the integration and connectivity of the transportation system, across and between modes, for people and freight	Capacity Management/Mobility
Promote efficient system management and operation	Capacity Management/Mobility
Emphasize the preservation of the existing transportation system	System Preservation
Improve the resiliency and reliability of the transportation system and reduce or mitigate storm water impacts of surface transportation	System Preservation, Capacity Management/Mobility, Clean Air/Clean Communities
Enhance travel and tourism	N/A

Source: Boston Region MPO.

United States Department of Transportation Code of Federal Regulations (CFR)—Metropolitan Transportation Planning and Programming Regulations

Year Enacted: 23 CFR Parts 450 (2016); 23 CFR Parts 450 (1996); 49 CFR Part 613 (2016). These are updated as needed.

MPO Goal Areas Addressed: Safety, System Preservation, Capacity Management/Mobility, Clean Air/Sustainable Communities, Economic Vitality, Transportation Equity

The United States CFR—especially in 23 CFR Parts 450 and 500 and 49 CFR Part 613—documents the administrative rules and regulations that define how MPOs and other entities carry out their transportation planning processes. To receive federal transportation dollars, MPOs are required to carry out a "continuing, cooperative, and comprehensive" (3C) transportation planning process, which includes the development of its certification documents: the Long-Range Transportation Plan (LRTP), the Transportation Improvement Program (TIP), and the Unified Planning Work Program. The processes for the TIP and LRTP are to

- Encourage and promote safe and efficient development, management, and operation of surface transportation systems to serve the mobility needs of people and freight (including accessible pedestrian walkways, bicycle transportation facilities, and intermodal facilities that support intercity transportation, including intercity buses and intercity bus facilities and commuter vanpool providers);
- Foster economic growth and development and take resiliency needs into consideration, while minimizing transportation-related fuel consumption and air pollution; and
- Encourage continued development and improvement of metropolitan transportation planning processes as guided by the transportation planning factors (see the description of the FAST Act).

MPOs must also conduct an inclusive public participation process for its certification documents, which includes meaningful public engagement with those who have been traditionally underserved by the transportation planning process; maintain transportation models and data resources to support air quality conformity determinations; carry out ongoing programs, such as a congestion management process; and conduct long-range and short-range planning work. The MPO has established the following objectives for carrying out the 3C planning process in the region. These objectives include:

- Identify transportation problems and develop possible solutions
- Balance short-range and long-range considerations so that decisions that lead to beneficial incremental actions adequately reflect an understanding of probable future consequences and possible future options

- Represent both regional and local considerations, as well as both transportation and nontransportation objectives and impacts (such as land use and economic impacts) in the analysis of project issues
- Assist implementing agencies in effecting timely policy and project decisions with adequate consideration of environmental, social, fiscal, and economic impacts, and with adequate opportunity for participation by other agencies, local governments, and the public
- Help implementing agencies prioritize transportation activities in a manner; consistent with the region's needs and resources
- Comply with the requirements of the FAST Act, the Americans with Disabilities Act of 1990 (ADA), the Clean Air Act, the Civil Rights Act of 1964, Executive Order (EO) 12898 (regarding environmental justice), EO 13166 (regarding non-English language accommodations), and EO 13330 (regarding the coordination of human services transportation)

Americans with Disabilities Act (ADA)

Year Enacted: 1990

MPO Goal Areas Addressed: Safety, System Preservation, Capacity Management/Mobility, Clean Air/Sustainable Communities, Economic Vitality, Transportation Equity

Title III of the ADA "prohibits states, MPOs, and other public entities from discriminating on the basis of disability in the entities' services, programs, or activities," and requires all transportation projects, plans, and programs to be accessible to people with disabilities. To satisfy these requirements, all MPO meetings, documents, and services are accessible to people with a disability. The MPO also considers the mobility needs of persons with disabilities throughout the planning process, which includes public engagement and data analysis to better understand transportation needs, and the programming of capital projects in the MPO's planning documents to help ensure that the MPO's investments meet these needs. These needs are documented in the Transportation Equity chapter (Chapter 8) in the context of the other goal areas.

Title VI of the Civil Rights Act of 1964

Year Enacted: 1964

MPO Goal Areas Addressed: Safety, System Preservation, Capacity Management/Mobility, Clean Air/Sustainable Communities, Economic Vitality, Transportation Equity

Title VI of the Civil Rights Act of 1964 prohibits discrimination on the basis of race, color, and national origin (minority populations) in all activities, policies, and programs undertaken by recipients of federal funding, including intentional (disparate treatment) and unintentional (disparate impact) discrimination. The MPO considers the transportation needs of minority populations throughout all areas of the planning process and projected programming and selection, including the LRTP Needs Assessment. The needs of minority populations are also documented in the Transportation Equity chapter in the context of each of the other goal areas.

Executive Order (EO) 12898, Federal Actions to Address Environmental Justice in Minority Populations and in Low-Income Populations

Year Enacted: 1994

MPO Goal Areas Addressed: Safety, System Preservation, Capacity Management/Mobility, Clean Air/Sustainable Communities, Economic Vitality, Transportation Equity

The Environmental Justice (EJ) EO requires that each federal agency achieve EJ by identifying and addressing any disproportionately high adverse human health or environmental effects on minority or low-income populations, including interrelated social and economic effects resulting from its programs, policies, and activities.

On April 15, 1997, the USDOT issued its *Final Order to Address Environmental Justice in Minority Populations and Low-Income Populations*. The Order was updated in 2012 with DOT Order 5610.2(a), which provided clarification while still maintaining the original framework and procedures. Among other provisions, this order calls for programming and planning activities to meet the following requirements:

- Explicitly consider the effects of transportation decisions on minority and low-income populations
- Provide meaningful opportunities for public involvement for minority and low-income populations
- Gather demographic information such as the race, color, national origin, and income level of the populations affected by transportation decisions
- Avoid, minimize, or mitigate adverse impacts on minority or low-income populations

The MPO considers the transportation needs of minority and low-income populations throughout the MPO's planning process and project programming and selection, including the LRTP Needs Assessment. The needs of minority and low-income populations are documented in the Transportation Equity chapter in the context of each of the other goal areas.

Executive Order 13166, Improving Access to Services for Persons with Limited English Proficiency

Year Enacted: 2000

MPO Goal Areas Addressed: Safety, System Preservation, Capacity Management/Mobility, Clean Air/Sustainable Communities, Economic Vitality, Transportation Equity

This EO extends Title VI protections to people who, because of their national origin, have limited English proficiency (LEP). Specifically, it calls for improved access to federally conducted and federally assisted programs and activities, and requires MPOs to develop and implement a system by which people with LEP can meaningfully participate in the MPO's planning process. In 2002, the Department of Justice guidance (*Guidance to Federal Financial Assistance Recipients Regarding Title VI Prohibition Against National Origin Discrimination Affecting Limited English Proficient Persons*) subsequently requires recipients of federal funding to develop Language Assistance Plans that document the organization's process for providing meaningful language access to people with LEP who access their services and programs. The MPO considers the transportation needs of people with LEP throughout all areas of its planning process, project selection and programming, including the LRTP Needs Assessment. The transportation needs of people with LEP are documented in the Transportation Equity chapter in the context of each of the other goal areas.

Age Discrimination Act of 1975

Year Enacted: 1975

MPO Goal Areas Addressed: Safety, System Preservation, Capacity Management/Mobility, Clean Air/Sustainable Communities, Economic Vitality, Transportation Equity

The Age Discrimination Act of 1975 prohibits discrimination on the basis of age in programs or activities that receive federal financial assistance. To comply with this law, the MPO considers the transportation needs of youth (age 17 or younger) and the elderly (age 75 and older) across all areas of the MPO planning process and project selection and programming, including the LRTP Needs Assessment. The needs of the youth and elderly populations are documented in the Transportation Equity chapter in the context of each of the other goal areas.

STATE REQUIREMENTS, POLICY DIRECTIVES, AND PLANS

Choices for Stewardship: Recommendations to Meet the Transportation Future—Created by the Commission on the Future of Transportation in the Commonwealth

Year Enacted: 2018

MPO Goal Areas Addressed: Safety, System Preservation, Capacity Management/Mobility, Clean Air/Sustainable Communities, Economic Vitality, Transportation Equity

This report explores the expected changes in demographics, technology, land use, energy use, climate, and other factors that may affect transportation in Massachusetts between 2020 and 2040. The report also includes several potential scenarios, based on trends, and recommendations based on the results of scenario planning. These recommendations also include the implications for traditionally underserved populations, both potential impacts that may disproportionately burden these populations and those impacts that may benefit them.

Global Warming Solutions Act and Related Plans and Policies

Year Enacted: 2008

MPO Goal Areas Addressed: System Preservation, Capacity Management and Mobility, Clean Air/Sustainable Communities

The Global Warming Solutions Act (GWSA), signed into law in 2008, is a comprehensive regulatory program to address climate change in Massachusetts, and it makes the Commonwealth a leader in setting aggressive and enforceable greenhouse gas (GHG) reduction targets and implementing policies and initiatives to achieve these targets. The GWSA established emission reductions targets for specific sectors, including transportation, and it recommended strategies for adapting to climate change.

In keeping with this law, the Massachusetts Executive Office of Energy and Environmental Affairs, in consultation with other state agencies and the public, developed the *Massachusetts Clean Energy and Climate Plan for 2020*. This implementation plan, released in 2010 (and updated in 2015), establishes the following targets for overall statewide GHG emission reductions:

- 25 percent reduction below statewide 1990 GHG emission levels by 2020
- 80 percent reduction below statewide 1990 GHG emission levels by 2050

In January 2015, the Massachusetts Department of Environmental Protection promulgated regulation 310 CMR 60.05, GWSA Requirements for the Transportation Sector and the Massachusetts Department of Transportation (MassDOT). This regulation places a range of obligations on MassDOT and MPOs to support achieving the state's climate change goals through the programming of transportation investments. In particular, GHG impacts must be a selection criterion for projects considered for programming in the TIP.

