Appendix 3.1-E

Modified Rapid Bus Alternative Technical Memorandum

Draft Technical Memorandum

Modified Rapid Bus Alternative

Prepared for

massDOT

Massachusetts Department of Transportation
10 Park Plaza
Boston, Massachusetts 02116

Prepared by

VHB *Vanasse Hangen Brustlin, Inc.*

99 High Street, 10th Floor
Boston, Massachusetts 02110

SCR
SOUTH COAST RAIL

May 2012

Table of Contents

List of Tables

List of Figures

This Page Intentionally Left Blank

1

Introduction and Background

In February 2011, the United States Army Corps of Engineers (USACE), in cooperation with the Massachusetts Department of Transportation (MassDOT) issued a Draft Environmental Impact Statement/Draft Environment Impact Report (DEIS/DEIR) for the South Coast Rail project. A number of alternative routes and alternative modes were presented in the DEIS/DEIR and in June 2011, the EOEEA issued a Certificate pursuant to Massachusetts Environmental Projection Act (MEPA) identifying the Stoughton Electric Alternative as the Preferred Alternative and the alternative that should be progressed through the Final Environmental Impact Report (FEIR). However, comments received on the DEIS/DEIR raised questions about the Rapid Bus Alternative that prompted the USACE to request additional analysis. The comments received on the DEIS/DEIR Rapid Bus Alternative were reviewed and can be summarized as follows:

- *Performance*: Travel speed of the DEIS/DEIR Rapid Bus Alternative was identified as too slow. The slow travel speed did not make the alternative competitive with rail. Further analysis of speed improvements was requested, including additional opportunities for the Rapid Bus Alternative to operate in its own designated lane or at higher speeds. Overall reductions in travel time would be the objective of these modifications.
- *Congestion*: It was noted that the Rapid Bus Alternative was subjected to congestion "hot spots," which would affect its projected travel time and reliability. It was suggested that the Rapid Bus Alternative include additional measures to address congestion.

- *Ridership*: Ridership on the Rapid Bus Alternative was noted as being lower than the Commuter Rail alternatives. The May 2010 memo from Central Transportation Planning Staff (CTPS) accompanying the projections indicated there were five major factors contributing to lower performance measures than the Commuter Rail alternatives including:
  - Run times are longer to South Station;
  - The Commuter Rail alternatives serve several more stations;
  - Lack of connectivity with the Orange Line;
  - Transfer times between the Rapid Bus Alternative and the rapid transit lines are a little longer than with the commuter lines;
  - Fewer new stations are being provided in areas of projected growth; and
  - Lack of intra-regional connectivity/no intermediate stations.

The goal of this memorandum is to address these comments. This memorandum reevaluated the DEIS/DEIR Rapid Bus Alternative and the opportunities available to improve its service and make it a more attractive alternative that more closely matches what the rail alternatives achieve. This new Modified Rapid Bus Alternative was then compared against the Preferred Alternative as outlined in the Secretary's Certificate. More specifically, the evaluation addressed the following questions on the Modified Rapid Bus Alternative:

- Does the alternative meet the project purpose?
- Is it practicable as defined in 40 C.F.R. 2310.10?
- Is it the least environmentally damaging?

2

DEIS/DEIR Rapid Bus Alternative

The following sections describe the Rapid Bus Alternative as it was developed and presented in the South Coast Rail project DEIS/DEIR focusing on the infrastructure, operating plan, construction, ridership, cost, and the environmental impacts.

2.1 Infrastructure

This section outlines the infrastructure proposed of the Rapid Bus Alternative in the DEIS/DEIR. It summarizes the improvements to the guideway, proposed stations, and the midday/overnight layover facility. Figure 1 shows the location of the guideway and stations of the DEIS/DEIR Rapid Bus Alternative.

2.1.1 Guideway

The DEIS/DEIR Rapid Bus Alternative alignment would use the existing Route 140 and Route 24 highway corridors from New Bedford and Fall River, a proposed dedicated bus lane along Route 24 from I-495 to I-93 and along I-93 to the existing Zipper Lane, which starts at the Braintree Split. The DEIS/DEIR Rapid Bus would travel along the Zipper Lane until its terminus in Savin Hill where it would merge into a section of mixed traffic on I-93 and enter again into an HOV lane that brings the buses into the South Station Bus Terminal. Figure 1 outlines this guideway.

This alignment would require:

- Route 24 mainline widening between Route 140 and I-495 to accommodate new general purpose lanes;
- Route 24 mainline widening between Route 139 and I-93 to accommodate a new median bus Zipper Lane;

- An I-93 barrier-separated, permanent, single reversible bus lane in the median of I-93/Route 24 from the Route 139 interchange to the Logan Express lot;
- Separate single-direction bus ramps within the I-93 interchange area ;
- A bus-only connection to the Logan Express lot via a flyover from I-93;
- A two-lane, two-way barrier separated bus lane on I-93 between the Logan Express Lot and the I-93 existing Zipper Lane; and
- Interchange modifications.

2.1.2 Stations

The DEIS/DEIR Rapid Bus Alternative included six new stations in the corridor as well as serving an expanded South Station in Downtown Boston as shown in Figure 1:

- Whale's Tooth
- Kings Highway
- Fall River Depot
- Freetown
- Galleria
- Downtown Taunton

Each station would provide ADA compliant access with canopies/shelters, parking, drop-off areas and bus access. South Station would be the downtown terminal for all Rapid Bus Alternative service. Because South Station's bus terminal is at capacity, it would be expanded to accommodate the Rapid Bus Alternative vehicles and passengers.

2.1.3 Midday and Overnight Layover Facilities

A site for a midday and overnight layover facilities would be required to support the DEIS/DEIR Rapid Bus Alternative. The site identified for the midday layover was the Logan Express site on I-93 in Braintree. The Logan Express site is currently used as a park-and-ride station for buses serving Logan Airport. About 35 to 40 buses would use this site. Direct bus access ramps between the site and the I-93 exclusive busway would be constructed. A parking deck would be required to replace park-and-ride spaces lost to bus storage.

It was assumed that the contract bus provider would secure an overnight layover facility and include the cost of acquiring and operating the site as part of the contract bid. The overnight storage and maintenance facilities for the Rapid Bus Alternative would be close to the South Coast and Taunton terminals with enough space to accommodate the 60-bus fleet.

2.2 Operations

This section describes the DEIS/DEIR Rapid Bus Alternative operating plan, which focused on the proposed service, the stations locations, travel time and frequency, and the fleet that would be required. Rapid Bus Alternative service would be operated by a private contractor.

2.2.1 Service

The DEIS/DEIR Rapid Bus Alternative would operate four routes and serve the following stations:

- New Bedford Route stopping at stations:
  - Whale's Tooth
  - King's Highway
  - South Station
- Taunton (Galleria) Route stopping at stations:
  - Galleria Station
  - South Station
- Fall River Route stopping at stations:
  - Fall River
  - Freetown
  - South Station
- Downtown Taunton Route stopping at stations:
  - Downtown Taunton
  - South Station

Each route would provide peak-period peak-direction service on 15-minute headways with hourly service in the reverse direction during the peak periods. During off-peak periods hourly service would be provided in both directions. Figure 2 shows the service pattern provided by the DEIS/DEIR Rapid Bus Alternative. Table 1 provides the estimated end-to-end travel time for each route.

Table 1 DEIS/DEIR Rapid Bus Alternative Travel Time

Routes	Estimated Travel Time (hr:min)
New Bedford	1:43
Fall River	1:31
Downtown Taunton	1:08
Galleria Station	1:06

2.2.3 Fleet

The DEIS/DEIR Rapid Bus Alternative would need 58 buses to operate its planned service. The buses would be over-the-road buses with amenities that include seating for all passengers, restrooms, reading lights, individual air controls, WiFi and other regional bus comfort amenities.

2.3 Logistics/Construction Impacts

The DEIS/DEIR Rapid Bus Alternative would require about 4.5 years to construct and would be largely focused on reconstructing Route 24 to accommodate the reversible bus lane, the flyovers on Route 24 to I-93 and the I-93 flyover across the Braintree Split. All the bridges and interchanges from Route 140 to I-93 would be reconstructed to accommodate the widening. Construction staging would require Traffic Management Plans on these roadways to ensure temporary construction impacts are minimized on the regional transportation network.

2.4 Ridership

The DEIS/DEIR Rapid Bus Alternative was projected to have a daily ridership potential of 4,200 riders with a net increase in transit boardings of 1,700 in 2030. Table 2 provides the daily inbound boardings by station as well as other summary information.

Table 2 DEIS/DEIR Daily Ridership Projection (2030)

Stations	Daily Boardings
Whales Tooth	580
Kings Highway	280
Fall River Depot	420
Freetown	290
Galleria	130
Downtown Taunton	400
Total Daily Station Inbound Boardings	2,100
Total Daily Ridership	4,200
Total Daily New Transit Boardings	1,700

2.5 Cost

Estimated capital costs include the cost of new infrastructure such as modification to bridges, the highway, stations and the new Zipper Lane as well as the cost of new buses. The cost to expand the South Station bus facility and the Logan Express lot were also included. The DEIS/DEIR Rapid Bus Alternative cost was calculated in present year capital costs and escalated to mid-year of construction. As shown in Table 3, capital cost for the DEIS/DEIR Rapid Bus Alternative would be an estimated $812 million.

