MEMORANDUM

To: **Scott Hamwey, MassDOT** **March 22, 2011**

From: **Scott Peterson**

Re: **Analysis of Silver Line Service to Airport Station and Chelsea**

BACKGROUND

The MBTA Silver Line Bus Rapid Transit service presently operates between South Station and Boston Logan International Airport, making five stops at the airport terminals. However, the existing service does not connect to the Blue Line's Airport Station, and does not directly serve any neighborhood adjacent to the airport. The objectives of this study are to assist MassDOT in an investigation of extending the existing Silver Line service to a connection with the Blue Line at Airport Station, and to study the potential to extend service beyond Airport Station to the city of Chelsea by utilizing the proposed East Boston Bypass Road (Bypass). This study will examine the travel demand and capital costs associated with three transit service plans for connecting Chelsea to Airport Station in the horizon year of 2020, using two different operating strategies for the Bypass. Each one of the service plans for the routes to Chelsea will focus on serving the Blue Line's Airport Station and will not serve the terminals directly.

METHODOLOGY

This analysis utilized the regional travel forecasting model set developed by the Central Transportation Planning Staff (CTPS). It follows the traditional four-step travel-modeling process of trip generation, trip distribution, mode choice, and trip assignment and is implemented in the EMME software package. This modeling process is employed to estimate present and future daily transit ridership and daily highway traffic volumes, based primarily on land use (households and employment) and the transportation network. The model set simulates travel on the entire eastern Massachusetts transit and highway systems. When the model set is estimating future travel, the inputs include forecasts of land use, transit, and highway improvements.

In addition to the traditional four-step model set, this analysis also employed the Logan Ground Access Mode Choice Model and the Tour-based Truck Travel Forecasting Model to mimic reality. The Logan Airport Passenger Ground Access Mode Choice Model was used to forecast the impact on the modal distribution of passenger travel to and from Logan Airport and the demand for parking at Logan Airport due to changes in the regional transportation system. This model was used because of the special transportation services in the regional network available for Logan passengers and because the factors that affect Logan modal choices are different from the factors affecting modal choices for non-airport travel. It was developed based upon the 2003 Logan passenger survey and validated to the 2007 Logan passenger survey data. This was accomplished by combining the survey data with travel-time and cost data from the regional highway and transit networks, along with Massport data on Logan services. The Logan model estimates the distribution of average weekday travel by 16 market segments. A forecast was made for both access and egress travel.

A separate model is used to estimate truck demand because truck trip-making has fundamentally different characteristics from person trip-making. The forecasting model used for truck travel is tour-based and includes its own trip generation and trip distribution processes. The results of these truck trip generation and distribution steps are then added to the trip tables produced in the mode choice step of the regional model.

The truck-travel forecasting model was constructed so that it could forecast truck demand based on changes in demographics, tolls, and infrastructure characteristics of the regional transportation system. The survey data used to estimate the truck model and truck trip ends included truck ownership information, truck/vehicle inventories and use surveys, surveys of local businesses, field observations of trucks, vehicle classification counts, and information about truck travel by industrial sector. Once truck trip ends are established, the trips are estimated based on observed trip length frequencies. The resulting trip tables are created for three truck vehicle classes: commercial pickup trucks and vans, big trucks (including the seven U.S. DOT use categories), and tankers. This model component was used to estimate the demand for the Bypass using the two different operating strategies described below.

ASSUMPTIONS

The base year used to calibrate the travel model was 2007 and the forecast year was 2020. The No-Build alternative is shown in Figure 1 (at the end of this memorandum) and is built on the Boston Region MPO's Long-Range Transportation Plan for the background land use and transportation network assumptions. The No-Build alternative was then used to measure the impacts of six transit scenarios.

Scenarios Examined

The six transit scenarios can be broken down into two major components: East Boston Bypass Road operation strategies and three bus/bus rapid transit upgrade alternatives. The two Bypass operation strategies are mixed-traffic usage and buses/commercial trucks usage only.

The proposed Bypass is intended to provide a new limited-access roadway connection between Logan Airport and Chelsea Street, near the new Chelsea Street Bridge. By diverting traffic to the Bypass, traffic congestion on East Boston streets could be reduced, and traffic safety in East Boston could be improved. The Bypass would provide an alternative to existing roadway connections through East Boston's Day Square and the Neptune Road corridor, which have closely spaced intersections, irregular roadway geometry, and significant vehicular congestion. The Bypass is being planned, designed, and constructed by, and will be operated by, the

Massachusetts Port Authority (Massport). In this study, two operational strategies are examined: one that allows mixed traffic on the Bypass (variant "a"), and the second one, that only allows commercial vehicles, including transit vehicles, to use the Bypass (variant "b"). Variant b could result in a somewhat greater travel-time saving than variant a.