Massachusetts Freight Plan

Year Enacted: 2017

MPO Goal Areas Addressed: Safety, Capacity Management/Mobility, and Economic Vitality

The Massachusetts Freight Plan identifies a vision for "a multimodal freight system that is safe, secure, resilient, efficient, reliable, and sustainable, and one that catalyzes economic development while supporting the continued competitiveness of the Commonwealth." The Freight Plan identifies critical freight corridors and networks, important facilities, bottleneck locations, as well as key issues impacting the freight system. It uses a scenario-based approach to inform freight-related strategies and policies and identify freight projects for inclusion in future Massachusetts Capital Improvement Plans.

weMove Massachusetts: Planning for Performance

Year Enacted: 2014

MPO Goal Areas Addressed: System Preservation, Capacity Management/Mobility, Clean Air/Sustainable Communities, Economic Vitality

weMove Massachusetts (WMM) is MassDOT's statewide strategic multimodal plan. The initiative is a product of the transportation reform legislation of 2009 and the youMove Massachusetts civic engagement process. In May 2014, MassDOT released *WMM: Planning for Performance*, a single, multimodal LRTP for Massachusetts. WMM identifies policy priorities (including infrastructure maintenance), access to jobs and opportunities, quality of life, and sustainability. It also incorporates performance management into investment decision-making to calculate the differences in performance outcomes resulting from different funding levels available to MassDOT.

Massachusetts State Rail Plan

Year Enacted: 2018

MPO Goal Areas Addressed: Safety, System Preservation, Capacity Management, and Economic Vitality

The Massachusetts State Rail Plan is the 20-year plan for the statewide rail system. It describes the state's policy for freight and passenger rail transportation, serves as the basis for investments within Massachusetts, and establishes the mechanism to coordinate with adjoining states for corridor planning and investment strategies. It also describes the state's existing rail system, future trends, forecasts, needs, and opportunities.

MassMoves

Year Enacted: 2017

MPO Goal Areas Addressed: Safety, System Preservation, Capacity Management/Mobility, Clean Air/Sustainable Communities, Transportation Equity, Economic Vitality

The MassMoves initiative involved a series of public workshops held between January and April 2017 that were designed to engage citizens across the Commonwealth about their ideas for a twenty-first century transportation system. This initiative was a component of the Massachusetts Senate's Commonwealth Conversations forums. MPO staff reviewed feedback from MassMoves when developing the Needs Assessment.

REGIONAL REQUIREMENTS, POLICY DIRECTIVES, AND PLANS

Metropolitan Area Planning Council's *MetroFuture*/Regional Plan (Update—*MetroCommon 2050*)

Year Enacted: 2008/Underway

MPO Goal Areas Addressed: Safety, System Preservation, Capacity Management/Mobility, Clean Air/Sustainable Communities, Transportation Equity, Economic Vitality

MetroFuture, which was developed by the Metropolitan Area Planning Council (MAPC) and adopted in 2008, is the long-range plan for land use, housing, economic development, and environmental preservation for the Boston region. It includes a vision for the region's future and a set of strategies for achieving that vision. *MetroFuture* is the foundation for land-use projections used in the MPO's LRTP, *Charting Progress to 2040*. MAPC is now developing *MetroCommon*, the next regional plan, which will build off of *MetroFuture* and include an updated set of strategies for achieving sustainable growth and equitable prosperity. The MPO will continue to consider *MetroFuture's* goals, objectives, and strategies in its planning and activities, and will monitor *MetroCommon* as it develops.

RailVision

Year Enacted: Underway

MPO Goal Areas Addressed: System Preservation, Capacity Management/Mobility, and Economic Vitality

Currently underway, the Massachusetts Bay Transportation Authority's (MBTA's) *RailVision* will identify cost-effective strategies to transform the MBTA's existing commuter rail system to better support improved mobility and economic competitiveness in the Boston region. Slated to be completed in 2019, *RailVision* will evaluate costs, ridership potential, operational feasibility of alternatives, as well as public feedback to develop a vision of the future of the MBTA's commuter rail system. Currently, seven alternatives have been proposed.

MBTA Strategic Plan

Year Enacted: 2017

MPO Goal Areas Addressed: Safety, System Preservation, Capacity Management/Mobility, and Economic Vitality

The MBTA Strategic Plan sets forth the MBTA's vision, mission, and values and establishes specific objectives for the agency. Among the most critical priorities identified by the MBTA are:

- Reinventing the bus service to improve reliability and amenities
- Redesigning the bus network
- Eliminating the State of Good Repair backlog in 15 years
- Installing a new automated fare collection system by 2021, along with a new fare structure that increases revenue, ridership, and affordability
- Increasing non-fare, own-source revenue
- Completing planning for fleets, facilities, and service

Focus40

Year Enacted: 2019

MPO Goal Areas Addressed: System Preservation, Capacity Management and Mobility

Focus40 is the MBTA's 20-year investment plan to position the agency to meet the needs of the greater Boston area through 2040. The *Focus40* process created a long-term investment vision that recognizes current infrastructure challenges and the shifting demographics, changing climate, and evolving technology that may alter the role that the MBTA plays in Greater Boston. *Focus40* emphasizes 1) improving system performance and reliability; 2) supporting economic growth; 3) supporting inclusive growth; 4) mitigating and adapting to climate change; and 5) providing a seamless multimodal experience. The MPO will consider *Focus40* recommendations when making transit capital investment programming decisions in the TIP and LRTP.

LOCAL REQUIREMENTS, POLICY DIRECTIVES, AND PLANS

GoBoston 2030

Year Enacted: 2017

MPO Goal Areas Addressed: Safety, System Preservation, Capacity Management/Mobility, Clean Air/Sustainable Communities Transportation Equity, Economic Vitality

GoBoston 2030 is the City of Boston's long-term mobility plan, and is based on an extensive, multiyear public visioning process. It was developed according to the guiding principles of equity, economic opportunity, and climate responsiveness, and includes goals related to expanding access, improving safety, and ensuring reliability. The final plan includes both a vision framework and an action plan, the latter of which includes projects and policies designed to achieve the plan's performance goals.

Metro Boston Regional Climate Change Adaptation Strategy Report

Year Enacted: 2015

MPO Goal Areas Addressed: System Preservation, Clean Air/Sustainable Communities, Transportation Equity

MAPC released a revised version of its *Metro Boston Regional Climate Change Adaptation Strategy Report* in 2015 to support implementation of one of the goals of *MetroFuture*, which is that "the region will be prepared for and resilient to natural disasters and climate change." This report includes a Vulnerability Assessment for the region as well as goals and action steps to support adaptation and resilience for multiple sectors, including infrastructure.

OTHER LAWS, REQUIREMENTS, POLICIES, AND PLANS, BY GOAL AREA

Table A-5 lists the laws, regulations, guidance, policies, and plans that address fewer than three MPO goal areas, organized by geographic scope.

Table A-5

Specific Laws, Regulations, Guidance, and Policies by Goal Area

Policy or Plan	Year Enacted	Description	Safety	System Preservation	Capacity Management and Mobility	Clean Air/ Sustainable Communities	Transportation Equity	Economic Vitality
Federal								
Public Transportation Agency Safety Plan Rule—49 CFR Part 673	2018	Establishes requirements for recipients of federal transit funds to develop public transportation agency safety plans. These plans describe strategies for minimizing person and property exposure to unsafe conditions and include targets for transit safety performance measures.	X					
National Public Transportation Safety Plan	2017	Outlines a framework to guide the national effort to manage safety risks and hazards within the US public transportation system. It describes the FTA's SMS approach and identifies safety performance measures.	X					
Opportunity Zones Program	2017	The US Tax Cut and Jobs Act of 2017 created this program to provide incentives for investment in low-income communities. An opportunity zone is a geographic area in which individuals can gain favorable tax treatment on their capital gains by investing those funds (through a private Opportunity Fund) into economic activities in the area.						X
Highway Safety Improvement Program Rule—23 CFR Part 494	2016	Details policy, planning, implementation, and evaluation requirements for States and MPOs who spend dollars provided by the federal Highway Safety Improvement Program.	X					
Public Transportation Safety Rule—49 CFR Part 670	2016	Establishes rules for carrying out FTA's Public Transportation Safety Program.	X					
Transit Asset Management Rule—49 CFR Part 625	2016	Requires entities that receive funding from FTA to develop transit asset management plans, report asset information to the NTD annually, and to set targets and monitor asset conditions for established performance measures.		X				
FHWA Environmental Justice Reference Guide	2015	Provides guidance for recipients of financial assistance from the FHWA for complying with federal Title VI and EJ requirements.					X	
FTA Circular 9070.1G: Enhanced Mobility of Seniors and Individuals with Disabilities Program Guidance and Application Instructions	2014	Describes the development of the CPT-HST that identifies the specific transportation needs for elderly individuals and people with a disability. The MPO is responsible for developing the CPT-HST for the Boston region.					X	
FTA Circular 4307.1: Environmental Justice Policy Guidance for FTA Recipients	2012	Provides guidance to recipients of FTA financial assistance with guidance for incorporating EJ principles into activities that receive funding from FTA.					X	
FTA Circular 4702.1B: Title VI Requirements and Guidelines for FTA Recipients	2012	Provides recipients of FTA financial assistance with guidance for carrying out USDOT Title VI regulations.					X	
The Clean Air Act Amendments of 1990 (Title II) and Related Regulations	1990	Forms the basis of the US air pollution control policy, with certain requirements for MPOs.				X		
United States Environmental Protection Agency 40 CFR Parts 51 and 93—Conformity Regulation	Updated as needed	EPA-issued regulations requiring nonattainment and maintenance areas to demonstrate that their LRTPs are consistent with the SIP for attaining air quality standards.				X		
State								
Massachusetts State Implementation Plan	Ongoing	Discusses the state's status with respect to air quality standards and strategies it will follow to improve or maintain its status. It informs the MPO's assessment of air quality and transportation management needs.				X		
Municipal Vulnerability Grant Program	Ongoing	Provides support to Massachusetts municipalities to plan for resiliency and implement climate change adaptation. The state awards municipalities with funding to complete vulnerability assessments and develop resiliency plans.						

