

**REVERSE
COMMUTE
AREAS
ANALYSIS**



Reverse Commute Areas Analysis

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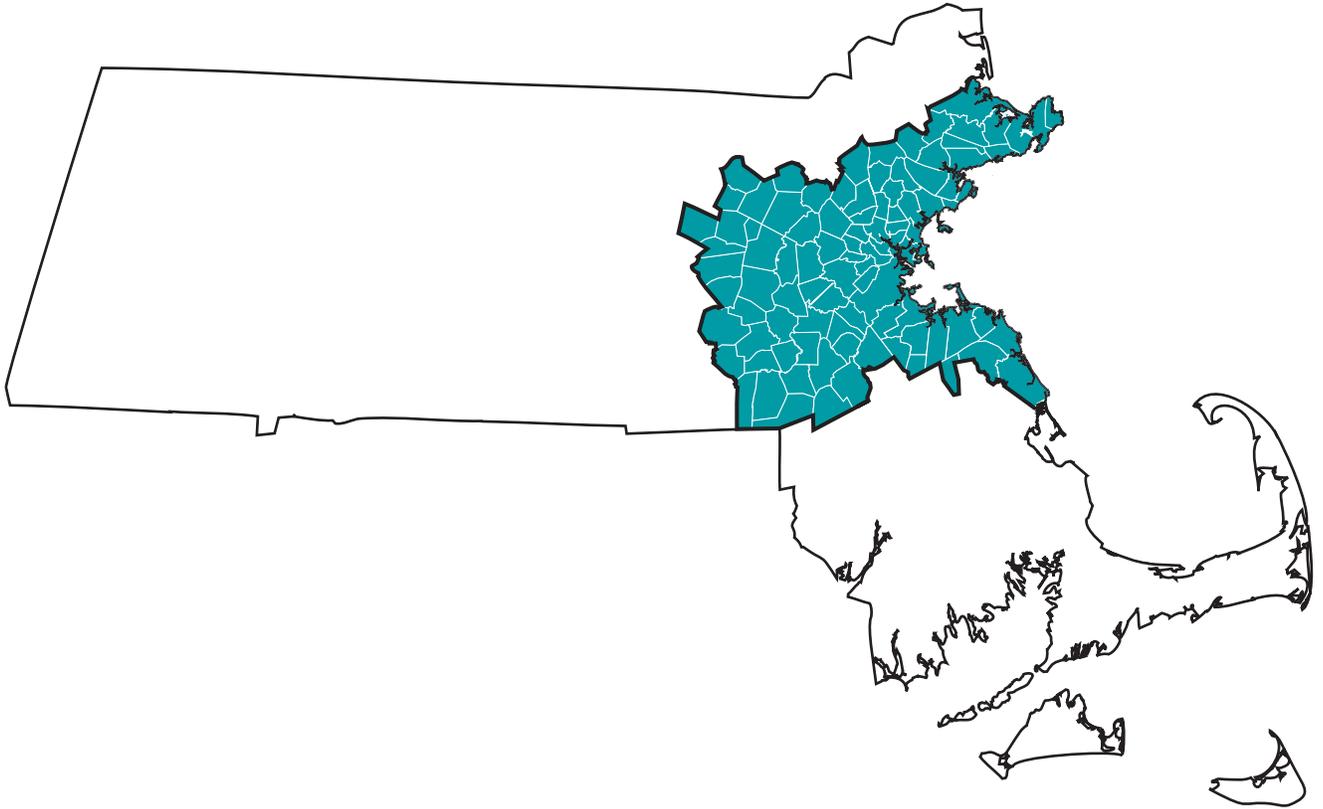
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Abstract

The term *reverse commuting* refers to trips made by residents of a major urban area, such as Boston, to and from work locations in its suburbs—the opposite direction from traditional commuting patterns. This report analyzes reverse commuting in the Boston region. The US Census Bureau’s data show that 15.4 percent of all commuting trips in the region are reverse commutes, but relatively few of these trips are made by transit. This report contains case studies about reverse commuting from the urban core to the suburbs of Burlington, Needham, Waltham, and Woburn, all of which have large concentrations of jobs. Each case study discusses existing transit options, barriers to accessing suburban employment locations from the urban core, and potential means of reducing these barriers. Finally, this report reviews existing Guaranteed Ride Home programs, which can help to assure commuters who use transit instead of personal vehicles that they will not be stranded if faced with the need to return home from work during hours the transit service is not operating.

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Executive Summary

ES.1 REVERSE-COMMUTING SHARE OF WORK TRIPS IN THE BOSTON REGION

For purposes of this study, the 97 cities and towns in the Boston Region Metropolitan Planning Organization (MPO) area were divided into seven groups, identified as the urban core and the Northeast, North, Northwest, West, Southwest, and Southeast subregions. Reverse-commuting trips were defined as trips from homes in Boston or other core cities and towns to work locations in any of the subregions, or trips from homes outside the core to work locations farther from the core within the same subregion.

There is no source of completely accurate and up-to-date information about the number of home-to-work trips in the Boston region. For this study, the US Census Bureau's Longitudinal Employer-Household Dynamics (LEHD) reports for the year 2015 were the source of data for identifying the origins and destinations, at the town-to-town level, of commuters making home-to-work trips. For certain cities and towns, LEHD reports at the census tract or zip code area level also were a resource.

According to the LEHD results, reverse-commuting trips, as defined above, accounted for 15.4 percent of all work trips entirely within the Boston region and 22.2 percent of work trips from the city of Boston to destinations in the subregions in 2015. The destinations on these trips were widely dispersed; only six municipalities in the subregions attracted more than 1.0 percent of reverse commuters from Boston and none attracted more than 2.5 percent.

The US Census Bureau's LEHD data were not sufficient to determine the means of travel for all the home-to-work trips, however. The US Census Bureau's American Community Survey (ACS) reports, which contain data obtained by different methods than that of the LEHD reports, do show travel modes for home-to-work trips, but this information is based on small samples with large margins of error.

To determine the specific transit modes commuters used on their journeys to work, recent passenger boarding and alighting counts for transit services and the results of the Massachusetts Bay Transportation Authority's (MBTA) 2015–17 systemwide passenger survey were analyzed. In general, existing transit options were found to capture only small shares of work trips from Boston to the six subregions.

ES.2 CASE STUDIES OF REVERSE COMMUTING IN THE BOSTON REGION

Based on the findings about reverse-commuting patterns and dense employment locations in the Boston region, two cities and two towns were selected for more detailed analysis. The selected communities were Woburn, Burlington, Waltham, and Needham. Census data show that these four communities have the largest concentrated employment areas in the Boston region outside the urban core. None of the four municipalities has heavy rail rapid transit service, but each has one or more office parks that account for large shares of the reverse commuters from Boston.

The primary objectives of the case studies were to identify barriers to worker access from the urban core to employment locations in the study areas and to recommend ways to reduce the barriers.

ES.2.1 Woburn Case Study

In Woburn, the heaviest concentration of employment is in census Tract 3336, which includes all of the city north of Route 128 (Interstate 95). This tract accounts for 46.4 percent of all jobs in Woburn and 43 percent of reverse-commuting work trips from Boston to Woburn. Most of the jobs in this tract are located in the eastern half, which is served by two commuter rail stations on the MBTA's Lowell Line.

In Boston, the only boarding location for the Lowell Line is North Station, but the LEHD reports indicate that only approximately six percent of the 1,107 trips to Tract 3336 in 2015 originated within a 20-minute walk of that station. If made entirely by transit, approximately 94 percent of the trips would require the use of one or two rapid transit lines to access North Station. In some cases a bus connection to the initial rapid transit line would also be needed.

On a sample weekday in 2018, there were 81 AM peak outbound alightings at the two commuter rail stations combined, although some of these passengers may not have been going from home in Boston to work in Tract 3336. Many of the employers in this tract are within walking distance of one of the stations, but no shuttle connections are provided. Improving pedestrian and bicycle access from the stations to the employment locations, potentially through a multi-use path along the railroad tracks, could increase the attractiveness of reverse commuting by transit.

ES.2.2 Burlington Case Study

In Burlington, the heaviest concentration of employment is in census Tract 3324, which is located on the southwest side of the town. The Burlington Mall, the

Lahey Hospital and Medical Center, and several office complexes are located in this tract. Transit access from the Boston area to the main employment locations in Tract 3324 is provided by MBTA bus Routes 350 and 351 from the Red Line rapid transit terminal at Alewife Station in Cambridge. Most of these employment locations are within walking distance of stops on one or both of the bus routes.

To access Route 350 or Route 351, Boston residents traveling entirely by transit would take the Red Line to Alewife Station. The LEHD results show that in 2015 approximately 25 percent of Boston residents commuting to Tract 3324 lived in a zip code area that had at least one Red Line station. However, not all of these residents lived within a 20-minute walking distance of the nearest station. Some would have started their trips by taking another MBTA service to the Red Line, and some would have used two transit services to reach the Red Line.

In 2018, average daily outbound AM peak alightings from bus Routes 350 and 351 in Tract 3324 totaled 175 riders. Provision of through bus service from downtown Boston to the employment locations along Burlington Mall Road is worth considering to provide more options for people to make reverse commutes to Burlington.

ES.2.3 Waltham Case Study

In Waltham, the largest concentration of jobs is in census Tract 3682. This tract is located on the west side of the city. It includes several office parks along both sides of Route 128 and others along the west end of Winter Street. Transit service that could be used for reverse commuting from Boston or other core cities and towns to the work locations in this tract is provided primarily by a combination of three shuttle routes operated by the 128 Business Council that run from Alewife Station. In 2018, these shuttles carried a combined total of approximately 130 outbound AM riders per day.

The LEHD results showed that approximately 17 percent of Boston residents employed in Tract 3682 in 2015 lived in a zip code area with at least one Red Line station. However, not all of them could have accessed the Red Line without use of a connecting form of transportation.

The MBTA express bus Route 170 from Roxbury, the South End, and Back Bay makes four stops in Waltham's Tract 3682. Passenger counts from 2018 showed approximately 19 passengers a day alighting at these stops and some of them may have boarded at stops in Newton or Waltham rather than in Boston.

ES.2.4 Needham Case Study

In Needham, the largest concentration of jobs is in census Tract 4035. This tract is located in the northern corner of Needham near the borders with the city of Newton and the town of Wellesley. The largest concentrations of employment within this tract are in the office parks and retail establishments located in the area bounded by Route 128 and the Newton border and Kendrick and Fremont Streets.

There is no direct MBTA transit service to the largest employment locations in Tract 4035. The minimum walking distance to any of these work locations from the Needham Heights commuter rail station is one mile. Passenger counts from a sample weekday in 2018 showed only eight outbound AM peak alightings at Needham Heights Station from all origins and for all trip purposes combined.

The 128 Business Council operates shuttle service to the largest office park in Tract 4035 from the Newton Highlands Station on the Green Line D Branch. In 2018, outbound AM ridership on this route averaged 107 passengers per day. However, some of these passengers may have come from locations other than Boston. Approximately six percent of Boston residents employed in Tract 4035 lived in zip code areas with stations on the Green Line D Branch.

An expanded bike-share program in Newton could provide an additional option for travel between Newton Highlands Station and the dense employment areas in Needham. Additionally, planned improvements to Needham Street in Newton to improve safety and encourage bicycle use could make reverse-commute trips by transit and bicycle more attractive.

ES.2.5 Conclusions

Because of the dispersed characteristics of suburban work locations and of homes of urban core residents who now reverse commute or might want to reverse commute to those work locations, it is difficult to provide reverse-commuting transit services that are efficient from an operations standpoint and do not require multiple transfers or long walking distances at one or both ends of a trip.

Suburban employers cannot successfully recruit transit-dependent employees if no transit is available, but the MBTA does not have the resources to implement new reverse-commuting services that could require years for ridership to build. At the last-mile end, employer-sponsored shuttles, such as those offered by the 128 Business Council, connecting with MBTA rapid transit or commuter rail lines are probably the best solution for serving employment locations beyond reasonable walking distance of fixed-route transit. However, for Boston residents or other

urban core residents without direct access to the transit lines these shuttles connect with, the need to make several transfers may discourage those considering reverse commuting by transit.

ES.3 REVIEW OF GUARANTEED RIDE HOME PROGRAMS

Transit services for reverse commuting often provide schedules suitable for travel from home to work in the AM peak hours and from work to home in the PM peak hours, but little or no service is offered during middays or after the end of PM peak hours. Such service patterns may prevent use of the transit service by commuters who are worried about being able to return home in the middle of the day in case of emergency or in the evening if required to work overtime. However, it is not cost-effective for transit operators to add midday or evening service that may be rarely used. Guaranteed Ride Home (GRH) or Emergency Ride Home (ERH) programs can provide substitute transportation for commuters who find that they must unexpectedly return home from work at times when their usual transit services do not run.

A literature review revealed many similarities and few differences between GRH/ERH programs currently offered in Greater Boston and those described in a study sponsored by the Federal Transit Administration (FTA) in 2007. Most GRH/ERH programs are run by transportation management associations (TMAs) or other employer associations rather than by individual employers. Most employees of participating businesses or organizations are eligible to register for GRH/ERH programs, but there are restrictions about how they may use the program.

In general, to be eligible for a GRH/ERH service a commuter must commit to using a mode of transportation other than driving a single-occupant vehicle to travel to and from work a specified number of days per week and the commuter must have traveled to work by that mode on the day that the GRH/ERH trip was requested. Most programs consider travel by transit, carpool, vanpool, bicycling, and walking as acceptable alternatives to driving.

The need for a commuter to use GRH/ERH service must have been unforeseen at the time the commuter went to work. Most programs place a limit on the number of times per year that an individual may use a GRH/ERH service. These limits typically range from four to six trips.

GRH/ERH transportation is most often provided by taxi or rideshare companies approved by the program operator. The cost of trips is usually paid for by the program operator, but commuters may be required to pay for amounts above

specified limits. Some programs provide commuters with rental cars instead of taxis or other ride-share vehicles.

The FTA study found that most GRH/ERH programs serve more to reassure commuters that they will not be stranded at work than to provide actual emergency transportation. During the one year studied, fewer than five percent of commuters who were registered in GRH/ERH programs made use of them. Therefore, the cost to employers relative to other employee benefits was not substantial.

In each municipality that was the focus of a case study, some form of GRH/ERH program was already in place. However, many of the employers in these cities and towns are not members of the associations that offer these programs.

Chapter 1—Reverse Commuting in the Boston Region

1.1 BACKGROUND

The term *reverse commuting* usually refers to trips made by residents of a major urban area, such as Boston, to and from work locations in its suburbs—the opposite direction from the traditional commuting pattern. Some counter-flow work trips by residents of nearby urbanized areas could also be classified as reverse commuting.

The Massachusetts Bay Transportation Authority's (MBTA) 2015–17 systemwide passenger survey revealed that travel to or from work was the most common trip purpose for MBTA users, accounting for 73 percent of all trips on the system. Of the reported work ends of these trips, 90 percent were in Boston or Cambridge, compared to 40 percent of the work-trip destinations for all transportation modes combined. These results suggest that for many work trips to destinations outside of Boston or Cambridge the existing transit system is not a practical option.

Anecdotally, some suburban areas within the Boston region with significant job concentrations are facing challenges filling jobs with local residents. Some of these jobs could potentially be filled by residents of the urban core who are prevented from doing so by a lack of transportation options.

This study examines the present magnitude of reverse commuting in the metropolitan Boston region, the limitations on such travel imposed by the transportation system, and potential strategies for making reverse commuting more feasible.

1.2 REVERSE COMMUTING FROM THE URBAN CORE

Usually, reverse commuting in the Boston region would be defined as trips from homes in Boston or other municipalities in the urban core to suburban work locations. The Boston urban core has been defined in various ways for past studies. In the present study, we define the core as Boston and the 13 surrounding cities and towns that constituted the old Metropolitan Transit Authority district: Arlington, Belmont, Brookline, Cambridge, Chelsea, Everett, Malden, Medford, Milton, Newton, Revere, Somerville, and Watertown.

This core area has more extensive transit coverage than most of the cities and towns in the rest of the Boston region. All of the core cities and towns except Arlington, Belmont, Chelsea, Everett, Milton, and Watertown have heavy or light

rail service that leads to downtown Boston. The six core municipalities with no heavy or light rail service to downtown Boston all have multiple feeder bus connections to the rapid transit system. In addition to feeder bus connections, Milton has a light rail connection to heavy rail; Chelsea has through transit service to downtown Boston via commuter rail, bus rapid transit, and local bus routes; and Watertown has express bus service to downtown Boston.

This study is limited to consideration of trips made entirely within the Boston region, the planning area of the Boston Region Metropolitan Planning Organization (MPO), which includes Boston and 96 other cities and towns in eastern Massachusetts. Because of MPO borders, historic town boundaries, and geographic features, the distance from downtown Boston to the outer border of the MPO area is not uniform in all directions.

For this study, the cities and towns in the Boston region outside the core are divided into six geographical subregions, mostly conforming to definitions used in past editions of the MBTA's Program for Mass Transportation. These subregions are identified as Northeast, North, Northwest, West, Southwest, and Southeast. Figure 1 shows the core and six subregions.

This study focuses on two types of reverse-commute trips:

- trips from homes in the core to work locations in a subregion
- trips from homes outside the core to work locations farther from the core within the same subregion

1.3 DATA SOURCES

Information about journey-to-work trips in the Boston region must be drawn from a combination of surveys, passenger counts, and traffic counts because no system exists for continuous tabulating of all such travel. The budget for the present study did not allow for any new surveys or counts to be conducted, so it was necessary to work with data previously compiled by Central Transportation Planning Staff (CTPS) and others.

1.3.1 American Community Survey Data

The US Census Bureau produces journey-to-work tabulations from two different sources, each of which requires some caveats. One source of these tabulations is the American Community Survey (ACS). For this survey, forms are sent to 2.5 percent of US households each year. To obtain statistically acceptable sample sizes, it is necessary to combine ACS results in five-year increments. At this time, the most recent five-year data set available is based on survey results from the years 2009 through 2013.

The ACS results for journey-to-work trips between each selected home area and work area pair are published as estimates projected from the survey samples with margins of error (MOE) expressed as absolute numbers. The MOE values are calculated using statistical formulas related to sample size and survey population. In general, the greater the actual number of work trips between an origin and destination pair, the more accurate estimates of total trips and of trips by mode of travel based on ACS samples are likely to be. However, because of different sample sizes, some municipalities have higher ratios of MOE to total estimates than other municipalities with similar total estimates.

