

MEMORANDUM**TO: Transportation Planning and Programming
Committee****January 13, 2009****FROM: Alicia Wilson****RE: Recommended Improvements to MBTA Feeder Bus Routes to Alewife Station to
Increase Feeder Bus Ridership to the Red Line****INTRODUCTION**

The purpose of this memorandum is to fulfill the requirements of Task 2 of the work program “Alewife Station: Improvements to Feeder Bus Routes, Bus Access and Egress, and Route 2/Route 16 Intersection,” November 1, 2007. Task 2 pertains to improving feeder bus routes. Bus access and egress, and the operations of the Route 2/Route 16 intersection are examined in separate technical memos.

Alewife Phase I study analysis revealed that almost one-third of vehicles observed parked at the Alewife MBTA station are garaged in Arlington and Lexington, both of which have bus service to the MBTA station. Given that the Alewife Station garage is over capacity and the surrounding roadway network is severely congested, it makes sense to examine the coverage of the Arlington and Lexington bus routes to the garage to determine if there are potential route changes that would encourage many of those who presently drive to Alewife to take a bus to the station instead. This analysis was not performed for Bedford and Burlington, the other two communities served by MBTA buses from Alewife, since less than 5% of all parked vehicles are from these towns.

Figure 1 shows the number of vehicles by census block group observed at the Alewife garage in May 2007 that are garaged in Lexington and Arlington. The numbers of vehicles observed from each community are almost equal, even though Arlington’s population is larger than Lexington’s.

An analysis of the potential of fixed-route bus service requires the consideration of demographic characteristics such as population density, income, number of commuters who work in Boston and Cambridge, and the proportion of these commuters who live within one-quarter mile of an existing bus stop.¹

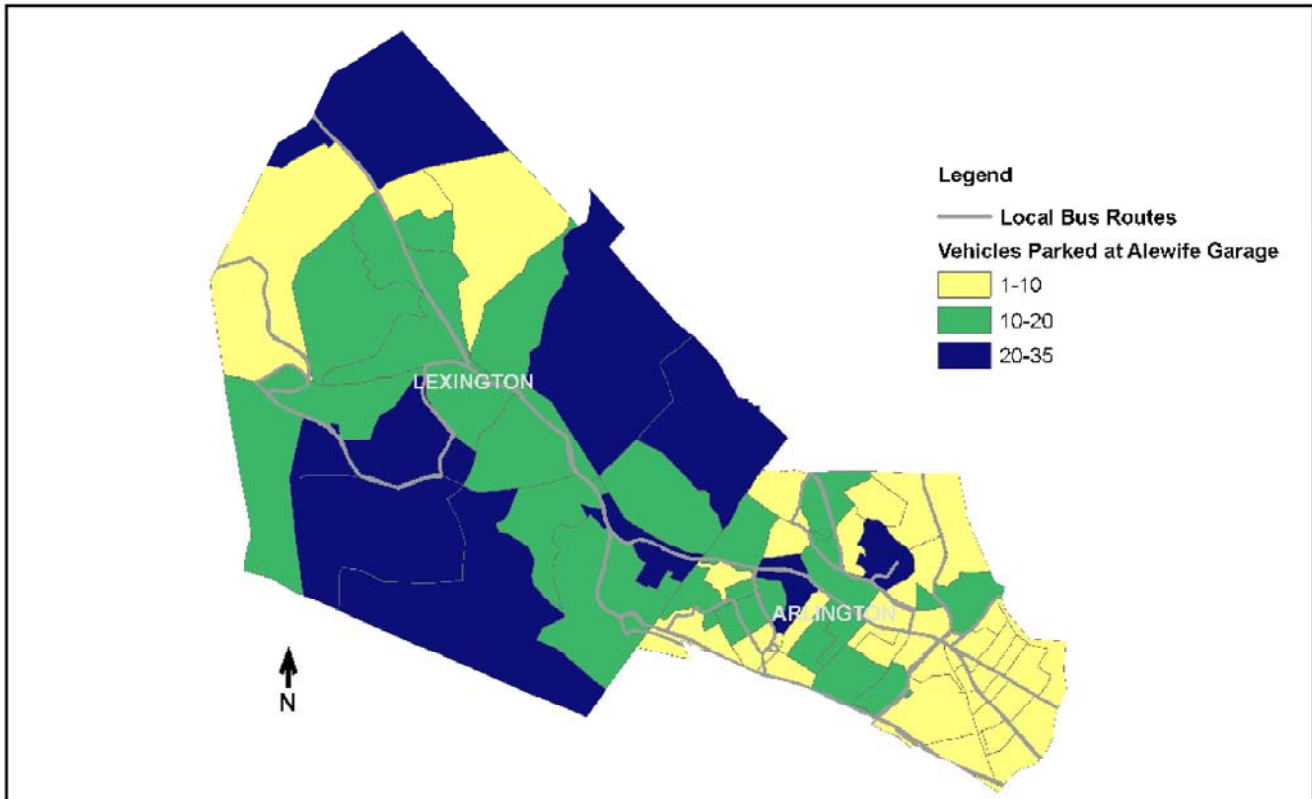
PHYSICAL CHARACTERISTICS

Development is spread throughout Lexington but is most concentrated in the very center of town and the area bounded by Route 2 to the south and Route 128 to the west and north. The

¹ One-quarter mile is the generally accepted maximum distance a person will walk to bus service.

concentration of development lessens outside this boundary, particularly in the western corner of town at the border of Lincoln and Bedford. The entirety of Arlington is quite densely developed. With a few exceptions, the bus routes operate on major roadways.