Policy or Plan	Year Enacted	Description	Safety	System Preservation	Capacity Management and Mobility	Clean Air/ Sustainable Communities	Transportation Equity	Economic Vitality
Massachusetts FHWA Transportation Asset Management Plan	Forthcoming	Federally required risk-based asset management plan for the NHS to improve asset condition and system performance. Elements include information on the condition of NHS pavements and bridges, condition performance targets, and supporting investment strategies. MassDOT submitted an initial plan to FHWA in 2018 and will be submitting a fully compliant plan in 2019, per federal requirements.		X				
Massachusetts Statewide FTA Transit Asset Management Plans	Forthcoming	Transit providers that receive federal financial assistance must develop TAM plans that include asset inventories and condition assessment; processes and tools that support investment prioritization; and a prioritized list of projects and programs to improve transit SGR. MassDOT will coordinate the development of a TAM Plan for smaller transportation providers that receive FTA Section 5310 funds, which support mobility for seniors and persons with disabilities.		X				
Massachusetts Bicycle Plan	2019	Plan advances bicycling statewide for everyday travel—particularly for short trips of three miles or less—to the broadest base of users and free of geographic inequities.			X			
Massachusetts Pedestrian Plan	2019	Plan recommends policies, programs, and projects for MassDOT to guide decision-making and capital investments, as well as develop guidance for municipalities to improve walkability in local communities.			X			
Massachusetts State Hazard Mitigation and Climate Adaptation Plan	2018	Serves as an update to the state's existing 2013 State Hazard Mitigation Plan and is also driven by the state EO No. 569, "Establishing an Integrated Climate Change Strategy for the Commonwealth." It addresses the state's federally mandated hazard mitigation plan requirements and results in the first statewide climate adaptation plan.		X		X		
Massachusetts Strategic Highway Safety Plan	2018	Identifies key roadway safety issues and needs in the state; sets goals and objectives for safety outcomes; and identifies strategies for improving safety.	X					
Housing Choice Initiative	2017	A state program that rewards municipalities that have produced a certain amount of new housing units in the last five years and that have adopted best practices related to housing production that will sustain a twenty-first century workforce and increase access to opportunity for Massachusetts residents.						X
Environmental Justice Policy of the Executive Office of Energy and Environmental Affairs	2017	Makes environmental justice an integral consideration in the implementation of all state environmental programs.					X	
Massachusetts EO 569: An Integrated Climate Change Strategy for the Commonwealth	2016	Requires state-specific executive agency activities to create a strategy to mitigate and reduce greenhouse gas emissions and to build resilience and adapt to the impacts of climate change. Transportation system preservation-related requirements include publishing a Climate Adaptation Plan.				X		
Community Compact Program	2015	A voluntary agreement between the state and municipalities in which a municipality agrees to implement at least one best practice selected from several areas, including housing and economic development, economic competitiveness, and sustainable development and land protection.						X
Department of Environmental Protection GHG Regulation	2015	Requires that MPO's calculate GHG reductions associated with all projects programmed in the LRTP and TIP and report that information to MassDOT.				X		
Massachusetts EO on Environmental Justice	2014	Directs the Executive Office of Energy and Environmental Affairs to update its EJ policy, define "environmental justice population," and provide updated data and maps of EJ populations to the public.					X	
Healthy Transportation Policy Directive	2013	Requires all state transportation projects to increase bicycling, transit and walking options.			X			
Massachusetts "Toward Zero Deaths" Goal	2013	This long-term goal, which is identified in the SHSP, is to eliminate fatalities and serious injuries on Massachusetts roadways.	X					

Policy or Plan	Year Enacted	Description	Safety	System Preservation	Capacity Management and Mobility	Clean Air/ Sustainable Communities	Transportation Equity	Economic Vitality
Accelerated Bridge Program	2008	Legislation for this program was passed with the goal of reducing Massachusetts's backlog of structurally deficient bridges below 450 by September 30, 2016.		X				
MassDOT Project Development and Design Guide	2006	Defines the standards to which state-funded projects are expected to adhere.	X		X			
TIP Greenhouse Gas Assessment and Reporting Guidance	2017	MassDOT guidance for evaluating GHG emissions in the LRTP and the TIP that requires MPOs to provide an air-quality analysis, calculating CO_2 emissions for all TIP projects and for the LRTP.				X		
Regional								
Congestion Management Process	Ongoing	The CMP 1) monitors and analyzes performance of roadway facilities and services; 2) develops strategies to manage congestion based on the results of monitoring; and 3) moves those strategies toward implementation by providing decision-makers in the region with information and recommendations to improve the transportation system's performance.			X			
Coordinated Public Transit–Human Services Transportation Plan	Forthcoming (2019)	Documents the MPO region's unmet human-service transportation needs. It is prepared by the MPO to allow organizations in the region to be eligible to receive funding from FTA's Section 5310 program, which provides capital and operations funding for services for the elderly and people with disabilities.			X		X	
Municipal Climate Action Plans	2016 and later	Municipalities throughout the MPO region are developing plans to enhance resiliency and support adaptation in response to climate change.		X		X		
Climate Justice for the City of Boston: Visioning Policies and Processes	2018	Provides an overview of how future climate change projections could affect Boston neighborhoods, the status of Boston's climate activities, and the social and economic vulnerabilities that currently exist and that may be exacerbated by climate change.				X	X	
MBTA, MWRTA, and CATA Transit Asset Management Plans	2018	These transportation agencies will create TAM plans to comply with the TAM Rule.		X				
State of Equity in Metro Boston Policy Agenda	2018	Describes policies to advance local and regional policy changes that address disparities in transportation, public health, and housing (among others areas) in the MAPC region.					X	
MAPC Regional Climate Strategy	2015	Provides recommendations for local, regional, and state action for reducing vulnerability to the impacts of climate change.		X		X		
Local								
Greenovate Boston	2014	Describes Boston's climate action plan for reaching its goals of reducing greenhouse gas emissions 25 percent by 2020 and carbon neutral by 2050.				X		

CATA = Cape Ann Transit Authority. CO_2 = Carbon Dioxide. CFR = code of federal regulations. CMP = congestion management process. CPT-HST = Coordinated Public Transit–Human Services Transportation. EJ = environmental justice. EO = Executive Order. EPA = Environmental Protection Agency. FHWA = Federal Highway Administration. FTA = Federal Transit Administration. GHG = greenhouse gas. LRTP = Long-Range Transportation Plan. MAPC = Metropolitan Area Planning Council. MassDOT = Massachusetts Department of Transportation. MBTA = Massachusetts Bay Transportation Authority. MPO = metropolitan planning organization. MWRTA = Metrowest Regional Transit Authority. NTD = National Transit Database. SGR = State of Good Repair. SHSP = Strategic Highway Safety Plan. SIP = State Implementation Plan. SMS = Safety Management System. TAM = transportation asset management. TIP = Transportation Improvement Program. USDOT = United States Department of Transportation.
Source: Boston Region MPO.

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appendix B

Relevant MPO Studies and Reports

The Metropolitan Planning Organization (MPO) staff, also known as the Central Transportation Planning Staff, undertakes several studies each year that explore regionwide transportation issues. These issues are described in full in the MPO's Unified Planning Work Program. The studies described in this appendix relate to one or more MPO goal areas: Safety, Capacity Management/Mobility, System Preservation, Clean Air/Sustainable Communities, Economic Vitality, and Transportation Equity. The studies help the MPO improve its approach to transportation issues that are of regional import, achieve the objectives of the MPO's goal areas, and help the MPO to better comply with federal guidance. Some of the studies are undertaken by the MPO's member agency, the Metropolitan Area Planning Council. Relevant reports that have been completed as part of the MPO's ongoing programs are also described in this appendix.

Table B-1 lists relevant studies and reports including the year it was completed, the source, and the related goal areas.

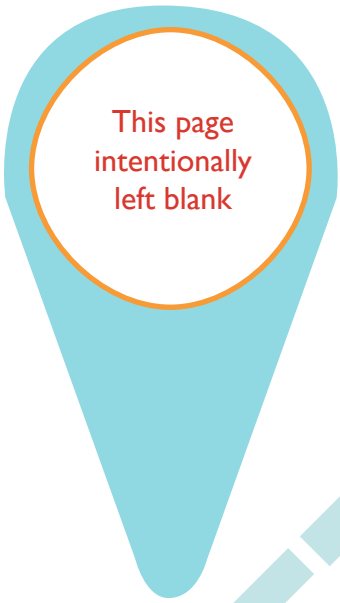

Table B-1

MPO Studies, Reports, and Technical Assistance Programs Related to MPO Goal Areas