A sample with a large MOE that overstates the amount of travel between two places may lead to excessive resources being allocated to planning or implementing transit improvements in the corridor. Conversely, a sample with a large MOE that understates the amount of travel between two places may conceal a promising opportunity for transit improvements.

The total sample of work trips to a given municipality is composed of responses from all origins with at least one work trip to that municipality. Statistically, the absolute MOE in an estimate of total work trips to a municipality should be smaller than the aggregate absolute MOE for all individual home origins of those trips. However, potential transit improvements affect specific origin and destination pairs, so aggregate values are the more useful MOE measure for preliminary screening of subregions.

For origin-destination pairs with any reported home-to-work trips, the ACS figures include breakdowns of the estimated totals by transportation mode and the MOE for each mode. The choices of reported modes are *drove alone*, *carpooled*, *transit*, and *other mode* (including alternatives such as walking or biking). For reverse-commuting trips from Boston to the majority of other cities and towns in the Boston region, driving alone or carpooling account for a much larger share than all transit modes combined. Because the existing transit system is oriented for travel to and from downtown Boston, the overall transit share of work trips from the other 13 cities and towns in the core to each of the six subregions is even lower than the transit share from Boston alone. The transit share of work trips within each subregion is lower than the shares of trips from Boston and from the rest of the core.

1.3.2 Longitudinal Employer-Household Dynamics Data

The second source of journey-to-work tabulations produced by the US Census Bureau is the Longitudinal Employer-Household Dynamics (LEHD) reports. The data underlying these reports are based on Unemployment Insurance earnings data and Quarterly Census of Employment and Wages data that states share with the Census Bureau.

Unlike the ACS reports, which produce estimates from samples, the LEHD reports are essentially counts of workers, with some exceptions, and the data are not adjusted to control totals. LEHD databases do not include data on self-employed workers, who do not file Unemployment Insurance Reports, and they do not include information about certain security-sensitive jobs. Some work locations shown in the LEHD reports are based on employers' corporate headquarters rather than the actual work locations of all employees.

For the purposes of this study, LEHD reports of volumes of home-to-work trips at the town, census tract, or zip code level were preferable to ACS reports. However, the sources of LEHD data do not provide any information about modes of travel to work. Some references to transit shares shown in ACS reports are included as rough estimates of transit use, but they are too imprecise to state as values.

1.3.3 MBTA Passenger Counts

The majority of cities and towns in the Boston region have some form of transit connection with Boston, but not all have service at times appropriate for reverse commuting. Transit alternatives vary among cities and towns, but may include heavy rail rapid transit, light rail, bus rapid transit, feeder bus to some other form of transit, MBTA express bus, private carrier express bus, or commuter ferry.

Passenger counts by station or stop are available for most MBTA services. These counts do not indicate passengers' trip purposes. However, if it is assumed that the majority of passengers making reverse-commute trips to work would need to arrive before 9:30 AM, counts of outbound alightings before that time can serve as upper bounds on estimates of transit use for such trips.

1.3.4 MBTA Systemwide Passenger Survey

The most recent MBTA systemwide passenger survey was conducted between 2015 and 2017. The target numbers for responses from users of each MBTA service mode were based on all-day ridership totals, but there were no targets for responses by time of day. Depending on total ridership and on response rates to previous surveys, the service units for which targets were set ranged from individual stations to route segments, entire routes, and groups of routes serving the same neighborhoods.

Outbound AM peak and inbound PM peak ridership accounts for a small share of all-day ridership on most MBTA services. In general, the number of responses from passengers traveling in the lower-volume direction at each time of day was insufficient to provide accurate breakdowns of trip purposes. However, the responses from most routes showed that not all passengers traveling outbound in AM peak hours or inbound in PM peak hours were making reverse-commuting work trips.

1.4 EXISTING JOURNEY-TO-WORK PATTERNS

The ACS employment estimates discussed in this section are those from the five-year summary file based on surveys conducted in the years 2009 through 2013. These were the most recent ACS results available at the time this study was conducted.

1.4.1 Comparisons of Reverse-Commuting Trips in the Boston Region with Total Home-to-Work Trips

For overviews of commuting patterns in Massachusetts, ACS and LEHD tabulations do not differ significantly. The travel volumes in the following sections of this chapter are based on the 2015 LEHD tabulations, but estimates of percentages of workers using transit are based on the 2009–13 ACS results.

Distribution of Jobs in Massachusetts

According to the LEHD results, 3,409,845 workers were employed in Massachusetts in 2015. Of these, 3,153,829 (92.5 percent) also resided in Massachusetts.

The city of Boston had by far the largest estimated individual share of job locations in the state, with 621,665 (18.2 percent), followed by Cambridge with 121,790 (3.6 percent), and Worcester with 104,768 (3.1 percent).

Table 1 summarizes the distribution of jobs in Massachusetts held by residents of all states.

**Table 1
Distribution of Jobs in Massachusetts**

Location	Jobs
City of Boston	621,665
City of Cambridge	121,790
Other Boston Region Municipalities	1,240,306
Total Jobs in Boston Region	1,983,761
City of Worcester	104,768
Other Massachusetts Municipalities	1,321,316
Total Jobs in Massachusetts	3,409,845

Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

Distribution of Home and Work Locations in the Boston Region

This study is concerned primarily with work trips made entirely within the 97 cities and towns in the Boston region. According to the LEHD figures shown in Table 1, of all the jobs in Massachusetts, 1,983,761 (58.2 percent) were located within the Boston region. Of these jobs, 1,866,657 (94.1 percent) were held by Massachusetts residents, a share slightly greater than the 92.5 percent of all Massachusetts jobs held by Massachusetts residents.

Of the jobs in the Boston region, 1,406,407 (70.9 percent) were held by residents of the region. The city of Boston contained 488,885 (34.8 percent) of the jobs in the region that were held by residents of the region.

Table 2 summarizes the distribution of the jobs in the Boston region that were held by residents of the region.

Table 2
Distribution of Boston Region Work Locations of Boston Region Residents

Work Location	Boston Residents	Other Core Residents	Subregion Residents	Total Boston Region Residents
City of Boston	176,374	126,433	186,078	488,885
Other Core Municipalities	54,439	121,461	103,136	279,036
Municipalities in Subregions	65,910	88,185	484,391	638,486
Total Boston Region Employment	296,723	336,079	773,605	1,406,407

Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

Distribution of Work Locations of Boston and Other Core Residents

Of all the jobs in the Boston region held by residents of the region, 296,723 (21.1 percent) were held by city of Boston residents. Of these jobs, 176,374 (59.4 percent) were also within the city of Boston. Of the other 120,349 Boston region jobs held by Boston residents, 54,439 were in the other 13 core cities and towns, and 65,910 were in the six subregions beyond the core. The latter group is of interest for this reverse-commuting study. This group represented 10.3 percent of the 638,486 jobs within those subregions held by Boston region residents.

Residents of the other 13 core cities and towns held 336,079 (23.9 percent) of the jobs within the Boston region held by residents of the region. Of these jobs, 126,433 (37.6 percent) were in the city of Boston, 121,461 (36.1 percent) were in other core cities and towns, and 88,185 (26.2 percent) were in the subregions beyond the core. Travel between some of the core cities and towns and some of the cities and towns in the subregions would be made by traveling though parts of Boston.

Distribution of Work Locations of Other Boston Region Residents

Of the total jobs in the Boston region held by residents of the region, an estimated 773,605 (55.0 percent) were held by residents of cities and towns beyond the core. Of these jobs, an estimated 186,078 (24.1 percent) were in the city of Boston, 103,136 (13.3 percent) in other core cities and towns, and 484,391 (62.6 percent) in non-core cities and towns.

Overall, of the 484,391 jobs in non-core cities and towns held by non-core residents, 123,458 (25.5 percent) were held by people residing and working in the same city or town. The remaining 360,933 jobs (74.5 percent) were held by people residing in one Boston region city or town outside the core and working in another Boston region city or town outside the core. There were 5.5 times as many jobs that people were reverse commuting to between cities and towns outside the core as there were people reverse commuting to jobs from the city of Boston to cities and towns outside the core.

For purposes of this study, reverse-commuting trips within the Boston region but outside the core are defined as trips from a home location to a work location in the same subregion farther from Boston along either a commuter rail line, another transit route, or a highway corridor. Based on that definition, 62,640 (12.9 percent) of the trips entirely in the non-core area would be classified as reverse-commuting trips.

Table 3 summarizes the existing reverse-commute trips in the Boston region.

Table 3
Reverse-Commute Trips to Jobs Outside the Core Area

Trip Origin	Number of Reverse-Commute Trips	Percent of Reverse- Commute Trips
City of Boston	65,910	30.4
Other Core Municipalities	88,185	40.7
Municipalities in Subregions	62,640	28.9
Total in MPO Area	216,735	100.0

Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

1.4.2 Reverse-Commuting Trips by Subregion

The ACS figures show that transit trips represent very small shares of all home-to-work trips in each of the six subregions outside the core, including both reverse-commuting and non-reverse commuting trips. For many of these trips there are no transit options. The six subregions are discussed below in descending order of the total number of reverse-commute trips made to that subregion from origins in the Boston region. For each subregion, work trips entirely within that subregion are discussed first, followed by the reverse-commuter share of those trips, the number of trips from Boston, and the number of trips from the rest of the core.

Northeast Subregion

As defined for this project, the Northeast subregion consists of Beverly, Danvers, Essex, Gloucester, Hamilton, Ipswich, Lynn, Lynnfield, Manchester, Marblehead, Middleton, Nahant, Peabody, Rockport, Salem, Saugus, Swampscott, Topsfield, Wenham, and Winthrop. These municipalities are all beyond the limits of the heavy and light rail systems.

Beverly, Gloucester, Hamilton, Ipswich, Lynn, Manchester, Rockport, Salem, Swampscott, and Wenham all have commuter rail service from Boston. Beverly, Danvers, Lynn, Lynnfield, Marblehead, Nahant, Peabody, Salem, Saugus, Swampscott, and Winthrop have MBTA local bus service connecting either with commuter rail or with heavy rail rapid transit. Lynn, Marblehead, Salem, and Swampscott also have some through bus service from downtown Boston at times suitable for reverse commuting.

In the 2015 LEHD results, the Northeast subregion had the largest total number of reverse-commute trips, 48,715. These trips amounted to 35.1 percent of all commuting trips to work locations in the subregion.

Of the 98,359 total work trips entirely within the Northeast subregion, 27,493 (28.0 percent) were reverse-commute trips based on the definition used in this study. The ACS data suggests that 3.0 percent of reverse-commute trips in this subregion were made by transit. By far the largest number of reverse-commute trips within the subregion originated in Lynn, 10,153. The ACS results indicate that approximately 5.9 percent of reverse-commute trips from Lynn were made by transit, including 4.0 percent going to cities and towns connected with Lynn by commuter rail. However, on a sample weekday in 2018 commuter rail passenger counts showed only 47 passengers boarding outbound trains in Lynn in the AM peak and 179 all day.

The LEHD results show that Boston residents made 7,141 work trips to the Northeast subregion. The ACS results suggest that at least 3.1 percent and at most 16.0 percent of trips from Boston to the Northeast subregion were made by transit. The present transit options for reverse-commuting from Boston to this subregion consist of the Newburyport/Rockport commuter rail line from North Station, the Blue Line with a transfer to a bus at Wonderland Station, MBTA bus Routes 426 or 450 from Haymarket Station, and MBTA bus Routes 448 or 449 from Downtown Crossing or South Station.

The commuter rail passenger counts from a sample weekday in 2018 showed 181 passengers boarding outbound AM peak Newburyport/Rockport Line trains

at North Station for all trip purposes, including 161 passengers traveling at least as far as Lynn.

The MBTA’s 2018 automated passenger counter (APC) data from buses showed an average of 62 passengers boarding outbound AM peak North Shore express buses in Boston daily on weekdays and 242 passengers boarding outbound AM peak buses at Wonderland Station destined for Lynn or points farther north. These results do not show trips purposes or actual trip origins and destinations.

The LEHD results show that residents of the other 13 core cities and towns made 14,081 work trips to the Northeast subregion. The ACS results suggest that at most 5.6 percent of work trips from the other core municipalities were made by transit. Almost all of the transit trips from the core outside Boston originated in cities and towns northeast or north of Boston.

Table 4 summarizes the traditional and reverse-commute trips to the Northeast subregion.

Table 4
Commute Trips to the Northeast Subregion from within the Boston Region

Trip Origin	Traditional-Commute Trips	Reverse-Commute Trips	Total Trips	Reverse-Commute Percent
Northeast Subregion	70,866	27,493	98,359	28.0
City of Boston	N/A	7,141	7,141	100.0
Other Core Municipalities	N/A	14,081	14,081	100.0
Other Subregions	19,127	N/A	19,127	0.0
Boston Region Trip Origins	89,993	48,715	138,708	35.1

Note: N/A = Not applicable.
Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

North Subregion

For purposes of this study, the North subregion consists of Burlington, Melrose, North Reading, Reading, Stoneham, Wakefield, Wilmington, Winchester, and Woburn. All except Burlington, North Reading, and Stoneham have commuter rail service. Burlington and Stoneham have MBTA bus service connecting to rapid transit, and Burlington also has MBTA express bus service connecting to downtown Boston. North Reading has no transit service.

In the 2015 LEHD results, the North subregion had the second-largest total number of reverse-commute trips, 37,819. These trips amounted to 37.6 percent

of all commuting trips to the subregion. This was the largest reverse-commute percentage of the subregions (along with the Northeast subregion, which also had a reverse commute rate of 37.6 percent).

Of the 33,875 total work trips entirely within the North subregion, 7,549 (22.3 percent) were reverse-commute trips. The ACS results suggest that 1.2 percent of reverse-commute trips entirely within the North subregion were made by transit.

The LEHD results show that Boston residents made 9,229 work trips to the North subregion. The ACS results suggest that the transit share of work trips from Boston to the North subregion was between 2.8 and 12.7 percent.

Residents of the other 13 core cities and towns made 21,041 work trips to the North subregion. The ACS results suggest that at as many as 7.6 percent of work trips from the core outside Boston to this subregion were made by transit. However, the actual transit share was probably much lower because most such trips would have to be made by first traveling into Boston or Cambridge. Destinations in Burlington and Woburn, discussed in greater detail in the case studies, account for the largest shares of work trips from the core outside Boston to the North subregion.

Table 5 summarizes the traditional and reverse-commute trips to the North subregion.

**Table 5
Commute Trips to the North Subregion from within the Boston Region**

Trip Origin	Traditional-Commute Trips	Reverse-Commute Trips	Total Trips	Reverse-Commute Percent
North Subregion	26,326	7,549	33,875	22.3
City of Boston	N/A	9,229	9,229	100.0
Other Core Municipalities	N/A	21,041	21,041	100.0
Other Subregions	36,318	N/A	36,318	0.0
Boston Region Trip Origins	62,644	37,819	100,463	37.6

Note: N/A = Not applicable.
Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

Northwest Subregion

For purposes of this study, the Northwest subregion consists of Acton, Bedford, Bolton, Boxborough, Carlisle, Concord, Lexington, Lincoln, Littleton, Maynard, Stow, Waltham, and Weston. Acton, Concord, Lincoln, Littleton, Waltham, and Weston have commuter rail service from Boston. Waltham also has MBTA bus connections from rapid transit and express bus service from downtown Boston. Bedford and Lexington also have MBTA bus connections from rapid transit. Maynard has a locally sponsored shuttle service to the South Acton commuter rail station. Bolton, Boxborough, Carlisle, and Stow have no transit service.

In the 2015 LEHD results, the Northwest subregion had the third-largest number of reverse-commute trips, 36,674. These trips amounted to 37.6 percent of all commuting trips to the subregion.

Of the 27,150 total work trips entirely within the Northwest subregion, 3,225 (11.9 percent) were reverse-commute trips. The ACS results suggest that 1.5 percent of the reverse-commute trips entirely in the Northwest subregion were made by transit.

The LEHD results show that Boston residents made 11,630 work trips to the Northwest subregion. The ACS results suggest that the transit share of work trips from Boston to the Northwest subregion was between 8.9 and 16.5 percent.

Residents of the other 13 core cities and towns made 21,819 work trips to the Northwest subregion. The ACS results suggest that between 0.6 percent and 7.6 percent of work trips from the core cities around Boston to the Northwest subregion were made by transit.

In the LEHD results, trips to Waltham and Lexington accounted for more than 70 percent of the work trips to the Northwest subregion from Boston and from the core outside Boston.

Table 6 summarizes the traditional and reverse-commute trips to the Northwest subregion.

Table 6
Commute Trips to the Northwest Subregion from within the Boston Region

Trip Origin	Traditional-Commute Trips	Reverse-Commute Trips	Total Trips	Reverse-Commute Percent
Northwest Subregion	23,925	3,225	27,150	11.9
City of Boston	N/A	11,630	11,630	100.0
Other Core Municipalities	N/A	21,819	21,819	100.0
Other Subregions	37,008	N/A	37,008	0.0
Boston Region Trip Origins	60,933	36,674	97,607	37.6

Note: N/A = Not applicable.
Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

Southeast Subregion

For purposes of this study, the Southeast subregion consists of Braintree, Cohasset, Hingham, Holbrook, Hull, Marshfield, Norwell, Quincy, Randolph, Rockland, Scituate, and Weymouth. Braintree and Quincy have heavy rail rapid transit service, but all the other cities and towns in the subregion are beyond the limits of the heavy and light rail systems. All except Hull, Marshfield, Norwell, and Rockland have commuter rail service. Braintree, Hingham, Holbrook, Hull, Quincy, Randolph, and Weymouth have MBTA local bus service connecting with rapid transit and/or commuter rail service. Hingham and Hull also have commuter ferry service.

In the 2015 LEHD results, the Southeast subregion had the fourth-largest total number of reverse-commute trips, 34,406. These trips amounted to 36.7 percent of all commuting trips to the subregion.

Of the 54,656 total work trips entirely within the Southeast subregion, 11,454 (21.0 percent) were reverse-commute trips. The ACS results suggest that 3.9 percent of these trips were made by transit. The majority of these transit trips would have originated in Quincy with approximately half destined for Braintree, based on the share of reverse-commute trips in the Southeast subregion originating in Quincy, the origin-destination combinations that can reasonably be made by transit, and AM peak transit boarding and alighting counts. Quincy and Braintree are connected by Red Line rapid transit service and MBTA bus service.

