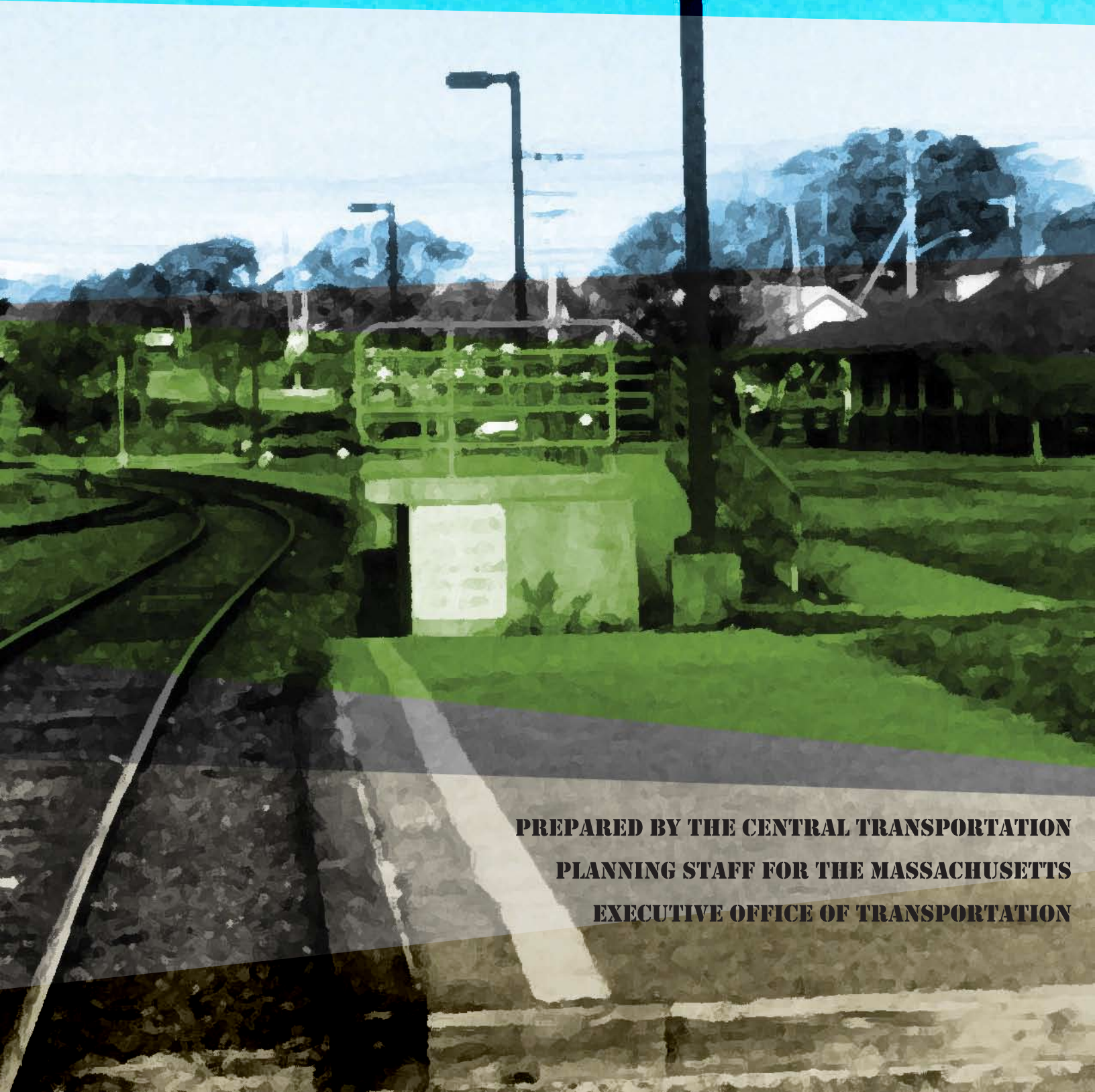


BUZZARDS BAY COMMUTER RAIL EXTENSION FEASIBILITY STUDY



**PREPARED BY THE CENTRAL TRANSPORTATION
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EXECUTIVE OFFICE OF TRANSPORTATION**

Buzzards Bay Commuter Rail Extension Feasibility Study

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EXECUTIVE SUMMARY

At present, the nearest commuter rail service to points in Barnstable County is provided at the outer terminals of the Massachusetts Bay Transportation Authority (MBTA) Kingston and Middleborough/Lakeville lines. These are each about 20 miles north of the Cape Cod Canal. In the past, rail passenger service to Buzzards Bay and points beyond has been provided via a rail line that continues beyond the end of the Middleborough/Lakeville Line, but is currently used only for freight service. U.S. census figures from the year 2000 indicate that more than 4,000 people each day were then commuting to work in Boston or Cambridge from Barnstable County or from intermediate points along the rail corridor between Middleborough/Lakeville and Buzzards Bay. However, the existing commuter rail service captured less than 10% of this traffic.

This study has been prepared by the Central Transportation Planning Staff (CTPS) of the Boston Region Metropolitan Planning Organization in response to a request from the Massachusetts Executive Office of Transportation (EOT) to examine the feasibility of reestablishing commuter rail service as far as Buzzards Bay.

It must be emphasized that neither the MBTA nor EOT currently has any funds programmed for the capital or operating costs of such an extension. Also, more detailed engineering and operational studies would be required to refine the cost and impact estimates if such a project were to move forward.

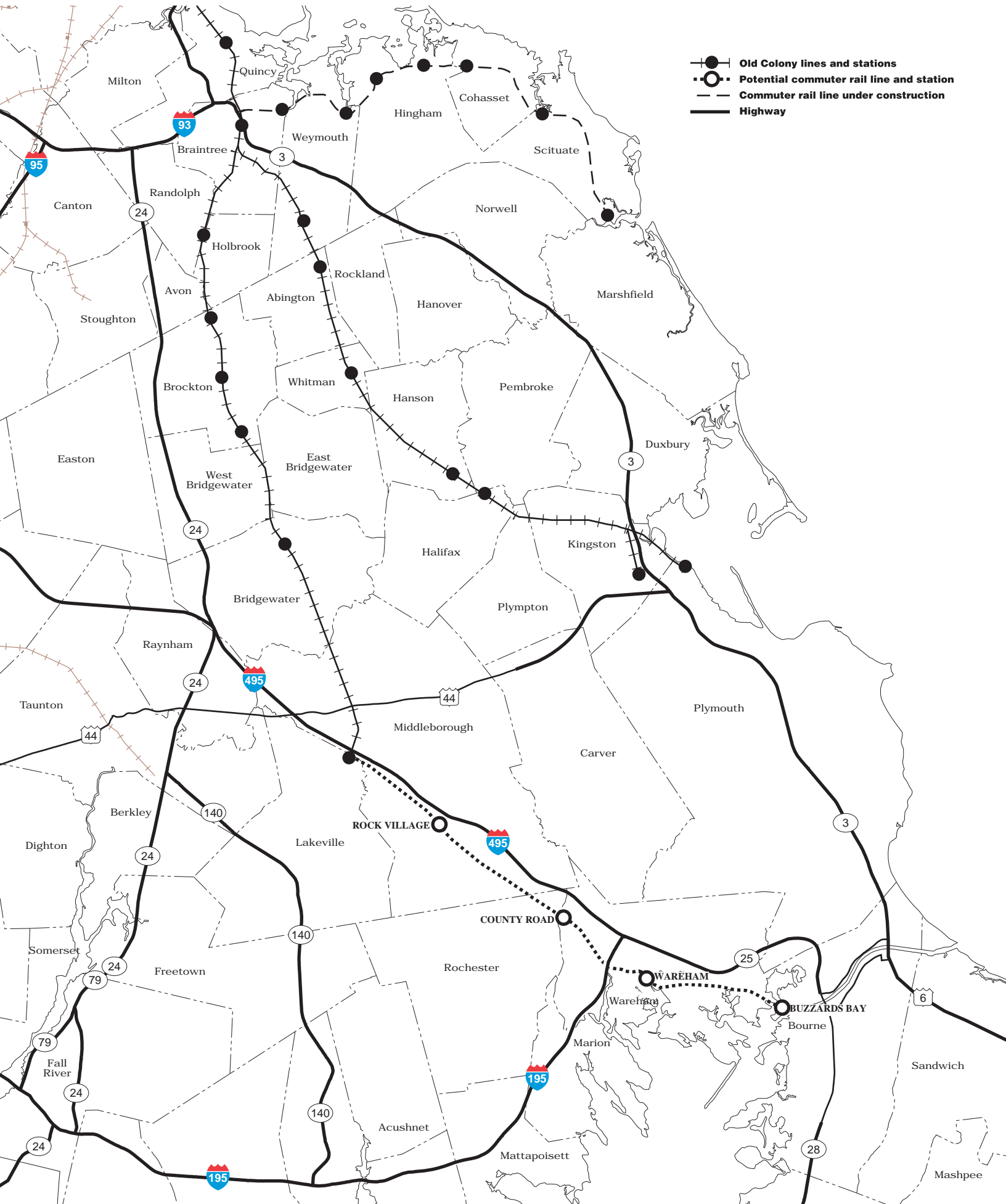
Project Description

A Buzzards Bay commuter rail extension would begin at the outer terminal of the present MBTA Middleborough/Lakeville commuter rail line and run on a railroad line currently used only for freight service, through the towns of Middleborough, Rochester, and Wareham to Buzzards Bay village in the town of Bourne. The alignment is shown on Figure ES-1. The station locations depicted on this figure are assumed for purposes of analysis only. Identification of specific station locations is beyond the scope of this study. Geographic limitations at Buzzards Bay allow little choice other than the past station site for location of platforms and waiting facilities there. The most recent past station site in Wareham has very limited parking capacity, with no room for expansion. To maximize ridership potential, it would be necessary to locate a Wareham station at some other site.

The primary service area of a Buzzards Bay extension would consist of the towns directly on the route and towns directly adjoining these. The latter would include Carver, Marion, Mattapoisett, Sandwich, and Falmouth. In addition to these towns, this study considers all of the rest of Barnstable County to be within the potential market area of a Bourne extension.

Because of track capacity constraints, service on a Buzzards Bay extension would have to be provided by extending existing Middleborough/Lakeville Line trips with no significant changes to their schedules between Middleborough/Lakeville and Boston.

**Figure ES-1
ALIGNMENT AND STATIONS**



Depending on the maximum speeds allowed by track upgrading on the extension and the number and location of intermediate stations, the running time from Buzzards Bay to South Station would range from about 75 to 85 minutes. Times to Boston from a station in Wareham would be about 8 to 12 minutes less.

With zone lengths similar to those on existing MBTA lines, most potential station sites in Wareham would be in fare Zone 8, the highest zone now used. A Buzzards Bay Station could be either in Zone 8 or in a new higher zone. At the time the analysis for this study was conducted, the one-way full fare to downtown Boston from Zone 8 stations was \$6.00, and an unlimited-ride monthly pass cost \$198.00.

Ridership Estimates

The primary travel market served by a Buzzards Bay commuter rail extension would consist of work trips to Boston from homes in Wareham, Bourne, and Cape Cod communities as far east as Barnstable. At present, the predominant travel mode for this traffic is private automobile, with a share of about 70%, including driving alone and carpooling. Well-established private-carrier bus services capture another 15% to 20%.

Potential ridership on a Buzzards Bay extension was calculated by first estimating the shares of work trips to Boston that the extension could be expected to capture, and then adding factors for non-work trips and for trips to other destinations. The work trip share was estimated at the mid-range of the maximum and minimum shares captured by comparable lines in the Boston commuter rail system. Ridership potential in future years was calculated by adding factors for projected increases in population and employment by the year 2020.

Table ES-1 summarizes the results of the ridership estimates. At the travel levels found in the year 2000 census (the last year for which a journey-to-work questionnaire was distributed) the mid-range ridership estimate for a Buzzards Bay extension was 1,766 inbound boardings per day. With estimated changes in overall travel levels up to the year 2006, the estimated extension share would be 2,045 riders. With projected growth to the year 2020, the commuter rail share would be 2,750 riders. All of these estimates are contingent on assumptions that demand would not be limited by parking capacity at stations or passenger capacity onboard trains.

Capital Cost Estimates

A Buzzards Bay commuter rail extension would operate over a rail line that is currently all single-tracked, does not have a working signal system, and last had a major rehabilitation in 1986. Work required to allow restoration of passenger service with travel times competitive with other modes would include the replacement of worn-out crossties, installation of at least one new passing track, upgrading of an existing side track near Buzzards Bay, rebuilding of grade-crossings, and installation of signals.

Installation of new full-length high-level platforms would be required at each station, of which there would be at least two. Parking facilities would need to be provided at each station, with adequate capacity for the number of riders predicted to

Table ES-1
Estimated Mid-Range Inbound Weekday Trip Origins on a Buzzards Bay Extension
Under Year 2000, 2006, and 2020 Total Travel Levels*

Origin Town	2000 Origins	2006 Origins	2020 Origins
Bourne	238	275	335
Falmouth	218	250	300
Sandwich	226	255	280
Barnstable	250	295	385
Mashpee	116	170	320
Yarmouth	97	135	230
Other Barnstable County	<u>81</u>	<u>105</u>	<u>150</u>
Subtotal Barnstable County	1,226	1,485	2,000
Wareham	220	185	185
Carver	63	65	100
Rochester	89	120	190
Marion	106	150	240
Mattapoisett	<u>62</u>	<u>40</u>	<u>35</u>
Subtotal Plymouth County	540	560	750
TOTAL SERVICE AREA	1,766	2,045	2,750

*Note: Totals in this table do not include summer-only recreational trips.

use park-and-ride access. In the case of Buzzards Bay, adequate capacity would require construction of a multi-story parking garage.

Additional coaches would need to be obtained to provide capacity for the net ridership increase on the Middleborough/Lakeville line. More additional coaches and at least one additional locomotive would also be needed because the longer round trip time would not allow each train set to cover as many trips as are covered on the present route.

Based on analysis at the level of detail possible for this study, capital costs for a Buzzards Bay extension at present cost levels would range from about \$81.8 million to \$103.5 million, as shown in Table ES-2.

Operating Cost and Revenue Estimates

Operating costs for a Buzzards Bay extension were calculated for three potential service levels. The minimum service level would provide as many trips as could be operated using only the number of train sets (four) currently assigned to the Middleborough/Lakeville Line. A medium service level would provide some additional service during midday hours using equipment that is assumed to otherwise be idle in Boston at that time of day. The maximum service level would extend all trains

**Table ES-2
Summary of Estimated Capital Costs for Buzzards Bay
Commuter Rail Extension with Maximum Service Level
at 2006 Cost Levels (in \$Millions)***

Item	Amount
Maximum Service – Fixed Facilities	
Track, Signals, and Passing Sidings	\$15.0 to \$18.6
Grade Crossing Surface Replacement	\$1.3
Fencing	\$1.1
Station Platforms and Shelters	\$3.0 to \$5.0
Parking Facilities (with garage at Buzzards Bay)	\$23.3 to \$35.4
Contingencies	\$4.1 to \$5.8
Engineering, Administration and Inspection	<u>\$5.7 to \$8.1</u>
Subtotal	\$53.5 to \$75.2
Maximum Service – Rolling Stock	
Locomotives and Coaches	\$26.7
Engineering, Administration and Inspection	<u>\$1.6</u>
Subtotal	\$28.3
TOTAL CAPITAL COST FOR MAXIMUM SERVICE	\$81.8 to \$103.5

*Note: All costs shown above are preliminary estimates. Detailed engineering studies would be required to refine costs. The total above assumes that no new train layover facilities would be built on an extension.

on the Middleborough/Lakeville Line to Buzzards Bay and would require the assignment of one additional train set to the line. Operating cost estimates for each alternative were based on the increase in daily train-hours for service with an extension compared with present service.

Operating costs for Saturday and Sunday service were estimated for a maximum service level, under which all Middleborough/Lakeville Line trains would be extended to Buzzards Bay on weekends, and for a minimum service level, under which about half of weekend trips would be extended.

Revenue estimates for the minimum, medium, and maximum service levels were estimated under the assumption that all stations on an extension would be in fare Zone 8, with fares at the 2006 level. (The 2007 fare increase had not been approved as of the time that the analysis was done.) The mix of ticket and pass fares was assumed to be similar to that found for existing Zone 8 stations in the MBTA 2005 fare-mix study. Riders diverted to the extension from existing commuter rail stations were assumed to have no net impact on revenue. However, no adjustments were made for possible diversions from other MBTA services such as the Red Line.

Revenue for weekend service was estimated using weekend fare-mix data for the existing system, and assuming that the ratio of weekend to weekday ridership would be

similar to that on existing lines that have weekend service. Estimates of revenue and operating cost for the minimum, medium, and maximum service levels for a Buzzards Bay extension are summarized in Table ES-3.

Table ES-3
Estimated Revenue and Operating Cost for Buzzards Bay Extension
at 2006 Travel, Fare, and Cost Levels

Alternative	Estimated Annual Cost	Estimated Annual Revenue	Revenue/ Cost	Annual Net Cost
Weekday Minimum Service	\$4,125,000	\$2,316,000	0.561	\$1,809,000
Weekday Medium Service	\$7,864,000	\$2,641,000	0.336	\$5,223,000
Weekday Maximum Service	\$9,750,000	\$4,063,000	0.417	\$5,687,000
Saturday Minimum Service	\$1,281,000	\$116,000	0.091	\$1,165,000
Saturday Maximum Service	\$1,303,000	\$203,000	0.156	\$1,100,000
Sunday Minimum Service	\$1,281,000	\$73,000	0.057	\$1,208,000
Sunday Maximum Service	\$1,303,000	\$128,000	0.098	\$1,175,000
Holiday Minimum Service	\$172,000	\$11,000	0.064	\$161,000
Holiday Maximum Service	\$175,000	\$20,000	0.114	\$155,000
Weekend/Holiday Minimum Service	\$2,734,000	\$200,000	0.073	\$2,534,000
Weekend/Holiday Maximum Service	\$2,781,000	\$351,000	0.126	\$2,430,000
Weekly Minimum Service	\$6,859,000	\$2,516,000	0.367	\$4,343,000
Weekly Medium Service	\$10,598,000	\$2,841,000	0.268	\$7,757,000
Weekly Maximum Service	\$12,531,000	\$4,414,000	0.352	\$8,117,000

Environmental Impact Estimates

Environmental impacts for a Buzzards Bay extension were estimated for the mid-range ridership estimates for the maximum, medium, and minimum service alternatives at 2006 total travel levels. The maximum service alternative was estimated to produce a net reduction of 122,225 vehicle-miles of travel (VMT) per weekday. For the medium service level, the reduction would be 79,450 VMT per weekday, and for the minimum level it would be 69,670. Associated with the VMT reductions would be reductions in emissions of carbon monoxide (CO), nitrogen oxides (NOx), and volatile organic compounds (VOCs). Partly offsetting the CO and VOC reductions, and more than offsetting the NOx reductions, would be increases in emissions from diesel locomotives used on the extension. In addition, the locomotives would emit particulate matter (PM). At 2006 motor vehicle and locomotive average emission rates, the net air quality impacts of an extension are shown in Table ES-4.

Table ES-4
Buzzards Bay Extension
Net Changes in Average Weekday Emissions

	Maximum Service	Medium Service	Minimum Service
CO Change	-1,432.3 kg	-919.0 kg	-822.4 kg
NOx Change	+325.9 kg	+293.2 kg	+145.5 kg
VOC Change	-53.3 kg	-30.2 kg	-32.6 kg
PM Change	+13.4 kg	+11.5 kg	+6.3 kg

The largest reduction in highway traffic as the result of a Buzzards Bay extension would occur on the Southeast Expressway just south of Furnace Brook Parkway in Quincy. This would include diversions of auto trips to Boston, Cambridge, or points beyond, or to Quincy. At 2006 traffic levels, the reduction at that location, with the maximum assumed commuter rail service level, would be about 1,220 inbound auto trips per day. The maximum reduction in any 30-minute interval would occur between about 7:15 and 7:45 AM, when about 315 auto trips would be eliminated. This would be equal to about 8% of the present traffic level on the Expressway in that time interval. However, the net impact on traffic congestion on the Expressway would be expected to be lower because of traffic shifting from parallel routes and other time intervals to take advantage of the freed capacity.

A commuter rail extension terminating at Buzzards Bay would result in increases in traffic crossing the Bourne and Sagamore bridges. These would result mostly from diversions to Buzzards Bay of passengers formerly boarding express buses at stops south of the canal. In addition, there would be return trips of vehicles used to drop off passengers at Buzzards Bay instead of driving all the way to final destinations.

On the Bourne Bridge, the increase would be about 195 cars each way per day, with a peak of about 40 cars in one-half hour. On the Sagamore Bridge, the increase would be about 245 cars per day, with a peak of about 50 cars in one-half hour. Because of the travel time to Boston, the added traffic would be heaviest between about 6:15 and 6:45 AM, but other traffic on the bridges is usually well below peak levels then. Some of the return traffic in the evening would, however, occur during times of heavy southbound travel over the bridges.

Regardless of the specific station sites chosen, a Buzzards Bay extension would result in increased traffic congestion on local streets around the stations prior to inbound train departures and after outbound train arrivals. At 2006 travel levels, with the maximum service level, in the 10 minutes preceding departure of the most heavily patronized AM peak train, vehicle arrivals would average about 13 per minute at a station in Wareham and about 35 per minute at a station in Buzzards Bay.

At present, much of the land along the right-of-way of the Buzzards Bay extension route is sparsely populated. There are 11 grade crossings of public roads, but most of these are lightly traveled, with limited potential for traffic backups when trains were

passing. The crossing of U.S. Route 6 in downtown Wareham would have the greatest potential for traffic backups, but further studies would be needed to determine how serious a problem these would create.

For abutters to the rail line, negative impacts of adding commuter rail service would include vibration and noise, and increased blocking of road crossings while trains were passing. Sounds that would carry furthest would be those of train horns at the crossings.

A total of about 75 houses are located within 200 feet of the extension route along its entire length, or an overall average of about 4 per mile. About two-thirds of these are partially screened from the rail line by cuts or embankments. About 60 of the houses, or 80%, are located along the six-mile segment between the Main Street bridge at Parker Mills and the Onset Avenue bridge, both in Wareham.

1. INTRODUCTION

Commuter rail service to Boston on two lines serving southeastern Massachusetts was reinstated by the Massachusetts Bay Transportation Authority (MBTA) in 1997. (These lines are known as the Old Colony Lines, because they were once part of the Old Colony Railroad.) The outer terminals of these lines, at the Kingston and Middleborough/Lakeville stations, now provide the closest rail passenger service to points on Cape Cod. Previous passenger service on both lines was discontinued in 1959. Prior to that discontinuance, some passenger service via the Middleborough/Lakeville Line extended south through Wareham to Buzzards Bay and points beyond in Barnstable County. The rail line between Middleborough/Lakeville and Buzzards Bay is still used for freight service.

Section 6005-9564 of the 1995 state Transportation Bond Bill authorized funds for the MBTA to study the feasibility of extending commuter rail service beyond the Middleborough/Lakeville terminal to the Buzzards Bay area of the town of Bourne. Such a study was performed for the MBTA by the Central Transportation Planning Staff (CTPS) of the Boston Region Metropolitan Planning Organization in 1996–1997.

In 2006, the Massachusetts Executive Office of Transportation (EOT) requested that CTPS conduct an updated study of a Buzzards Bay commuter rail extension, taking into consideration journey-to-work tabulations from the year 2000 U.S. census and observed changes in travel patterns after the reestablishment of passenger service on the Old Colony Lines. This report presents the results of the updated study.

2. SERVICE AREA AND PRESENT TRANSPORTATION SERVICES

Extension Service Area

A Buzzards Bay commuter rail extension would begin at the outer terminal of the present MBTA Middleborough/Lakeville commuter rail line and run on a railroad line currently used only for freight service, through the towns of Middleborough, Rochester, and Wareham to Buzzards Bay village in the town of Bourne. The primary service area for such an extension, as shown on Figure 2-1, would consist of the towns directly on the route and towns directly adjoining those towns. The latter would include Carver, Marion, Mattapoisett, Sandwich, and Falmouth. In addition to these towns, this study considers all of the rest of Barnstable County to be within the potential market area of a Buzzards Bay extension for reasons set forth below.

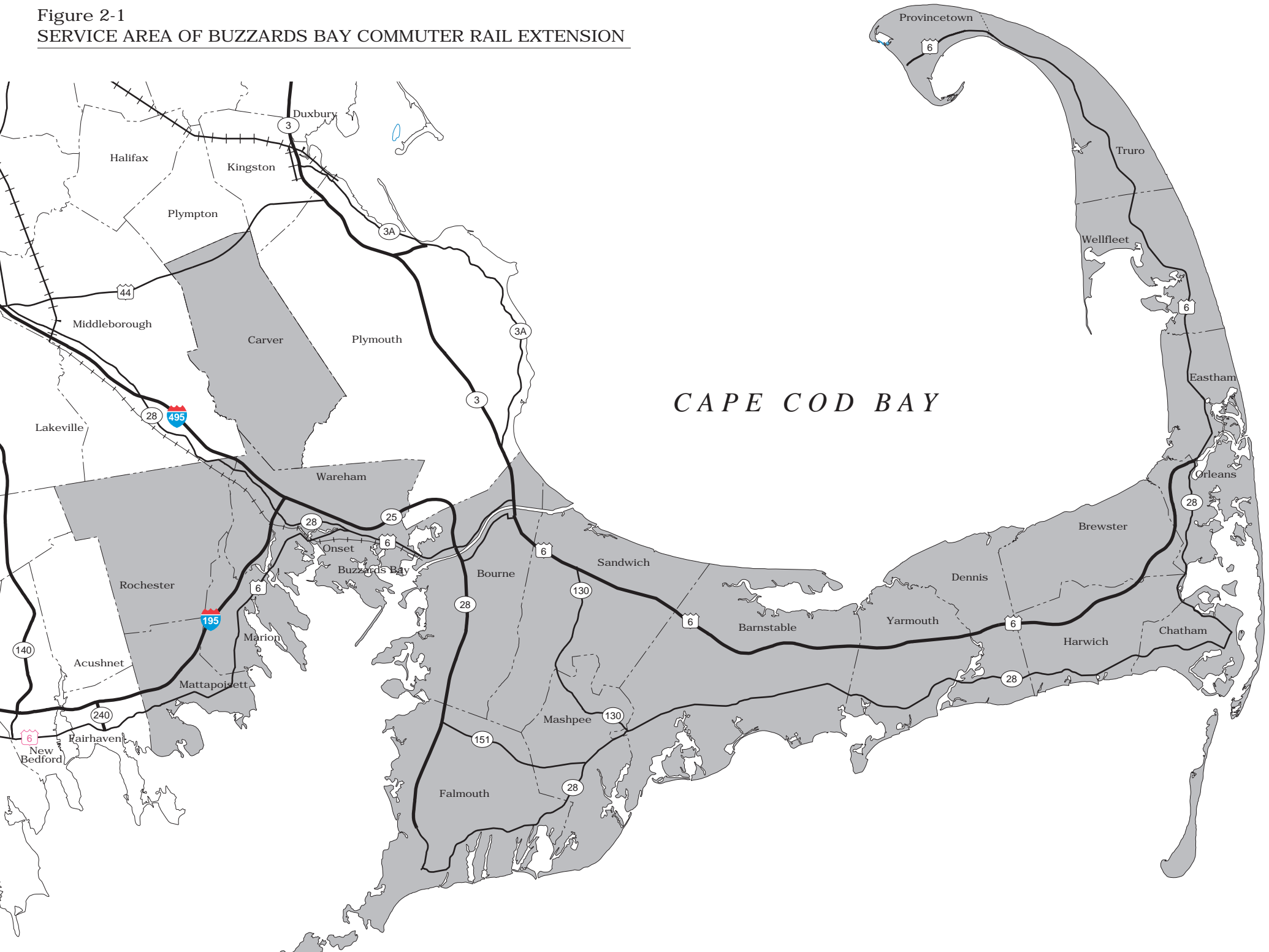
The outer terminals on commuter rail lines often attract riders from greater distances than intermediate stops do. All highway traffic from Cape Cod (except for the northern edge of Bourne and the Scussett Beach section of Sandwich) to points outside Barnstable County must cross the Cape Cod Canal, either on the Bourne Bridge or on the Sagamore Bridge. The north end of the Bourne Bridge is 1.6 miles from the past Buzzards Bay Station location. The north end of the Sagamore Bridge is five miles from that station site. According to census figures, several Cape Cod towns originate greater numbers of work trips to the Boston area than Bourne does. Therefore, a Buzzards Bay station with unconstrained parking capacity could be expected to attract some of the commuters from each Barnstable County town who would have to cross one of the bridges anyway.

The town of Plymouth also adjoins both Bourne and Wareham. However, the sections of Plymouth nearest to these borders, including a large state forest, are among the most sparsely settled in the town. Access from these areas to stations at Buzzards Bay or in Wareham would require traveling several miles in the opposite direction from Boston over local roads. The Sagamore park-and-ride lot, now served by express buses to Boston, is also in Bourne, but highway access to this facility from most of Plymouth is faster than access to a Buzzards Bay or Wareham station would be. A March 2006 passenger count and license plate survey at Sagamore indicated that fewer than 15 of the AM peak bus passengers boarding there came from Plymouth. In contrast, about 400 vehicles parking at the Kingston commuter rail lot in the morning came from Plymouth. For these reasons, Plymouth was not included in the assumed service area of a Buzzards Bay commuter rail extension.

Present Mass Transportation Services in the Extension Service Area

At present, a variety of mass transportation options are available for travel to and from points in the Buzzards Bay extension service area, as defined above. Some of these would be in competition with an extension, some could act as feeders or distributors, and some would have little impact either on or from an extension. Information that was available on each of these services as of the spring of 2006 is presented in the following sections of this chapter, and in Appendix A.

Figure 2-1
SERVICE AREA OF BUZZARDS BAY COMMUTER RAIL EXTENSION



Direct public transportation between Boston and communities in the study area in 2006 consisted primarily of express bus routes operated by private companies. Scheduled airline service and seasonal ferry service were provided from a few Cape Cod locations, but were oriented more toward vacation and business travelers than to daily commuters. There was no direct rail passenger service to the study area, but there were commuter rail terminals with large park-and-ride lots near exits on both of the main highway routes from the Cape (Route 3 and I-495), about 20 miles north of the canal.

Express Bus Service to Boston

At present, two private carriers, the Plymouth & Brockton Street Railway Company (P&B) and Peter Pan Bonanza Bus Lines, operate express bus service between Boston and points in the study area, with no direct public subsidies. Each company has one basic route in the area, with some variation among trips in the stops served. North of the Cape, these buses travel mostly on limited-access highways, making their final Boston approach over the Southeast Expressway (I-93). Inbound AM peak and outbound PM peak trips use the high-occupancy-vehicle (HOV) lane on the expressway. The routes of both companies currently serve the intercity bus terminal at South Station. The same routes also provide direct service to Park Square, Logan Airport, or both. More detailed information about the service on these bus routes appears in the following subsections and in Appendix A. Service frequencies and fares on these routes are summarized in Table 2-1.

Hyannis Route

P&B operates the most frequent bus service to Boston from the study area. The main P&B route runs from downtown Hyannis, with several combinations of intermediate stops. On the Cape Cod end, all trips in both directions make intermediate stops at park-and-ride lots at state Routes 6 and 132 in Barnstable and near the north end of the Sagamore Bridge.

The schedule in effect in the spring of 2006 had 26 round-trips on weekdays. Of these, 6 inbound and 4 outbound trips terminated at Logan Airport but made no downtown Boston stops. All of the others served South Station, including 10 inbound trips that continued to Logan and 13 outbound trips that started at Logan. Of the trips that did not go to Logan, 9 inbound trips continued beyond South Station to Park Square, and 9 outbound trips started at Park Square before going to South Station. One inbound trip went only to South Station. The scheduled running time from the Sagamore park-and-ride lot to South Station ranged from 60 to 80 minutes during AM peak hours. Fares varied by distance traveled.

On Saturdays, Sundays, and holidays in the spring of 2006, the Hyannis–Boston route had 17 round-trips a day. Departures were mostly hourly from each end. Except for the first inbound trip of the day, which went only to Logan Airport, all trips served both South Station and Logan, but there was no Park Square service.

Woods Hole/Falmouth Route

All trips operated by Peter Pan/Bonanza Bus Lines to Boston from the study area originate either at Woods Hole or at downtown Falmouth, and serve two intermediate stops in Bourne (outside Otis Air Force Base and near the south end of the Bourne Bridge, which spans the Cape Cod Canal). The schedule in effect in the winter of 2006 had 9 round-trips on weekdays. The first two inbound trips of the day originated at Falmouth, and the first trip continued to Logan Airport after stopping at South Station in Boston. The other 7 inbound trips originated at Woods Hole, with 6 continuing to Logan after South Station. All 9 outbound trips ran to Woods Hole, with 7 starting at Logan before going to South Station. The scheduled running time from the Bourne park-and-ride lot to South Station was 65 to 70 minutes on non-stop trips.

Of the 9 scheduled trips on weekdays, 6 also operated on both Saturdays and Sundays, 1 on weekdays and Saturdays only, 1 on weekdays and Sundays only, and 1 only on weekdays. Fares varied by distance traveled.

**Table 2-1
Express Bus Weekday Frequency and Fares from Study-Area Points to
Downtown Boston – Spring 2006**

Stop Location	Weekday		10-Ride	Senior	Child	Child
	Inbound Departures	One-Way Full-Fare		Round-Trip Fare	One-Way Fare	One-Way Fare
Sagamore Bridge	20	\$15.00	\$27.00	\$61.00	\$11.00	\$13.50
Barnstable Park-and-Ride	20	\$17.00	\$31.00	\$67.00	\$12.00	\$15.50
Hyannis	20	\$17.00	\$31.00	\$67.00	\$12.00	\$15.50
Harwich	2	\$22.00	\$40.00	\$76.00	\$22.00	\$20.00
Orleans	2	\$23.00	\$41.00	\$83.00	\$23.00	\$20.50
Provincetown	2	\$27.00	\$49.00	*see note	\$27.00	\$24.50
Wareham	1	\$12.00	\$22.00	\$70.00	\$11.40	\$13.20
Bourne	9	\$14.00	\$25.00	\$70.00	\$13.30	\$15.00
Falmouth	9	\$18.50	\$32.00	\$80.00	\$17.60	\$19.20
Woods Hole	7	\$18.50	\$32.00	\$80.00	\$17.60	\$19.20

*Note: 10-ride tickets are not sold for travel to and from towns beyond Orleans.

Commuter Rail Service to Boston

At present, the Middleborough/Lakeville and Kingston/Plymouth branches of the MBTA Old Colony Lines provide the commuter rail service running nearest to the Buzzards Bay extension study area. The highway distance from Buzzards Bay to Middleborough/Lakeville Station via Route 25 and I-495 is about 22 miles. Intermediate access to the highways is available at five interchanges: four in Wareham and one in Middleborough. Rochester is not served directly by limited-access highways, but I-195, and I-495, and state Route 140 run through adjoining towns.

Kingston Station, off Route 3, is about 18 miles from the Sagamore Bridge, but Route 3 does not pass through any of the intermediate towns in the study area. Plymouth Station is also about 18 miles from the Sagamore Bridge but is farther off Route 3, and has service only during off-peak hours. A survey of passengers on the Old Colony Lines conducted in 1998, at the end of their first year of service, found that almost all Barnstable County residents who used the service boarded at either Kingston or Middleborough/Lakeville. Kingston Station alone captured 72% of all Old Colony ridership from Barnstable County. Further details about use of these stations for trips from the study area appear later in this chapter.

The spring of 2006 commuter rail schedule included 12 weekday round-trips to Boston from Middleborough/Lakeville, 11 from Kingston, and 4 from Plymouth. All three terminals are in commuter rail fare Zone 8. From there, fares to Boston in the spring of 2006 were \$6.00 for a one-way full fare or \$198.00 for a monthly pass. Twelve-ride tickets were available, at the same cost per ride as one-way tickets. For senior citizens, persons with disabilities, children ages 5 through 11, and students up to high school, one-way fares were half of the full fare. Ten-ride half-fare tickets were priced the same as ten one-way half-fares, and there were no reduced-fare monthly passes. Family fares allowed same-day off-peak round-trips for one or two adults and up to three children for the price of four full one-way fares.

Effective January 1, 2007, fare increases are being implemented throughout the MBTA system. On commuter rail lines, the Zone 8 one-way full fare will increase by 29%, to \$7.75, and the monthly pass price will increase by 26%, to \$250.00.

Airline Service to Boston

Scheduled airline service to Logan Airport from Hyannis and from Provincetown is currently provided by Hyannis Air Service, Inc., doing business as Cape Air. Service frequency varies by season. In 2006, the Hyannis route had a base service of 2 round-trips on weekdays, expanding to 4 northbound and 2 southbound trips in summer months. The scheduled flight time was 35 minutes. At some times during the year, schedules were provided that would have been marginally suitable for commuting to Boston. However, the fares of \$109.75 one-way or ten rides for \$752.50 were not aimed at typical commuters

On the Provincetown route, the base schedule provided 3 round-trips on weekdays, expanding to up to 7 northbound and 5 southbound trips on certain days of the week in summer months. The scheduled flight time was 25 minutes. Schedules throughout the year included at least one round-trip at times that would be suitable for Boston work commuting, but according to the most recent census figures, very few residents of Provincetown or nearby towns on the Cape work in Boston. The air fares of \$119.75 for a one-way trip or ten trips for \$852.50 were not aimed at typical commuters.

Most of the service on the Hyannis and Provincetown routes was provided with nine-passenger planes, making the total capacity very limited, even in peak seasons.

Ferry Service to Boston

Seasonal ferry service between Boston and Cape Cod is provided by two separate boat lines from Provincetown. Schedules are not compatible with most Boston work trips, but there is some competition between water and land transportation for other components of Cape Cod travel. A more detailed description of this service is contained in Appendix A.

Local Transportation Service in Barnstable County

Local transportation service in Barnstable County is provided by the Cape Cod Regional Transportation Authority's Breeze bus system. The schedule in effect from Labor Day 2005 through late June 2006 had four fixed routes radiating from the Hyannis Transportation Center, which also served the P&B express bus route to Boston and interstate service to Providence and New York run by Peter Pan/Bonanza Bus Lines. A more detailed description of the Breeze service is contained in Appendix A.

Local Transportation Service in Wareham and Bourne

Local transportation service in Wareham and Bourne is provided by the Greater Attleboro Taunton Regional Transit Authority (GATRA) Onset Wareham Link (OWL) bus system. The schedule in effect in the spring of 2006 had four routes converging at the Cranberry Plaza shopping mall in Wareham. These routes, called Link 1, 2, 3, and 4, are described in more detail in Appendix A.

The most recent past rail passenger service through Wareham (Amtrak summer weekend intercity service that ended in 1996) included a stop at Wareham Center near the intersection of Main Street and Sandwich Road. This site is on the Link 1 route in both directions and on the Link 4 eastbound route. Because of parking constraints, this would not necessarily be the best site for a Wareham station on a Buzzards Bay commuter rail extension. The rail line also runs close to Cranberry Plaza, so a new station there with connections to the Link system might be desirable.

Tourist Train Service on Cape Cod

Since the mid-1980s, tourist trains have been operated on the state-owned rail lines on Cape Cod during summer months. For several years in the 1980s, the tourist train operators also ran state-funded trips to connect with Red Line rapid transit service at Braintree and with Amtrak intercity passenger train service at Attleboro. However, current tourist train operations are run for entertainment rather than for practical transportation. Tourist train operations are described in more detail in Appendix A.