The three different transit alternatives are described below:

1) Alternative 1 realigns Route 112 from Wood Island Station (Blue Line) to Airport Station (Blue Line) in East Boston and uses East Boston Bypass Road as part of the route. In doing so, some stops from the original bus route are eliminated (Chelsea Street/Eagle Square, Chelsea Street/Curtis Street, and Wood Island Station), and Airport Station is added. (see Figure 2, at the end of this memorandum). The proposed Route 112 also has headway improvement, as described in Table 1. The original Route 112 has an AM headway of 36 minutes, Midday 36 (inbound) and 33 (outbound) minutes, PM 36 minutes, and Nighttime 120 (inbound) and 90 (outbound) minutes. The new headway is 20 minutes for all time periods.

TABLE 1
Headway Improvements on Route 112

	Inbound		Outbound	
Time of Day	**Original Service (minutes)**	**New Service (minutes)**	**Original Service (minutes)**	**New Service (minutes)**
AM	36	20	36	20
Midday	36	20	33	20
PM	36	20	36	20
Night	120	20	90	20

2) Alternative 2 adds an additional bus rapid transit line from South Station to Chelsea commuter rail station. The new line first follows the existing route from South Station to Silver Line Way, and then adds Airport Station, Neptune Station, and Eastern Avenue as stops before it reaches Chelsea Station. It utilizes East Boston Bypass Road and Grand Junction Busway. The headway for the existing line from South Station to Silver Line Way (SS-SLW), also known as Route 746, is approximately five minutes in the peak periods in the base scenario, and the headway of the line from South Station to the airport, SL1, is 11 minutes. In the build scenario, during the peak periods half of the existing (SS-SLW) line service will be extended to Chelsea, resulting in 10-minute headways, while the remaining half will continue to operate between South Station and Silver Line Way. During the off-peak periods, the added extension line has a 20-minute headway in the build scenario. The SL1 service remains the same as in the no-build alternative for both peak and off-peak periods (see Figure 3, at the end of this memorandum).

3) Alternative 3 adds an additional bus rapid transit line from South Station to Chelsea City Hall. The new line utilizes East Boston Bypass Road but follows the existing Route 112 alignment in Chelsea before it reaches its terminal. The common stations are South Station, Court House, World Trade Center, Silver Line Way, Airport Station (Blue Line), Neptune Street in East Boston, and Eastern Avenue in Chelsea. Alternatives 2 and 3 are both limited-stop service and serve the same station stops except for the terminal stop, which is Chelsea Commuter Rail Station in Alternative 2 and Chelsea City Hall in Alternative 3. The headway assumption in this scenario is the same as in the Alternative 2 scenario (see Figure 4, at the end of this memorandum).

TRAVEL DEMAND RESULTS

The transit results are presented in Table 2 (following the figures at the end of this memorandum). These results show that changing the operational strategy of the Bypass has little impact on the transit ridership. The differences in ridership between the a's and b's are very small, and they can be accounted for by runtime differences on the Bypass due to the different operational strategies. The proposed extension of transit service to the Airport and Chelsea results in an increase of between 240 and 620 transit users per day, with Alternatives 2a and 2b producing the largest number of auto diversions and the greatest number of unlinked transit trips in the transit system. Alternatives 3a and 3b have benefits similar to those of Alternatives 2a and 2b, but produce a slightly lower number of new linked and unlinked transit trips in the transportation system. The differences in ridership between Alternatives 2 and 3 are due to their different alignments: One alignment serves the Chelsea commuter rail station via Eastern Avenue, and one serves Chelsea City Hall via Central Avenue. Alternatives 1a and 1b have slightly less than half the new linked transit trips and about one fifth of the new unlinked transit trips that 2a and 2b have. There is no discernible difference in ridership between 1a and 1b.

The difference of ridership between Alternative 1 (1a and 1b) and the No-Build alternative is mainly attributable to three factors:

1) The terminal of the bus line in Alternative 1 differs from the terminal in the No-Build alternative. Because in Alternative 1 Route 112 would terminate at Airport instead of Wood Island, a transfer to the Blue Line is provided at Airport Station. The Route 112 bus experiences an increase of 880 daily boardings, while other bus routes lose around 480 daily boardings, resulting in a net increase of 400 daily bus boardings in 2020. The Chelsea commuter rail station loses 20 daily boardings as a result of the expanded Route 112 service. The rapid transit line ridership increases by 200, with Airport Station gaining 360 daily boardings, while Wood Island ridership declines by 100 daily boardings, and Maverick boardings decrease by 210. The total ridership on the Blue Line (including all stops) increases by 100. There is a small increase in demand for the western end of the Route 112 bus serving Wellington Station on the Orange Line. The loss of 210 boardings on the Blue Line at Maverick corresponds to the loss in ridership the bus Routes 114, 116, and 117, whose riders are diverted to Airport Station. The loss in bus ridership is a function of the improved Route 112 service siphoning off ridership from other local buses that share the same catchment areas.

2) The Route 112 bus headway improves for all time periods; in the peak periods it improves from 36 minutes to 20 minutes. This improvement in headway is likely the major factor in attracting riders to this route.

3) The utilization of East Boston Bypass Road in Alternative 1a and 1b produces a small time saving.