Study Title	Publication Year	Source	Description	Safety	System Preservation	Capacity Management and Mobility	Clean Air/Clean Communities	Transportation Equity	Economic Vitality
Equitable Transit-Oriented Development	Ongoing	MAPC	Provides assistance to municipalities to use financing tools, zoning, and TOD plans to construct affordable residential and commercial developments in places accessible by public transit.					X	X
Corridor/Sub-Area Multimodal Transportation Planning	Ongoing	MAPC	Provides assistance to selected subregions or on roadway corridors to coordinate multimodal transportation planning and transit service operations to be implemented by MassDOT, MBTA, RTAs, TMAs, DCR, and/or municipalities with local land use planning to achieve livability and smart growth goals.			X			X
Local Parking Management Plans in Selected Communities	Ongoing	MAPC	Provides assistance to selected municipalities to develop local parking management plans, with the goals of improving parking availability, stimulating local economic prosperity, reducing congestion caused by circling vehicles, helping municipalities plan for greater density by decreasing parking requirements, and encouraging mode shift away from SOV trips.			X			X
MPO GHG calculations (performed for all projects evaluated for funding consideration)	Ongoing	CTPS	Evaluates all projects that are submitted for potential funding in the LRTP and TIP for air quality emissions (VOC, CO, NO_x, PM, and GHG).				X		
Addressing Safety, Mobility, and Access on Subregional Priority Roadway studies	Multiple years	CTPS	Analyzes and recommends safety and mobility improvements for arterial corridors throughout the MPO region each year. Staff selects locations based in part on crash incidence within the corridor.	X	X	X			
Priority Corridors for LRTP Needs Assessment studies	Multiple years	CTPS	Analyzes and recommends safety and mobility improvements each year for corridors identified as top priorities in LRTP Needs Assessments. Staff selects locations based in part on crash incidence within the corridor.	X	X	X			
Low-Cost Improvements at Select Highway Bottleneck Locations studies	Multiple years	CTPS	Identifies low-cost improvements each year that will help reduce congestion at freeway bottleneck locations in the Boston region. These studies also include safety-oriented recommendations.	X		X			
Community Transportation Technical Assistance studies	Multiple years	MAPC and CTPS	Provides municipalities with technical advice on local transportation concerns, including safety, traffic operations, and other issues.	X	X	X			
Road Safety Audits	Multiple years	CTPS	Provides formal safety reviews, performed by MassDOT, for existing and planned roadways and intersections each year in order to identify issues and opportunities for improvements. MPO staff regularly participates in these reviews for locations in the Boston region.						
Safety and Operations Analyses at Selected Intersections studies	Multiple years	CTPS	Analyzes locations within the Boston region each year that have a history of numerous crashes and extensive congestion during peak travel periods. It includes conceptual designs and recommendations for safety improvements and congestion management strategies.	X	X	X			
Bicycle Level-of-Service Metric	2018 (current)	CTPS	Will formulate a plan for developing and applying bicycle LOS metrics. These metrics may consist of information collected from various sources, including intersection surveys and bicyclist counts. These data could help transportation planners and government officials make decisions about bicycle infrastructure, including prioritization of projects and allocation of funding.			X			
Boston MPO's current LRTP, *Charting Progress to 2040* and conformity determinations	2015 (amendment in 2018)	CTPS	Describes GHG emissions, other air quality emissions associated with the LRTP.				X		

Study Title	Publication Year	Source	Description	Safety	System Preservation	Capacity Management and Mobility	Clean Air/Clean Communities	Transportation Equity	Economic Vitality
Livable Community Workshops	(multiple years; in 2015 these were folded into Community Transportation Technical Assistance)	MAPC and CTPS	Facilitated municipal-level workshops to discuss opportunities to incorporate livability considerations into planning and design activities. Bicycle and pedestrian travel, including related safety issues, have been discussed at these workshops.	X		X	X		
Fare Choices: A Survey of Ride-hailing Passengers in Greater Boston	2018	MAPC	Analyzes the results of in-vehicle surveys taken by ride-hailing passengers in the Boston region.			X			
Share of Choices: Further Evidence of the Ride-hailing effect in Metro Boston and Massachusetts	2018	MAPC	Analyzes the extent of mode shift, congestion, and fiscal impact caused by the presence of ride-hailing operators in the Boston region, building on the work of the study *Fare Choices*.			X			
Connected and Autonomous Vehicles and the Boston MPO—A First Look	2018	CTPS	Examines the phenomenon of CVs and AVs, reviews current developments in CV and AV technology, and discusses the range of benefits and impacts that could result once implemented. It recommends actions that the MPO can take in order to incorporate and understand CV and AV technology.	X		X			
Review of and Guide to Implementing Transit Signal Priority in the MPO Region	2018	CTPS	Develops a guidebook for use in planning and evaluating potential transit signal priority treatments in the Boston region. This guidebook is an analysis tool that the MPO staff can use to assist municipalities and transit operators that are considering implementing such treatments.			X			
Bicycle Network Gaps: Feasibility Evaluation	2018	CTPS	Builds from the work of the 2014 *Bicycle Network Evaluation* study, which identified gaps in bicycle facility networks and gaps in connectivity between bicycle facilities and regional transit stations in the Boston region. The 2018 study is presented in three memoranda, each memoranda providing recommendations for closing three of the highest priority gaps identified in the 2014 study.		X	X			
Development of a Scoring System for Bicycle Travel in the Boston Region	2018	CTPS	Develops a performance monitoring tool for bicycle routes, which includes measures for identifying safety deficiencies.	X					
Promising Greenhouse Gas Reduction Strategies for the Boston Region	2018	CTPS	Follows up on the recommendations of *GHG Reduction Strategy Alternatives: Cost-Effectiveness Analysis* and identifies cost-effective strategies employed by other agencies and MPOs, and suggests steps to reduce GHG emissions in the region.				X		
Trucks in the South Boston Waterfront	2017	CTPS	Focuses on truck and heavy vehicles in the South Boston Waterfront regarding congestion, growth trends, and truck volumes.			X	X		X
Weight and Height Restrictions that Impact Truck Travel	2017	CTPS	Reviews regulations that govern road use by large vehicles and maps locations with restrictions.		X				X
Identifying Opportunities to Alleviate Bus Delay	2017	CTPS	Investigates factors that lead to increased dwell time at bus stops by estimating the amount of time contributed by each fare payment type and by the boardings and on-board presence of baby carriages, wheeled mobility devices, and portable shopping carts. It also assesses the potential of various operational and scheduling improvements.						
Exploring the 2011 Massachusetts Travel Survey: Barriers and Opportunities Influencing Mode Shift	2017	CTPS	Quantifies characteristics of transit-competitive travel submarkets, which serve as a basis for specific strategies to increase transit mode share.			X			

Study Title	Publication Year	Source	Description	Safety	System Preservation	Capacity Management and Mobility	Clean Air/Clean Communities	Transportation Equity	Economic Vitality
Shared-Use Mobility Options: Literature Review	2017	CTPS	Provides an overview of shared-use mobility services, which involve sharing vehicles, bicycles, or other transportation modes that give users short-term access to transportation on an as-needed basis. It defines various types of shared-use mobility services and describes companies and service providers that operate in the Boston region.			X			
Fairmount Line Station Access Analysis	2017	CTPS	Reviews bicycle and pedestrian conditions in the vicinity of existing or planned Fairmount Line stations in Boston, and recommends improvements to enhance the safety and comfort of bicyclists and pedestrians seeking to connect to these stations.	X					
Spatial Distribution of Crashes in EJ and Non-EJ Communities in the Boston Region MPO	2017	CTPS	Explores the frequency and severity of crashes in EJ communities compared with non-EJ communities in the Boston region, using crash data from 2010–14. The analysis examines variations in crash incidence, severity, involved modes, and exposure metrics.	X				X	
Boston Region MPO 2017 Triennial Title VI Report	2017	CTPS	Documents the MPO's compliance with FTA and FHWA Title VI, EJ, and other federal nondiscrimination regulations.					X	
System-wide Title VI/Environmental Justice Assessment of TIP Projects	2017	CTPS	Develops an initial methodology for conducting an equity analysis of the distribution of target-funded projects in the TIP.					X	
Improving Truck Travel in the Everett-Chelsea Industrial Area	2016	CTPS	Analyzes volumes and truck routes in the area and makes recommendations to modify the road network to improve access to industrial areas and reduce impacts to non-industrial areas.						X
Rest Locations for Long Distance Drivers in Massachusetts	2016	CTPS	Presents existing conditions and suggests strategies and opportunities to expand and improve truck parking locations in Massachusetts.		X				X
Core Capacity Constraints	2016	CTPS	Examines the capacity of road and transit facilities in the MPO's core area. It relates these capacities to current and projected levels of traffic and ridership and determines the location and severity of congestion and crowding in the core area.			X			
Greenhouse Gas Reduction Strategy Alternatives: Cost Effectiveness Analysis	2016	CTPS	Provides information about various strategies that support reduction of GHG emissions to help the MPO identify investments that are most cost-effective for reducing GHGs.				X		
Comprehensive Economic Development Strategy	2015	MAPC	Outlines goals for the region, identifies barriers to economic development, calls out the needs for transportation systems that are adequately financed, and seeks to build on existing strengths in looking toward the future. It incorporates and elaborates on themes of MAPC's *MetroFuture*.						X
Pedestrian Signal Phasing Study	2015	CTPS	Provides information designed to help municipal engineers and planners to select an appropriate pedestrian signal phase type and enhancements for intersections, which can help increase pedestrian and motorist safety.	X					
Boston MPO's current LRTP, *Charting Progress to 2040* Needs Assessment	2015	CTPS	Includes information on environmental, safety, system preservation, mobility, economic, and transportation equity needs in the region.	X	X	X	X	X	X
Central Artery/Tunnel Vulnerability and Adaptation Assessment	2015	MassDOT, University of Massachusetts-Boston, University of New Hampshire, Woods Hole Group Inc.	Assesses the Central Artery and Tunnel System's vulnerability to climate change. It was completed in 2015 and created the Boston Harbor Flood Risk Model. This model is being expanded to cover the full Massachusetts coast and will be renamed the Massachusetts Coastal Flood Risk model.		X				
Freight Planning Action Plan	2013	CTPS	Identifies freight study efforts in the Boston region.			X			X

Study Title	Publication Year	Source	Description	Safety	System Preservation	Capacity Management and Mobility	Clean Air/Clean Communities	Transportation Equity	Economic Vitality
Massachusetts Regional Bus Study	2013	CTPS	Analyzes changes that have taken place in regional bus services in Massachusetts since 1980; identifies the reasons for the changes; examines how regional services relate to local services; identifies issues that have prevented the retention or expansion of services; and suggests measures to better meet the needs of underserved markets, foster system growth, and promote improved mobility options in the state.			X			
Safe Access to Transit for Pedestrians and Bicyclists	2012	CTPS	Examines issues related to non-motorized accessibility to transit stations and identifies low-cost, quick-implementation measures to improve pedestrian and bicyclist access to the MBTA system.	X	X	X			
Screening Regional Express Highways for Possible Preferential Lane Implementation	2012	CTPS	Evaluates all express highways in eastern Massachusetts to identify additional locations where an HOV facility would relieve congestion for general traffic while offering a premium LOS to users of the HOV lane.			X			
Roundabout Screening Tool	2012	CTPS	Develops a screening tool for state and municipal agencies to use when evaluating the benefits and implications of roundabout proposals. Safety factors are included in the screening tool.	X		X			
Statewide Economic Impact Evaluation Study	2018	MassDOT	Reviews technical resources to establish economic scoring criteria for transportation projects, which included a rigorous stakeholder engagement process.						X
Health Impact Assessment: Speed Limit Bill	2012	MAPC and CTPS	Analyzes the potential impacts of a bill proposing to lower default local speed limits from 30 to 25 miles per hour. This analysis, which used information from the CTPS travel demand model, examines changes in collisions, injuries, and fatalities; fuel burned; time spent in traffic, and health effects from air pollution.	X					
Carbon Dioxide, Climate Change, and the Boston Region MPO: 2012 Update	2012	CTPS	Updates the 2008 MPO report, *Carbon Dioxide, Climate Change, and the Boston Region MPO,* with new observed changes in climate, new policies and legislation, and recent MPO activities to address climate change.				X		
Carbon Dioxide, Climate Change, and the Boston Region MPO: A Discussion Paper	2008	CTPS	Provides an overview of climate change and its local impacts; a summary of the MPO's plans and programs that help reduce GHG emissions; and next steps to further reduce climate change impacts through MPO initiatives.				X		