FIGURE 1
Origins of Vehicles Parked in the Alewife Garage



CHARACTERISTICS THAT AFFECT TRANSIT USAGE

Characteristics that often affect transit usage in the metropolitan area are:

- Population density
- Vehicle ownership
- Median household income
- Residents working in Boston and Cambridge
- Percent of residents working in Boston and Cambridge living within one-quarter mile of a bus stop

Each characteristic as it applies to Arlington and Lexington is discussed below.

Population Density

The 2006 MBTA accessibility standards/guidelines (the latest available²) define the minimum levels of service that should be provided, if possible, for access to the transit system, in terms of geographic coverage. Coverage is expressed as a guideline rather than a standard, because uniform geographic coverage cannot always be achieved due to constraints such as topographical and street network restrictions. In addition, coverage in some areas may not be possible due to the infeasibility of modifying existing routes without negatively affecting their performance.

The guideline states that on weekdays and Saturday, access to transit service will be provided within a quarter mile walk to residents of areas served by bus, light rail, and/or heavy rail with a population density of greater than 5,000 persons per square mile. Figure 2 shows population density by census block group for the two communities. Arlington is home to a population of 42,389 in 5.5 square miles, while Lexington has a population of 30,355 in 16.4 square miles. Even though there are some high-density block groups in Lexington, concentrated along Massachusetts Avenue, most of the block groups with the highest population densities are located in Arlington. Block groups in Lexington generally have less than 2,500 people per square mile, while many in Arlington have 8,000 or more people per square mile. Only one block group in Lexington has a density that exceeds 5,000 people per square mile.

Transit is generally assumed to be most suitable in areas of high density, less so in medium-density locations, and difficult to justify in low-density locations due to the low concentration of trip origins and destinations and the consequent challenges to providing these locations with public transit that is both convenient and cost-effective.³ All of the higher-density block groups in both Arlington and Lexington currently have MBTA bus service.

Vehicle Ownership

The level of vehicle ownership can be an indicator of the demand for transit. The lower the level of vehicle ownership, the greater the demand for transit. The level of vehicle ownership is generally lower in Arlington than in Lexington (Figure 3). All block groups with less than one vehicle per household are located in Arlington. All with two or more vehicles per household are located in Lexington.

² MBTA Service Delivery Policy, Service Standards, 2006, p. 6. The MBTA is in the process of updating its service standards.

³ Draft technical report: *Analysis of the Potential for Demand-Responsive Service in the Town of Lexington*, Robert Guptill, CTPS, February 27, 2008, p. 8.