Table 3 DEIS/DEIR Rapid Bus Alternative Costs

Total Infrastructure Cost	$449,777,000
Real Estate Cost	$12,770,000
Eng./Services Cost	$60,945,000
Contingency	$142,579,000
Vehicle Cost	$34,800,000
Total	$700,871,000
Year-of-Expenditure	$811,579,000
O&M Cost	$39,600,000/year

Notes: Total infrastructure costs were estimated in 2009 dollars.
Professional services are13.55% of infrastructure costs without contingency.
Professional services include Design, Permitting, Construction Phase Inspection & Project Management.
Contingencies are 31.70% of infrastructure costs and include Indirect Soft Costs, Mitigation Contingency, and Construction Contingency.
Escalation was calculated at 3.25% per year +

Operating and Maintenance (O&M) costs include the cost to operate the buses and maintain the Rapid Bus Alternative infrastructure including stations and dedicated Rapid Bus Alternative zipper and permanent lanes. The annual O&M costs (2009 $) for the DEIS/DEIR Rapid Bus Alternative were estimated to be $39.56 Million.

2.6 Environmental Impacts

The environmental impacts of the DEIS/DEIR Rapid Bus Alternative can be summarized as follows:

- A loss of 21.5 acres of wetlands, 4.0 acres of which are located in Areas of Critical Environmental Concern (ACEC);
- A loss of 16.3 acres of priority habitat for three state-listed species;
- A loss of 4.5 acres of Article 97 public open space; and
- An anticipated annual $41,638 municipal tax loss.

In addition, the Rapid Bus Alternative had lowest reduction in vehicle miles traveled (VMT) with 81,500 miles/day and the lowest air quality benefits with a 9.3 kg/day reduction in volatile organic compounds (VOCs) and a 6,588 tons/year reduction in carbon dioxide (CO_{2}).

3

Modified Rapid Bus Alternative

Based on the comments received on the DEIS/DEIR Rapid Bus Alternative, the new Modified Rapid Bus Alternative would reduce travel times, increase reliability, and connectivity by:

- Eliminating bottlenecks associated with the Zipper Lane;
- Improving connection to Back Bay employment area by directly routing some service; and
- Provide additional Rapid Bus Alternative stations in the vicinity of stations proposed for the Commuter Rail alternative, specifically the Raynham and Easton areas.

An array of alternatives was considered to accomplish these changes. A detailed evaluation was conducted on each alternative based on the criteria established in the DEIS/DEIR. The changes that were selected and are now part of the Modified Rapid Bus Alternative are described in the next sections.

3.1 Infrastructure

This section outlines the infrastructure requirements for the Modified Rapid Bus Alternative including improvements to the guideway, the proposed new stations, and the midday/overnight layover facility.

3.1.1 Guideway

Many of the components of the Modified Rapid Bus Alternative would remain unchanged from the DEIS/DEIR Rapid Bus Alternative. The unchanged guideway elements are:

- Use existing Route 140 and Route 24 highway corridors from New Bedford and Fall River to I-495 along Route 24 in Taunton;
- Widen Route 24 from two to three general purpose lanes in each direction between Route 140 and I-495 in Taunton;
- Provide a barrier-separated, permanent, single reversible bus lane in the median of I-93 and Route 24 from I-495 on Route 24 in Taunton through the I-93 in Canton to the Logan Express lot in Braintree;
- Provide separate single-direction bus ramps within the Route 3/I-93 interchange (the Braintree Split);
- Provide a bus-only connection to the Logan Express lot in Braintree via a flyover from I-93;
- Provide a two-lane, two-way barrier separated bus lane on I-93 between the Logan Express lot and the I-93 existing Zipper Lane; and
- Expand/deck the Logan Express lot to replace parking spaces lost to bus staging.

The following sections describe changes to the guideway from the DEIS/DEIR Rapid Bus Alternative.

3.1.1.1 Route 24

The Modified Rapid Bus Alternative changes the Route 24 Zipper Lane, replacing it with a permanent, reversible exclusive bus lane. Zipper Lane was a technology proposed to replicate the existing high-occupancy vehicle (HOV) facility on I-93 from Braintree to Boston. HOV facilities are typically designated for vehicles with two or more passengers. This HOV lane is assembled for the morning and evening peak periods by “borrowing” a lane from the non-peak direction and installing a temporary barrier that allows the peak direction to use it as an HOV lane. For instance, in the morning when traffic is predominantly traveling to the north from the South Shore areas to Boston, one southbound travel lane is taken to provide the northbound HOV lane. This technology was envisioned for a segment of the DEIS/DEIR Rapid Bus Alternative alignment, as well, and included a new 15-mile Zipper Lane on Route 24 between I-495 in Taunton and Route 139 in Stoughton.

Since publication of the DEIS/DEIR, MassDOT has indicated the proposed Route 24 Zipper Lane is no longer an operationally viable improvement. At more than double the length of the existing I-93 Zipper Lane, it was judged to have significant long-term operational, maintenance and reliability issues[1]. Therefore, the Modified Rapid Bus Alternative would include a barrier-separated, permanent, reversible lane in the median of Route 24. Route 24 would be widened to provide a 22-foot median (inside dimension) with a 10-foot right shoulder and 4-foot left shoulder in both the northbound and southbound directions. The exclusive bus lane would be increased to 21 miles with 2-foot wide barriers on either side. Figure 3 depicts the DEIS/DEIR and the Modified Rapid Bus Alternative cross-sections for this segment of Route 24. The overall Route 24 roadway width including the Modified Rapid Bus Alternative guideway would be 126 feet, which is 8 feet narrower than the DEIS/DEIR Rapid Bus Alternative cross-section as the shoulder and the travel lanes would be reduced 2 feet each.

3.1.1.2 Bridging the I-93 Zipper Lane to South Station Gap

There are two HOV facilities on I-93 between Braintree and Boston. The southern HOV facility extends from Braintree to just south of the MBTA Savin Hill Station in Boston and provides alternating northbound and southbound HOV travel in a moveable Zipper Lane that “borrows” roadway capacity from a non-peak direction lane during peak periods. The northern HOV facility (South Station HOV) is a permanent, two-lane (one in each direction) facility that begins on I-93 at the Massachusetts Avenue Connector and continues to I-90 eastbound, South Station and the Kneeland Street at Lincoln Street intersection. The gap between the HOV facilities is approximately two miles.

The DEIS/DEIR Rapid Bus Alternative was proposed to use both of these facilities. However, like all I-93 HOV traffic today, the buses would merge into the I-93 general purpose lanes at the exit of the Zipper Lane, travel in the general purpose lanes and then enter the north HOV facility to access South Station. This merge into general traffic results in significant congestion in both the Zipper Lane and the general purpose lanes.

According to the Central Transportation Planning Staff (CTPS), 2030 future conditions result in further deterioration of traffic conditions through this area. Under 2030 future conditions, the Zipper Lane is expected to provide little to no

▼

[1] [1] Per 12/16/11 meeting with Frank DePaola, Massachusetts Department of Transportation

travel time savings over the general purpose lanes. The DEIS/DEIR Rapid Bus Alternative operations reflected this projected change.

The Modified Rapid Bus Alternative evaluated design alternatives that would bridge this gap and improve future flow through this area. However, this section of I-93 is constrained by many elements that have previously precluded connecting these two HOV facilities. These constraints include:

- Immediately east of the highway:
  - Savin Hill Bay
  - McConnell Park
  - Savin Hill neighborhood including Environmental Justice communities
- Immediately west of the highway:
  - MBTA Savin Hill Station
  - Four MBTA Red Line Tracks
  - One MBTA Commuter Rail Track
  - Savin Hill/Columbia neighborhood including Environmental Justice communities

The following sections describe the design alternatives that work within these constraints, the impacts of these alternatives on the immediate area and on regional transportation, and summarizes with a conclusion that bridging this gap is not a practicable improvement for the Modified Rapid Bus Alternative.

Design Alternatives

Four alternatives were evaluated that could potentially bridge the I-93 HOV gap for the Modified Rapid Bus Alternative.

- ***Alternative 1, The "Commitment" Alternative*** – This alternative was developed to assess the maximum travel time benefit for this segment of I-93. The connection would be provided by constructing a reversible HOV lane that does not allow entry or exit from Braintree to South Station. This "commitment" would maximize the speed through this section for both the HOV lane and the general purpose lanes (merges and diverges contribute greatly to highway delay so eliminating them maximizes flow). The "commitment" from Braintree to South Station, however, would displace some HOV vehicles not destined to South Station. Figure 4 highlights the configuration and operation of this alterative. Figure 5 demonstrates the widening required for this alternative and shows the widening into existing rail infrastructure in Savin Hill; these impacts will be discussed in greater detail in later sections.