Note: Under the Publication Year column, "ongoing" refers to studies that are currently being undertaken as of this writing. "Multiple years" refers to studies that are funded on a recurring basis through the UPWP and often have a technical assistance focus
AV= autonomous vehicles. CO = Carbon Monoxide. CO_2 = Carbon Dioxide. CTPS = Central Transportation Planning Staff. CV = connected vehicles. DCR = Department of Conservation and Recreation. EJ = environmental justice. FHWA = Federal Highway Administration. FTA = Federal Transit Administration. GHG = greenhouse gas. LOS = level of service. LRTP = Long-Range Transportation Plan. HOV = high-occupancy vehicle. MAPC = Metropolitan Area Planning Council. MassDOT = Massachusetts Department of Transportation. MBTA = Massachusetts Bay Transportation Authority. MPO = metropolitan planning organization. NOx = Nitrogen Oxides. PM = particulate matter. RTA = Regional Transit Authority. SOV = single-occupancy vehicle. TIP = Transportation Improvement Program. TMA = Transportation Management Association. TOD = transit oriented development. VOC = volatile organic compounds.
Source: Boston Region MPO.

appendix C

Data Resources

Each chapter in the Needs Assessment was developed using a variety of data sources. These sources include demographic and employment data, crash data, land use data, data about the condition of the transportation system, information about various transportation services in the Boston region, and transportation emissions data. Table C-1 summarizes these data, with information about relevant online applications.

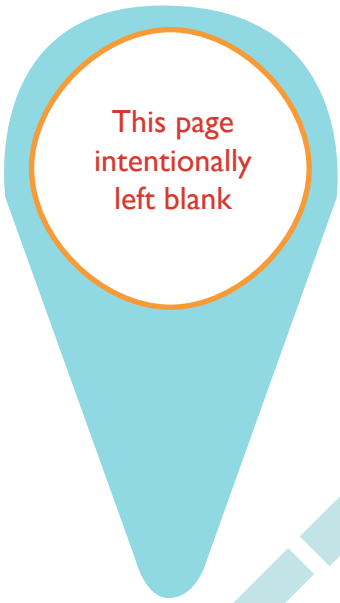

Table C-1

Data Resources Used in the Needs Assessment

Topic Area	Data Resource	Relevant Applications	Safety	System Preservation	Capacity Management and Mobility	Clean Air/Clean Communities	Transportation Equity	Economic Vitality
Bridge Condition	MassDOT Bridge Database	MPO Performance Dashboard		X				
Congestion	INRIX speed data	MPO Performance Dashboard			X			
Crashes	Crash Data System of the Massachusetts RMV	MassDOT Crash Portal	X				X	
Demographics	2010 US Census 2010–14 American Community Survey	LRTP Needs Assessment Data Browser MPO Performance Dashboard					X	
Employment Density	Census and American Community Survey Data MPO projections	LRTP Needs Assessment Data Browser						X
Environment	Natural, environmental, and historic resources mapped for the Boston region	MassGIS Data Layers				X		
Existing Growth District Communities	Executive Office of Housing and Economic Development	None						X
Freight (Truck) Trip Density and Generators	MPO regional travel demand model CTPS research	LRTP Needs Assessment Data Browser						X
Freight Network	MassDOT Freight Plan	None		X				
Greenhouse Gas and Air Pollution	CTPS travel demand model	MPO Vehicle-Miles Traveled and Emissions Data Browser				X		
Greenhouse Gas and Environment	MassGIS data layers on flooding, seawater inundation from hurricane storm surges, and sea level rise	MPO All-Hazards-Planning Application				X		
Hazards Planning	Federal Emergency Management Agency	MPO All-Hazards-Planning Application		X				
Hazards Planning	U.S. Army Corps of Engineers (New England District)	MPO All-Hazards-Planning Application		X				
Hazards Planning	U.S. Geological Survey Final Technical Report: Liquefaction Hazard Mapping in Boston, Massachusetts: Collaborative Research with William Lettis & Associates, Inc., and Tufts University	MPO All-Hazards-Planning Application		X				
Hazards Planning	Intergovernmental Panel on Climate Change, Climate Change 2007: Synthesis Report	MPO All-Hazards-Planning Application		X				
High Crash Locations	MassDOT-identified Highway Safety Improvement Program Clusters and Top High Crash Intersection Locations	MassDOT Interactive Top Crash Locations Map LRTP Needs Assessment Data Browser	X					
Land Use and Development	MAPC Municipal Development Database	MAPC MassBuilds						X
Maven Fleet	Maven	None			X		X	
Off-Street Trails	Metro Boston network of foot trails and bicycle paths	MAPC TrailMap			X		X	
Pavement Condition	MassDOT Roadway Inventory MassDOT Pavement Management System	MPO Performance Dashboard LRTP Needs Assessment Data Browser		X				

Topic Area	Data Resource	Relevant Applications	Safety	System Preservation	Capacity Management and Mobility	Clean Air/Clean Communities	Transportation Equity	Economic Vitality
Population Density	US Census and American Community Survey data, MPO projections	LRTP Needs Assessment Browser						X
Traffic Fatalities	Fatality Analysis Reporting System	FARS Web-based Encyclopedia	X					
Traffic Incidents and Injuries	Massachusetts Crash Data System	MassDOT Crash Portal	X					
Transit	MBTA Bus Crowding Model	None			X			
Transit	Measures of reliability, ridership, and customer satisfaction with MBTA performance	MBTA Back on Track Dashboard			X			
Transit Assets	MBTA, CATA, and MWRTA Transit Asset Management Plans and performance data submittals	None		X				
Transit Routes	MBTA, MWRTA, CATA, MVRTA, BAT, and GATRA GTFS	None			X		X	
Transit Safety	MBTA FMCB Quarterly Safety Reports, MassDOT Tracker	MassDOT Tracker website	X					
Vehicle-Miles Traveled	VMT	MPO VMT and Emissions Data Browser MassDOT VMT Data Viewer	X		X			
Zipcar Fleet	Zipcar	None			X		X	

Notes: The Safety Goal Area is in Chapter 4; System Preservation is in Chapter 5; Capacity Management and Mobility is in Chapter 6; Clean Air/Sustainable Community is in Chapter 7; Transportation Equity is in Chapter 8; and Economic Vitality is in Chapter 9.
BAT = Brockton Area Transit. CATA = Cape Ann Regional Transit Authority. CTPS = Central Transportation Planning Staff. FARS = Fatality Analysis Reporting System. FMCB = Fiscal Management and Control Board. GATRA = Greater Attleboro Taunton Regional Transit Authority. GTFS = General Transit Feed Specification. LRTP = Long-Range Transportation Plan. MAPC = Metropolitan Area Planning Council. MassDOT = Massachusetts Department of Transportation. MassGIS = Massachusetts Bureau of Geographic Information. MBTA = Massachusetts Bay Transportation Authority. MPO = Metropolitan Planning Organization. MWRTA = Metrowest Regional Transit Authority. MVRTA = Merrimack Valley Regional Transit Authority. RMV = registry of motor vehicles. VMT = vehicle-miles traveled.
Source: Boston Region MPO.

appendix D

Public Input on Transportation Needs

INTRODUCTION

MPO staff relied upon public input to complement its own analyses about existing and future transportation needs in the Boston region. This appendix describes the public outreach MPO staff undertook in 2017 and 2018 for the *Destination 2040* Needs Assessment. It summarizes the public outreach approach and includes the communication and engagement methods used to gather input. Through online and in-person outreach, MPO staff heard about a wide variety of transportation needs and opportunities for improvement.

Commenters provided feedback about experiences when walking, biking, taking transit (including buses, subways, commuter rail, paratransit, Council on Aging vans, Transportation Management Association shuttles, and ferries), driving, carpooling, carsharing, and bikesharing. Some commenters advocated for location-specific interventions, while others shared overarching concerns about the transportation system as relates to accessibility, connectivity, safety, reliability, innovation, affordability, connectivity, legibile signage, and maintenance. Others discussed transportation's influence on public health, equity, greenhouse gas emissions, and economic vitality in the Boston region. Finally, some commenters expressed a range of opinions about the availability and management of parking and other interactions between transportation and land use.

Staff organized and summarized all of the input received by goal area in the "Stakeholder/ Public Input" sections of Chapters 4 through 9. Staff incorporated this input in its recommendations to address the region's transportation needs, which are also summarized by goal area in Chapters 4 through 9.

PUBLIC OUTREACH APPROACH FOR THE *DESTINATION 2040* NEEDS ASSESSMENT

Communication Methods

MPO staff used a variety of methods to provide information for the public to understand, follow, and engage in the MPO's long-range transportation planning (LRTP) process. In-person meetings, webpage content, emails, social media, and other electronic means were used for external communications, as summarized below.

Meetings

MPO staff introduced *Destination 2040* to audiences at meetings, conferences, and events. These conversations were aided by posters, timelines, and brochures. The events are described in more detail in the Engagement Methods section.

Webpage

MPO staff developed a webpage for *Destination 2040* for interested parties to follow the LRTP's development. The webpage includes a timeline of upcoming and past events, a Needs Assessment page with data visualization applications where needs can be suggested, places to take surveys and provide comments, and information detailing how to get involved. The webpage is designed to provide everything needed to understand, follow, and participate in the MPO's LRTP in one centralized location.