Travel demand estimates for Alternatives 2a and 2b are slightly higher than for Alternative 3a and 3b. The difference in ridership between Alternatives 2a and 2b and Alternatives 3a and 3b is attributable to two factors:

1) The terminal stop of the route differ, Alternative 2 terminates at the Chelsea commuter rail station, while Alternative 3 serves Chelsea City Hall.
2) The travel time differs between Alternatives 2 and 3: Alternative 2 has a shorter travel time than Alternative 3. It is estimated that the travel-time saving between Alternative 2 and Alternative 3 is around 4 minutes. As result, the Alternative 2 scenarios, which utilize both East Boston Bypass Road and Grand Junction Busway in Chelsea, generate the higher ridership.

Maverick Station experiences the biggest decline in daily boardings. For example, in Alternative 2, the average daily boardings were reduced by approximately 600 at this station, as a result of ridership on Routes 114, 116, and 117 being siphoned off onto the proposed Silver Line route that would serve Airport Station and continue from there to Chelsea. Wood Island would lose about 150 daily boardings to the new Silver Line Extension service, which would be serving Airport Station, resulting in an increase of approximately 1,000 daily boardings for the latter. Alternative 2 produces approximately 600 daily auto diversions, which is reduced by about 100 in Alternative 3. Alternatives 2 and 3 both cause a small increase in Silver Line ridership originating in the Seaport area and destined to Blue Line market areas north of Boston.

The net daily revenue that the MBTA is likely to receive from these scenarios is consistent with the demand that each alternative generated. This ranged from a low of $700 per day in Alternatives 1a and 1b to $3,300 in Alternative 2b. Alternative 2a generated $3,200, and Alternatives 3a and 3b generated $2,600 and $2,500 per day for the horizon year 2020, respectively. These figures are in 2007 dollars.

CAPITAL COST COMPARISONS

Each of the three alternatives was examined to understand the potential capital costs associated with them. There would not be any differential costs associated with running these transit alternatives using either one of the operational strategies for the Bypass Road.

Alternative 1: Route 112 Rerouted to Haul Road

The capital costs for this alternative are limited to possible signal improvements at the entrance to Airport Station and the possible addition of an additional shelter at the turnaround area at the east end of the station, which would be utilized by the rerouted Route 112 service. This turnaround is presently only used by emergency Blue Line shuttles and is separated from the primary busways used by Massport's own shuttles.

Although currently running in flash mode, the existing signalized intersection and traffic signal are equipped to incorporate a timing phase for the bus loop approach to the north section of Service Road. Prior to implementing any new bus service, the signal timing and phasing will have to be reevaluated, particularly in light of Massport's implementation of the unified shuttle bus system (expected to be in service in 2013).

A shelter would cost between $5,000 and $10,000. There presently is no shelter at this location.

The peak vehicle requirement for Route 112 buses would increase by three buses from the existing three to a total of six, in order to accommodate improved headways. Based on existing vehicle spare ratios, the present MBTA bus fleet at the Charlestown bus garage should be able to absorb this increase without needing to procure additional vehicles.

Total potential capital cost for Alternative 1: One shelter: $5,000 to $10,000

Alternative 2: New Silver Line Service to Chelsea Commuter Rail station

This alternative would include the construction of an exclusive bus transitway from the Chelsea commuter railroad station to an area near Eastern Avenue. The proposed routing would be identical to the alternative recommended for the Chelsea segment of the Urban Ring. Capital costs for this transitway segment were estimated as part of the Urban Ring Environmental Impact Report at $20 million. Included within this estimate are the costs for two bus-rapid-transit (BRT) stations, a rebuilt commuter rail station, reconstruction of retaining walls, reconstruction of bridges, installation of busway access control signals, and the construction of the new roadway within the former railroad right-of-way. The commuter rail station needs to be rebuilt because the bus shares the right-of-way with the commuter rail and it would force a reconstruction of the commuter rail platforms in order to make the stop ADA accessible.

Based on estimated travel times and peak headways, the peak requirement for MBTA dual-mode vehicles for operating a Chelsea–South Station service would be six. The vehicle requirements for dual-mode buses would increase by five, as one vehicle could be reallocated from the existing South Station–Silver Line Way (SS-SLW) service to Chelsea service, while still maintaining the same headway in the SS-SLW segment. The present vehicle requirement for dual-mode vehicles for the route between Design Center and South Station (SL2) and the existing SS-SLW shuttle trips is 10 of the 24 dual-mode buses owned. If the peak requirement numbers where to increase to 15 of the 24, it would still provide at least a 20% spare ratio. However, given the complex nature of the dual-mode vehicles, MBTA maintenance staff may feel it is necessary to expand the fleet to maintain adequate maintenance spares and to maintain the ability to add service to the SS-SLW trunk segment of the Silver Line to meet anticipated ridership growth from the developing South Boston Waterfront area. It could cost up to $10 million to procure five additional dual-mode vehicles because of the unique design of the equipment, as the existing buses cost close to $1.5 million each when they were purchased in 2004.