- ***Alternative 2, The "Maintain Exit at Savin Hill" Alternative*** – This alternative would also provide a reversible HOV lane between the two existing HOV systems but would maintain the access points in the vicinity of Savin Hill and the Massachusetts Avenue Connector for commuters not destined for South Station. The purpose of this alternative is to assess what travel time savings can be achieved without altering who uses the lanes today. Figure 6 highlights the configuration and operation of this alterative. Figure 7 demonstrates the widening required for this alternative and shows the widening into existing rail infrastructure in Savin Hill; these impacts will be discussed in greater detail in later sections.
- ***Alternative 3, The "HOV Lanes in Both Direction" Alternative*** – The goal of this alternative is to provide permanent infrastructure that would not require reversing direction of a single HOV lane; this alternative would provide a permanent two-directional solution by constructing HOV lanes in both directions of the highway. The lanes would not be barrier separated from the general purpose lanes, which would require less widening. Figure 8 highlights the configuration and operation of this alterative. Figure 9 demonstrates the widening required for this alternative and shows the widening into existing rail infrastructure in Savin Hill; these impacts will be discussed in greater detail in later sections.
- ***Alternative 4, The "Minimalist" Alternative*** – This alternative attempts to improve the Zipper Lane travel time without significant infrastructure improvements. It would make only an operational change where the Zipper Lane merges with the general purpose lanes in Savin Hill. To make this exit more efficient for the Zipper Lane, the general purpose lanes would merge from four lanes to three and allow the Zipper Lane to exit in its own auxiliary lane. It was determined that this alternative would improve the operation of the Zipper Lane, but it would cause a queue in the general purpose lanes that would have regional transportation impacts. Figure 10 highlights the configuration and operation of this alterative. No widening would be required in the Savin Hill area (See Figure 11).

Impacts and Costs

Although these alternatives would provide improvements to the operation of the HOV lane, they would have significant impacts on regional transportation or significant costs that would make them impracticable. The following sections describe this in further detail.

Highway Impacts

As shown in Figures 5, 7 and 9, Alternatives 1, 2 and 3 would require widening I-93 by 40 to 50 feet from approximately the Savin Hill area to the Massachusetts Avenue

Connector. The widening would accommodate the connection between the existing Zipper Lane and the South Station HOV lane and would require:

- Reconstructing approximately ¼ mile of the I-93 viaduct;
- Rebuilding seven overhead bridges and two undergrade bridges;
- Shifting and reconstructing two on-ramps and four off-ramps; and
- Tunneling approximately ½ mile of the Commuter Rail.

VISSIM traffic simulation prepared for this analysis showed that Alternatives 1, 2 and 3 would increase flow on I-93 through this section and would provide a travel time savings over 2030 projections for both HOV traffic and general purpose traffic. Table 4 shows these travel time savings.

As shown in Figure 11, Alternative 4 would not require highway widening in Savin Hill, the most constrained area of the HOV lane gap. This alternative would instead alter the operation at the merge of the Zipper Lane with the general purpose lanes. However, in order to increase flow through the area, I-93 would be widened north of Savin Hill to accommodate auxiliary lanes that ease flow upstream of Savin Hill. Two bridges, two on-ramps, and two off-ramps would be reconstructed for this widening.

VISSIM traffic simulation of the Alternative 4 improvements show that while these improvements would increase flow for HOV traffic coming out of the Zipper Lane, it would have significant impact on the general purpose lanes. Table 4 shows this impact on the general purpose lane travel time. Slowing general purpose lanes through this already congested section of I-93 would have a significant impact on regional transportation and regional air quality. MassDOT is committed to make no alterations to I-93 that would impact regional transportation and regional air quality.

It should be noted that the VISSIM traffic simulation also showed that the Zipper Lane in the 2030 No-Build and with each alternative could not process all the general HOV traffic entering from the Braintree Split. Should the Modified Rapid Bus Alternative become the Preferred Alternative, the proposed Braintree Split bus flyover and the bus merge with general HOV traffic would need to be expanded to include additional infrastructure. This additional infrastructure was not included in the capital cost estimate of the Modified Rapid Bus Alternative.

Table 4 Braintree Split to Boston Travel Times per Alternative

	Travel Times (m:ss)					
	Existing	2030 No Build	2030 Alternative 1	2030 Alternative 2	2030 Alternative 3	2030 Alternative 4
Zipper/HOV Lane	15:47	24:52	11:10	16:08	16:04	14:14
General Purpose Lanes	21:32	26:49	22:49	24:23	25:42	30:47

The regional transportation impact of Alternative 4 would make this alternative an impracticable solution for the Modified Rapid Bus Alternative. Alternatives 1, 2, and 3 would improve travel time; however, their impact on adjacent transit operation in order to provide this travel time savings are significant and are discussed in the next section.

Transit Impacts

Widening I-93 in the Savin Hill area would be feasible but difficult and it would impact the MBTA Savin Hill Station, four MBTA Red Line tracks (two tracks service Ashmont and two tracks serving Braintree) and one MBTA Old Colony Commuter Rail Line track; MBTA infrastructure through Savin Hill abuts I-93 for 1 ½ miles.

As shown in Figures 5, 7 and 9, widening the highway to accommodate Alternatives 1, 2 and 3 would require widening onto MBTA right-of-way and would significantly impact the MBTA service. MBTA tracks would need to be combined, tunneled, or both combined and tunneled in order to accommodate this widening.

Many alternatives were considered to determine the most feasible and cost-effective solution. One option considered tunneling the two MBTA Red Line Braintree tracks and one Commuter Rail track. Another option considered relocating the Red Line Braintree tracks, merging them with the Ashmont tracks, and tunneling only the Commuter Rail track. A new flyover structure for the Braintree tracks would be constructed to pass over the Commuter Rail track and the inbound Ashmont track. Of these design alternatives, it was determined that the second option would be more feasible and cost-effective as it would require tunneling only the Commuter Rail track.

This alternative would have transit impacts on all three MBTA services. While Ashmont service and the Commuter Rail would experience some service disruptions and weekend outages, the Braintree service would be significantly more impacted; service to Braintree would be suspended for more than one year. Alternative shuttle transportation would need to be provided during this shutdown and this would have significant regional transportation impacts to South Shore communities.

The regional transportation impacts of Alternatives 1, 2, and 3 would make these alternatives impracticable solutions for the Modified Rapid Bus Alternative. While Alternative 4 does not require any transit shutdown, it would have regional transportation impact on the general purpose lanes that make Alternative 4 also an impracticable solution for the Modified Rapid Bus Alternatives.

Environmental Impacts

All of the alternatives would require property acquisitions. Alternatives 1, 2, and 3 requiring the most (up to 14 private property acquisitions), eight of which are in environmental justice neighborhoods. These alternatives would also acquire the Boston Collegiate Charter School. Potential job losses and loss of property tax revenue would be expected. Alternatives 1, 2, and 3 also would move the highway closer to environmental justice residential neighborhoods for a length of approximately ½ to ¾ mile, which would increase noise levels. This impact would be somewhat offset by noise levels reduced by a new Commuter Rail tunnel.

Alternative 4 would require seven private-property acquisitions, none within environmental justice neighborhoods. However, Alternative 4 would move the highway closer to environmental justice residential neighborhoods for a length 550 feet. Alternative 4 would also impact the Washburn Street Green and General Casimir Pulaski Square for highway widening north of Savin Hill. The General Casimir Pulaski Square is a memorial to a Revolutionary War hero of Polish descent, and is located adjacent to the Polish America Citizen Club. Acquiring a portion of the Washburn Street Green and General Casimir Pulaski Square would impact the public's use of these properties, could trigger Article 97 review, and would likely be subject to Article 97 and Section 4(f) requirements. The General Casimir Pulaski Square likely does not qualify for Article 97 protection because it is not used for conservation or recreation purposes. This site would, however, likely qualify for Section 4(f) protection if the project were subject to approval by one of the federal Department of Transportation agencies (FHWA, FTA, FRA). Washburn Street Green's function as a recreation area and buffer from the highway would be diminished. General Casimir Pulaski Square would be entirely taken, removing this facility from public use. The locations of these two facilities within environmental justice communities mean that the loss of their use for Alternative 4 could be considered a disproportionate impact to the environmental justice populations, since there would not be similar losses in non-environmental justice neighborhoods. The Washburn Street Green is location-specific and its function as a neighborhood resource could not be replaced by a similar facility at another location without acquiring and demolishing residences. Replacement of this facility is considered infeasible.

In addition, shutting down and shuttling MBTA Red Line Braintree service for a period of more than one year can have a significant impact on environmental justice populations in South Shore communities, who rely on transit to access jobs, schools, and health care services as well as social and cultural events. Environmental justice populations would be disproportionately impacted by a disruption of these transit services for Alternatives 1, 2, or 3.

Costs

The estimated order-of-magnitude capital cost for construction of each of the I-93 alternatives is shown in Table 5. The estimate for mid-point of construction is included, as well.

Table 5 I-93 Alternatives Capital Costs

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Total Infrastructure Cost ($M)	$625	$624	$625	$15
Real Estate Cost ($M)	$11	$11	$11	$5
Eng./Services Cost ($M)	$84	$84	$84	$2
Contingency ($M)	$313	$312	$313	$5
Total ($M)	$1,033	$1,031	$1,033	$27
Mid-Year of Construction ($M)	$1,212	$1,210	$1,212	$31

As shown in Table 5, Alternatives 1, 2, and 3 would be more than $1 billion to construct, which would make the improvements cost-prohibitive and impracticable for the Modified Rapid Bus Alternative. While Alternative 4 is a less costly option, it has regional transportation impacts that make that alternative also impracticable for the Modified Rapid Bus Alternative.