Ferry Service between Cape Cod, Martha's Vineyard, and Nantucket

In the past, passengers transferring to and from ferries serving Martha's Vineyard and Nantucket were an important component of ridership on commuter and intercity rail passenger service to Cape Cod. The Falmouth Branch rail line formerly ran from Buzzards Bay directly to the Woods Hole terminal of the Steamship Authority. Several miles of the right-of-way have been converted to the Shining Sea Bikeway, so rail-ferry

connections would now require an intermediate bus connection regardless of where a commuter rail terminal was located. The Peter Pan/Bonanza Bus Lines Woods Hole route described above now serves the ferry terminal, and the buses are scheduled to provide ferry connections.

Ferries formerly sailed to both islands from Woods Hole, but at present only Martha's Vineyard ferries sail from there. The Steamship Authority's Nantucket ferries now sail from a terminal at Hyannis. A separate Hyannis terminal serves ferries to Martha's Vineyard and Nantucket that are operated by a private company, Hy-Line Cruises. Both of the Hyannis terminals are about one-quarter mile from the main bus terminal and the railroad station in Hyannis (currently used only by the seasonal tourist trains). Bus connections between the ferry terminals and the downtown transportation terminals have been provided at times in the past. One route of the Cape Cod Regional Transit Authority's Breeze bus system stops at either of the Hyannis ferry terminals on request, but times are not coordinated either with ferry service or with intercity or commuter bus services.

Three smaller, independent companies also operate seasonal service to the islands from various Cape points. These are Freedom Cruise Line, sailing from Harwich Port to Nantucket; Island Commuter Corporation, sailing from Falmouth Harbor to Oak Bluffs; and Falmouth-Edgartown Ferry, sailing between its namesake towns.

Present Highway Connections from the Study Area to Boston

A Bourne commuter rail extension would begin at the outer terminal of the Middleborough/Lakeville commuter rail line. This station is at Exit 4 of I-495, which parallels the extension route as far south as Wareham. (The straight-line distance between the highway and the railroad is under one mile at most points, but distances via connecting roads are somewhat greater.) State Route 25 continues parallel with the railroad from the end of I-495 to Bourne, and has an exit 1.6 miles from the center of Buzzards Bay village. These limited-access highways provide the fastest road link to the Middleborough/Lakeville commuter rail line from communities in the corridor between Middleborough and Buzzards Bay.

The Route 25/I-495 combination is part of one of the two main highway routes between Cape Cod and Boston. From I-495, Boston-bound traffic proceeds via Route 24 and I-93, passing through most of the same cities and towns that are served by the Middleborough/Lakeville commuter rail line. The other main highway route from the Cape to Boston is state Route 3, which follows a more easterly alignment and joins I-93 in Quincy. Route 3 has more direct access than Route 25 to most towns on the Cape. Its closest point to the Buzzards Bay commuter rail extension, as defined for the present study, would be at the Sagamore Bridge. This is five miles from the location of Buzzards Bay stations used in the past.

In addition to the I-495/Route 25 combination, the rail line to Bourne is followed closely by state Route 28 all the way from Middleborough to Buzzards Bay. This is an older, undivided highway, mostly two-lane, with unlimited access. It provides local collection and distribution for the newer routes.

Radial connections to the Buzzards Bay–Middleborough highways (or future rail service) are provided mostly by unnumbered local roads. Exceptions include I-195 and U.S. Route 6, which both provide links to Wareham from the southwest, and state Route 58, which provides a connection from the north near the Wareham/Rochester border. Of these, only I-195 has limited access.

Present Travel Volumes on Transportation Facilities in the Buzzards Bay Extension Service Area

Overview of Information Sources

Highway traffic counts and transit passenger counts can determine the travel volumes on individual links in transportation systems. To determine the actual trip ends of travelers, additional information must be obtained through surveys. Responses to any survey will come from only a subset of the total population from which information is needed, and there is always some uncertainty as to how representative a given sample is.

As part of the present study, CTPS conducted one-day counts of passengers boarding all scheduled bus trips to Cape Cod points at South Station and Park Square in Boston. Inbound AM peak bus trip boarding counts were conducted at the Sagamore park-and-ride lot served by express buses to Boston. Past surveys found that most commuter rail riders with trips originating in the Buzzards Bay extension study area boarded either at Middleborough/Lakeville or at Kingston, and that the majority of these used park-and-ride access. For the present study, license plate surveys were conducted at those two stations as a basis for calculating present commuter rail trips by study-area residents. A license plate survey was also conducted at the Sagamore park-and-ride lot. Highway traffic volumes at selected locations were obtained from reports compiled by the Massachusetts Highway Department (Mass Highway).

In conjunction with past decennial U.S. censuses up to the year 2000, supplementary questionnaires were sent to randomly selected subsets of all households, asking for information on work location and means of travel to work. The results were presented in the journey-to-work tabulations. For the present study, figures were obtained from the year 2000 tabulations for work trips by mode from each town in the study area to Boston Proper, the rest of Boston, Cambridge, and intermediate communities on the rail line between Middleborough/Lakeville and Boston. However, there are no similar tabulations of non-work trips.

In addition to trips starting from homes of study-area residents, a Buzzards Bay commuter rail extension would be expected to capture some recreational travel to and from Cape Cod points. As discussed in the highway travel-volume section of this report, the overall level of recreational travel can be estimated from the difference between traffic volumes over the Canal bridges on summer and non-summer days. However, specific information is lacking on the portion of recreational travel originating at points from which rail service would be a convenient alternative. (This is discussed in greater detail in chapter 4.)

U.S. Census Journey-to-Work Tabulations

The census journey-to-work tabulations determined the work location and travel mode of each respondent during the week in which the supplementary questionnaire was completed. The forms were sent to permanent residence locations in April, so they did not obtain information about summer commuting from vacation homes.

According to the tabulations for the year 2000, (summarized in Tables 2-2 and 2-3), a total of 1,507 Barnstable County residents were employed in Boston Proper, 1,215 in other parts of Boston, 273 in Cambridge, and 1,398 in communities with intermediate stations outside Boston on the Middleborough/Lakeville commuter rail line. The destinations in intermediate communities included 636 at locations within one mile of a commuter rail or rapid transit station. For trips to Boston Proper, driving alone was the most common means of travel, reported at 49.3%, followed by bus (30.1%), carpool (11.5%), and unspecified other transit (9.2%). The latter would have consisted mostly of park-and-ride or drop-off trips to commuter rail or rapid transit stations outside of the study area. For trips to Boston destinations outside Boston Proper, the drive-alone share increased to 67.7%, while bus use fell to 17.5% and other transit use to 3.5%, with carpool slightly lower, at 11.3%. For destinations in Cambridge, 68.5% drove alone and 13.9% carpooled. Buses served 15.8%, and other transit 1.8%. For intermediate destinations, buses and other transit served only 0.4%, but most of the intermediate points have only indirect transit connections from Barnstable County.

The five Plymouth County towns in the study area (Wareham, Rochester, Carver, Marion, and Mattapoisett) originated a combined total of 568 work trips to Boston Proper, 624 to other parts of Boston, 95 to Cambridge, and 2,235 to communities with intermediate stations outside Boston on the Middleborough/Lakeville line. The destinations in intermediate communities included 674 at locations within one mile of a commuter rail or rapid transit station. For destinations in Boston Proper, the drive-alone share was slightly lower than that from Barnstable County, at 43.5%, and the carpool share slightly higher, at 13.9%. However, the bus share was much lower, at 8.1%, and the other transit share much higher, at 34.5%. These differences are consistent with the much lower level of express bus service and shorter distance to commuter rail from these communities compared with Barnstable County. Buses and other transit captured 1.5% of the work trips from the five towns to intermediate points on the Middleborough/Lakeville line.

For trips from the five Plymouth County towns to Boston destinations outside Boston Proper, bus use was much lower than from Barnstable County, at 3.2%, but other transit use was slightly higher, at 4.2%. The drive-alone share was much higher, at 80.9%, but carpooling was about the same, at 11.7%. For trips from the five towns to Cambridge, the drive-alone share was even higher, at 87.4%. There was no reported bus use, but other transit use was greater than from Barnstable County, at 6.3%.

Present bus service from Cape Cod to Boston includes connections at Woods Hole with ferries from Martha's Vineyard at times that would make commuting from that island to Boston possible. However, there are no ferries from Nantucket with mainland arrivals early enough for Boston commuting. The 2000 journey-to-work tabulations showed a total of only 23 work trips from Martha's Vineyard to Boston Proper, and 12

Table 2-2
U.S. Census Year 2000 Journey-to-Work Tabulations

From	To Destinations in:			To Destinations within One Mile of Commuter Rail or Red Line Station in:					
	Boston Proper	Other Boston	Cambridge	Quincy	Braintree	Randolph or Holbrook	Brockton	Bridgewater	Middle-borough or Lakeville
Bourne	204	156	70	74	6	0	33	5	25
Falmouth	229	243	30	15	28	0	13	4	22
Sandwich	267	165	27	91	20	0	38	28	25
Barnstable	317	291	54	56	1	0	10	0	6
Mashpee	151	101	23	15	3	0	5	0	0
Yarmouth	132	99	0	0	9	0	8	0	20
Other Cape Cod	207	160	69	42	4	0	10	20	0
Subtotal Barnstable County	1,507	1,215	273	293	71	0	117	57	98
Wareham	178	202	28	44	9	10	195	0	33
Carver	171	184	27	75	15	12	87	23	25
Rochester	46	146	13	18	3	1	17	3	5
Marion	124	46	21	16	0	0	26	14	4
Mattapoisett	49	46	6	0	3	0	16	20	0
Subtotal Plymouth County	568	624	95	153	30	23	341	60	67
Marthas Vineyard	23	12	17	3	0	0	0	0	0
Nantucket	16	0	7	0	0	0	0	0	0
Subtotal Islands	39	12	24	3	0	0	0	0	0
TOTAL STUDY AREA	2,114	1,851	392	449	101	23	458	117	165

Table 2-3
U.S. Census Year 2000 Journey-to-Work Mode Share Tabulations

From	To Boston Proper Percent via:					To Other Boston Percent via:					To Cambridge Percent via:				
	Total	Drive Alone	Car-pool	Bus	Other transit	Total	Drive Alone	Car-pool	Bus	Other transit	Total	Drive Alone	Car-pool	Bus	Other transit
Bourne	204	52.0%	22.5%	20.1%	5.4%	156	77.6%	14.1%	2.6%	5.8%	70	60.0%	22.9%	17.1%	0.0%
Falmouth	229	39.7%	9.6%	38.4%	12.2%	243	78.2%	4.5%	11.9%	5.3%	30	23.3%	0.0%	76.7%	0.0%
Sandwich	267	41.6%	10.1%	34.8%	13.5%	165	67.9%	10.3%	21.8%	0.0%	27	81.5%	0.0%	0.0%	18.5%
Barnstable	317	44.5%	10.4%	41.3%	3.8%	291	59.8%	9.3%	28.5%	2.4%	54	87.0%	13.0%	0.0%	0.0%
Mashpee	151	48.3%	19.9%	9.9%	21.9%	101	54.5%	37.6%	7.9%	0.0%	23	100.0%	0.0%	0.0%	0.0%
Yarmouth	132	55.3%	7.6%	29.5%	7.6%	99	61.6%	10.1%	22.2%	6.1%	0	0.0%	0.0%	0.0%	0.0%
Other Cape Cod	207	71.5%	2.4%	22.2%	3.9%	160	68.8%	7.5%	19.4%	4.4%	69	66.7%	21.7%	11.6%	0.0%
Subtotal Barnstable County	1,507	49.3%	11.5%	30.1%	9.2%	1,215	67.7%	11.3%	17.5%	3.5%	273	68.5%	13.9%	15.8%	1.8%
Wareham	178	43.8%	9.0%	25.8%	21.3%	202	83.7%	6.4%	9.9%	0.0%	28	100.0%	0.0%	0.0%	0.0%
Carver	171	22.2%	28.1%	0.0%	49.7%	184	82.6%	6.5%	0.0%	10.9%	27	100.0%	0.0%	0.0%	0.0%
Rochester	46	43.5%	6.5%	0.0%	50.0%	146	67.1%	32.9%	0.0%	0.0%	13	53.8%	46.2%	0.0%	0.0%
Marion	124	72.6%	9.7%	0.0%	17.7%	46	87.0%	0.0%	0.0%	13.0%	21	71.4%	0.0%	0.0%	28.6%
Mattapoisett	49	42.9%	0.0%	0.0%	57.1%	46	100.0%	0.0%	0.0%	0.0%	6	100.0%	0.0%	0.0%	0.0%
Subtotal Plymouth County	568	43.5%	13.9%	8.1%	34.5%	624	80.9%	11.7%	3.2%	4.2%	95	87.4%	6.3%	0.0%	6.3%
Marthas Vineyard	23	82.6%	0.0%	0.0%	17.4%	12	100.0%	0.0%	0.0%	0.0%	17	17.6%	0.0%	41.2%	41.2%
Nantucket	16	0.0%	0.0%	0.0%	0.0%	0	0.0%	0.0%	0.0%	0.0%	7	100.0%	0.0%	0.0%	0.0%
Subtotal Islands	39	48.7%	0.0%	0.0%	10.3%	12	100.0%	0.0%	0.0%	0.0%	24	41.7%	0.0%	29.2%	29.2%
TOTAL STUDY AREA	2,114	47.7%	11.9%	23.6%	16.0%	1,851	72.4%	11.3%	12.6%	3.7%	392	71.4%	11.2%	12.8%	4.6%

Note: Due to survey sample sizes, the totals indicated are more reliable than the mode percentages.

to the rest of Boston, but none of these were reported as being made by bus. There were 16 reported work trips from Nantucket to Boston Proper, all by unspecified “other mode,” probably scheduled airline service. There were no reported work trips from Nantucket to the rest of Boston.

Passenger Counts on Existing Bus Services

During March 2006, CTPS conducted counts of passengers boarding P&B and Peter Pan/Bonanza Bus Lines buses departing South Station or Park Square in Boston for Cape Cod points between 3:30 and 6:30 PM on one weekday. The results are summarized in Table 2-4, and discussed in greater detail in Appendix A.

Also in March 2006, CTPS conducted a one-day count at the park-and-ride lot in Sagamore of passengers boarding buses or already onboard there on trips going to South Station or Park Square and scheduled to arrive at South Station between 6:30 and 9:30 AM. After the departure of the last bus due in Boston by 9:30, a license plate survey of all vehicles parked in the lot was conducted. The results were compared with files obtained from the Registry of Motor Vehicles to help determine the trip origins of passengers boarding the buses. The results are summarized in Table 2-5, and discussed in greater detail in Appendix A. Results of bus passenger counts taken by CTPS in 2000 are also included in Appendix A for comparison.

Comparisons of Bus Passenger Counts with Census Journey-to-Work Tabulations

The passenger count results do not reveal trip purposes, and the census tabulations do not include non-work trips. To compare them, it is necessary to make some assumptions about the proportion of bus riders making work trips. Most work trips would be expected to be made on peak-period bus trips. Under the extreme assumption that all peak-period bus ridership is work trips, the counts done in 2000 indicated a total of 499 work trips by bus from Cape Cod and 36 from Wareham. The Census figures from that year showed a total of 453 bus trips from Cape Cod to Boston Proper alone, with another 213 to the rest of Boston, and 43 to Cambridge. Even without taking into account non-work trips on peak-period buses, the census figures appear to have overstated the bus share of work trips from the Cape. From Wareham, the 2000 bus passenger count of 36 (which may have included some boardings at Buzzards Bay) compares with the census report of 46 work trips to Boston Proper and 20 to the rest of Boston, but none to Cambridge.

**Table 2-4
March 2006 Express Bus Boarding Counts at South Station and Park Square**

Route	Before 3:30 PM	3:30–6:30 PM	After 6:30 PM	Total Day
P&B to Hyannis	124	271	60	455
Bonanza to Woods Hole/Falmouth	31	69	7	107
TOTAL	155	340	67	562

**Table 2-5
March 2006 Estimated Origins of AM Peak Bus Passengers from Study Area
to South Station or Park Square Boarding at Sagamore**

Origin Town	
Sandwich	36
Bourne	22
Barnstable	14
Falmouth	13
Mashpee	11
Brewster	2
Yarmouth	2
Dennis	1
Chatham	1
Eastham	1
Harwich	1
Barnstable County Subtotal	102
Wareham	2
Marion	1
Mattapoisett	1
Rochester	0
Carver	0
Plymouth County Subtotal	4
TOTAL STUDY AREA	106

Passenger Counts on Commuter Rail

Use of existing commuter rail service for travel to or from the Buzzards Bay extension study area cannot be determined by observations of passenger boardings, such as those done for the express bus service. Commuter rail currently serves the study area only indirectly, and the majority of the trip origins and destinations of the train riders are also outside the study area.

To date, the only origin-destination survey of passengers on the Old Colony Lines of the MBTA commuter rail system was that conducted in October 1998. This was one year after the service was reinstated and nearly two years before the 2000 census journey-to-work figures were collected.

The 1998 survey indicated that overall there were 122 Barnstable County boardings at Kingston, 36 at Middleborough/Lakeville, and 11 scattered among other stations, for a total of 169 trips. Of these, 97 (57.4%) were trips from home to work in any location, including 68 (40%) that were to work locations in Boston Proper. This was equal to half the number of “other transit” trips from Barnstable County to Boston Proper indicated

by the 2000 census results, but those would also have included alternatives such as driving to a rapid transit station closer to Boston. The Old Colony survey figures for ridership from Barnstable County towns were also well below the census figures for other transit to other parts of Boston from these towns (7 versus 26) but exceeded the census figures to Cambridge (10 versus 5).

Park-and-ride access was used in 87% of the Barnstable County boardings at Kingston and in 97% of those at Middleborough/Lakeville. Therefore, license plate surveys at these stations should provide a reasonable basis for estimating current total ridership from Barnstable County. CTPS conducted such surveys at these stations in March 2006. The results are summarized in Table 2-6, and are discussed in greater detail in Appendix A.

Table 2-6
March 2006 Commuter Rail Park-and-Ride Trips from Study Area via
Kingston and Middleborough/Lakeville Before Noon

Origin Town	Trips before Noon		Total
	Kingston	Middleboro	
Sandwich	55	2	56
Bourne	18	16	33
Barnstable	23	0	23
Falmouth	3	17	20
Mashpee	10	5	14
Yarmouth	2	0	2
Dennis	0	2	2
Chatham	2	0	2
Eastham	2	0	2
Barnstable County Subtotal	113	41	153
Wareham	0	71	71
Carver	11	20	32
Mattapoisett	0	28	28
Marion	0	27	27
Rochester	2	22	24
Plymouth County Subtotal	13	168	181
TOTAL STUDY AREA	126	208	334

Rapid Transit Ridership from Buzzards Bay Extension Service Area

The most recent comprehensive survey of passengers on the MBTA rapid transit system was conducted in 1994, three years before the reopening of the Old Colony commuter rail lines. Therefore, aside from any other changes in travel patterns, the survey results do not take into account diversions of riders from the rapid transit system to the Old Colony Lines. The survey indicated that between 6:00 AM and 3:30 PM, Barnstable County was the origin of 154 boardings on the rapid transit system, and the five Plymouth County towns in the Buzzards Bay extension service area originated another 85 trips. (These totals exclude passengers who used the rapid transit system only to continue to their final destinations after taking express buses or other means of transportation into downtown Boston.) Most of the reported boardings were at stations on the Braintree Branch of the Red Line, with park-and-ride or drop-off access.

In the 1998 Old Colony survey, 17 passengers with Barnstable County origins and 29 with origins in the five other study-area towns reported that they had switched from use of the rapid transit system. With no other changes in rapid transit origins from these towns, these results would indicate that 137 trips from Barnstable County and 56 from the other five towns, or a total of 193, were still being made by rapid transit in 1998. Since then, more of these may have switched to Old Colony service. However, the 2006 license plate survey results in Table 2-6 show an overall gain of only about 53 passengers from the study area using park-and-ride access to commuter rail. Therefore, even if all of the commuter rail riders added between 1998 and 2006 were diverted from rapid transit, as many as 140 riders from the study area might still be rapid transit users. (This does not take into account changes in rapid transit use from the study area for reasons unrelated to Old Colony service.)

Highway Travel Volumes

The census journey-to-work tabulations provide one source of information on the number of highway trips from homes in the Buzzards Bay extension study area to work locations that could be reached by commuter rail, but they do not provide any information on non-work travel. The total volume of highway traffic from the study area to the Boston area is, however, a relatively small component of both total traffic to and from the Cape and total traffic to and from Boston. Consequently, there was no practical means of making direct measurements of the volume of study-area-to-Boston-area traffic for purposes of this study.

To estimate volumes of non-work trips from the study area to the Boston area, ratios of non-work to work trips among study area respondents in the 1998 Old Colony passenger survey were applied to the 2000 census journey-to-work figures. The results are shown in Table 2-7, along with average weekday highway traffic counts at selected count stations from 1999 or 2000. Traffic destined for the Boston area from the study area is more heavily concentrated in peak hours than overall traffic on these highways. Consequently, diverting study-area traffic to commuter rail would have a proportionally greater impact in peak hours than on a daily basis.

Overall highway traffic levels to and from the study area are significantly higher in summer months than in non-summer months. However, there is little reliable

information as to how much of the added volume is going to or from locations for which a commuter rail extension could offer a practical alternative. Additional surveys that could not be conducted within the time frame of this study would be needed to determine that information.

A more detailed discussion of highway travel volumes between the study area and the Boston area is included in Appendix A.

Table 2-7
Selected Weekday Non-Summer Highway Traffic Volumes Related to
Buzzards Bay Commuter Rail Extension Study*

Auto work trips from Barnstable County to Boston or Cambridge	1,815
Barnstable County: non-work auto trips to Boston or Cambridge and auto trips for all purposes to points reached via Boston or Cambridge	1,815
Auto work trips from 5 Plymouth County towns to Boston or Cambridge	912
Five Plymouth County towns: non-work auto trips to Boston or Cambridge and auto trips for all purposes to points reached via Boston or Cambridge	288
Northbound vehicle trips across Bourne and Sagamore bridges (March 2000)	41,124
Northbound vehicle trips at Southeast Expressway peak load point (1999)	113,000

Note: All volumes shown are from the year 2000, except where otherwise indicated.

3. DESCRIPTION OF POTENTIAL EXTENSION SERVICE

Alignment of Buzzards Bay Commuter Rail Service

North of Middleborough/Lakeville Station

Future rail passenger service between Boston and Buzzards Bay would use the route of the existing MBTA Middleborough/Lakeville commuter rail line between Boston and Middleborough/Lakeville Station. This route was used for most previous rail service between Boston and Cape Cod, and it is still the most feasible alternative. The Kingston/Plymouth commuter rail line, which extends as far south as the Middleborough/Lakeville Line does, has never had a track connection continuing to the Cape.

New service to Buzzards Bay could be provided either by through trains to and from Boston or by shuttle trains connecting with Boston commuter trains at Middleborough/Lakeville Station, the present outer terminal. Because of track capacity constraints discussed elsewhere in this report, it would not be feasible to run Buzzards Bay trains through to Boston separately from present commuter trains during weekday peak hours, and available time slots for additional trains during off-peak hours and on weekends would be very limited.

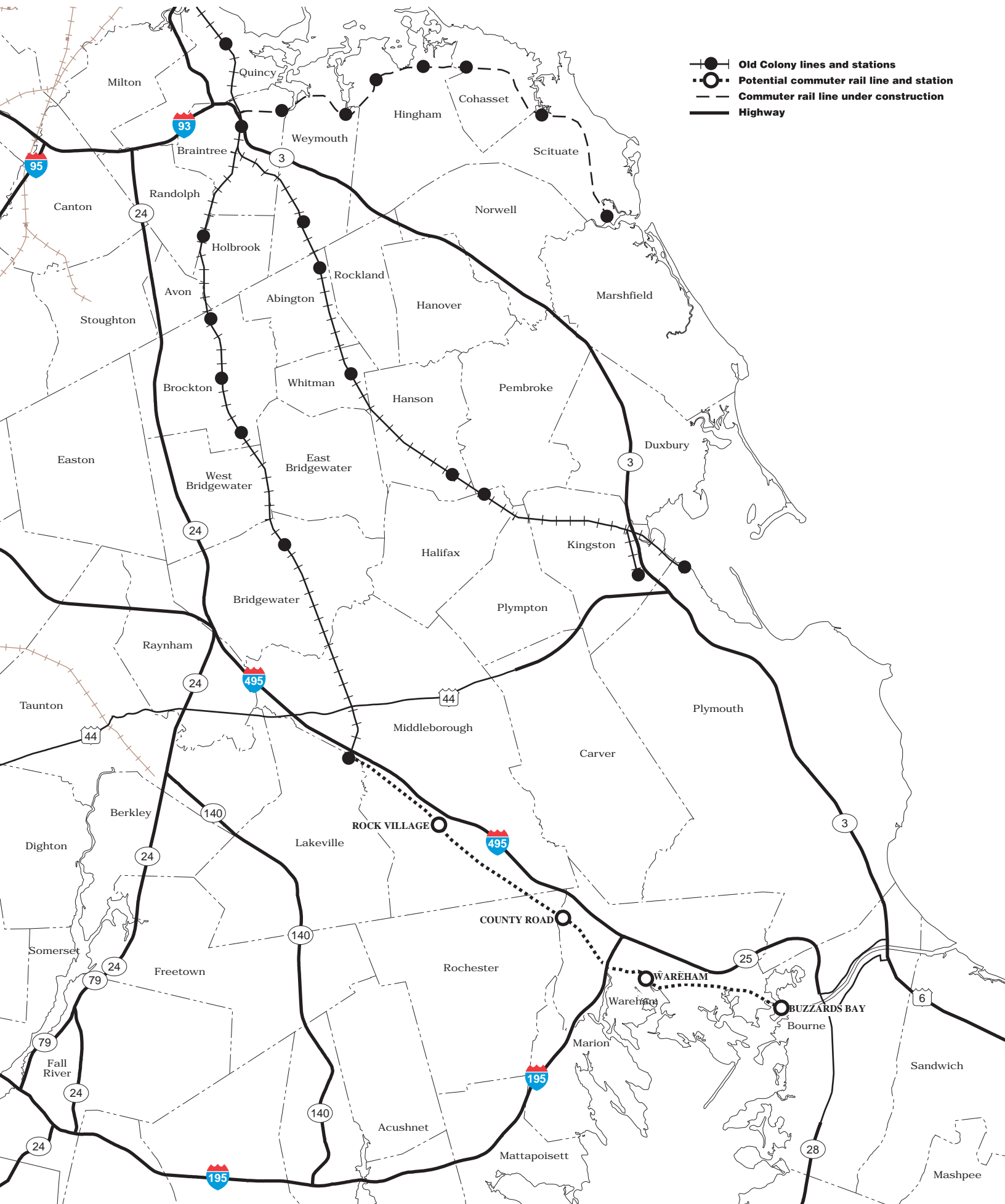
South of Middleborough/Lakeville Station

South of Middleborough/Lakeville Station, a Buzzards Bay commuter rail extension would use an existing rail freight line, known variously as the Buzzards Bay Secondary Track or the Bay Colony Railroad Cape Main Line. (See Figure 3-1.) Weekend-only summer passenger service was last operated on this line in 1996. Due to limited demand, freight service north of Rochester is currently run only as needed, but trash trains run once or twice daily in each direction between an incinerator in Rochester and points farther south. At Buzzards Bay, rail lines branch to Falmouth and to Hyannis, but passenger service beyond Buzzards Bay is not within the scope of the present study.

Station Locations

Selecting sites for commuter rail stations is often one of the most difficult elements of planning, either for a new extension or for improvements to an existing line. Considerations based strictly on optimal transportation operations must be weighed against environmental impacts, present and potential future alternate uses of the sites in question, and the desires of public officials, residents, and other interested parties in the affected communities. Sites identified in preliminary feasibility studies may be quite different from those eventually chosen. For purposes of analysis, however, it was necessary to make some assumptions about approximate station locations on a Buzzards Bay extension. These are described in the following subsections, and are indicated on Figure 3-1.

Figure 3-1
ALIGNMENT AND STATIONS



Buzzards Bay

Past rail passenger service to Buzzards Bay, a village in the town of Bourne, has always used stations located on the south side of Main Street at Academy Drive. The last station building there, dating from the early twentieth century, is still standing, and is used as a tourist information center. A platform is also still in place there, including a mini-high platform for wheelchair access. These facilities were last used regularly for Amtrak summer weekend service that ended in 1996. This is an obvious location for trains to stop in the future, but it has a drawback of very limited parking capacity. Because of this, it would likely be necessary to arrange for additional parking farther away. In any case, the choice of a Buzzards Bay station location could not differ greatly from the past one, because the length of track between the Wareham/Bourne town line and the Cape Cod Canal is only one-half mile. (Express bus service from Buzzards Bay to Boston, which ended in 2004, used an on-street stop on Main Street rather than the railroad station.)

Wareham

In the past, there have been railroad stations in at least seven different locations in Wareham, though they were not all active at the same time. The most recent active station location was at Wareham Center, near the intersection of Main and Sandwich streets. The facilities there were not very elaborate, and potential parking space is constrained by a row of stores to the south and a river immediately to the north. Therefore, it is less certain that a future Wareham station would be located there.

At present, the maximum distance between stations on any of the MBTA commuter rail lines is about eight miles, but most stations are closer together than that. The most recent past Wareham station site is 13.6 miles from Middleborough/Lakeville Station and 5.4 miles from Buzzards Bay. A station halfway between Middleborough/Lakeville and Buzzards Bay would be 9.5 miles from each one. This would be near the former Tremont Station site in Wareham, at Pierceville Road. There is a large amount of vacant land around that site. The location is about 1.5 miles from I-495 Interchange 2 via County Road and Main Street. County Road is the southerly continuation of state Route 58. A station location closer to the County Road crossing of the railroad could have access distance of slightly under one mile from I-495. There has not been a station at that location in the past. The predominant surrounding land uses are gravel pits and cranberry bogs, but there is also some residential development along County Road and side streets.

Rochester

The Buzzards Bay Secondary Track passes through the town of Rochester for a distance of only about 1.5 miles, and there has never been a station in that segment in the past. County Road, discussed above, follows the town line between Wareham and Rochester, so a station at the crossing might be in either town or partly in each one. Much of the other rail frontage in Rochester that is also near existing roads is currently occupied by a regional trash incinerator and an asphalt mixing plant.

Middleborough

In the past, there were two stations in Middleborough on the Buzzards Bay Secondary Track south of the present Middleborough/Lakeville Station. These were Rock Village, at Miller Street, and South Middleboro,¹ at Spruce Street. They were about 4.0 and 6.1 miles from Middleborough/Lakeville Station. Preliminary analysis indicates that Rock Village would be the better of the two sites for a future station location if either one were to be used. However, neither site appears to have strong potential for attracting riders.

Rock Village is about halfway between Middleborough/Lakeville Station and County Road, discussed above. The Miller Street crossing is about one mile by road from I-495 Interchange 3. There is insufficient undeveloped land for a large park-and-ride lot directly at Miller Street, but there is a large amount of vacant land on both sides of the track a short distance to the north. Access to that land would require construction of a new connecting road, however.

There are no interchanges on I-495 between Interchange 3 and Interchange 2 at County Road, so access from that highway to a South Middleboro station would be much less direct than that to a Rock Village station. If there were stations with unconstrained parking both at County Road and at Rock Village or South Middleborough, they would compete for diversion of the same traffic from I-495. Travelers concerned with minimizing driving distance would prefer County Road. Under the present fare structure, all three stations would be in the same fare zone. Therefore, none of the sites would offer an advantage to passengers over the others in terms of transit cost.

The next interchange north of Rock Village is Interchange 4, which adjoins Middleborough/Lakeville Station. Parking constraints there could give an incentive to travelers from farther south on I-495 to use new stations on a Buzzards Bay extension. A March 2006 count found 670 of the 735 spaces there (91%) in use by late morning on a weekday. (The capacity of this lot was recently reduced from 864 spaces, because part of the site is being redeveloped.) Unless all trains on the existing line were extended or had connections farther south, some passengers from the extension corridor would continue to board at Middleborough/Lakeville in any case.

State Route 28, an older unlimited-access highway, closely parallels I-495 through Wareham and Middleborough and collects traffic between interchanges on the newer road. At County Road, Route 28 is between I-495 and the railroad, so a station at County Road would be expected to serve most of the rail users from Route 28 south of that point. Traffic intercepted from the short segment of Route 28 in Rochester would also be most likely to go to a County Road station, so most traffic diverted to Rock Village from Route 28 would originate within Middleborough. There is a limited amount of residential development along this section of Route 28, mostly concentrated near the old South Middleboro station. This would leave local streets in the southwest corner of Middleborough as the main source of users of a Rock Village station.

¹ In the past, simplified spellings of town names were used in naming many railroad stations, including South Middleboro. The MBTA currently uses full legal town names in station names.

Running Times

North of Middleborough/Lakeville

For reasons discussed in Chapter 7, it is assumed that the segment of a Buzzards Bay service between Middleborough/Lakeville Station and Boston would be provided by commuter trains running on or close to schedules of trains now running on that line. This could be done either by having the passengers transfer at Middleborough/Lakeville or by having trains extended over the full length of the route. From the standpoints of both operations and customer service, through trains would be preferable. Rolling stock constraints for both strategies are also discussed in Chapter 7.

The commuter rail schedule in effect in the spring of 2006 (which had not changed significantly for several years) provided 12 round-trips between Middleborough/Lakeville and Boston on weekdays and 7 round-trips each on Saturdays, Sundays, and holidays. All trains made intermediate stops, at minimum, at Bridgewater, Campello, Brockton, Montello, and Holbrook/Randolph. They also stopped at Braintree or Quincy Center or both, and some stopped at JFK/UMass Station in Dorchester.

Scheduled running times between Middleborough/Lakeville and South Station ranged between 56 and 58 minutes in each direction during peak hours and between 54 and 57 minutes in off-peak hours, except that the first outbound trip of the day took 74 minutes because of waiting for inbound trains at passing sidings. The main reason for other variations in scheduled running times was differences in the length of dwell times allowed at intermediate stations.

South of Middleborough/Lakeville

At present, no passenger service is operated on the track between Middleborough/Lakeville and Buzzards Bay, and the most recent past service did not include a stop at Middleborough/Lakeville. Therefore, it is necessary to base running time estimates partly on theoretical considerations. This line does not have a working signal system. Under federal regulations, this would limit trains to a maximum speed of 59 mph, regardless of other considerations. With working track-side signals, a maximum speed limit of 79 mph would be allowed. Higher speeds would require onboard signaling, but for the distance involved, further time savings from speeds above 79 mph would be small.

The line has relatively few curves that would affect allowable speeds. In the 1950s when daily passenger service was still being run, the line had trackside signals, and the speed limit almost all of the way between Middleborough and Buzzards Bay was 79 mph. The exceptions were two short sections in Wareham where curves required limits of 60 mph and 40 mph. With a top speed of 59 mph and one intermediate stop at the old Wareham Station site, the minimum running time from departure at Buzzards Bay to arrival at Middleborough/Lakeville for a locomotive-hauled passenger train would be about 23 minutes. Raising the maximum speed to 79 mph while also making a stop at Wareham would reduce the running time from Buzzards Bay to Middleborough/Lakeville by about 3.5 minutes compared with the time at a maximum of 59 mph.

Relocating the stop in Wareham from the old Wareham Station site to County Road would increase the running time by about 0.25 minutes with a top speed of 59 mph, and by about one minute with a top speed of 79 mph, because trains would still have to slow to 40 mph on the curve south of the old station. Regardless of which station location was used in Wareham, adding an intermediate stop at Rock Village would add about 2.3 minutes to the running time with a top speed of 59 mph, and about 2.9 minutes with a top speed of 79 mph. Table 3-1 summarizes the estimated running times from Buzzards Bay departure to Middleborough/Lakeville arrival with the combinations of maximum speeds and station locations discussed above. If new speed restrictions were imposed anywhere along the way they could add to these times.

**Table 3-1
Estimated Running Times from Buzzards Bay to Middleborough/Lakeville
at Selected Combinations of Speed Limits and Station Locations**

Intermediate Stop Locations	59 mph	79 mph
Wareham downtown	22.8 min.	19.3 min.
County Road	23.1 min.	20.2 min.
Wareham downtown and Rock Village	25.1 min.	22.2 min.
County Road and Rock Village	25.4 min.	23.1 min.

Total Time to Boston

Travel to and from Boston would be expected to account for the largest share of ridership on a Buzzards Bay extension. If Buzzards Bay service were operated by extending existing commuter train trips, the total time would equal the sum of the time for those trips plus dwell time at Middleborough/Lakeville and running time on the extension. Connecting service would increase travel time by the amount of time provided for passengers to change trains. As discussed in Chapter 7, the present platform configuration at Middleborough/Lakeville is not well suited for quick transfers.

Combining the fastest present commuter train trip with the fastest estimated time on the extension, with a one-minute stop at Middleborough/Lakeville, would result in a time of 74.5 minutes from Buzzards Bay to South Station. Combining the longest scheduled commuter train trip with the slowest estimated time on the extension would result in a time of 83.5 minutes.

Comparisons of Train Travel Times with Bus and Auto Travel Times

The most comparable bus times to Boston are those from the Sagamore park-and-ride lot, which is also just north of the Cape Cod Canal. Scheduled times from there range between 60 and 80 minutes in AM peak hours. Trains would be most time-competitive in peak hours, but off-peak travel is likely to be less time-sensitive. Present bus service all continues to points south of the canal, but the train service being considered for the present study would not go beyond Buzzards Bay.

Direct travel time comparisons between private automobiles and bus or rail service are difficult, because automobile trips include all or most of the entire journey from origin to destination, whereas most mass transit trips are made in combination with other access and egress modes. Other sections of this chapter show rail and bus times between specific station pairs, but no attempt has been made to calculate access and egress times.

Based on information from 2004–2005 CTPS travel time runs, an automobile trip from Sagamore Circle to Kneeland Street in Boston via Route 3 would now take about 81 minutes under typical traffic conditions in the heaviest travel hour. For cars using the HOV lane on the Southeast Expressway, the time would be about 8 minutes less. From Route 25 Exit 2 in Bourne to Kneeland Street via Route 24, peak-hour automobile travel time would also average about 92 minutes without use of the HOV lane, and about 9 minutes less using it.

Potential Operating Strategies for Weekday Service

Future rail passenger service between Boston and Buzzards Bay could be provided either by through trains operating over the entire route or by shuttle trains connecting at Middleborough/Lakeville Station with commuter trains that now terminate there. For reasons discussed in Chapter 7, it would not be feasible to operate separate through trains during weekday peak hours, and possibilities for new through trains during off-peak hours would be very limited. Shuttle service would be difficult to coordinate with service on the existing lines and would be much less convenient for passengers. Therefore, the analysis of operating strategies concentrated on various levels of through service.

Three potential service levels were considered for a Buzzards Bay extension in this analysis. The minimum service level would extend as many trains as possible using only the amount of rolling stock currently assigned to the Middleborough/Lakeville Line. The maximum service level would extend all Middleborough/Lakeville Line trains to Buzzards Bay and would require assignment of an additional train set to that line throughout the day. The medium service level would include the same trips extended under the minimum level, but would also extend some midday trains by redeployment of equipment that would otherwise be underutilized during those hours.