The Middleborough/Lakeville and Kingston/Plymouth commuter rail lines also serve the Quincy Center and Braintree Stations; most trains stop at one station or the other but not both. The passenger counts for a sample weekday in 2018 showed only 32 passengers boarding outbound AM peak trains at Quincy and

Braintree Stations, and some of them may have been bound for destinations beyond the limit of the Southeast subregion.

The LEHD results show that Boston residents made 13,952 work trips to the Southeast subregion. The ACS results suggest that the transit share of trips from Boston to the Southeast subregion was between 17.5 percent and 22.5 percent. These unusually large values were attributable mostly to trips from Boston to Quincy and Braintree. The ACS results show that there were likely no transit trips from Boston to Hingham, Hull, Holbrook, Marshfield, Norwell, or Scituate.

The LEHD results show that residents of the other 13 core cities and towns made 9,000 work trips to the Southeast subregion. The ACS results suggest that the transit share of trips from these core communities to the Southeast region may have been as great as 17.2 percent. Almost all of the estimated transit trips from the core outside Boston to the Southeast subregion were destined for Quincy, Braintree, Weymouth, or Hingham.

Table 7 summarizes the traditional and reverse-commute trips to the Southeast subregion.

**Table 7
Commute Trips to the Southeast Subregion from within the Boston Region**

Trip Origin	Traditional-Commute Trips	Reverse-Commute Trips	Total Trips	Reverse-Commute Percent
Southeast Subregion	43,202	11,454	54,656	21.0
City of Boston	N/A	13,952	13,952	100.0
Other Core Municipalities	N/A	9,000	9,000	100.0
Other Subregions	16,228	N/A	16,228	0.0
Boston Region Trip Origins	59,430	34,406	93,836	36.7

Note: N/A = Not applicable.
Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

West Subregion

For purposes of this study, the West subregion consists of Ashland, Dover, Framingham, Holliston, Hopkinton, Hudson, Marlborough, Natick, Needham, Sherborn, Southborough, Sudbury, Wayland, and Wellesley. These are all beyond the limits of the heavy and light rail rapid transit systems. Ashland, Framingham, Natick, Needham, Southborough, and Wellesley all have commuter rail service from Boston, and Southborough Station is on the border of Hopkinton. Needham is the only one of these communities with MBTA bus

service, but Framingham, Holliston, Hopkinton, Hudson, Marlborough, Natick, Southborough, and Wayland have MetroWest Regional Transit Authority bus service that connects with commuter rail and/or light rail service.

In the 2015 LEHD results, the West subregion had the fifth-largest total number of reverse-commute trips, 33,579. These trips amounted to 28.3 percent of all commuting trips to the subregion. The West subregion had the second-largest total number of work trips of the subregions but the smallest percentage of reverse-commute trips.

Of the 52,748 total work trips entirely within the West subregion, 7,480 (14.2 percent) were reverse-commute trips. The ACS results suggest that only 0.2 percent of these trips were made by transit.

The LEHD results show that Boston residents made 12,189 work trips to the West subregion. The ACS results suggest that the transit share of these trips was between 1.9 and 6.4 percent.

The Worcester commuter rail line connects Boston with several municipalities in the West subregion, and the Needham commuter rail line connects Boston with Needham, also in the West subregion. The commuter rail counts from a sample weekday in 2018 showed a total of 243 passengers on board outbound AM peak Worcester Line trains leaving the last station in Boston, and these trains did not serve any intermediate stops before entering the West subregion. The counts showed 59 passengers on outbound AM peak Needham Line trains leaving the last station in Boston.

Another transit alternative for travel to Needham is to take the Green Line D Branch to Newton Highlands and MBTA bus Route 59 to Needham. The 2018 APC counts showed an average of 75 passengers boarding Route 59 buses at Newton Highlands Station heading in the direction of Needham in the AM peak but did not show how many of these passengers transferred from the Green Line, nor did they show passengers' origins, destinations, or trip purposes.

The LEHD results show that residents of the other 13 core cities and towns made 13,910 work trips to the West subregion. The ACS results suggest that at most 4.8 percent of trips from the core outside Boston were made by transit. However, the actual transit share was probably much lower because most transit riders traveling from the other 13 core cities and towns would need to make connections in Boston to reach the West subregion.

Table 8 summarizes the traditional and reverse-commute trips to the West subregion.

Table 8
Commute Trips to the West Subregion from within the Boston Region

Trip Origin	Traditional-Commute Trips	Reverse-Commute Trips	Total Trips	Reverse-Commute Percent
West Subregion	45,268	7,480	52,748	14.2
City of Boston	N/A	12,189	12,189	100.0
Other Core Municipalities	N/A	13,910	13,910	100.0
Other Subregions	39,795	N/A	39,795	0.0
Boston Region Trip Origins	85,063	33,579	118,642	28.3

Note: N/A = Not applicable.
Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

Southwest Subregion

For purposes of this study, the Southwest subregion consists of Bellingham, Canton, Dedham, Foxborough, Franklin, Medfield, Medway, Milford, Millis, Norfolk, Norwood, Sharon, Walpole, Westwood, and Wrentham. These towns are all beyond the limits of heavy and light rail service. Canton, Dedham, Franklin, Norfolk, Norwood, Sharon, Walpole, and Westwood all have commuter rail service from Boston. Canton, Dedham, Norwood, Walpole, and Westwood also have MBTA bus service that connects to rapid transit or light rail stations.

In the 2015 LEHD results, the Southwest subregion had the smallest total number of reverse-commute trips, 25,542. These trips amounted to 28.6 percent of all commuting trips to the subregion, which was similar to the percentage of reverse-commute trips in the West subregion.

Of the 42,588 total work trips entirely within the Southwest subregion, 5,439 (12.8 percent) were reverse-commute trips, but no transit share was shown for such trips in the ACS results.

The LEHD results show that Boston residents made 11,769 work trips to the Southwest subregion. The ACS results suggest that the transit share of work trips from Boston to the Southwest subregion was between 7.5 and 13.4 percent.

Residents of the other 13 core cities and towns made 8,334 work trips to the Southwest subregion. The ACS results suggest that at most 2.7 percent of trips from the core outside Boston to this subregion were made by transit.

Table 9 summarizes the traditional and reverse-commute trips to the Northeast subregion.

Table 9
Commute Trips to the Southwest Subregion from within the Boston Region

Trip Origin	Traditional-Commute Trips	Reverse-Commute Trips	Total Trips	Reverse-Commute Percent
Southwest Subregion	37,149	5,439	42,588	12.8
City of Boston	N/A	11,769	11,769	100.0
Other Core Municipalities	N/A	8,334	8,334	100.0
Other Subregions	26,539	N/A	26,539	0.0
Boston Region Trip Origins	63,688	25,542	89,230	28.6

Note: N/A = Not applicable.
Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

Chapter 2—Case Studies of Reverse Commuting in the Boston Region

2.1 SELECTION OF CASE STUDIES

The purpose of this study was to identify employment locations where residents of the urban core make reverse commutes to work, and then understand the barriers that prevent other such workers from accessing suburban employment opportunities and consider ways to reduce these barriers. The 2015 LEHD results showed that some work trips from Boston or other cities and towns in the urban core, as defined in Chapter 1, were made to each of the cities and towns in the subregions outside the core. However, there were large ranges in the absolute numbers of such trips and in the shares that such trips represented of total employment in these cities and towns.

When selecting locations for case studies, staff expected that the most promising areas would be ones where there were large concentrations of jobs and large numbers of workers traveling to these jobs from Boston and other communities in the core, but where existing transit services attracted only small shares of these trips. Thus, the four municipalities selected for the case studies are located in subregions with the largest total number of reverse-commute trips.

Outside the core, the greatest number of dense employment concentrations, as shown on the US Census Bureau's online application *OnTheMap*, are located along state highway Route 128 (Interstate 95), which runs through five of the six subregions, from Gloucester in the Northeast to Canton in the Southwest. The largest of these concentrated employment areas are in Burlington, Needham, Waltham, and Woburn.

It is not coincidental that the densest employment concentrations outside the core are all along this highway. Real-estate developers bought large tracts of mostly vacant land along the highway when it was built in the 1950s and promoted these tracts as sites for new light industrial developments and office parks. The expectation was that jobs in these developments would be filled mostly by suburban residents who would arrive by car and take advantage of acres of free parking. Little thought was given to providing public transportation for workers, regardless of their home locations.

Over time, most of the one-story buildings where low-density manufacturing and warehousing activity occurred in these developments were replaced by new multi-story office buildings. Now employers at these sites require a large pool of

workers to fill the available jobs in these developments, and reverse commuters from the Boston urban core are part of that pool.

2.2 WOBURN CASE STUDY

2.2.1 Overview of Work Travel to Woburn

The city of Woburn is located in the North subregion of the Boston region. The shortest distance by highway from downtown Boston to the center of Woburn is 12.0 miles via Interstate 93 and local roads.

The 2015 LEHD figures show a total of 43,901 jobs in Woburn, including 26,333 (60.0 percent) held by residents of the Boston region and 18,088 (41.2 percent) held by residents of subregions outside the urban core. Of the jobs in Woburn held by residents of subregions, 3,449 (19.1 percent) were held by Woburn residents. For comparison, of a total of 484,391 work trips from homes in the subregions to work locations in the subregions, 123,458 (25.5 percent) were made by people living and working in the same municipality. These figures show that Woburn employers must rely to an above-average extent on attracting workers from other cities and towns to fill their jobs.

Table 10 summarizes the home locations of people employed in Woburn.

Table 10
Home Locations of People Employed in Woburn

Table with 3 columns: Home Location, Number of Woburn Employees, Percent of Woburn Employees. Rows include City of Boston, Other Core Municipalities, Other Subregions, Total in Boston Region, Outside Boston Region, and Total Employment in Woburn.

Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

The LEHD figures do not indicate modes of travel; however, the ACS figures suggest that at most 4.8 percent of work trips from Boston to Woburn were made by transit. From the rest of the urban core, the ACS figures suggest that as many as 6.3 percent of work trips to Woburn were made by transit. Passenger counts from 2018 showed that an average of 110 passengers alighted daily at the MBTA bus stops in Woburn during the weekday AM peak period, excluding passengers who also boarded within Woburn. A one-day commuter rail passenger count in 2018 showed a combined total of 94 outbound AM peak alightings at the two

commuter rail stations in Woburn. However, the bus and train counts did not show passengers' trip origins or trip purposes.

2.2.2 Travel to Densest Employment Concentration in Woburn

Woburn Employment Locations by Census Tract

Woburn has seven census tracts, as shown in Figure 2. Table 11 shows the distribution of jobs in Woburn census tracts. As the table shows, 86.8 percent of jobs in the city are concentrated in three of the seven tracts.

Table 11
Distribution of Woburn Employment by Census Tract

Census Tract	Employment	Percent of Woburn Employment
Tract 3336	20,351	46.4
Tract 3335.01	10,998	25.1
Tract 3334	6,713	15.3
Other Four Tracts*	5,839	13.3
Total	43,901	100.0%

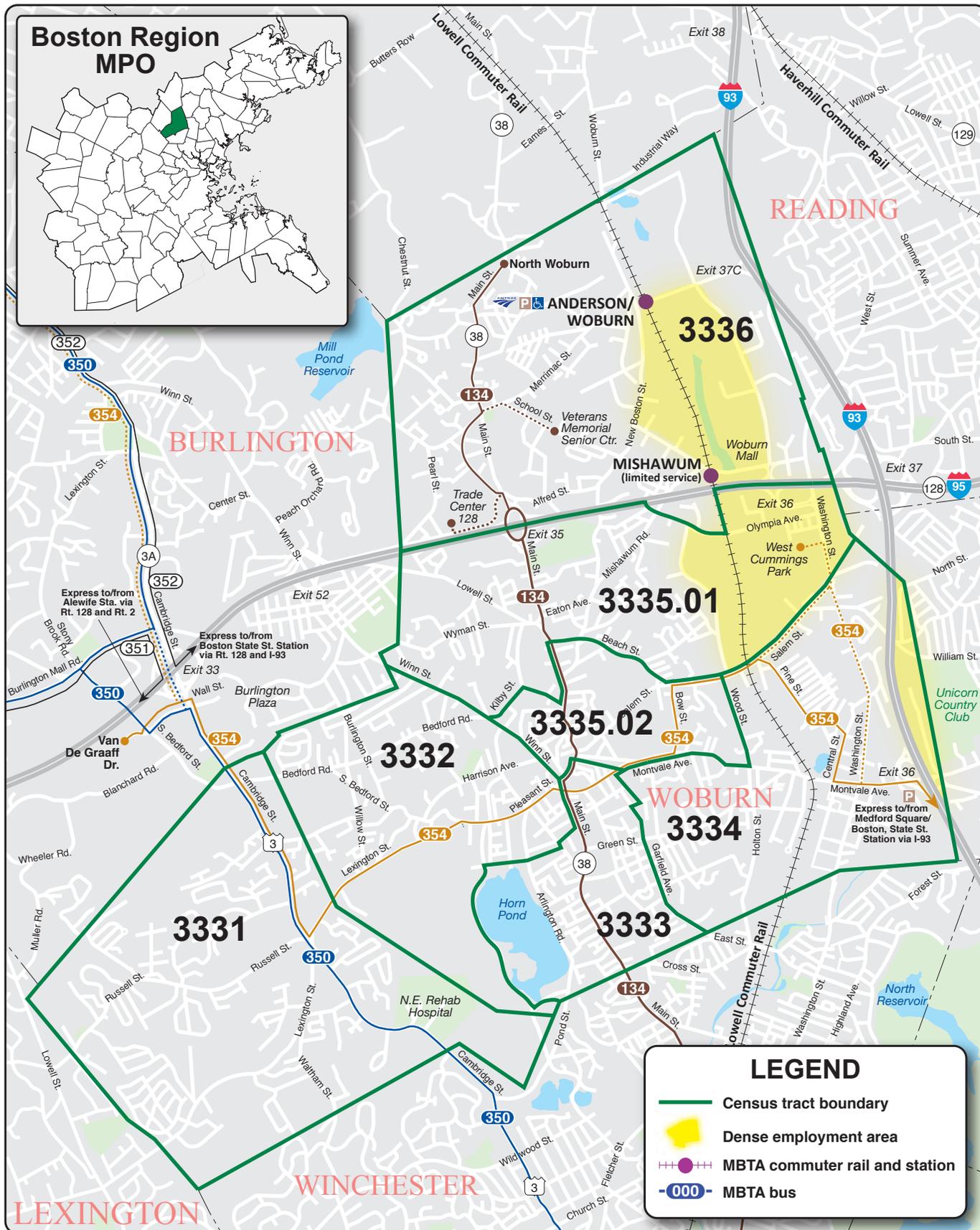
*Note: The other four tracts are numbered 3331, 3332, 3333, and 3335.02.
Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

The home locations of workers employed in the three Woburn census tracts with the largest number of jobs were distributed across a number of cities and towns. The city of Boston accounted for the largest individual share of workers employed in each of these tracts, with 1,107 (5.4 percent) of Tract 3336 workers, 793 (7.2 percent) of Tract 3335.01 workers, and 393 (5.9 percent) of Tract 3334 workers.

The job locations within each of these three census tracts are not uniformly distributed. The densest employment areas are shown on Figure 2. In Tract 3336, the heaviest concentration of jobs is in the area north of Route 128, bounded to the east by Commerce Way, to the north by Atlantic Avenue, and to the west by Industrial Parkway and New Boston Street as far north as Merrimac Street.

In Tract 3335.01, the heaviest concentration of jobs is in the area between Wildwood Avenue and the border of Stoneham north of Salem and Cedar Streets. However, in the middle of this area is a large undeveloped tract in the flood plain of the Aberjona River.

In Tract 3334, the heaviest concentration of employment is in an office park between Interstate 93 and the border of Stoneham. A hotel at the north end of the office complex employs some Boston residents.



BOSTON
 REGION
 MPO

FIGURE 2
Woburn Census Tracts and Existing Transit Service
Reverse Commute Areas Analysis

*Reverse Commute
 Areas Analysis*

Commuter Rail Access Options

Mishawum Station on the Lowell commuter rail line is located in Tract 3336, a short distance north of Route 128. Service to the station is currently suited to reverse commuters as three outbound AM peak trains and three inbound PM peak trains are scheduled to stop there. The scheduled trip time from North Station to Mishawum Station is 23 minutes on each train. Although the station is within walking distance of many of the employment locations in Tract 3336, CTPS's one-day passenger counts in 2018 showed only ten passengers alighting from each of the first two outbound AM trains and 19 alighting from the third train. Most of the employment locations in the section of Tract 3336 south of Route 128 are not within convenient walking distance of Mishawum Station by authorized routes, but in the 2018 counts and in CTPS's 2012 counts it was noted that some passengers exited the station by walking along the railroad tracks.

The primary commuter rail station in Woburn is the Anderson Regional Transportation Center (RTC), also in Tract 3336. It is one mile north of Mishawum Station along the tracks, but twice as far away by road. There are many more employment locations within walking distance of Mishawum Station than there are within walking distance of Anderson RTC.

The scheduled AM peak trip time from North Station to Anderson RTC ranges from 19 to 24 minutes, depending on the number of intermediate stops. All outbound AM peak trains on the Lowell Line stop at Anderson RTC. In the one-day counts in 2018, alightings at Anderson RTC from the six trains scheduled to stop there before 9:30 AM totaled 55, compared with 39 alightings at Mishawum Station from the three trains that also stopped there. Only 20 of the 55 alightings at Anderson RTC were from trains that also stopped at Mishawum Station.

Boston residents taking commuter rail to Woburn board at North Station. Those living in neighborhoods other than downtown Boston must use some intermediate form of transportation to access North Station and must allow for delays if they need to connect with specific trains to arrive at work on time.

All three outbound AM peak trains that stop at Mishawum Station and one other AM peak train that stops at Anderson RTC also stop at West Medford Station in the core city of Medford. These same trains also stop at Wedgemere and Winchester Center Stations in the North subregion town of Winchester. According to the one-day counts in 2018, a total of 25 passengers boarded these trains at West Medford Station and seven at the two stations in Winchester. However, the counts did not determine whether any passengers who boarded in Medford or Winchester alighted at Mishawum Station or Anderson RTC.