Electronic notifications

Stakeholders were notified of LRTP milestones and participation opportunities through complementary modes of communication provided by MPO staff. The modes of communication are detailed below.

Emails

Emails are the MPO staff's primary means of notifying interested parties about opportunities for engagement. Subscribers to the MPO's email list can opt in or opt out of different types of communication, such as general notices, meeting reminders, Advisory Council notices and updates from the MPO's blog, *TRANSREPORT*. The chart below summarizes the various notices sent to MPO subscribers.

Table D-1
Notices Sent to MPO Subscribers

Date	Action
September 2017	Subscribers received an email about opportunities to provide input on local and regional transportation needs.
October 2017	Subscribers received an email that announced the development of a new LRTP and shared a timeline of opportunities to participate.
March 2018	Subscribers were invited to attend the *Summit on Accessible Transportation*, where they could share input on accessible transportation needs and help shape the LRTP.
April 2018	Subscribers received an email encouraging them to explore the *Destination 2040* website and share their transportation needs.
July 2018	Attendees of the *Summit on Accessible Transportation* and members of the former Access Advisory Committee of the Massachusetts Bay Transportation Authority (MBTA) received an email with a summary on feedback received about transportation needs and links to the *Destination 2040* development page.
December 2018	Subscribers received an email announcing that the Draft Needs Assessment Summary and Recommendations was available for review and comment.
October 2018	Advisory Council members received an email with a notice about an upcoming presentation on the Needs Assessment.
October 2018	Subscribers received an email with a notice about an upcoming presentation to the MPO on the draft Needs Assessment.
June 2018-December 2018	Subscribers to MPO meeting reminders received agendas to meetings, including meetings with presentations and discussions about the *Destination 2040* Needs Assessment.
December 2018	Subscribers to Advisory Council notices received an email with a notice about an upcoming presentation on the draft Needs Assessment. Summary and Recommendations
January 2019	Subscribers to updates from the MPO's blog, *TRANSREPORT*, received an email notifying them about a new post describing the Draft Needs Assessment Summary and Recommendations.

LRTP= Long-Range Transportation Plan. MBTA= Massachusetts Bay Transportation Authority. MPO=Metropolitan Planning Organization.
Source: Boston Region MPO.

Tweets

Tweets complement the use of email communications by MPO staff. The MPO's Twitter account is followed by transportation advocates, community groups, other government agencies, and interested members of the public. MPO staff tweets are outlined below by date.

Table D-2
Tweets Sent to MPO Subscribers

Date	Action
August 2016	Staff tweeted about information about upcoming LRTP development.
April 2018	Staff tweeted a link to an email encouraging people to explore the *Destination 2040* website and to share their transportation needs.
March 2018	Staff tweeted a link to a survey about transportation needs.
December 2018	Staff tweeted that the Draft Needs Assessment Summary and Recommendations document was available for review and also shared a link to the *TRANSREPORT* blog post on the topic.

LRTP= Long-Range Transportation Plan. MPO=Metropolitan Planning Organization.
Source: Boston Region MPO.

TRANSREPORT

MPO staff crafted a post in *TRANSREPORT*, the MPO's blog, describing the Draft Needs Assessment Summary and Recommendations and kicked off a series of posts providing information and updates about *Destination 2040*.

MPO Homepage Banners

A large, inviting banner graphic with a prominent "action button" on the MPO's homepage alerted MPO website visitors to the *Destination 2040* website.

Metropolitan Area Planning Council (MAPC) Matters

The MAPC publishes a monthly newsletter, *MAPC Matters*, and MPO staff consistently sends updates on MPO activities to be included in the "MPO Corner" section of the newsletter to reach a broader audience. Subscribers to *MAPC Matters* received notices about the kickoff of the *Destination 2040* website, the availability of the transportation needs survey, discussions about needs occurring at subregional group meetings and other venues (described in more detail below), presentations at MPO meetings about the development of the Needs Assessment, and the release of the Draft Needs Assessment Summary and Recommendations.

Engagement Methods

MPO staff provided opportunities for members of the public to participate in *Destination 2040's* development to ensure that feedback could be heard, valued, and considered. A combination of electronic surveys and in-person meetings were used to seek public input and

feedback on transportation needs and opportunities for improving transportation. All of the MPO-sponsored public outreach venues complied with Americans with Disabilities Act (ADA) accessibility standards and were accessible by public transportation.

MPO Meetings

MPO staff updated the MPO about developments in the *Destination 2040* Needs Assessment at the following meetings:

Table D-3
MPO Meeting Developments

Date	Action
December 1, 2016	Presentation about the work plan for developing *Destination 2040* and its Needs Assessment
June 15, 2017	Presentation about scenario planning for the LRTP and its Needs Assessment
October 5, 2017	Update about the development of the LTRP Needs Assessment and a presentation about the LRTP's Public Participation Plan
November 16, 2017	Presentation about developing the LRTP's 2040 population and employment projections
June 21, 2018	Update about developing the LRTP's 2040 population and employment projections and the initial results of the 2016 Base Year and 2040 No-Build travel demand model runs
September 20, 2018	Update about developing the LRTP and its Needs Assessment
November 15, 2018	Presentation of the Draft Needs Assessment Summary and Recommendations
December 6, 2018	Presentation of the final population and employment projections for 2040

LRTP= Long-Range Transportation Plan. MPO=Metropolitan Planning Organization.
Source: Boston Region MPO.

As a policy, the MPO welcomes public comments at all meetings, offering stakeholders a chance to offer their input and feedback about MPO decisions. Staff has also provided related materials on the *Destination 2040* website and the MPO meeting calendar.

Advisory Council Meetings

The chair of the Advisory Council kept the Council abreast of information and updates shared at the MPO meetings described above. MPO staff updated the Council about the development of the LRTP and its Needs Assessment at the Council's October 10, 2018, meeting. MPO staff also presented the Draft Needs Assessment Summary and

Recommendations to the Advisory Council on December 12, 2018. The meeting was open to the public and attendees included representatives from municipalities, public agencies, advocacy groups, and other interested parties. After the presentations to the Council, MPO staff answered members' questions. Staff also solicited feedback in emails sent to members and friends of the Council.

Subregional Group Meetings

MPO staff visited each of the eight MAPC subregional groups in fall 2017 to gather input on transportation needs and opportunities for improving the transportation system. Staff returned to each MAPC subregional group in fall 2018 to encourage members to review the Draft Needs Assessment Summary and Recommendations and provide feedback. Attendees of these meetings included planners, department directors, and other interested municipal officials (including elected officials). The following table provides the number of attendees at each meeting.

Table D-4
Attendance Totals at Subregional Group Meetings

Subregion	2017	2018
Inner Core Committee	19	19
North Shore Task Force	13	7
North Suburban Planning Council	16	9
Minuteman Advisory Group on Interlocal Coordination	17	24
MetroWest Regional Collaborative	17	12
SouthWest Advisory Planning Committee	11	12
Three Rivers Interlocal Council	16	11
South Shore Coalition	8	9

Source: Boston Region MPO.

Meetings with Stakeholder Organizations

MPO staff regularly respond to invitations to attend scheduled meetings of transportation advocacy organizations and other organizations interested in discussing transportation issues and those interested in learning how to shape the transportation system in the region. At

these meetings, staff discussed transportation needs and opportunities for improving the transportation system with the following groups:

- 495/MetroWest Partnership Transportation Committee (25 attendees)
- MBTA's Rider Oversight Committee (approximately five attendees)
- LivableStreet's Advocacy Committee (approximately 14 attendees)

In addition, staff have been proactively building relationships with organizations serving the needs of people who identify as a minority, people with limited English proficiency, people with disabilities, people who are 75 years or older, and people who are members of low-income households or transit-dependent households. Staff reached out to contacts in these organizations to discuss opportunities to communicate and engage with their constituents. This outreach resulted in visits to these organizations:

- Transportation Resources, Information, Planning and Partnership for Seniors (eight attendees)
- Boston North Regional Coordinating Council (14 attendees)

Outreach has also led to collaboration with the Access Advisory Committee to the MBTA (AACT) and the City of Boston's Disabilities Commission to host a *Summit on Accessible Transportation* in March 2018. More than 100 attendees engaged in discussions about transportation needs related to sidewalks, bicycle infrastructure, the subway and commuter rail, buses, paratransit, taxis, transportation network companies, and autonomous vehicles.

Office Hours

During 2017 and 2018, staff offered monthly *Office Hours* at consistent, designated times for the public to engage in one-on-one conversations with MPO staff. Interested parties either visited the Boston Region MPO office or called staff on the phone. Visitors often shared about transportation needs and opportunities to improve the transportation system. Staff incorporated these concerns and interests into the LRTP Needs Assessment.

Open Houses

MPO staff hosted two *Open Houses* in spring 2018 to allow the public the opportunity to comment in person on the MPO's draft Transportation Improvement Program and Unified Planning Work Program. At each event, staff provided information about *Destination 2040* via posters and interactive displays. Participant's comments about transportation needs and opportunities for improvement were considered as input into the Needs Assessment.

Partner Events

Staff sought opportunities to partner with other agencies and organizations to reach broader audiences. In March 2018, MPO staff participated in a panel discussion at the Neponset Valley Transportation Management Association's forum on *Bridging Transportation Gaps in the Neponset Valley*. Staff also appeared in person at the following events:

- Massachusetts Department of Transportation (MassDOT)'s Moving Together Conference (2017 and 2018)
- MassDOT's Innovation and Mobility Exchange (2018)
- MBTA's Focus40 public events (2016 Kickoff, 2016 Interactive Open House, and 2017 Open House)
- MAPC's Fall Council meetings (2016 and 2017)

Surveys and Comments

MPO staff distributed an electronic survey asking stakeholders for input about transportation needs and opportunities for improving transportation. Surveys were posted on the *Destination 2040* website, sent out via email and Twitter, and included in a *TRANSREPORT* blog post. Two hundred and fifty individuals responded to the survey and the responses are included in the overall summary of comments in Chapters 4 through 9.