Conclusions

It was concluded that the alternatives that require widening the highway and tunneling the Commuter Rail (Alternative 1, 2 and 3) would cause unacceptable impacts to regional transportation and environmental justice communities while significantly increasing the construction costs. These alternatives, therefore, would be impracticable for the Modified Rapid Bus Alternative. Alternative 4 would increase general purpose travel time, which would have regional transportation impacts and regional air quality impacts that make that operational change alone also impracticable for the Modified Rapid Bus Alternative. In addition, MassDOT is committed to make no alterations I-93 that that would have negative impacts on regional transportation and air quality.

For these reasons, the Modified Rapid Bus Alternative would not include any of the infrastructure or operational changes considered here to close the I-93 HOV gap; in terms of this gap, the Modified Rapid Bus Alternative would be unchanged from the DEIS/DEIR Rapid Bus Alternative.

3.1.2 Stations

The stations identified in the DEIS/DEIR Rapid Bus Alternative would remain in the Modified Rapid Bus Alternative. In addition, there would be two new stations in the South Coast region, one equivalent to the rail alternatives' Raynham Place Station at Exit 16 in West Bridgewater and the other equivalent to the rail alternatives' Easton Station at Exit 18 in Brockton. Back Bay Station would also be added to the alternative and would provide a direct connection to the Orange Line and the Back Bay employment area. The Modified Rapid Bus Alternative would, therefore, include the following stations:

- Whale's Tooth
- King's Highway
- Fall River Depot
- Freetown
- Galleria
- Downtown Taunton
- West Bridgewater
- Brockton
- South Station
- Back Bay

Alternative locations for potential, additional Modified Rapid Bus Alternative stations in or near Raynham and Easton were also evaluated. Existing park-and-rides, vacant parcels and underutilized parcels were all reviewed for potential station siting. Proposed, new station locations were selected based on the availability of property near an existing Route 24 interchange, that avoids wetland impacts and can support an in-line station with adjacent park-and-rides with access from local street networks.

The Brockton and West Bridgewater in-line stations would be located within the Route 24 right-of-way. They would offer the Modified Rapid Bus Alternative easy access with a ramp from the reversible bus lane, which would save travel time by not requiring the buses to have to get on and off the highway. Commuters would access the stations' park-and-ride from local street networks and would access the stations' platform via a pedestrian bridge. Figure 13 depicts a cross-section of how Brockton and West Bridgewater Stations would be designed for the alternative. Figure 14 shows the location of these stations.

3.1.2.1 West Bridgewater Station

The West Bridgewater Station would located on a privately help undeveloped area north of West Street. The West Bridgewater Station would acquire 5.49 acres (portions of four parcels) of privately property. No residential, business, or community facility displacements would result from these acquisitions for the West Bridgewater Station.

3.1.2.2 Brockton Station

The Brockton Station would be located on Oak Street, adjacent to an existing parking lot and industrial building. The Brockton Station would acquire 2.35 acres (approximately 16 percent) of one privately held property. No residential, business, or community facility displacements would result from this acquisition for the Brockton Station.

3.1.2.3 Back Bay

Back Bay Station was also added to the Modified Rapid Bus Alternative. A connection to Back Bay would more closely match the service provided by the rail alternatives and would provide a direct connection for the South Coast communities to the employment area in the Back Bay area of Boston. The Back Bay area of Boston, served by the Orange Line, is second only to South Station in terms of office market size.

3.1.3 Midday and Overnight Layover Facilities

The Logan Express site on I-93 in Braintree was identified as the site for the Rapid Bus Alternative midday layover as part of the DEIS/DEIR. Bus and Logan Express parking on this site would need to be expanded to accommodate the additional buses estimated for the Modified Rapid Bus Alternative. It is also anticipated that an overnight layover facility would need to be acquired for the alternative. Previously, it was assumed that a private operator would provide the Rapid Bus Alternative service and would use their existing facilities. However, no private operator has an overnight facility in the South Coast Region that would be able to accommodate all the buses for the Modified Rapid Bus Alternative. Therefore, it is assumed that the Modified Rapid Bus Alternative would carry the cost of this overnight facility.

3.2 Operations

The DEIS/DEIR Rapid Bus Alterative operations were modified to accommodate local and express service that provide interregional connectivity. The following sections describe the operating plan of the Modified Rapid Bus Alternative including interregional connections, travel times, frequency and the fleet required to provide this service.

3.2.1 Service Plan

The Modified Rapid Bus Alternative would operate multiple routes as shown in Table 6.

Table 6 Modified Rapid Bus Alternative Operations

	EXPRESS ROUTES												LOCAL ROUTES									
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Whale' s Tooth	●	●											●	●					●		●	
Kings Highway			●	●									●	●					●		●	
Fall River Depot					●	●									●	●				●		●
Freetown							●	●							●	●				●		●
Galleria									●	●			●	●	●	●			●	●	●	●
Downtown Taunton											●	●					●	●	●	●	●	●
West Bridgewater													●	●	●	●	●	●	●	●	●	●
Brockton													●	●	●	●	●	●	●	●	●	●
South Station	●		●		●		●		●		●		●		●		●		●	●		
Back Bay		●		●		●		●		●		●		●		●		●			●	●

The routes and stops summarized in Table 6 were developed to enhance the DEIS/DEIR Rapid Bus Alternative operating plan that provided express service but did not provide interregional connectivity. To provide interregional connectivity, the Modified Rapid Bus Alternative would operate with both local and express service. As shown in Table 6, an example of express service would be Route 1. It would make only two stops; it would pick up passengers at Whale's Tooth Station and travel express to South Station. Route 13, on the other hand, would provide a local service starting at Whale's Tooth Station and making stops at Kings Highway, Galleria, West Bridgewater, Brockton, and South Station. The local routes would provide a more robust regional connectivity for the South Coast region than what was provided in the DEIS/DEIR Rapid Bus Alternative.

Figure 15 shows a schematic of express and local services the Modified Rapid Bus Alternative would provide. Each route would operate peak-period peak-direction service with 15-minute headways and hourly service in the reverse direction during the peak. During off-peak periods hourly service would be provided in both directions. Table 7 provides the estimated end-to-end travel time for each route.

Table 7 Modified Rapid Bus Alternative Travel Time and Frequency

Route	Estimated Travel Time (hr:min) Local Service	Express Service
Whale's Tooth to South Station	1:30	1:18
Whale's Tooth to Back Bay	1:37	1:25
Kings Highway to South Station	1:14	1:09
Kings Highway to Back Bay	1:21	1:17
Fall River Depot to South Station	1:26	1:11
Fall River Depot to Back Bay	1:33	1:18
Freetown to South Station	1:05	1:00
Freetown to Back Bay	1:12	1:07
Downtown Taunton to South Station	1:04	1:00
Downtown Taunton to Back Bay	1:12	1:08
Galleria Station to South Station	1:01	0:56
Galleria Station to Back Bay	1:09	1:04
West Bridgeport Station to South Station	0:42	NA
West Bridgeport Station to Back Bay	0:50	NA

Buses in the peak direction would utilize the proposed Route 24 permanent, reversible HOV lane. Reverse peak buses would not have access to this lane and would be required to exit Route 24 to access the stations at West Bridgewater and Brockton. In the off-peak periods, the lane would be temporarily closed, all buses would be cleared, and it would be prepared to operate in the next peak direction. With this alternative, the permanent reversible lane on Route 24 and the in-line stations would not be accessible in the midday and nighttime service periods. During those periods, the Modified Rapid Bus Alternative would use the general purpose lanes and passengers would board/alight at the adjacent park-and-ride facilities.

3.2.2 Feeder Bus Plan

Feeder bus connections would also be included in the Modified Rapid Bus Alternative. The feeder bus service would be designed to:

- Minimize the number of transfers required by Modified Rapid Bus Alternative riders;
- Employ potential route modifications to existing bus routes to integrate the Modified Rapid Bus Alternative and local bus service to the extent possible;

- Minimize route modifications to avoid inconveniencing current bus users;
- Accommodate feeder buses within the Modified Rapid Bus Alternative station sites as close as possible to boarding areas/platforms; and
- Plan for ADA compliant pedestrian connections to bus stops adjacent to and within the station sites.

Three regional transit authorities currently provide local bus service proximate to the corridor: Brockton Area Transit Authority (BAT), the Southeastern Regional Transit Authority (SRTA), and Greater Attleboro Taunton Regional Transit Authority (GATRA). Based on consultations with those operators the proposed feeder bus plan presented in Table 8 was developed.

There are no existing local bus routes or operators in the vicinity of the proposed West Bridgewater station. Development of a new route to serve just this station would not be cost-effective. Therefore, no feeder buses are proposed to serve West Bridgewater station. For the remaining stations, extensions/modifications of the existing routes would comprise the feeder bus service. Existing headways for each of these routes would not be modified.

Table 8 Modified Rapid Bus Alternative Feeder Bus Plan

Station	Potential for Feeder Bus	Routes Serving Station (Extensions/Modifications Required)
Fall River Depot	Yes	SRTA 2, FRIP
Whales Tooth Station	Yes	SRTA 1, 2
Kings Highway Station	Yes	SRTA 8
Freetown Station	Yes	SRTA 2
Galleria Station	Yes	GATRA 3,8
Taunton Depot	Yes	GATRA 1, 6, 7, 8
Brockton Station	Yes	BAT 4, 4A, 14
West Bridgewater Station	No	

3.2.3 Fleet

The Modified Rapid Bus Alternative would require 144 over-the-road buses (with spares) with amenities that include seating for all passengers, restrooms, reading lights, individual air controls, WiFi and other regional bus comfort amenities.