The LEHD results showed that there were 833 work trips in 2015 from Medford to Woburn, including 342 to Tract 3336, and 478 from Winchester to Woburn, including 171 to Tract 3336. These results are not broken down by mode of travel. The ACS results suggest that only 0.2 percent of work trips from Medford to Woburn and no trips from Winchester to Woburn were made by transit.

Other Transit Access Options

Other than the commuter rail line, the only through transit service between Boston and Woburn is that of MBTA express bus Route 354. This route originates at State Street in downtown Boston and makes two other stops in Boston in the Government Center area. Before entering Woburn it makes one intermediate stop, at Medford Square. The outer end of the route is in Burlington at Van De Graff Drive, a short distance beyond the Woburn border. Stops in Woburn include one on Montvale Avenue by Interstate 93 near the south end of the office park in Tract 3334 and one at 400 West Cummings Park in the dense employment area in Tract 3335.01. Five outbound trips arrive at these stops before 9:00 AM and five inbound trips depart between 3:30 PM and 6:30 PM. Scheduled times in the outbound direction from State Street to 400 West Cummings Park range from 28 to 36 minutes.

APC figures from spring 2018 show that on average there were 49 passengers boarding the outbound AM peak Route 354 trips in Boston and 11 at Medford Square, and no Medford alightings on most days. Alightings from these trips averaged only five per day on Montvale Avenue at Interstate 93 and 20 per day at 400 Cummings Park. The APC results do not show where the passengers boarded.

One additional transit alternative for travel between Boston and Woburn is to take the rapid transit Orange Line to Wellington Station and transfer to MBTA bus Route 134, which runs to North Woburn via Medford Square, Winchester Center, and Woburn Center. This route does not serve the densest employment areas in Woburn. The scheduled AM peak time from Wellington to Woburn Center ranges from 23 to 40 minutes depending on expected traffic conditions and intermediate route variations. The scheduled AM peak outbound time on the Orange Line to Wellington Station is eight minutes from North Station, but many Boston residents would have to make longer Orange Line trips to reach Wellington Station.

Four Route 134 trips arrive in Woburn before 9:30 AM. APC figures from spring 2018 showed an average of 72 passengers boarding these buses at Wellington Station, but their starting points are unknown. There are many intermediate stops

in Medford and Winchester before the Route 134 bus enters Woburn. There were an average of 63 passengers on board at the border of Winchester and Woburn.

It is also possible to travel from Boston to Woburn by taking the rapid transit Red Line from Boston to Alewife Station and transferring to MBTA bus Route 350. However, this route passes through the west side of Woburn which is mostly residential and where there are few employment opportunities.

Travel Trade-off Example

Many factors, such as travel time and cost, affect employees' decisions about how to travel to work. One response to the MBTA's 2015–17 systemwide passenger survey from a passenger making a reverse-commuting trip from Boston to Woburn illustrates the obstacles to making such trips using transit.¹ From an outlying neighborhood, the respondent took a local MBTA bus to the Orange Line, rode to Wellington Station, and then took a Route 134 bus to a stop in Woburn Center. From there, an employer shuttle took the respondent the final 1.8 miles to the work location. The trip, as described, would have taken at least 89 minutes excluding wait and transfer times.

With present fares, the least expensive transit option for this trip for an adult would have been a monthly LinkPass, priced at \$90.00. Used for five round trips per week in an average month, the cost per trip would have been \$2.08 each way. This is the same as the cost of a rapid transit trip or a rapid transit and local bus trip within the core.

Making the same trip on the Route 354 bus from State Street would have reduced the travel time to approximately 72 minutes excluding wait and transfer times. However, the least expensive fare option would have been a monthly Outer Express Bus pass, priced at \$168.00. The trip would cost \$3.88 each way.

Traveling by commuter rail from North Station to Mishawum Station and transferring to a hypothetical employer shuttle connecting to the work location would have taken approximately 76 minutes excluding wait and transfer times. This trip would require a Zone 2 commuter rail monthly pass, currently priced at \$232.00. Used for five round trips a week in an average month, this trip would cost \$5.35 each way.

For the trip described above, the driving distance would be approximately 14 miles. According to Google Maps, the AM peak driving time would range from 24

¹ The MBTA's 2015–17 passenger survey did not generate enough responses from passengers making outbound AM peak or inbound PM peak trips on MBTA bus Route 134 to determine the percent traveling between homes in Boston and work locations in Woburn.

to 45 minutes depending on traffic conditions. Even a commute with the longest drive time would be significantly faster than the fastest transit alternative.

In 2018, the American Automobile Association (AAA) calculated the cost per mile for an owner of a medium-size sedan driven 15,000 miles a year at \$0.591. This cost estimate includes fuel, maintenance, repair and tires, insurance, license, registration and taxes, depreciation, and finance charges. This would make the fully allocated cost of a 14-mile reverse-commuting trip in a single-occupant vehicle \$8.27 each way, or 55 percent greater than the most expensive transit option described above.

The AAA figures do not factor in expenses for parking. Suburban employment locations typically provide free employee parking. Some Boston residents have free parking either on-street, in private driveways, or in parking spaces included in apartment rent, but some residents have to pay to park near their homes in Boston.

Workers who have the option of using transit or private transportation make trade-offs between travel time and travel cost, but they do not always consider the full cost of driving. For those with skills that can be applied at a variety of employment locations, the relative travel times and travel costs to these locations are also a consideration. Although driving from Boston to Woburn is more expensive than taking transit, the time savings are considerable, even in heavy traffic. Additionally, because many costs of private vehicle ownership are hidden, commuters who drive to work may underestimate the true cost of their commute.

First-Mile/Last-Mile Considerations at Home End

For most reverse commuters traveling between homes in Boston or other core cities and towns and work locations in Woburn, the transit alternatives described above could not provide one-vehicle service directly from home to work. The home locations of existing and potential reverse commuters are widely dispersed. Consequently, it would be difficult to offer cost-effective transit services that would be attractive to large shares of the reverse-commuting population.

In Boston, the only departure point for the commuter rail line is North Station. Bus Route 354 makes three stops in the Government Center area of downtown Boston, near the State, Government Center, and Haymarket rapid transit stations. The inner terminal of bus Route 134 is at Wellington Station, in Medford, which is on the rapid transit Orange Line.

It is possible to reach the departure points of all these routes via transit from every neighborhood in Boston, but in many cases the access trip would include a two- or three-vehicle ride, with some wait time for each vehicle and transfer time for all but the first link.

The LEHD results show that the home locations of the commuters who made the 1,107 trips from Boston to work locations in Tract 3336 in 2015 were dispersed among 28 Boston zip code areas. For these trips, commuter rail to Mishawum Station or Anderson RTC would be the most likely transit option. However, only approximately 70 of these trips originated at homes within a 20-minute walk of North Station.

The home locations of the 793 Boston residents employed in Tract 3305.01 and the 393 Boston residents employed in Tract 3334 were also dispersed throughout the city. For these trips, the main transit option would be MBTA bus Route 354. Only approximately 40 trips from Boston to Tract 3305.01 and 20 to Tract 3334 originated within a 20-minute walk of the Route 354 bus stops in Boston.

It is also possible to access the departure locations of the transit lines to Woburn from the other core cities and towns, but in many cases a commuter would have to travel in the opposite direction from Woburn to reach them.

Revere, Chelsea, and Everett are northeast of Boston and have bus connections to Wellington Station. Malden and Medford are north of Boston. Malden, which is east of Medford, has bus and Orange Line connections to Wellington Station, and bus connections to Routes 134 and 354 at Medford Square. Route 134 serves several stops in Medford and connects with other bus routes at Wellington, Medford Square, and West Medford.

Cambridge, Somerville, Arlington, and Belmont are northwest of Boston. All except Belmont have bus connections to Route 134 at Medford Square or West Medford, to Route 354 at Medford Square, and to the Lowell commuter rail line at West Medford.

The 2009–13 ACS figures did not show any transit trips to Woburn from Belmont, Cambridge, Everett, Malden, Milton, Newton, Revere, or Watertown. For the other five core communities, the estimated transit shares of work trips to Woburn ranged from 2.2 percent of the trips from Arlington to 12.5 percent of the trips from Chelsea. However, the MOE in the ACS transit estimate for each of these five origins was greater than the estimate, which indicates significant uncertainty in the transit shares.

First-Mile/Last-Mile Considerations at Work End

The Mishawum Station platforms are located below the Mishawum Road overpass. The outbound platform has stairs directly to the south side of the overpass, but they have been closed for several years because of their deteriorated condition. Therefore, outbound passengers must cross both tracks on a narrow paved strip to the inbound platform to reach the exits. The choices for entering or leaving the inbound platform are stairs or a long, four-tier wheelchair ramp. The tops of the stairs and ramp are at the parking lot of an office building and do not provide direct access to the street. The sidewalk from there to the street is indirect, but it is also possible to walk across a section of lawn and step over a guardrail to get to the street.

A short distance west of the station, Mishawum Road turns to the southwest while the main road to the employment areas continues northwest as Industrial Parkway. Low-rise office buildings line both sides of the latter road. A one-quarter mile walk on Industrial Parkway leaves a pedestrian near the intersection of Rath Road.

Industrial Parkway ends at New Boston Street, along which is a densely developed commercial and industrial area with multiple work locations. A pedestrian walking one-half mile from Mishawum Station will reach approximately the intersection of New Boston Street and Gill Street. There is more dense commercial and industrial development beyond on another half-mile section of New Boston Street to approximately the intersection of Sixth Road, including on several side streets off New Boston Street.

There are sidewalks on both sides of Mishawum Road and Industrial Parkway, but New Boston Street has a sidewalk only on the west side. Gill Street has a sidewalk on one side, but the other side streets have no sidewalks. The main roads have lighting from fixtures on utility poles at approximately 500-foot intervals. Gill Street and Sixth Road also have lighting, but the smaller side streets do not.

To the east of Mishawum Station, Mishawum Road ends at Washington Street, 0.4 miles from the station. Land use on both sides of the road is mostly retail, including Woburn Mall, which is being redeveloped. The main Woburn Post Office is on Washington Street, one-half mile from the station.

All the employment areas on the south side of Route 128, including the West Cummings Park office complex, are more than one-half mile from Mishawum Station, and most are at least three-quarters of a mile from the station. The sidewalk is interrupted by many curb cuts and wide intersections.

The Anderson RTC can be accessed only from the east side of the rail line, either by vehicles or pedestrians. The nearest railroad crossing is that of Mishawum Road at Mishawum Station. The shortest driving distance from Anderson RTC to the office and industrial area directly across the tracks from it is 2.9 miles, compared with 1.3 miles to the same location from Mishawum Station. A bridge is currently being designed to connect New Boston Street on either side of the railroad tracks, which would reduce the walking and driving distances from Anderson RTC to the industrial area west of the tracks. Most large employers on the east side of the rail line are more than a one-half mile walking distance from Anderson RTC.

Potential Last-Mile Improvements

Shuttle services from Mishawum Station or Anderson RTC to employment locations more than one-half mile from either station might attract some additional reverse commuters from Boston or other core cities and towns. This would require extensive ongoing efforts by the potential employers to inform potential workers of the availability of jobs and transportation as well as long-term commitments to maintain the shuttle services. Some subsidization of transit passes might also be needed.

Most of the streets within distances that most commuters would be willing to walk from the Mishawum or Anderson Stations already have sidewalks with lighting. However, several other streets in Woburn's areas with a concentration of employers include sidewalks but do not accommodate bicycle travel. Wide, high-demand streets such as Mishawum Road and Commerce Way should be restriped to narrow the width of the travel lanes and allow for the addition of bike lanes at least five-feet wide. Buffer space, ideally including vertical separation between bike lanes and vehicle traffic, should be included.

Washington Street features bike lanes near the on-ramp to Route 128, but improvements could be made by adding buffered bike lanes throughout the length of the roadway where it is wide enough. Furthermore, there are only sidewalks on the west side of Washington Street within Woburn's areas with a concentration of employers. The east side of the roadway should be prioritized for future sidewalk construction.

Olympia Avenue does not include bicycle or pedestrian accommodations. The right-of-way along Olympia Avenue measures approximately 50 feet in width, which would provide sufficient space to add two six-foot wide sidewalks, two six-foot wide bike lanes, and two three-foot wide buffers with lighting and vegetation

to separate travel modes, while maintaining two ten-foot wide vehicle travel lanes.

A pedestrian and bicycle path parallel with the commuter rail line could shorten the access distances from Mishawum Station to some employment areas, but it is not clear whether there is enough room within the right-of-way to allow for such a path at a distance from the tracks that would be acceptable to the MBTA.

The right-of-way necessary for a multi-use path next to an active rail line depends on many factors, including

- the speed and frequency of train travel, which affects the minimum distance required between the trail and active rail line; and
- the expected volumes and mix of pedestrian and bicycle users, which informs the minimum path width.

The grade of the path and design of rail crossings must also be taken into account when considering the feasibility of a multi-use path.

2.2.3 Woburn Case Study Summary

The section of Woburn with the largest concentration of employment is served by the Lowell Line's Mishawum commuter rail station, which is within walking distance of many of the large employers. Pedestrian and bicycle access from Mishawum to the employment locations could potentially be improved with a multi-use path along the railroad tracks. Woburn's other commuter rail station, Anderson RTC, is not within easy walking distance of major employers, so shuttles to employment areas would be needed to make the station useful for reverse commuters.

Commuter rail passengers bound for Woburn would board at North Station, which most Boston residents would access via the Green Line or the Orange Line, and many would need to first access those lines via local buses. Similarly, commuters who take MBTA buses to Woburn would first need to reach downtown Boston or Wellington Station. Whether they travel by train or bus, many residents of Boston and other core communities would have to take long, multi-link trips to access the largest concentrations of employment in Woburn.

2.3 BURLINGTON CASE STUDY

2.3.1 Overview of Work Travel to Burlington

The town of Burlington is located in the North subregion of the Boston region. According to Google Maps, the shortest highway distance from downtown Boston to the center of Burlington is 14.9 miles, mostly via roads with unrestricted

access. The fastest route, via Interstate 93, Route 128, and local roads is 16.4 miles.

The 2015 LEHD figures show a total of 48,138 jobs in Burlington, including 28,872 (60.0 percent) held by residents of the Boston region and 19,181 (39.8 percent) held by residents of the subregions. Of the jobs in Burlington held by residents of the subregions, 2,408 (12.6 percent) were held by Burlington residents. For comparison, 25.5 percent of all home-to-work trips with both ends in the subregions were made by people living and working in the same municipality, and 19.1 percent of home-to-work trips starting in subregions and ending in Burlington were made by Burlington residents. These figures indicate that Burlington employers must rely to a much greater extent than employers elsewhere in the subregions, including neighboring Woburn, on attracting workers from other cities and towns to fill their jobs.

Of the 28,872 jobs in Burlington held by residents of the Boston region, 3,201 (11.1 percent) were held by Boston residents and 6,490 (22.5 percent) were held by residents of other core cities and towns.

Table 12 summarizes the home locations of people employed in Burlington.

Table 12
Home Locations of People Employed in Burlington

Home Location	Number of Burlington Employees	Percent of Burlington Employees
City of Boston	3,201	6.6
Other Core Municipalities	6,490	13.5
Subregions	19,181	39.8
Total in Boston Region	28,872	60.0
Outside Boston Region	19,266	40.0
Total Employment in Burlington	48,138	100.0

Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

The LEHD figures do not indicate modes of travel; however, the ACS figures suggest that at most 15.8 percent of work trips from Boston to Burlington were made by transit. The ACS figures suggest that as many as 12.8 percent of work trips to Burlington from other municipalities in the core were made by transit. Burlington has no commuter rail service. Passenger counts in 2018 showed an average weekday total of 275 outbound AM peak alightings at all MBTA bus

stops in Burlington, excluding passengers who also boarded within that town. These counts did not show trip origins or trip purposes.

2.3.2 Travel to Densest Employment Concentration in Burlington

Burlington Employment Locations by Census Tract

Burlington has four census tracts, as shown on Figure 3. Table 13 shows the distribution of jobs in Burlington census tracts. The dense employment areas in Burlington are shown on Figure 3.

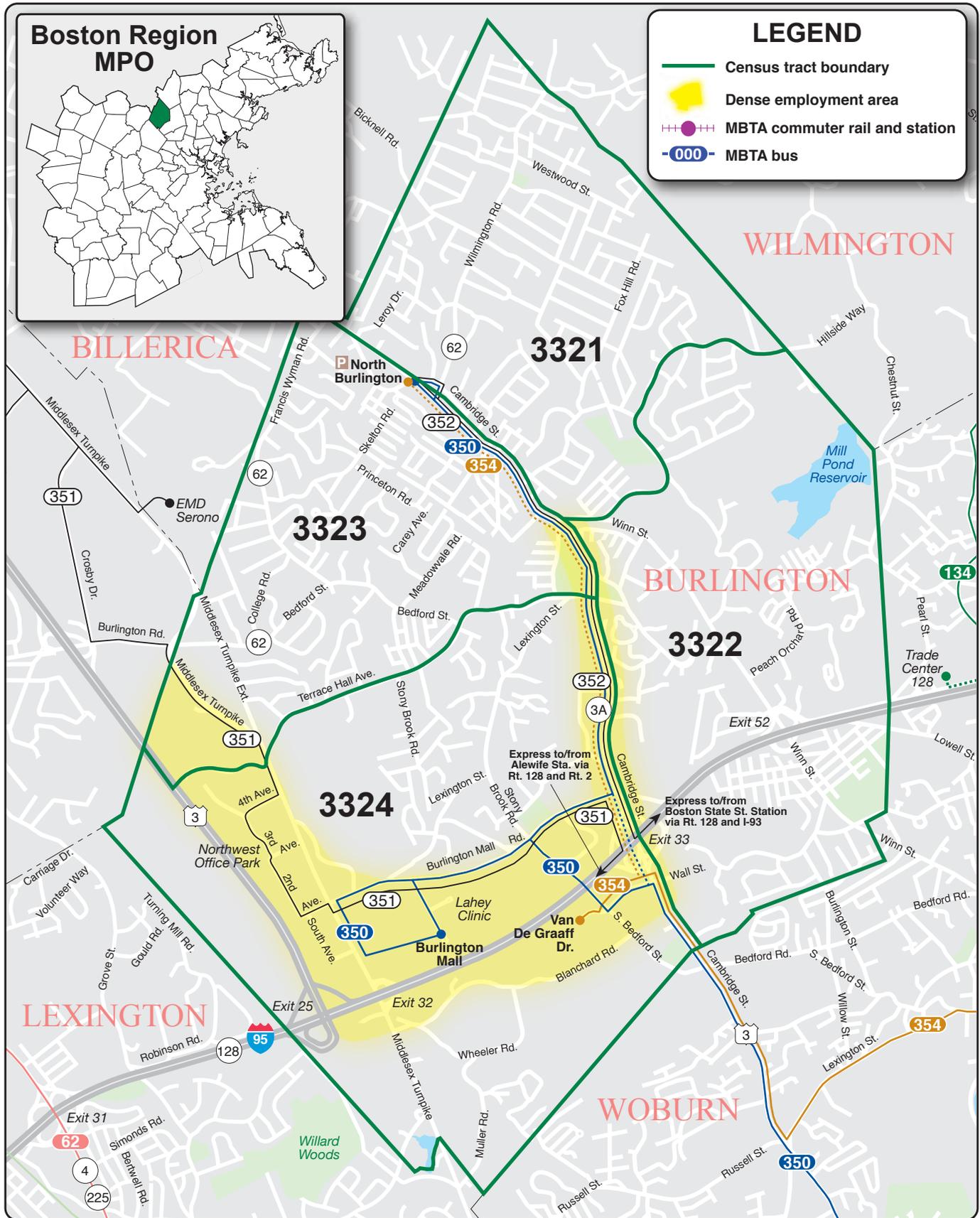
Table 13
Distribution of Burlington Employment by Census Tract

Census Tract	Employment	Percent of Burlington Employment
Tract 3324	34,530	71.7
Tract 3323	7,350	15.3
Tract 3322	5,471	11.4
Tract 3321	787	1.6
Total	48,138	100.0%

Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

Tract 3324 is located on the southwest side of Burlington. The Burlington Mall, the Lahey Hospital and Medical Center, and several office complexes are located in this tract. Tract 3323 adjoins the northwest side of Tract 3324. Employment in this tract is concentrated in an office complex near the border of Bedford. Tract 3322 is located on the northeast side of Tract 3324. Job locations in this tract are concentrated along Cambridge Street.