Table 3-2 shows which trains on the existing Middleborough/Lakeville Line would be extended to Buzzards Bay under the minimum, medium, and maximum weekday service strategies. Trips shaded in the table would be extended. Trips not shaded would continue to operate between Boston and Middleborough/Lakeville Station only. Intermediate stops would remain the same as at present for all trains.

Potential Operating Strategies for Weekend and Holiday Service

Service on the Middleborough/Lakeville Line is much less frequent on weekends and holidays than on weekdays, with only 7 round-trips instead of 12. A single schedule is used for Saturdays, Sundays, and seven major holidays (New Years Day, President's Day, Memorial Day, July 4, Labor Day, Thanksgiving Day, and Christmas). Regular weekday service is operated on all other holidays. With the current schedule, a

single equipment set based at Middleborough is sufficient for 6 of the 7 round-trips. One midday round-trip originates at Boston, and uses an equipment set that is between trips on the Kingston/Plymouth Line.

With no change in the schedules between Middleborough/Lakeville and Boston, use of a second equipment set from those based at Middleborough would allow all weekend and holiday service to be extended to Buzzards Bay. Without using a second set, only the first inbound trip of the day, due in Boston at 8:12 AM, and the last outbound trip, leaving Boston at 10:30 PM, could be extended.

**Table 3-2
Middleborough/Lakeville Commuter Rail Line
Weekday Trips Extended to Buzzards Bay under Three Service Strategies
(Shaded Areas Indicate Trains to be Extended)**

Minimum Service Level

Train No.	2	4	6	8	10	12	14	16	18	20	22	28
Dep. MIDD	5:25	6:00	6:55	7:20	8:05	9:38	11:10	13:01	15:25	16:55	18:03	21:25
Arr. SSTA	6:20	6:57	7:52	8:16	9:02	10:34	12:04	13:56	16:21	17:52	19:06	22:20
Train No.	3	5	7	9	15	17	19	21	23	25	27	29
Dep. SSTA	6:36	8:23	9:57	11:55	14:15	15:45	16:45	17:15	17:55	18:45	20:10	22:30
Arr. MIDD	7:50	9:20	10:53	12:50	15:11	16:41	17:43	18:12	18:54	19:41	21:06	23:26

Medium Service Level

Train No.	2	4	6	8	10	12	14	16	18	<i>New</i>	20	22	28
Dep. MIDD	5:25	6:00	6:55	7:20	8:05	9:38	11:10	13:01	15:25	16:11	16:55	18:03	21:25
Arr. SSTA	6:20	6:57	7:52	8:16	9:02	10:34	12:04	13:56	16:21	17:08	17:52	19:06	22:20
Train No.	3	5	<i>New</i>	7	9	15	17	19	21	23	25	27	29
Dep. SSTA	6:36	8:23	9:12	9:57	11:55	14:15	15:45	16:45	17:15	17:55	18:45	20:10	22:30
Arr. MIDD	7:50	9:20	10:09	10:53	12:50	15:11	16:41	17:43	18:12	18:54	19:41	21:06	23:26

Maximum Service Level

Train No.	2	4	6	8	10	12	14	16	18	20	22	28
Dep. MIDD	5:25	6:00	6:55	7:20	8:05	9:38	11:10	13:01	15:25	16:55	18:03	21:25
Arr. SSTA	6:20	6:57	7:52	8:16	9:02	10:34	12:04	13:56	16:21	17:52	19:06	22:20
Train No.	3	5	7	9	15	17	19	21	23	25	27	29
Dep. SSTA	6:36	8:23	9:57	11:55	14:15	15:45	16:45	17:15	17:55	18:45	20:10	22:30
Arr. MIDD	7:50	9:20	10:53	12:50	15:11	16:41	17:43	18:12	18:54	19:41	21:06	23:26

Note: MIDD indicates Middleborough/Lakeville Station. SSTA indicates South Station in Boston.

4. DEMAND ESTIMATES FOR AN EXTENSION

Travel Markets to be Served

The largest single component of travel on the existing MBTA commuter rail network is work trips to employment locations in Boston or Cambridge from homes in outlying cities and towns. This would likewise be expected to be the largest single component of ridership on a Buzzards Bay extension. This is also part of the travel market for which the most information about current volumes and modes is available. Other sources of ridership would include non-work trips to Boston or Cambridge, trips to destinations beyond Boston or Cambridge, and trips to intermediate destinations. Recently there has been some interest by suburban elected officials and business leaders in encouraging the use of commuter rail for reverse-commuting from homes in the urban core to suburban work locations. Transit lines that serve areas in which tourism is an important part of the economic base can also serve some travel related to this activity. This can include day-trips, trips at the beginning or end of multi-day visits, or seasonal commuting from vacation homes. Summer recreational travel is a major component of total travel to Barnstable County towns, and also to Wareham, and is included in the markets considered for a Buzzards Bay extension.

Demand Estimation Method for a Buzzards Bay Commuter Rail Extension

The Bourne Commuter Rail Feasibility Study, completed by CTPS for the MBTA in March 1997, included ridership estimates for an extension essentially the same as that being examined for the present study. Because the extension service area would be outside the boundaries of the CTPS regional demand model, a manual demand forecasting method was used. (A similar manual method has produced results consistent with those of the regional model when applied to potential new services within the boundaries of the model.)

A review of the demand estimates in the 1997 study indicates that the method used was appropriate, but that the numbers should be updated, incorporating more recent data. In 1997 the newest census journey-to-work tabulations were those from 1990. The newest tabulations now available are those from 2000. (The U.S. Census Bureau has announced that journey-to-work data will not be collected as part of future decennial censuses. It is unclear whether an alternate data collection method now being implemented by the Bureau will yield comparable results.)

The 1997 study was completed prior to the re-opening of the Middleborough/Lakeville and Kingston/Plymouth commuter rail lines, so information on base-case ridership on those lines was itself based on predictions. Information is now available on actual use of these lines for travel from communities that would be served by a Buzzards Bay extension.

The steps used in the manual demand estimation for ridership at year 2000, 2006, and 2020 travel levels are described in detail in Appendix B.

Estimated Ridership on a Buzzards Bay Commuter Rail Extension

Table 4-1 summarizes the ridership estimates produced by the methods discussed in Appendix B. Ridership was estimated for the minimum and maximum shares of total travel that an extension would be likely to capture, based on experience at comparable locations on the existing MBTA commuter rail system. The volumes shown in the tables in this chapter are for the mid-range between the minimum and maximum estimates.

According to the mid-range estimates, if total work trips by all modes were still at the levels indicated by the 2000 census, a Buzzards Bay commuter rail extension unconstrained by capacity and with maximum feasible service would carry about 1,765 inbound riders for all trip purposes combined on an average non-summer weekday. This total includes the return halves of reverse-commuting trips, but does not include summer-only recreational trips to Cape Cod. It should be noted that reverse-commuting and recreational trips would require extensive networks of feeder service connections. Such services would have to be funded by entities other than the MBTA, such as towns, regional transit authorities, or private businesses. Of the municipalities in the assumed service area of a Bourne extension, only Wareham, Rochester, and Carver are within the MBTA Service District as currently defined. Furthermore, direct MBTA operation or funding of feeder routes in any town as far from Boston as Wareham or Bourne would be unprecedented.

**Table 4-1
Estimated Mid-Range Inbound Weekday Trip Origins on a Buzzards Bay Extension
under Year 2000, 2006, and 2020 Total Travel Levels and Maximum Service**

Origin Town	2000 Origins	2006 Origins	2020 Origins
Bourne	238	275	335
Falmouth	218	250	300
Sandwich	226	255	280
Barnstable	250	295	385
Mashpee	116	170	320
Yarmouth	97	135	230
Other Barnstable County	<u>81</u>	<u>105</u>	<u>150</u>
Subtotal Barnstable County	1,226	1,485	2,000
Wareham	220	185	185
Carver	63	65	100
Rochester	89	120	190
Marion	106	150	240
Mattapoisett	<u>62</u>	<u>40</u>	<u>35</u>
Subtotal Plymouth County	540	560	750
TOTAL SERVICE AREA	1,766	2,045	2,750

Note: The totals above do not include summer-only recreational trips.

Adjusted for estimated changes in work trips between 2000 and 2006, the extension would carry an estimated 2,045 riders per day for all trip purposes combined. By the year 2020, extension ridership is estimated to increase to about 2,750 per day. The estimates for all years are midpoints between ridership with the maximum and minimum shares of total travel that the extension would be likely to attract. However, it must be emphasized that all of the estimates are contingent on the ability to provide parking for the majority of riders at the boarding stations and adequate capacity aboard trains for these riders in addition to those continuing to use existing stations on the Middleborough/Lakeville commuter rail line.

Table 4-2, provides a further breakdown of the components of the year 2000 ridership estimates in Table 4-1. Details of the methods used in estimating these components are provided in Appendix B. The work-to-home halves of reverse-commuting trips are included within the inbound non-work trip totals. Estimates of summer-only recreational demand are not included in these tables, but are discussed in Appendix C.

Based on the present distribution of modes used for travel between origin-destination pairs that would be served by a Buzzards Bay extension, approximately 35% of the riders would be diverted from existing MBTA or private-carrier transportation services and the rest would be diverted from private autos.

**Table 4-2
Summary of Mid-Range Inbound Non-Summer Weekday Trip Types on a
Buzzards Bay Extension under Year 2000 Travel Levels With Maximum Service**

Origin Town	Boston Proper Work	Boston Other Work	Cambridge Work	Inter-zone Work	Beyond Boston Work	Non-Work	Total
Bourne	87	58	35	18	4	36	238
Falmouth	92	69	8	10	3	36	218
Sandwich	107	47	7	25	3	37	226
Barnstable	127	54	15	9	4	41	250
Mashpee	60	26	6	3	2	19	116
Yarmouth	53	22	0	5	1	16	97
Other Barnstable County	<u>31</u>	<u>21</u>	<u>5</u>	<u>10</u>	<u>1</u>	<u>13</u>	<u>81</u>
Subtotal Barnstable County	557	297	76	80	18	198	1,226
Wareham	76	56	14	36	3	35	220
Carver	33	7	2	10	1	10	63
Rochester	22	41	4	6	1	15	89
Marion	59	13	6	8	2	18	106
Mattapoisett	<u>23</u>	<u>20</u>	<u>2</u>	<u>5</u>	<u>1</u>	<u>11</u>	<u>62</u>
Subtotal Plymouth County	213	137	28	65	8	88	540
TOTAL SERVICE AREA	770	434	104	145	26	287	1,766

Estimated Ridership for Alternate Weekday Service Strategies

Chapter 3 and 7 of this report include discussion of three alternative weekday service strategies for a Buzzards Bay commuter rail extension. The ridership estimates in Tables 4-1 and 4-2 are based on the mode shares that would be expected under the maximum service strategy. This would extend all present weekday trips on the Middleborough/Lakeville Line to Buzzards Bay. An extension with less frequent service would be expected to attract fewer riders. At present, all routes in the MBTA commuter rail system have all-day service, so there are no examples of mode shares with service levels comparable to the minimum and medium service levels considered for Buzzards Bay. Therefore, it was necessary to estimate ridership for the reduced service levels by making adjustments to the full-service estimates. Details of these estimates are included in Appendix B.

With the minimum service strategy, ridership on a Buzzards Bay extensions at 2006 total travel levels is estimated to be 1,165 each way per weekday. With the medium service strategy, ridership is estimated to be 1,330 each way per weekday.

Estimated Weekend and Holiday Ridership

The weekday ridership estimation method relies heavily on work-trip data. Work travel is a much smaller component of weekend ridership, and there is no source of overall work trip data for weekend days. Therefore, weekend ridership was estimated in proportion to weekday ridership.

Based on the results of the 2005 MBTA fare-mix study, if all Middleborough/Lakeville trains were extended to Buzzards Bay on all days of the week, average Saturday ridership would be expected to equal at most about 35% of average weekday ridership, and average Sunday ridership would be expected to equal at most about 20% of average weekday ridership. With estimated mid-range weekday ridership of 2,045 each way per day at 2006 travel levels, this would result in Saturday ridership of about 715 each way and Sunday ridership of about 410 each way on the extension in non-summer months. Little information is available on holiday ridership on the commuter rail system. Some holidays have Saturday service schedules, some have Sunday service schedules, and some have normal weekday schedules. For purposes of analysis, it was assumed that ridership on a holiday with a weekday schedule would be the same as average weekday ridership, that ridership on a holiday with a Saturday schedule would be the same as average Saturday ridership, and that ridership on a holiday with a Sunday schedule would be the same as average Sunday ridership.

As an alternative to extending all weekend and major holiday Middleborough/Lakeville Line trains to Buzzards Bay, a strategy of extending only selected trains was also considered. Under this strategy, 4 of the 7 Middleborough/Lakeville round-trips would be extended to Buzzards Bay on Saturdays, Sundays, and major holidays. This would be 57% of the trips on those days. If ridership was also reduced to 57% of the estimated total with all trains extended, about 410 riders each way would be expected to use the extension on Saturdays or Saturday-schedule holidays. About 235 riders each way would be expected on Sundays or Sunday-schedule holidays.

Impacts of Capacity Constraints on Buzzards Bay Extension Ridership

In the demand estimates above, there is an implicit underlying assumption that a Buzzards Bay extension would be able to carry as many passengers as wanted to use it. In reality, ridership would be limited by the capacities of the rail system itself, and of the travel modes used to get to and from the rail stations. Appendix D discusses these capacity constraints and the potential strategies for mitigating them.

5. CAPITAL COST ESTIMATES FOR AN EXTENSION

Main Cost Items Examined

The main capital costs for commuter rail extensions generally consist of construction or upgrading of tracks, signals, bridges, and road crossings, construction of station and parking facilities and train layover facilities, and acquisition of rolling stock. A Buzzards Bay extension would operate entirely over a single-track line that was rebuilt in 1986 in conjunction with Amtrak intercity passenger train service that operated each summer from that year until 1996. The level of traffic carried on the line since 1986 has caused limited wear-and-tear on the track. However, some deterioration of roadbed and ties has occurred due to weathering. There has also been wear from vehicular traffic on grade-crossing surfaces.

Most of the present main-line track has 115-pound-per-yard continuous welded rails on wooden crossties and crushed stone ballast. A spot-check visual inspection conducted by CTPS in October 2006 found no problems with the alignment and surface of the rails. The majority of crossties appeared not to be defective, according to Federal Railroad Administration (FRA) standards, though most had extensive sun bleaching and many were starting to crack. The ballast was generally free of vegetation, and no drainage problems were observed.

Installation of new wayside automatic block signals was begun as part of the 1986 upgrade project. Signal masts and heads were installed then, but final wiring was never completed because the train speeds and traffic levels did not require signals. The 2006 field inspection found two of these signals still in place, and potentially usable, but a third signal had been damaged beyond repair.

The station locations used for future commuter rail service would not necessarily be the same as those used for the past Amtrak service. Even the former station locations that might be re-used lack full-length high-level platforms. They also have very limited parking capacity.

The operating cost estimates in Chapter 6 assume that trains used on the extension would be based at the Middleborough layover facility, where trains on the Middleborough/Lakeville line are currently based. This would require some shifting of trains without passengers between the yard and Buzzards Bay at the beginning and end of each service day. In the short term this would avoid the cost and time for construction of a new layover facility for the extension. However, if service were established permanently, the operating cost savings from reduction of non-revenue train-hours would eventually exceed the cost of a layover facility. (The Amtrak trains were stored between trips in a yard north of Hyannis Station, but this site is even farther from Buzzards Bay than the Middleborough yard is.)

The remainder of this chapter discusses the estimated capital requirements for a Buzzards Bay extension with sufficient capacity to meet the mid-range projected demand for the maximum service level at 2006 travel levels. These costs, as summarized

in Table 5-1, would range from \$84 million to \$106 million at present cost levels. The unit costs used in calculating these totals were based on a combination of costs from past MBTA commuter rail extension feasibility studies updated by application of construction cost index figures, and reported costs for projects recently begun or completed on the MBTA system and other rail systems in the United States. More detailed engineering studies and review by the MBTA would be needed to refine these estimates. It must be emphasized that at present, EOT has no capital funds programmed for a Buzzards Bay extension and the MBTA has no operating funds programmed for one. Therefore new funding sources would need to be identified before such an extension could be implemented.

Main Track

A Buzzards Bay extension would be dissimilar to many commuter rail extensions examined by the MBTA, in that extensive upgrading for passenger service on the route was done 20 years ago, after which limited use was made of the line. More detailed engineering studies than were possible within the scope of this study would be needed to refine cost estimates for the further upgrading now required.

The FRA sets forth safety standards for determining the maximum speed limit allowed on a given section of railroad track. After the 1986 track upgrading on the Buzzards Bay extension route, the speed limit was set at 59 mph, the maximum permitted on a track with no signals. However, it appears that the condition of the track itself would have permitted a higher speed limit if signal installation had been completed. Present MBTA policy calls for FRA Class 4 track, which would allow a top speed of 79 mph with wayside signals only, or 80 mph with in-cab signals.

One of the main factors determining the FRA classification of a section of track is the number of crossties rated as not-defective in a given length of rail. For Class 4 track, approximately two-thirds of the ties must be not-defective. The CTPS visual spot-checks in October 2006 indicated that tie condition generally met or fell only slightly below Class 4 standards. Because of the light traffic density on the line, most of the tie deterioration since installation was the result of normal weathering rather than wear-and-tear. However, few ties had been replaced more recently than the 1986 rebuilding project, and some were older. Wooden ties such as those used on this line have an average service life of about 30 years, with a range of approximately 25 to 40 years. Consequently, by the time a commuter rail extension could be implemented or not long after that, a need for extensive tie replacement could be anticipated. At present cost levels, replacement of two-thirds of the ties between Middleborough/Lakeville and Buzzards Bay would cost approximately \$3.8 million.

Passing Tracks

The current (April 2006) schedule on the Middleborough/Lakeville Line provides 12 trains a day in each direction on weekdays. If all of these were extended to Buzzards Bay while maintaining their departure and arrival times at Middleborough/Lakeville, 8 southbound trains would each have to pass one northbound train somewhere on the extension. (The other 4 trains in each direction would face no opposing traffic on the extension.) At present, there are no passing tracks between Middleborough/Lakeville

Station and Buzzards Bay at locations that would be compatible with the requirements of this schedule. A more detailed analysis of the location requirements and configuration for a passing siding is included in Chapter 7.

Depending on maximum train speeds, and on the amount of delay acceptable at the passing location, the required length of a new passing siding would range from about 1.0 miles to 3.3 miles. The cost of such a siding, excluding related signals, would range from about \$1.9 million to \$5.5 million.

Signals

At present, the rail line that would be used for a Buzzards Bay commuter rail extension does not have a working signal system. Installation of wayside signals was begun in conjunction with the 1986 implementation of intercity passenger service on the line, but was never completed. The 2006 field inspection found two signal masts still standing, with signals for both directions apparently intact, but a third signal set had been damaged beyond repair. There may have been others at locations not visible from road crossings. The locations of the signals installed in 1986 would not necessarily meet the needs of future commuter rail service.

A wayside signal system would allow maximum train speeds of up to 79 mph where track geometry and condition also allowed such speeds. For top speeds above 79 mph, an in-cab signaling system would be required. On the Buzzards Bay extension route, the distances between restricted-speed segments would be too short to produce significant time savings from operating trains at top speeds over 79 mph. However, the Middleborough/Lakeville Line currently uses a cab-signaling system, in addition to wayside signals, for safety enhancement rather than for high speed limits. Installation of this system on a Buzzards Bay extension might also be called for.

Signal requirements for a Buzzards Bay extension are examined in greater detail in Chapter 7. As discussed there, an extension would require, at minimum, installation of six sets of signals (at Middleborough/Lakeville, Buzzards Bay, each end of a new passing track, and at each end of the SEMASS Resource Recovery complex in Rochester). The estimated combined cost for these would be approximately \$7.9 million. If signals were installed at more locations, or if a cab-signal system were installed, the cost would be greater. (The need for another signal in conjunction with the Buzzards Bay side track is discussed separately below.) Exact determination of the signal configuration to be used would require further discussion with the MBTA.

Road Crossings at Grade

At present, there are 11 grade crossings of public roads and 3 authorized private crossings on the rail line between Middleborough/Lakeville Station and the old Buzzards Bay station area. (The old station building there is now a visitor information center.) There is only one track at each of these crossings. All of the public crossings are protected by flashing lights, and all except the crossing of Academy Drive, just north of the old Buzzards Bay station building, are also protected by automatic two-quadrant gates. All of these appeared to be properly maintained at the time of the October 2006 CTPS field check, but they were not observed in operation.

The distance from a crossing at which trains activate lights and gates is established on the basis of the fastest trains expected to use the crossing. The present crossing devices were installed when the top speed was 59 mph. If the top speed were raised to 79 mph, some re-wiring of the crossing circuits would be required, at undetermined cost.

In 2006, the surfaces of 8 of the public crossings consisted of wooden guard timbers on either side of each rail, with asphalt pavement on either side of the crossing and between the inside guard timbers. One crossing (County Road) had an asphalt surface with no guard timbers, and one (Route 6) had a rubber surface. The asphalt crossing surfaces were generally in fair to poor condition, apparently having had little maintenance since they were rebuilt in the 1980s. Prior to implementation of commuter rail service, they should be replaced with more durable surfaces, such as rubber or concrete panels. The total cost to do this at ten crossings would be about \$1.3 million. The rubber crossing surface at Route 6 was still in good condition, but showed some signs of wear and would eventually also need to be replaced.

The 3 private crossings all appeared to have infrequent use in 2006, but could potentially provide access to new development projects in the future. Each of these crossings was only one lane wide, with an asphalt surface and guard timbers in fair to poor condition. All 3 were on dirt roads or trails. One was protected by stop signs on the road on either side and the other two had no protection other than the whistling of trains. The necessary costs of upgrading these crossings, and responsibility for those costs, would depend on their future use. The rights to cross at two of the locations are long established, but the third has been added in relatively recent times.

A fourth private crossing of the rail line, just south of the old Buzzards Bay station platform, could also be affected by an extension, depending on a new platform configuration there. That crossing is the driveway to U.S. Army Corps of Engineers buildings related to operation of the Cape Cod Canal. The crossing is paved, but not protected. It might be feasible either to relocate this crossing farther from Academy Drive, or to replace it with a new entrance from Taylor Road.

Bridges

Between Middleborough/Lakeville Station and the old Buzzards Bay station, the rail line crosses only one road (Main Street in South Wareham) on a bridge. The superstructure of this bridge was replaced in the 1980s. The only visually apparent defect found in October 2006 was that the steelwork needed to be scraped and repainted. The rail line also crosses four bodies of water on fixed bridges ranging in length from 40 to 278 feet. These were also found to be mainly in need of painting, but more thorough inspection could reveal other problems. In addition to these, there are numerous culverts over small streams, and some of them may be in need of repairs.

The work program for the present study calls for consideration of a commuter rail extension only as far south as Buzzards Bay. This is the farthest that trains could be run on the line without crossing the existing vertical-lift bridge over the Cape Cod Canal. This bridge, which was built in 1935, is owned and maintained by the U.S. Army Corps of Engineers. It is normally kept in the raised position, being lowered only for passage

of trains. Operation of rail passenger service beyond Buzzards Bay would require much more frequent raising and lowering of the bridge than has occurred in recent years. The Corps has an ongoing project to upgrade the bridge structure and draw mechanism. The costs of this work are being borne by the Corps and do not need to be included in capital cost estimates for the present study.

Fencing

At present, none of the right-of-way between Middleborough/Lakeville and Buzzards Bay is fenced in, except where abutting property owners have installed their own fences. At grade crossings, gates have been placed across the former second-track location to prevent entry of unauthorized vehicles, but trespassing by pedestrians and dirt-bikers is not uncommon. For safety, the right-of-way should be fenced wherever developed land abuts the tracks. A preliminary investigation indicates that, at a minimum, between Middleborough/Lakeville and Buzzards Bay, segments totaling about 10 miles should be fenced, at a cost of about \$1.1 million. Fencing the entire right-of-way would cost approximately \$3.8 million.

Station Platforms and Shelters

All stations on the present Middleborough/Lakeville Line have full-length high-level platforms. The doors on all cars on each train used on the line are opened and closed remotely from a single control point aboard the train. This allows much faster boarding and alighting than is possible with low-level boarding. None of the station sites used in the past on the Buzzards Bay extension route had full-length high-level platforms, although the old Buzzards Bay station does have a mini-high-level platform.

To comply with a provision of the Americans with Disabilities Act of 1990, the United States Department of Transportation has proposed a new rule requiring that all new commuter or intercity rail passenger stations be built with full-length platform heights matching the floor heights of the cars on the trains that will use them. If this rule is implemented, it would require full-length high-level platforms at the stations on a Buzzards Bay extension. For this reason, as well as for consistency with operations north of Middleborough/Lakeville, full-length high-level platforms are assumed in the cost estimates for this study.

The costs of station construction can vary widely, depending on the site constraints and on the amenities included. At the low end, estimates for the New Bedford/Fall River commuter rail extension feasibility study, updated for construction cost increases, indicate that a simple design for a single-track ground-level station with roofs sheltering one-third of the length would cost about \$1.5 million. At the opposite extreme, a station in the Chicago area on which construction began in 2006, with two full-length high-level platforms above street level, access ramps and stairs, full roofing of one platform, and multiple enclosed waiting areas was reported to cost \$5.4 million. A similar two-track station in the Philadelphia area, on which construction also began in 2006, was reported to cost \$4.9 million.

Stations on a Buzzards Bay extension would most likely be at ground level, and would have only one track and one platform. For purposes of analysis, it was assumed

that the cost of such a station would be no more than half the cost of the Chicago and Philadelphia stations described above, or about \$2.5 million.

Parking Facilities

As discussed in Chapter 4 and Appendix B, park-and-ride would be the main mode of access to stations on a Buzzards Bay extension. At 2006 travel levels, ridership under the maximum service level alternative would require about 1,190 parking spaces at a Buzzards Bay station and another 450 spaces at a Wareham station. A surface parking lot can accommodate a maximum of about 130 cars per acre, but irregularly shaped parcels have lower capacities. Surface lots with the number of spaces listed above would therefore require at least 8 acres at Buzzards Bay and at least 3.5 acres in Wareham.

At Buzzards Bay, 8 acres would be equivalent to all of the currently undeveloped land within the area bounded to the west by the railroad, to the north by Main Street, and to the south by the Cape Cod Canal, for a distance of nearly one-quarter mile from the past station location. At present this land is occupied by a park, woods, and a small parking lot that was used by a now-closed building materials store. A multi-level parking garage would require less land, but because of the need for ramps and stairways, the parking capacity per acre on each floor would be lower than the maximum for a surface lot. A four-level garage with capacity for 1,190 cars would occupy about three acres. To minimize visual impact, at least some levels would likely be underground, although proximity to the canal would pose some construction challenges.

The former downtown Wareham station site would not be able to accommodate parking for 450 cars in either a surface lot or a garage. Some other locations along the rail line, such as the County Road site that was assumed for purposes of the service operation analysis, would have room for a 450-car lot, but recommendation of a specific station site is beyond the scope of the present study.

Capital costs for parking garages can vary widely, depending on factors such as present site use, topography, and type of foundation needed. At the low end, a 538-car garage completed in 2006 on a site that was already owned by the MBTA, had never had any buildings on it, and consisted of level solid ground, cost approximately \$15,800 per space. In contrast, a proposed 420-space garage in a metropolitan-Boston town center where land-taking and building-demolition would be required was recently estimated to cost about \$23,000 per space. Another garage recently completed on a similar site cost about \$26,000 per space. At these rates, the cost of a 1,190-car garage would range from \$18.8 million, to \$30.9 million.

Capital costs for surface parking lots are influenced by many of the same factors that affect garage costs, with construction being a smaller component of the total for a surface lot. In 2005, a 200-space expansion of an existing surface lot at one MBTA suburban commuter rail station cost \$10,000 per space, including land acquisition. At the same rate, a 450-car surface parking lot would cost \$4.5 million.

The estimated costs above would provide sufficient parking only for the mid-range demand estimates at 2006 travel levels. Higher demand in early years and projected future growth would require even more capacity.

Train Layover Facilities

At present, all service on the Middleborough/Lakeville Line is provided with four train sets of 5 or 6 cars each. These are based at night at a yard one mile north of Middleborough/Lakeville Station. All of the service alternatives for a Buzzards Bay extension examined for this study would require either four train sets or five. For purposes of the operating cost estimates in Chapter 6, it was assumed that a Buzzards Bay extension would also be operated with equipment based at the Middleborough yard. There is sufficient capacity there to base a fifth train set. Nevertheless, at times during peak hours it would be necessary for up to four train sets to be in the vicinity of Buzzards Bay simultaneously. This would require upgrading an existing side track just north of the station, including installation of signals, at an estimated cost of \$1.4 million. Issues related to layover facilities are discussed in more detail in Chapter 7.

Rolling Stock

Commuter rail service to Buzzards Bay would be operated by extending trips that currently run between Middleborough/Lakeville Station and Boston. At present, all service on this route is provided by four train sets. Because of additional running time between Middleborough/Lakeville and Buzzards Bay, a fifth train set would be needed if all weekday trips were extended. The minimum service alternative analyzed in Chapter 3 would extend as many trips as feasible using only the present four train sets. The medium service alternative would extend the same trips as extended under the minimum alternative, and would also provide additional midday service using an equipment set that is assumed to otherwise be idle in Boston during that time.

Regardless of which of the three service levels was implemented, additional ridership generated by the extension could require increasing the passenger capacities of some or all peak-period trains. These increases are discussed in detail in Chapter 7. The conclusion there is that the minimum and medium service strategies would require the net addition of two bi-level coaches to the fleet. The maximum service strategy would require the net addition of 10 bi-level coaches and one locomotive.

Based on recent orders, bi-level coaches currently cost about \$2.4 million each, and diesel locomotives suitable for commuter service currently cost about \$2.7 million each. At these prices, the additional two cars needed for the minimum and medium service levels would have a capital cost of \$4.8 million. The 10 cars and one locomotive needed for the maximum service level would have a capital cost of \$26.7 million. It should be noted that in order to obtain rolling stock for these unit prices, it would likely be necessary to include Buzzards Bay rolling stock as part of a larger equipment order. This could have an impact on the potential timing of the implementation of an extension.

Summary of Capital Costs

The estimated capital cost requirements for a Buzzards Bay commuter rail extension are discussed in detail in the preceding sections of this chapter, and are summarized below in Table 5-1. As shown, estimated cost requirements to provide sufficient capacity to meet the mid-range projected demand for the maximum service level at 2006 travel levels would range from \$84 million to \$106 million at present cost levels. Provision of capacity for anticipated future ridership growth would incur additional cost. All of the cost figures shown are preliminary estimates, and more detailed engineering studies would be needed to refine them.

Table 5-1
Summary of Estimated Capital Costs for Buzzards Bay
Commuter Rail Extension with Maximum Service Level
at 2006 Cost Levels (in \$Millions)*

Item	Amount
Maximum Service – Fixed Facilities	
Track, Signals, and Passing Sidings	\$15.0 to \$18.6
Grade Crossing Surface Replacement	\$1.3
Fencing	\$1.1
Station Platforms and Shelters	\$3.0 to \$5.0
Parking Facilities (with Garage at Buzzards Bay)	\$23.3 to \$35.4
Contingencies	\$4.1 to \$5.8
Engineering, Administration, and Inspection	<u>\$5.7 to \$8.1</u>
Subtotal	\$53.5 to \$75.2
Maximum Service – Rolling Stock	
Locomotives and Coaches	\$26.7
Engineering, Administration, and Inspection	<u>\$1.6</u>
Subtotal	\$28.3
TOTAL CAPITAL COST FOR MAXIMUM SERVICE	\$81.8 to \$103.5

*Note: All costs shown above are preliminary estimates. Detailed engineering studies would be required to refine costs. The total above assumes that no new train layover facilities would be built on an extension.

6. OPERATING COSTS AND REVENUES FOR AN EXTENSION

Because of the difficulty of predicting future trends in operating expenses or fares, this study followed the standard practice of using current unit costs and fare structure. Consequently, the revenue estimates in this chapter are based on the fares in effect during 2006 rather than the new, higher fares to be implemented in January 2007. At this writing, it is uncertain how the new fares might impact ridership or the mix of fare-payment options used by riders on a Buzzards Bay extension.

It is important to note that present constraints on the MBTA operating budget would not allow for any service expansion that would result in an increase in the net cost of service (operating cost minus operating revenue) of the overall system. As discussed below, a Buzzards Bay extension would, like other MBTA services, have incremental operating costs greater than incremental revenue. Therefore, additional funding would need to be identified before implementing such an extension.

Operating Cost Estimates

The main components of operating costs for commuter rail include train crew wages and benefits, fuel, maintenance of equipment, maintenance of fixed facilities such as tracks, signals, and stations, and administrative costs. A precise calculation of these costs for a Buzzards Bay extension would require more specific information on schedules, train lengths, and crew assignments than can be determined at this time.

The MBTA commuter rail system is currently operated under a fixed-price/ fixed-service-level contract by a private company, Massachusetts Bay Commuter Railroad (MBCR). The incremental cost to the MBTA for adding Buzzards Bay service to the contract would be subject to negotiation. For purposes of studies such as this one, the practice of the MBTA in recent years has been to estimate costs using the average cost per car-hour calculated from the operating contracts and schedules for the most recent year available. The latest figures now available are from 2005, when the average cost was \$308.62 per car-hour. Most trains that would be extended to Buzzards Bay would have six-car equipment sets. If the same unit cost were to apply under a renegotiated agreement with MBCR (or a future successor), the average cost per train-hour would be \$1,851.74.

For reasons discussed in Chapters 3 and 7, all or most service on a Buzzards Bay extension would be provided by lengthening the trips of trains that would already be running between Boston and Middleborough/Lakeville Station. Therefore, most of the additional train-hour costs would be incurred between Middleborough/Lakeville Station and Buzzards Bay.

As discussed in Chapter 3, the running time between Buzzards Bay and Middleborough/Lakeville Station would range from approximately 20 to 26 minutes, depending on the maximum operating speeds established on the line and the number and location of intermediate stations. A minimum of 10 minutes would be required for trains to reverse direction between outbound arrivals and inbound departures at

Buzzards Bay. However, in order to maintain present schedules between Middleborough/Lakeville Station and Boston, most trains would have to wait at Buzzards Bay much longer than 10 minutes. Paid person-hours for train operation on the extension would include both end-to-end running time and time spent at Buzzards Bay between trips. Consequently, the long layovers would result in above-average operating costs per train trip.

Weekday Service Strategies and Costs

At present, weekday service on the Middleborough/Lakeville Line consists of 12 round-trips provided by four equipment sets that are based overnight at a yard north of Middleborough/Lakeville Station. Three potential service levels for a Buzzards Bay extension were considered in Chapter 3. Estimated operating costs for service at these levels are discussed below.

Minimum Weekday Service Level

The minimum weekday service level considered would extend to Buzzards Bay as many trips as feasible using only the number of train sets (four) now assigned to the Middleborough/Lakeville Line. This would include all trips that are now provided by train sets that come from the Middleborough yard just prior to starting for Boston or that return to that yard just after arrival from Boston. One additional evening trip in each direction would also be extended. Overall, this would provide five trips in each direction. Specific details of the trips to be extended are provided in Appendix E and shown in Table 3-2.

Including layover time between trips, the minimum service schedule would result in a net increase of 8.8 train-hours per weekday. Service on the Middleborough/Lakeville Line currently operates on weekend schedules on seven major holidays, and on regular weekday schedules on all other holidays. Therefore, in a typical year, weekday service is run on 254 days. With the minimum extension of weekday service, 2,228 train-hours per year would be added. The cost of this, at the average rate of \$1,851.73 per hour, would be \$4,125,000.

Medium Service Level

Without acquisition of an additional train set, the most service that could be provided on a Buzzards Bay extension would be that using the same number of train sets currently assigned to the Middleborough/Lakeville Line, along with equipment not being fully utilized on other South Side commuter rail lines. Present midday schedules use fewer train sets than AM or PM peak schedules, leaving some equipment theoretically available for additional midday service. However, in order not to disrupt existing schedules, any midday redeployment of a train set could not begin until after completion of its last AM peak assignment, and would have to end prior to the start of its first PM peak assignment.

Any midday trips operated on a Buzzards Bay extension in addition to those feasible under the minimum service scenario would need to be run at times far enough away from those trips to be useful additions to the service. As under any of the service

scenarios, schedules would be constrained by the limited number of double-track sections and passing sidings.

Based on an examination of the current deployment of train sets on the South Side commuter rail lines, it was concluded that, at most, one additional set could be diverted to the Middleborough/Lakeville Line with a Buzzards Bay extension during midday hours, while satisfying all of the constraints discussed above. Specific details of the service that could be provided with this equipment are provided in Appendix E and shown in Table 3-2.

Including equipment positioning trips, this strategy would increase train-hours compared with present service by 16.7 per weekday, or 4,247 per year, at an estimated annual cost of \$7,864,000.

Maximum Service Level

The maximum service level considered would extend all 12 weekday round-trips on the Middleborough/Lakeville Line to Buzzards Bay. This alternative would require assignment of a fifth train set to the line, also to be based at the Middleborough yard. Including equipment positioning trips, this strategy would increase train-hours compared with present service by 20.7 per weekday, or 5,265 per year, at an estimated annual cost of \$9,750,000. Additional information pertaining to this cost estimate is contained in Appendix E.

Weekend and Major Holiday Service

Most of the MBTA commuter rail lines now in operation have weekend service, though at less frequent intervals than weekday service. This includes the Middleborough/Lakeville Line. The private-carrier bus routes now serving communities in the assumed service area of a Buzzards Bay extension also offer weekend service. Present support for restoration of rail passenger service to Buzzards Bay is based partly on a perceived need to serve recreational travel. Much of this would take place on weekends rather than on weekdays. (The most recent intercity rail passenger service to Cape Cod, intended primarily for recreational travel, operated only on Fridays and Sundays.) Based on these considerations, it is most likely that if weekday service were provided on a Buzzards Bay extension, there would also be weekend service.

Two operating strategies for weekend service were examined, and are discussed in detail in Appendix E. A maximum service strategy would extend all 7 round-trips currently operated on the Middleborough/Lakeville Line on weekend days and major holidays to Buzzards Bay. This would result in an annual total of 1,502 added train-hours, at an estimated cost of \$2,781,000.

The minimum service strategy examined would extend alternate Middleborough/Lakeville Line trips to Buzzards Bay on weekend days and major holidays. Because of the relatively inefficient possible use of train crews and equipment, this would be only slightly less costly than extending all trains. It would result in an annual total of 1,476 added train-hours, at an estimated cost of \$2,734,000. As discussed below, the reduction

in estimated revenue from the minimum service level compared with the maximum level would exceed the cost saving.

Revenue Estimates

Factors Affecting Revenue

The estimated revenue that would be generated by a Buzzards Bay extension would depend on the amount of ridership, the fare structure, and non-fare revenue from sources such as parking fees. Ridership estimates for the extension at present total travel levels and predicted year 2020 travel levels are discussed in Chapter 4. The demand estimation method produces estimates for average weekdays, assuming service levels similar to those on existing MBTA commuter rail lines. This would apply to the maximum service level scenario described above. Estimates of ridership for the medium and minimum service level scenarios require some downward adjustment from the maximum level estimates. Ridership for weekend and holiday service was not estimated directly in Chapter 4, but was calculated from the ratios of Saturday and Sunday ridership to weekday ridership on existing MBTA commuter rail lines.