FIGURE 2
Population Density, 2000

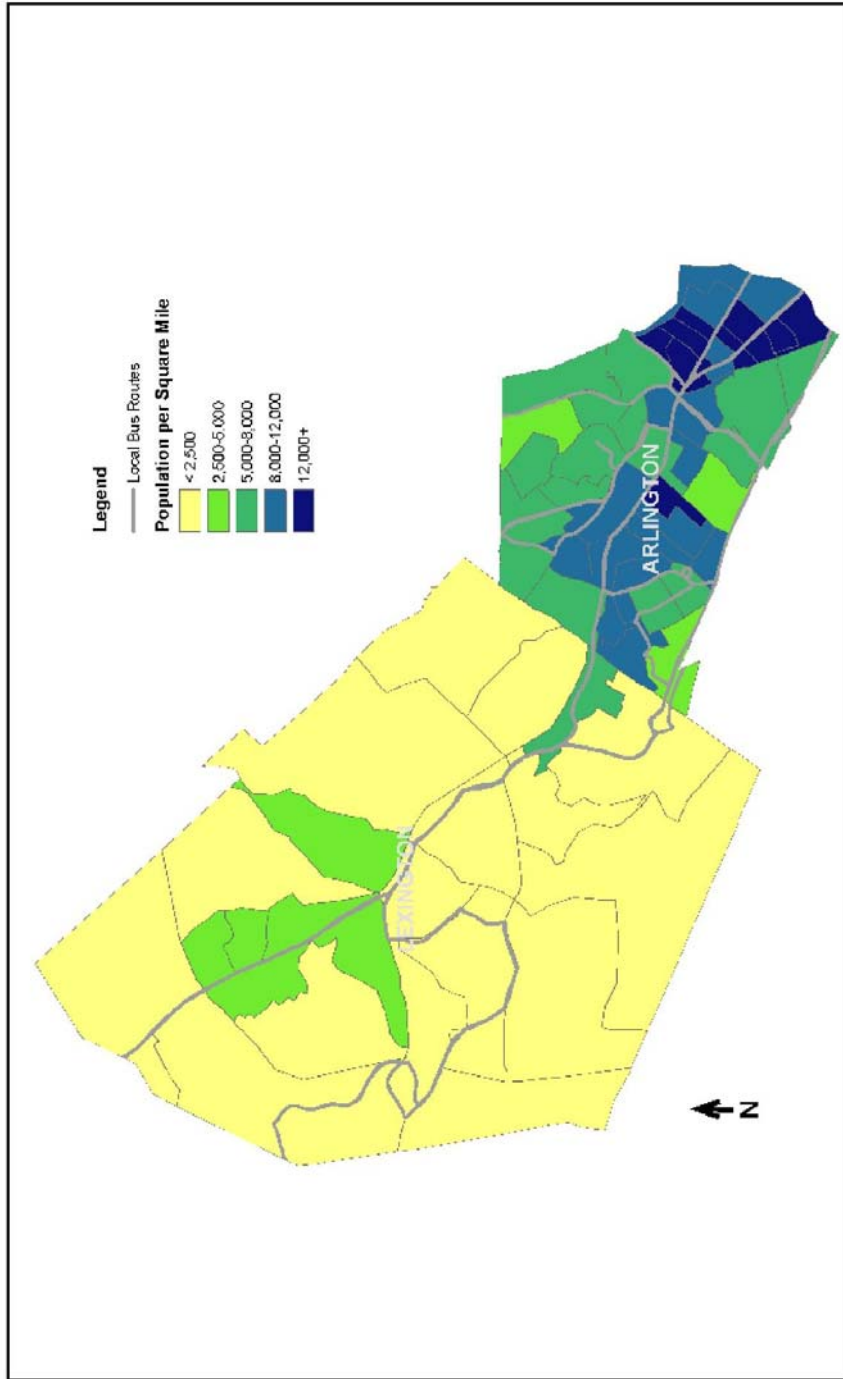
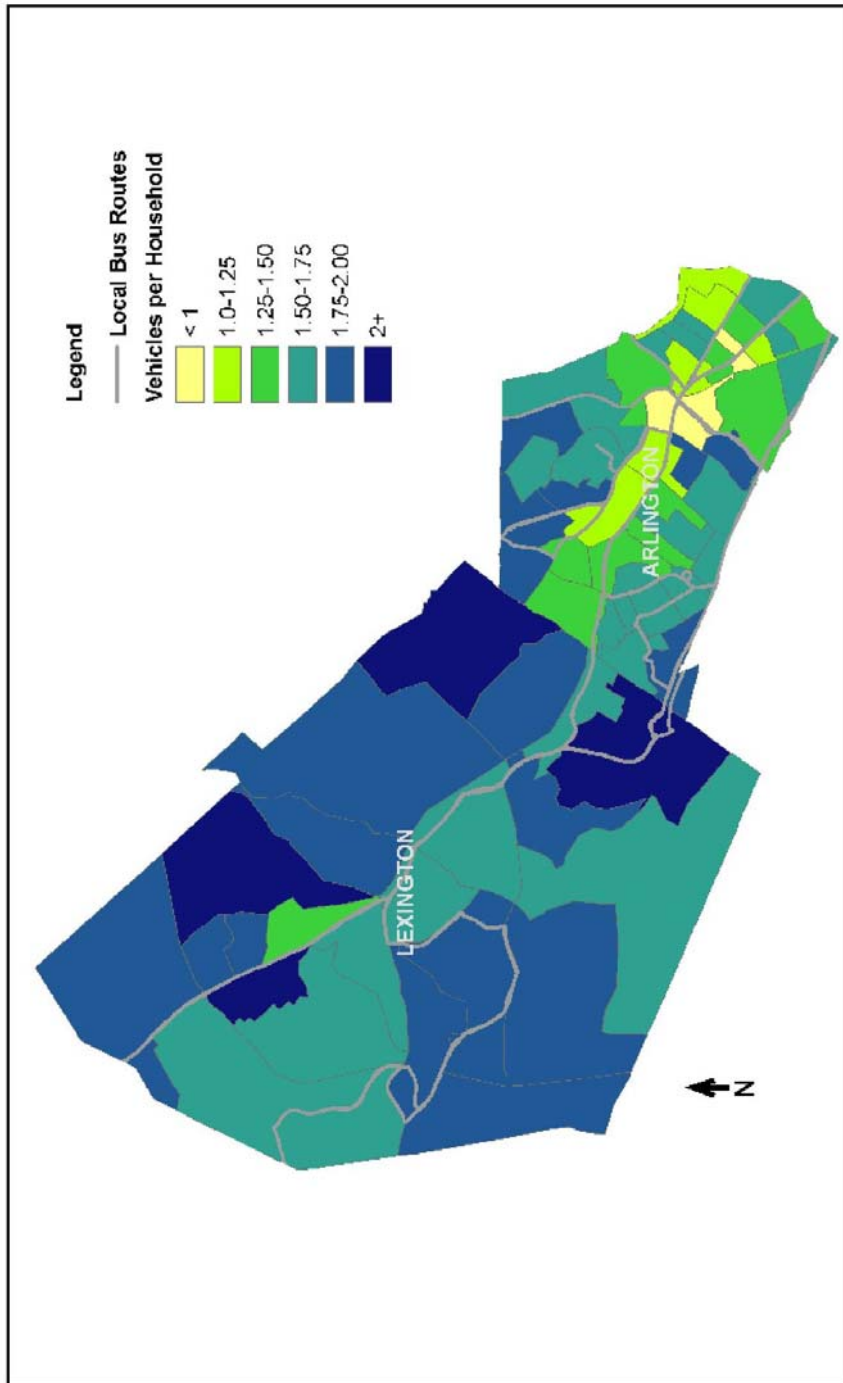