The home locations of workers employed in the three Burlington census tracts with the largest number of jobs were divided among a number of cities and towns. The city of Boston accounted for the largest individual share of workers employed in two of these tracts, 2,402 (7.0 percent) of Tract 3324 workers and 405 (5.5 percent) of Tract 3323 workers. Boston was the second-largest source of Tract 3322 workers, 369 (6.7 percent).



BOSTON REGION MPO

FIGURE 3
Burlington Census Tracts and Existing Transit Service

Reverse Commute Areas Analysis

Transit Access Options

Burlington has no direct commuter rail service or transit connections from commuter rail stations in other suburban communities. MBTA bus Route 354 from downtown Boston ends at Van de Graff Drive in Burlington, south of Route 128, but beyond convenient walking distance to the largest employment locations. APC figures from spring 2018 showed an average total of 15 alightings at Van de Graff Drive from the five outbound AM peak trips, but it is not known where these passengers boarded. Scheduled travel times from State Street in Boston to Van de Graff Drive range from 46 to 58 minutes.

There is no through bus service between downtown Boston and the work locations along Burlington Mall Road. MBTA bus Routes 350 and 351 both provide connections from the Red Line rapid transit terminal at Alewife Station to Burlington Mall Road at times suitable for reverse commuting.

Route 351 runs nonstop from Alewife Station to South Bedford Road in Burlington, so all passengers shown alighting on Burlington Mall Road in APC reports must have boarded at Alewife Station. However, it cannot be determined how many of these passengers were residents of Boston or other core communities who worked in Burlington. In 2018, the Route 351 schedule had four outbound AM peak trips. Spring 2018 APC results showed an average of 16 passengers per day alighting from all four trips combined at the stops along Burlington Mall Road. Most of the passengers on these buses continued to stops farther north in Burlington or Bedford. This included four stops in Burlington along Second, Third, and Fourth Avenues in Tract 3324 where the 2018 results showed a combined average total of 15 alightings a day. There was also one stop on Network Drive in Burlington in Tract 3323, where the counts showed an average of 14 alightings a day.

Route 350 travels on local roads and makes many intermediate stops between Alewife Station and Burlington Mall Road. It is not possible to determine from the APC reports how many Route 350 passengers were residents of Boston or other core cities and towns who worked in Burlington.

In 2018, the Route 350 schedule included six outbound AM peak trips between Alewife and points along Burlington Mall Road. Five of these trips continued to North Burlington. The spring 2018 APC results showed an average of 152 passengers a day alighting at stops along Burlington Mall Road from the six outbound AM peak trips combined. Based on the distribution of boardings and alightings before and after Burlington Mall Road, at least 68 of the passengers alighting along the Mall Road must have boarded at Alewife.

Route 350 trips in the AM peak that served the segment of Cambridge Street between Burlington Mall Road and Bedford Street had a combined average total of 15 alightings, according to the 2018 APC results. This segment of Cambridge Street forms the border between Tracts 3324 and 3322. Of these alightings, eight were at Rita Avenue, which is the nearest stop to one of the largest office complexes in Tract 3322.

The 2015 LEHD figures show that approximately 610 of the 2,402 Boston residents who were employed in Tract 3324 lived in one of the six Boston zip code areas with at least one Red Line station. However, not all of these residents lived within a 20-minute walking distance of the nearest station.

Published schedules for Route 350 do not include AM peak travel times from Alewife Station to Burlington Mall Road for most AM peak trips, but the time is shown as 38 minutes on two trips. Based on the distribution by zip code area of the homes of Boston residents working in Tract 3324, most of those traveling to Alewife Station on the Red Line would have to ride from at least as far as Broadway Station. The scheduled AM peak running time from Broadway Station to Alewife Station is 29 minutes. Excluding waiting and transfer times, the total travel time from Boston to Burlington Mall Road would be at least 67 minutes.

Published schedules for Route 351 do not show travel times from Alewife Station to Burlington Mall Road, but based on the travel time for the full length of the route the trip would take about 30 minutes, which would be eight minutes faster than Route 350.

A private shuttle from Alewife to an office complex near the Burlington Mall has trips arriving at 8:05 AM and 9:10 AM, with scheduled travel times of 35 minutes each. In June 2016, the most recent month for which ridership figures have been published, these two trips carried a combined average of 22 riders per day.

For a passenger commuting between Boston and the Burlington Mall area via the Red Line with a transfer to the Route 350 bus, the least expensive fare option would be a monthly LinkPass, currently priced at \$90.00. Used for five round trips per week in an average month, the cost per trip would be \$2.08 each way. This is the same as the cost of a rapid transit trip or a rapid transit and local bus trip within the core.

A trip on the Red Line and transfer to Route 351 requires an Inner Express Bus pass priced at \$136.00. The trip would cost an average of \$3.14 each way. A passenger taking Route 354 from downtown Boston to Van de Graff Drive would need an Outer Express Bus pass, priced at \$168.00. That trip would cost an average of \$3.88 each way.

The private shuttle is funded by members of the Middlesex 3 Transportation Management Association. Costs to riders are not published.

Travel Trade-off Example

Peak-period driving times between downtown Boston and the Burlington Mall can vary widely, depending on traffic conditions and the route selected. Google Maps estimates times ranging from 35 to 60 minutes on a route of 14.8 miles mostly on local roads, or 26 to 45 minutes on a route of 17.4 miles mostly on limited-access highways. The fastest driving time would be approximately twice as fast as the fastest scheduled transit time, but the slowest driving time would have little or no advantage over the fastest transit alternative.

At the AAA-estimated cost of \$0.591 per mile, the cost of a 14.8-mile trip would be \$8.75 and a 17.4-mile trip would be \$10.28.

First-Mile/Last-Mile Considerations at Home End

Reverse commuters using Route 354 to travel to Burlington would first need to travel to board the bus at one of three stops in downtown Boston. It is possible to reach the departure points of Route 354 via transit from every neighborhood in Boston, but in many cases the access trip would include a two-vehicle or three-vehicle ride and there would be some wait time for each vehicle and transfer time for all but the first link. For transit access to Route 350, Route 351, or the Middlesex 3 TMA shuttle, Boston or Cambridge residents would take the Red Line to Alewife Station. From some origins, travelers would require other transit service to first access the Red Line.

The only core municipality with bus access to Alewife Station that does not require an intermediate transfer is Arlington. Route 350 runs directly through Arlington Center, and residents from most sections of the town would connect with it there rather than at Alewife Station.

There is connecting bus service to the Red Line at Harvard Station from Watertown and Belmont. Somerville has direct Red Line service at Davis Station and bus connections to several Red Line stations in Cambridge. Medford residents would most likely use a bus connection directly to Route 350 at Arlington Center rather than a bus to the Red Line for an intermediate connection to Alewife Station.

The 2009–13 ACS results did not show any work trips to Burlington by transit from Belmont, Brookline, Revere, or Watertown. From the other nine core communities, estimates of transit trips ranged from 3.1 percent from Somerville

to 8.8 percent from Arlington, but the MOE exceeded the estimate from most origins.

First-Mile/Last-Mile Considerations at Work End

Much of the dense employment area on the south side of Route 128 in Burlington is not served directly by any transit service from Boston or other core cities and towns. Route 354 terminates near the dead end of Van de Graff Drive. Most of the employment locations on the south side of this road have access only from Blanchard Road, the next road south of Van de Graff Drive. The local Burlington bus system provides the only transit service on Blanchard Road, and that service is scheduled only for local travel in the town.

A paved pedestrian path runs from Van de Graff Drive near the end of Route 354 to Blanchard Road, but the nearest employment locations on Blanchard Road, either east or west of the end of the path, are one-half mile from the bus stop. Most of Blanchard Road and its westerly continuation, Wheeler Road, have no sidewalks and have very narrow shoulders on both sides. These roads also appear to be too narrow for safe operation of full-size transit buses.

In the dense employment area on the north side of Route 128 in Burlington, Route 350 and 351 buses each make several stops along Burlington Mall Road. Many of the employment locations are not directly on this road but on side streets or driveways on the south side. The walking distances to most of these locations from the nearest bus stops are as much as one-third of a mile. Some of the side streets have no sidewalks, and where there are sidewalks they are interrupted by many curb cuts for parking lots.

The section of the dense employment area west of Middlesex Turnpike in Burlington is served by four stops on Route 351 on Second, Third, and Fourth Avenues, and by one stop on Network Drive. Most of the employment locations are not directly on the streets the bus travels on, but are within one-quarter mile walking distance from a bus stop. Second, Third, and Fourth Avenues have sidewalks, but most of Network Drive and most of the driveways to buildings not directly on the bus route do not have sidewalks.

Potential Service Improvements for Reverse Commuters

It does not appear that any significant transit improvements could be made to create last-mile connections to the most dense employment locations in Burlington. The existing transit services run as close to these work locations as is feasible to run full-size buses, and the additional distances to the work locations are too short to justify running connecting shuttles with smaller vehicles.

Provision of through service from downtown Boston to the employment locations along Burlington Mall Road is worth considering. The most cost-effective strategy for implementing such service may be to reconfigure the outer end of Route 354 so that buses on at least some trips continue to Burlington Mall after arriving at Van de Graff Drive. The current scheduling practice has buses at the end of the route waiting 17 to 33 minutes for the next inbound departure. A reconfiguring of the route could allow buses to depart immediately and travel back over Van de Graff Drive as far as South Bedford Street. From there, they would follow the outbound Route 350 alignment on South Bedford Street and Burlington Mall Road to the mall. Inbound trips would follow Burlington Mall Road and South Bedford Street to Wayside Road, where they would resume the regular Route 354 routing.

Passengers traveling inbound from the two stops on Van de Graff Drive would have their travel time lengthened by at least 15 minutes, the running time from Van de Graff Drive at South Bedford Street to Burlington Mall and back. The 2018 APC results show an average total of only 8.9 passengers boarding the five inbound trips at the two stops on Van de Graff Drive, or 1.8 passengers per trip. After arriving back at State Street in Boston, these buses now return to the garage; so, any increase in running times would not affect service on subsequent trips. Because outbound trips do not arrive at Van de Graff Drive at uniform intervals, if the buses proceeded with no layover time to minimize travel times for passengers continuing to Burlington Mall Road, layover time would need to be included at the new outer endpoint to restore uniform inbound headways. This would further increase in-vehicle times for passengers boarding at Van de Graff Drive.

In the PM peak there are currently nine departures from State Street to Van de Graff Drive on Route 354. After arriving at Van de Graff Drive, buses from five of these trips return to State Street to make second outbound trips, and buses from the other four trips return to the garage. Most of the buses on return trips to the garage could not be extended to Burlington Mall early enough to pick up reverse commuters going home after work. Therefore, it would be necessary to revise the sequence of trips followed by buses on the earlier trips to allow for the added running time to the mall. A net increase of one vehicle would be required.

Reverse commuters returning home from Van de Graff Drive would have their trip times increased by approximately 15 minutes if buses continued to Burlington Mall to pick up more passengers. The 2018 APC counts showed an average of only 0.9 passengers per trip boarding inbound at the stops on Van de Graff Drive. Alternatively, buses could be sent to Burlington Mall first. This would lengthen the trip times for passengers going to Van de Graff Drive, of which there was an average of 1.3 per trip. It would also increase travel times for passengers

returning from Burlington Mall Road compared with an inbound trip bypassing Van de Graff Drive.

2.3.3 Burlington Case Study Summary

The densest concentration of employment in Burlington is in the area around the Lahey Hospital and Medical Center and the Burlington Mall. There is no commuter rail service to Burlington. To reach Burlington by MBTA bus, commuters from Boston and most other core communities first need to travel to Alewife Station in Cambridge or downtown Boston, making for a potentially lengthy, multi-link trip. There is one private employer shuttle that provides service from the rapid transit station at Alewife to Burlington. Offering more MBTA bus service from downtown Boston to the Burlington Mall area could make reverse commuting to Burlington more feasible.

2.4 WALTHAM CASE STUDY

2.4.1 Overview of Work Travel to Waltham

The city of Waltham is located in the Northwest subregion of the Boston region. According to Google Maps, the shortest highway distance from downtown Boston to the center of Waltham is 10.7 miles, via the Massachusetts Turnpike and local roads.

The 2015 LEHD figures showed a total of 64,033 jobs in Waltham, including 46,123 (72.0 percent) held by Boston region residents and 27,580 (43.1 percent) by residents of subregions outside the urban core. Of the jobs in Waltham held by residents of subregions, 6,208 (22.5 percent) were held by Waltham residents. This figure is slightly less than the average of 25.5 percent of home-to-work trips with both ends in the subregions made by people living and working in the same municipality. These figures show that Waltham employers rely on attracting workers from other cities and towns to fill their jobs to a similar degree as other municipalities in the subregions.

Of the 46,123 jobs in Waltham held by residents of the Boston region, 7,200 (15.6 percent) were held by Boston residents and 11,343 (24.6 percent) were held by residents of other core cities and towns.

Table 14 summarizes the home locations of people employed in Waltham.

Table 14
Home Locations of People Employed in Waltham

Home Location	Number of Waltham Employees	Percent of Waltham Employees
City of Boston	7,200	11.2
Other Core Municipalities	11,343	17.7
Subregions	27,580	43.1
Total in Boston Region	46,123	72.0
Outside Boston Region	17,910	28.0
Total Employment in Waltham	64,033	100.0

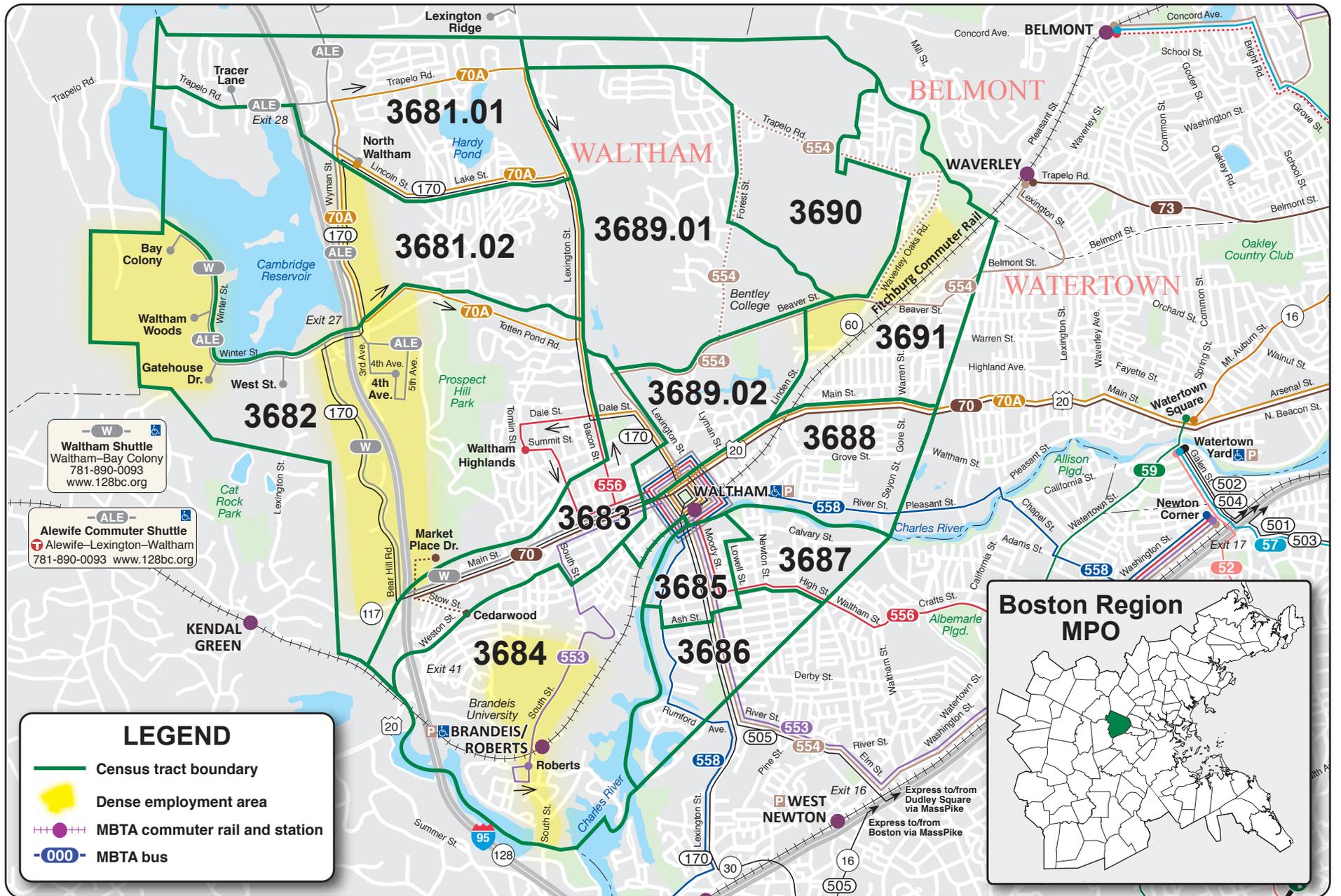
Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

The LEHD figures do not indicate modes of travel, however the ACS figures suggest that as many as 18.2 percent of work trips from Boston to Waltham and 10.6 percent of work trips from the rest of the core to Waltham were made by transit. Passenger counts from 2018 showed an average of 475 passengers on board buses during the weekday AM peak as they entered Waltham from core communities. One-day commuter rail passenger counts from 2018 showed a combined total of 188 outbound AM peak alightings at the two commuter rail stations in Waltham. The 128 Business Council shuttles from Alewife Station to Waltham carried an average of approximately 190 passengers outbound on weekday AM peak periods. These data do not indicate passenger origins and, except for the shuttles, some of the ridership would have been for purposes other than travel from home to work.