The CTPS demand analysis also included a potential stop along the Haul Road at Neptune Road in East Boston, near Day Square. Given the width of the available former railroad right-of-way, the construction of this stop would most likely require land taking to increase the width to accommodate a transit station. Bridge crossings of Neptune Road and Bennington Street over the right-of-way would also require reconstruction. As the right-of-way is depressed at this location, platform accessibility may require the construction of elevators or an elaborate ramp network. Drainage improvements may also be required.

Based on the expected final cost of the new commuter rail stations along the Fairmount Line at Four Corners and Talbot Avenue, the construction cost of a new commuter rail station would be approximately $15–17 million. At both those locations, construction requires widening a section of the right-of-way to accommodate station platforms. While a station platform for bus rapid transit would not have to be as long and would not need to be raised as high as a commuter rail platform, the cost of preparing the right-of-way to accommodate station platforms may be comparable, and in fact, a facility at Neptune Road may be even more complex because of the existing roadway bridge crossings at the potential station site and because of possible drainage issues. A lower-cost alternative would be to locate an East Boston local station closer to Frankfort Street; however, such a location would be very close to the Airport Station terminal.

Total potential capital costs for Alternative 2

- Construction of BRT right-of-way in Chelsea: $20 million
- Buses: $10 million (if existing fleet cannot be used for increased requirement)
- New station at Neptune Road in East Boston on Haul Road: $15–17 million

Alternative 3: New Silver Line Service to Bellingham Square via Local Roadway Network

The potential cost for vehicles would be identical to the cost of implementing Alternative 2. The remaining costs would include a new or improved shelter at the Bellingham Square terminal and one shelter in each direction at Eastern Avenue. The cost of three shelters would be $15,000 to $30,000. As is the case with Alternative 2, the inclusion of a bus rapid transit stop at Neptune Road/Day Square along the Haul Road itself would be high, given the need to widen the total right-of-way and possibly rebuild the bridges over the right-of-way at Bennington Street and Neptune Road.

Total potential capital costs for Alternative 3

- Shelters: $15,000 to $30,000
- Buses: $10 million (if existing fleet cannot be used for increased requirement)
- New station at Neptune Road in East Boston on Haul Road: $15–17 million.