3.3 Logistics/Construction Impacts

The construction elements of the Modified Rapid Bus Alternative are largely the same at those of the DEIS/DEIR Rapid Bus Alternative. The Modified Rapid Bus Alternative would also require about 4.5 years to construct and would be focused on reconstructing Route 24 to accommodate the reversible bus lane, the flyovers on Route 24 to I-93 and the I-93 flyover across the Braintree Split. All the Route 24 bridges and interchanges from Route 140 to I-93 would be reconstructed to accommodate the widening. Construction staging would require Traffic Management Plans on these roadways to ensure temporary construction impacts are minimized on the regional transportation network.

In addition to highway improvements, the Modified Rapid Bus Alternative would now also include the construction of the Brockton and West Bridgewater in-line stations. Constructing these stations would require additional widening of Route 24 to accommodate the ramps to and from the elevated in-line station in addition to the added width needed for the guideway. A deceleration and acceleration lane would transition to/from these ramps at the level of the roadway. Buses bypassing these stations would remain at the level of the roadway in the Modified Rapid Bus Alternative guideway unimpeded by stopping buses or the station infrastructure. The South Station bus terminal would also be expanded to accommodate the additional Modified Rapid Bus Alternative fleet. A midday layover facility would be constructed at Logan Express in Braintree and an overnight layover would be required but a site has not yet been selected for that facility.

3.4 Ridership

The 2030 ridership projected for the Modified Rapid Bus Alternative would have a projected total daily ridership of 10,330 total riders and approximately 5,900 new transit boardings as summarized in Table 9.

Table 9 Modified Rapid Bus Alternative Ridership

	2030 Ridership		
Station	South Station	Back Bay	Total
Whales Tooth	400	210	610
Kings Highway	390	220	610
Fall River Depot	810	270	1,080
Freetown	420	190	610
Galleria	290	150	440
Downtown Taunton	450	185	635
West Bridgewater	410	190	600
Brockton	420	160	580
Total Station Peak Inbound Boardings	3,590	1,575	5,165
Total Daily Ridership	7,180	3,150	10,330
Total Daily New Transit Boardings			5,900

3.5 Costs

Estimated order-of-magnitude capital costs were developed and include the cost of new infrastructure such as modification to bridges, the highway, stations and the new Zipper Lane as well as the cost of new buses. The cost to expand the South Station bus facility and the Logan Express lot were also included. As shown in Table 10, the Modified Rapid Bus Alternative is estimated to be $1.0 billion.

Table 10 Modified Rapid Bus Alternative Costs

Total Infrastructure Cost	$515,000,000
Real Estate Cost	$18,000,000
Eng./Services Cost	$70,000,000
Contingency	$163,000,000
Vehicle Cost	$86,000,000
Total	$852,000,000
Year-of-Expenditure	$1,000,000,000
O&M Cost	$39,600,000/year

Notes: Total infrastructure costs were estimated in 2009 dollars.
Professional services are13.55% of infrastructure costs without contingency.
Professional services include Design, Permitting, Construction Phase Inspection & Project Management.
Contingencies are 31.70% of infrastructure costs and include Indirect Soft Costs, Mitigation Contingency, and Construction Contingency.
Escalation was calculated at 3.25% per year +

The annual O&M costs (2009 $) for the Modified Rapid Bus Alternative are estimated to be $74.5 Million. Operating and Maintenance costs include the cost to operate the buses and maintain the Modified Rapid Bus Alternative infrastructure including stations and dedicated Modified Rapid Bus Alternative lanes.

3.6 Environmental Impacts

The environmental effects of the Modified Rapid Bus Alternative are summarized in this section.

3.6.1 Beneficial Effects

The Modified Rapid Bus Alternative would improve access to jobs, colleges, hospitals and Boston. None of the impacts would result in disproportionately high and adverse human health or environmental effects to environmental justice populations, meeting the requirements of the Executive Order, DOT Order, and EPA guidance.

Climate change is also an important consideration in evaluating the South Coast Rail project alternatives. The primary greenhouse gas emitted by transportation sources is Carbon Dioxide (CO_2). The Modified Rapid Bus Alternative would reduce the greenhouse gas CO_2 by 48,416.3tons/year.

The Modified Rapid Bus Alternative would also reduce vehicle miles traveled (VMT) by approximately 284,800.

3.6.2 Adverse Impacts

The Modified Rapid Bus Alternative would also have adverse impacts. The adverse impacts are summarized in the following sections.

3.6.2.1 Wetland Impacts

Wetland impacts are the principal category of environmental impacts considered for Section 404 permits and the Massachusetts Wetlands Protection Act. Direct wetland impacts, both temporary and permanent, are anticipated for the Modified Rapid Bus Alternative.

Temporary impacts include short-term disturbances (erosion controls, temporary structures, etc.) to wetlands and waterways during construction that would cease once construction activities are complete.

Permanent impacts are those that would result in the loss of wetlands. Permanent impacts may include, but are not limited to, wetland fill, dredging, and watercourse relocation or alteration. This analysis also summarized wetland fill within Areas of Critical Environmental Concern (ACEC), as these wetlands receive a higher level of state regulatory protection.

The Modified Rapid Bus Alternative would result in approximately 21.5 acres of wetland loss, of which 4.0 acres are in ACECs and an additional 8.7 acres of temporary impact.

3.6.2.2 Open Space and Tax Loss

A total of 0.19 acres of protected open space would be acquired for the Modified Rapid Bus Alternative. An additional 38.9 acres of property that is not open space would be acquired, projected to cause an annual loss in municipal taxes of $41,638. The Modified Rapid Bus Alternative, because it requires modifications to an instate highway, would require approval and NEPA review by FHWA. Impacts to public open space would trigger FHWA review under Section 4(f) of the Department of Transportation Act, which prohibits the use of public parkland unless these are no feasible and prudent alternatives.

3.6.2.3 Priority Habitat

Rare species are an important environmental resource, protected under the Massachusetts Endangered Species Act and Wetlands Protection Act. Temporary and permanent direct impacts to rare species and their habitat are anticipated for each of the project build alternatives. Direct impacts include impacts from construction, grading, vegetation management, and mortality associated with potential collisions with rail traffic. These activities may result in degradation of ecological function, loss of habitat, as well as loss of rare plant and animal species. This criterion also describes the amount of 'barrier effect' for each alternative. A corridor may act as a barrier that interferes with the movement of some mammals, amphibians, birds and reptiles from one habitat to another. The width of a corridor can influence the frequency of wildlife crossings, as well as the mortality associated with potential collisions with traffic. The Modified Rapid Bus Alternative would result in a loss of 16.3 acres of priority habitat for state-listed species, which include the Blandings Turtle, Eastern Box turtle, and Marbled Salamander. The Modified Rapid Bus Alternative would not create a new barrier to wildlife movement.

3.6.2.4 Water Quality

The Modified Rapid Bus Alternative would involve construction within two Zone A areas and within Zone II areas for 11 wells. These areas would be disturbed only temporarily and would not receive any long-term impacts. This alternative would also require stormwater discharges to two Zone A areas, Zone II areas for 11 wells, and five different waterbodies, including Town River in the Hockomock Swamp ACEC. The Modified Rapid Bus Alternative may require a variance from the Massachusetts Department of Environmental Protection (MA DEP) unless the proposed stormwater discharges in Zone A areas can be removed or relocated.

Although the Rapid Bus Alternative would use highways near multiple waterbodies and ground water protection areas, the road upgrades and new traffic would not introduce new pollutant sources because they would occur within and along existing highways. The increased paved area would only increase pollutant loading if the new pavement increased the amount of traffic on the road. Based on the change in vehicle miles traveled (VMT) at the peak hour, the Rapid Bus Alternative would reduce roadway use by approximately 0.3 percent. Since this alternative would actually decrease the total automotive traffic conveyed along the corridor by approximately one percent, the additional paved area would not increase loading of roadway contaminants such as metals, hydrocarbons, salt, and sediment. The primary potential for water resource impacts would be from increased runoff rates due to increased paved area.

This Page Intentionally Left Blank

4

Evaluation of the Modified Rapid Bus Alternative

This section summarizes the results the Modified Rapid Bus Alternative analysis and compares it to the results of the alternatives developed during the DEIS/DEIR including the Stoughton Electric Alternative and the Rapid Bus Alternative. The evaluation is consistent with the evaluation conducted for the DEIS/DEIR Alternatives Analysis, which follows the process described in *The Highway Methodology*[2]. In evaluating the Modified Rapid Bus Alternative, this chapter addressed the following questions:

- Does the Modified Rapid Bus Alternative meet the project purpose?
- Is the Modified Rapid Bus Alternative practicable?
- What are the environmentally impacts of the Modified Rapid Bus Alternative?

The following sections answer these questions individually and in comparison to how the DEIS/DEIR Stoughton Electric Alternative and the DEIS/DEIR Rapid Bus Alternative compare.