Staff also received comments and questions related to transportation needs throughout the development of the LRTP Needs Assessment and during a review period for the Draft Needs Assessment Summary and Recommendations. Staff responded using the same means of communication through which the comment or inquiry was made and presented all written comments to the MPO for consideration.

CONCLUSION

MPO staff conducted public outreach for the *Destination 2040* Needs Assessment to help stakeholders and the public understand, follow, and participate in the development of *Destination 2040*. Through online and in-person communications and outreach, staff received over 2,000 ideas about needs and opportunities for improving the transportation system. Staff gathered and summarized this input and incorporated stakeholders' interests into the Needs Assessment Summary and Recommendations. This draft document was returned to the public for review and comment. Staff responded to these comments and concerns and incorporated them into its recommendations for how to address the region's transportation needs in Chapters 4 through 9 of the final Needs Assessment. The public comments are summarized by goal area in the "Stakeholder/Public Input" sections in Chapters 4 through 9.

appendix E

Destination 2040
Vision, Goals, and Objectives

BACKGROUND

During each Long-Range Transportation Plan (LRTP) development cycle, the Boston Region Metropolitan Planning Organization (MPO) has the opportunity to review and revise its vision, associated goals, and objectives. As part of developing the *Charting Progress to 2040* LRTP in 2014 and 2015, the MPO used scenario planning to inform potential revisions to the vision, goals, and objectives. Specifically, as part of its Capacity Management and Mobility goal area, the MPO used scenario planning to determine if it should give priority to a congestion-reduction program for major arterials and express highways, or if it should prioritize lower-cost multimodal improvements. Scenario planning led the MPO to emphasize capacity management through low-cost improvements. Once the scenario planning was completed, the revised vision, goals, and objectives were adopted by the MPO as part of *Charting Progress to 2040* (adopted in 2015). The vision, goals, and objectives framework forms the basis of the criteria used in making investment decisions in the LRTP and Transportation Improvement Program.

During the development of *Destination 2040*, staff conducted outreach about the transportation needs in the MPO region. Staff also collected and analyzed data through its studies, travel-demand modeling analyses, and performance-based planning and programming process (PBPP).

Staff found that most of the *Charting Progress to 2040* goals and objectives were broad enough to cover the topics and concerns identified via public input and analysis results. However, some changes did seem warranted for *Destination 2040* to

1. better align the objectives with the roles and responsibilities of the MPO;
2. incorporate additional feedback heard during outreach; and
3. incorporate new planning requirements.

Based on the public's input, the Transportation Equity goal contains the most changes.

This appendix cites the MPO's *Charting Progress to 2040* goals and objectives, revisions, and the rationale for the *Destination 2040* revisions. The *Charting Progress to 2040* vision and goals are shown in *italics*, and the revisions for *Destination 2040* are shown in **bold**. The objectives are listed in their own tables, with the *Destination 2040* revisions shown in **bold,** along with staff's rationale for the revisions. An additional column was included in Table E-3, for the Capacity Management and Mobility goal, so that staff and the MPO could review the objectives by mode to determine if all areas were being addressed; this led to a change in the order of the listed objectives.

MPO VISION

Charting Progress to 2040 Vision:

The Boston Region Metropolitan Planning Organization envisions a modern transportation system that is safe, uses new technologies, and provides equitable access, excellent mobility, and varied transportation options—in support of a sustainable, healthy, livable, and economically vibrant region.

Destination 2040 Changes:

*The Boston Region Metropolitan Planning Organization envisions a modern**, well-maintained** transportation system that **supports a sustainable, healthy, livable, and economically vibrant region. To achieve this vision, the transportation system must be** safe and **resilient; incorporate emerging** technologies; **and** provide equitable access, excellent mobility, and varied transportation options.*

The *Charting Progress to 2040* vision incorporated themes from all of the goal areas. Staff proposed the revisions for *Destination 2040* to emphasize that the System Preservation goal includes a well-maintained and resilient transportation system. It also includes editorial revisions.

SAFETY GOAL AREA

Staff found that the *Charting Progress to 2040* safety goal and objectives were broad enough to cover the topic areas and concerns identified through public input and analysis results. The *Destination 2040* revisions to the objectives outlined in Table E-1 were designed to incorporate additional types of safety events besides crashes, and to align better the objectives with the roles and responsibilities of the MPO, which are focused on capital investment as opposed to operations.

Charting Progress to 2040 and *Destination 2040* Goal

- ***Charting Progress to 2040 Goal***: *Transportation by all modes will be safe*
- ***Destination 2040 Goal*:** *No changes*

Charting Progress to 2040 and *Destination 2040* Objectives

Table E-1
Safety Objectives

Charting Progress to 2040 Objective	*Destination 2040* Objective	Rationale
Reduce number and severity of crashes, all modes	Reduce the number and severity of crashes **and safety incidents for** all modes	Change is more inclusive of transit system safety events that are not crashes
Reduce serious injuries and fatalities from transportation	Same	N/A
Protect transportation customers and employees from safety and security threats	**Make investments and support initiatives that help** protect transportation customers, employees, **and the public** from safety and security threats	Focuses on the MPO's role, capital investment, rather than operations

MPO = Boston Region Metropolitan Planning Organization. N/A = Not applicable or available.

Source: Boston Region MPO.

SYSTEM PRESERVATION GOAL AREA

Staff found that the *Charting Progress to 2040* System Preservation goal and its objectives were broad enough to cover the topics and concerns identified through public input and analysis. However, staff proposed to incorporate modernization into the System Preservation goal statement. *Destination 2040* revisions to the objectives were restructured to include broader objectives in three categories—maintenance, modernization, and resiliency. With that change, staff also requested the MPO's feedback on potentially changing the goal name from System Preservation to System Preservation **and Modernization**. The MPO agreed with this change.

Although resiliency was included in one of the *Charting Progress to 2040* objectives, staff also proposed to include resiliency in the System Preservation goal statement. Addressing climate change remains a priority for the MPO and has become a core goal of the Commonwealth. Feedback from public outreach also indicated the importance of creating a resilient transportation network to mitigate climate change and maintain existing sidewalks.

Charting Progress to 2040 and *Destination 2040* Goal

- ***Charting Progress to 2040 Goal***: *Maintain the transportation system*
- ***Destination 2040 Goal***: *Maintain* ***and modernize*** *the transportation system* ***and plan for its resiliency***

Charting Progress to 2040 and *Destination 2040* Objectives

Table E-2
System Preservation and Modernization Objectives

Charting Progress to 2040 Objective	*Destination 2040* Objective	Rationale
Improve condition of on- and off-system bridges	**Maintain the transportation system, including roadway, transit, and active transportation infrastructure, in a state of good repair**	Creates a broader goal to include the infrastructure previously identified in existing objective—bridges, pavement, and transit; but also to include sidewalks (identified as a need in public outreach)
Improve pavement conditions on MassDOT-monitored roadway system	Delete	This objective was included in the first objective
Maintain and modernize capital assets, including transit assets, throughout the system	**Modernize transportation infrastructure across all modes**	Focuses on modernization, reducing overlap with objective above, which focuses on maintenance; this modernization objective could address obsolete assets and incorporate new technologies into existing systems
Prioritize projects that support planned response capability to existing or future extreme conditions (sea level rise, flooding, and other natural and security-related man-made impacts)	Same	N/A

MassDOT = Massachusetts Department of Transportation. N/A = Not applicable or available.

Source: Boston Region MPO.

CAPACITY MANAGEMENT AND MOBILITY GOAL AREA

As a result of outreach and analysis, staff believed that while the Capacity Management and Mobility goal required little modification, the objectives required some rearrangement and minor modifications. Staff believed that many of the region's needs were covered under the *Charting Progress to 2040* goals and objectives.

The revision to the *Charting Progress to 2040* goal to "increase transportation options" reflects analysis as well as public input that the MPO should promote transit, walking, and biking while attempting to support congestion mitigation. It should also remain flexible in the face of emerging technologies and mobility paradigms such as connected and autonomous vehicles and transportation network companies such as Uber and Lyft.

In addition, the MPO must respond to a wide variety of federal performance metrics, as well as values and mandates that derive from state-level legislation. The updates to the Capacity Management and Mobility goals and objectives were intended to capture public input and new MPO commitments, as well as to align the objectives better with the MPO's role in the transportation planning process.

Charting Progress to 2040 and *Destination 2040* Goal

- ***Charting Progress to 2040 Goal:*** *Use existing facility capacity more efficiently and increase healthy transportation capacity*
- ***Destination 2040 Changes:*** *Use existing facility capacity more efficiently and increase transportation* ***options***

Charting Progress to 2040 and *Destination 2040* Objectives

As mentioned earlier, Table E-3 contains an additional column that allowed the MPO and staff to review the objectives by mode to determine if all areas are being addressed. This led to a change in the order of the listed objectives.