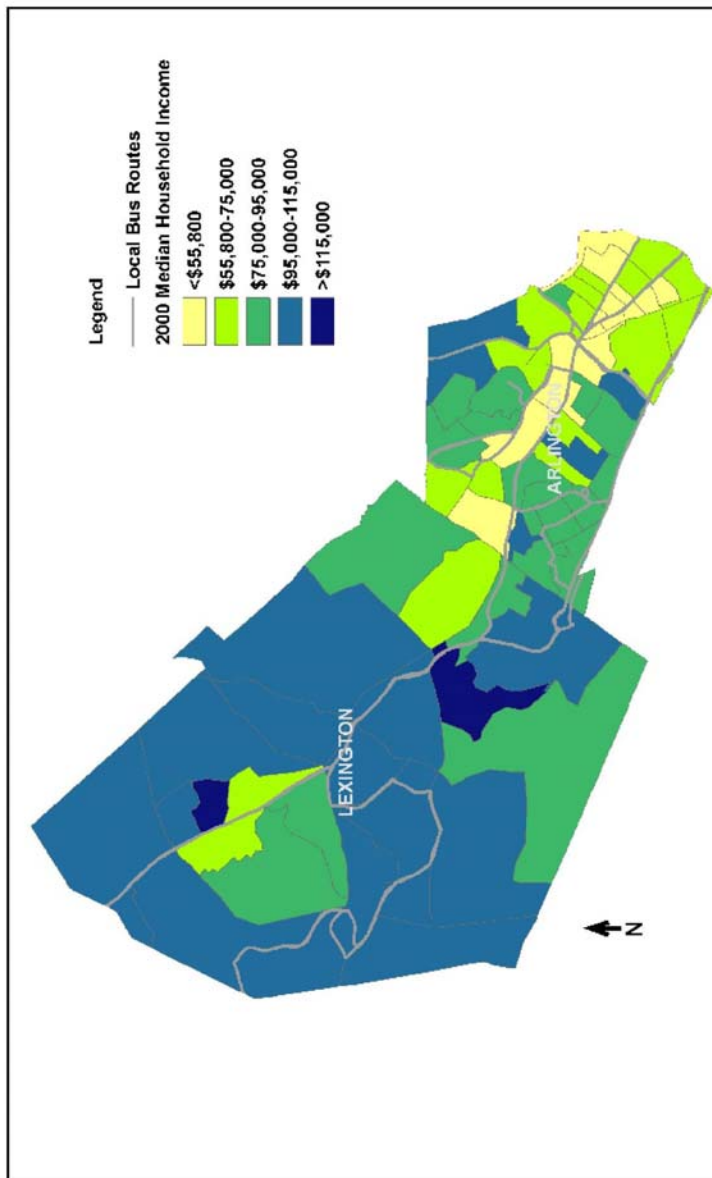
FIGURE 3
Vehicle Ownership, 2000



Median Income

Arlington's median household income is \$64,344; Lexington's is \$96,825. Both are higher than the median Boston Region MPO household income of \$55,800.⁴ Less than 20% of the census block groups in the two communities have median household incomes that fall below the MPO median. All are in Arlington, all have bus service, and all but one had 10 or fewer cars parked at the Alewife garage. More than 50% of Lexington's block groups have median incomes that exceed \$100,000

FIGURE 4
Median Household Income, 2000



⁴ 2000 U.S. Census

Residents Working in Boston and Cambridge

Most MBTA service is radial in nature, directed towards Boston and Cambridge, both of which have high employee concentrations. Thirty-nine percent of commuters from Arlington work in Boston and Cambridge; 27% of those from Lexington do so. Thirty percent of these commuters to Boston and Cambridge use transit, compared with 12% of all commuters from Arlington and Lexington.

One-quarter mile is generally considered to be the maximum distance a person will walk to bus service. Altogether, two-thirds of the communities' commuters to Boston and Cambridge live within one-quarter mile of a bus stop (Figure 5). However, the profile differs by community. Eighty percent of those who commute to Boston and Cambridge from Arlington live within one-quarter mile of a bus stop. Forty percent of these commuters use transit; 49% drive alone. Only 19% of Lexington's commuters to Boston and Cambridge live within one-quarter mile of a bus stop. Only 23% percent of these commuters use transit; 71% drive alone.