4.1 Evaluation of Project Purpose

This evaluation assesses whether the Modified Rapid Bus Alternative would meet the project purpose "to more fully meet the existing and future demand for public transportation between Fall River/ New Bedford and Boston, Massachusetts to enhance regional mobility." The performance measures used to evaluate how well the alternative meets the project purpose include:

- <u>*Ridership demand*</u> – Does the alternative meet the demand for public transportation?

▼

[2] United States Army Corps of Engineers, NEDEP-360-1-30, *The Highway Methodology*, October 1993.

- *Improve quality of service* – Does the alternative provide a transit trip that is competitive to travel by car and does it meet the MBTA's Service Delivery Policy?
- *Reduce vehicle miles traveled* – Does the alternative shift from auto mode reliance to using the transit mode?
- *Improve regional mobility* – Does the alternative provide public transit connections between New Bedford/Fall River and Boston and provide public transit connections between South Coast cities (New Bedford, Fall River, Taunton and others)?

4.1.1 Ridership Demand

Table 11 provides the projected 2030 ridership of the Modified Rapid Bus Alternative in comparison to the DEIS/DEIR Stoughton Electric and Rapid Bus Alternatives.

Table 11 Ridership Comparison

	DEIS/DEIR		
Station	Stoughton Electric	Rapid Bus	Modified Rapid Bus
Total Station Peak Inbound Boardings	4,790	2,100	5,165
Total Daily Ridership	9,580	4,200	10,330
Total Daily New Transit Boardings	5,900	1,700	5,900
Percent New Transit Trips	61.6%	40.5%	57.1%

As shown in Table 11, the Modified Rapid Bus Alternative is projected to capture 5,165 boardings at the proposed new stations. Of these trips, 57.1 percent are anticipated to be new transit trips (an improvement from the DEIS/DEIR Rapid Bus Alternative that captured 40.5 percent new transit trips). The remaining Modified Rapid Bus Alternative ridership (42.9 percent) would be shifted from existing transit modes and transit services, such as the Providence/Attleboro Commuter Rail line or the regional bus service provided today in the South Coast Region. By comparison, the Stoughton Electric alternative is projected to capture approximately 61.6 percent new transit ridership.

It is worthwhile to note that the ridership estimates presented in this table were calculated using optimal run times based on future traffic volumes. The model does not adjust for reliability or on-time performance issues that could occur. This will be discussed in more detail in the practicability evaluation section of this chapter.

4.1.2 Travel Time

Commuters from the South Coast region currently rely on autos and private bus service to access Boston. The average commuting time by auto during rush hour is currently 90 minutes from Fall River and New Bedford to Boston. The CTPS travel demand model projects slower commutes as congestion along already slow corridors continues to degrade. A future (2030) commute from New Bedford and Fall River to Boston is expected to be approximately 10 to 30 minutes longer than in current peak period conditions. An improved quality of service would provide a competitive travel time and improved reliability with respect to existing commuter options during peak commuting periods.

Speed data provided by CTPS supplemented by VISSIM traffic simulation for the Modified Rapid Bus Alternative was used to determine future travel time from end-point to end-point along these corridors.

Table 12 Travel Time Comparison (2030)*

	DEIS/DEIR		
	Stoughton Electric	Rapid Bus	Modified Rapid Bus
Travel Time (min)	76	103	90 (local service) 78 (express service)

* Presented in travel time from Whale's Tooth to South Station.

Table 12 summarizes the travel times for each alternative. The Modified Rapid Bus Alternative has improved travel times compared to the DEIS/DEIR Rapid Bus Alternative, but the travel times are still longer than the travel time achieved by the Stoughton Electric Alternative. The Modified Rapid Bus Alternative is anticipated to have a 90-minute travel time with local service and a 78-minute travel time with express service. The DEIS/DEIR Rapid Bus Alternative had a travel time of 103 minutes, with the Stoughton Electric providing the fastest travel time of 76 minutes.

The travel time estimates presented in this summary provide an understanding of the most optimistic service the Modified Rapid Bus Alternative is able to provide. These travel times do not account for delays beyond average daily congestion and how frequently those delays would occur, which will be discussed in more detail in the Practicability section of this chapter.

4.1.3 Service Delivery Policy

While an alternative might offer benefits for the transit system in the South Coast region, it may not meet the MBTA Service Delivery Policy. To maintain acceptable service, the MBTA has established a Service Delivery Policy[3] to ensure it provides quality transit services that meet the needs of the riding public. The minimum frequency of service levels provides the guidelines by which the MBTA maintains accessibility to the transportation network within a reasonable waiting period. The minimum frequency of service standards is the minimum frequency that must be maintained in a service. Commuter Rail and Commuter Bus minimum frequencies should provide at a minimum three trips in a peak direction during the morning and evening peak periods.[4] The Modified Rapid Bus Alternative was designed to exceed this minimum standard and provides 15-minute headways in the peak periods and one-hour headways in the non-peak.

4.1.4 Vehicle Miles Traveled

Vehicle Miles Traveled (VMT) is an important gauge for an alternative's transportation system benefits. VMT measures the extent of motor vehicle operation or the total number of vehicle miles traveled within the study area on given day. This particular measure quantifies how many miles of travel would be removed from the regional roadway network by commuters who elect to travel by train or bus rather than drive. This reduction in driving has several environmental benefits, notably cleaner air and a reduction in greenhouse gas emissions. Fewer cars on the road also eases congestion along highway corridors, resulting in travel time benefits. The alternative with the greatest VMT change (reduction) receives the highest score under this criterion.

Table 13 Reduction in 2030 VMT Comparison

	DEIS/DEIR		
	Stoughton Electric	Rapid Bus	Modified Rapid Bus
Reduction in VMTs	295,900	81,500	284,800

As shown in Table 13, Stoughton Electric Alternative would have the highest reduction in VMT with 295,900 daily miles. While the Modified Rapid Bus Alternative would reduce VMT by 284,800 daily miles, the difference between what the Modified Rapid Bus Alternative is able to reduce in VMT to that of Stoughton Electric Alternative is equivalent to one vehicle traveling around the world approximately 125 times every year. Alternatively, if an average daily commute is 40 miles (20 miles each way), this difference is also the equivalent of taking approximately 277 cars off the road every day.

[3] Massachusetts Bay Transportation Authority, *Service Delivery Policy*, MBTA Board of Directors approved January 14, 2009.
[4] Between LIRR, MNRR, MBTA, and METRA, the average service provided is 2.9 peak period trains.

4.1.5 Regional Mobility

This section discusses the interregional connectivity provided by this alternative and how well it meets the project purpose to improve regional mobility. As all the alternatives provide a connection from Fall River and New Bedford to Boston, an alternative will be considered more favorable if it also enhances mobility between points within the region by including interregional links that provide one-seat rides from one municipality to another. Connections within a municipality were not counted. For instance, New Bedford, which would accommodate two stations, would provide a one-seat ride from Whale's Tooth to King's Highway. However, this connection was not considered an improvement to regional mobility as it is confined to just New Bedford.

The Modified Rapid Bus Alternative would provide commuter bus service to South Station via Route 24, Route 140, and I-93 serving stations in: New Bedford, Fall River, Taunton (Downtown Taunton and Galleria), Freetown, West Bridgewater, Brockton, and Boston. The service plan provides regional connectivity between stations in these communities. Table 14 summarizes how many connections each alternative is able to provide.

Table 14 Interregional Links Comparison

	DEIS/DEIR		
	Stoughton Electric	Rapid Bus	Modified Rapid Bus
Interregional Links	41	5	18

As shown in Table 14, the Modified Rapid Bus Alternative would provide 18 interregional one-way links, which improves the interregional connectivity of the DEIS/DEIR Rapid Bus Alternative that has only five links. The Stoughton Electric Alternative would have the greatest interregional connectivity with 41 links.

4.1.6 Project Purpose Summary

Based on the measures established in the evaluation of the Project Purpose, it was concluded that the Modified Rapid Bus Alternative has the ability to meet the Project Purpose. It is projected to have a strong ridership demand, would improve the quality of service, reduce vehicle miles traveled, and improve regional connectivity. However, the Practicability evaluation in the next section challenges this conclusion. The Practicability evaluations dive deeper into the question of whether or not the Modified Rapid Bus Alternative really would provide a quality service and meet the projected ridership demand.

4.2 Evaluation of Practicability

One of the goals of this analysis was to determine if the Modified Rapid Bus Alternative is practicable. This section summarizes the practicability of the alternative in terms of its constructability, cost effectiveness, and performance.

The following measures indicate how practicable the alternative would be to implement based on the Clean Water Act regulatory definition of practicable: "capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purpose." Three measures were used to evaluate how practicable the alternative is:

- *Cost per Rider*– Measures how costly it would be to provide an alternative compared to the number of riders expected to use the system.
- *Construction Schedule and Constructability* – The time required to construct the alternative and the complexity of that construction are also measures of practicability because longer and complex construction schedules become increasingly more expensive, as well as delay the delivery of project benefits.
- *On-Time Performance and Reliability* – Measures how well the alternatives would be able to serve the South Coast region in terms of providing the passengers an assurance that they will arrive on time. This measure also demonstrates how existing capacity constraints translate into impacts on the overall reliability of the service.