SAP/sap/yb

FIGURE 1

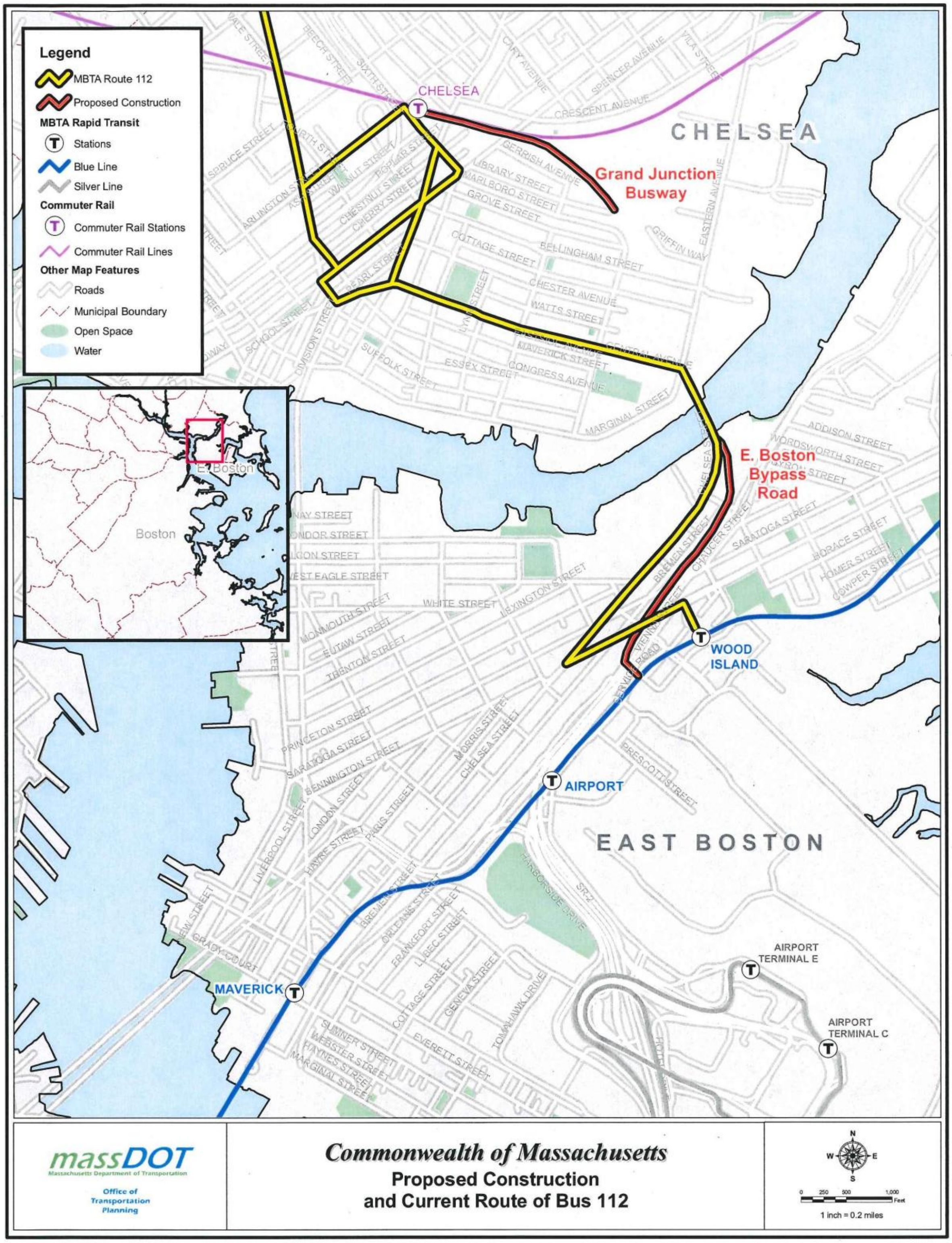
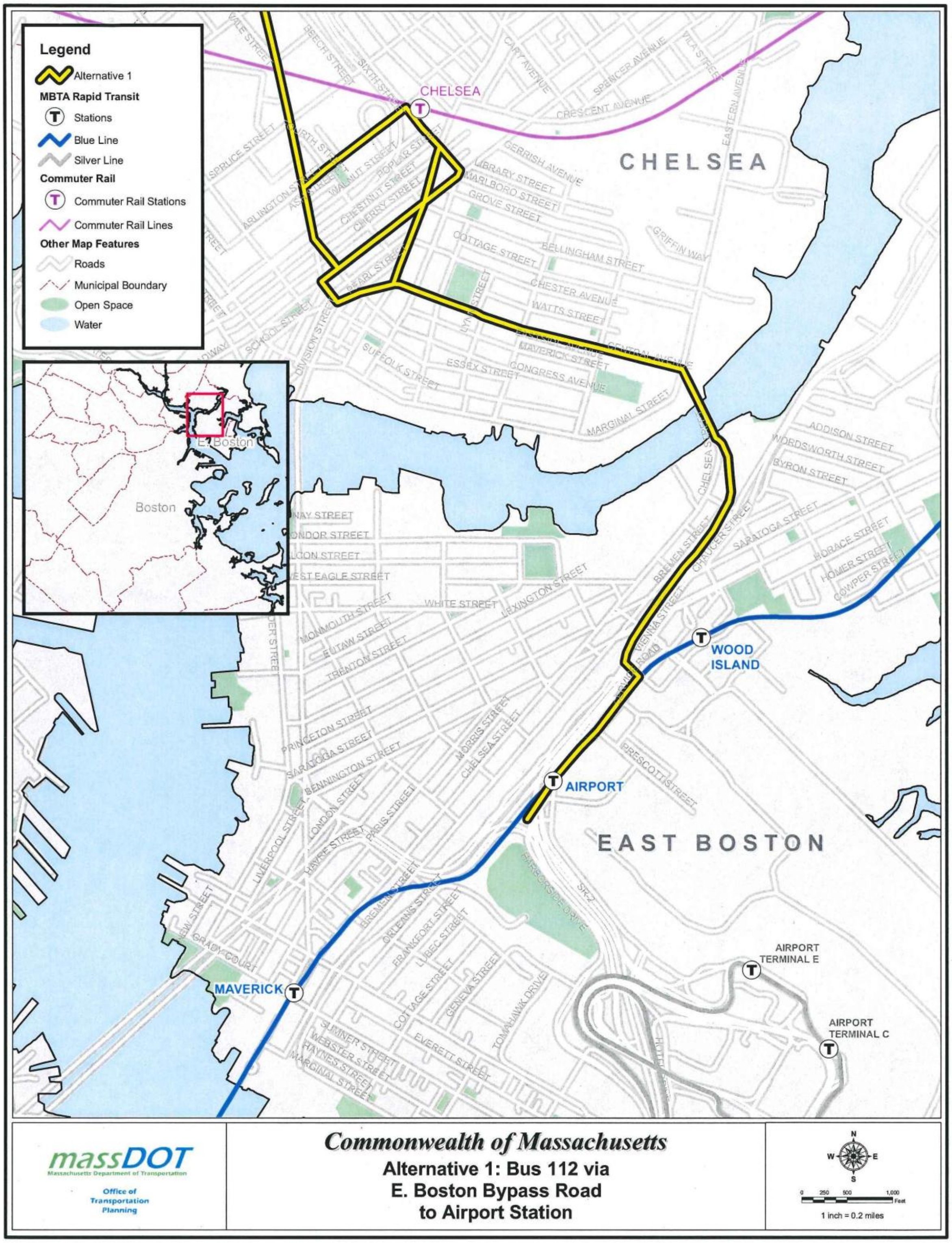

Legend
MBTA Route 112
Proposed Construction
MBTA Rapid Transit
Stations
Blue Line
Silver Line
Commuter Rail
Commuter Rail Stations
Commuter Rail Lines
Other Map Features
Roads
Municipal Boundary
Open Space
Water
CHELSEA
CHELSEA
Grand Junction Busway
E. Boston Bypass Road
WOOD ISLAND
AIRPORT
EAST BOSTON
AIRPORT TERMINAL E
AIRPORT TERMINAL C
MAVERICK
E. Boston
Boston
massDOT
Massachusetts Department of Transportation
Office of Transportation Planning
Commonwealth of Massachusetts
Proposed Construction
and Current Route of Bus 112
1 inch = 0.2 miles