Table E-3
Capacity Management and Mobility Objectives

Mode	*Charting Progress to 2040* Objective	*Destination 2040* Objective	Rationale
All	Improve access to/ accessibility of transit and active transportation modes	Improve access to and accessibility of **all modes, especially** transit and active transportation	Accessibility of transportation modes, especially new/emerging modes, is a major concern for many in MPO region (learned from outreach). Accessibility objectives are also included in the transportation equity and economic vitality goal areas
Roadway	Implement roadway management/operations strategies, constructing improvements to bicycle/ pedestrian network, and supporting community-based transportation	**Support implementation of** roadway management and operations strategies **to improve travel reliability, mitigate congestion, and support non-single-occupant vehicle travel options**	Focuses text on MPO's role (capital investment rather than management/ operations). Also incorporates reliability objectives of federal PBPP
Roadway	Emphasize capacity management through low-cost investments; prioritize projects that focus on lower-cost operations/ management-type improvements such as intersection improvements, Complete Streets solutions	Emphasize capacity management through low-cost investments; prioritize projects that focus on lower-cost operations/ management-type improvements such as intersection improvements, **transit priority**, and Complete Streets solutions	Links roadway objective to transit reliability objective by including transit priority as a low-cost improvement concept
Transit	Improve reliability of transit	Same	N/A
Transit	Increase percentage of population and employment within one-quarter mile of transit stations and stops	Same	N/A
Transit/ Accessibility	Support community-based and private-initiative services and programs to meet last-mile, reverse commute, and other non-traditional transit/ transportation needs, including those of people 75 years old or older and people with a disability	Support community-based and private-initiative services and programs to meet **first-/ last-**mile, reverse commute, and other non-traditional transit/transportation needs, including those of people 75 years old or older and people with a disability	Corrects term to include first- as part of the first-/last-mile service

Mode	*Charting Progress to 2040* Objective	*Destination 2040* Objective	Rationale
Transit/ Parking	Increase automobile and bicycle parking capacity and usage at transit stations	**Support strategies to better manage** automobile and bicycle parking capacity and usage at transit stations	Qualifies language to suggest MPO wants to support concepts such as remote parking shuttles/ empty lot leases rather than constructing new spots
Bicycle/ Pedestrian	Create connected network of bicycle and accessible sidewalk facilities (both regionally and in neighborhoods) by expanding existing facilities and closing gaps	**Fund improvements to bicycle/pedestrian networks aimed at** creating a connected network of bicycle and accessible sidewalk facilities (both regionally and in neighborhoods) by expanding existing facilities and closing gaps	Focuses text on MPO's role of funding capital investments
Bicycle	Increase percentage of population and places of employment with access to bicycle facilities	Increase percentage of population and places of employment with access **to facilities on the bicycle network**	Links to the previous objective and clarifies that bicycle facilities are most valuable when connected in a network
Freight	Eliminate bottlenecks on freight network	Eliminate bottlenecks on freight network/**improve freight reliability**	Incorporates freight reliability objectives of federal PBPP
Freight/ Intermodal	Enhance intermodal connections	Enhance **freight** intermodal connections	Specifies freight intermodal connection

N/A = Not applicable or available. MPO = Boston Region Metropolitan Planning Organization. PBPP = Performance-based planning and programming process.

Source: Boston Region MPO.

TRANSPORTATION EQUITY GOAL AREA

The *Destination 2040* changes to the goals and objectives for Transportation Equity reflect

- Public input and analyses documented in the Needs Assessment;
- Federal Transit Administration (FTA) and Federal Highway Administration (FHWA) Title VI, environmental justice (EJ), and other nondiscrimination guidance; and
- Consideration of all equity populations[1] in all aspects of the MPO's planning and decision-making process beyond people who identify as minority or are members of low-income households.

[1] Equity populations are populations that are protected by Title VI, EJ, or other nondiscrimination mandates: people who identify as minority, have limited English proficiency, are 75 years old or older or 17 years old or younger, or have a disability; or are members of low-income households.

The changes tie the equity goal more closely with the other MPO goals, recognizing that equity is integral to all MPO activities. To that end, the MPO also considers the effects of its investments on equity populations in the context of the other goal areas, even if they are not stated as objectives—for example, this could include analyzing the safety effects on equity populations.

Because of themes that have emerged as part of the Needs Assessment, staff proposed to add two new objectives—improved accessibility for people with a disability and investments to support transportation needs of the elderly (people 75 years old or older) and youth (people 17 years old or younger) populations in the region. While transportation needs of the elderly and youth populations, and people with a disability, are encompassed in other objectives, their prominence in the Needs Assessment suggests that they deserve particular attention. In addition, the region's elderly population is projected to increase.

The *Charting Progress to 2040* goal and objectives were refined to focus on the potential effects—whether benefits or burdens—of MPO investments on equity populations. This change reflects the MPO's recent and planned work that examines the potential benefits and burdens associated with MPO investments. In addition, the objective related to public outreach was removed because the goals and objectives are concerned with transportation system outcomes, rather than the MPO's planning processes. This change in no way reflects the MPO's commitment to ensuring that all people have meaningful opportunities to be engaged in MPO activities. Instead, this commitment will be described in detail in a revised MPO Public Participation Plan, and documented in the public outreach process for the LRTP, *Destination 2040*.

The changes to the *Charting Progress to 2040* goal and objectives also brought them into alignment with guidance from FHWA and FTA by clarifying which equity populations are covered and by expanding the populations that are covered to include all equity populations, per federal guidance. The *Charting Progress to 2040* goal and objectives refer only to minority and low-income populations, whereas FTA and FHWA recommend including all populations protected by federal mandates throughout the entire MPO planning process.

Charting Progress to 2040 and *Destination 2040* Goal

- ***Charting Progress to 2040 Goal:*** *Provide comparable transportation access and service quality among communities, regardless of income level or minority population*
- ***Destination 2040 Changes: Ensure that all people receive comparable benefits from, and are not disproportionately burdened by, MPO investments, regardless of race, color, national origin, age, income, ability, or sex***

Charting Progress to 2040 and *Destination 2040* Objectives

Table E-4
Transportation Equity Objectives

Charting Progress to 2040 Objective	*Destination 2040* Objective	Rationale
Target investments to areas that benefit high percentage of low-income and minority populations	**Prioritize MPO investments that benefit equity populations***	Focuses on effects of transportation on people, rather than on where people live; people who live near a project may not necessarily benefit from it. Also, the populations covered by this objective are expanded to include all equity populations, as recommended by federal guidance
Minimize any burdens associated with MPO-funded projects in low-income/ minority areas	**Minimize potential harmful environmental, health, and safety effects of MPO-funded projects for all equity populations***	States types of effects that will be addressed, which relate directly to other MPO goal areas. Also, the populations covered by this objective are expanded to include all equity populations, as recommended by federal guidance
Break down barriers to participating in MPO-decision making	Delete	Because goals/objectives relate to transportation system outcomes, this and other process-oriented objectives will be described in future revisions to MPO's Public Participation Plan and included in public-outreach chapter of *Destination 2040*
N/A	**Promote investments that support transportation for all ages (age-friendly communities)**	A new objective based on results of the needs assessment; transportation needs of youth and elderly populations emerged as a major theme
N/A	**Promote investments that are accessible to all people regardless of ability**	A new objective based on results of the needs assessment; ensuring that all people have access to transportation regardless of ability emerged as a major theme

* Equity populations include people who identify as minority, have limited English proficiency, are 75 years old or older or 17 years old or younger, or have a disability; or are members of low-income households.

N/A = Not applicable or available. MPO = Boston Region Metropolitan Planning Organization.

Source: Boston Region MPO.

CLEAN AIR/CLEAN COMMUNITIES GOAL AREA

Staff proposed to change the name of the goal area from Clean Air/Clean Communities to Clean Air/**Sustainable** Communities, as "Sustainable Communities" could include more types of environmental initiatives. The MPO agreed with this change. Staff proposed changes to the objectives to include other regional and state plans and policies that were being implemented in the region regarding climate change.

Charting Progress to 2040 and *Destination 2040* Goals

- ***Charting Progress to 2040 Goal*:** *Create an environmentally friendly transportation system*
- ***Destination 2040 Changes***: *No changes*

Charting Progress to 2040 and *Destination 2040* Objectives

Table E-5
Clean Air/Sustainable Communities Objectives

Charting Progress to 2040 Objective	*Destination 2040* Objective	Rationale
Reduce GHG emissions generated in Boston region by all transportation modes as outlined in the GWSA	Reduce greenhouse gases generated in Boston region by all transportation modes	Change makes reduction of GHG emissions broader than those addressed in the GWSA; this would cover all work undertaken in the region and Commonwealth
Reduce other transportation-related pollutants	Same	N/A
Minimize negative environmental impacts of the transportation system	Same	N/A
Support land use policies consistent with smart and healthy growth	Support land use policies consistent with smart, healthy, and **resilient** growth	Change adds resilient to refer to clean energy policies

GHG = greenhouse gas. GWSA = Global Warming Solutions Act. N/A = Not applicable or available.

Source: Boston Region MPO.

ECONOMIC VITALITY GOAL AREA

After conducting analysis and outreach concerning the region's needs, staff found that the majority of concerns were addressed in the *Charting Progress to 2040* Economic Vitality goal and objectives. However, staff proposed a change to one objective based on public input regarding the workforce population—that it should be inclusive of all populations. Other changes include the incorporation of freight as an important part of targeted development, inclusion of *Focus40* "Priority Places" as targeted development sites and the reference to the regional land use plan.

Charting Progress to 2040 and *Destination 2040* Goals

- ***Charting Progress to 2040 Goal**: Ensure our transportation network provides a strong foundation for economic vitality*
- ***Destination 2040 Changes**: No changes*

Charting Progress to 2040 and *Destination 2040* Objectives

Table E-6
Economic Vitality Objectives

Charting Progress to 2040 Objective	*Destination 2040* Objective	Rationale
Respond to mobility needs of 25–34-year-old workforce	Respond to mobility needs of the **workforce population**	Objective should address mobility needs of all populations in the workforce including older adults, youth, persons with disabilities, and equity populations, not just the 25–34-year-old age group.
Minimize burden of housing/ transportation costs for residents in the region	Same	N/A
Prioritize transportation investments that serve targeted development sites	Prioritize transportation investments that serve **residential, commercial, and logistics** targeted development sites **and "Priority Places" identified in MBTA's *Focus 40* plan**	This identifies types of targeted development to include freight as an important part of economic activity. Included "Priority Places" based on a comment received during the public comment period.
Prioritize transportation investments consistent with compact-growth strategies of MetroFuture	Prioritize transportation investments consistent with compact-growth strategies of **the regional land use plan**	Changed MetroFuture to "the regional land use plan" since this plan is currently being updated as MetroCommon 2050.

N/A = Not applicable or available.

Source: Boston Region MPO.

CONCLUSION

The MPO discussed the proposed changes to the vision, goals, and objectives at its November 15, 2018, meeting. The proposed changes were made available for public comment and the MPO conducted a survey to solicit feedback. At the MPO's meeting on January 17, 2019, after reviewing public comments and survey responses, the MPO agreed to the revised vision, goals, and objectives. The MPO will use the revised vision and goals to guide all of its planning efforts and investment decisions.

appendix F

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