4.2.1 Cost per Rider

This criterion evaluates how well an alternative performs based on the capital and operating and maintenance cost needed to serve riders projected to use the system. The metric for this criterion is cost per rider including infrastructure construction, land acquisition, environmental mitigation and other construction elements as well as the cost of operating and maintaining the system. 2030 ridership was developed using the Central Transportation Planning Staff (CTPS) regional model. CTPS refined their regional travel demand model set to include regional transportation projects, land use alternatives based on regional plans for the study area, and the proposed operation plan for each project alternative. Further information incorporated into their analysis includes station locations, station parking availability and cost, and fares.

Table 15 Cost per Rider Comparison

	DEIS/DEIR Stoughton Electric	Rapid Bus	Modified Rapid Bus
Capital Cost (YOE)	$1.88 billion	$0.81 billion	$1.00 billion
O&M Cost	$28.1 million/year	$39.6 million/year	$74.5 million/year
Cost per Rider	$45.76	$99.79	$42.07

4.2.2 Construction Schedule

Construction time contributes to short-term impacts and how quickly new transit services can be implemented. The Modified Rapid Bus Alternative was evaluated to determine whether it could be constructed within a reasonable, 4-year timeframe to achieve the Project Purpose and meet the 4-year construction schedule commitment outlined in Governor Patrick's *South Coast Rail, A Plan for Action*. In addition to trying to maintain this schedule, a shortened construction period would potentially ensure lower construction costs. Construction costs escalate over time and increase significantly with longer construction periods (particularly with regard to the cost of materials such as steel and concrete). As with the previous measures, this criterion was used to evaluate the alternatives in the DEIS/DEIR, as well. The Modified Rapid Bus Alternative would have the same 4.5-year schedule as did the DEIS/DEIR Rapid Bus Alternative. The construction schedule, despite adding new elements to enhance the alternative, has not changed since the DEIS/DEIR. Therefore, from the constructability perspective, the Modified Rapid Bus Alternative would be a practicable alternative.

4.2.3 On-Time Performance and Reliability

While project travel time is an important initial criterion in evaluating the practicability of an alternative, the reliability of meeting that travel time on a consistent basis is another key factor. The MBTA Service Delivery Policy defines "on time" as being no more than 5 minutes late, particularly for routes with published schedules such as a Commuter Rail or Commuter Bus service. This is the basis by which proposed system on-time performance is evaluated. Infrastructure constraints, however, can affect on-time performance and an alternative's reliability. The Modified Rapid Bus Alternative was calculated to have a maximum on-time performance of 88 percent. This on-time performance calculation was based historical rates of:

- Accidents in mixed-traffic sections of the corridor;

- Accidents in the I-93 Zipper Lane; and
- Zipper lane closures due to inclement weather.

Table 16 summarizes the On-Time Performance difference between alternatives.

Table 16 On-Time Performance Comparison

	DEIS/DEIR		
	Stoughton Electric	Rapid Bus	Modified Rapid Bus
On-Time Performance	97.9%	88.3% (maximum)	88.3% (maximum)

Figure 15, however, demonstrates that highway delays are routinely caused by many other factors, as well. All factors that cause delay could not be included in the on-time performance calculation of the Modified Rapid Bus Alternative. More specifically, impacts of on-time performance that were not taken into account for the Modified Rapid Bus Alternative include:

- *Delays caused by minor incidents on a highway that is already at capacity.* On a congested highway or an HOV lane at capacity, even a seemingly minor incident such as solar glare or a slow-moving vehicle can have a cascading impact on delay, which influences the perception of the commuter and their decision to take a bus. The Federal Highway Administration describes congested highway systems as highly variable and unpredictable and that on any given day, unusual circumstances can change the highway's performance, dramatically affecting travel speeds and delays. The traveling public experiences these drastic performance swings, and their expectation or fear of unreliable traffic conditions affects how they choose to travel.[5]
- *Delays caused by incidents such as rain events or less-severe snow storms that do not close the Zipper Lane for the entire peak period but do impact on-time-performance.* The frequency of these types of delays are not quantifiable for the corridor. However, anecdotal evidence shows these types of incidents frequently impact travel times.
- *Delays caused by vehicles pulled over in the shoulder of a highway due to a flat tire, a general breakdown, or simply from being stopped by police.* While the frequency of these incidents is not recorded, they contribute a great deal to delay on a highway system during peak periods (as shown in Figure 15).

[5] Federal Highway Administration, "Traffic Congestion and Reliability: Trends and Advanced Strategies for Congestion Mitigation, September 1, 2005, http://ops.fhwa.dot.gov/congestion_report/

While the Modified Rapid Bus Alternative would have an exclusive bus lane for the majority of its travel into Boston, it is vulnerable to all of these elements once it enters the Zipper Lane at the Braintree Split as well as while it travels in the general purpose lanes. This last eight miles on I-93 can severely impact the reliability and on-time performance and sway travel time delay drastically. When there is an incident on I-93, the magnitude of delay from Braintree to Boston can easily exceed 30 minutes under current conditions. In order to alleviate the issue of reliability, the Modified Rapid Bus Alternative would need an exclusive bus lane for the entire length of the corridor including to:

- Upgrade the Braintree Split flyover to include a more-efficient merge between Modified Rapid Bus Alternative buses with general HOV traffic;
- Widen I-93 from the Braintree Split to Boston and improve the capacity/ reliability of the Zipper Lane to allow vehicles to pass breakdowns in the lane; and
- Provide a connection from the end of the existing Zipper Lane to South Station, which was ruled infeasible due to cost and impact to regional transportation, as outlined in Chapter 3.

Without these improvements, the Modified Rapid Bus Alternative would not be a practicable alternative because:

- The last eight miles of the corridor into Boston would be at capacity by 2030[6];
- Breakdowns, incidents, weather, and any other factors will continue to compromise the reliability of the Zipper Lane;
- As the system becomes more saturated, delays will be cascading;
- Delay caused at the merge of the Zipper Lane with general purpose lanes in Savin hill will continue to degrade and impact reliability;
- Reliability issues would degrade the service from its onset.

Ridership, as it is currently shown for the Modified Rapid Bus Alternative, would not increase no matter what additional infrastructure improvements are made to increase reliability.

It should be noted that rail is not subject to the variability and reliability issues associated with traffic on highways. Rail alternatives are also able to more readily add capacity to a transit system without infrastructure modifications simply by adding additional train cars to a train set.

6 Central Transportation Planning Staff (CTPS) studies.

4.2.4 Practicability Summary

For the reasons outlined in this section, the evaluation finds that the Modified Rapid Bus Alternative is not a practicable alternative based on lack of reliability on the existing, at-capacity highway infrastructure in the northern section of the corridor, though it may be slightly less expensive per rider than the DEIS/DEIR Stoughton Electric Alternative.

It is also important to note that the travel demand model, which projects ridership for the South Coast Rail project and which measured whether the Modified Rapid Bus Alternative would meet the Project Purpose, bases its estimates on a service operating plan, travel time, and the connections the system will make to employment areas, to name a few factors. The model does not take into account the reliability of a highway network that the transit system would operate on. As a result, the ridership presented in this memorandum (like the travel time of the Modified Rapid Bus Alternative service and its on-time performance) were all estimated average conditions.

4.3 Evaluation of Environmental Impacts

The purpose of this section is to compare the environmental impacts of the Modified Rapid Bus Alternative to the DEIS/DEIR Stoughton and Rapid Bus Alternatives. As stated in the Section 404(b)(1) Guidelines at 40 CFR 230.10(a), "no discharge of dredged or fill material shall be permitted if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences." Therefore, the discussion below identifies impacts to the aquatic environment under the Clean Water Act. It identifies other impacts to the overall natural environment, as is required under the Guidelines, and also to the human environment and compares the Modified Rapid Bus Alternative to the DEIS/DEIR Stoughton Electric and Rapid Bus Alternatives.

4.3.1 Beneficial Effects

The following sections summarize the environmental benefits provided by each alternative including those to environmental justice and air quality.

4.3.1.1 Environmental Justice

The Modified Rapid Bus Alternatives would improve access to jobs, colleges, hospitals and Boston. None of the impacts would result in disproportionately high and adverse human health or environmental effects to environmental justice populations, meeting the requirements of the Executive Order, DOT Order, and EPA guidance.

4.3.1.2 Air Quality

The predominant sources of air pollution anticipated from the proposed South Coast Rail project include emissions of carbon monoxide (CO), nitrogen oxides (NOx), and volatile organic compounds (VOCs) from locomotive engines and from motor vehicles traveling to and from the train stations. A mesoscale analysis evaluated the regional air quality impacts (VOCs, NOx, CO, and PM emissions) from the proposed project by determining the change in total ozone precursor emissions (volatile organic compounds and nitrogen oxides) for the existing and future conditions within the study area; the microscale analysis calculated the CO and PM concentrations for the same conditions at congested intersections near the proposed stations.