2.4.2 Travel to Densest Employment Concentrations in Waltham
Waltham Employment Locations by Census Tract

Waltham has 13 census tracts, as shown on Figure 4.

Table 15 shows the distribution of jobs in Waltham census tracts.



BOSTON
REGION
MPO



FIGURE 4
Waltham Census Tracts and
Existing Transit Service

Reverse Commute
Areas Analysis

Table 15
Distribution of Waltham Employment by Census Tract

Census Tract	Employment	Percent of Waltham Employment
Tract 3682	23,883	37.3
Tract 3684	8,443	13.2
Tract 3681.02	6,605	10.3
Tract 3691	4,894	7.6
Other Nine Tracts*	20,208	31.6
Total	64,033	100.0

*Note: The other nine tracts are numbered 3681.01, 3683, 3685, 3686, 3687, 3688, 3689.01, 3689.02, and 3690.

Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

Tract 3682 is located on the west side of Waltham. As shown in Figure 4, the largest employers within this tract are located in office parks along both sides of Route 128 south of Totten Pond Road and in an office park between Winter Street and the border of Lincoln. As shown in Table 15, in 2015 this tract had the largest concentration of jobs in the city, 23,883 (37.3 percent). Of these jobs, 2,412 (10.1 percent) were held by Boston residents and 555 (2.3 percent) by Cambridge residents.

Tract 3684 is located in the southwest corner of Waltham. The largest employers within this tract are located on the Brandeis University campus and in office parks on both sides of South Street on the south side of the Fitchburg commuter rail line. This tract had the second-largest concentration of jobs, 8,443 (13.2 percent). Of these jobs, 1,356 (16.1 percent) were held by Boston residents and 209 (2.5 percent) by Cambridge residents.

Tract 3681.02 is located near the northwest corner of Waltham. The largest employers in this tract are located in office parks east of Wyman Street between Totten Pond Road and Lincoln Street. This tract had the third-largest concentration of jobs, 6,605 (10.3 percent). Of these jobs, 714 (10.8 percent) were held by Boston residents and 158 (2.4 percent) were held by Cambridge residents.

Tract 3691 is located in the northeast corner of Waltham. The largest concentrations of employment in this tract are in an office park on Waverley Oaks Road east of Beaver Street and the University of Massachusetts College of Agriculture campus on Beaver Street west of Waverley Oaks Road. This tract had the fourth-largest concentration of jobs, 4,894 (7.6 percent). Of these jobs, 548 (11.2 percent) were held by Boston residents and 139 (2.8 percent) were held by Cambridge residents.

Commuter Rail Access Options

Waltham has two stations on the Fitchburg commuter rail line: Waltham Station in Tract 3688 and Brandeis/Roberts Station in Tract 3684. Tract 3688 was the area with the seventh-largest number of jobs in Waltham, according to the 2015 LEHD results.

The largest employment locations in Tract 3684 are all within one-half mile of Brandeis/Roberts Station. Most of the walking paths to these work locations have sidewalks, but final walk access to some of the work locations is along private access driveways.

The 2018 commuter rail passenger counts showed 144 passengers alighting from outbound trains stopping at Brandeis/Roberts Station before 9:30 AM on a sample weekday. In the MBTA's 2015–17 passenger survey, 91 percent of respondents alighting from outbound trains at Brandeis/Roberts Station before 9:30 AM were going from home to work. This suggests that the 2018 count would have included 131 people making AM peak reverse-commute trips to Brandeis/Roberts Station.

There are no through transit connections from Brandeis/Roberts Station to work locations in any other tracts in Waltham, although some are slightly closer to this station than to Waltham Station. The nearest point to rail service in office parks along Route 128 in Tract 3682 is 2.4 miles from Waltham Station and 2.1 miles from Brandeis/Roberts Station. The nearest point to rail service in the Winter Street office complex is 3.4 miles from Waltham Station and 3.7 miles from Brandeis/Roberts Station.

Connections from Waltham Station to Tract 3682 by MBTA Bus Route 170
Several transit routes connect to large employment areas in Tract 3682 from Waltham Station. MBTA bus Route 170 serves four stops in office parks west of Route 128 and south of Totten Pond Road on a route between Dudley Station in Roxbury and many work locations in Waltham. This route has only two outbound AM peak trips and two inbound PM peak trips.

Route 170 includes a stop on Carter Street opposite the inbound platform at Waltham Station, on the east side of Moody Street. The outbound platform is on the west side of Moody Street, and the nearest stop to the outbound platform on Route 170 is near the intersection of Moody Street and Carter Street.

The 2018 APC figures for Route 170 show an average of only 1.4 boardings a day at the stop on Carter Street near the inbound platform and only 0.2 boardings a day at the intersection near Moody Street and Carter Street. The

same counts show an average of 19.2 alightings a day at the four stops west of Route 128 south of Totten Pond Road. These results do not indicate where alighting passengers initially boarded, or whether any passenger transferred from trains. There were a combined average of 23.3 passengers on board the two outbound Route 170 trips leaving Boston and 30.1 on board leaving Waltham Station, with some intermediate boardings and alightings. A combined average total of 36.6 passengers were on board the two inbound PM peak trips entering Boston.

Connections from Waltham Station to Tracts 3682 and 3681.02 by MBTA Bus Routes 70 and 70A

MBTA bus Routes 70 and 70A, which run from Central Square, Cambridge, to Waltham, serve the inbound platform stop at Waltham Station. Route 70 buses go to Cedarwood Avenue and make a side diversion to the Main Shopping Center on Tower Road on the east side of Route 128 on some trips. From there, the walking distance to the nearest area of concentrated employment east of Route 128 is 0.6 miles. Until recently, the walking path north of Tower Road was still partly under construction.

Route 70A goes to North Waltham. Stops on this route include two on Totten Pond Road between dense employment areas in Tracts 3682 and 3681.02 and three stops on Wyman Street serving dense employment areas in Tract 3681.02. The 2018 APC counts for seven outbound trips arriving at North Waltham before 9:30 AM showed a combined average daily total of 56.5 alightings at the two stops serving employment locations along Totten Pond Road and 43.5 alightings at the three stops along Wyman Street. The stop on Wyman Street at Winter Street, which had an average of 15.1 alightings, could also be used to access the office park on Winter Street in Tract 3682. However, the offices in that complex are all more than one mile from this stop.

Connections from Waltham Station to Tract 3682 by the 128 Business Council Shuttle

The 128 Business Council runs an employer-sponsored shuttle called Waltham Route B between Waltham Station, the office complexes in Tract 3682 on the west side of Route 128 south of Totten Pond Road, and the Winter Street office complex. Like the MBTA routes, this shuttle stops at the inbound commuter rail platform at Waltham Station. Route B has three outbound AM peak trips and five inbound PM peak trips. It serves 11 stops at employment locations, including five south of Totten Pond Road and six in the Winter Street Office complex.

The 128 Business Council does not track ridership by trip or by stop. In October 2018, ridership on Route B averaged 49 passengers per day. If distributed

equally between inbound and outbound service, this was equivalent to an average of 8.2 riders on each outbound AM trip.

Transit and Auto Time and Cost Comparisons for Reverse-Commuting Trips to Tract 3682

The scheduled trip time from Waltham Station to the outer end of Route B at 1100 Winter Street is 30 minutes on the first two trips and 28 minutes on the third trip. If outbound trains from Boston are on time, passengers transferring to this route would have wait times of 13, 15, and 13 minutes, respectively. Total travel time from North Station to the outermost stop would be 65, 67, and 63 minutes, respectively, excluding the time required to access and wait for trains at North Station. With typical AM peak traffic, driving time from downtown Boston to the same location in Waltham would range from 30 to 50 minutes, according to Google Maps.

The three outbound trains that have Route B connections all also stop at Porter Square Station in Cambridge and at the Belmont and Waverley Stations in Belmont. Compared with times from North Station, run times to Waltham are 10 minutes less from Porter, 15 minutes less from Belmont, and 17 minutes less from Waverley. According to Google Maps, the ranges of AM peak driving times to the outermost stop on Route B are 28 to 55 minutes from Porter Square, 20 to 40 minutes from Belmont Center, and 16 to 35 minutes from Waverley Square. Excluding initial access and wait times, travel times to 1100 Winter Street by train and Route B would be 53 to 57 minutes from Porter Square, 48 to 52 minutes from Belmont Station, and 46 to 50 minutes from Waverley Station.

Passengers on Route B may transfer from trains or several local MBTA bus routes that serve Waltham Station. The one-day commuter rail counts in the spring of 2018 showed a combined total of 44 passengers alighting from the three outbound trains that connected with Route B. Another 38 passengers alighted from inbound trains that also allowed reasonable connections to Route B.

The one-way fare on Route B is \$2.00 for members of participating companies and \$3.00 for others. The least expensive adult rail fare from Boston would be obtained by using a Zone 2 commuter rail monthly pass, currently priced at \$232.00 and valid for connecting rapid transit or bus service at North Station. Five round trips a week in an average month would cost \$5.35 per trip each way for the rail portion. The total one-way cost would be \$7.35 with the shuttle member fare and \$8.35 with the non-member fare.

Porter Square is in the same fare zone as North Station, so the combined trains and shuttle fares to 1100 Winter Street are the same from either station. Belmont

and Waverley Stations are in Zone 1, from which a two-zone Interzone fare applies when traveling to Waltham Station. The price of a monthly pass for this trip is \$110.00. The average one-way cost is \$2.54, if used for five round trips a week. Combined with the Route B fare, the total cost per trip would be \$4.54 for members or \$5.54 for non-members.

The driving distance from downtown Boston to 1100 Winter Street via the fastest route is 19.5 miles. At the cost per mile of \$0.591 calculated by AAA, the cost of driving this distance would be \$11.52. The shortest driving distances to the same destination are 6.7 miles from Waverley Square, 7.6 miles from Belmont Center, and 10.8 miles from Porter Square. At the same driving cost per mile, the respective costs would be \$3.96, \$4.49, and \$6.38. A passenger taking into consideration the full cost of driving (rather than just the cost of fuel) would find the combination of commuter rail and the Route B shuttle significantly less expensive from North Station, more expensive from Porter Square and Waverley Stations, and almost the same from Belmont Station.

Feeder Bus Connections to Tract 3691 from Waltham and Waverly Stations

MBTA bus Route 554 runs from Waverly Square in Belmont to downtown Boston via Waltham Center and Newton Corner. It connects with the Fitchburg commuter rail line at Waverley Station and at Waltham Station. The route between those stations passes through the dense employment area on Beaver Street in Waltham's Tract 3691. The 2018 APC counts showed a combined average total of 4.1 passengers a day alighting from Route 554 buses traveling westbound from Waverley Square before 9:30 AM at the stops serving this employment area. From buses going away from Waltham Station toward Waverley Square the combined average total was 3.9 alightings in this area before 9:30 AM. Only 2.1 of the westbound alightings and 0.5 of the eastbound alightings were from bus trips that could have provided connections to trains in reasonable timeframes for commuters.

Other Transit Access Options for Reverse Commuting to Waltham

MBTA Routes 70, 70A, and 170 are the only MBTA routes that run close to the densest employment areas in Waltham, but they are not dependent solely on the commuter rail connection at Waltham Station to function as reverse-commute routes. Routes 70 and 70A have stops close to Central Square Station on the Red Line in Cambridge. Route 170 connects with several MBTA local bus routes at Dudley Station and along Washington Street in Boston and with the rapid transit Orange Line at Back Bay Station. Three south side commuter rail lines have train arrivals early enough to connect with at least the later of the two outbound Route 170 trips. The 2018 APC counts showed that on a weekday an

average of 13.4 of the 23.3 passengers on board Route 170 buses leaving Boston boarded at Back Bay Station, but the counts did not indicate if any of these passengers transferred from the Orange Line or commuter rail.

The 128 Business Council operates four shuttle routes open to the general public between the Red Line terminal at Alewife Station in Cambridge and the employment areas along Route 128 in Waltham. These include one route serving the office complexes on the east side of Route 128 south of Totten Pond Road, one route serving the office complexes on the west side of Route 128 south of Totten Pond Road, and one route serving the Winter Street office complex. AM peak service on each of these routes provides six outbound trips on 45-minute headways. Scheduled trip times from Alewife Station to the outermost stop on each route range from approximately 30 to 35 minutes. The fourth route serves employment locations in Waltham outside the two dense employment areas under discussion here and also serves some employment areas in Lexington.

The 128 Business Council does not track ridership separately for the four routes. In October 2018, combined inbound and outbound ridership for the four routes averaged 386 passengers per day. The schedule called for a total of 27 AM trips from Alewife Station to Waltham and 28 PM trips from Waltham to Alewife Station carrying passengers only in the reverse-commute direction. Divided over all 55 trips, this would equal an average of 7.0 riders per trip.

Most Boston residents using these shuttles would ride the Red Line to Alewife Station from at least as far as Park Street Station, from which the scheduled AM peak running time is 21 minutes. Excluding waiting and transfer times, the minimum total travel time from Boston to the outer endpoint of each shuttle route would be approximately 51 to 56 minutes. As noted above, the driving time from downtown Boston to the most distant location in the dense employment areas in Waltham can range widely, from approximately 30 to 50 minutes, depending on traffic conditions.

First-Mile/Last-Mile Considerations at Home End

Boston residents taking commuter rail to Waltham to transfer to the 128 Business Council's Route B would first have to travel either to North Station or via the Red Line to Porter Square Station. It is possible to reach North Station by transit from every Boston neighborhood, but in many cases a commuter would have to take a bus and one or more rapid transit lines.

Approximately 19 percent of Boston residents working in Waltham and 17 percent of those working specifically in Tract 3682 live in zip-code areas with at least one Red Line station. However, not all of these residents live within walking

distance of a station. Those taking the Red Line to Porter Square Station or Alewife Station from homes without convenient walk-in access to the Red Line would have to start with a bus trip to the Red Line or to another rapid transit line connecting with the Red Line.

The 2009–13 ACS figures suggest that there were some transit trips to Waltham from each of the core cities and towns outside Boston except Milton. However, except for trips from Cambridge, Belmont, and Somerville, the transit MOE exceeded the transit total estimate.

Not all transit trips to Waltham are made via the Red Line to Alewife or Porter Square Stations or via commuter rail to Waltham Station. Cambridge and Somerville have direct Red Line service and local bus connections to the Red Line. However, residents of Newton, Watertown, and Belmont would be unlikely to use the shuttles from Alewife to access jobs in Waltham because they would first have to travel too far in the opposite direction from Waltham.

MBTA bus Routes 62, 67, 76, 79, 84, and 350 together provide service to Alewife Station from within walking distance of most homes in Arlington. These routes allow for direct transfers to the shuttles to Waltham, so passengers would not have to use the Red Line.

Residents of Brookline, Chelsea, Everett, Malden, Medford, and Revere can use various combinations of bus and rapid transit service to access the Red Line and continue to Alewife Station. Except in Brookline, route coverage throughout these communities is extensive enough to allow most residents to walk to the first transit service used for the trip. However, because of the number of intermediate transfers needed on the way to Alewife Station, transit is not always a viable option for work trips to Waltham from these cities and towns.

For Belmont residents, an alternative to taking a train to Waltham Station and transferring to Route B is to take MBTA bus Route 554 from Waverley Square to Waltham. However, the scheduled bus travel time is 14 minutes compared with a five-minute trip by train over the same distance, and there is a good connection from Route 554 to only the first of the three Route B trips. Waverley Square is beyond convenient walking distance from most homes in Belmont. MBTA Route 73 provides a connection to Waverley Square from points farther east, but its alignment on or near the southern border of the town puts it within convenient walking distance of only a small portion of Belmont homes.

From Watertown, MBTA bus Route 70 provides good connections with all three shuttle trips on Waltham Route B. The scheduled time from Watertown Square to the stop nearest Waltham Station is 15 minutes. More than half of the residential

development in Watertown is within one-half mile of either Route 70 or Route 71, which connects with Route 70 at Watertown Square.

MBTA bus Routes 553, 554, 556, and 558 provide connections to Waltham Station from Newton Corner, Newtonville, West Newton, Auburndale, and Riverside Station. From stops on Routes 553 and 554, good connections are available to all three shuttle trips to Winter Street. From stops on Route 556, passengers can connect to the three shuttle trips after wait times of 26 to 31 minutes. From stops on the west end of Route 558, good connections are available to the second and third shuttle trips. From the east end of Route 558, there is a good connection only to the first shuttle trip.

These four bus routes all serve neighborhoods on the north side of Newton. From the south side of the city, MBTA bus Route 52 provides connections from Oak Hill and Newton Centre to all four north side routes at Newton Corner and to Route 70 at Watertown Square. Route 59 connects Upper Falls and Newton Highlands with Routes 553, 554, and 556 at Newtonville, with Route 558 at Nonantum, and with Route 70 at Watertown Square. The Green Line D Branch connects Chestnut Hill, Newton Centre, Newton Highlands and Waban with Route 558 at Riverside. However, most of the present schedules do not allow close connections between the various bus routes, and not all Newton homes are within walking distance of these transit lines.