Assumed Fare Structure

At present, a zone-fare system is used on the MBTA commuter rail system, with zone limits based on rail distance from the downtown Boston terminals. Currently, the highest fare zone is Zone 8, but in the past there have been higher zones. The farthest distance from any Zone 8 station to a Boston terminal now is that from Fitchburg to North Station, at 49.6 miles. The distance from the old Buzzards Bay station location to South Station in Boston is 54.5 miles, or 10% greater than the present Zone 8 maximum. The most recent past rail passenger station location in Wareham is 49.1 miles from South Station, but alternate sites in the town could be closer or farther than this. For purposes of analysis, it was assumed that future Buzzards Bay and Wareham stations would both be in Fare Zone 8, but this would be subject to changes in the fare structure.

At present, several fare payment options are available to commuter rail passengers, so the amount of revenue generated per trip is variable, even for all passengers traveling between the same station pairs. Fare-mix studies are conducted by CTPS for the MBTA at regular intervals in order to determine the average revenue per passenger for various MBTA services. In the case of commuter rail, these include average revenue per passenger by fare zone, though not for individual station pairs. The most recent such study was conducted in 2005, and is used as the basis for average fare-revenue estimates in this chapter. Calculations of the average fare for Zone 8 are detailed in Appendix F.

Non-Fare Revenue Potential

The amount of parking revenue obtained by the MBTA from facilities on a Buzzards Bay extension would depend on the ownership and control of those facilities. At existing stations in the system, parking is provided by a combination of MBTA, municipal, and private lots, garages, or on-street spaces. The MBTA receives parking revenue only from its own facilities. However, even these are not operated directly by

the MBTA but are instead leased in groups to private management companies. If parking facilities on a Buzzards Bay extension were owned by the MBTA but operated under arrangements similar to those of present facilities, a significant portion of the revenue would go to the management company.

Depending on station configuration and ownership, rental fees from concessions, such as newsstands or coffee shops, could produce some additional revenue. However, concessions at stations outside of areas with steady non-passenger foot traffic have not proven to be very successful. Survey data and field observations show that most MBTA commuter rail passengers boarding at suburban stations time their arrivals very close to train departure times, leaving them little or no time to stop for purchases. Because parking and concession fees are much less predictable than fare revenue, they are not included in the revenue estimates below.

Adjustments for Diversions from Other MBTA Services

In order to show the true revenue impact of a Buzzards Bay extension on the MBTA system as a whole, it is necessary to adjust for passengers who would be diverted from other MBTA services. The largest number of diversions would come from the Kingston or Middleborough/Lakeville commuter rail stations, which are both in fare Zone 8. If stations on the extension were also in Zone 8, there would be no increase in the fare revenue obtained from such passengers. Most of these passengers now drive to and park at their boarding stations, and most of them would also use park-and-ride access to their new stations. The net impact of parking location diversions on MBTA revenue would depend on the fee levels and the ownership or management arrangements at the old and new locations.

Estimated Weekday Fare Revenue at Maximum Service Level

The demand estimation procedures used in Chapter 4 and Appendix B indicate that a Buzzards Bay extension with maximum service would be used by an average of 2,045 riders each way per day at present travel levels, excluding summer-only recreational trips. Of these, 1,860 would be trips to or through downtown Boston, and 185 would be trips to intermediate destinations. Of the through trips, an estimated 365 would be diverted from existing Zone 8 stations, and 1,480 would be new MBTA riders. The fare-mix calculations detailed in Appendix F indicate that average combined ticket and pass revenue for through trips from Zone 8 at 2006 fare levels would be \$4.946 per trip. At this rate, through ridership would generate total new revenue of \$14,787 per weekday, or \$3,756,000 per year.

With all stations on the extension assumed to be in fare Zone 8, interzone trip distances would range from 1 zone for a trip to Middleborough/Lakeville Station to 8 zones for a trip to Quincy Center. At 2006 fare levels, full cash fares for such trips would range from \$2.25 to \$5.00. Although interzone passes are available, only about 6% of all interzone passengers used them in 2005. Based on the mix of interzone trip distances in the demand estimates, the average revenue per interzone trip would be \$3.27. Assuming that all of the interzone ridership would be new, revenue would average \$1,210 per weekday, or \$307,000 per year. Added to through revenue, this would make a grand total of \$4,063,000.

Estimated Fare Revenue at Minimum Service Level

As discussed in Chapter 4, estimated ridership at the minimum service level would be only 57% as great as that under the maximum level, or 1,165 riders each way per day at 2006 travel levels. This would include 850 new commuter rail riders. Ignoring differences in the fare-mix by time of day, it would then be estimated that net added revenue for the minimum service level would be 57% as great as that for the maximum service level. This would be \$9,119 per day, or \$2,316,000 per year.

Estimated Fare Revenue at Medium Service Level

Under the medium service level, the trips to be extended in addition to those in the minimum service level would be determined by equipment availability rather than by demand. This would result in estimated ridership 65% as great as that for the maximum service level, or 1,330 riders each way per day. This would include 970 new commuter rail riders. The net added revenue would be \$10,398 per day, or \$2,641,000 per year.

Estimated Fare Revenue for Weekends and Major Holidays

As discussed in Chapter 4, with all Middleborough/Lakeville trains extended to Buzzards Bay on all days of the week, average Saturday ridership would be expected to equal at most about 35% of average weekday ridership, and average Sunday ridership would be expected to equal at most about 20% of average weekday ridership. In the estimates above, weekday maximum service was estimated to carry an average of 1,680 new riders each way per day. Applying the weekend ratios above, extension service would be expected to average about 590 new riders each way on Saturdays and 335 on Sundays.

In the fare-mix calculations in Appendix F, all revenue from monthly passes is already attributed to weekday service, so the only additional revenue to be calculated for weekend and major holiday service would be that from ticket users. The 2005 fare-mix study results indicate that about 65% of the new riders on Saturdays (380) and about 70% of those on Sundays (235) would be ticket-users. At the calculated average ticket revenue of \$5.10 on Saturdays and \$5.22 on Sundays, this would produce estimated new revenue of \$3,898 per Saturday and \$2,455 per Sunday. Annual new revenue would therefore equal \$203,000 from Saturday service and \$128,000 from Sunday service.

Little information is available on ridership on the seven major holidays on which weekend service frequencies are operated on the Middleborough/Lakeville Line. On lines that have different Saturday and Sunday schedules, Saturday schedules are operated on two of the major holidays, and Sunday schedules on the rest. If it is assumed that this reflects ridership levels on these days, holiday revenue on a Buzzards Bay extension can be estimated as the equivalent of revenue from two Saturdays and five Sundays. Annual revenue from holiday service would then be \$20,000. Combined annual weekend and holiday revenue would total \$350,000.

The operating cost calculations above included a strategy of extending alternate Middleborough/Lakeville Line trains to Buzzards Bay on weekends and holidays

instead of extending all trains. If 4 of the 7 trains were extended, this would be 57% of the service. If this also resulted in revenue 57% as great as would be attracted by extending all trains, the annual totals would be \$116,000 from Saturdays, \$73,000 from Sundays, and \$11,000 from holidays, or an annual combined total of \$200,000.

Revenue and Operating Cost Comparisons

The preceding sections of this chapter discuss estimates of incremental revenue and incremental operating cost for a Buzzards Bay extension under various potential service strategies. These results are summarized in Table 6-1. For the MBTA commuter rail system as a whole, the ratio of revenue to operating cost is currently about 41%, but this figure is not easily separable into weekday and weekend ratios. This average is greater than the weekly ratios for all of the service alternatives for a Buzzards Bay extension shown in Table 6-1. The minimum service alternative would have the highest ratio, because service would be concentrated in peak hours when train load factors would be highest. The medium service alternative would have the lowest ratio, because most of the service added above that of the minimum service strategy would be in off-peak hours, when average train loads would be lowest.

It would be feasible to operate service on the extension only on weekdays, although most existing MBTA commuter rail lines have some weekend service. For weekday-only service, the maximum service strategy would have a revenue-to-cost ratio slightly above that of the overall average for the present system, and the minimum service strategy would have an even higher ratio. However, the ratio for the medium service strategy would still be below average.

The weekend and holiday alternatives would have much lower revenue-to-cost ratios than overall commuter rail service, but ratios for weekend and holiday service alone on existing lines would also be expected to be lower than weekly averages. The low weekend ratios for a Buzzards Bay extension are partly a result of the assumption that all pass revenue should be allocated to weekday service. Allocation of some pass revenue to weekend service would require a corresponding reduction in weekday pass revenue. This would in turn lower the revenue-to-cost ratio for weekday service.

Revenue from summer recreational ridership is not included in the revenue estimates in Table 6-1. This revenue would be generated during only one-quarter to one third of all weeks during the year, and could not be obtained without operation of additional feeder services, which would incur additional costs.

As discussed in Appendix C, it is reasonable to assume that recreational travel would add an average of at most 300 riders each way per day during the peak summer tourist season. If this level were attained for four months of the year (mid-June to mid-October), it would add an average of at most 100 riders each way per day on an annualized basis. If all of these trips generated new ticket revenue, they would raise annual revenue in the maximum service strategy by about 9%. This would still result in a revenue-to-cost ratio somewhat below the system average, even before taking into account the operating cost of necessary feeder service.

Table 6-1
Estimated Revenue and Operating Cost for Buzzards Bay Extension
at 2006 Travel, Fare, and Cost Levels

Alternative	Estimated Annual Cost	Estimated Annual Revenue	Revenue/ Cost	Annual Net Cost
Weekday Minimum Service	\$4,125,000	\$2,316,000	0.561	\$1,809,000
Weekday Medium Service	\$7,864,000	\$2,641,000	0.336	\$5,223,000
Weekday Maximum Service	\$9,750,000	\$4,063,000	0.417	\$5,687,000
Saturday Minimum Service	\$1,281,000	\$116,000	0.091	\$1,165,000
Saturday Maximum Service	\$1,303,000	\$203,000	0.156	\$1,100,000
Sunday Minimum Service	\$1,281,000	\$73,000	0.057	\$1,208,000
Sunday Maximum Service	\$1,303,000	\$128,000	0.098	\$1,175,000
Holiday Minimum Service	\$172,000	\$11,000	0.064	\$161,000
Holiday Maximum Service	\$175,000	\$20,000	0.114	\$155,000
Weekend/Holiday Minimum Service	\$2,734,000	\$200,000	0.073	\$2,534,000
Weekend/Holiday Maximum Service	\$2,781,000	\$351,000	0.126	\$2,430,000
Weekly Minimum Service	\$6,859,000	\$2,516,000	0.367	\$4,343,000
Weekly Medium Service	\$10,598,000	\$2,841,000	0.268	\$7,757,000
Weekly Maximum Service	\$12,531,000	\$4,414,000	0.352	\$8,117,000

7. OPERATIONAL ISSUES

This chapter discusses various constraints on the operation of a Buzzards Bay commuter rail extension that would need to be taken into consideration in planning of service to be provided.

Impact of a Buzzards Bay Extension on Other Rail Services

Because of track capacity constraints discussed below, all service on a Buzzards Bay commuter rail extension under the minimum and maximum schedules analyzed for this study would be provided by extending Middleborough/Lakeville Line trips with no changes in the schedules that they would otherwise have on the existing portion of the route. Under the medium service alternative, it would be necessary to add one midday trip in each direction for equipment shifting purposes. Because the minimum and maximum schedules would add no trains to line segments that currently have passenger service, they would create no new scheduling conflicts. The added running time between Buzzards Bay and Middleborough/Lakeville would, however, increase the potential for late departures of inbound trains at Middleborough/Lakeville Station. This in turn would increase the potential for delaying other trains at passing sidings or on tracks shared with other lines between Braintree and Boston. The added service would require no net increase in time slots allocated to the Middleborough/Lakeville Line at South Station, but there again, late inbound train arrivals could cause delays to other services.

The schedule of the added midday trips assumed to be run under the medium service alternative was designed so as not to conflict with schedules of any other passenger trains, including the planned schedules of Greenbush Line trains on shared tracks.

Present freight service operated by CSX Transportation on the Middleborough/Lakeville Line typically runs during middays. All trains on this line are dispatched by the MBTA's contract operator of the commuter rail service, and freight trains are given access at times when there are sufficient "windows" between passenger trains, to prevent or minimize delays to the latter. The minimum and maximum service alternatives would not alter the times available for freight train operation, but the added trips under the medium schedule would create additional constraints on freight service.

At present, the rail line between Middleborough/Lakeville and Buzzards Bay is used exclusively by Bay Colony Railroad freight trains. North of the SEMASS Resource Recovery Facility in Rochester, freight trains are run only as often as needed. This results in no more than one round-trip per day, and many days with no trips. Between the SEMASS facility and Buzzards Bay, there are usually one or two trash trains a day in each direction. These make no intermediate stops, and can do all necessary switching at SEMASS on tracks completely separate from the main line.

Operation of passenger trains between Middleborough/Lakeville and Buzzards Bay would result in reduced flexibility of times for operation of Bay Colony freight trains, but this should not create significant problems. Bay Colony would, however, have to relocate some unserviceable passenger cars from a former excursion service and some spare trash container cars that have been stored recently on the main-line track adjacent to SEMASS.

At present, there is no intercity rail passenger service on any of the tracks that would be used for Buzzards Bay commuter rail service, except in the immediate vicinity of South Station in Boston, and none is planned. At South Station, Buzzards Bay service would not introduce any additional conflicts with intercity passenger trains. The most recent past intercity service to Cape Cod ran only on Fridays, Saturdays, and Sundays, and included at most one train per day in each direction. These trains used a connecting line from the Northeast Corridor at Attleboro, and used the Buzzards Bay extension route only south of Middleborough. The Friday service ran on the latter segment well after the end of the PM peak. In the event that intercity service were restored at some time in the future, coordination of schedules with those of commuter trains should not be difficult.

Track Capacity Constraints Between Boston and Middleborough/Lakeville

The existing rail line between Boston and Middleborough/Lakeville Station is mostly single-tracked, with several long passing sidings. To minimize delays, schedules of trains in each direction must take into consideration the schedules in the opposite direction. The total length of this route is 35.6 miles. For the first 11.3 miles out of Boston, Middleborough/Lakeville trains share the tracks with Kingston/Plymouth Line trains. Starting in 2007, the first 10.1 miles out of Boston will also be shared with trains of the Greenbush Line, which is now under construction. The schedules of trains on the two existing lines have anticipated the addition of Greenbush trains, and include vacant time slots for them. However, after that expansion it will not be feasible to add any more trains to the shared track segment during peak hours. In off-peak hours, the shared track will have some additional capacity, but new trains operating in the available time slots on that segment could be delayed by, or cause delays to, other trains south of Braintree. This is because of the limited number of passing sidings between Braintree and Middleborough/Lakeville.

To provide capacity for more trains on the Middleborough/Lakeville route, it would be necessary to allow greater flexibility in passing locations. This would involve lengthening existing passing sidings or adding new ones in other locations. The shared segment between Boston and Braintree already has the maximum amount of second track that can fit into the right-of-way, and adjoining land uses preclude acquisition of additional property. However, between Braintree and Middleborough/Lakeville Station, the entire line was once double-tracked. This would make it possible to add or lengthen passing tracks there if this should prove to be desirable.

If Buzzards Bay service could be provided with separate, limited-stop trains, most of the potential time savings compared with local trains would occur in the segment between Middleborough/Lakeville and Braintree. Passenger trains are currently permitted to operate at a maximum speed of 70 mph through most of this segment, but

have to run at slower speeds for much of the way because of acceleration and deceleration at stations. The fastest scheduled time between Middleborough/Lakeville and Braintree is now 35 minutes, including five intermediate stops. A non-stop run could theoretically be made in about 25 minutes.

At present, the fastest scheduled time between Braintree Station and South Station in Boston for a train making no intermediate stops is 18 minutes. Therefore, the minimum feasible time for an express train stopping only at Braintree between Middleborough/Lakeville and Boston would be about 44 minutes, including dwell time at Braintree. As discussed above, track capacity constraints north of Braintree would preclude peak-period operation of Buzzards Bay trains except as extensions of Middleborough/Lakeville trains that would run anyway. Consequently, any separate Buzzards Bay express service would have to run in off-peak hours, when the time savings compared with existing local trains would be 10 to 13 minutes. Off-peak riders would mostly be making non-repetitive, non-work trips, and would be less likely to be concerned with travel times than daily commuters would be. Reducing the number of intermediate stations would also reduce the possibilities for attracting trips between Cape Cod points and points south of Braintree. Given the infrastructure requirements for express service and the limited travel time benefit that would be achieved, express service is not considered further in this analysis.

Impact of Curves on Speed Limits on an Extension

Present MBTA policy calls for track on commuter rail lines to be maintained to FRA Class 4 standards. This class allows overall maximum passenger train speeds of 79 mph with wayside signals only, or 80 mph with in-cab signals, but additional considerations may require lower speeds in some locations. One factor in determining allowable maximum train speeds on a given line is the amount of elevation of the outside rail on curves. Between Middleborough/Lakeville Station and Buzzards Bay, there are nine curves that would limit speed to less than 80 mph with no rail elevation. Of these, six are 1° curves that would require only 1.5" of rail elevation, but three would require more substantial changes. The sharpest of these curves is 2°32', at Elm Street in Wareham. Historically, this curve had a 60 mph limit. With a 6" rail elevation, the maximum permitted by the FRA, the top speed there would be 72 mph. This amount of elevation could, however cause problems for slower-moving freight trains on the line, and would also be difficult to provide without creating a hazard on the Elm Street crossing. Therefore, the analysis of potential operating times in Chapter 3 assumed that the maximum speed limit in this segment would not be raised above the 60 mph allowed in the past. A 60 mph limit would call for 3.5" of elevation of the outside rail.

A curve of 1°42' centered on the Route 6 crossing in Wareham would limit train speed with no rail elevation to 50 mph. Because of the grade crossing, the feasible elevation of the rail there would be limited to less than the 5" required for a 79 mph speed. For other safety reasons, the speed on this crossing was historically limited to 40 mph for northbound trains and 15 mph for southbound trains. Wareham Station was just north of Route 6. The activation point for the crossing protection would have had to be between the platform and the crossing to keep trains from blocking traffic while stopped in the station. Because of the short distance, southbound trains running

through the station without stopping would still have had to slow almost to a stop so as not to reach the crossing before or too soon after the lights or gates activated. The 15 mph restriction would have had little running time impact on trains that stopped at Wareham Station, but would have caused some delays for trains not stopping there.

Because of insufficient room for parking facilities at the most recent past Wareham Station location, the present study assumes that a future station would be at a different location. If no trains had to stop at the old location, the crossing protection circuit could be adjusted to allow the same train speeds northbound or southbound at Route 6.

In the October 2006 field check by CTPS, it was observed that there was already some elevation of the outside rail on the Elm Street and Route 6 curves, though the amount was not measured. There was also some elevation on other curves. For purposes of travel-time analysis, it was assumed that no significant additional curve elevation would be provided for commuter rail service, and that maximum speeds in both directions would be 40 mph at Route 6 and 60 mph at Elm Street unless station locations necessitated lower limits.

Necessity for a Passing Siding on an Extension

At present, the Buzzards Bay Secondary Track has only one track for its entire length, except for sidings intended mainly for use in conjunction with freight service to on-line industries. If present Middleborough/Lakeville trains were extended to Buzzards Bay only in peak hours, it would be feasible to arrange schedules so that inbound and outbound trains would not need to pass anywhere on the extension. Provision of off-peak service would require a new passing siding, however.

At present on weekdays, equipment from 8 outbound trains turns back at Middleborough/Lakeville to provide the next inbound trips. The time between scheduled outbound arrival and inbound departure ranges from 11 to 20 minutes. With service extended to Buzzards Bay, each outbound train would leave Middleborough/Lakeville about one minute after its present arrival time there, and each inbound train would have to be there about one minute before its present departure time. Therefore, intervals between outbound departures and inbound arrivals would range from 9 to 18 minutes. With a 9-minute interval and no delays, inbound and outbound trains would pass when each was 4.5 minutes south of Middleborough/Lakeville. With an 18-minute interval, the passing location would be 9.0 minutes from Middleborough/Lakeville. Where these times would be reached would depend on train speeds and station locations.

The ideal location for a passing track for a given pair of trains would allow them both to maintain the same schedules they would have if they faced no opposing traffic. On a Buzzards Bay extension, if two trains had to meet at a passing track north of the ideal location, it would be necessary to lengthen the running time of one or both of them to maintain the schedules at Middleborough/Lakeville. For example, if a southbound train was scheduled to leave Middleborough/Lakeville 16 minutes before the arrival of a northbound train, they would ideally meet at a point 8 minutes south of that station. If the passing siding was only 6 minutes from the station at normal speeds, schedules would need to be adjusted to add 4 minutes to the combined times of the two

trains. If all of this delay were added to the southbound train, it could either run slowly approaching the meeting point or stop for 4 minutes there. If all of the delay were added to the northbound train, it would first have to leave Buzzards Bay 4 minutes earlier than it otherwise would in order to reach the new meeting point at the same time as the southbound train. It would then have to run slowly north of the passing track or wait at Middleborough/Lakeville for its scheduled departure time.

If two trains had to meet at a passing track south of the ideal location, their combined running times between there and Middleborough/Lakeville would exceed the interval between their scheduled departure and arrival times at that station. This would make it impossible to maintain the present schedules of both trains north of Middleborough/Lakeville. In terms of the overall impact on operations and service, it would be preferable for meeting points to be farther north of the ideal location than farther south. The nearest existing passing track to Middleborough/Lakeville is south of County Road, on the border of Rochester and Wareham. This is farther south than the ideal passing location for any pair of trains under the maximum service schedule. In addition, the October 2006 field inspection found that this track was out-of-service and in very poor condition, and that it would need to be completely rebuilt if it were to be reactivated.

Because of the expense of installing and maintaining switches and associated signals and controls, it would be preferable to have one long siding on which trains could pass at various distances from the ends, rather than several shorter sidings used by different trains. With the present schedules being maintained north of Middleborough/Lakeville Station, an appropriately sited passing track about two miles long should limit delays from meets between inbound and outbound trains on the extension to 1.5 minutes or less per train pair on weekdays. (Depending on priority, one train could take the entire 1.5-minute delay, each could be delayed 0.75 minutes, or some other combination could be used.) On weekends and holidays, average scheduled layover times are slightly longer than on weekdays. Consequently, delays for meets of inbound and outbound trains with a two-mile passing track at the optimal location for weekday service would range up to a combined 5 minutes for each pair of meeting trains. A passing track longer than two miles would provide for a greater margin to prevent late arrival at the siding of a train in one direction from delaying a train in the opposite direction.

To minimize delays, a new passing siding would need to be located somewhere in the segment between the former Rock Village Station site in Middleborough and the border between Middleborough and Rochester. The length and endpoints of the siding would depend on the maximum speeds at which trains were to be run, and the acceptable amount of delays. With a maximum speed of 59 mph on the extension and present schedules north of Middleborough/Lakeville Station, a passing siding approximately one mile long would allow three trains in each direction to meet their opposing trips with no delays. The other five pairs needing to meet on the extension would encounter combined northbound and southbound delays of 1 to 3 minutes. A two-mile siding would allow five pairs of trains to meet without delays. With a maximum speed of 79 mph, a passing siding about 3.3 miles long would be needed to allow 4 of the 8 trains in each direction to meet with no delays. With speeds limited to 59 mph, the same 3.3-mile siding would allow all but two pairs of trains to meet with no delay to either train.

The entire Buzzards Bay Secondary Track was once double-tracked, but the second track was removed between 1938 and 1940. However, the right-of-way is still graded for a sufficient width to accommodate a second track. Gates and signals at grade-crossings within the passing section would have to be relocated to protect both tracks, but with a two-mile siding, at most two to three crossings would be involved.

Layover Facility Considerations

At present, all service on the Middleborough/Lakeville Line is provided with train sets that are based at night at a yard one mile north of Middleborough/Lakeville Station. Each set makes one non-revenue trip from the yard to the station at the start of its service day, and another from the station back to the yard at the end of its service day. For purposes of the operating cost estimates in Chapter 6, it was assumed that a Buzzards Bay extension would also be operated with equipment based at the Middleborough yard. The extension would require at most one more train set than the four now based there, and there is sufficient capacity for five sets.

The distance of 19 miles from the Middleborough yard to Buzzards Bay that each train set would need to be shifted at the beginning and end of the service day is less than the distance that train sets are now shifted on several existing MBTA commuter rail lines. For efficiency, as on those lines, trains could be shifted with two sets coupled together, requiring only one crew instead of two for that portion of the trip.

Although no capital cost would have to be incurred for a new layover facility on a Buzzards Bay extension, use of the present facility with extended service would result in a substantial increase in non-revenue train hours. The cost of running the non-revenue trips would range from approximately \$1.1 million per year for minimum weekday service with no weekend service, to \$2.0 million per year for maximum feasible weekday and weekend service. These costs could be reduced proportionally to the reduction in non-revenue train hours achieved by having a layover facility closer to Buzzards Bay. Based on construction costs for other MBTA layover facilities, a facility at Buzzards Bay with capacity for five trains of 6 cars could be expected to cost between \$8 million and \$12 million.

Although operating cost savings could eventually offset the capital cost of a new layover facility, finding a suitable site for such a facility could be difficult. As discussed in Appendix D, provision of substantial parking capacity at Buzzards Bay would be essential to attaining the projected ridership levels. Use of available land near the station for parking facilities would be of higher priority than use for a layover facility. Therefore, it would be advisable to begin Buzzards Bay service using the existing Middleborough layover facility.

Even with trains based at Middleborough at night, the most efficient scheduling of the maximum service level would result in four train sets being at Buzzards Bay simultaneously for a short time in the early evening each weekday. One set would be in the station, and the others would have to be on a side track waiting to return to Middleborough. With six-car sets, this would call for at least 1,800 linear feet of storage track. There is already a siding longer than this in place from south of the railroad bridge over Cohasset Narrows on the Bourne town line to just north of the Onset

Avenue overpass in Wareham. It occupies the location of a former main-line second track. It had not been used recently at the time of the CTPS October 2006 field inspection. It would require some upgrading for use as part of a future commuter train operation, and would also need additional signal protection at the north end. (Signaling at the south end could be provided as part of the departure signal at Buzzards Bay, discussed further below.)

Signal Requirements

The purposes of railroad signals include controlling the entry of trains into given sections of track and regulating the spacing of trains after they enter a track section. Under the maximum service level analyzed for a Buzzards Bay extension, all trains on the Middleborough/Lakeville Line would be extended to the new outer terminal, but their schedules between Boston and Middleborough/Lakeville would be unchanged. With the present scheduled intervals between trains and the estimated running times on the extension, each southbound train would have time to arrive at Buzzards Bay before the following train was due to leave Middleborough/Lakeville. Likewise, each northbound train would have time to arrive at Middleborough/Lakeville before the following train was due to leave Buzzards Bay. Therefore, as long as there was a means of confirming train arrivals at each end of the extension, there might not be a need for signals that would have no purpose beyond regulating the spacing of trains traveling in the same direction.

As discussed above, the majority of trains would have to meet trains traveling in the opposite direction at a passing siding within the extension. This would require a signal system or other means of communication to prevent any train from entering the single-track segments on either side of the passing track if another train had already entered or was then entering that segment from the opposite end.

The signals or other communication system would also be used to coordinate operations of freight trains with those of passenger trains on the extension. At present, freight train activity on the extension route consists mostly of one or two daily trash trains in each direction on the segment between Buzzards Bay and the SEMASS Resource Recovery Facility in Rochester. These trains spend about two hours a day switching cars in the SEMASS yard. The track layout there allows trains to stay entirely off of the main-line track while switching. However, it would be necessary to add signals or other means of communication to indicate when these trains left the main line on the way to SEMASS and to control their entry back onto it on their return trips. The only other active rail-freight user on the extension route in 2006, Harris Rebar in Rochester, was served by a side track that diverged from the same track that led to the SEMASS complex rather than directly from the main line. Therefore, separate signal protection would not be needed for the Harris siding.

In summary, an extension would require, at minimum, installation of six sets of signals (at Middleborough/Lakeville, Buzzards Bay, each end of a new passing track, and at each end of the SEMASS complex). The signals at Buzzards Bay could also control train operation in and out of the side track just north of there, but another new signal would be needed at the north end of that track.

Rolling Stock Issues for Through Service

Train Scheduling

As discussed in chapter 3, three potential through-service levels were analyzed for a Buzzards Bay extension. The minimum service level would extend as many trains as possible using only the amount of rolling stock currently assigned each weekday to the Middleborough/Lakeville Line. The maximum service level would extend all trains on the Middleborough/Lakeville Line to Buzzards Bay and would require assignment of an additional train set to that line throughout the day. The medium service level would include the same trips extended under the minimum level, but would also extend some midday trains by redeployment of equipment that would otherwise be underutilized during those hours. These service levels are described below in greater detail. Table 3-2 shows which trains on the existing Middleborough/Lakeville Line would be extended to Buzzards Bay under each strategy.

Minimum Service Strategy

At present, weekday service on the Middleborough/Lakeville Line requires four equipment sets to provide the 12 round-trips. These sets are based at night at a yard one mile north of Middleborough/Lakeville Station, and they provide the first 4 inbound trips of the day (Trains 2, 4, 6, and 8), due in Boston at 6:20, 6:57, 7:52, and 8:16 AM. Any or all of these sets could theoretically be run to Buzzards Bay very early in the morning and return from there in time to maintain their present schedules on the existing route.

The other 8 inbound trips are provided with equipment that turns back from outbound trips. Times between scheduled outbound arrivals and inbound departures for these trains range from 11 to 20 minutes. At any location where trains reverse, a minimum of 10 minutes is allowed for the engineer to move to the new control position and perform a mandatory brake test. The additional time beyond 10 minutes in the schedules of trains that reverse at Middleborough/Lakeville Station would be insufficient to allow them to continue any farther south and still maintain their present schedules north of there.

Starting in the PM peak, equipment from 4 trains returns to the Middleborough layover facility for the night instead of going back to Boston. These are the trips leaving Boston at 5:15, 5:55, 6:45, and 10:30 PM (Trains 21, 23, 25, and 29). Any of these trips could be extended to Buzzards Bay without interfering with present schedules. After reaching Buzzards Bay, the trains could return to Middleborough/Lakeville Station, either with or without passengers. The earliest that any of these trains would arrive back at Middleborough/Lakeville would be about 7:15 PM. The only inbound train currently scheduled to leave there later than that is the one departing at 9:25 and due in Boston at 10:20 PM (Train 28). An extension of this train leaving Buzzards Bay at about 9:00 PM could be provided using any of the first three outbound train sets to arrive there in the evening. This would also allow the 8:10 PM outbound trip (Train 27) to be extended to Buzzards Bay.

Maximum Service Strategy

To provide Buzzards Bay continuations of all Middleborough/Lakeville trains, including those that now reverse quickly at the outer terminal, one additional train set would need to be assigned to the line. The Middleborough layover yard has the capacity for a fifth train set to be based there.

At present, with only four train sets, the equipment from the first inbound trip of the day returns from Boston on the first outbound trip and then turns at Middleborough/Lakeville Station to provide the fifth inbound trip. With five train sets, the fifth set would cover the fifth inbound trip, allowing enough time for the equipment on the first outbound trip to continue through to Buzzards Bay and return to Middleborough/Lakeville to provide the sixth inbound trip. Throughout the day, every train that now returns to Boston shortly after completing an outbound trip to Middleborough/Lakeville would instead run through to Buzzards Bay and return to Middleborough/Lakeville in time to cover the next later inbound trip from there than the one it now covers.

Medium Service Strategy

Extension of several midday trips to Buzzards Bay would be feasible by redeploying one train set that is assumed to otherwise be idle in Boston during midday hours. With the present Old Colony Lines schedules and the tentative Greenbush Line schedule, the greatest amount of Buzzards Bay service that could be provided under this strategy, over and above the minimum described above, would be four round-trips. These would include extensions of the outbound trips now leaving South Station at 9:57 AM, 11:55 AM, and 2:15 PM (Trains 7, 9, and 15) and the inbound trips due at South Station at 12:04, 1:56, and 4:21 PM (Trains 14, 16, and 18). To reposition equipment, it would also be necessary to add a new outbound trip leaving South Station at 9:12 AM and a new inbound trip arriving at 5:08 PM.

Without additional equipment, it would not be possible to maintain present Middleborough/Lakeville Line schedules while also extending the 6:36 or 8:23 AM outbound trips (Trains 3 and 5) or the 3:45 or 4:45 PM outbound trips (Trains 17 and 19) to Buzzards Bay. Likewise, it would not be possible to provide extensions of the trips due in Boston at 9:02 or 10:34 AM (Trains 10 and 12) or at 5:52 or 7:06 PM (Trains 20 and 22). The earliest South Station departure for Buzzards Bay would be at 9:12 AM and there would be gaps in departures from 2:15 to 5:15 PM. Inbound, there would be gaps in South Station arrivals from 8:16 AM to 12:04 PM and from 5:08 PM to 10:20 PM.

Train Capacity

Regardless of which of the three service levels was implemented, additional ridership generated by the extension could require increasing the passenger capacities of some or all peak-period trains. The capacity of each train is determined by the number of cars in the train and the combination of car models assigned. MBTA service standards for commuter rail call for provision of enough seats so that maximum loads do not exceed 110% of seating capacity in peak hours or 100% in off-peak hours, but these goals are not always possible to attain. The present commuter rail car fleet

includes single-level cars with 94 to 127 seats each and bi-level cars with 175 to 185 seats each. The planned equipment assignment for each train is based on the typical expected ridership, but equipment shortages on a given day may necessitate different assignments.

Present Capacity of Middleborough/Lakeville Line Trains

The number of cars per train on the Middleborough/Lakeville Line is currently limited to a maximum of 6 because of the lengths of the platforms normally used by these trains at South Station in Boston. The first inbound train of the day, Train 2, arrives in Boston just before the start of the AM peak. The next 4 trains, Trains 4, 6, 8, and 10, are all classified as peak trains. Train 10 uses the same equipment as Train 2, but there are no other equipment repeats in these five trips. As of June 2006, Trains 2, 4, and 6 had planned assignments of four bi-level cars and one single-level car each. Train 8 had a planned assignment of five bi-level cars and one single-level car. Allowing loads of 100% of seating on Train 2 and 110% on Trains 4, 6, 8, and 10 would have resulted in available capacity for about 3,785 riders on Trains 2, 4, 6, and 8, combined, and another 915 on Train 10, for a total of 4,700.

Recent official ridership totals for these trips indicate that Trains 2, 4, 6, and 8 carried approximately 3,100 riders at the maximum load point, leaving capacity for 685 more riders within the service standards. Train 10 carried about 750 riders, leaving capacity for another 165 riders.

Additional Capacity Required for Minimum and Medium Extension Service

At 2006 travel levels, the demand forecasts for the minimum service alternative, which would extend only Trains 2, 4, 6, and 8 to Buzzards Bay, would add a net of 935 riders to these trains. This would exceed their current available capacity by 250. In order to add this capacity and distribute it in a manner that would match anticipated demand most closely, a net addition of two bi-level cars would be needed. These would be added, one each, to Train 6 and Train 8 in place of the single-level cars now used on those trains. One of the freed single-level cars would be swapped to Train 2 for a bi-level that would be used to lengthen Train 6 from 5 cars to 6. The other freed single-level car would be available for use elsewhere in the system.

In the medium service alternative, the only extension trips run in addition to those run in the minimum alternative would be in off-peak hours, when they would not require any net rolling stock increase.

Additional Capacity Required for Maximum Extension Service

At 2006 travel levels, the maximum service alternative is predicted to add a combined total of 1,175 riders to Trains 2, 4, 6, and 8. This would exceed the present available capacity on these trips by 490. In order to add this capacity and distribute it in a manner that would match anticipated demand most closely, a net addition of five bi-level cars would be needed. These would be distributed by replacing the single-level cars on Trains 4, 6, and 8 with bi-level cars, and also lengthening Trains 4 and 6 from 5 cars to 6. The added capacity would be 140 more than the predicted shortfall with

present assignments, but this would be unavoidable because car capacity is added in fixed increments. Even with this capacity increase, not all passengers would be able to travel at their first-choice times without causing some overcrowding.

Train 10 is currently operated with the same equipment as Train 2, but under the maximum service alternative an additional set would be needed for Train 10. The combined present and added ridership for Train 10 at the peak load point would be approximately 1,130. Allowing peak ridership at 110% of seating capacity, this would require a six-car set, with five bi-level cars and one single-level car. The single-level car could be one of those replaced on the earlier trains, but the bi-levels would have to be net additions to the fleet. Overall, the maximum service level would require the acquisition of ten bi-level coaches. The added fifth train set would also require an additional locomotive.

Shuttle Service Issues

Schedule Coordination

A shuttle train service to Buzzards Bay would inevitably involve some inconvenience for passengers because of the need to change trains at Middleborough/Lakeville Station. A through train would have to stop there only for the length of a typical station stop, or about one minute. If two trains were allowed to share the platform end-to-end at the same time, a shuttle making a connection only from an outbound train could be scheduled to depart fairly quickly after the arrival of that train. Enough time would have to be allowed for passengers to alight from one train, walk to the other train, and re-board. With the present platform length, the limited number of doors that could be opened on each train would slow this process. Inbound connections could not be scheduled as closely, as it would be important to prevent late shuttles from delaying their Boston connections. As discussed above, schedules of trains on the present line are highly constrained by those of other trains on shared track segments, and delays to one train can affect several others.

For the 8 outbound trains that return to Boston shortly after arrival at Middleborough/Lakeville, the average time between scheduled outbound arrival and inbound departure is 16 minutes, with a range of 11 to 20. Therefore, a shuttle train picking up passengers from an outbound trip and dropping off passengers for the corresponding inbound trip would be unable to provide close connections in both directions. For example, Train 15 is now scheduled to arrive at Middleborough/Lakeville at 3:11 PM. The equipment from Train 15 is then used to provide inbound Train 18, departing at 3:25. With an allowance of two minutes for passengers to change trains, a shuttle already waiting could depart at 3:13. However, with the typical 10-minute allowance to reverse direction, the shuttle train would have to arrive by 3:03. Inbound transfer passengers would therefore have a 22-minute stop at Middleborough/Lakeville. Alternatively, if priority were given to a close inbound connection, with a two-minute allowance for transferring and a three-minute allowance to make up for train delays, the shuttle train would be scheduled to arrive at Middleborough/Lakeville at 3:20 at the earliest. The soonest it could depart would be 3:30. Passengers transferring from the train arriving at 3:11 would then have to spend 19 minutes at the transfer

point. If safety considerations required that only one train at a time be in the station, delays would be even greater.

Constraint of Middleborough/Lakeville Station Layout

The layout of the existing Middleborough/Lakeville Station is not well suited for train-to-train transfers. The optimal layout for such transfers would have two tracks with an island platform, so that two trains could stop side-by-side. The second-best arrangement would be to have one platform long enough for two trains to stop end-to-end. The present station has only one track and one platform, located between the track and the parking lot. As at other stations on the Middleborough/Lakeville Line, it is about 8 car-lengths long and is high-level for its entire length. At present, all commuter trains on the line run with 6 cars and 1 engine, with the engine on the end away from Boston. The platform is not long enough for such a commuter train and a connecting Buzzards Bay train to be in the station at the same time with all doors usable. Allowing only one train at a time in the station would result in much longer transfer times than would be possible with direct cross-platform transfers.