FIGURE 2



Commonwealth of Massachusetts

Alternative 1: Bus 112 via E. Boston Bypass Road to Airport Station

FIGURE 3

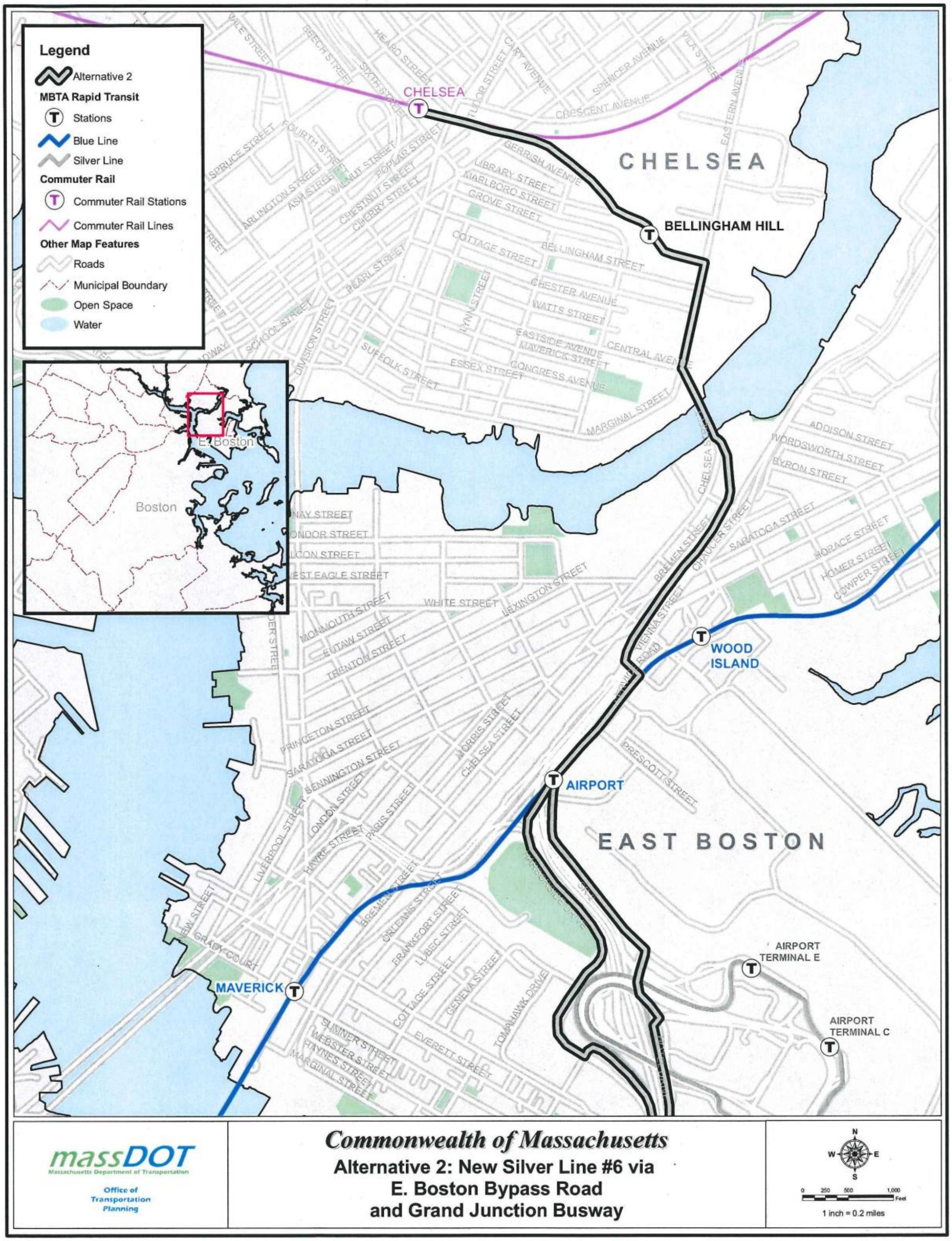

Legend
Alternative 2
MBTA Rapid Transit
Stations
Blue Line
Silver Line
Commuter Rail
Commuter Rail Stations
Commuter Rail Lines
Other Map Features
Roads
Municipal Boundary
Open Space
Water
E. Boston
Boston
CHELSEA
BELLINGHAM HILL
WOOD ISLAND
AIRPORT
MAVERICK
AIRPORT TERMINAL E
AIRPORT TERMINAL C
CHELSEA
EAST BOSTON
massDOT
Massachusetts Department of Transportation
Office of Transportation Planning
Commonwealth of Massachusetts
Alternative 2: New Silver Line #6 via
E. Boston Bypass Road
and Grand Junction Busway
N
S
W
E
1 inch = 0.2 miles