First-Mile/Last-Mile Considerations at Work End

The 128 Business Council's shuttles from Alewife Station provide service directly to or within reasonable walking distance of all work locations in the densest employment areas in Waltham. These shuttles are most likely to attract residents of Boston or other core cities and towns who have convenient access to the Red Line. However, information on the home locations of the shuttle users is not available.

The shuttle from Waltham Station serves fewer destinations than all the shuttles from Alewife Station. Furthermore, for passengers starting from Boston or from core municipalities farther from Waltham, there is little incentive to use the commuter rail connection rather than the Red Line connection because overall travel time is longer and cost is greater via the commuter rail.

Further Discussion of Bus Route 170

At present, bus Route 170 from Dudley Square to North Waltham is the only example of an MBTA transit service that runs through from an outlying residential neighborhood in Boston to a suburban location with a large concentration of jobs. This route has been running in some form since 1968. It originally continued

beyond Waltham via Route 128 to employment areas in Burlington. It was cut back to its current configuration in 2009 because of low ridership at the Burlington stops and the availability of alternate service to Burlington from Alewife Station.

Route 170 was originally intended to provide access to jobs in Waltham and Burlington for low-income residents of Roxbury. It was never heavily patronized, and the MBTA did not even report ridership figures for it separately until 1997. Then average ridership was reported as 32 riders (on both inbound and outbound trips) per weekday on two outbound AM trips and one inbound PM trip. In 1998, the route was modified to provide more pick-up points in Boston and more drop-off points in Waltham. By fall 2001, ridership had increased to an average of 34 outbound and 16 inbound per day. The imbalance reflected the service of two outbound AM trips but only one inbound PM trip.

A second inbound PM trip was added when the Burlington route segment was discontinued in 2009. In 2018, with the present route configuration, ridership averaged 45.4 outbound and 58.5 inbound passengers per day. However, much of the increase in ridership has been because of riders making trips locally within Waltham rather than riders from in the original intended market of Roxbury residents who would travel to jobs along Route 128.

Of the average 45.4 outbound boardings a day in 2018, an average of 6.2 took place at Dudley Station and 1.1 at the other two stops in Roxbury. An average of 1.4 boardings occurred at stops in the South End. Local stops in the Back Bay neighborhood accounted for an average of 4.9 boardings. The largest number of boardings at any individual stop was 10.0, on average, at the Back Bay Station busway. These boardings probably included some transfers from commuter rail, the Orange Line, or other MBTA bus routes. There was a small amount of local travel within Boston on the route, accounting for an average of 0.3 alightings. The average load leaving Boston on the two AM trips combined was 23.3 riders, representing 51.3 percent of the total outbound ridership.

Inbound PM ridership was slightly weighted toward travel to Boston from suburban stops. The average load entering Boston on the two trips combined was 36.6 riders, representing 62.6 percent of total inbound boardings. The most passengers, an average of 26.1, alighted at Back Bay Station, possibly because the inbound routing served no other Back Bay stops. There was an average of 3.6 alightings at stops in the South End, 8.7 at Dudley Station, and 1.0 at other Roxbury stops. Local travel entirely within Boston accounted for only 0.7 boardings on average.

The longtime experience of Route 170, which was originally designed to provide one-seat transportation from a Boston neighborhood with above-average unemployment and below-average vehicle ownership to suburban locations with many job opportunities, is not encouraging for the prospects of new reverse-commute transit service. In times of overall high employment, urban core residents do not have to travel to the suburbs to find work, and in times of lower overall employment, suburban employers do not have to recruit workers from long distances.

2.4.3 Waltham Case Study Summary

The largest concentration of employment in Waltham is located along Route 128, but the area is not close to either of the city's commuter rail stations. Reverse commuters to the Brandeis area can use Brandeis/Roberts Station, but the area around Waltham Station has a relatively low concentration of employment. However, reverse commuters to the area in Waltham by Route 128 have multiple options for bus service. They can take MBTA buses from Central Square in Cambridge or Dudley Square in Boston, or they can take private shuttles from the Waltham commuter rail station or Alewife Station on the Red Line. As a result, Waltham offers more options to reverse commuters than Burlington or Woburn.

2.5 NEEDHAM CASE STUDY

2.5.1 Overview of Work Travel to Needham

The town of Needham is located in the West subregion of the Boston region. The shortest highway distance from downtown Boston to the center of Needham is 11.7 miles, via state Route 9 and local roads.

The 2015 LEHD figures showed a total of 22,419 jobs in Needham, including 16,548 (73.8 percent) held by residents of the Boston region and 10,845 (48.4 percent) held by residents of subregions outside the urban core. Of the jobs in Needham held by residents of subregions, 1,769 (16.3 percent) were held by Needham residents; this figure is significantly lower than the average of 25.5 percent for subregion residents who live and work in the same municipality. These figures show that Needham employers must rely to an above-average extent on attracting workers from other cities and towns to fill their jobs.

Of the 16,548 jobs in Needham held by residents of the Boston region, 2,972 (18.0 percent) were held by Boston residents and 2,731 (16.5 percent) were held by residents of other core cities and towns. The smallest number of reported work trips to Needham from any individual core city or town was 69 a day, from Chelsea.

Table 16 summarizes the home locations of people employed in Needham.

Table 16
Home Locations of People Employed in Needham

Home Location	Number of Needham Employees	Percent of Needham Employees
City of Boston	2,972	13.3
Other Core Municipalities	2,731	12.2
Subregions	10,845	48.4
Total in Boston Region	16,548	73.8
Outside Boston Region	5,871	26.2
Total Employment in Needham	22,419	100.0

Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

The LEHD figures do not indicate modes of travel; however, the ACS figures suggest that at most 12.9 percent of work trips from Boston to Needham were made by transit. From the rest of the core, the ACS figures suggest that at most 5.1 percent of work trips to Needham were made by transit. One-day weekday passenger counts from 2018 showed a combined total of 41 passengers on board outbound AM peak commuter rail trains as they entered Needham. In 2018 counts, the only MBTA bus route serving Needham averaged 82 passengers on board weekday AM peak buses crossing into Needham from Newton. Neither the train counts nor the bus counts showed passenger origins or trip purposes. The 128 Business Council shuttles from the Newton Highlands Green Line station carried an average of approximately 50 weekday outbound AM peak passengers to Needham in 2018.

2.5.2 Travel to Densest Employment Concentration in Needham

Needham Employment Locations by Census Tract

Needham has five census tracts as shown in Figure 5. Table 17 shows the distribution of jobs in these census tracts. Tract 4035 had by far the largest concentration of jobs in Needham in the 2015 LEHD results, 11,277 (50.3 percent). Of these jobs, 1,379 (12.2 percent) were held by Boston residents. Tract 4572 had the second-largest concentration of jobs, 4,144 (18.5 percent). Tract 4033 had the third-largest concentration of jobs, 3,134 (14.0 percent).

Table 17
Distribution of Needham Employment by Census Tract

Census Tract	Employment	Percent of Needham Employment
Tract 4035	11,277	50.3
Tract 4572	4,144	18.5
Tract 4033	3,134	14.0
Other Two Tracts*	3,864	17.2
Total	22,419	100.0

Note: The other two tracts are numbered 4031 and 4034.
Source: US Census Bureau Longitudinal Employer-Household Dynamics Reports for 2015.

Figure 5 shows the dense employment areas in Needham. Tract 4035 is located in the northern corner of the town. The largest concentrations of employment within this tract are in the office parks and retail establishments located between Route 128 and the Newton border between Kendrick Street and Fremont Street.

Tract 4572 is located near the geographic center of the town. Most of the jobs in this tract are located along Highland Avenue between Great Plain Avenue and West Street.

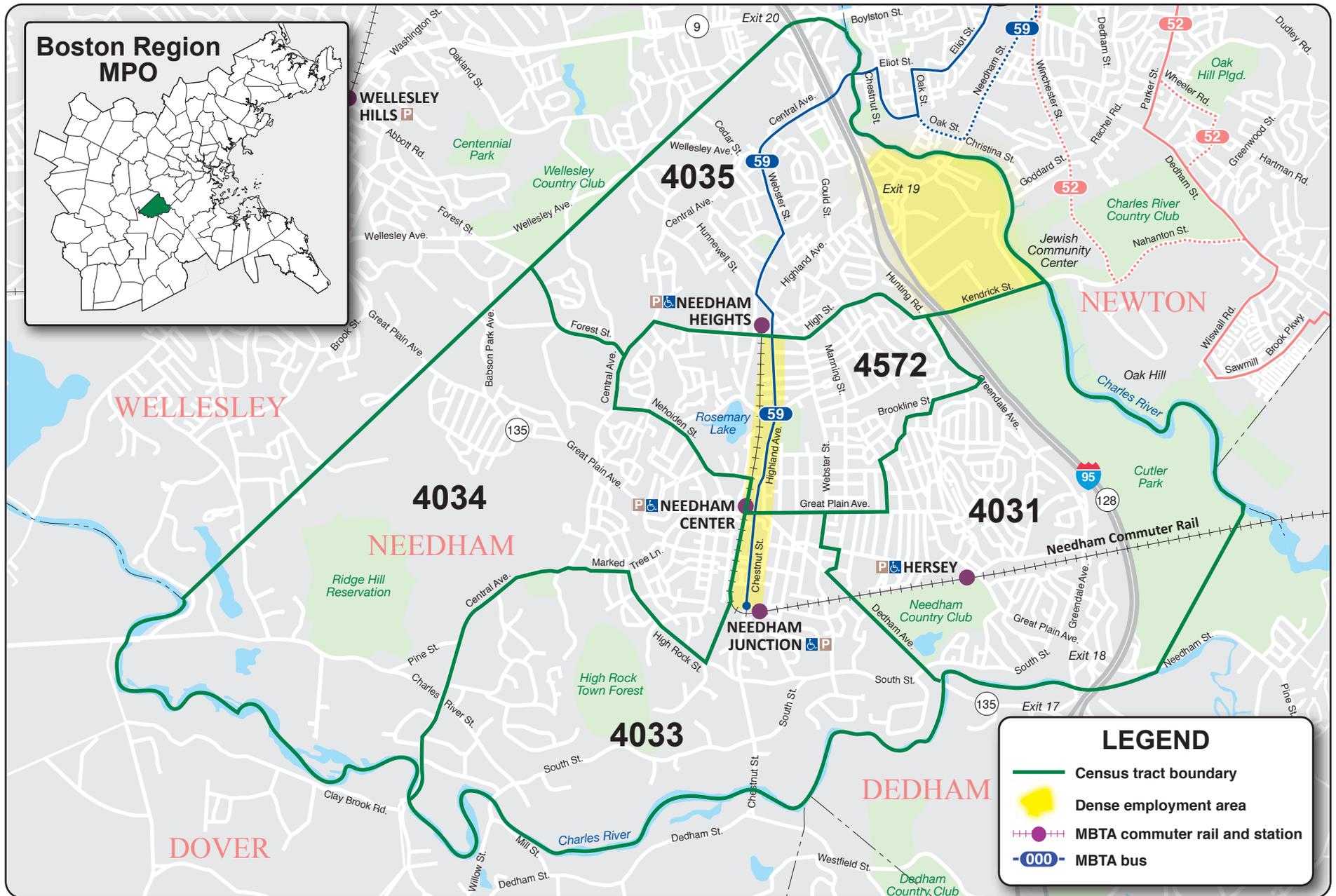
Tract 4033 is located on the southern border of the town. Most of the employment in this tract is located along Chestnut Street between Great Plain Avenue and the Needham Junction commuter rail station.

Commuter Rail Access Options

There are four commuter rail stations in Needham. The outer terminal of the line is Needham Heights Station. Two outbound trips arriving there before 9:30 AM. The scheduled time from South Station to Needham Heights is 46 minutes on the first trip, which serves nine intermediate stations in Boston and Needham, and 40 minutes on the second trip, which makes only four intermediate stops.

The walking distances from Needham Heights Station to the nearest points in the dense employment areas in Tract 4035 are 1.0 mile via the Highland Avenue side and 1.3 miles via the Kendrick Street side. There is no connecting transit service to this employment area from Needham Heights Station or from any other station on the commuter rail line. CTPS's 2018 passenger counts showed eight passengers alighting at Needham Heights Station from the first train and five from the second train, but did not determine their egress modes or final destinations.

The largest employment locations in Tract 4572 are within one-half mile of either Needham Center Station or Needham Heights Station. The largest employment locations in Tract 4033 are within one-half mile of either Needham Center Station or Needham Junction Station. The one-day 2018 passenger counts showed eight passengers alighting at Needham Center Station from the first outbound train and three from the second train. At Needham Junction Station there were eight alightings from the first train but none from the second train.



BOSTON REGION MPO

FIGURE 5
Needham Census Tracts and Existing Transit Service

Reverse Commute Areas Analysis

Other Transit Access Options

The Needham commuter rail line provides the only through transit service between Boston and Needham. MBTA bus Route 59 from Watertown Square to Needham Junction connects with the Green Line D Branch at Newton Highlands Station and has two variations. The stop nearest to the densest employment area in Needham is in Newton on Needham Street near the intersection of Oak Street. The walking distance from there to the nearest employment location in Needham is 0.1 mile, but most of the employment locations are at least one-quarter mile from the bus stop.

Four outbound trips stop at Oak Street before 9:30 AM. The scheduled running time to there from Newton Highlands Station is five to six minutes. Spring 2018 APC counts show a combined total of 13.2 alightings at this stop from the four trips. The final destinations or trip purposes of these passengers is unknown.

The 128 Business Council operates a shuttle from Newton Highlands Station to several of the offices in Needham in the dense employment area south of Highland Avenue and to one of the offices on Needham Street in Newton. There are seven outbound departures leaving the station from 6:25 AM to 9:20 AM. In October 2018, all-day ridership (on both inbound and outbound trips) averaged 107 per day. If AM and PM ridership was equal, this was equivalent to an average of 7.6 riders per trip in the morning.

Scheduled travel times for shuttles from Newton Highlands Station to the Needham employment area range from 6 to 11 minutes to the first stop and from 23 to 28 minutes to the outermost stop, with allowances for traffic on Needham Street accounting for the ranges. The scheduled travel time on the Green Line from Park Street Station to Newton Highlands Station in the AM peak is approximately 31 minutes, so total travel time to the first Needham stop is 37 to 42 minutes and total travel time to the last Needham stop is 54 to 59 minutes, excluding wait and transfer times. According to Google Maps, with typical AM peak traffic conditions, the driving time from downtown Boston to the nearest point in Needham's densest employment area would range from 30 to 60 minutes. The driving distance on the fastest route, via the Massachusetts Turnpike and local streets, is 11.7 miles.

For a passenger using the Green Line D Branch and Route 59 and walking from Oak Street, the least expensive fare option would be a monthly LinkPass, priced at \$90.00. Used for five round trips per week in an average month, the cost per trip would be \$2.08 each way. This pass also allows free transfers to the Green Line rapid transit lines and local buses.

The 128 Business Council's shuttle is free for employees of participating companies, so passengers transferring from the Green Line would pay only the MBTA fare. For passengers who are not employees of participating companies, the shuttle fare is \$4.00. The minimum cost for those passengers transferring from the Green Line would be \$6.08 each way.

All commuter rail stations in Needham are in commuter rail fare Zone 2. For reverse commuters taking a train to Needham from any station from South Station through Forest Hills, the least expensive fare option would be a Zone 2 monthly pass, priced at \$232.00. Used for five round trips a week in an average month, the cost per trip would be \$5.35 each way.

Stations from Roslindale through West Roxbury are in fare Zone 1. Riders boarding at these locations would require a two-zone Interzone pass, priced at \$110.00, or pay an average one-way cost of \$2.54 for five round trips a week. A trip between any two stations in Needham would require a one-zone Interzone pass, priced at \$90.00, or pay an average one-way cost of \$2.08 for five round trips a week.

At the cost per mile of \$0.591 calculated by AAA, the cost of driving from downtown Boston to the nearest point in Needham's densest employment area via the fastest route would be \$6.91.

First-Mile/Last Mile Considerations at Home End

Boston residents taking the 128 Business Council's Needham shuttle from Newton Highlands would first have to access the Green Line. Each of the heavy rail rapid transit lines has at least one direct connection with the Green Line. There are also a few bus connections to the Green Line in Boston, but most passengers starting out on a local bus route would have to use an intermediate rapid transit connection to reach the Green Line.

Of the other 13 core cities and towns, the ACS results show use of transit for work trips to Needham only from Brookline, Everett, and Malden. There are four stations on the Green Line D Branch in Brookline, and two other stations on that line are just outside Brookline. However, some Brookline residents would have to use means of access other than walking to reach the stations nearest to their homes.

Malden has two stations on the Orange Line, which connects with the Green Line directly at North Station and Haymarket Station, and via a pedestrian tunnel between Downtown Crossing and Park Street Stations. However, under current scheduling practice D Branch trains run only as far as Government Center

Station, so passengers transferring at North Station or Haymarket Station must use a C or E Branch train to reach the D Branch. Passengers from Everett would first have to take a local bus to the Orange Line to connect with the Green Line.

Despite the possibility of connecting to the Green Line with a single rapid transit link, residents of Cambridge, Somerville, and Revere did not do so in sufficient numbers to appear in the ACS samples. Watertown residents can take the Route 59 bus to Newton Highlands, to connect with the 128 Business Council's shuttle or ride to Oak Street and continue on foot, but many would first have to make connections to Route 59 from Route 70 or 71.

First-Mile/Last-Mile Considerations at Work End

The 128 Business Council shuttle offers good last-mile connections from the Green Line at Newton Highlands Station to work locations in part of the dense employment area south of Highland Avenue in Needham. For workers in the area north of Highland Avenue, the nearest transit service requires a walk of at least 0.1 mile from the Route 59 bus stop at Oak Street.

At present, there is no transit connection from Needham Heights Station to the dense employment area in Tract 4035. Given the less frequent service, higher fares, and longer trip times on the commuter rail line from South Station to Needham Heights Station compared with the Green Line service from Park Street Station to Newton Highlands Station, it is doubtful that many people who do not use the existing connections via Newton Highlands would be attracted by a new shuttle from Needham Heights.