BUS SERVICE

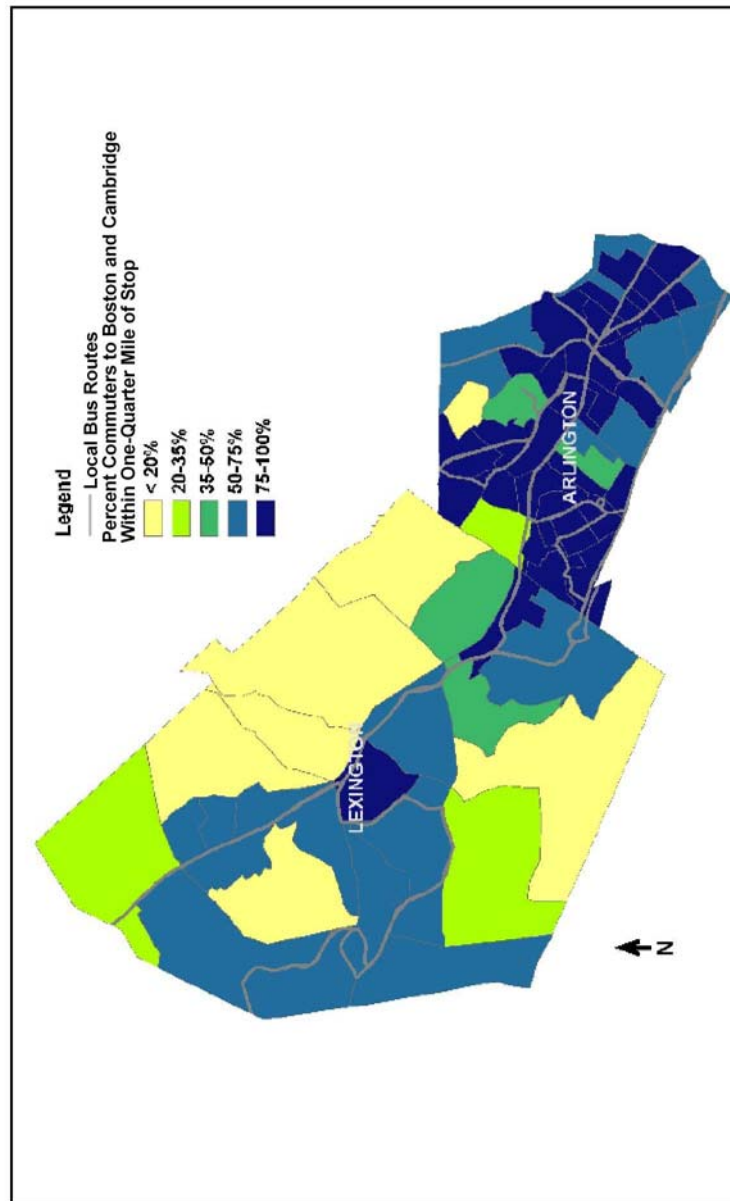
MBTA Bus Service

MBTA bus routes 62, 67, 76, 79, 84 and 350 provide service to Alewife Station from the study area. Routes 62, 67, 76, and 84 operate on 30-minute headways during peak periods. Route 79 operates on 16-minute headways. Route 350 headways vary, but are approximately 20 minutes.

Table 1 shows how each route performs during weekday peak periods. During the morning peak period, the highest per-trip inbound boardings occur on Routes 62 and 67, the lowest on Route 79. Outbound during the evening peak period, the highest per-trip boardings occur on Route 62, the lowest on Route 84. Load factors, the ratio of passengers to capacity in the peak direction, are generally higher during the morning than in the evening. The load factors indicate that, on average, Route 62 inbound buses are close to seated capacity in the morning.

MBTA operations are generally level-funded. An existing route is evaluated on a net cost/passenger ratio that is determined by adding the cost per weekday peak hour, the cost per weekday off-peak hour, and the cost per mile, and subtracting the average fare per passenger. The average net cost during the last service plan was approximately \$1.50 per passenger. A ratio that is three times the system average is failing. Route 76 exceeds this ratio.

FIGURE 5
Proportion of Commuters to Boston and Cambridge
Living Within One-Quarter Mile of an MBTA Bus Stop