FIGURE 4

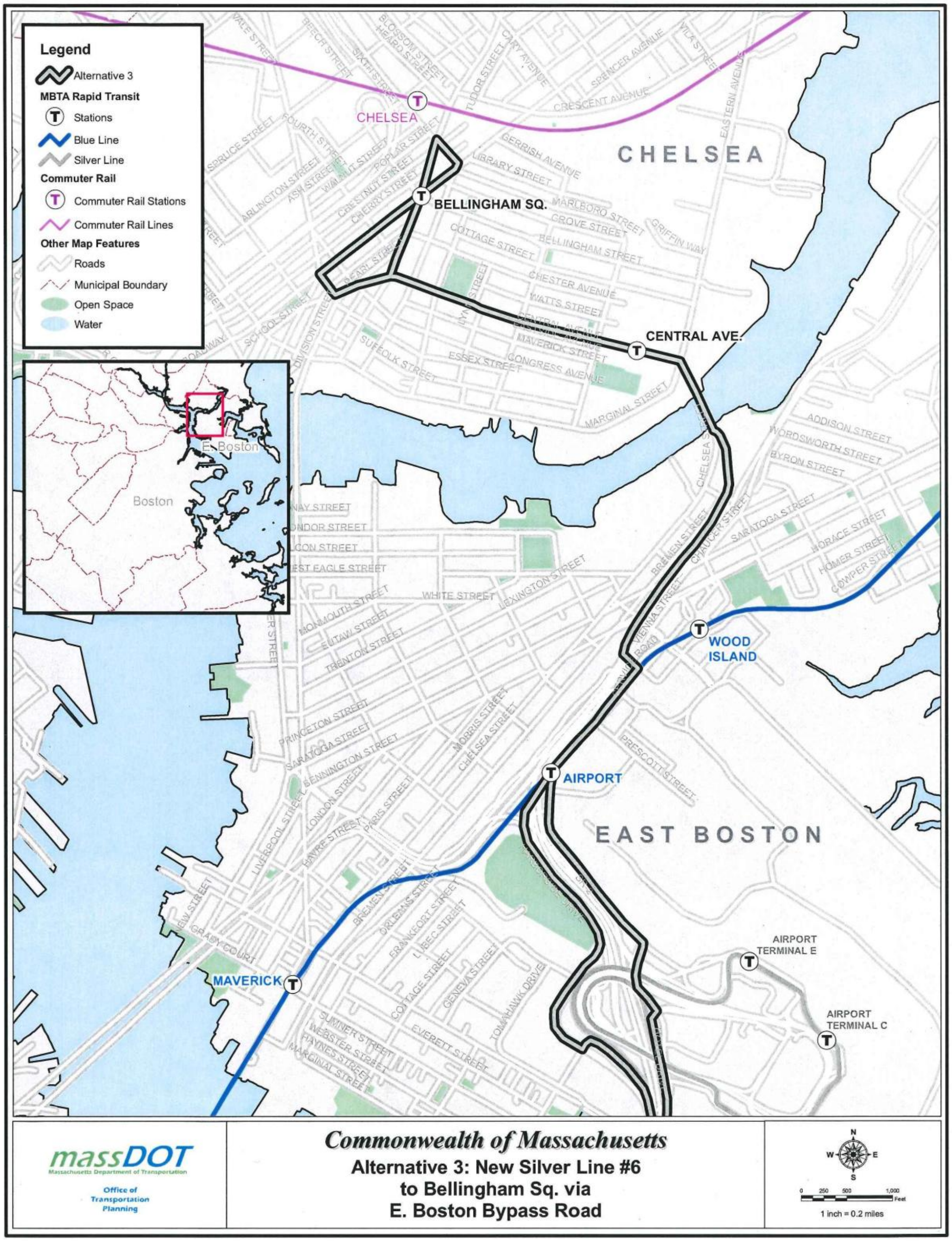

Legend
Alternative 3
MBTA Rapid Transit
Stations
Blue Line
Silver Line
Commuter Rail
Commuter Rail Stations
Commuter Rail Lines
Other Map Features
Roads
Municipal Boundary
Open Space
Water
E. Boston
Boston
CHELSEA
BELLINGHAM SQ.
CENTRAL AVE.
WOOD ISLAND
AIRPORT
MAVERICK
AIRPORT TERMINAL E
AIRPORT TERMINAL C
CHELSEA
EAST BOSTON
massDOT
Massachusetts Department of Transportation
Office of Transportation Planning
Commonwealth of Massachusetts
Alternative 3: New Silver Line #6
to Bellingham Sq. via
E. Boston Bypass Road
N
W
E
S
1 inch = 0.2 miles