8. ENVIRONMENTAL AND COMMUNITY IMPACTS

Impacts on Air Quality

Air quality impacts of transit projects are typically calculated on the basis of expected changes in vehicle-miles of travel (VMT) resulting from the project, and the levels of various pollutants linked with these VMT levels. If a Buzzards Bay commuter rail extension were not implemented (the “no-build case”), most of the potential users of the extension would either drive all the way to their destinations, drive to stations on currently existing commuter rail lines, or drive to express bus park-and-ride lots. A few would be dropped off at transit facilities. Access to an extension would be predominantly by park-and-ride, with some drop-offs and walk-ins. For the VMT change calculations, breakdowns of travel modes for the no-build case were based on information collected for the inventory of existing conditions, discussed in Chapter 2 and Appendix A. Estimated breakdowns of travel modes for extension station access were based on an analysis of trip-origin locations relative to potential station locations, and observed access mode shares for comparable existing stations.

The demand forecasts included estimates of travel at a town-to-town level, but not at the level of specific origin address to specific destination address. Destinations in Boston were subdivided into Boston Proper and the rest of Boston. For trips made by driving for the entire distance under the no-build case, VMT totals were based on highway mileage between the center of the origin town and the center of the destination city or town. (Distances were estimated separately to Boston Proper and to the rest of Boston.) For trips made by driving to an existing transit station, VMT totals were based on highway mileage from town centers to each station from which there would be diversions. For drop-off trips, access mileages were doubled, under the assumption that the drop-off vehicle would return from the station to the starting point after the morning drop-off and return to the station for the evening pick-up.

For each alternative service level examined, calculations of VMT incurred in accessing extension stations were similarly calculated from highway distances between origin town centers and the locations of stations assumed for purposes of analysis. All of the VMT calculations were based on ridership estimates for 2006 travel levels. Because vehicle emission standards and compliance rates are changing over time, no attempt was made to calculate VMT changes and associated emission levels for future years.

The mid-range demand estimate for 2006 at the maximum assumed service level would result in a net reduction of 122,225 VMT per weekday for an extension terminating at Buzzards Bay with one intermediate station in Wareham. Using current emission factors for vehicles moving at the average speeds observed from Wareham and points in Barnstable County to Boston, the extension service would produce reductions in carbon monoxide (CO), nitrogen oxides (NO_x), and volatile organic compounds (VOCs) as shown in Table 8-1. Reductions in VMT and corresponding air quality impacts for the minimum and medium assumed service levels are also shown.

**Table 8-1
Average Weekday Traffic and Air Quality Impacts of
Buzzards Bay Commuter Rail Extension at 2006 Mid-Range Travel Levels
For Maximum, Medium, and Minimum Service Levels**

	Maximum Service	Medium Service	Minimum Service
VMT Reduction	122,225	79,450	69,670
CO Reduction	1,489.9 kg	968.4 kg	849.3 kg
NOx Reduction	64.0 kg	41.6 kg	36.5 kg
VOC Reduction	74.6 kg	30.2 kg	42.5 kg

In addition to the air quality impacts from VMT reductions, it is also necessary to take into account emissions from the diesel locomotives that would be used on trains on an extension. In addition to CO, NOx, and VOCs, particulate matter (PM) is of concern for diesel vehicles. For an extension to Buzzards Bay under the assumed maximum, medium, and minimum service strategies, estimated locomotive emission increases are as shown in Table 8-2.

The net impacts of the reduction in auto emissions and the increases in locomotive emissions are as shown in Table 8-3. As can be seen from the tables, an extension with any of the assumed service levels would result in overall reductions in CO and VOC levels but increases in NOx and PM levels.

**Table 8-2
Increase in Average Weekday Train Emissions
for a Buzzards Bay Extension**

	Maximum Service	Medium Service	Minimum Service
CO Increase	57.6 kg	49.4 kg	26.9 kg
NOx Increase	390.0 kg	334.8 kg	182.0 kg
VOC Increase	21.2 kg	18.2 kg	9.9 kg
PM Increase	13.4 kg	11.5 kg	6.3 kg

**Table 8-3
Net Changes in Average Weekday Emissions
for a Buzzards Bay Extension**

	Maximum Service	Medium Service	Minimum Service
CO Change	-1,432.3 kg	-919.0 kg	-822.4 kg
NOx Change	+325.9 kg	+293.2 kg	+145.5 kg
VOC Change	-53.3 kg	-30.2 kg	-32.6 kg
PM Change	+13.4 kg	+11.5 kg	+6.3 kg

Impacts on Water Resources

The rail line that would be used for a Buzzards Bay extension currently has one main-line track, with passing sidings in three locations. However, the entire line between Middleborough/Lakeville and Buzzards Bay was formerly double-tracked. This would make it feasible to install additional passing sidings wherever needed for passenger train operations without additional grading or land-taking. Therefore, the only expected landform changes potentially affecting water flow would occur at station areas.

The Final Environmental Impact Report for the Old Colony Railroad Rehabilitation Project concluded that pollutants such as oil and brake dust dropped on railbeds by trains would be present in low concentrations, and would be unlikely to migrate to wetlands, waterways, or groundwater in significant volumes. Runoff of pollutants from parking lots was considered to be a more likely problem, which would need to be dealt with by use of appropriate drainage systems and lot maintenance strategies. Similar findings would apply to a Buzzards Bay extension.

Any parking facility for a Buzzards Bay station would be near the edge of the Cape Cod Canal. For reasons discussed Chapter 5 and Appendix D, the facility would be more likely to be a multi-level garage than a surface lot, but drainage from the top level would need to be controlled. The most recent past station site in Wareham was at the junction of the Agawam and Wareham rivers, with the track located between the parking lot and the water. Because of lack of room for expansion there, a future Wareham station with adequate parking capacity for all of the estimated demand would have to be at a different location. The County Road site assumed for purposes of analysis does not directly adjoin any bodies of water, but there are several cranberry bogs in the same general vicinity. Depending on the specific site location, a station at Rock Village in Middleborough might be close to a brook.

Impacts on Cultural Resources

Impacts on cultural resources include changes that would occur to historic buildings, sites, and districts; to archeological sites; to parks and open spaces; and to buildings and resources that are important to the expression of cultural values, such as schools, churches, and monuments.

A Buzzards Bay extension would use an active rail right-of-way that would not need to be widened, so the only necessary taking of land would occur at stations. Land uses at other points could, however, be impacted by their proximity to the rail line. There are no public parks in the vicinity of the rail line between Middleborough/Lakeville and Buzzards Bay. One church abuts the right-of-way, at Rock Village in Middleborough. The Decas School and its playground adjoin the rail line at Station Street in Wareham. The old Wareham Town Hall is located at the Elm Street crossing, and is still used as offices for some town departments. The historic Tremont Nail Company factory is also located near the Elm Street crossing. It is a tourist attraction, and Elm Street is one of the approach routes to it. The existence of archeological sites along the rail line has not been determined.

Traffic Impacts on Major Arterial Routes

Data on auto trips from the Bourne extension corridor to Boston and Cambridge are not broken down by individual route, but reasonable assumptions can be made on the basis of route locations and travel times. Boston- and Cambridge-bound traffic from Wareham, Marion, most of Bourne, and Falmouth would be most likely to use I-495, Route 24, and I-93. Traffic from Rochester and Mattapoisett would use either this same combination from Wareham, or would join it in Raynham via Routes 140 and 24. Traffic from all other origins south of the Cape Cod Canal would be most likely to use Route 3 and I-93, joining traffic from the other towns on the Southeast Expressway north of Braintree. Traffic from Carver would be divided between I-495 and Route 3. Trips from the entire extension service area to destinations on the rail line south of Braintree would mostly use Route 25 and I-495 to Route 24. Braintree and Quincy trips would split in the same fashion as Boston and Cambridge trips, as would trips to points north of Boston. Table 8-4 summarizes traffic impacts on selected highways.

Table 8-4
Change in Inbound Daily and Peak-30-Minute Auto Traffic on Selected Roads
for a Buzzards Bay Extension with Maximum Service Level and
2006 Mid-Range Estimated Ridership

<u>Road</u>	<u>Inbound Daily Change</u>	<u>Inbound Peak-30-Min. Change</u>
Southeast Expressway	-1,220	-315
Route 3	-775	-200
Route 24	-685	-180
Bourne Bridge	+195	+50
Sagamore Bridge	+245	+65

As shown in Table 8-4, the greatest absolute reduction in traffic originating from the Buzzards Bay extension corridor would occur on the Southeast Expressway just south of Furnace Brook Parkway in Quincy. This would include diversions of former auto trips to Boston, Cambridge, or points beyond, and trips to Quincy. At 2006 traffic levels, the reduction at that location, with the maximum commuter rail service level, would be about 1,220 inbound auto trips per day. The maximum reduction in any 30-minute interval would occur between about 7:15 and 7:45 AM, when about 315 auto trips would be removed. This would be equal to about 8% of the present traffic level on the Expressway in that interval. However, the net impact on traffic congestion on the Expressway would be expected to be lower because of traffic shifting from parallel routes and other time intervals to take advantage of the freed capacity.

The maximum diversions of Buzzards Bay extension corridor traffic from Route 3 would occur just south of Interchange 8 in Kingston. This would include diversions of former auto trips to Boston, Cambridge, and points beyond, some trips to Quincy or Braintree, and former access trips to the Kingston commuter rail station. The diversions at that point would total about 775 inbound trips per day, including about 200 between

6:45 and 7:15 AM. This would be equivalent to about 16% of the present traffic on that segment of Route 3 in that time interval. However, at the point of greatest volumes on Route 3 in Braintree, the peak-30-minute diversions of Buzzards Bay corridor traffic would equal only about 5% of the present total highway traffic in the same time interval.

The maximum diversions of Buzzards Bay extension corridor traffic from Route 24 would occur just north of the junction with I-495 on the border of Raynham and Bridgewater. This would include diversions of former auto trips to Boston, Cambridge, and points beyond, some trips to Quincy or Braintree, and trips to intermediate points along the Middleborough/Lakeville Line in Bridgewater, Brockton, Randolph, or Holbrook. The diversions at that point would total about 685 inbound trips per day, including about 180 between 6:45 and 7:15 AM. This would be equivalent to about 9% of the present traffic at that location in that time interval. However, at the point of maximum traffic on Route 24 in Randolph, the peak-30-minute diversion of Buzzards Bay extension traffic would be equivalent to only about 6% of the present total highway traffic in the same time interval.

A commuter rail extension terminating at Buzzards Bay would result in increases in traffic crossing the Bourne and Sagamore bridges. These would result mostly from diversions to a Buzzards Bay station of passengers formerly boarding express buses at stops south of the canal. In addition, there would be return trips of vehicles used to drop off passengers at Buzzards Bay instead of driving all the way to final destinations.

On the Bourne Bridge, the increase would be about 195 cars each way per day, or about 40 cars in the peak half hour. On the Sagamore Bridge, the increase would be about 245 cars per day, or 50 cars in the peak half hour. Because of the travel time to Boston, the added traffic would be heaviest between about 6:15 and 6:45 AM, but other traffic on the bridges is usually well below peak levels then. Some of the return traffic in the evening would, however, occur during times of heavy southbound travel over the bridges.

Traffic Impacts of Station Access

To the extent that the impacts of stations on surrounding land areas would be site-specific, they are beyond the scope of this study. Certain impacts could be expected regardless of station location, however. Final access to any station would require some use of undivided highways or local streets. Most of this would consist of traffic that now bypasses these areas on limited-access highways, so there would be some localized increases in traffic congestion at any site.

If a Buzzards Bay extension were operated with maximum service under present-day travel levels, the mid-range estimated ridership on the extension would be about 2,045 per day in each direction. (This estimate assumes unconstrained parking capacity at all stations and retention of some of the existing express bus service.) A Wareham station would be used mostly by the passengers with trips originating in Wareham, Rochester, Marion, Carver, or Mattapoisett. A Buzzards Bay Station would serve the passengers from Bourne and other towns in Barnstable County. With this split,

boardings would total about 560 per day at Wareham, and about 1,485 per day at Buzzards Bay.

With peaking similar to that on the present Middleborough/Lakeville Line trains, the heaviest boardings on individual trains on an extension would be about 145 at Wareham and 385 at Buzzards Bay. Because of the relatively low population densities of Wareham and Bourne, and constraints on potential station locations, walk-ins would account for negligible numbers of access trips to either station. The low population density would likewise make it challenging to design feeder bus routes that could stop within convenient distance of large numbers of trip origins and also be sufficiently direct to be time-competitive with auto access. Bicycle access accounts for much smaller percentages of access trips than walk-ins at all MBTA commuter rail stations. Therefore, for planning purposes it must be assumed that almost all access trips to the Wareham and Buzzards Bay stations would be made by auto, including park-and-ride drivers and their passengers, and drop-offs.

The 1998 Old Colony commuter rail passenger survey found that the average occupancy of vehicles arriving to park at stations was 1.03 at Middleborough/Lakeville and 1.04 at Kingston. For all Old Colony Lines stations combined, the rate was 1.034. The survey did not determine the extent to which drop-off passengers arrived together. However, direct observations at other stations have found that more than one drop-off per vehicle is rare. Consequently, it is reasonable to assume a similar ratio of vehicles to passengers for drop-offs as for park-and-ride passengers.

If all passengers accessed the Wareham and Buzzards Bay stations by either park-and-ride or drop-off vehicle with an average occupancy of 1.03, the most heavily patronized train would attract about 140 auto-access trips to Wareham Station and 375 to Buzzards Bay. Surveys and direct observations have shown that commuter rail passengers typically time their station arrivals to be close to train departure times. In the 1998 survey, 80% of the park-and-ride drivers boarding at Kingston Station and 92% of those boarding at Middleborough/Lakeville reported waiting 10 minutes or less for their trains at the stations. With a pattern similar to that at Middleborough/Lakeville, auto arrivals for the most heavily used train in the last 10 minutes before departure would average 13 per minute at Wareham and 35 per minute at Buzzards Bay.

A Buzzards Bay station would be at the extreme northwest corner of its attraction area, and because of the road layout, almost all access trips would arrive there from the east. A Wareham station would draw ridership from several directions, but with the station site assumed for purposes of analysis, the largest share of access trips would arrive from the north along County Road, after approaching that road from the east.

MBTA commuter rail service, including that on the Middleborough/Lakeville Line, typically has less sharp peaking outbound than inbound. However, most alighting passengers leaving a station by auto attempt to do so immediately after train arrival rather than over the course of 10 minutes, so congestion following evening train arrivals at Wareham and Buzzards Bay could be more severe than that prior to morning train departures.

The ability of the roads at Wareham and Buzzards Bay to accommodate vehicles going to and from the stations, in addition to existing traffic levels, would require more detailed analysis than is covered by the scope of this study. The estimated 375 auto access trips to the most heavily patronized train at Buzzards Bay would, however, exceed the maximum number of auto access trips per train found at almost all existing MBTA commuter rail stations. At some of the most heavily used present stations, congestion is mitigated by multiple approach routes, multiple parking sites, or longer average wait times from vehicle arrival to train departure.

To accommodate the maximum projected ridership for a Buzzards Bay extension with less traffic congestion, boardings and alightings could be dispersed among more than two stations. Historically, Wareham was always served by at least two stations during the years when passenger service to Boston was operated. Because of the short distance between the north border of Bourne and the Cape Cod Canal, any station intended to draw off some of the ridership from a Buzzards Bay station would have to be located either over the town line in Wareham or on the south side of the canal. Traffic approaching a station in Wareham near enough to Bourne to be an effective alternative to a Buzzards Bay station would still have to pass through Buzzards Bay village on the way.

Grade Crossings

At present, there are 11 grade crossings of public roads between Middleborough/Lakeville and Buzzards Bay, with an overall average spacing of 1.9 miles. The greatest concentration of these crossings is in the town of Wareham, where there are 7 crossings in one segment of 5.5 miles. The minimum separation there is 0.4 miles. The only grade crossing of a numbered highway is that of U.S. Route 6 in the center of Wareham, near the Wareham stop for the most recent past rail passenger service on the Buzzards Bay extension route. Train operation there could result in some backup of traffic at peak times, particularly in summer months. More detailed traffic studies of this crossing would be needed prior to implementation of service. Most of the other crossings are on streets that appear to be used mainly by local traffic at low volumes.

The Depot Street and Main Avenue crossings in Wareham are both on access routes to the summer resort area of Onset, and may be heavily traveled at times. The Academy Drive Crossing by the old Buzzards Bay Station is the main access route to the Massachusetts Maritime Academy. It also serves a large private boat marina, which is active mostly during summer months. A grade-separated connection from Academy Drive to Main Street was formerly provided by the Taylor Avenue bridge over the tracks, just to the west. This bridge and the fill for the south approach were removed long ago. The marina parking lot is partly on the site of the removed fill.

All of the public crossings are protected by flashing lights. All except the Academy Drive crossing are also protected by automatic gates. However, since most of these devices were installed over 20 years ago, some upgrading could be required if commuter rail service were instituted. There are also 3 authorized crossings on private property on the route, protected either by stop signs or by the sounding of train whistles.

Impacts on Abutters

South of Middleborough/Lakeville Station the entire Buzzards Bay extension would use an active rail line that has been in operation since 1848. Commuter service would involve a much greater number of trains than have been run in recent years, however. Passenger service on this line was last operated in the summer of 1996, and consisted of only one southbound train on Friday evenings and one northbound train on Sunday afternoons. The southernmost 11-mile segment between Buzzards Bay and the SEMASS Resource Recovery Facility in Rochester is used once or twice a day in each direction by “trash trains” operated by the Bay Colony Railroad from transfer facilities in Barnstable County. The 7-mile segment between Middleborough/Lakeville Station and the SEMASS facility is currently used only on an as-needed basis, for bringing freight cars to and from one customer in Rochester and for shifting rolling stock to and from other lines in the Bay Colony system.

For abutters to the rail line, negative impacts of adding commuter rail service would include vibration and noise, and increased blocking of road crossings while trains were passing. Sounds that would carry farthest would be those of train horns at the crossings.

Aerial photographs from the 2003 Electronic Field Study of Massachusetts show that much of the land along the rail line between Middleborough/Lakeville and Buzzards Bay is either undeveloped or is non-residential in character. Development along the right-of-way in many places could occur only if new access roads were built. However, new housing is under construction or recently completed on streets that are within one-half mile of the line in some places.

According to the 1997 Bourne Commuter Rail Extension Feasibility Study, in 1996 there were approximately 75 houses located within 200 feet of the rail line between Middleborough/Lakeville and Buzzards Bay, or an overall average of 4 per mile. About 60 of these houses, or 80%, were located along the six-mile segment between the Main Street bridge at Parker Mills and the Onset Avenue bridge, both in Wareham. The 2003 aerial photos indicate little change in these numbers. This is within the segment of the line in daily use by trash trains.

At each of the 11 grade crossings of a road with the railroad in this segment, land uses in 1996 were noted separately in four directions or quadrants (on each side of the road and on each side of the railroad). Within each quadrant, the impact of train operation would be greatest for the parcels immediately bordering the railroad track. Of the four parcels bordering both the road and the railroad at each crossing, an average of 1.3 were occupied by houses, 1.2 by commercial or industrial buildings, 0.5 by other structures, and 1.1 were vacant. The other structures included one elementary school, at the Station Street crossing in Wareham. The 2003 aerial photos and 2006 field observations indicate that these averages were still valid.

About two-thirds of the houses within 200 feet of the railroad are provided with some sound buffering by the earth cuts for the tracks and by embankments for road approaches to bridges. In addition, much of the land along the railroad, including that around houses, is heavily wooded.

9. SUMMARY AND CONCLUSIONS

An extension of the Middleborough/Lakeville commuter rail line to Buzzards Bay would be feasible from an operations standpoint. Capacity constraints on the line between Boston and Middleborough/Lakeville Station would require that all or most of the Buzzards Bay trains be run as extensions of trips that would be run anyway on the Middleborough/Lakeville Line rather than as separate service. This would preclude provision of express service.

Depending on the maximum speeds and number of intermediate stations on the extension itself, peak-period scheduled trip times from Buzzards Bay to Boston during peak hours would range from about 75 to 84 minutes. Even at the upper end, the time would be competitive with bus and private-auto times.

If ridership were unconstrained either by train capacity or by parking capacity at stations, at 2006 total travel levels the extension would carry an estimated 2,045 riders each way per weekday. With projected population increases by the year 2020, ridership would increase to an estimated 2,750 each way per weekday. These totals do not include summer recreational ridership. Because Buzzards Bay is not within convenient walking distance of most of the recreational trip attractions in Barnstable County, extensive feeder-service connections would be needed in order for the extension to serve recreational travel. Even then, recreational travel would not be expected to exceed an average of 300 riders each way per day in the summer.

The maximum number of auto diversions from highways as the result of a Buzzards Bay extension would occur on the Southeast Expressway in Quincy. During the half hour of heaviest train use, the number of diverted auto users would be equivalent to up to 8% of the present traffic volume on the Expressway in the same time interval. However, the net reduction would be much smaller, as traffic flow typically adjusts to take advantage of freed-up capacity. Also because commuter rail ridership is more highly concentrated than highway use, traffic impacts outside of the peak half-hour would be much smaller.

At the present average train-hour costs for the MBTA commuter rail system, the annual incremental cost of extending all present weekday Middleborough/Lakeville Line trains to Buzzards Bay would be about \$9,750,000. At 2006 fare levels, the incremental revenue would be about \$4,063,000, for a revenue-to-cost ratio of about 42%. Extending all weekend service to Buzzards Bay would increase the annual incremental cost of the extension to about \$12,531,000, but increase the annual revenue only to about \$4,414,000, reducing the revenue-to-cost ratio to about 35%. This would be lower than the present ratio of about 41% for the commuter rail system as a whole.

At recent construction and equipment cost levels, the capital cost for an extension would range from approximately \$81.8 million to \$103.5 million, with the largest component of the difference accounted for by the potential cost range of parking facilities at Buzzards Bay. Adequate parking there would be critical to attaining the

ridership and revenue levels indicated above, but obtaining a site that was large enough and also configured in a manner acceptable to the community could be difficult.

In terms of air quality measures, a Buzzards Bay extension would result in net reductions in emissions of carbon monoxide and volatile organic compounds, but would cause some net increases in emissions of nitrogen oxides and particulate matter.

The results above are summarized in Table 9-1. It must be emphasized that at present neither the MBTA nor EOT has any funding programmed for either the capital cost or the annual net operating cost of a Buzzards Bay extension.

**Table 9-1
Summary of Performance Measures for
Extension from Middleborough/Lakeville to Buzzards Bay
With Maximum Weekday Service Level**

Item	Amount
Weekday inbound riders (2006 travel levels)	2,045
New inbound transit riders (2006 travel levels)	1,335
Weekday inbound riders (Year 2020)	2,750
New transit riders (year 2020)	1,795
Annual operating cost of weekday service	\$9,750,000
Incremental weekday revenue (2006 travel levels)	\$4,063,000
Incremental revenue/ operating cost – weekday	0.417
Incremental revenue/ operating cost – weekly	0.352
Capital cost of extension at year 2006 prices	\$82,000,000 to \$104,000,000
Capital cost/new rider (at year 2020 ridership)	\$45,680 to \$57,940
Weekday reduction of VOCs (2000 travel levels)	53.3 kg
Capital cost/kg of weekday reduction of VOCs	\$1,540,000 to \$1,950,000

APPENDIX A – PRESENT TRANSPORTATION SERVICES AND FACILITIES IN THE EXTENSION SERVICE AREA

Chapter 2 of this report contains brief descriptions of the present transportation services and facilities in the geographical area from which a Buzzards Bay commuter rail extension would be expected to attract riders. Additional details are provided below.

Present Mass Transportation Services in the Extension Service Area

Express Bus Service to Boston

Hyannis Route

As discussed in Chapter 2, the schedule in effect on this route in the spring of 2006 had 26 round-trips on weekdays, and 17 on Saturdays, Sundays, and holidays. On all days, 2 of the off-peak Hyannis–Boston trips in each direction continued through to Provincetown, with intermediate stops at North Truro, Truro, Wellfleet, South Wellfleet, North Eastham, Eastham, Orleans, and Harwich. Off the Cape, several trips also stopped at park-and-ride lots off Route 3 in Plymouth and Rockland.

The summer schedule in effect as of June 10, 2006 increased overall weekday frequency on the Hyannis route to 31 round-trips. This included 3 trips each way serving Logan but not downtown Boston, 21 inbound and 20 outbound trips serving both South Station and Logan, and 7 inbound and 8 outbound trips serving South Station and Park Square but not Logan. There were 4 connecting round-trips between Hyannis and Provincetown. Weekend frequency remained at 17 round-trips, but the 2 Provincetown through trips were each replaced with 4 connecting round-trips.

Fares on this service varied by distance. From Sagamore, the nearest stop to Buzzards Bay, fares to South Station in the spring of 2006 were \$15.00 one-way, \$27.00 round-trip, and 10 rides in 30 days for \$61.00. Additional discounts were available for children and senior citizens. From Hyannis, the rates to South Station were \$17.00 one-way, \$31.00 round-trip, and 10 rides in 30 days for \$67.00. From Provincetown, the rates to South Station were \$27.00 one-way or \$49.00 round-trip. Ten-ride tickets were not offered from points farther from Boston than Orleans. Fares between all Cape Cod points and Logan Airport were higher than Cape Cod–South Station fares by \$5.00 one-way and \$9.00 round-trip, and no 10-ride fares to Logan were offered.

Woods Hole/Falmouth Route

As discussed in Chapter 2, the schedule in effect on this route in the winter of 2006 had 9 round-trips on weekdays and 7 on Saturdays and Sundays. The majority of trips in both directions ran non-stop between Bourne and Boston. One inbound and 2 outbound trips stopped at a privately owned park-and-ride lot at the Mill Pond Diner in Wareham on Route 28 at Tihonet Road. The trip stopping in Wareham involved a side diversion off of the main highway and had a scheduled time of 95 minutes from Bourne to Boston. Of this, 85 minutes was from Wareham to Boston.

Fares on this route varied by distance. From Bourne, the fares to South Station as of April 2006 were \$14.00 one-way and \$25.00 round-trip. From Falmouth or Woods Hole, the rates were \$18.50 one-way and \$32.00 round-trip. From Wareham, the rates were \$12.00 one-way and \$22.00 round-trip. Ten-ride tickets valid for 30 days were priced at \$70.00 from Wareham or Bourne and \$80.00 from Falmouth or Woods Hole. Additional charges applied for travel to or from Logan Airport, ranging from \$6.50 one-way and \$12.00 round-trip from Falmouth or Woods Hole to \$8.00 one-way and \$14.00 round-trip from Wareham. Senior one-way fares were discounted 5% and child fares 40% from full adult fares.

As in past seasons, the spring schedule added one daily round-trip in the evening, running between Woods Hole, South Station, and Logan. The summer schedule increased service to 11 inbound trips Monday through Saturday, 10 inbound trips Sunday, and 13 outbound trips daily between Falmouth or Woods Hole and South Station. Five of the inbound trips continued to Logan Airport, and another 3 inbound trips ran to Logan without stopping at South Station. Seven of the outbound trips originated at Logan, and one other outbound trip ran from Logan with no stop at South Station.

Ferry Service to Boston

Boston Harbor Cruises runs a 600-passenger high-speed catamaran from Provincetown to Long Wharf in Boston. The 2006 schedule was to run from May 13 through October 8, with frequency ranging from 1 to 3 trips per day. The scheduled trip time was 90 minutes. The fare on this route was \$45.00 one-way and \$70.00 round-trip, with reduced fares for children and senior citizens.

Bay State Cruises operates a 149-passenger high-speed catamaran and a 1,100-passenger conventional boat from Provincetown to the World Trade Center in South Boston. The 2006 schedule was to run from May 19 to October 2, with three daily round-trips and sailing times of 90 minutes. The fares on this service were \$41.00 one-way and \$64.00 round-trip, with reduced fares for children and senior citizens. The conventional boat was to make one round-trip on Saturdays and Sundays only, from June 24 to September 3, with a sailing time of three hours. The fares on this service were \$18.00 one-way and \$29.00 round-trip, with reduced fares for children and senior citizens.

The distance from Boston to Provincetown by water is much shorter than that by land. The scheduled trip times of 90 minutes for the faster boats compare favorably with the fastest scheduled bus time of 2 hours and 50 minutes. With a direct bus connection from a boat, travel times between Boston and Truro, Wellfleet, and North Eastham could all be faster than overland times.

Local Transportation Service in Barnstable County

Local transportation service in Barnstable County is provided by the Breeze bus system of the Cape Cod Regional Transportation Authority (CCRTA). In the off-season, four fixed routes radiate from the Hyannis Transportation Center. Under the schedule in effect from Labor Day 2005 through late June 2006, the Red Line (Hyannis Villager

Breeze) ran to the Hyannis Senior Center. The Yellow Line (Barnstable Villager Breeze) ran to the Barnstable County Courthouse complex. The Blue Line (Sealine Breeze) ran to Woods Hole via Mashpee and Falmouth. At Woods Hole it connected with Steamship Authority ferries to Martha's Vineyard and with Peter Pan/Bonanza Bus Lines service to Boston. The Green Line (Hyannis to Orleans Breeze) ran to Orleans via Yarmouth, Dennis, Harwich, and Chatham. All four Breeze routes had service Monday through Saturday, with headways ranging from 1 to 3 hours. Connections with Boston bus routes were not at times suitable for most work commuting. None of the routes came close enough to Buzzards Bay to allow them to be modified to provide connections with future rail passenger service at that location.

The CCRTA also has two seasonal fixed routes based in Provincetown. One route connects MacMillan Wharf and the Provincetown Airport. The other route runs between North Truro, MacMillan Wharf, and Race Point Beach. The North Truro route includes a stop at Dutra's store, which is also served by the Plymouth & Brockton Street Railway Company (P&B) Provincetown-Boston buses. These routes operate from Memorial day weekend to mid-October, with the most frequent service being provided during July and August.

In June 2006, the CCRTA established a new route, The Flex, between Harwich and Provincetown via Brewster, Orleans, Eastham, Wellfleet, and Truro. This was a fixed-route service that also made diversions of up to three-quarters of a mile off the regular route, by advance reservation, for passengers with difficulty accessing regular stops.

In addition to the fixed routes described above, the CCRTA has a demand-responsive shared-bus service (the b-bus) operating in all 15 Barnstable County towns. Service is open to anyone, but reservations must be made no later than 11:00 AM on the day before travel, and exact pick-up times are not guaranteed. The CCRTA formerly also provided the Boston Hospital Transportation Bus, running from fixed pick-up points at six Cape locations to hospitals in downtown Boston for medical appointments. This service also required advance reservations. As of May 2006, transportation to Boston medical appointments was being provided instead as part of the demand-responsive b-bus service.

Local Transportation Service in Wareham and Bourne

Local transportation service in Wareham and Bourne is provided by the Greater Attleboro Taunton Regional Transit Authority (GATRA) Onset Wareham Link (OWL) bus system. The schedule in effect in the spring of 2006 had four routes, called Link 1, 2, 3, and 4. Link 1 ran from the Cromeset section of Wareham through Wareham Center to Onset Village. Link 2 ran from Cranberry Plaza via Onset Village to Buzzards Bay, the Tedeschi's market near the south end of the Bourne Bridge, and the Bourne Oaks development north of the bridge. (The market is also a stop for Peter Pan/Bonanza buses to and from Boston, Providence, and New York.) Link 3 ran from Cranberry Plaza to the Shangri-La development on Glen Charlie Pond on the north side of Wareham. Link 4 ran from Cranberry Plaza to West Wareham on state Route 28 at the border of Rochester. Outbound trips stopped at the Mill Pond Diner, which is also a stop for a few Peter Pan/Bonanza Boston bus trips. Inbound Link 4 trips ran via Wareham Center. All Link routes ran from 7:55 AM to 6:30 PM Monday through Friday, and from 8:50 AM to

5:30 PM Saturday, with hourly departures except for a two-hour midday gap. All routes were scheduled to converge at Cranberry Plaza at 30 minutes past each hour.

Tourist Train Service on Cape Cod

The most recent operator of tourist trains on Cape Cod, the Cape Cod Central Railroad, was under new ownership as of February 2006. The overall schedule in 2006 was to run from late April through mid-December. Most trains operated by this company and recent predecessors have run between Hyannis and a point near the south end of the Sagamore Bridge. For logistical reasons, they have not continued as far as the potential future commuter rail line terminal at Buzzards Bay, although it would be possible for them to do so.

At the height of the vacation season in July and August, the 2006 schedule was to include a scenic fun train making two round-trips Tuesday through Saturday and one round-trip Sunday and Monday. Lunch was to be offered on the noon train Tuesday through Thursday. A family supper train was to run Tuesday and Wednesday evenings, and an elegant dinner train Thursday through Saturday evenings. A brunch train was to run Sunday mornings.

Passenger Counts on Existing Bus Services

Hyannis Route

A one-day weekday passenger count by CTPS at South Station in March 2006 found 371 passengers boarding outbound P&B Hyannis buses there all day, including 197 boarding trips leaving there between 3:30 and 6:30 PM. Another 84 passengers boarded these buses at Park Square, including 74 in the PM peak. This was a total of 455 downtown Boston boardings, including 271 (59.6%) in the PM peak. In addition to these, 146 passengers boarded Hyannis buses at Logan Airport on trips that stopped at South Station. Logan boardings on trips that by-passed downtown Boston were not counted.

A March 2006 CTPS count at the Sagamore park-and-ride lot found 117 inbound boardings there on trips due at South Station between 6:30 and 9:30 AM. Another 142 passengers were already onboard these buses when they arrived at Sagamore, for a total of 259 leaving there. All but one of these buses ran non-stop between Sagamore and South Station and then continued to a final stop at Park Square. The last trip made one intermediate stop at a park-and-ride lot in Plymouth, but as there are no trip attractions near there, it can be assumed that all passengers on this bus leaving Sagamore also went to South Station or Park Square. The total of 259 riders leaving Sagamore on AM peak buses was consistent with the outbound PM peak boarding total of 271 at South Station and Park Square combined. All of those buses ran non-stop from South Station to Sagamore, so passengers had to have ridden at least that far.

In addition to the Sagamore boardings on downtown Boston buses, 21 passengers boarded three buses there that were scheduled to arrive at Logan Airport in the AM peak. These buses did not serve either of the downtown Boston stops. Another 59

passengers were on board the Logan buses when they arrived at Sagamore, for a total of 80 on departure.

The most recent previous CTPS passenger count for this route was taken in May 2000. It showed 219 PM peak boardings at South Station and 70 at Park Square, or a combined total of 289 that was 6.6% greater than the 2006 count. In addition to this, in 2000 P&B also ran a route from Boston to Harwich and Orleans. Buses on that route served the Sagamore and Barnstable park-and-ride lots, but bypassed the downtown Hyannis terminal. The May 2000 counts found another 66 PM peak boardings at South Station and 40 at Park Square on the Orleans route. The PM peak boardings for the Hyannis route alone in 2006 were 31.4% lower than the combined Hyannis and Orleans route totals (395) for 2000. Part of this difference may have been normal seasonal variation. Mass. Highway Department continuous traffic counts for the Cape Cod Canal bridges for 2004 show 21% fewer average daily vehicle crossings in March than in May.

Sagamore License Plate Survey Results

On the same day that the March 2006 boarding counts were conducted at the Sagamore park-and-ride lot, license plates of all vehicles parked there at the end of the AM peak were recorded. The number of parked vehicles was 2.5 times as large as the total number of passengers boarding AM peak downtown Boston or Logan buses there (346 versus 138). An estimated one-third of this difference was attributable to vehicles parked by passengers who boarded three buses scheduled to arrive at Logan or downtown Boston before 6:30 AM. A few vehicles were left by carpoolers, but the observer reported seeing very few car-to-car transfers. A few bus passengers were dropped off rather than leaving parked vehicles. Most of the difference between observed boardings and total parked vehicles appeared to result from long-term parking by Logan passengers. The lot arrangement did not allow identification of vehicles by passenger destination. However, unless there is reason to believe that the Sagamore lot draws downtown Boston commuters and Logan passengers from significantly different origins, the overall percentage distribution of vehicle registrations by origin should be applicable to either group.

Overall, CTPS was able to match 69% of the in-state vehicle registrations recorded at Sagamore to a city or town of origin. This is a typical match rate given the present age of the files available. For purposes of analysis, origin locations for which Sagamore would not be a convenient starting point (such as towns north of Boston) were assumed to belong to visitors or people who had moved since the file provided by the Registry of Motor Vehicles was updated, or were attributed to survey errors. Excluding these and out-of-state registrations, the number of matches was equivalent to 62% of the parked vehicles. (This is much larger than the sample typically obtained from direct surveys of passengers.)

Overall, license plate survey results indicated that the largest source of parked vehicles at the Sagamore lot was Barnstable County, at 87.2%. The town with the largest individual share was Sandwich, at 30.6%. Bourne was second, at 18.2%. In absolute terms these accounted for an estimated 36 AM peak trips to downtown Boston stops from Sandwich and 22 from Bourne. Although the Sagamore lot is in Bourne, it is closer

to more homes in Sandwich. In addition, no Boston bus service stops directly in Sandwich, but there is Boston bus service from two other stops in Bourne.

The next-largest percentages and estimated AM peak trips to downtown Boston were from Barnstable (11.9%, 14 trips), Falmouth (11.4%, 13 trips), and Mashpee (9.6%, 11 trips). The remaining Barnstable County origins (5.0% of Sagamore boardings or 6 trips) came from towns east of Barnstable. The same buses that stop at Sagamore also make two stops in Barnstable, at a park-and-ride lot at U.S. Route 6 and state Route 132, and at the Hyannis Transportation Center. The AM peak boarding counts at Sagamore found 142 passengers already onboard buses from the two Barnstable stops. If the origin split of these was similar to that at Sagamore, about 100 of these trips would have originated in Barnstable itself, and 42 in towns beyond.

Falmouth has alternate bus service to downtown Boston and Logan from stops at Woods Hole and at downtown Falmouth, but only the latter has parking for bus passengers, and capacity there is much lower than at Sagamore. No Boston buses serve Mashpee directly. Bus patronage from that town would also be expected to be split between Sagamore and stops in Falmouth or Bourne.

The license plate survey results found very little use of the Sagamore lot for trips originating in any of the five towns outside Barnstable County that would be in the assumed service area of a Buzzards Bay commuter rail extension. Together they accounted for an estimated total of only three AM peak boardings to downtown Boston. Of the five towns (Wareham, Rochester, Carver, Marion, and Mattapoisett) only Wareham currently has bus service to Boston, and only one inbound AM peak and two outbound PM peak trips stop there. However, access from any of the five towns to the Wareham stop would be shorter than that to Sagamore.

Woods Hole Route

A one-day weekday passenger count by CTPS at South Station in March 2006 found 107 passengers boarding outbound Peter Pan/Bonanza Woods Hole/Falmouth buses there all day for all destinations combined. Another 37 passengers were already aboard these buses from Logan Airport. Of these boardings, 69 at South Station and 15 at Logan were on trips leaving South Station between 3:30 and 6:30 PM.

A May 2000 CTPS count found 103 inbound South Station alightings from AM peak trips alone. In addition, at that time there were two inbound AM peak short-turn trips from Buzzards Bay via Wareham, which had another 36 alightings at South Station. This made a total of 139 inbound AM peak trips. Assuming that inbound AM peak and outbound PM peak ridership would be about equal, the 2006 peak results show a decrease of 49.6% compared with the 2000 counts. This was much larger than would be expected merely as a result of seasonal variation.

The Sagamore license plate survey results, discussed above, indicate that about 50 passengers boarding inbound AM peak buses there and going to stops in downtown Boston had origins in towns also served directly or indirectly by the Falmouth bus route.