**TABLE 1
MBTA Bus Route Performance Statistics**

| AM PEAK | Route | | | | | |
|----------------------------------|--------------|-----------|-----------|-----------|-----------|------------|
| | 62 | 67 | 76 | 79 | 84 | 350 |
| Inbound | | | | | | |
| Average Time Period Maximum Load | 38.2 | 35 | 21.8 | 15.3 | 27.3 | 29.2 |
| Average Time Period Load Factor | 0.96 | 0.88 | 0.54 | 0.38 | 0.68 | 0.73 |
| Average Boardings per Trip | 40 | 40 | 25 | 17 | 27.5 | 32 |
| Total Scheduled Trips | 4 | 4 | 4 | 9 | 4 | 6 |
| Outbound | | | | | | |
| Average Time Period Maximum Load | 25.7 | 6.2 | 15.3 | 8.2 | 0 | 20.8 |
| Average Time Period Load Factor | 0.64 | 0.16 | 0.38 | 0.21 | 0 | 0.52 |
| Average Boardings per Trip | 31.7 | 1.2 | 14.5 | 9.7 | 0 | 23.6 |
| Total Scheduled Trips | 3 | 5 | 4 | 9 | 4 | 5 |
| PM PEAK | | | | | | |
| Inbound | | | | | | |
| Average Time Period Maximum Load | 29.3 | 4.2 | 15.8 | 5.2 | 5.6 | 15.8 |
| Average Time Period Load Factor | 0.73 | 0.1 | 0.39 | 0.13 | 0.14 | 0.39 |
| Average Boardings per Trip | 34.2 | 6.6 | 16.2 | 7 | 6.4 | 19 |
| Total Scheduled Trips | 5 | 5 | 4 | 11 | 5 | 6 |
| Outbound | | | | | | |
| Average Time Period Maximum Load | 25.5 | 21.3 | 22 | 11.1 | 14 | 0.67 |
| Average Time Period Load Factor | 0.64 | 0.53 | 0.55 | 0.28 | 0.35 | 0.67 |
| Average Boardings per Trip | 29.3 | 18.7 | 24.5 | 13.4 | 9 | 32 |
| Total Scheduled Trips | 6 | 6 | 4 | 14 | 6 | 7 |
| 2006 Weekday Cost per Passenger* | \$2.50 | \$3.69 | \$6.02 | \$3.09 | \$3.01 | \$3.39 |

Route 62: Bedford V.A. Hospital to Alewife Station

Route 67: Turkey Hill to Alewife Station

Route 76: Hanscom Air Base to Alewife Station via Mass. Ave.

Route 79: Arlington Heights to Alewife Station via Mass. Ave.

Route 84: Arlmont Village to Alewife Station

Route 350: North Burlington to Alewife Station via Burlington Mall

*2006 average weekday cost per passenger for all MBTA bus routes was \$1.50.

Table 2 gives bus stop information for each route. Route 62 has the most stops, with 77 over 13 miles; Route 79 has the fewest, with 22 stops over 3.85 miles. The MBTA does not have an adopted service standard pertaining to the spacing of bus route stops (it is working on drafting such a guideline). Local communities generally dictate placement and spacing of stops.

Bus stop spacing affects demand by impacting access and travel time. “In general, there is a tradeoff between closely spaced, frequent stops with a shorter walking distance but more time on the vehicle and stops spaced further apart with a longer walking distance, but less time on the vehicle.”⁵ DC Metro officials indicate that bus service would be 20%-30% faster in limited-stop corridors. After introducing skip-stop service, which combines both local-stop and limited-stop sections, Dallas Area Rapid Transit (DART) officials indicate that ridership increased by 12.3% and speed increased by 10% during a one-year period.⁶ A CTPS memorandum indicates that a bus route strategy in a selected corridor that includes fewer bus stops would bring about reductions in peak hour average bus travel time that are in the range of those observed by D.C. Metro and DART.⁷

TABLE 2
Distance Between Inbound MBTA Bus Route Stops (miles)

| Route Number | Length (Miles) | Number Stops | Distance Between Stops | | | |
|--------------|----------------|--------------|------------------------|---------|---------|---------|
| | | | Median | Average | Minimum | Maximum |
| 62 | 13 | 77 | 0.14 | 0.17 | 0.05 | 0.74 |
| 67 | 4.5 | 23 | 0.18 | 0.2 | 0.08 | 0.62 |
| 76 | 17.6 | 57 | 0.21 | 0.31 | 0.05 | 1.97 |
| 79 | 3.8 | 22 | 0.16 | 0.17 | 0.09 | 0.69 |
| 84 | 4.8 | 25 | 0.16 | 0.19 | 0.05 | 0.62 |
| 350 | 14.8 | 68 | 0.16 | 0.22 | 0.05 | 0.86 |

LEXPRESS Bus Service

The Town of Lexington operates LEXPRESS, a minibus system with six routes operating on one-hour headways. Service begins at 6:35 AM and ends at 6:25 PM. Figure 6 shows LEXPRESS and MBTA bus service in Lexington and Arlington. All routes stop on demand outside of Lexington Center. Within the Center, routes stop at the following locations, all of which are within easy walking distance of MBTA bus stops:

OUTBOUND

- Depot Square, *all routes*
- MBTA stop across from the Post Office, *Routes 1, 3*
- Grant Street next to Post Office, *Route 5*