Potential Last-Mile Improvements

An expanded bike-share program in Newton could provide an additional option for travel between Newton Highlands Station and the dense employment areas in Needham. Planned improvements to Needham Street in Newton include raised bicycle lanes and a reduction in the number of curb cuts to improve safety and encourage bicycle use.

In Newton, a former railroad right-of-way owned by the MBTA runs parallel with Needham Street. It has been converted to the Newton Upper Falls Greenway, a pedestrian and bicycle path, from a point approximately 0.5 miles from Newton Highlands Station to the Charles River, which is the border between Newton and Needham. The existing south end of this trail is a dead-end at the Newton side of a bridge that carried the rail line across the river but is currently unsafe even for foot traffic.

Approximately 600 feet farther south on the Needham side of the river, the rail line crossed Route 128 on a bridge that was removed several years ago when the highway was widened. However, the largest employment areas in Needham still could be accessed from the rail right-of-way if the bridge over the Charles River were repaired or replaced.

A spur from this rail line that formerly provided more direct access to the densest employment area in Needham has been almost completely obliterated by redevelopment. The spur crossed the Charles River south of Christina Street on a bridge that is still in place, but this bridge would require substantial repairs to make it suitable for trail use. The south approach to the bridge connects with an existing paved trail that leads to Second Avenue at Fourth Avenue in the largest office park. This trail can also be accessed directly from Highland Avenue in Needham.

2.5.3 Needham Case Study Summary

The densest employment area in Needham is adjacent to Route 128. Needham has four commuter rail stations, but none of them serves the densest employment area. One MBTA bus route runs close to the dense employment area, but it does not come directly from Boston. Reverse commuters to Needham have the option of taking a shuttle from Newton Highlands Station on the Green Line D Branch to Needham employers near Route 128, but many reverse commuters coming from Boston or other core communities would need to take additional buses or trains to reach the D Branch. An expanded bike-share program in Newton could provide an additional option for travel between Newton Highlands Station and the dense employment areas in Needham.

2.6 CASE STUDIES SUMMARY AND CONCLUSIONS

In the preceding sections of this chapter, we have examined the existing reverse commuting patterns to four of the areas with the densest concentration of employment in the Boston region outside the 14 cities and towns that we have classified as the urban core. For reasons stated above, these employment concentrations are all in cities and towns along state Route 128.

All of the dense employment areas have some form of public transit access from Boston and, to a lesser extent, from other urban core cities and towns:

- The section of Woburn with the largest concentration of employment is served by Mishawum Station on the Lowell commuter rail line, which is within walking distance of many, but not all, of the large employers.
- The section of Burlington with the largest concentration of employment has local and express MBTA bus connections from the rapid transit Red

Line terminal at Alewife Station to stops at or within walking distance of many, but not all, of the large employers. There is also a privately operated shuttle that runs from Alewife Station to one large office complex in this area.

- The section of Waltham with the largest concentration of employment has very limited direct MBTA transit service. The 128 Business Council runs shuttle connections to most of the employment locations in that area from Alewife Station and to some of the same employment locations from Waltham Station on the Fitchburg commuter rail line.
- The section of Needham with the largest concentration of employment does not have direct MBTA transit service. The 128 Business Council runs shuttle connections to many of the employment locations in that area from Newton Highlands Station on the Green Line D Branch.

Many residents of Boston and other core cities and towns would have to use some intermediate form of transportation to access the transit services that go to the largest sources of employment in the case study areas, as discussed below:

- Mishawum Station in the Woburn study area is on the Lowell commuter rail line. The Boston boarding location for this line is North Station, which most Boston residents would have to access via the Green Line or the Orange Line. Many Boston residents would need to first access these lines via local buses. The only other core municipality with a station on the Lowell Line is Medford.
- To access the bus routes that provide direct service to work locations in the Burlington study area or to access most of the 128 Business Council's Waltham shuttles, Boston residents would take the Red Line to Alewife Station. Residents of many Boston neighborhoods would have to take a bus or another rapid transit line to access the Red Line, and some would have to take both a bus and another rapid transit line.
- The only other core municipalities with Red Line stations are Cambridge and Somerville. However, Alewife Station can be accessed by bus, without use of the Red Line, from some neighborhoods of Arlington and Belmont. MBTA bus Route 350 to Burlington also connects at Arlington Center with MBTA bus routes from Arlington, Somerville, and Medford.
- Boston residents traveling to Waltham Station on the Fitchburg Line would need to take the Green Line or the Orange Line to North Station or the Red Line to Porter Square Station. Many Boston residents would need to first access those lines via local buses. The only other core municipalities with stations on the Fitchburg Line are Cambridge and Belmont. The station in Cambridge is on the border of Somerville.
- MBTA bus Route 170 provides through bus service from a few Boston neighborhoods to a few of the work locations in the Waltham study area,

but many Boston residents would need to use local bus, rapid transit, or bus and rapid transit connections to access Route 170. Newton is the only other core municipality with stops on Route 170, but very few riders board at these stops.

- Access from Boston to the 128 Business Council shuttle to the Needham study area is via the Green Line D Branch. Residents of many Boston neighborhoods would have to take a bus or another rapid transit line to access the Green Line, and some would have to take both a bus and another rapid transit line. The only other core municipalities with stations on the D Branch are Brookline and Newton.

Because of the dispersed characteristics of suburban work locations and of homes of urban core residents who reverse commute or might want to reverse commute to those work locations, it is difficult to provide reverse-commuting transit services that are efficient from an operations standpoint and do not require multiple transfers or long walking distances at one or both ends of a trip.

At present, the only MBTA service that offers a one-seat ride from a Boston neighborhood other than downtown Boston or Back Bay to a suburban location with a large concentration of jobs is bus Route 170 from Dudley Square, which runs to north Waltham. This route has been in operation in various forms for more than 50 years, but it has never successfully met its objective of providing low-income Boston residents transportation to jobs in the suburbs. A few other attempts at running reverse-commuting bus service from Boston to suburbs have been short-lived.

Suburban employers cannot successfully recruit transit-dependent employees if no transit is available, but the MBTA does not have the resources to implement new reverse-commuting services that could require years for ridership to build. At the last-mile end, employer-sponsored shuttles, such as those offered by the 128 Business Council, connecting with MBTA rapid transit or commuter rail lines are probably the best solution for serving employment locations beyond reasonable walking distance of fixed-route transit. However, for Boston or other urban core residents without direct access to the transit lines these shuttles connect with, the need to make several transfers may discourage those considering reverse commuting by transit.

Chapter 3—Review of Guaranteed Ride Home Programs

3.1 BACKGROUND

Transit services extending beyond densely developed urban core areas often have schedules suitable for travel from home to work during AM peak hours and from work to home in PM peak hours, but little or no service is offered midday or after PM peak hours. Such schedules may discourage transit use by commuters who are concerned that they would be unable to return home promptly in the event of midday emergencies, or if they were required to perform unscheduled overtime work.

Guaranteed Ride Home (GRH) programs, also known as Emergency Ride Home (ERH) programs, can help to assure commuters that by using transit instead of personal vehicles they will not be stranded if faced with the need to return home from work during hours the transit service is not operating.

This study included a literature review to research best practices for GRH programs and the identification of alternatives appropriate for each of the case study areas. An online search revealed that most information about these programs was in the form of information posted on the websites of transit operators or employer associations for potential users of such services. Evaluations of the effectiveness of such services were not readily available. The only academic study found was a report prepared for the Federal Transit Administration (FTA) in 2007 titled *Guaranteed Ride Home Programs: A Study of Program Characteristics, Utilization, and Cost*.²

3.2 FINDINGS FROM LITERATURE SEARCH

3.2.1 Federal Transit Administration Study

The FTA study found that most GRH programs required participating workers to be registered in advance and to commute regularly by some form of transportation other than single-occupant vehicle. Most programs included very specific lists of the trip purposes for which participants would be allowed to use GRH services and trip purposes that would be ineligible, but the rules were not the same for all programs. Approved trip purposes usually included personal or family illness, unscheduled overtime approved by a supervisor, or unavailability

² Menczer, William B., Federal Transit Administration, “*Guaranteed Ride Home Programs: A Study of Program Characteristics, Utilization, and Cost*,” *Journal of Public Transportation*, Vol. 10, No. 4, 2007.

of a usual rideshare partner because of an unexpected change in that person's travel needs. Trip purposes for which GRH service was generally not approved included travel to a pre-planned event such as medical appointments or business-related travel. The FTA study found that most GRH programs placed a limit on the number of times per year that an individual participant could use the service. Most programs placed limits on either the distance or the cost of a GRH trip.

The FTA study pre-dated the establishment of rideshare services such as Uber and Lyft. In 60 percent of the programs examined in the study, GRH transportation was provided exclusively by taxis. A choice of taxis or rental cars was offered in 27 percent of the programs. In 13 percent of the programs, transit agency vehicles provided GRH transportation; of those programs, nine percent used both taxis and agency vehicles and four percent used agency vehicles exclusively. Some of the GRH programs provided service all the way from place of work to home; others required that the trip be made partly by taxi and partly by transit.

The FTA study found that the most common method of payment for GRH services, used in 56 percent of the programs examined, was to issue vouchers accepted by participating taxi or rental car companies. In the other 44 percent of programs, the payment method was equally divided between direct payment to the vendor by the program administrators and reimbursement to the user for payment to the vendor. The latter method allowed for reimbursements to be capped or claims to be rejected.

The FTA study results indicated that GRH service was important for assuring workers that emergency transportation would be available if needed; however, the service was not used extensively. On average, during the one year (2005) for which data were examined, only 4.57 percent of the commuters registered for GRH programs used GRH transportation.

3.2.2 Guaranteed Ride Home Programs in Greater Boston

Five GRH programs are currently active in the Greater Boston area. They are summarized below.

A Better City

The A Better City (ABC) Transportation Management Association (TMA) membership includes more than 50 employers, developers, and property managers representing more than 80,000 employees and residents in Boston. The ABC TMA's GRH program is open to employees or tenants of ABC member

organizations who use public transit, carpools, or vanpools, or who walk or bike to work at least three days a week.

Program participants are eligible for a maximum of six free rides per year for qualifying emergency trips. Service is provided by Metro Cab (an association of independent taxi operators) or by Uber or Lyft. When signing up for the program, a participant is issued an electronic voucher valid for the full cost of a trip, including gas, tolls, and gratuity, with no distance limits. After completing a trip, the user submits a confirmation report and is issued a new voucher if the annual limit has not been reached. Participants may also use a taxi service other than Metro Cab, but must pay for those trips and submit claims for reimbursement to the ABC TMA.

Trips that qualify under the GRH program include travel for an emergency or illness, either of the participant or someone the participant cares for; travel resulting from mandated unscheduled overtime; unexpected changes to a carpool or vanpool schedule; and damage to a bicycle that makes it unusable.

Trips that do not qualify include travel from home to work or trips resulting from voluntary overtime; inclement weather; city, state, or national emergencies; MBTA service failures; celebrations that are not during work hours; scheduled meetings; scheduled overtime; events taking place after normal business hours; and building evacuations.

Charles River Transportation Management Association

The Charles River TMA website lists 23 member organizations in Cambridge, including employers, the City of Cambridge, the Massachusetts Institute of Technology, commercial property managers, and residential property managers. Employees of these organizations are eligible to register for the organization's ERH program if they use public transportation, bike, walk, or carpool to work.

Qualifying trips include personal emergencies such as illness of a participant or family member, a flat tire or excessive snow if the primary method of transportation is biking, and unexpected overtime work. Non-qualifying trips include those resulting from transit delays, weather events, or trips originating outside the workplace.

For a qualifying trip, a participant may use any ridesharing app or cab company to get home and submit a request for reimbursement. The Charles River TMA website does not state if there is an annual limit on the number of trips per participant.

Seaport Transportation Management Association

The Seaport TMA website lists 56 member companies or organizations in South Boston. Employees of these TMA members are eligible to participate in the GRH program if they commit to commuting by transit, carpooling, biking, or walking at least two days a week instead of driving a single-occupant vehicle.

Participants are allowed to make as many as four GRH trips per year. These are made by taxi from a participating cab company, and the trips are paid for with vouchers that include the fare and tip. No limit on trip distance is specified. The list of qualifying and non-qualifying trips is essentially the same as that of the Charles River TMA.

Medical Academic and Scientific Community Organization

The website of the Medical Academic and Scientific Community Organization (MASCO) lists 16 member organizations and four associate members, mostly located in the Fenway and Longwood Medical Area in Boston. The total employment of these organizations is stated to be more than 45,200. MASCO's ERH program is open to employees of member and associate member organizations who walk, bike, carpool, vanpool, or take public transportation to work. The program is not open to students.

The ERH program is to be used for an unexpected personal emergency during the day. Participants may use the service for as many as five trips a year. Transportation is provided either by taxi or Lyft. The service is free to users.

Allston/Brighton Transportation Management Association

The Allston/Brighton TMA membership includes four employers and 12 developers and property managers, mostly in the Allston and Brighton neighborhoods of Boston, representing more than 12,000 employees and residents. Eligibility in the Allston/Brighton TMA's GRH program is open to employees or tenants of member organizations who currently use public transit, carpool, vanpool, walk, or bike to work at least three days a week. The ABC TMA manages the program for the Allston/Brighton TMA and, therefore, the rules and procedures are identical to those of the ABC TMA described above.

3.2.3 Guaranteed Ride Home Programs in the Suburbs

Middlesex 3 Transportation Management Association

Membership in the Middlesex 3 TMA is open to any public or private business, educational institution, or residential complex in Bedford, Billerica, Burlington, Chelmsford, Lowell, Tewksbury, Tyngsborough, and Westford. Of these towns, only Bedford and Burlington are within the Boston region.

The Middlesex 3 TMA's ERH program is available to any registered participant who has traveled to work by carpool, vanpool, bike, walking, or public transportation on the day that the ride home is needed. The ride may be made either by rental car or by taxi at no cost to the user. Most rides are arranged within 30 minutes of a request.

Junction Transportation Management Organization

Membership in the Junction Transportation Management Organization (TMO) is open to any business or commercial or residential development in Andover, North Reading, Reading, Tewksbury, Wilmington, or Woburn. Of these municipalities, all except Andover and Tewksbury are within the Boston region. As of June 2019, the Junction TMO website listed only five members, including three in Andover, one in Wilmington, and one in Woburn. The Woburn member's site is 0.6 miles walking distance from the commuter rail station at the Anderson RTC, as discussed in the Woburn case study area in this report.

The Junction TMO's GRH program is for employees of member businesses who rideshare, take transit, bike, or walk to work. The GRH service is provided by Uber and is billed directly to the Junction TMO unless it is determined that the trip does not qualify for the service.

128 Business Council

The membership of the 128 Business Council includes 44 businesses and other organizations. They are located in the towns of Lexington, Bedford, and Needham and the cities of Waltham and Newton, all of which are located along Route 128.

The 128 Business Council's ERH program is for employees of member businesses and organizations who commute at least two days per week on a regular basis by carpool, vanpool, bike, walking, or transit, which may include shuttles operated by the 128 Business Council. An individual is limited to using the service two times during any six-month period.

Acceptable reasons for use of the ERH include becoming too ill at work to walk home after walking to work; a sudden illness of a family member; an unexpected overtime work assignment; a carpool driver leaving early; and a bicycle getting a flat tire or other damage on the way to work. Unacceptable reasons for use of the ERH include personal errands; pre-planned medical appointments; business-related travel; working late without a supervisor's request; early departure or delays due to inclement weather or utility failure; and an injury on the job that qualifies for a workers' compensation claim.

To use the ERH service the commuter must first obtain approval from his/her supervisor and then contact an approved service provider. For trips shorter than 10 miles, or after 6:00 PM, the choices of provider are Uber, Lyft, three Waltham-based taxi companies, and a Waltham-based car service. For trips longer than 10 miles between 8:00 AM and 6:00 PM, the commuter must contact the nearest office of Enterprise Rent-a-Car in Lexington, Waltham, or Needham. Enterprise will pick the commuter up at the work location.

Regardless of which ERH service is used, the commuter must initially pay for the ride. The 128 Business Council will reimburse a maximum of \$50.00 per trip if a receipt is submitted within 30 days of the trip.

Two of the case studies in this report include sections of Waltham and Needham that are served by the 128 Business Council's shuttles. The shuttles discussed in the case studies can be used either by employees of 128 Business Council members or by employees of non-member companies, but non-member employees are charged higher fares. Only member employees would be eligible to use the ERH service if they needed to return home when the shuttle is not operating.

3.3 POTENTIAL ADDITIONAL GUARANTEED RIDE HOME SERVICE FOR CASE STUDY COMMUNITIES

As discussed above, most GRH/ERH programs are open to commuters who use any means of transportation other than driving alone. The present study is concerned with reverse commuting by transit, so GRH/ERH services for transit users in the four case-study communities are discussed below.

As noted above, Woburn employers are eligible to join the Junction TMO, which has a GRH program. Burlington employers are eligible to join the Middlesex 3 TMA, which has an ERH program. However, the TMA website shows only one employer in Burlington as a current member. Employers who do not want to join the Junction TMO or the Middlesex 3 TMA might want to establish their own ERH program.

Transit alternatives for reverse commuting to Waltham vary among work locations. As noted above, commuters who use the 128 Business Council's shuttles from Alewife Station or Waltham Station to go to work locations at companies or organizations that are members of the 128 Business Council are already eligible for the organization's ERH program. Employers who are not currently members might find that joining would improve their ability to attract transit-dependent employees because of the ERH service and the lower shuttle

fares for member employees. Employers who do not want to join the 128 Business Council might consider subsidizing off-peak taxi or ride-sharing service to Alewife Station or Waltham Station for employees who use the 128 Business Council's shuttles during peak hours.

At present, the only direct transit service to the densest concentration of employers in Needham consists of the 128 Business Council's shuttles from the Newton Highlands Station on the Green Line. Shuttle passengers who work for companies that are 128 Business Council members are eligible to use the existing ERH program. However, use of the shuttles is not restricted to employees of these companies.

Employers who are not currently members of the 128 Business Council might find that joining would improve their ability to attract transit-dependent employees because of the ERH service and the lower shuttle fares for member employees. Employers who want to offer GRH/ERH service without joining the 128 Business Council could subsidize trips by taxis or ride-sharing services to Newton Highlands Station during hours when the shuttles do not operate. These trips would be slightly more direct than the shuttle trips because they would not have to serve all the stops along the route.