Commuter Rail Station License Plate Surveys

A March 2006 license plate survey at Kingston Station at midday on a weekday found plausible origin matches for 62% of the vehicles parked there, or the same as the sample rate at Sagamore. The results are summarized in Table 2-6. The Kingston Station lot is used only for one-day commuter rail parking. (Commuter bus service from Kingston to Boston stops at a private lot at a shopping plaza.) The license plate survey results indicated that 15.5% of all vehicles that were parked at Kingston Station before noon, or a total of 113, came from Barnstable County, compared with 99 (13.9%) in the 1998 passenger survey. In the 1998 survey another 6 Barnstable County passengers reported arriving at Kingston Station in carpools, and another 8 were dropped off there.

In 2006, the largest number of vehicles from Barnstable County parking at Kingston came from Sandwich (55), followed by Barnstable (23), Bourne (18), Mashpee (10), and Falmouth (3). The rest came from towns east of Barnstable. Most of these trips would have originated at points closer to the Sagamore Bridge than to the Bourne Bridge. Vehicles crossing the Sagamore Bridge would be more likely to continue north on Route 3, which runs past Kingston Station, than on I-495, which runs past Middleborough/Lakeville Station.

A March 2006 license plate survey at Middleborough/Lakeville at midday on a weekday found plausible origin matches for 64% of the vehicles parked there, or slightly greater than the rates at the Sagamore and Kingston lots. The Middleborough/Lakeville lot is used only for one-day commuter rail parking. These survey results indicated that 6.1% of all vehicles parked there before noon, or a total of 41, came from Barnstable County, compared with 34 (6.6%) in the 1998 passenger survey. In both surveys, most of these came from Falmouth, Bourne, or Mashpee, with 17, 16, and 5 in 2006. Origins in Falmouth or in some sections of Bourne or Mashpee would be closer to the Bourne Bridge than to the Sagamore Bridge. Vehicles crossing the Bourne Bridge would be more likely to continue north via I-495, than via Route 3. In the 1998 survey, no Barnstable County passengers reported arriving at Middleborough/Lakeville Station in carpools, and only one was dropped off.

Among the five Plymouth County towns assumed to be in a Buzzards Bay extension service area, the 1998 survey showed Middleborough/Lakeville Station capturing 130 of the 131 Old Colony boardings from Wareham, Rochester, Marion, and Mattapoisett. Boardings from Carver were more widely dispersed, with only 25 of 96 going to Middleborough/Lakeville. Other Carver boardings were at the following stations: 36 at Halifax, 28 at Kingston, and 7 at Hanson. Of the 227 trips from the five towns, 191 (84.1%) were trips from home to work in any location, including 145 (63.9%) that were to work locations in Boston Proper. This was equivalent to about 3 out of 4 of the non-bus transit trips to Boston Proper indicated in the 2000 census tabulations. For trips to other Boston destinations, the 1998 survey figure was slightly over half the 2000 census figure (15 versus 26), but for trips to Cambridge the survey number was higher (13 versus 6).

Of the 155 Middleborough/Lakeville boardings from the five Plymouth County towns in the Old Colony survey, 135 (87%) had park-and-ride access, with all arriving by noon. The March 2006 license plate survey at this station indicated that 168 of the

vehicles parked there by noon came from the five towns. Most of the gains came from Wareham (17), Mattapoisett (11), and Rochester (4), with volumes from Carver and Marion almost unchanged from 1998. At Kingston, the park-and-ride volume from Carver dropped by nearly half, from 21 to 11. These results suggest that surveys at Hanson and Halifax would find park-and-ride activity from Carver to have increased at most by about the amount of the loss at Kingston.

Highway Travel Volumes

Non-Summer Months

According to the 2000 census figures, drive-alone and carpool trips to work would have generated about 770 inbound vehicle-trips each way per day from Barnstable County to Boston Proper, another 875 to the rest of Boston, and 170 to Cambridge, for a total of 1,815. Most of these trips would have originated south of the Cape Cod Canal, and would have had to cross either the Sagamore Bridge or the Bourne Bridge. Mass. Highway Department traffic counts show very little variation from year to year in non-summer traffic over the bridges. In March 2000, the average number of vehicles crossing both bridges combined in both directions combined was 82,247 per day, or 41,124 in each direction. If all of the private vehicles making work trips from Barnstable County to Boston or Cambridge were included in these totals, they would have accounted for a 4.4% share.

The 1998 survey results showed that 50% of all the passenger trips from Barnstable County made via the Old Colony commuter rail lines were work trips to Boston or Cambridge, with the other 50% consisting of non-work trips or trips to other destinations beyond Boston. If the number of private auto trips from Barnstable County to work in Boston or Cambridge is assumed to equal half the combined total auto trips for all purposes from the county to all destinations in Boston or beyond that could be reached practically using the Middleborough/Lakeville Line, the combined total would be 3,630 vehicle trips. This would be equivalent to 8.8% of the volume over the canal bridges in non-summer months, and diversions of auto traffic to a Buzzards Bay extension would be some subset of this. However, with a commuter rail extension terminating at Buzzards Bay, almost all of the access trips to it would still have to cross the bridges. Access by drop-off instead of park-and-ride could even increase daily traffic volumes on the bridges slightly if the drop-off vehicles returned home between the morning drop-offs and evening pick-ups.

Most highway traffic going from Cape Cod to Boston, Cambridge, or points beyond would proceed north either via state Route 3 or via Route 25, I-495, Route 24, and I-93. These routes converge on the Southeast Expressway for the final approach into Boston. The most recent available traffic counts and travel-time runs indicate that in peak hours, traffic on both highway routes from the Cape typically moves at or near the posted speed limits at least as far north as it is necessary to travel to reach the present outer ends of the Old Colony commuter rail lines (Kingston and Middleborough/Lakeville).

The maximum traffic volumes on the Southeast Expressway are usually found south of Freeport Street in Dorchester. In 1999, the average daily northbound traffic volume at that location was 113,000 vehicles, including traffic in the high-occupancy-vehicle lane.

The estimated 3,630 vehicle trips per day from Barnstable County for trips to or through Boston for all purposes would equal 3.2% of this. Traffic destined for the Boston area from the study area is more heavily concentrated in peak hours than overall traffic on the Expressway. Consequently, diverting study-area traffic to commuter rail would have a proportionally greater impact in peak hours than on a daily basis.

According to the 2000 census figures, drive-alone and carpool trips to work would have generated about 285 inbound vehicle-trips each way per day from the five Plymouth County towns in the study area to Boston Proper, another 541 to the rest of Boston, and 86 to Cambridge, for a total of 912. The Old Colony commuter rail survey results showed that 76% of all the passenger trips from the five towns were work trips to Boston or Cambridge. If work trips to Boston or Cambridge also accounted for 76% of private auto trips from the five towns to destinations in Boston or beyond that could be reached practically using the Middleborough/Lakeville Line, an additional 288 trips would be made for non-work purposes, or to destinations beyond Boston or Cambridge. From Wareham, Rochester, Marion, and Mattapoisett, most highway travel toward Boston would go via I-495 and Route 24. From Carver, traffic would be split between that routing and Route 3. However, as in the case of Barnstable County traffic, this traffic would converge on the Southeast Expressway for the final approach to Boston. The combined total of 1,200 vehicles for work and non-work trips would be equivalent to 1.1% of the traffic on that highway at the maximum load point.

Summer Months

During summer months, highway traffic to and from Cape Cod increases significantly, with the peak month being July. Traffic over the Canal bridges in July 2004 averaged 128,889 vehicles per day, compared with 83,070 in March of that year. This was an increase of 45,819 (55%), or 22,910 in each direction. Average vehicle occupancy would be greater for recreational trips than for work trips, so the percentage increase in the number of people crossing the bridges during summer months would be even greater than 55%. For recreational travel, the off-Cape trip ends would vary from day-to-day and week-to-week, unlike work-trip ends. Consequently, any short-term survey effort would not necessarily obtain representative results. A 1979 study conducted for the MBTA estimated that at most 25% of the summer traffic to Cape Cod originated within Metropolitan Boston (inside Route 128), but did not include estimates of volumes from individual municipalities. Much of the traffic from suburban origins in this group would go around, rather than through, Boston on the way to the Cape. The same study estimated that 40% of the traffic going to the Cape originated on the South Shore, but again did not provide breakdowns by individual municipality. However, the most direct highway route to the Cape from most South Shore communities is Route 3, which is not intercepted by the alignment that rail service to Buzzards Bay would take.

APPENDIX B – FURTHER DETAILS ON DEMAND ESTIMATION METHODS

Summary of Steps in Demand Estimation Process

Travel from Origins in Extension Service Area at Year 2000 Travel Levels

The manual demand estimation process for the present study began by obtaining census journey-to-work tabulations for the year 2000 for origin-destination pairs expected to be served by a Buzzards Bay extension. For each origin-destination pair, minimum and maximum shares of the work trips that would be expected to be captured by a commuter rail extension were calculated. These ranges were based on the shares of work trips that other commuter rail lines in the MBTA system captured from origin-destination pairs in their service areas in 2000. The estimated minimum and maximum shares were multiplied by the year 2000 total work trips to calculate the ranges of absolute numbers of trips that an extension would have been expected to carry if it had been in operation in the year 2000. This method was used to estimate work trips to destinations in Boston Proper, the rest of Boston, Cambridge, and intermediate destinations along the Middleborough/Lakeville Line. Work trips to destinations beyond Boston or Cambridge were estimated by adding factors to the total estimated Boston, Cambridge, and intermediate trips, because the likely numbers to individual destinations would be too small to calculate directly. Estimates of non-work trips were based on the ratios of non-work trips to work trips on existing lines.

Adjustments from Year 2000 to 2006 and 2020 Travel Levels

Changes in estimated ridership on a Buzzards Bay extension in 2006 or future years compared with the year 2000 could result from changes in overall travel levels in the markets served by the extension or changes in the shares of these markets that the extension captured. As discussed in subsequent sections of this appendix, the market shares at year 2000 travel levels were assumed to fall in the mid-range between the highest and lowest shares observed for comparable services in the present MBTA commuter rail system. In existing markets, the commuter rail share varies from approximately 10-20% on the lower end to 70-80% on the higher end. Given this already wide range between the upper- and lower-bound values of commuter rail market share for work trips to Boston, it would not be possible for the upper-bound values to increase in such a way as to greatly raise the mid-range estimates. Consequently, there is more potential for ridership to grow from the 2000 estimates because of increases in total travel than because of changes in commuter rail share of that travel.

At present, residents of the expected service area of a Buzzards Bay extension account for only a small share of all workers employed in Boston or Cambridge. The population of the service area is, however, projected to grow at a much faster rate than total Boston or Cambridge employment. Moreover, an examination of trends in census journey-to-work tabulations shows that in most towns in the extension service area, the percentage of employed residents who work in Boston or Cambridge has been increasing over time. Consequently, future growth in the travel markets from which ridership on a Buzzards Bay extension would be drawn will depend much more on population growth than on employment growth.

For each origin town or cluster of towns, total year 2000 estimated extension trip origins were multiplied by the ratios of the projected number of residents aged 20 to 64 in the years 2006 and 2020 to the actual number in the year 2000. (Rates of change in the labor force were assumed to be similar to rates of change in this age range.) The population projections used were produced in 2003 by the Massachusetts Institute for Social and Economic Research (MISER) at the University of Massachusetts at Amherst. The year 2020 was the latest date for which projections were made by MISER before that function was discontinued.

For each town or cluster of towns in the extension service area, the ratios of total residents employed in Boston or Cambridge to total residents aged 20 to 64 in the years 1990 and 2000 were compared. For years after 2000, the ratios were assumed to change at the same average annual rate as the observed changes between 1990 and 2000. For example, if the ratio was 2.5% in 1990 and 3.5% in 2000, the average change was assumed to be 0.1% per year. Therefore, the ratio in 2006 was estimated to increase to 4.1%, and that in 2020 to 5.5%. For a given population, a 5.5% share would represent 1.57 times as many individuals as a 3.5% share. Therefore, the ridership estimates previously adjusted by projected population change from 2000 to 2020 would be further multiplied by a factor of 1.57.

Travel to Destinations in Extension Service Area

The steps described above were used to estimate travel starting from origins in the extension service area. Separate calculations were required to estimate travel to destinations in this area. Such travel would consist of a combination of year-round reverse-commuting work trips and seasonal recreational trips. Travelers in either of these groups would require some means for completing their trips between extension stations and their final destinations. The most recent census tabulations show very few work trips from Boston or Cambridge to any town that would be served directly by a Buzzards Bay extension, and not all of these would be to destinations within convenient walking distance of a station. The number of Boston and Cambridge residents employed in towns that would be served indirectly by an extension is also relatively small and all of these would be to destinations requiring additional transportation connections from stations. Because of the long travel distances involved and limited potential choices of arrival and departure times, institution of extension service would be unlikely to induce large numbers of additional Boston or Cambridge residents to begin working in the extension service area.

Census figures also show that cities and towns served by intermediate stations on the Middleborough/Lakeville Line originate relatively small numbers of work trips to destinations in the service area of a Buzzards Bay extension. Most of these intermediate stations currently have no feeder service connections. Consequently, an extension would also not be expected to attract large numbers of reverse-commuting trips from intermediate points.

The number of reverse-commuters on the present MBTA commuter rail system is small relative to the number of commuters going to work in Boston or Cambridge. Results of passenger counts and surveys conducted by CTPS indicate that for the commuter rail system as a whole, only about 2.5% of riders are reverse-commuters.

There is very little variation among lines in this proportion. The highest observed percentages for individual MBTA commuter rail lines have not exceeded 7%, and these have occurred on lines that have large office parks within short walks of suburban stations or have extensive private shuttle connections from stations to employment locations. These findings suggest that although reverse-commuters could contribute some revenue to a Buzzards Bay extension, precise estimates of their numbers would not be critical for decisions on implementation of extension service.

Recreational Travel

Recreational travel volumes are much less predictable than levels of travel for other purposes. Transit demand forecasting methods that rely on journey-to-work data inputs are generally unable to predict recreational demand with any degree of confidence. As discussed later in this appendix, estimation of recreational ridership for a Buzzards Bay extension was based on an analysis of conditions specific to its service area that would be expected to influence such travel.

Census Journey-to-Work Tabulations for Year 2000

According to the census journey-to-work tabulations for the year 2000, summarized in Table 2-2 in Chapter 2, a total of 1,507 Barnstable County residents were employed in Boston Proper, 1,215 in other parts of Boston, 273 in Cambridge, and 1,398 in communities with stations outside Boston on the Middleborough/Lakeville commuter rail line. The five Plymouth County towns in the study area (Wareham, Rochester, Carver, Marion, and Mattapoisett) originated a combined total of 568 work trips to Boston Proper, 624 to other parts of Boston, 95 to Cambridge, and 2,235 to communities with stations outside Boston on the Middleborough/Lakeville Line. Together, all of these trips would be expected to be the main potential ridership source for a Buzzards Bay commuter rail extension.

Although the number of work trips from the extension service area to communities with intermediate stations on the commuter rail line exceeded that to Boston Proper, the share of intermediate trips captured by rail would be much smaller. The majority of the intermediate destinations are beyond convenient walking distance of any station, and no transit connections are provided from the stations to most of these.

Census tabulations of work trips from the extension service area to destinations beyond Boston or Cambridge would be of limited value as a basis of predicting travel volumes to such locations via the extension. The inner terminal of the Middleborough/Lakeville Line is South Station in Boston. It is also the only station within Boston Proper that is served directly by this line. Passengers alighting at South Station and having final destinations beyond walking distance of that point must use some other form of transportation to complete their trips. The 1998 Old Colony passenger survey found that only 3.6% of riders on the Middleborough/Lakeville Line had final destinations in cities or towns beyond Boston or Cambridge. These were scattered among 24 municipalities, with the largest numbers going to communities served by the rapid transit system. However, no individual city or town accounted for as much as 0.5% of the total ridership on the line. Therefore, travel from Buzzards Bay extension stations to

points beyond Boston or Cambridge can reasonably be estimated by applying an add-on factor to the more important volumes.

Estimated Extension Share of Boston Proper Work-Trip Market at 2000 Travel Levels

This section provides a detailed analysis of the number of work trips to Boston Proper that a Buzzards Bay commuter rail extension would be expected to capture from each of the communities in its service area if total travel by all modes was at the levels shown in the year 2000 census. The results are summarized in Table 4-2 in Chapter 4. Adjustments of commuter rail volumes for year 2006 and 2020 travel levels are discussed in a later section of this appendix.

On-Line Towns

Commuter Rail Market Shares for Present On-Line Towns

The share of the Boston Proper work-trip market captured by the existing commuter rail lines varies widely among the cities and towns served. These differences can be attributed to many underlying causes, but are influenced strongly by the range of options available to residents of these communities. In general, among cities and towns with direct commuter rail service, the highest rail market shares are found where average rail travel speeds are highest, highway access to Boston is poorest, and no other direct transit alternatives are available. Commuter rail typically also attracts higher market shares as travel distance from Boston increases.

A Buzzards Bay commuter rail extension would run through the towns of Middleborough, Rochester, Wareham, and Bourne. As discussed in Chapter 3, the extension would include one station in Bourne and at least one in Wareham, but it is questionable whether there would be appropriate sites for stations in Rochester or Middleborough. Wareham and Bourne are both farther from Boston than most towns on the existing commuter rail system. Most highway trips from Wareham or Bourne to Boston are made in part via the heavily congested Southeast Expressway. These conditions would be conducive to high market share for rail service to these towns. Both towns also have well-established private-carrier express bus service to Boston, however, which would decrease the potential of rail service to attract new transit users. In the past two decades, when rail passenger service to Boston has been reestablished after an absence of several years, bus companies serving the same corridors have usually reduced their service frequency, but few routes have been eliminated completely. It is probable that some bus service to Boston from Bourne would continue to operate in competition with a rail extension. The future of bus service to Wareham is less certain, as that has already been reduced to one inbound AM peak and two outbound PM peak trips a day.

As a result of changes in confidentiality regulations, the census journey-to-work tabulations for 2000 provide much less detailed breakdowns of means of work travel between individual origin and destination pairs than was provided in earlier tabulations. Until 1990, work trips by transit were subdivided into bus, trolley, subway, rail, and ferry. In the year 2000 tabulations, transit trips were subdivided into these same categories for travel to all destinations in Boston combined, but for travel to sub-

areas, such as Boston Proper, transit trips were categorized either as bus or as “other transit,” with commuter rail included in the latter. Results of older tabulations indicate that in many cases commuter rail would account for all, or practically all, of the “other transit” trips. Nevertheless, the “other transit” share of work trips in 2000 should be considered an upper limit on the commuter rail share, rather than the value for the commuter rail share alone.

According to the 2000 journey-to-work tabulations, the highest non-bus transit share of Boston Proper work trips from any city or town with direct MBTA commuter rail service was 74%, from Mansfield. Based on the commuter rail shares of transit work trips to all of Boston in 2000 and to Boston Proper and the rest of Boston in the 1990 tabulations, the commuter rail share of all Boston Proper work trips in 2000 would have been about 70%. The Providence Line, which serves Mansfield, has the highest average train speeds of any line in the system, and parking capacity at or near Mansfield Station ranks near the top among all stations in the MBTA commuter rail system. There is currently no through bus service from Mansfield to Boston, and as far as can be determined there never has been any. Traffic on the outer segments of the most direct limited-access highway route from Attleboro to Boston generally moves at or near the posted speed limits, but the final approach to Boston is via the Southeast Expressway.

The only other municipalities with a combination of conditions as favorable to commuter rail use as those at Mansfield are Attleboro, Sharon, and Canton, all of which are also on the Providence Line. According to the 2000 census figures, non-bus transit shares of Boston Proper work trips from these origins were 68%, 70%, and 62%, respectively. Based on the commuter rail shares of transit work trips to the city of Boston as a whole in the 2000 tabulations and to Boston Proper and the rest of Boston in the 1990 tabulations, the commuter rail shares of all Boston Proper work trips in 2000 would have been about 67%, 65%, and 55%. The largest commuter rail share of Boston Proper work trips in 2000 from any city or town with direct service from a route other than the Providence Line was about 54%, from Bridgewater on the Middleborough/Lakeville Line. (Bridgewater also had very limited peak-period express bus service to Boston in 2000, but that captured only about 2% of the work trips from there to Boston Proper.)

At the opposite extreme, commuter rail attracts very low shares of Boston Proper work trips from some cities and towns with direct service. Several of the communities in fare Zones 1B, 1, and 2 had commuter rail market shares of under 5% in 1990. These included Malden, Cambridge, Chelsea, Medford, Belmont, and Lynn. Newton and Waltham each had commuter rail shares of between 5% and 7%. All of these cities and towns were served by a variety of other MBTA-operated transit alternatives, including direct rapid transit, feeder bus to rapid transit, or express bus.

There were no directly-operated MBTA bus or rapid transit services to points more than 20 miles from downtown Boston in 1990 or 2000. Cities and towns at such distances with any transit service to Boston were served either by commuter rail or by private-carrier express buses, with a few having both. Census figures indicate that in most municipalities served directly by commuter rail stations at least 25 miles from North or South Station, commuter rail captures at least 25% of total work trips to Boston Proper.

Estimated Demand From Wareham and Bourne

As discussed in Chapter 3, combining the fastest present commuter train trip on the Middleborough/Lakeville Line with the fastest estimated time on the extension would result in a time of 74.5 minutes from the old Buzzards Bay Station to South Station. Combining the longest scheduled commuter train trip with the slowest estimated time on the extension would result in a time of 83.5 minutes. The longest time would result in an end-to-end average speed of 39.2 mph. Even this would be slightly faster than the present average AM peak scheduled speed of 37.4 mph to South Station from Attleboro Station or 36.9 mph from Mansfield Station. (The average speed from a station in Wareham with the longest estimated running time would be about the same as the average from Attleboro.)

The only stop in Boston Proper for Buzzards Bay service would be South Station, but Providence Line trains all serve both South Station and Back Bay directly. A Buzzards Bay service would also have express bus competition, which Attleboro and Mansfield do not. For these reasons, the 70% commuter rail share of trips from Mansfield is assumed to represent the upper bound of the combined share of work trips to Boston Proper from Bourne and Wareham that could be captured by the commuter rail system, including a Buzzards Bay extension, if there were no bus competition. With continued bus service, 70% is assumed to represent the maximum combined rail and bus share of Boston Proper work trips from Bourne and Wareham. The 2000 census figures show express bus shares of 20% of the work trips to Boston Proper from Bourne and 26% from Wareham, but comparisons with bus ridership counts indicate that the actual totals were somewhat lower. If buses continued to capture shares of at least 10%, this would reduce the maximum commuter rail shares to 60%. The minimum rail share was assumed to be 25%, regardless of bus competition.

The 2000 census figures show a total of 204 work trips to Boston Proper from Bourne and 178 from Wareham, or a combined total of 382. (Compared with 1990, these figures show an increase of 56 from Bourne but a decrease of 107 from Wareham.) A 70% combined bus and rail share of this total would be 267 trips. At a maximum of 60%, the commuter rail share alone would be 229 trips. At a minimum of 25%, the rail share of this market would be 96. The midpoint between 96 and 229 would be 163.

Comparison of Census Tabulations with Other Data

The 2000 census figures indicate that 87 of the 382 work trips per day from Bourne or Wareham to Boston Proper were being made by bus. Both towns are served directly by a bus route to Boston from Falmouth and Woods Hole. A park-and-ride lot in the Sagamore section of Bourne is served by a bus route between Hyannis and Boston. Available ridership counts for these routes are not broken down by origin, destination, and trip purpose. Comparisons of one-day passenger counts indicate that overall peak-period ridership on the routes declined by about 15% between 2000 and 2006. If the census figures were accurate, and if the change in work trips from Bourne or Wareham to Boston Proper by bus after 2000 was similar to the overall change in bus ridership, then by 2006 the number would have dropped from 87 to about 74.

It would be expected that most journey-to-work travel by bus would take place on peak-period trips. Peak-period ridership counted in 2000 on the bus routes serving the extension service area was about 7% greater than the combined total number of work trips by bus from all towns in this area to Boston Proper alone according to the census figures. However, the ridership counts were equivalent to only 70% of the reported total work trips by bus from these towns to all of Boston and Cambridge combined. This implies that some components of the census figures were overstated.

In the 1998 Old Colony commuter rail passenger survey, the only stations with reported passenger origins from Bourne or Wareham were Middleborough/Lakeville and Kingston. The March 2006 license plate surveys at these stations indicated that a total of 105 cars parked there came from one of these towns. Based on the distributions of destinations, trip purposes, and access modes reported in 1998, the 105 parked cars meant that about 68 work trips to Boston Proper from Bourne or Wareham were made by commuter rail. This was equivalent to an 18% share of the 2000 census total figure.

Off-Line Towns

Present Commuter Rail Market Shares for Present Off-Line Towns

Commuter rail typically captures smaller shares of trips from cities and towns without stations than from those with direct service. According to the 2000 census figures, the only municipalities in Massachusetts without direct rail service and more than 10 work trips per day to Boston Proper where the non-bus transit share was at least 65% were Dighton at 77%, Holden at 67%, and Webster at 65%. Tabulations for trips to the entire city of Boston from these 3 towns show that all non-bus transit trips were made by commuter rail. None of these towns had any reported commuter rail trips in 1990, but most of the riders from them now use stations that opened after that. Holden borders directly on Worcester, where commuter rail service was reinstated in 1994. Webster does not border directly on any city or town that has rail service, but a limited-access highway runs from Webster to Worcester Station. The nearest stations to Dighton are on the Middleborough/Lakeville Line, but access to them is indirect. With a total of only 31 work trips per day from the town to Boston Proper, the commuter rail share shown in the census is imprecise. Among other non-rail towns it is difficult to discern a pattern, but in 1990 the Providence/Stoughton Line captured at least 24% of the Boston Proper work trips from each Massachusetts town in its logical service area.

The only community in Rhode Island served directly by commuter rail service to Boston is Providence. Rhode Island towns south of Providence are comparable to Cape Cod towns in terms of distance from Boston and highway access, but most have no direct bus service to Boston. Residents of these Rhode Island communities use not only the Providence station but also several stations in Massachusetts. The overall commuter rail share of Boston Proper work trips from these towns in 1990 was around 40%.

Estimated Demand From Barnstable County Towns, Excluding Bourne

Excluding Bourne, there are 14 towns in Barnstable County. The 2000 census figures show a total of 1,303 Boston Proper work trips per day from these towns, or an increase of 566 (77%) from 1990. Barnstable, Sandwich, and Falmouth were the top 3 towns in

this group in the number of Boston Proper work trips originated in both years, but they accounted for only 62% of the group total in 2000, down from 74% in 1990. Their individual totals in 2000 were Barnstable (317, or 24%), Sandwich (267, or 20%), and Falmouth (229, or 18%). These were the only Barnstable County towns individually originating more Boston Proper work trips than Bourne. The only other towns in the county with more than 50 work trips to Boston Proper were Mashpee (151, or 12%) and Yarmouth (132, or 10%). The remaining 9 towns in the county (Dennis, Brewster, Harwich, Chatham, Orleans, Eastham, Wellfleet, Truro, and Provincetown) generated a combined total of 207 Boston Proper work trips in 2000. This was an increase of 137 (196%) compared with the 70 in 1990. In general, the farther a town is from Buzzards Bay, the lower the number of Boston Proper work trips it generated. The top 5 towns were all nearer than the remaining 9.

Based on the results above from towns served indirectly by commuter rail, it is reasonable to assume that with a Buzzards Bay extension, the combined commuter rail and express bus share of work trips to Boston Proper from the 5 Barnstable County towns nearest to Bourne would be at most 65%. This would be a total of 712 of the 1,096 trips at 2000 travel levels.

Census journey-to-work figures indicate that 366 of the work trips to Boston Proper from the 5 Barnstable County towns nearest to Bourne were made by bus in 2000. However, as discussed above in the analysis for Bourne and Wareham, one-day counts in 2000 on all bus routes connecting the extension service area with Boston found peak-period total ridership equivalent to only 70% of the bus work trips from this area to all of Boston and Cambridge combined, as shown by the census. Some work trips may have been made outside of peak hours, but not all peak-period ridership would have consisted of work trips to Boston or Cambridge. Assuming that actual bus work-trip ridership from each of the towns in the extension service area was about 70% of the number indicated in the census tabulations, the estimated number of work trips by bus to Boston Proper from the 5 towns nearest Bourne would be 256. This would be a 23.3% share of the total work trips from these towns to Boston Proper by all modes.

In the 1998 Old Colony passenger survey, almost all of the passengers starting from the 5 Barnstable County towns listed above boarded at Middleborough/Lakeville or Kingston. The March 2006 license plate surveys at these stations indicated that a total of 115 cars parked there came from one of these towns. Based on the distributions of destinations, trip purposes, and access modes reported in 1998, the 115 parked cars meant that about 52 work trips to Boston Proper from the 5 towns were made by commuter rail. This was equivalent to a 5% share of the 2000 census figure.

From the calculations above, it appears that in 2000 about 23% of the 1,096 work trips to Boston Proper from Barnstable, Sandwich, Yarmouth, Falmouth, and Mashpee were made by bus. If the bus share decreased to 10% after implementation of commuter rail service, the commuter rail share of the estimated maximum 712 transit trips would be 603. At a minimum of 25% of the total work trips to Boston Proper from these 5 towns, the commuter rail share of this market would be 274. The midpoint between 274 and 603 would be 439.

For the outer 9 Barnstable County towns, the nearest bus service with schedules suitable for Boston commuting is in Barnstable. According to the 2000 census tabulations, buses carried 46 of the 207 work trips to Boston Proper from these towns. Applying the same adjustment factor used for other towns would reduce this total to 32, or 15.5%. The 2006 Sagamore passenger counts and license plate surveys results indicate that about 48 inbound AM peak riders on the Hyannis route came from these 9 towns, but they were probably not all going to work in Boston Proper.

In the 1998 Old Colony passenger survey, all of the passengers starting from the outer 9 Barnstable County towns boarded at Kingston. The March 2006 license plate surveys indicated that a total of only 6 cars parked at Kingston or Middleborough/Lakeville came from one of these towns. Based on the distribution of destinations and trip purposes reported in 1998, arrivals in these vehicles represented an estimated 2 work trips to Boston Proper. This was equivalent to a 1% share of the 2000 census figure.

The past and most likely future Buzzards Bay commuter rail station site is farther away from all of these towns than any of the stops on the Hyannis bus route, and commuter rail service would be less frequent than present bus service. Therefore, it is unlikely that commuter rail would attract a much larger market share than the buses do. At 20%, this would be 42 trips; at 10% it would be 21.

Estimated Demand from Other Towns North of Cape Cod Canal

Because of their location relative to stations on the existing Middleborough/Lakeville and Kingston/Plymouth commuter rail lines and the layout of the highway network, stations on a Buzzards Bay extension would attract riders from only a few towns outside of Barnstable County. The only towns other than Wareham itself for which access to a station in Wareham would be more convenient than that to the nearest existing stations would be Marion, Mattapoisett, Rochester, and Carver. These are all relatively small generators of Boston Proper work trips, and the utility of a Wareham station would depend largely on its location and parking capacity.

Of the 4 towns, Carver had the most Boston Proper work trips in 2000, at 171. This was an increase of 78 (84%) from 1990. Population is most heavily concentrated in the northern half of the town, and access from there to a station in Wareham would require traveling several miles in the opposite direction from Boston. License plate surveys in March 2006 indicated that by midday only 20 parked vehicles at Middleborough/Lakeville and 11 at Kingston came from Carver. License plate surveys were not done at other Old Colony stations in 2006.

Results of the 1998 Old Colony passenger survey indicate that Carver boardings then were dispersed among several stations, with Middleborough/Lakeville and Kingston together serving slightly over half of them. At the same rate, it would be expected that in 2006 there were about 58 parked vehicles from Carver at all Old Colony stations combined. In 1998, the number of work trips from Carver to Boston Proper on the Old Colony lines was equal to 76% of the number of parked cars from Carver. At the same rate, there would have been 44 work trips from Carver to Boston Proper via the Old Colony Lines in 2006. This would have been equivalent to 26% of the total

number of work trips from Carver to Boston proper by all modes combined shown in the 2000 census tabulations. For purposes of analysis, it is reasonable to assume that a Wareham station would attract at most the same number of Boston Proper work trips from Carver (44) that would otherwise be attracted from Carver to all other stations combined. This would include a combination of new riders and diversions from those stations. An assumed lower bound would be half of this, or 22 weekday trips, so the midpoint between the upper and lower bounds would be 33.

Rochester, Marion, and Mattapoisett had a combined total of 219 work trips per day to Boston Proper in the 2000 census tabulations. This was an increase of 79 (56%) from 1990. There were no reported bus trips from any of these towns. In the 1998 Old Colony passenger survey, Middleborough/Lakeville was the only station where origins from any of these towns were reported. The March 2006 license plate survey at that station indicated that 77 vehicles parked there at midday came from 1 of these 3 towns. Based on the destinations, trip purposes, and access modes of passengers from these towns reported in the 1998 survey, the drivers of these vehicles would have included about 54 making work trips to Boston Proper. This was equivalent to a 25% share of the 2000 census figure for total work trips from these towns to Boston Proper, which would be the minimum assumed for the commuter rail system with a Buzzards Bay extension. A 70% share of the 2000 total would be 153. The midpoint between 54 and 153 would be 104.

Estimated Extension Share of Work Trips to Boston Outside Boston Proper at 2000 Travel Levels

This section provides a detailed analysis of the number of work trips to Boston destinations outside Boston Proper that a Buzzards Bay commuter rail extension would be expected to capture from each of the communities in its service area if total travel by all modes was at the levels shown in the year 2000 census. The results are summarized in Table 4-2 in Chapter 4. Adjustments of commuter rail volumes for year 2006 and 2020 travel levels are discussed in a later section of this appendix.

Market Shares for Present Lines

As discussed above, the commuter rail share of work trips to Boston is much lower for destinations outside Boston Proper than for those inside. According to the 2000 census figures, the only municipality with direct commuter rail service where that mode captured over 35% of work trips to Boston destinations outside Boston Proper was Attleboro, at 39%. Shares from cities and towns served indirectly by commuter rail were also mostly below 35%. The rail shares from individual towns varied according to the locations of the destinations. The highest rail shares occurred in the neighborhoods adjoining Boston Proper.

The 1998 Old Colony survey results showed that 81% of work trips on these lines to Boston neighborhoods outside Boston Proper were destined to South Boston or Fenway/Parker Hill, with 92% going to these neighborhoods or to Charlestown, Allston/Brighton, or North Dorchester. In the 1993 commuter rail survey on South Side lines, 81% of work-trip destinations to Boston outside Boston Proper also went to South

Boston or Fenway/Parker Hill, with 96% going to these neighborhoods or to Charlestown, North Dorchester, or Allston/Brighton.

In both surveys, South Boston destinations were usually accessed either by walking or by transferring to an MBTA bus or private shuttle at South Station. Most of the private shuttles have now been replaced by the MBTA's Silver Line Waterfront service.

In addition to serving South Station, most of the South Side lines in operation in 1993 served Back Bay Station, also within Boston Proper, and some also served Ruggles Station in Roxbury. Fenway/Parker Hill destinations for most survey passengers on those lines were accessed either by walking from Ruggles Station or by transferring to the Orange Line or a bus at Back Bay. Most Old Colony passengers going to work in Fenway/Parker Hill transferred to the Red Line at South Station and transferred again to the Green Line at Park Street. A few transferred from the Red Line to the Orange Line at Downtown Crossing, and some transferred at South Station to other commuter rail lines and rode to Back Bay or Ruggles.

In 1993, most South Side passengers destined for Charlestown transferred to the Orange Line at Back Bay or Ruggles. Those riding trains that served only South Station used the Red Line as an intermediate link to the Orange Line, as did Old Colony riders in 1998.

In 1998, most Old Colony riders destined for Allston/Brighton transferred to the Red Line at South Station and transferred again to the Green Line at Park Street. In 1993, South Side riders going to Allston/Brighton had the same option, but the majority transferred instead by alighting at Back Bay Station and walking to the Green Line at Copley Station.

In 1993, most South Side passengers destined for North Dorchester transferred to the Red Line at South Station. In 1998 Old Colony riders going to North Dorchester had a choice of transferring to the Red Line at South Station, Quincy Center, or Braintree. Some Old Colony trains now also stop at JFK/UMass Station in North Dorchester. The largest source of ridership there appears to be students commuting to Boston College High School or UMass/Boston rather than work trips.

Estimated Demand from a Buzzards Bay Extension

Given the dominance of South Boston, Fenway/Parker Hill, Charlestown, Allston/Brighton, and North Dorchester as destinations for Old Colony and other commuter rail work trips to Boston outside Boston Proper, the demand estimates for the Buzzards Bay extension concentrated on trips to these neighborhoods. Because of the greater access distances to these neighborhoods than to destinations within Boston Proper, the commuter rail share would be lower. Therefore, using the same mode splits assumed for Boston Proper work trips should result in high estimates.

According to the census journey-to-work tabulations, there were 114 work trips per day to the five specified neighborhoods from Wareham and 118 from Bourne in 2000, or a total of 232. The total from these towns to all Boston neighborhoods outside Boston Proper was 358. Of the total number of work trips from these towns to the five

neighborhoods, 9% went by bus and 4% by commuter rail, according to the census figures. With a Buzzards Bay extension, a 70% commuter rail and bus share of this total would equal 162. If 5% continued to use buses, the rail share would be 151. A 25% rail share would equal 58, and the midpoint value would be 105. Assuming that this would account for 92% of the work trips to Boston outside Boston Proper from these 2 towns, add-ons to account for other destinations would range from 5 to 13, with a midpoint value of 9. These figures would result in an estimated midpoint rail share of 114 work trips out of the total of 358 to all Boston neighborhoods located outside of Boston Proper from Wareham and Bourne, or 32%. This is within the range of results from communities served directly by existing lines, though near the high end.

In 2000, the 5 Barnstable County towns nearest Bourne originated a total of 513 work trips per day to the five selected Boston neighborhoods outside Boston Proper. The total from these towns to all Boston neighborhoods outside Boston Proper was 899. Of the total to the five neighborhoods, 24% went by bus and 5% by commuter rail, according to the census tabulations. A 65% rail and bus share of this would equal 333 trips. If 12% continued to use buses, the rail share would be 272. A 25% rail share would equal 128, and the midpoint value would be 200. Assuming that this would account for 92% of the work trips to Boston outside Boston Proper from these two towns, add-ons to account for other destinations would range from 11 to 24, with a midpoint value of 18. These figures would result in an estimated midpoint rail share of 218 work trips out of the total of 899 to all of Boston outside Boston Proper from the 5 towns, or 24%. This is within the range of results from communities served indirectly by existing lines.

The other 9 Barnstable County towns originated a total of 130 work trips per day to the five specified neighborhoods. A 20% share of this would equal 26, and a 10% share would equal 13, with a midpoint of 19. Add-ons to account for other destinations would equal only 1 or 2 more riders.

Rochester, Marion, and Mattapoisett originated a total of 145 work trips per day to the five selected neighborhoods. Of these, 4% used commuter rail, but none used buses. A 70% rail share of this total would equal 102 trips. A 25% share would be 36 trips. The mid-range value would be 69. The add-on for destinations to other neighborhoods would be 3 to 8 more trips.

Carver originated 157 work trips to the five selected neighborhoods, with 6% using commuter rail, but none using buses. Assuming that the total number of trips to these neighborhoods from Carver via stations on a Buzzards Bay extension would not exceed the base-case combined total at all existing stations, this would be a total of 10.