INBOUND

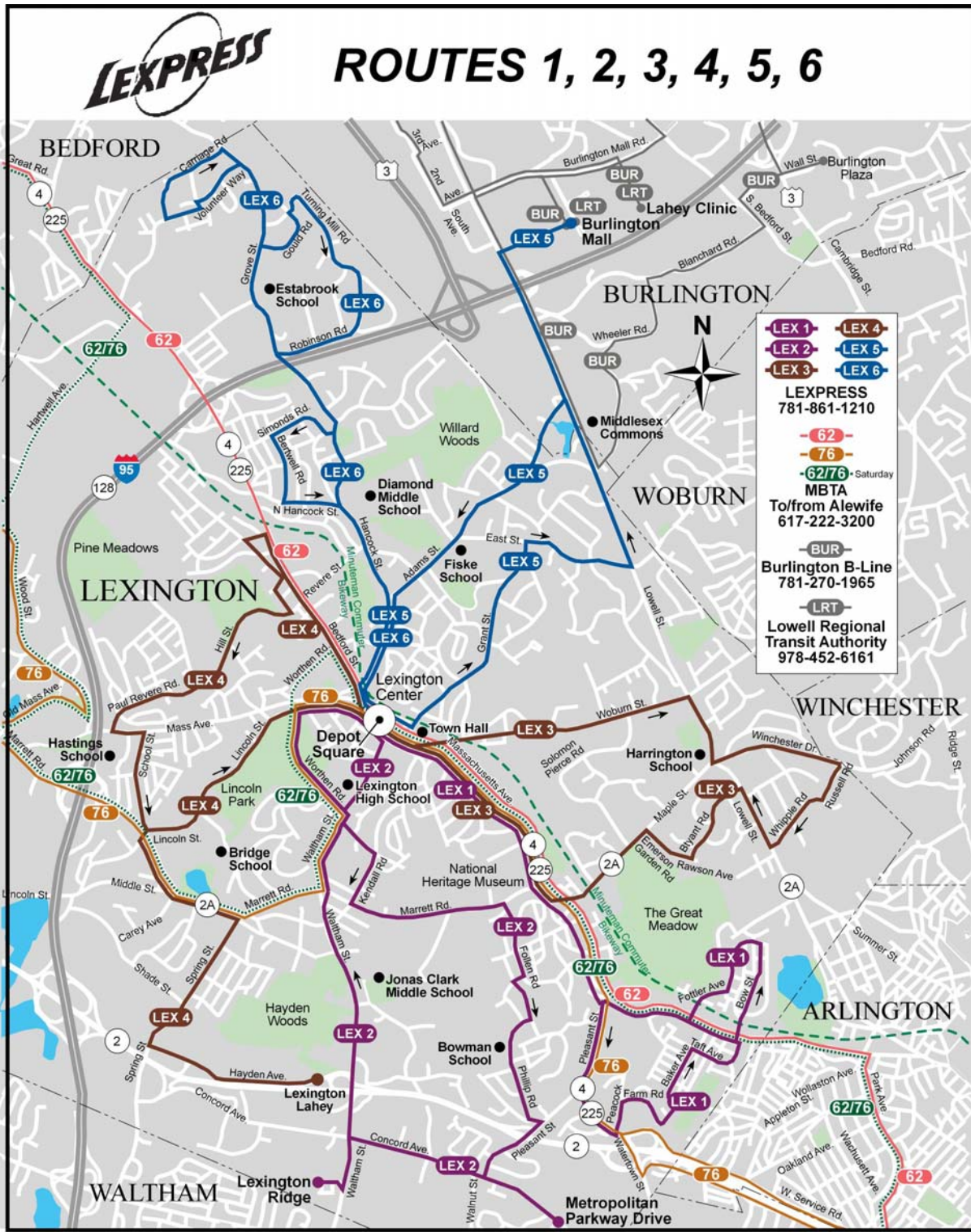
- Depot Square, *all routes*
- Town Hall, *Routes 1, 3*
- MBTA stop across from Depot Square, *Routes 4, 5, 6⁸*

⁵ “DC Metro May Increase Bus Stop Spacing to Improve Service,” *Urban Transportation Monitor*, June 13, 2008, p. 1.

⁶ *Ibid.*, p. 2.

⁷ “MBTA Transit Signal Priority Study: Arborway Corridor,” draft memorandum, CTPS, July 11, 2008, p. 13.

⁸ <http://ci.lexington.ma.us/Lexpress/lexpress.htm>.



Courtesy of the Town of Lexington

CTPS

FIGURE 6
LEXPRESS and MBTA Bus Routes 62 and 76

*AlewifStudy:
Phase II*

Potential Transfers Between LEXPRESS and MBTA Routes

Table 3 shows LEXPRESS and MBTA peak period schedules in Lexington Center. The LEXPRESS schedule shows when buses leave Depot Square; MBTA schedules show arrival times. In practice, both are affected by traffic and weather conditions. Since LEXPRESS serves the high school, the number of students boarding can also affect morning trip times.

During the morning, commuters wishing to transfer from LEXPRESS to Routes 62 or 76 to arrive in Cambridge or Boston before 9:00 AM would have to arrive on LEXPRESS at 6:35 or 7:05 AM with 8- to 16-minute layovers. The LEXPRESS morning schedule cannot be changed appreciably, as it ties in with the school schedule.

MBTA Route 76’s evening schedule appears to coordinate with LEXPRESS with a 15-minute layover. Theoretically, Route 62 passengers could connect with LEXPRESS with practically no layover, if LEXPRESS buses could wait for the MBTA bus arriving one or two minutes later.