TABLE 2
Silver Line to Airport Station and Chelsea Travel Demand Analysis

Boardings by Mode	2007 Base	2020 No-Build	Mixed Traffic on By-Pass Rd						Truck Traffic on By-Pass Rd					
			Alt 1a		Alt 2a		Alt 3a		Alt 1b		Alt 2b		Alt 3b	
			Boardings	Delta	Boardings	Delta	Boardings	Delta	Boardings	Delta	Boardings	Delta	Boardings	Delta
Linked Transit Trips	**900,000**	**1,030,000**	**1,030,240**	***240***	**1,030,600**	***600***	**1,030,500**	**500**	**1,030,240**	**240**	**1,030,620**	**620**	**1,030,510**	**510**
Commuter Rail Total	**100,500**	**114,400**	**114,360**	***-40***	**114,280**	***-120***	**114,340**	**-60**	**114,360**	**-40**	**114,260**	**-140**	**114,320**	**-80**
Chelsea Station	220	280	260	*-20*	220	*-60*	250	-30	260	-20	220	-70	240	-40
Rapid Transit Total	**692,400**	**762,500**	**762,700**	***200***	**763,250**	***750***	**762,980**	**480**	**762,700**	**200**	**763,310**	**810**	**762,930**	**430**
Blue Line Total	62,400	71,000	71,100	*100*	71,500	*500*	71,320	320	71,100	100	71,520	520	71,320	320
Wood Island	2,100	2,200	2,100	*-100*	2,050	*-150*	2,010	-190	2,100	-100	2,040	-160	2,000	-200
Airport	5,500	5,980	6,340	*360*	6,980	*1,000*	6,850	870	6,340	360	7,010	1,030	6,860	880
Maverick	8,300	9,160	8,950	*-210*	8,560	*-600*	8,640	-520	8,950	-210	8,550	-610	8,640	-520
Bus Rapid Transit	**25,600**	**36,500**	**36,500**	***0***	**38,800**	***2,300***	**38,520**	**2,020**	**36,500**	***0***	**38,870**	**2,370**	**38,560**	**2,060**
Other Silver Line Rtes (Including Dudley)	**25,600**	**36,500**	**36,500**	***0***	**34,520**	***-1,980***	**34,520**	**-1,980**	**36,500**	***0***	**34,520**	**-1,980**	**34,520**	**-1,980**
South Station to Chelsea	**na**	**na**	**na**	***na***	**4,280**	***4,280***	**4,000**	**4,000**	**na**	***na***	**4,350**	***4,350***	**4,040**	**4,040**
South Station	na	na	na	*na*	1,130	*1,130*	1,090	1,090	na	*na*	1,150	*1,150*	1,100	1,100
Court House	na	na	na	*na*	470	*470*	460	460	na	*na*	480	*480*	470	470
WTC	na	na	na	*na*	200	*200*	190	190	na	*na*	210	*210*	190	190
SLW	na	na	na	*na*	220	*220*	210	210	na	*na*	220	*220*	210	210
Logan (Blue Line)	na	na	na	*na*	1,000	*1,000*	870	870	na	*na*	1,000	*1,000*	870	870
Neptune	na	na	na	*na*	210	*210*	210	210	na	*na*	210	*210*	210	210
Eastern Ave	na	na	na	*na*	70	*70*	70	70	na	*na*	80	*80*	80	80
Chelsea CR	na	na	na	*na*	980	*980*	0	na	na	*na*	1,000	*1,000*	0	na
Chelsea City Hall	na	na	na	*na*	na	*na*	900	900	na	*na*	na	*na*	910	910
Bus	**344,800**	**410,400**	**410,630**	***230***	**409,230**	***-1,170***	**409,380**	**-1,020**	**410,630**	**230**	**409,180**	**-1,220**	**409,340**	**-1,060**
Study Area Bus Routes	**19,400**	**22,600**	**23,000**	***400***	**21,540**	***-1,060***	**21,670**	**-930**	**23,000**	**400**	**21,490**	**-1,110**	**21,640**	**-960**
Rt 111	8,700	8,900	8,840	*-60*	8,810	*-90*	8,800	-100	8,840	-60	8,800	-100	8,800	-100
Rt 112	1,200	1,700	2,580	*880*	1,480	*-220*	1,500	*-200*	2,580	*880*	1,460	*-240*	1,480	*-220*
Rt 114	1,000	1,000	940	*-60*	850	*-150*	900	-100	940	-60	850	-150	910	-90
Rt 116	4,400	5,700	5,500	*-200*	5,350	*-350*	5,390	-310	5,500	-200	5,340	-360	5,380	-320
Rt 117	4,100	5,300	5,140	*-160*	5,050	*-250*	5,080	-220	5,140	-160	5,040	-260	5,070	-230
MBTA Ferry Service	**4,400**	**4,800**	**4,800**	***0***	**4,800**	***0***	**4,800**	**0**	**4,800**	**0**	**4,800**	**0**	**4,800**	**0**
Unlinked transit trips by sub-mode	**1,167,700**	**1,328,600**	**1,328,990**	***390***	**1,330,360**	***1,760***	**1,330,020**	**1,420**	**1,328,990**	**390**	**1,330,420**	**1,820**	**1,329,950**	**1,350**
Average Daily Change from No-Build in Cash Revenue				***$ 700***		***$ 3,200***		***$ 2,600***		***$ 700***		***$ 3,300***		***$ 2,500***