Estimated Extension Share of Cambridge Work-Trip Market at 2000 Travel Levels

This section provides a detailed analysis of the number of work trips to Cambridge that a Buzzards Bay commuter rail extension would be expected to capture from each of the communities in its service area if total travel by all modes was at the levels shown in the year 2000 census. The results are summarized in Table 4-2 in Chapter 4. Adjustments of commuter rail volumes for year 2006 and 2020 travel levels are discussed in a later section of this appendix.

Among towns with South Side rail stations, the highest commuter rail shares of work trips to Cambridge indicated in the 2000 journey-to-work tabulations were 100% from Halifax, 75% from Kingston, and 56% from Sharon. However, no other towns served directly by South Side lines had more than 40% of their work trips to Cambridge made by commuter rail. Wareham and Bourne both had much lower work-trip orientation to Cambridge than to Boston Proper in 2000, with 28 trips per day from Wareham and 70 from Bourne to Cambridge versus 178 and 204 to Boston Proper. The Wareham total was almost unchanged from 1990. The Bourne total showed a large increase, but the 1990 reported figure there looked unreasonably low. None of the trips in 2000 were made by commuter rail. With these limited levels of total work trips to Cambridge, assumptions about rail mode splits make little difference in overall demand estimates. A 70% share of Cambridge work trips from Bourne and Wareham would equal 69 trips, a 50% share would equal 49, and a 20% share would equal 20.

Among towns served by South Side commuter rail lines in 2000 but without stations within their borders, only 3 with more than 10 work trips per day to Cambridge had commuter rail shares of greater than 40% for those trips. Shares from many towns were much lower. For purposes of analysis, it is assumed that a Buzzards Bay extension would attract between 15% and 40% of the Cambridge work trips from the off-line towns in its service area, or somewhat more than half the mode split levels assumed for Boston Proper destinations before adjusting for bus service. Census figures indicate that the express buses from the Buzzards Bay extension service area capture very few work trips to Cambridge from towns that are not served directly. Bus passengers going to Cambridge must transfer to the rapid transit system at South Station to complete their trips, and Buzzards Bay extension riders would also have to do this.

Bourne originated the greatest number of work trips per day to Cambridge of any town in Barnstable County in 2000. The 5 towns nearest Bourne (Barnstable, Falmouth, Sandwich, Mashpee, and Yarmouth) originated a combined total of 134 such trips, or 66% of the total not from Bourne. This was an increase of 65 (94%) from 1990. A 15% share of the 2000 total would be 20. A 40% share would be 54. The mid-range value would be 37. The other 9 Barnstable County towns originated a total of 69 Cambridge work trips. This was a decrease of 2.4% from 1990. At half the capture rate assumed for Boston Proper work trips from these towns, the rail share of Cambridge work trips would range from 5% to 10%. This would be between 4 and 7 trips per day, with a midpoint of 5.

The 2000 tabulations show a combined total of 40 work trips per day to Cambridge from Rochester, Marion, and Mattapoisett, but the 1990 figures did not show any. Of the 40, six were made by commuter rail but none by bus. A 40% share would be 16 trips. A 15% share would be 6. The midpoint of these values would be 11.

The 2000 tabulations show 27 work trips per day to Cambridge from Carver, versus 25 in 1990. None of the trips in 2000 were shown as being made by transit. The 1998 Old Colony survey showed only 2 work trips from Carver to Cambridge. Stations on a Buzzards Bay extension would not be likely to attract more trips from Carver to Cambridge than the combined total at other Old Colony stations.

Estimated Extension Share of Other Work-Trip Markets at 2000 Travel Levels

This section provides a detailed analysis of the number of work trips to destinations outside Boston or Cambridge that a Buzzards Bay commuter rail extension would be expected to capture from each of the communities in its service area if total travel by all modes was at the levels shown in the year 2000 census. This includes two subgroups: interzone trips, and trips to points beyond Boston or Cambridge. The results are summarized in Table 4-2 in Chapter 4. Adjustments of commuter rail volumes for year 2006 and 2020 travel levels are discussed in a later section of this appendix.

Potential Interzone Work Trips from Bourne Extension

Definition of Interzone Trips

The present MBTA commuter rail fare structure uses a zone system, with zone lengths based roughly on the distance from downtown Boston. There are currently 10 fare zones, numbered outward from Boston as 1A, 1B, and 1 through 8. Trips with either end at one of the Boston terminals or at a station in Zone 1A or 1B are classified as through trips. Trips with both ends at stations in Zone 1 or above are classified as interzone trips. On the existing Middleborough/Lakeville Line, the only station in Zone 1A is JFK/UMass and there are no stations in Zone 1B. For travel to South Station or JFK/UMass, from any other station on the line, through fares apply. For travel between any two stations south of JFK/UMass, interzone fares apply.

Interzone Markets Served

As discussed in Chapter 3, commuter rail service to Buzzards Bay would be operated by extending trains of the Middleborough/Lakeville Line, which reopened in September 1997. At present, all trains on this line stop at Middleborough/Lakeville Station, plus one station in Bridgewater, three in Brockton, one on the border of Randolph and Holbrook, and either the Braintree or Quincy Center Red Line station or both. Trips between any two of these stations are classified as interzone.

A Buzzards Bay extension itself would most likely include one station in Bourne, one or two in Wareham, and at most one in Middleborough, in addition to Middleborough/Lakeville. Because of the relatively short distance between Buzzards Bay and Wareham (5.4 miles between the most recent past downtown station sites) and the small population able to reach Buzzards Bay Station by means other than driving, interzone travel from one station to the other would be negligible. Stations at County Road or Rock Village would not be within convenient walking distance of any sizeable work, shopping, or school destinations. Therefore, this analysis concentrates on trips from stations on the extension to stations from Middleborough/Lakeville north as far as Quincy Center.

At present, there is no local bus service in Bridgewater, Middleborough, or Lakeville. MBTA buses serve Randolph and Holbrook. Currently Route 238 and one variation of Route 240 connect Randolph/Holbrook Station with points in Randolph. There are no bus connections from this station into Holbrook, but Route 230, which runs through Holbrook, terminates at Montello Station in Brockton. All three of these

are long-established routes that were modified to serve the rail stations but are used primarily for travel unrelated to the rail line. The train and bus schedules at the stations are not well coordinated, with only a few of the northbound trains making close connections with buses departing either station. Based on past experience at other stations, there would be insufficient demand at this time to justify establishing new bus routes in Bridgewater or Middleborough specifically to provide commuter rail connections to employment centers.

Brockton Area Transit (BAT) buses provide connections throughout Brockton from a transportation center adjacent to the downtown Brockton commuter rail station. BAT service operates on a “pulse” schedule, intended to facilitate transfers among routes. In weekday AM peak hours in the spring of 2006, buses left the transportation center every 20 minutes on 9 routes and every 40 minutes on 4 routes, with the latter meeting alternate trips on the former. Commuter rail arrival times at Brockton Station are constrained by the need to coordinate track use with other trains on single-track and shared segments of the route. Four northbound trains stop there in the AM peak, with intervals between them ranging from 25 to 55 minutes. Only 1 of the 4 trains provides close connections to departing buses, but it does connect with all routes. The 1998 Old Colony survey showed only 4 passengers transferring from inbound trains to BAT buses.

All four inbound AM peak Middleborough/Lakeville trains stop at Quincy Center, and passengers can transfer to the Red Line there. (One of these trains formerly also stopped at Braintree, but has not done so since April 2006.) There are also 15 MBTA local bus routes serving Quincy Center. Red Line service is sufficiently frequent during peak periods (every 6 minutes) that passengers transferring from inbound commuter rail trains do not have to be concerned with connecting with specific Red Line trips. Outbound passengers do, however, have to plan their arrivals to avoid missing commuter rail connections. Headways in 2006 varied among the bus routes, ranging from 9 to 40 minutes. Scheduled departure times were controlled by considerations that would outweigh attempted coordination with commuter rail service. In the 1998 survey, alightings from Middleborough/Lakeville trains at Quincy Center included 79 transfers to the Red Line (46%), but only 15 to MBTA buses (9%). Walk-outs accounted for 66 trips (39%), with the rest leaving in private vehicles. Of the Red Line transfers, 49 had final destinations in Quincy and the rest continued into Boston.

Because of expense, use of taxis for commuter rail access and egress is very limited, and occurs mostly on non-repetitive or infrequent trips. A few suburban employers provide van connections to commuter rail stations, but none of these serve many riders.

Interzone Demand Estimation Method

For reasons discussed above, most interzone trips ending at stations on the Middleborough/Lakeville commuter rail line would have to be completed by walking from the alighting station to the final destination. Therefore, it is reasonable to base demand estimates on potential rail share of trips to points within walking distance of stations. In the 1993 commuter rail survey, among interzone passengers walking to their final destinations, fewer than 5% reported walking times of over 20 minutes, or about one mile. In the 1998 Old Colony survey, only 5.2% of interzone walking egress trips

had reported times of over 20 minutes. These results were apparently a reflection of unwillingness of passengers to walk greater distances rather than of a lack of possible destinations more than a mile from a station. Destinations of walking egress trips by interzone passengers starting from stations on a Buzzards Bay extension would presumably also be confined mostly to areas within one mile of their alighting stations. In Quincy and Braintree, destinations within walking distance of the Braintree, Quincy Adams, Wollaston, and North Quincy stations can also be included in the potential market area for interzone trips, since the transfers required to reach them would involve relatively little delay.

At present, the only way to travel by transit from any of the towns in the assumed service area of a Buzzards Bay extension to any of the cities and towns with stations on the Middleborough/Lakeville Line is either to start by driving to another station on that line or to ride an express bus into downtown Boston and ride back out on the commuter rail line or the Red Line. Such trips would be so time-consuming that it is unlikely that any are made on a regular basis. (Census journey-to-work reports support this assumption.) In the 1998 survey, only 3% of the interzone riders on the Middleborough/Lakeville Line had trip origins in the Buzzards Bay extension service area. Even with an extension, travel would not be so convenient that it would encourage large numbers of new trips to be made. For these reasons, almost all interzone trips captured by the extension can be assumed to be diverted from automobile trips.

Trips to most destinations in the corridor are most likely to be made by driving on Route 25, I-495, and Route 24. Trips to Braintree or Quincy could also be made via Route 3. Only trips to Quincy would use the Southeast Expressway. CTPS travel-time runs conducted in 2004–2005 indicated that AM peak northbound traffic on Route 24 was generally free-flowing (60–64 mph) as far north as state Route 106 in West Bridgewater. From there north to I-93, average speeds dropped to an overall average of 28 mph in the heaviest travel hour. At most suburban work locations there is either free or low-cost parking. When considering alternatives to driving, auto commuters typically take into consideration directly variable driving expenses (mainly gasoline) rather than fully-allocated costs (including items such as vehicle insurance and financing). Under such conditions, there would be limited incentive for present automobile users to shift to commuter rail.

The 1993 commuter rail survey results showed that among commuter rail riders making through trips to the downtown Boston stations, 82% had autos available that they could have used instead. In contrast, among passengers making interzone commuter rail trips, only 40% had autos available. This implies that it is more difficult for commuter rail to attract interzone riders who have the option of driving. Interzone riders also used commuter rail less often on average, with 24% reporting use three days per week or less, 34% four days per week or less, and 66% five days per week or more. The corresponding figures for through riders were 14%, 23%, and 77%. These findings further illustrate that commuter rail is less likely to attract non-Boston trips than Boston trips.

Recent information on commuter rail interzone ridership between specific station pairs is not readily available. Ticket receipts show inner and outer station zones only. A

one-day sample of ticket receipts from commuter rail lines serving South Station in 2002 found that the number of interzone trips between any given zone pair did not exceed 30 per day in each direction. The zone pairs having the greatest numbers of trips between them included numerous possible station combinations. The number of interzone trips between any given pair of stations would have been a subset of the total number of trips between the zone pair including these stations. In order for the number of trips between any given pair of stations to have been as great as 30, there would have had to be no interzone trips between any other pair of stations in the corresponding zones.

There does not appear to be any reason to assume that residents of the service area of a Buzzards Bay extension would be more inclined to make interzone trips than residents of existing commuter rail service areas are. (A terminal at Buzzards Bay would not relieve the residents who live south of the Cape Cod Canal from having to cross either the Bourne Bridge or the Sagamore Bridge to travel to destinations in the corridor served by the Middleborough/Lakeville Line.) Therefore, for purposes of analysis it is assumed that the extension could capture only a small segment of the total travel from towns in its service area to towns along the Middleborough/Lakeville Line. A low estimate of a 10% share of this travel and a high estimate of 15% are used below.

Estimated Interzone Demand

The census journey-to-work tabulations were based on the results of surveys distributed to about 16% of all households. Each response was weighted by a factor of about six to estimate the values that would have been obtained from a 100% sample. As is the case with any such survey effort, the distribution of answers from the sample population may not have corresponded exactly with the distribution in the total population. The more finely the census figures for origins and destinations are broken down by geographic area, the less reliable the results are. Data for work trips from homes in Wareham, Bourne, and other towns in the assumed service area of a Buzzards Bay extension to work locations in communities along the Middleborough/Lakeville commuter rail line are available by town of origin to census tract and block group of destination but cannot be further subdivided with any accuracy. The year 2000 census tabulations show a combined total of 434 work trips from Wareham or Bourne to block groups within one mile of stations on the Middleborough/Lakeville Line or Red Line stations in Braintree or Quincy. A 10% share of this market for commuter rail would equal 43 trips per day. A 15% share would be 65 trips. The midpoint between these would be 54.

The main other Barnstable County sources of interzone trips to stations on the Middleborough/Lakeville Line would be Falmouth, Mashpee, Sandwich, Barnstable, and Yarmouth. The 2000 census figures show a total of 417 work trips from these towns to the same destinations examined for Wareham and Bourne. A 10% share of this market for commuter rail would equal 42 trips per day, and a 15% share would be 63 trips. The midpoint of these would be 52. The remaining Barnstable County towns originated a total of 76 trips to the destinations within the assumed interzone service area. A 15% share of this would be 11 trips, and a 10% share would be 8, with a midpoint value of 10.

The 2000 census tabulations show a total of 237 work trips from Carver to destinations within one mile of stations on the Middleborough/Lakeville Line or Red Line stations in Braintree or Quincy. This included 75 to destinations in Quincy alone. The 1998 Old Colony Survey showed 10 work trips from Carver to destinations in Quincy, equivalent to a 13% share of 75 trips. Six of these passengers boarded at Middleborough/Lakeville, and the rest at Kingston. No work trips from Carver to other destinations on either Old Colony branch were reported. For passengers starting from the northern half of Carver, where population is most concentrated, existing stations would continue to be more easily accessible than stations on a Buzzards Bay extension. Therefore, it is reasonable to assume that the number of interzone trips from Carver made via the extension would not exceed the number made via the present stations. The 2006 license plate surveys indicated that overall boardings from Carver at Middleborough/Lakeville were unchanged from 1998, but Carver boardings at Kingston declined by about half.

The 2000 census tabulations show a total of 146 work trips from Rochester, Marion, and Mattapoisett to destinations within one mile of stations on the Middleborough/Lakeville Line or Red Line stations in Braintree or Quincy. A 10% share of this market for commuter rail would equal 15 trips per day, and a 15% share would be 22 trips.

The Wareham and Bourne figures would account for 38% of the total interzone trips estimated above at the high end and 37% at the low end. These are consistent with the shares of interzone trips drawn from towns in which large park-and-ride stations are located on existing lines. The 1998 survey found that 33% of the interzone passengers boarding at Middleborough/Lakeville or Kingston began their trips in the same towns as their boarding stations. Holding the estimated number from Wareham and Bourne but using this as 33% of the total would increase the overall total by 26 at the high end and 14 at the low end.

Potential Work Trips to Points Beyond Boston or Cambridge

The 1993 commuter rail survey found that 98.1% of the work trip destinations on South Side commuter rail lines then in operation were in either Boston or Cambridge. Another 0.6% consisted either of interzone trips specific to individual lines, or of trips to Braintree or Quincy. The remaining 1.3% of work trips were to destinations reached by transferring from commuter rail to other modes in Boston. In the 1998 Old Colony survey, work trip destinations not in Boston or Cambridge reached by traveling through Boston accounted for 1.8% of all home-to-work trips on the two lines combined.

Demand Estimation Method and Potential Demand

To estimate demand for work trips to points beyond Boston or Cambridge from a Buzzards Bay extension, it was assumed that such trips would represent 1.8% of all work trips from the extension. This was equivalent to 1.83% of the combined total work trips to destinations within Boston, Cambridge, or intermediate locations along the Middleborough/Lakeville Line. Work trips to Boston, Cambridge, and intermediate points were estimated first, as described above, and then multiplied by 1.83% to calculate trips through Boston.

After adjusting for express bus service ridership, the demand estimates above for a Buzzards Bay extension range from 895 to 1,995 work trips per day to Boston, Cambridge, or intermediate destinations. The midpoint value of these estimates would be 1,450. Multiplying these values by 1.83% to estimate work trips to points beyond Boston or Cambridge yields results of 16 at the low end and 37 at the high end, with a midpoint value of 26.

Estimated Extension Share of Non-Work Trips at Year 2000 Travel Levels

Little information is available on origins and destinations of travel for purposes other than commuting between home and work. Therefore, for commuter rail demand forecasts it is necessary to estimate volumes of non-work ridership on the basis of typical ratios of non-work trips to work trips via this mode. The results of such estimates for a Buzzards Bay extension, using the ratios described below, are summarized in Table 4-2. Lacking more precise information, the same ratios of non-work trips to work trips were applied to all origin towns in the extension service area. In reality, the ratio would be expected to vary somewhat among towns. Therefore, the estimated total of non-work trips from the extension service area as a whole is likely to be more accurate than the estimates for individual origin towns.

The 1993 commuter rail survey found that home-to-work trips accounted for 86% of all inbound ridership. On seven of the nine system routes, including all of those serving South Station, home-to-work trips ranged from 84% to 90% of all trips. The 1998 Old Colony survey yielded similar results, with 80.7% of the trips on the Middleborough/Lakeville Line and 84.8% of those on the Kingston/Plymouth Line going from home to work.

In the preceding sections of this appendix, estimates of home-to-work trips to all destinations total 912 for the minimum mode-split case, 2,033 for the maximum case, and 1,479 for the midpoint. A minimum value for ridership by all trip purposes is obtained by assuming that 912 home-to-work trips would represent 90% of all trips. This would make the total 1,013. A maximum value for ridership by all trip purposes is obtained by assuming that 2,033 home-to-work trips would represent 80.7% of all trips. This would make the total 2,520. The average of these high and low estimates would be 1,766.

Return halves of reverse-commuting trips, in other words, work-to-home trips, are among the components of the difference between total trips for all purposes and home-to-work trips only, discussed in the preceding paragraph. Therefore, unless there is reason to believe that reverse-commuting would account for a significantly higher percentage of ridership on a Buzzards Bay extension than on the existing MBTA commuter rail system, it is unnecessary to estimate reverse-commuting ridership separately for the extension.

On the Middleborough/Lakeville Line, the 18.3% of inbound riders not going from home to work in the 1998 survey included 1.9% going from work to home. In the 1993 commuter rail system survey, the overall average percentage of reverse commuters on lines then in operation was 2.5%. The highest percentage of reverse-commuting trips on any line was 6.7%, on the Fitchburg Line. This was mostly because of several office

parks and a university within a short walk of Brandeis/Roberts Station. On the Lowell Line, 5.0% of ridership was reverse commuters, mostly as a result of several employer-sponsored shuttles then running from Mishawum Station. Factors that would impact reverse-commuting on a Buzzards Bay extension are discussed in greater detail in Appendix C.

Estimated Changes in Travel Patterns from 2000 to 2006 and to 2020

Preceding sections of this appendix describe the steps that were used in estimating the mid-range value of 1,766 inbound weekday trips on a Buzzards Bay commuter rail extension using overall travel volumes at year 2000 levels. Trip origins by town are summarized in Table 4-1, with additional details in Table 4-2. This section discusses the methods used to adjust the year 2000 demand estimates to the totals, shown in Table 4-1, of 2,045 at year 2006 travel levels and 2,750 in the year 2020.

It should be noted that the demand estimation methods discussed above assume that all trips originating in all of the study-area towns except Carver that are now made on existing commuter rail lines would be diverted to the extension. These diverted trips are included in the totals above. Results of March 2006 license plate surveys indicated that approximately 190 vehicles parked at Middleborough/Lakeville Station and 115 parked at Kingston Station by noon, or a combined total of 305, had brought riders from communities in the extension service area other than Carver. With allowances for carpool passengers, drop-offs, and arrivals after noon, an estimated 365 total inbound current commuter rail trips would be diverted to the extension. Subtracting these from the estimated 2,045 riders in 2006 would reduce the number of new commuter rail riders to 1,680. This would include 1,495 new through and 185 new interzone commuter rail riders. Deducting riders diverted from private carrier buses reduces the total number of new transit users at 2006 travel levels to about 1,335.

As discussed above, work trips to Boston would account for the largest portion by far of ridership on a Bourne commuter rail extension. Therefore, in estimating ridership in future years, it is most important to examine changes in work travel. The most comprehensive information on work trips is that provided by the U.S. census journey-to-work survey. In the past, this was conducted in conjunction with the regular decennial census, so the most recent figures available are from 2000. Some changes in travel patterns would be expected in the six years since these figures were collected, and institution of commuter rail service implies a relatively long-term investment in fixed facilities. Thus, it is important to try to update the 2000 figures both to the present and to various future years.

Adjustment from 2000 to 2006

Census Bureau Population Projections

Between census years, the U.S. Census Bureau prepares population estimates for states, counties, and municipalities at one-year intervals. Town-level figures are based largely on a sampling of information contained in income-tax returns. The estimation process takes considerable time to complete. The most recent estimates are for population as of July 1, 2004, and these were released in the fall of 2005.

According to the census estimates, most of the towns that would be served by a Bourne extension had fairly small population increases between 2000 and 2004, with average gains of 2.9%. In Barnstable County, the only towns with estimated increases of more than 3.5% were Bourne, at 4.2%, and Mashpee, at 10.5%. Among the five Plymouth County towns that would be served by the extension, the average estimated population gain was 4.7%. The only individual gain above 4.5% was for Rochester, at 13.6%.

Although changes in total population provide some indication of likely changes in travel, work trips are generated at different rates by different age groups. For example, residents under age 20 are most likely to be students. Those among them who are employed are more likely to work close to home than at locations requiring long commuting trips. In the 1998 Old Colony survey, none of the passengers boarding at Middleborough/Lakeville or Kingston to make home-to-work trips were under age 18, and only 5% were ages 18 to 24. Residents age 65 or over are more likely to be retired than commuting to work. Among passengers making home-to-work trips from Middleborough/Lakeville or Kingston, only 2% in the survey were over age 65.

MISER Population Projections

For purposes of estimating changes in work trips, population projections formerly produced by the Massachusetts Institute for Social and Economic Research (MISER) are more useful than the census estimates. The final set of MISER projections was issued in 2003, and included projections of population for each town in Massachusetts for the years 2010 and 2020. These took into account many variables, including birth, death, and net migration rates. Furthermore, these projections were separated by five-year age groups, from 0 to 89, with one group for age 90 and above. Past MISER projections for Massachusetts were found to have been more accurate than census projections when the projection years were reached, with census projections being more likely to underestimate population. Therefore, MISER projections are used in the present Buzzards Bay extension analysis.

The MISER projections included a range of estimates of population changes for each town, with a "Middle" series being generated first, followed by a "Low" series and a "High" series under modified assumptions about changes in the input variables. The Middle series results have been used as the basis for this study. All of the MISER projections were done only for 10-year intervals, so it was assumed that approximately 60% of changes between 2000 and 2010 would have occurred between 2000 and 2006. (For the amount of 10-year population growth projected in the groups of interest, the difference between assuming uniform absolute growth and uniform percentage growth from year to year is insignificant.)

Overall, the MISER estimates indicate much greater population growth in study-area towns than indicated by the census estimates. From 2000 to 2006, the interpolated MISER figures indicate an overall population growth of 9.6% for Barnstable County as a whole. The projected increase of residents between the ages of 20 and 64 (those most likely to be commuters) is even higher, at 12.0%. For the town of Bourne alone, the overall projected increase is also 9.6%, but in the 20 to 64 age group, the projected increase is only slightly greater than this, at 9.9%.

For the 5 Barnstable County towns nearest Bourne (Falmouth, Sandwich, Mashpee, Barnstable, and Yarmouth), the projected total population growth is 11.2% from 2000 to 2006, with a gain of 13.5% in the 20 to 64 age group. For the remaining 9 towns in the county, the projected gain is only 6.2% overall, but 9.3% for ages 20 to 64.

For Wareham, the only town outside Barnstable County that would be certain to have a station on a Buzzards Bay extension, total population is estimated to have increased by only 2.1% overall from 2000 to 2006, with a gain of 4.9% in the 20 to 64 age group. For the four towns that would be served indirectly by a station in Wareham, the overall estimated population increase is 5.4%, with 7.6% in the 20 to 64 age group.

Changes in Trip-Making Rates

Percentage changes in the number of residents of a town potentially in the labor force would not necessarily be the same as percentage changes in the number of residents employed in Boston or Cambridge. Comparisons of journey-to-work and population data for 1990 and 2000 show that for the majority of towns in the study area, the ratio of Boston and Cambridge workers to residents between ages 20 and 64 was greater in 2000 than in 1990. For Barnstable County as a whole, this ratio increased from 2.10% to 2.46%, or an average gain of 0.036% per year. With the same average rate of increase, it would be expected that by 2006 the share would have grown to 2.68%, or 1.09 times as great as the share in 2000.

For purposes of analysis, estimates were first made of commuter rail ridership on a Buzzards Bay extension at year 2000 travel levels, using methods discussed in previous sections of this appendix. These estimates were then multiplied by the ratio of estimated population between ages 20 and 64 in 2006 to actual population in this range in 2000. The estimates were further multiplied by the projected change in proportion of residents in this age range working in Boston or Cambridge. Because of the relatively small percentages of residents in each study area town employed in Boston Proper, other sections of Boston, or Cambridge in 1990 and 2000, composite adjustment factors for all of Boston and Cambridge combined were applied for each town.

Changes in Total Employment in Boston and Cambridge

Changes from year to year in the number of work trips to Boston or Cambridge from a given town might be expected to be influenced by the total number of jobs in Boston and Cambridge. However, changes in distribution of trip origins for reasons that cannot be identified from the data available for this analysis outweigh any effects of employment changes. In general, the farther a municipality is from Boston or Cambridge, the smaller the percentage of its residents employed in those two cities is. Nevertheless, differences in housing supply, transportation facilities, and other amenities can result in differences in proportions of Boston and Cambridge workers among municipalities at similar distances.

Employment figures by town of residence are not broken down by age group, but as discussed above, the majority of commuters would be expected to be drawn from the population in the age range of 20 to 64. Comparisons of journey-to-work figures from the 2000 census with MISER population figures by age group for that year for all 351

cities and towns in Massachusetts show that the only municipalities in which the number of residents employed in Boston or Cambridge was equivalent to more than half the residents aged 20 to 64 were Cambridge (54.9%) and Boston (52.1%). Another 22 cities and towns (6.3% of all Massachusetts municipalities) had the equivalent of between 25% and 50% of residents aged 20 to 64 employed in Boston or Cambridge. These were all within metropolitan Boston and were within or on state Route 128 or the part of I-93 that was formerly part of Route 128. At the opposite extreme, the majority of cities and towns (258 or 73.5%) had the equivalent of under 10% of their residents aged 20 to 64 employed in Boston or Cambridge, including 26.5% (93) with no reported work trips to either of those cities.

Between 1990 and 2000, total employment in Boston and Cambridge increased by 5.3% according to the census figures. This was slightly lower than the increase in the total population of Massachusetts in the same time span (5.5%), but somewhat greater than the increase in the number of residents aged 20 to 64 (4.5%). However, there was great variation among cities and towns in the rates of change of the number of their residents employed in Boston or Cambridge. Boston itself showed a decrease of 2.0% in the number of residents employed there or in Cambridge despite the increase in total jobs, while Cambridge showed a gain of 7.8%.

Overall, of the 351 cities and towns, 210 (59.8%) had more of their residents employed in Boston or Cambridge in 2000 than in 1990. This included 8 (2.3%) that had no reported Boston or Cambridge workers in 1990. For the latter group, the absolute numbers of residents shown as employed in Boston or Cambridge in the year 2000 ranged from 4 to 40, with an average of 11.6. A total of 51 cities and towns (14.5%) showed no change in the number of residents employed in Boston or Cambridge, but 50 of these showed none in either year. The other 90 cities and towns (25.6%) each had fewer residents employed in Boston or Cambridge in 1990 than in 2000. This included 43 (12.3%) that had some reported Boston or Cambridge workers in 1990, but none in 2000. Absolute declines in the latter group ranged from 2 to 33, with an average of 9.1.

For almost half of the all the cities and towns (171, or 48.7%), percentage increases in the number of residents employed in Boston or Cambridge were more than twice the 5.3% increase in total Boston and Cambridge employment. This was true of 14 of the 20 towns in the assumed service area of a Buzzards Bay extension, in Barnstable and Plymouth counties.

Based on these findings, it was concluded that projected changes in total Boston and Cambridge employment would not be useful in predicting changes in work trips to these cities from the extension service area.

Projected Future Demand

The work program for this study calls for estimation of demand in the year 2025 as well as for the present year. The CTPS regional model provides forecasts for the year 2025 within the model area, but as noted earlier in this report, the service area of a Buzzards Bay extension would be outside of the area covered in the model. This necessitated the use of a manual method for demand forecasts. The MISER population projections extend only to the year 2020, and are not being expanded further. Hence,

demand projections beyond the year 2020 would require further extrapolation of estimates for that year. For that reason, projections in this report are carried out only as far as the year 2020.

The method used to project demand for the year 2020 was similar to that described above to update the year 2000 estimates to 2006. For each city and town, the estimate of ridership on an extension at year 2000 travel levels was multiplied by the ratio of projected population in the age range 20 to 64 in 2020 to the actual population in this range in 2000. This number was then multiplied by a factor equal to 20 times the average annual increase in percent of residents in this age range employed in Boston or Cambridge between 1990 and 2000. For reasons discussed above, this method does not take into consideration future changes in total employment in Boston and Cambridge.

Estimated Ridership for Alternate Weekday Service Strategies

Chapter 3 and 7 of this report include discussions of three alternative weekday service strategies for a Buzzards Bay commuter rail extension. The ridership estimates in the preceding sections of this appendix are based on the mode shares that would be expected under the maximum service strategy. This would extend all present weekday trips on the Middleborough/Lakeville Line to Buzzards Bay. An extension with less frequent service would be expected to attract fewer riders. At present, all routes in the MBTA commuter rail system have all-day service, so there are no examples of mode shares with service levels comparable to the minimum and medium service levels considered for Buzzards Bay. Therefore, it was necessary to estimate ridership for the reduced service levels by making adjustments to the full-service estimates.

Estimated Ridership under Minimum Service Strategy

Under the minimum service strategy, as described in Chapter 7, the first 4 trains of the day (currently due in Boston at 6:20, 6:57, 7:52, and 8:16 AM), and the last train, due at 10:20 PM, would be the only inbound trips extended to Buzzards Bay. The only outbound trains extended would be the last five trips, now leaving Boston at 5:15, 5:55, 6:45, 8:10, and 10:30 PM. One approach to estimating demand at this level of service is to first assume that extension ridership at the maximum service level would be distributed among trains in the same proportions as ridership on present Middleborough/Lakeville trains without the extension. It is then further assumed that for any service level below the maximum, the trains that would still be extended would carry the same number of extension riders that they would have under the maximum service level, but that all extension riders that would have been allocated to trains that would not be extended at the reduced level would be lost.

In reality, it would be expected that some riders whose first-choice trains would not be extended would shift to other trips. Counteracting this, reduced flexibility in arrival and departure times would result in loss of some riders who would usually choose to use the trains that would be extended, but would like the option of traveling at different times. Potential riders would take into consideration both inbound and outbound schedules. Those for whom the schedule in one direction would be convenient but the schedule in the other would not be would be less likely to use the service at all.

Passenger counts taken by CTPS in 1999 and 2000 showed that the inbound trains that would be extended to Buzzards Bay under the minimum service configuration carried 76% of the inbound daily riders on the Middleborough/Lakeville Line. However, the outbound trains that would be extended carried only 57% of the outbound daily riders on the line. Under the demand estimation method described above, it would be assumed that ridership at the minimum service level would be only 57% as great as that under the maximum level. As shown in Table 4-1, the mid-range ridership estimate for an extension with full service at 2006 travel levels is 2,045 inbound riders per day. At each service level, outbound ridership is assumed to be the same as inbound ridership. With a reduction to 57% of the maximum, the mid-range value for minimum service in 2006 would be 1,165 riders each way per day.

Estimated Ridership under Medium Service Strategy

The medium service level would include extension of all of the trips extended under the minimum alternative. In addition to these, inbound trips now due in Boston at 12:04, 1:56, and 4:21 PM and outbound trips departing at 9:57 and 11:55 AM and at 2:15 PM would be extended. For purposes of re-positioning equipment, it would also be necessary to add a new outbound trip leaving Boston at about 9:12 AM, and a new inbound trip arriving at about 5:08 PM. With assumptions similar to those used for the minimum service strategy, medium service would be expected to increase ridership only slightly, to 65% of the maximum-service level. For the 2006 mid-range level, this would mean about 1,330 riders each way per day.

APPENDIX C – FURTHER ANALYSIS OF REVERSE COMMUTING AND SUMMER RECREATIONAL DEMAND POTENTIAL

Reverse-Commuting Potential

At present, the MBTA commuter rail system is used predominantly for trips to work locations in Boston or Cambridge from homes in outlying areas. However, it is also used, to a limited extent, for reverse commuting from homes in the urban core to suburban employment locations. In recent years there has been growing interest from some suburban municipal officials and employers in promoting use of the system for such trips.

The ability of a Buzzards Bay commuter rail extension to attract reverse commuters would depend on several factors, including the number of urban core residents employed in locations served by stations on the extension, availability of connecting service from the stations to work locations beyond convenient walking distance, and compatibility of train schedules with work schedules.

At most outlying stations on the commuter rail system, the most common means of access for trips beginning at home are driving or being dropped off. Reverse commuters generally do not leave cars parked overnight at suburban stations for completing trips to and from work locations. Some employers provide private pick-up and drop-off services at transit stations, but the number doing so is generally small compared with the total number of employment locations.

Scheduling Considerations

For purposes of analysis in Chapter 3, it was assumed that most of the service on a Buzzards Bay extension would be provided by extending existing trips on the Middleborough/Lakeville commuter rail line. In the spring of 2006, as had been the case for many years, the first outbound morning train on this line left South Station in Boston at 6:36 AM, and was due at the outer terminal at 7:50. If this trip was extended through to Buzzards Bay, it would arrive there at about 8:15. With private shuttle connections or fixed-route service scheduled for close connections, this would allow reverse commuters to reach work locations in Wareham, Bourne, and several nearby towns in time for 9:00 AM work shifts. However, this would be the only train most reverse commuters could use. The second train on the Middleborough/Lakeville Line leaves South Station at 8:23 AM and is due at Middleborough at 9:20. If extended to Buzzards Bay, it would not arrive there until about 9:45.

In the spring of 2006 there were two inbound PM peak departures from Middleborough/Lakeville, at 4:55 and 6:03. The next trip was not until 9:25 PM. If these trips originated at Buzzards Bay, they would have to leave there at about 4:30, 5:40, and 9:00 PM. A 4:30 PM departure would be too early for most commuters who worked eight-hour shifts after taking an outbound train arriving at Buzzards Bay at 8:15 AM, and a 9:00 departure would be much too late, but a 5:40 departure would be compatible with such shifts. It should be noted that on the present commuter rail system, lines that

have the highest ratios of reverse commuters to total riders have at least two outbound AM peak trips and at least two inbound PM peak trips.

Travel Volumes

Towns that would be served directly by a Buzzards Bay extension are not major sources of employment for residents of the Boston urban core. This is partly because of limited total employment in these towns and partly because of the relatively long travel times and distances. The 2000 census journey-to-work tabulations show a total of only 25 work trips to Wareham from Boston Proper, 9 from the rest of Boston, and none from Cambridge. To Bourne, the totals from these origins were 3, 7, and 0. Towns that would be served indirectly by an extension also showed low total numbers of work trips from the urban core. To all of Barnstable County other than Bourne, the total was 31 from Boston Proper, 171 from the rest of Boston, and 33 from Cambridge. The majority of the destinations from Boston outside Boston Proper were in towns east of Barnstable. Present bus service to these towns is not scheduled for work travel either to or from Boston, implying that potential ridership is insufficient to attract private carriers.

Several of the cities and towns other than Boston with stations on the Middleborough/Lakeville Line originate more work trips to destinations in the Buzzards Bay extension area than Boston does. Most of these trips are made by driving alone or carpooling, as there are no direct transit alternatives. (A few suburb-to-suburb commuters start by traveling inbound to Boston by commuter rail or rapid transit and transferring to outbound express buses.) Of work trips from municipalities with stations on the Middleborough/Lakeville Line to those that would have stations on a Buzzards Bay extension, the largest origin-destination pair in 2000 was Brockton to Wareham, at 119, followed by Middleborough to Wareham, at 106, and Lakeville to Wareham, at 90. Brockton and Wareham both have local bus networks that could provide the commuter rail line with connections to and from points beyond walking distance of stations. Middleborough and Lakeville do not currently have local bus service. Most of the homes in Lakeville and many of those in Middleborough are located farther south than Middleborough/Lakeville Station, so use of commuter rail to travel from these homes to destinations in Wareham or Barnstable County would require starting out in the opposite direction. Overall, 5.9% of the jobs in Wareham were held by residents of communities with stations on the Middleborough/Lakeville Line.

Middleborough originated the largest number of work trips to Bourne of any community on the Middleborough/Lakeville Line, with 46, followed by Bridgewater, at 34, but Brockton sent only 9 workers to Bourne. Bridgewater Station currently has no bus connections. Overall, 2.1% of the jobs in Bourne and 0.7% of those in the rest of Barnstable County were held by residents of communities with stations on the Middleborough/Lakeville Line.

The year 2000 mid-range estimate of 1,766 inbound daily riders on a Buzzards Bay extension includes an implicit allowance of about 1.5%, or 26 trips, for the work-to-home segments of reverse-commuting trips. These are part of the difference between total ridership and home-to-work ridership, discussed in Appendix B. Coincidentally, 26 trips would also equal about a 1.5% share of the reverse-commuting trips by all modes from homes in Boston, Cambridge, or communities on the Middleborough/

Lakeville Line to work locations in the assumed service area of a Buzzards Bay extension. Given the limited amount of train service feasible at times suitable for reverse commuting, and the need to provide connecting service from extension stations to most of the work locations, this is probably a reasonable estimate. At the maximum proportion of 7% reverse-commuting trips observed on any existing MBTA commuter rail line, a Buzzards Bay extension would still have only about 100 more reverse commuters than the number it would have if only 1.5% of its riders were reverse commuters.

Summer Recreational Demand Potential

In Appendix B, the add-on factor for non-work trips implicitly includes some recreational travel. However, for a route serving an area such as Cape Cod that is a major destination for summer vacation travel, the potential rail share of such travel must be examined separately.

General Factors Affecting Recreational Travel Demand

Recreational travel volumes are much less predictable than levels of travel for other purposes. The individuals making recreational trips can be expected to differ from day to day, and the origins and destinations of those traveling on any selected day can differ substantially from those traveling on other days. The total number of recreational travelers on a particular transit line on a given day is influenced by factors such as weather, special events in locations that can be accessed by that transit line, and competition from attractions at locations not served by that line.