**TABLE 3
LEXPRESS and MBTA Bus Route 62 and 76 Schedules***

| AM Peak Period Inbound | | | PM Peak Period Outbound | | |
|--|---|---|--|---|---|
| LEXPRESS Departs Depot Square | MBTA Route 62 Arrives at 1666 Massachusetts Ave. | MBTA Route 76 Arrives at 1666 Massachusetts Ave. | LEXPRESS Departs Depot Square | MBTA Route 62 Arrives at Massachusetts Ave. at Depot Square | MBTA Route 76 Arrives at Massachusetts Ave. at Depot Square |
| 6:35 AM | 6:51 AM | 7:00 AM | 4:00 PM | 4:01 PM | 4:16 PM |
| 7:05 | 7:13 | 7:28 | 4:30 | 4:31 | 4:46 |
| | 7:42 | 7:58 | 5:00 | 5:01 | 5:16 |
| | 7:53 | | 5:30 | 5:31 | 5:46 |
| 8:00 | 8:12 | 8:31 | 6:00 | 6:03 | 6:16 |
| 8:30 | 8:42 | 9:01 | | | |

*MBTA schedule effective 12/27/08

A comparison of Figures 1, 3, 5 and 6 shows that LEXPRESS operates in areas that are not very densely populated, where many commuters to Boston and Cambridge live more than one-quarter mile from an MBTA bus route and where many commuters who park at the Alewife garage originate. Most LEXPRESS routes stop at MBTA stops across from Depot Square or across from the post office. Better coordination between the two services might attract some additional commuters; however, people generally dislike bus-to-bus transfers, and they would also have to pay fares on both the LEXPRESS buses and on MBTA buses. If they chose to do this, LEXPRESS’s operating costs would increase if an additional vehicle were required. Several LEXPRESS routes operate near MBTA stops on MBTA Routes 62/76. Since LEXPRESS stops

on demand outside the Center, these locations are additional opportunities for riders to transfer to MBTA buses.

To avoid issues with changing LEXPRESS service, perhaps the Town of Lexington, under the Boston Region MPO's Suburban Mobility Program, could apply for funds for a peak period shuttle to Alewife. If the shuttle proves that there is ridership, perhaps the MBTA can offer service.

CONCLUSIONS AND RECOMMENDATIONS

MBTA bus routes generally operate on major roads in Arlington and Lexington; however, several routes do run on local roads in each community.

The major conclusion from this study is that the current routing of MBTA bus service through Arlington and Lexington seems to be appropriate. There is more service in densely populated neighborhoods. Block groups with the lowest level of vehicle ownership generally have the largest proportions of Boston/Cambridge commuters who live within one quarter mile of an MBTA bus stop, and these block groups also have fewer vehicles parked in the Alewife garage. In addition, bus service seems to effectively serve those with lower incomes, as 81% of those who have household incomes below the MPO median live within one-quarter mile of a bus stop.

The following are possible route modifications that might encourage more commuters to ride buses to Alewife Station. Possible difficulties are also mentioned.

- With community input and an awareness of local characteristics, the MBTA and the communities involved should consider modifying the spacing of stops on some or all of the bus routes in the study area.
- Route 67 runs along the border of an Arlington block group that has one of the lowest levels of accessibility to bus service in the town, and the route also has a spur (now inactive until redevelopment in the area is complete) into that block group. Forty-seven percent of this block group's commuters to Boston and Cambridge live within one quarter-mile of this bus route, which is routed through what appears to be one of the less densely developed areas of the block group, near the former Symmes Hospital. The number of vehicles from this block group parked at the Alewife garage falls in the highest category of vehicles parked. Perhaps more of these commuters would use the bus if it were routed through the denser areas of the block group. It is unclear whether there is a specific grade beyond which the MBTA will not operate buses. However, the hilly terrain in this area is a possible impediment to rerouting buses here. This is also a predominantly residential area where local streets might not be able to accommodate regular-size buses.
- At one time, the Route 67 bus extended from Turkey Hill in Arlington into a section of Lexington that has LEXPRESS service, but that portion of the route was discontinued. Perhaps Lexington and the MBTA could explore the feasibility of reinstating the extension.

However, the existing route already operates on a loop. Lengthening the distance and increasing the headway could affect existing ridership.

- Better coordination between LEXPRESS and MBTA services, particularly in Lexington Center in the morning, might attract some additional commuters; however, people generally dislike bus-to-bus transfers, and they would also have to pay fares on both the LEXPRESS buses and MBTA buses. Coordinating services would add to LEXPRESS operating costs and would disrupt school service. Several LEXPRESS routes have sections in common with MBTA Routes 62 and 76. Since LEXPRESS stops on demand outside Lexington Center, riders can be encouraged to transfer to these MBTA routes to Alewife.
- Under the Boston Region MPO's Suburban Mobility Program, the Town of Lexington could apply for funds for a peak period shuttle to Alewife. If the shuttle were to prove that there is sufficient demand, perhaps the MBTA could offer service.

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