Factors Affecting Cape Cod Recreational Travel Demand at Origin End

A 1979 study conducted for the MBTA estimated that at most 25% of the summer traffic to Cape Cod originated within greater Boston inside Route 128. The study did not include estimates of volumes from individual municipalities. Much of the traffic from suburban origins in this group would go around, rather than through, Boston on the way to the Cape. The same study estimated that 40% of the traffic going to the Cape originated on the South Shore, but again did not provide breakdowns by individual municipality.

The only boarding location for Buzzards Bay trains in downtown Boston would be South Station. It is possible to get there by transit from most points in greater Boston, but in many cases this requires intermediate transfers. From points south of Boston, access to South Station requires traveling in the opposite direction from Cape Cod. With present scheduling practices, the first station outside downtown Boston that would be served by all Buzzards Bay trains would be Quincy Center, which is accessible via the Red Line and via a large network of bus routes serving other sections of Quincy and several nearby towns. Red Line stations in Quincy and Braintree have large parking facilities, but CTPS observations in the fall of 2005 found that only those at Quincy Center and Quincy Adams had significant numbers of spaces available after 9:00 AM.

Except for Brockton, the existing stations south of Quincy Center on a Buzzards Bay route have little or no connecting transit service. All of them have park-and-ride lots,

and all of the lots had substantial capacity remaining after 9:00 AM in the fall 2005 inventory. However, only Middleborough/Lakeville Station is close to an interchange on one of the main highway routes to the Cape. It is unlikely that many greater Boston residents heading for the Cape would drive as far as Middleborough/Lakeville, park there, and continue on trains that would not get them close to their final destinations.

Travel from South Shore origins to Cape Cod points now takes place mostly via state Route 3 or via Route 24, I-495, and Route 25. Because of the layout of the feeder roads connecting with these highways, the latter combination would be expected to be used mostly for trips starting in cities and towns with stations on the Middleborough/Lakeville Line or others immediately bordering these. For many of these trips, the distance to one of the commuter rail stations would be less than that to an interchange on the main highway, and in some cases the highway access routes run directly past a rail station. However, lack of direct connections to most final destinations would still put rail service at a disadvantage compared with driving.

Factors Affecting Cape Cod Recreational Travel Demand at Destination End

Among day-trippers to Cape Cod, it would be expected that a large proportion are destined for public beaches. There are dozens of these scattered among towns throughout the Cape, but none are within reasonable walking distance of the Buzzards Bay station site. The nearest one that attracts a large number of out-of-town users is Scussett Beach State Reservation, about seven miles away. A connecting bus service from Buzzards Bay to this beach could be fairly direct, running on U.S. Route 6 much of the way, but traffic congestion could have a serious impact on schedule reliability. It should be noted that the entrance to the beach access road is close to the Sagamore park-and-ride lot, which has frequent all-day express bus service to and from Boston. The distance from there to the beach itself is about two miles. Demand for connections to most other individual beaches would probably be insufficient to support dedicated bus routes from a commuter rail terminal, but their locations are not conducive to the operation of fixed-route buses serving multiple destinations. Most of the businesses located within walking distance of the Buzzards Bay station are not tourist-oriented, and there are no hotels in the vicinity.

Analogy to Other Rail-to-Bus Recreational Service

Connecting bus routes from Buzzards Bay to beaches or other tourist attractions on Cape Cod would have similarities to a shuttle bus service, called the Ipswich Explorer, that was implemented in the summer of 2005 in the North Shore towns of Ipswich and Essex. The Explorer consisted of three routes radiating from Ipswich Station, which is on the MBTA's Newburyport commuter rail line. It was partially funded through the Boston Region MPO's Suburban Mobility Funding Program, and operated only on weekend days and holidays for 11 weeks, from June 25 to Labor Day. The main route offered 13 round-trips a day between the station and Crane Beach, including 2 outbound trips making close connections with trains from Boston and 3 inbound trips with close connections to Boston.

The second route offered 4 round-trips a day between the station and a canoe rental service on the Ipswich River, with service on request to a nearby state park. The third

route had 3 round-trips per day between the station and Essex Center, which has numerous tourist-oriented shops and restaurants.

Over the course of the 2005 season, ridership on the entire three-route system averaged 123 passenger-boardings per day, with peaks of 521 on July 3 and 345 on the inaugural day. Excluding these, the average was 100 per day. Presumably, a large proportion of the riders made round-trips and accounted for more than one boarding each. At an average of 2.0 boardings per individual, the average number of people served per day, excluding the two unusually heavy ridership days, would have been 50. Onboard passenger surveys taken during August and September 2005 showed that 94% of the riders used the service to go to Crane Beach, but about 15% went to more than one attraction. About 35 passengers per day arrived in Ipswich by train and transferred to the Explorer buses. Of these, 39% were residents of the city of Boston, and 24% were residents of Cambridge, with the other 37% residing elsewhere in metropolitan Boston.

The distribution of passenger origins found in the Ipswich bus survey suggests that a Buzzards Bay train with connecting bus service to a beach would also appeal predominantly to metropolitan Boston residents. Ipswich is much closer to Boston than Buzzards Bay is. The scheduled train time from North Station in Boston to Ipswich Station on weekends is 49 to 50 minutes, compared with estimated times of at least 74 minutes from South Station to Buzzards Bay. For beachgoers who would have to begin their trips by traveling into downtown Boston to catch trains, shorter train trips would probably be more appealing than longer ones. This suggests that Buzzards Bay service would not attract a greater number of recreational trips than the Ipswich service did.

Because the Ipswich Explorer operated only on weekends and holidays, the results do not show what level of ridership could be expected for weekday service. Also, the results are only for the first season of operation, which might not reflect long-term ridership potential.

Previous Recreational Rail Service from the Boston Area to Cape Cod

During summers from 1984 to 1988, rail passenger service oriented toward recreational travel was operated between the Braintree Red Line rapid transit terminal and Hyannis by a private company under contract with the state. This operation preceded the restoration of year-round passenger service on the Middleborough/Lakeville Line, and it was not possible then to operate commuter rail trains the rest of the way from Braintree to Boston. Information available on the ridership patterns on this summer service is limited, but may provide some indication of patterns that might be anticipated on future service.

During the final year of service in 1988, the operating season ran from Memorial Day weekend to October 23. During the peak season, from June 21 to Labor Day, 4 round-trips were run between Hyannis and Braintree on Tuesdays through Thursdays, 3 on Sundays, Mondays, and Fridays, and 2 on Saturdays. Intermediate stops were made at West Barnstable, Sandwich, Buzzards Bay, Wareham, Middleborough, Bridgewater, Brockton, and Holbrook/Randolph. At Buzzards Bay, each inbound train made close connections with a train from Falmouth, and each outbound train had a close connection with a train to Falmouth. (On some days of the week, certain trips ran

between Braintree and Falmouth instead of Hyannis and connected with separate Buzzards Bay–Hyannis trains.) South of Buzzards Bay, the Falmouth trains made one intermediate stop, at Cataumet. All but the first inbound and last outbound trip of the day had dedicated bus connections between Falmouth and the Steamship Authority terminal at Woods Hole.

Ridership figures reported to the then Executive Office of Transportation and Construction showed that the Braintree–Cape Cod service carried an average of about 230 riders each way per day in July and 300 in August 1988. About 90 of these riders in July and about 105 in August had outer endpoints on the Falmouth line, with an estimated 85% of these transferring to or from shuttle buses to the Steamship Authority terminal at Woods Hole. For the other 140 riders each way in July and 195 in August, outer-end boarding or alighting points were on the Hyannis line, or at Buzzards Bay.

This service was less convenient than through service to Boston would have been, because of the required Red Line transfer at Braintree. Maximum train speeds were slower than assumed for a future combination of the Middleborough/Lakeville commuter rail line and a Buzzards Bay extension. The 1988 service did, however, provide rail service to five stations in Barnstable County in addition to Buzzards Bay, and offered shuttle bus connections to Woods Hole.

Some additional information on the distribution of riders along this route is provided by a one-day CTPS observation of operations in the first season of operation in 1984. At that time, weekday Braintree service included one round-trip from Buzzards Bay scheduled for Boston commuting, and one round-trip from Braintree to Hyannis with Falmouth line connections. The latter service was scheduled to leave Braintree at 9:00 AM and arrive back at 6:00 PM. On the day this service was observed, the outbound train carried 118 riders to points south of Middleborough, and the inbound train returned 89 from the same points.

Of the 118 outbound riders, 80 (68%) boarded at Braintree. This included an out-of-state charter bus group of 23 going to Martha's Vineyard via Falmouth. Excluding this group, Braintree boardings accounted for 50 of the 97 riders (60%). It was not determined how many of these transferred from the Red Line. The distribution of remaining boardings was: 9 (9.5%) at Holbrook/Randolph, 17 (17.9%) at Brockton, and 6 (6.3%) each at Bridgewater and Middleborough. The latter two stations were in different locations than those of the present commuter rail stations, and none of the four had dedicated parking facilities.

Observations of alightings, other than by the tour group, were not linked with boarding points. Of the 95 riders not in the tour group, 10 (10.5%) alighted at Wareham and 7 (7.4%) transferred to the Falmouth train, but none had final destinations at Buzzards Bay. The other 78 (82.1%) continued to Sandwich, West Barnstable, or Hyannis. Those going to the Falmouth line included 1 each alighting at Monument Beach, Pocasset, and Cataumet and 4 to Falmouth. None of the latter transferred to the Woods Hole bus.

Of the 89 passengers on the return trip to Braintree, 7 (7.9%) started from the Falmouth line, including 4 from Falmouth, 1 from Pocasset, and 2 from Monument

Beach. This trip did not have a Woods Hole bus connection. Stations on the Hyannis line accounted for 72 riders (80.9%), Buzzards Bay for 2 (2.2%), and Wareham for 8 (9.0%).

Of the 89 passengers, 49 (55.1%) went to Braintree, including at least 21 (23.6%) who left the station either on foot or in vehicles that had been parked there. Therefore, at most 28 (31.5%) transferred to the Red Line. Some of the latter may have had final destinations before Boston. The rest were distributed as follows: 6 (6.7%) at Middleborough, 4 (4.5%) at Bridgewater, 26 (29.2%) at Brockton, and 2 (2.2%) at Holbrook. (The 2 passengers who boarded at Buzzards Bay remained on the train at Braintree to ride the outbound evening commuter trip.)

These figures imply that given a choice of boarding and alighting points, very few recreational riders going to Barnstable County would use a Buzzards Bay station. Availability of through service from Boston instead of a Red Line transfer would be expected to increase the proportion of riders coming from Boston or points beyond compared with intermediate boardings. However, the park-and-ride facilities now provided at intermediate stations south of Braintree would also increase the attractiveness of those stations. Faster train speeds north of Buzzards Bay would only partly offset the inconvenience of the lack of service beyond that point.

The work program for the present study calls for analysis of extending commuter service only as far south as Buzzards Bay. However, the possibility remains open of providing connecting service to points on the Hyannis or Falmouth lines with shuttle trains rather than shuttle buses. (It is no longer possible to run trains as far as the old Falmouth Station because the bicycle path on the right-of-way has been extended north of that point since 1988.) Connecting train service might be provided by the operators of tourist trains that now run on the outer segments of the Hyannis line, rather than as part of the commuter train service per se. Even with some form of rail service to stations beyond Buzzards Bay, however, many recreational destinations in Barnstable County, as well as ferry service to Martha's Vineyard, could still be reached only with additional connections.

Variation in Recreational Travel by Day of Week

The most detailed information available on total travel to and from Cape Cod is that provided by MassHighway's continuous traffic count stations located just north of the Bourne Bridge and just east of the Sagamore Bridge. These provide counts of the number of vehicles passing, by direction, for each hour of each day year-round. However, they do not provide information about vehicle classification, trip purposes, or trip ends. There is some recreational travel at all times of year, but it is heaviest in the summer.

In counts from April 2005, a month outside of the peak vacation season, the day of the week with the heaviest average travel both to and from the Cape was Friday. For both bridges combined, average southbound Friday traffic was 21.5% higher than average daily traffic and 15.9% higher than average weekday traffic. Friday was the only day on which southbound traffic exceeded the weekday average. For other weekdays, southbound average traffic ranged from 89.1% of average weekday volume

on Mondays to 99.6% on Thursdays. Southbound average traffic on Saturdays was equivalent to 92.9% of the weekday average, and that on Sundays was 72.9% of the weekday average. However, these figures understate the importance of weekend recreational travel, because weekend volumes would be expected to include many fewer work trips than weekday volumes.

The increase in April Friday traffic was much smaller northbound than southbound, with an average 4.6% above the daily average and 2.4% above the weekday average. On Sundays, when most weekend visitors would be returning home, the average was 1.0% higher than the daily average and 1.1% lower than the weekday average. The lowest travel day for northbound traffic was Saturdays, averaging 11.9% below the weekday average.

The two heaviest Cape traffic months are typically July and August, but weather conditions can impact their relative numbers. In August 2005, two-way average weekday traffic at the canal bridges was 39% higher than the April 2005 average. Fridays were also the heaviest average southbound travel days in August, at 25.7% above the daily average and 21.4% above the weekday average for the month. However, Thursdays were also above average, at 9.3% above daily and 7.9% above weekday average levels. Southbound average traffic was still lowest on Sundays, at 77.3% of the daily and 76.3% of the weekday averages. However, Saturdays were the second-highest southbound travel days of the week, at 15.2% above the daily and 13.8% above the weekday average levels.

In August, Sundays were the heaviest average travel days for leaving the Cape, at 19.2% above the daily average and 23.6% above the weekday average. Mondays were second-highest, at 6.5% above the daily average and 10.3% above the weekday average. On other days, northbound traffic ranged from 3.0% below the daily average on Thursdays, to 7.9% below on Tuesdays and Wednesdays.

Conclusions

Given the uncertainties in predicting demand for any transit service for recreational trips, the limited suitability of a Buzzards Bay commuter rail extension for serving such trips, and the limited season during which most such trips are made, recreational ridership should not be assumed to account for a large part of the annual ridership on an extension. Based on past experience, an estimated average of at most 300 recreational riders each way per day during the peak summer tourist season would be reasonable.

With a base figure of 2,045 riders in non-summer months, 300 recreational riders would represent an increase of 14.7%. As discussed in Appendix A, overall traffic volumes on the Bourne and Sagamore bridges are about 55% higher in July than in March. Most of this increase is presumed to result from recreational travel. No breakdowns of origins and destinations of vehicles crossing the bridges are available, but auto users would be able to travel all or most of the way between their origins and destinations with their autos. In contrast, all Buzzards Bay extension users going to or from points south of the Cape Cod Canal would have to use some form of connecting transportation. Unlike commuters living in Barnstable County, recreational travelers would not have their own vehicles available for rail connections at the Cape Cod end,

and it would not be feasible to provide connecting transit services to all potential destinations. Therefore, the ratio of seasonal to year-round trips would be expected to be much lower than the 55% observed for highway traffic.

APPENDIX D – IMPACTS OF CAPACITY CONSTRAINTS ON RIDERSHIP

In the demand estimates in Chapter 3 and Appendix B, there is an implicit underlying assumption that a Buzzards Bay extension would be able to carry as many passengers as wanted to use it. In reality, ridership would be limited by the capacities of the rail system itself, and of the travel modes used to get to and from the rail stations. The most significant capacity constraints and some potential mitigations strategies for addressing them are discussed below.

Train Capacity Constraints

For reasons discussed in Chapters 3 and 7, all peak-period service on a Buzzards Bay extension (and most off-peak service) would have to be provided by extending trips on the existing Middleborough/Lakeville commuter rail line. Present track layout and necessary sharing of some track segments with trains on other routes would preclude any increase in the number of peak trips. The lengths of the platforms used by Middleborough/Lakeville trains at South Station prevent the use of trains longer than six cars on that line. The MBTA commuter rail fleet includes cars with several different configurations and capacities, with double-deck cars having the largest capacities.

The maximum number of seats that could be provided in one train of 6 double-deck cars would be about 1,100. If all 4 inbound AM peak trains on the Middleborough/Lakeville Line, along with the train due in Boston at 6:20 AM, were operated with such trains, this would provide a total of 5,500 seats. At present these trains carry a combined total of 2,700 to 3,000 riders at the maximum load point. Therefore, if all were operated with maximum-capacity train sets they could accommodate an additional 2,800 to 3,500 seated riders. This would be sufficient for the total midpoint estimated ridership on a Buzzards Bay extension in the year 2020, but less than the upper-end estimate. Demand is not uniformly distributed among trains, so some riders would have to use trips at times other than their first choices in order for all to have seats. Some of the riders boarding at extension stations would be diverted from existing stations on the Middleborough/Lakeville Line, and would use no additional capacity. However, the March 2006 license plate survey indicated that there were only about 200 such riders on all AM peak trains combined.

Constraints on Connecting Modes at Inner Trip End

Based on the findings above, it appears that capacity of access and egress modes could limit extension ridership more than train capacity would. At the Boston end of the trip, many of the final destinations are within walking distance of South Station, and most of the rest are accessible by rapid transit. The 1998 Old Colony passenger survey found that 61% of the Middleborough/Lakeville Line riders who alighted at South Station completed their trips by walking, with another 31% transferring to the Red Line. Additional transfers by Buzzards Bay extension riders would result in increased crowding on some Red Line trains at South Station, but the duration of this would be only one or two stops because of heavy alightings at Downtown Crossing and Park Street.

Parking Capacity Constraints at Outer Trip End

The biggest constraining factor on ridership on a Buzzards Bay extension would be parking capacity at stations. Very few of the trip origins in the demand forecasts would be within walking distance of stations, and scattered locations of these origins would make it difficult to provide efficient and convenient feeder services. Therefore, access would have to be primarily by private vehicles. The 1998 Old Colony survey found that 78.2% of the passengers boarding at Middleborough/Lakeville Station and 81.4% of those boarding at Kingston Station drove to the stations and left their vehicles there. Park-and-ride access would be expected to account for similar shares of ridership at Buzzards Bay extension stations.

At 2006 travel levels, the midpoint demand estimate for an extension with unconstrained capacity is 2,045 boardings per day. Of these, 1,485 would have trip origins in Barnstable County, and would board at Buzzards Bay. The other 560 would have trip origins in 1 of the 5 Plymouth County towns in the extension service area and would board at Wareham. If 80% of the passengers at each station used park-and-ride access, this would call for capacities of 1,190 spaces at Buzzards Bay and 450 at Wareham without allowance for day-to-day fluctuations in demand.

Provision of anything close to 450 spaces at the past station location in downtown Wareham would be impossible with either a lot or a garage. Therefore, the station would have to be at an outlying location such as County Road. Provision of 1,190 spaces at Buzzards Bay, if feasible at all, would require that they either be divided among several sites or put in a multi-level garage. Lots with capacity for 1,190 cars would take up at least 8 acres of land, and could require more on irregularly-shaped sites. At present, most of the buildings in the vicinity of the past Buzzards Bay station site have only one or two stories, so a multi-level above-ground garage, regardless of design, would be out of character with the neighborhood.

Potential Use of Feeder Services to Reduce Parking Capacity Needs

SRPEDD Survey Results – Potential Shuttle Service

At present, there are no feeder services from communities in the Buzzards Bay extension service area to existing commuter rail stations. Some idea of the demand for feeder service to extension stations might be obtained by a trial of connections to Middleborough/Lakeville or Kingston. The Southeastern Regional Planning and Economic Development District (SRPEDD) has conducted several surveys of passengers boarding AM peak trains at Middleborough/Lakeville Station. One of the questions asked was whether passengers would ride shuttles from central locations in their hometowns to the station if they existed. In 2005, 27.6% of the survey respondents answered yes, 37.5% maybe, and 34.9% no. However, responses to questions about hypothetical services with little specificity are likely to differ substantially from choices about services for which actual characteristics such as frequency, travel times, fares, and ride comfort are known.

The SRPEDD surveys were distributed only to people who were already commuter rail users, but attainment of the ridership levels predicted for a Buzzards Bay extension

would require diversions of large numbers of commuters that currently drive or carpool to their destinations. MBTA passenger surveys consistently show that for the majority of riders, convenience is a deciding factor in choosing whether to use a particular transit mode. Non-transit users from the extension service area could currently use park-and-ride facilities at commuter rail or express bus stops from which through service is provided to downtown Boston, and which have some excess capacity. To attract these trip-makers, new transit services would have to be perceived as more convenient than existing alternatives.

At present, there is no local bus service to Buzzards Bay or Wareham from most of the towns from which ridership on a commuter rail extension would be drawn. Therefore, most feeder service to extension stations would have to be in the form of entirely new routes rather than modifications of existing ones. There have been few recent attempts to operate dedicated shuttle services to the existing MBTA commuter rail stations. These are discussed below. As will be seen, these services have captured only small shares of the riders at the stations they served, and few have lasted beyond their initial demonstration phases. Consequently, it is also necessary to look to other systems for analogies.

Norton–Mansfield GATRA Route

The Greater Attleboro Taunton Regional Transit Authority (GATRA) has operated a fixed-route bus from the town of Norton to Mansfield Station on the Attleboro commuter rail line since 2001. The outer terminal is Wheaton College, in the center of Norton. Other designated stops in that town are at a park-and-ride lot operated by a gasoline station and at the Great Woods Plaza, both on state Route 140. Buses can also be flagged down at any point along the route within Norton, but the only stop allowed in Mansfield is at the railroad station.

A survey of passengers riding AM peak bus trips on this route was conducted for MassHighway in the fall of 2002. A total of 23 surveys were completed, apparently including all or most passengers on the six round-trips in this span. All but 1 of the respondents rode on inbound trips, to transfer to trains to Boston. Seventeen of the inbound passengers reported that they had boarded at the park-and-ride lot on Route 140. Of these, 15 drove and parked at the lot, 1 walked, and 1 did not specify an access mode. Two others that did not specify a boarding stop but reported driving to the bus probably also used the park-and-ride lot. Of the remaining three, 1 walked to the Wheaton stop, 1 walked to another stop on Route 140, and 1 was dropped off at a stop.

All but 4 reported that they had previously made the same trip by other means, but it is unclear whether they were referring to the entire trip or only to the bus portion. Of those that made the trip before, 13 formerly drove alone, but this could have been either to the station or to the final destination. Another 4 previously got rides, and one shifted from a carpool. For comparison, the CTPS fall 2005 parking inventory found that by 8:00 AM all 830 publicly owned commuter parking spaces at Mansfield were full. A privately owned lot with 105 spaces filled by 10:00 AM, and a second private lot with 175 spaces filled by noon. Based on the park-and-ride origins found in the 1993 commuter rail survey, an estimated 130 vehicles parked at Mansfield by 8:00 AM in

2005 would have come from Norton. Overall, these findings suggest that the bus reduced parking demand at Mansfield from Norton alone by at most about 10%.

Peabody Transit Commuter Shuttle

This service was implemented by the city of Peabody in 1993 to supplement long-established private-carrier bus service between Peabody and Salem. The Peabody Transit service has always operated only during peak hours. All trips run to or from Salem Station, which is on the Newburyport/Rockport commuter rail line. Several MBTA bus routes also serve that location. A passenger survey was conducted on this route by CTPS in the summer of 2003. At that time, during AM peak hours, Peabody Transit ran 4 round-trips to Salem Station, with 2 originating at the North Shore Mall and 2 at the Centennial Park office complex. (The sequence of stops varied, so all trips served both of these locations on the way either to or from Salem Station.) In PM peak hours there were 5 round-trips and a final one-way trip from Salem to Peabody Square.

The survey coverage included all of the morning shuttle trips. The total passenger count on the survey trips was 6 outbound (toward Peabody) and 3 inbound (toward Salem). The 3 inbound passengers all started in Peabody and transferred to trains at Salem. At least 2 of these transfer riders ended their trips in Boston. For comparison, the CTPS fall 2005 parking inventory found that by 7:50 AM all 454 parking spaces designated for rail passengers at Salem were occupied. Based on a 2005 license plate survey, about 75 of these vehicles came from Peabody. None of the bus riders reported that they had previously driven to the station.

Feeder Service from Milford to Southborough Commuter Rail Station

Southborough Station, which is on the Framingham/Worcester commuter rail line, opened in June 2002. In September of that year, a new mini-bus route was instituted to this station from the town of Milford, via Hopkinton. It was run as part of the Framingham LIFT bus system and was known as LIFT 4. This route was intended for use both by commuters going from homes in the communities along its route to work locations on the commuter rail route, and by commuters going to work locations on the bus route from homes on the rail line.

A survey of LIFT 4 passengers was conducted by CTPS in the summer of 2003. At that time, LIFT 4 had 5 inbound (toward Southborough Station) AM peak trips and 4 outbound (toward Milford) PM peak trips scheduled between downtown Milford and the station. Reverse-commuting service provided as a variation of LIFT 4 consisted of 1 outbound AM peak trip and 1 inbound PM peak trip between Southborough Station and an office complex in Hopkinton. A previous schedule included more outbound AM peak and inbound PM peak bus service. This was intended to attract passengers arriving by train from points west of Southborough, but was unsuccessful.

The survey distribution plan was to cover all of the morning trips on LIFT 4. On the survey day, the first inbound trip did not run because of equipment failure. The second trip had only 3 passengers, and the last three had none. The outbound trip had one passenger. All 4 passengers filled out surveys, and all were going from home to work. The 3 inbound passengers all had actual trip origins in Milford, and walked to or were

dropped off at their boarding stops. Two of them transferred to a train at Southborough Station and rode to Boston. One of these had a final destination in downtown Boston and the other continued on from there by rapid transit. The third inbound passenger transferred to another LIFT route in downtown Hopkinton to continue to a final destination in Framingham. The one outbound passenger on LIFT 4 had taken a train from Framingham to Southborough Station to get to work at the office complex. Because of the very low ridership, this route was discontinued in September 2003.

Shuttle Service from Marlborough to Southborough Station

The Southborough Rail Link was implemented in 2003 by the Metrowest/495 Transportation Management Association. It included two routes – the Westborough Shuttle and the Marlborough Shuttle. The latter provided connections to the station from downtown Marlborough and from a satellite parking lot on the border of Marlborough and Southborough for passengers going from homes in these towns to work locations served by other stations on the rail line. It also connected Southborough Station with several employment locations west of I-495 and south of U.S. Route 20 in Marlborough or in downtown Marlborough.

The published schedule for the Marlborough Shuttle showed 4 trips toward the station (2 from downtown Marlborough and 2 shorter trips from the satellite parking lot) during AM peak hours. A passenger survey on this route was conducted by CTPS in the summer of 2003. The survey strategy called for distributing surveys on all morning trips, but it was found that the first inbound trip from downtown Marlborough and the second short trip from the satellite lot were often not run. Consequently, they could not be relied on and did not attract passengers. The first trip from the satellite lot and the second trip from downtown Marlborough were run, but also had no passengers.

There were three outbound AM peak trips from the station to Marlborough, but only the second had any passengers, and it had only 2. Because of the low ridership, this route was discontinued in 2004. A demand-responsive service covering the same area was implemented in 2005.

For comparison with the Marlborough and Milford shuttle services, the CTPS fall 2005 parking inventory found that after departure of the last AM peak train there were 346 vehicles in the parking lot at Southborough Station.

Maynard Commuter Van Service

In April 2002, the town of Maynard instituted a shuttle-van service from a parking lot in the town center to the South Acton commuter rail station in the adjoining town of Acton. The shuttles were scheduled to make close connections with all five inbound AM peak trains and all five outbound PM peak trains that stopped at South Acton then. A passenger survey on this route was conducted for MassHighway in the fall of 2002. The five inbound AM peak trips carried a total of 8 riders. All of them boarded at the Maynard parking lot, but only one parked there. The rest all got to the lot either by walking or being dropped off. All of them started from homes in Maynard. At most, 4

formerly drove to South Acton Station. This route was discontinued in July 2003 because of low ridership.

The CTPS fall 2005 parking inventory found that by 8:10 AM, before departure of the last inbound peak train, there were 431 vehicles in parking spaces used by rail passengers at South Acton, with only 7 spaces remaining unoccupied. This station draws riders from many towns. Based on the park-and-ride origins found in the 1993 commuter rail survey, an estimated 26 of the parked cars at South Acton in 2005 were from Maynard. Overall, these findings suggest that the van reduced parking demand at South Acton from Maynard alone by about 15%, at most.

New Jersey Shuttles

Elsewhere in the United States, the most extensive use of dedicated shuttles to commuter rail now occurs along routes of the New Jersey Transit (NJT) system. Most of these shuttles have been implemented since 1998 under a program in which NJT leases 18- to 20-passenger mini-buses at no cost to applicant communities which are then responsible for their operation. Most participating municipalities receive one vehicle, which is used on one route entirely within that municipality during AM and PM peak hours only. In contrast, only two towns in the assumed service area of a Buzzards Bay extension would have stations within their borders, so feeder routes would have to be much longer than those in New Jersey. Most such routes would require more than one vehicle to make connections with all peak-period trains.

Most municipalities in the New Jersey program have much larger populations and higher population densities than most towns in the service area of a Buzzards Bay commuter rail extension. Moreover, the total number of commuter rail trips originating in the individual communities in the New Jersey program is much larger than the projected number of riders from individual towns in the Buzzards Bay extension service area. Little information on ridership on the New Jersey shuttle routes is available, but early in the program, a route was regarded as highly successful if it carried 10% of the commuter rail riders going to the station it served.

If an extensive network of feeder services was able to capture 10% of the unconstrained demand for a Buzzards Bay extension, this would be a total of 149 trips to Buzzards Bay and 56 to Wareham at 2006 demand levels. This would still leave a need for 1,041 parking spaces at Buzzards Bay and 394 at Wareham.

APPENDIX E – FURTHER DETAILS ON OPERATING COST ESTIMATES

Operating cost estimates for a Buzzards Bay extension are discussed in Chapter 6. More specific details concerning the various service strategies that were analyzed and the impacts of these strategies on estimated costs are provided below.

Minimum Weekday Service Level

Under the minimum weekday service strategy considered, inbound trains extended to Buzzards Bay would include the first 3 of the 4 trips now arriving in Boston in the AM peak period (at 6:57, 7:52, and 8:16), and the one train arriving just before the start of the AM peak (at 6:20). The only other inbound trip that could be extended using only the four train sets assigned to the Middleborough/Lakeville Line would be the one arriving in Boston at 10:20 PM. The outbound minimum weekday service would include extension of 2 of the 4 trains leaving Boston in the PM peak period (at 5:15 and 5:55), and all 3 trips departing after the PM peak (at 6:45, 8:10 and 10:40). However, there would be no midday service in either direction.

The rolling stock used for the minimum service would continue to be based at the Middleborough yard. Early each morning, the four train sets would be run out from the yard to Buzzards Bay in two coupled pairs (known as double drafts), without passengers. In the evening the process would be reversed, with the four sets returning from Buzzards Bay to the yard in two double drafts, again without passengers. One of the sets would make two evening trips to Buzzards Bay, returning the first time in service to Boston and the second time in one of the coupled pairs.

The net increase in weekday train operations resulting from the minimum service strategy would be that of five in-service trips each way plus two non-revenue double-draft trips each way. The average car-hour cost formulas are based on allocating all costs to revenue train operations. Although there are early-morning and late-night equipment-shifting moves on some lines, the number of train-hours that they generate is much smaller in proportion to revenue train-hours than would be the case for a Buzzards Bay extension. Therefore, it is appropriate to include some cost for non-revenue trains in the Buzzards Bay calculations. A double-draft move of two six-car sets would consume more fuel and put more wear-and-tear on rolling stock and track than a trip by a single six-car set would. However, with some of the train crew beginning and ending shifts at Buzzards Bay, each double-draft could be run with a minimum of one engineer and one conductor instead of two engineers, two conductors, and four assistant conductors. The available unit cost figures for MBTA commuter rail service do not provide separate breakdowns of crew costs and other costs. For purposes of cost estimation here, the hourly cost of a double-draft is assumed to be the same as the cost of a single six-car train.

Medium Weekday Service Level

In addition to the service discussed in the minimum strategy, this alternative would extend the 3 inbound trips now arriving in Boston at 12:04, 1:56 and 4:21 PM, and

would add a new trip arriving in Boston at 5:08 PM. Outbound, the 3 trains now leaving Boston at 9:57 and 11:55 AM and 2:15 PM would be extended to Buzzards Bay, and a trip leaving Boston at 9:12 AM would be added. (The operating constraints necessitating extension of these particular trips and no others are discussed in detail in Chapter 7.)

Although the medium service would not require any more non-revenue train moves than the minimum service, the average cost per new trip would be somewhat greater than the effective cost per revenue trip in the minimum strategy. There are two reasons for this. One is that the cost of the new trips leaving Boston at 9:12 AM and returning at 5:08 PM would have to be included for the segment between Boston and Middleborough/Lakeville as well as for that between Middleborough/Lakeville and Buzzards Bay. Operation of these trips would be necessary to provide enough equipment to run any other extended midday service. The other reason for the high incremental cost is that the additional extended trips would have relatively long layover times at Buzzards Bay. These layover times would be unavoidable in order to maintain present outbound arrival and inbound departure times at Middleborough/Lakeville. Under federal law, a break in the workday of a train crew member must be counted as time on duty if it is not at least four hours long. All of the layover times at Buzzards Bay would be well under four hours, and would therefore be paid time.

Maximum Weekday Service Level

The incremental cost per revenue trip for the maximum service level compared with the medium service level would be much lower than that for the medium level compared with the minimum level. This is partly because the maximum level would not require operation of any additional trips between Boston and Middleborough/Lakeville, and partly because average layover time at Buzzards Bay would be lower than that under the medium level. The maximum service level would, however, have higher capital costs than the other two because a fifth train set would have to be acquired. (All three service levels would require adding some capacity to peak-period trains to accommodate added ridership.)

Weekend and Major Holiday Service

At present, the Middleborough/Lakeville Line has 7 round-trips per day on Saturdays, Sundays, and seven major holidays, with the same schedule being used for all three types of non-weekdays. To extend all 7 round-trips to Buzzards Bay, it would be necessary to also operate one equipment-positioning trip with two coupled train sets between the Middleborough yard and Buzzards Bay at the start and end of each service day. Compared with present service, train-hours would therefore increase by 8 round-trips, or 13.5 hours, for each Saturday, Sunday, and major holiday. An average year would have 52 Saturdays, 52 Sundays, and seven major holidays, for a total of 111 non-weekdays. This would make an annual total of 1,502 added train-hours.

The effective cost per revenue trip for this weekend strategy would be somewhat higher than that for the weekday minimum service strategy because average layover times at Buzzards Bay would be longer for the weekend service. This disadvantage

would be partly offset by the lower ratio of non-revenue to revenue trips required for the weekend service (1 to 7 versus 2 to 5).

The minimum service strategy considered would be to run alternate trips from Buzzards Bay and from Middleborough/Lakeville. This would result in 4 round-trips for passengers and 1 round-trip for equipment positioning on the extension. However, it would also result in much longer paid layover times between trips for crews on trains going to Buzzards Bay. Consequently, there would be little cost saving compared with extending all trains through to Buzzards Bay. Train-hours would increase by 13.3 on each Saturday, Sunday, or holiday, adding 1,476 hours per year.

APPENDIX F – FURTHER DETAILS ON FARE REVENUE CALCULATIONS

Background

The MBTA commuter rail system has a zone fare structure, with zone limits based on the distance from downtown Boston. In addition, a variety of fare-payment methods are available, including unlimited-ride monthly passes, single-ride full-fare tickets, and half-fare tickets for children, students, senior citizens, and passengers with disabilities. The amount of revenue obtained at a given ridership level would depend on the mix of fare-payment methods used by the passengers and the cost per ride with each method.

Information on the mix of fare payments on the present system at prices that were in effect during 2006 is available from the 2005 MBTA fare-mix study conducted by CTPS. New, higher fares are to be implemented in January 2007, but at this writing it is uncertain as to how this might affect the fare-mix on a Buzzards Bay extension by the time it was implemented. Therefore, the revenue calculations were based on the 2006 fares. For purposes of analysis, all stations on a Buzzards Bay extension were assumed to be in fare Zone 8, the highest zone level now used, but because of the length of the extension, higher zones might be implemented.

Weekday Average Fare Calculations

In 2006, the fares in effect on the MBTA commuter rail system were those implemented in January 2004. The one-way full fare from any Zone 8 station to downtown Boston was \$6.00. Twelve-ride tickets were priced the same as 12 one-way full-fare tickets. Senior citizens, passengers with disabilities, children between the ages of 5 and 11, and students up through high school were all eligible for half fares of \$3.00. Ten-ride tickets for passengers eligible for half fares were priced the same as 10 one-way half fares. The most common fare-payment method in Zone 8, as in other zones, was a pre-paid monthly pass, allowing unlimited riding. The 2005 fare-mix study found that 63.5% of all weekday trips between Zone 8 stations and downtown Boston stations were made using such passes, and the rest using various ticket forms. For those that used tickets, the average revenue per trip was \$5.52, equivalent to 92% of the one-way full fare.

A Zone 8 pass can be used for travel on any MBTA bus or rapid transit line as well as on the entire commuter rail system. For accounting purposes, the MBTA allocates revenue from pass sales among all of the services on which they are used. The allocation factors are based on pass-user surveys conducted from time to time, with the most recent one having been done in conjunction with the 2005 fare-mix study. However, for purposes of analysis of potential new transit services such as a commuter rail extension to Buzzards Bay, what is of interest is the net changes in revenues and costs for the MBTA system as a whole. Therefore, all revenue from pass sales to new transit riders attracted by the extension can be included along with ticket sales revenue. For purposes of this analysis, it has been assumed that a Buzzards Bay extension would not involve any new MBTA-operated or MBTA-funded connecting services. Therefore, the cost calculations need only include changes in operating costs for the commuter rail system.

Survey results show that only small percentages of Zone 8 passes are used on an average Saturday or an average Sunday. This suggests that most passengers that obtain passes would do so whether or not weekend service was provided. In that case, it is reasonable to include all pass-sales revenue in the weekday calculations, and to include only revenue from ticket-users in the weekend calculations. The latter calculations would be based on the number of passengers using tickets on weekends rather than weekend tickets sales. Tickets purchased onboard trains must be used on the same day, but tickets purchased at stations or agencies may be purchased in advance of the actual travel date. (This is especially likely for 10-ride and 12-ride tickets.)

The price of a Zone 8 pass in 2005 was \$198.00 per month. The 2005 pass-users survey found that the average use rate for Zone 8 passes on the commuter rail system was 1.98 trips per weekday. In an average month, this would result in 42.9 pass uses, so the revenue generated per use would effectively be \$4.62. With pass rides accounting for 63.5% of all weekday rides, the overall average revenue per passenger trip for through trips to Boston would be \$4.946.

Weekend and Major Holiday Average-Fare Calculations

Commuter rail ridership is typically much lower on weekends and holidays than on regular weekdays. The proportion of riders using tickets rather than monthly passes is much higher on weekends and holidays than on weekdays, but under the revenue allocation method discussed above, all pass revenue is already attributed to weekday service. The fare-mix study indicated that combined through and interzone revenue from Zone 8 ticket users averaged \$5.10 per rider on Saturdays and \$5.22 per rider on Sundays.

Based on the 2005 fare-mix study results, about 65% of riders on Saturdays and about 70% on Sundays would be expected to be ticket users, and the rest pass users. Therefore, with only ticket revenue being attributed to weekend service, total revenue would be calculated by applying average ticket fares to about 380 riders each way on Saturdays and 235 on Sundays.