Table 17 Air Quality Beneficial Effects Comparison

	DEIS/DEIR		
	Stoughton Electric	Rapid Bus	Modified Rapid Bus
NOX Reduction (kg/day)	(43.3)	0.0	(39.3)
$PM_{2.5}$ Reduction (kg/day)	(1.7)	0.0	(1.4)
PM_{10} Reduction (kg/day)	(6.1)	1.7	(5.3)
VOCs Reduction (kg/day)	(55.9)	(9.3)	(50.9)
CO_2 Reduction (tons/year)	(62,333.7)	(6,588.0)	(48,416.3)

As shown in Table 17, while improved from the DEIS/DEIR Rapid Bus Alternative, the Modified Rapid Bus Alternative would still have fewer Air Quality benefits than the DEIS/DEIR Stoughton Electric Alternative. The Modified Rapid Bus Alternative would also reduce the greenhouse gas CO_2 by 48,416.3 tons/year compared the DEIS/DEIR Stoughton Electric Alternative, which would reduce CO_2 by 62,333.7 ton/year.

4.3.2 Adverse Impacts

The following sections compare the environmental impacts of each alternative including those to wetlands and priority habitat.

4.3.2.1 Wetland Impacts

Wetland impacts are the principal category of environmental impacts considered for Section 404 permits and variances under the Massachusetts Wetlands Protection Act. Direct wetland impacts, both temporary and permanent, are anticipated for each of the build alternatives.

Temporary impacts include short term disturbances (erosion controls, temporary structures, etc.) to wetlands and waterways during construction that would cease once construction activities are complete.

Permanent impacts are those that would result in the loss of wetlands. Permanent impacts may include, but are not limited to, wetland fill, dredging, and watercourse relocation or alteration. This analysis also evaluated the amount of wetland fill within an ACEC, as wetlands within ACECs receive a higher level of state regulatory protection.

Table 18 Wetland Loss Comparison

	DEIS/DEIR Stoughton Electric	DEIS/DEIR Rapid Bus	Modified Rapid Bus
Wetland Loss (acres)	11.9	21.5	21.6
Wetland Loss in ACECs (acres)	1.8	4.0	4.0

As shown in Table 18, the Modified Rapid Bus Alternative would result in 21.6 acres of wetland loss, 4.0 of which are in ACECs. By comparison, the Stoughton Electric would have approximately half of those impacts and Stoughton Electric would, therefore, be the less environmentally damaging alternative between the two.

4.3.2.2 Priority Habitat

Rare species are an important environmental resource, protected under the Massachusetts Endangered Species Act and Wetlands Protection Act. Temporary and permanent direct impacts to rare species and their habitat are anticipated for each of the project build alternatives. Direct impacts include impacts from construction, grading, vegetation management, and mortality associated with potential collisions with rail traffic. These activities may result in degradation of ecological function, loss of habitat, as well as loss of rare plant and animal species. This criterion also describes the amount of 'barrier effect' for each alternative. A corridor may act as a barrier that interferes with the movement of some mammals, amphibians, birds and reptiles from one habitat to another. The width of a corridor can influence the frequency of wildlife crossings, as well as the mortality associated with potential collisions with traffic.

Table 19 Priority Habitat Loss Comparison

	DEIS/DEIR		
	Stoughton Electric	Rapid Bus	Modified Rapid Bus
Priority Habitat Loss (acres)	9.9	16.3	16.3

The Modified Rapid Bus Alternatives would result in a loss of 16.3 acres of wildlife habitat, as would the Rapid Bus Alternative from the DEIS/DEIR. By comparison, Stoughton Electric would result in 6.4 fewer acres with 9.9 acres of priority habitat loss.

4.3.3 Environmental Benefits and Impacts Summary

The Modified Rapid Bus Alternative would have twice as much wetland impacts and approximately 30 percent less air quality benefit based on a reduction of annual CO_2 emissions. This evaluation finds that the Modified Rapid Bus Alternative would have environmental impacts beyond those of the DEIS/DEIR Stoughton Electric Alternative.

This Page Intentionally Left Blank.

5 Conclusion

The purpose of this analysis was to address concerns raised related to the evaluation of the Rapid Bus Alternative in the DEIS/DEIR. The concerns included:

- *Performance*: Travel speed was identified as too slow. The slow travel speed did not make the alternative competitive with rail.
- *Congestion*: The alternative was subjected to congestion "hot spots," which would affect its projected travel time and reliability.
- *Ridership*: Ridership on the Rapid Bus Alternative was noted as being lower than the Commuter Rail alternatives.

In order to address these concerns and improve the alternative so it is more competitive with rail, operational and infrastructure improvements were identified and evaluated in terms of cost and impacts. The Modified Rapid Bus Alternative was developed to reduce travel times, provide additional regional connections, and increase reliability in order to attract greater ridership.

This evaluation found that the Modified Rapid Bus Alternative would not practicable for the following reasons:

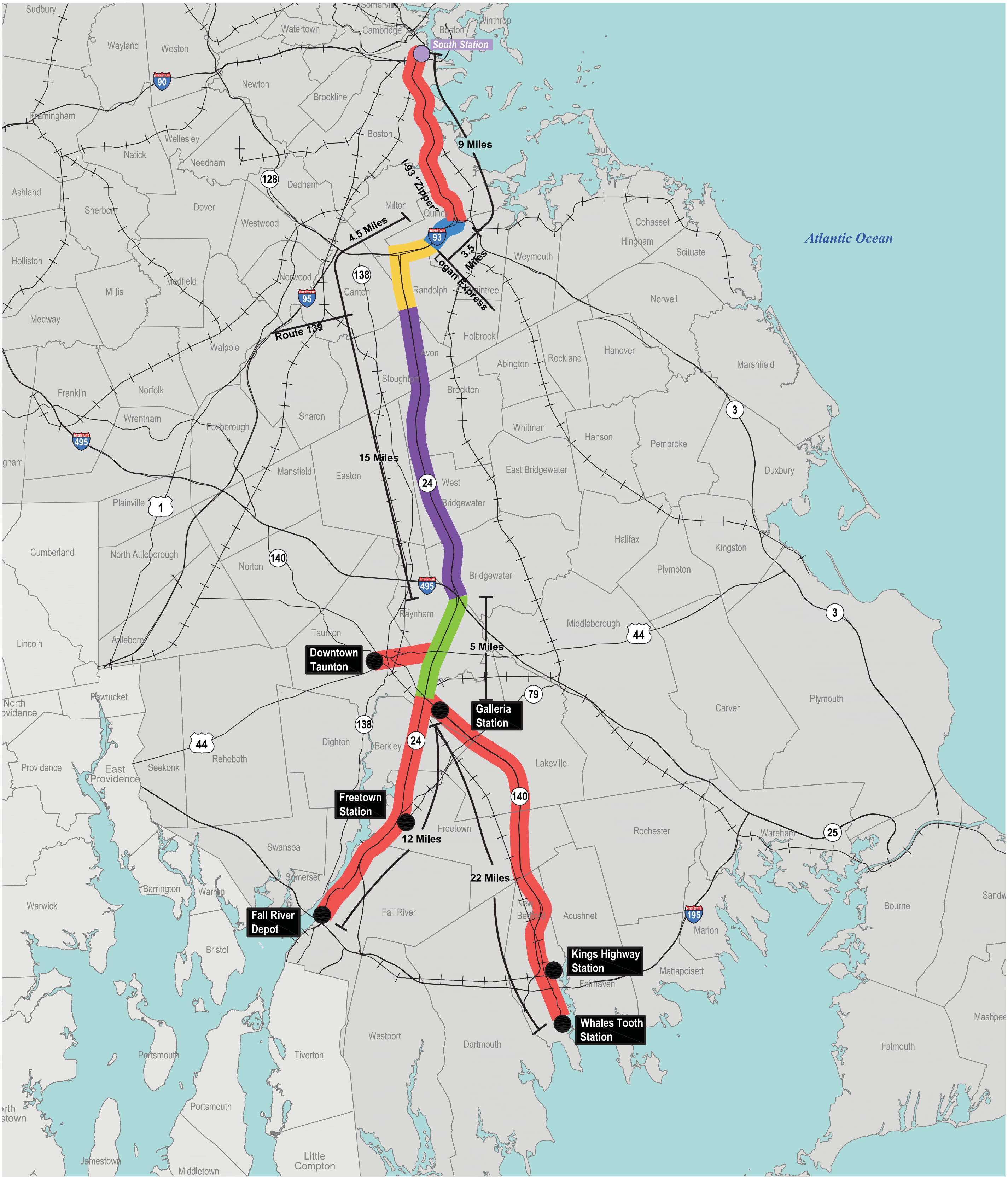
- It is infeasible to construct a fully exclusive bus lane all the way into Boston;
- The Modified Rapid Bus Alternative must use a section of existing highway system that is subject to heavy congestion and is vulnerable to significant delays, which impact the alternative's reliability (and would ultimately affect ridership);
- Additional investment would not result in additional ridership;
- Operating and maintenance costs would be almost three time that of the DEIS/DEIR Stoughton Electric Alternative; and
- The wetland impacts are greater than that of the DEIS/DEIR Stoughton Electric Alternative with fewer air quality benefits.

For these reasons, the finding in this evaluation suggest that the Modified Rapid Bus Alternative be removed from further South Coast Rail project consideration.

This Page Intentionally Left Blank.

Figures

This Page Intentionally Left Blank



massDOT
Moving Massachusetts Forward

SOUTH COAST RAIL

Legend

- No Change
- Expand from 2 to 3 Lanes in Each Direction Bus Uses GP Lanes
- Permanent Reversible (Bus Only in Median)
- Two-Way (Bus Only) in Median
- One-Way Contra-Flow Zipper Lane

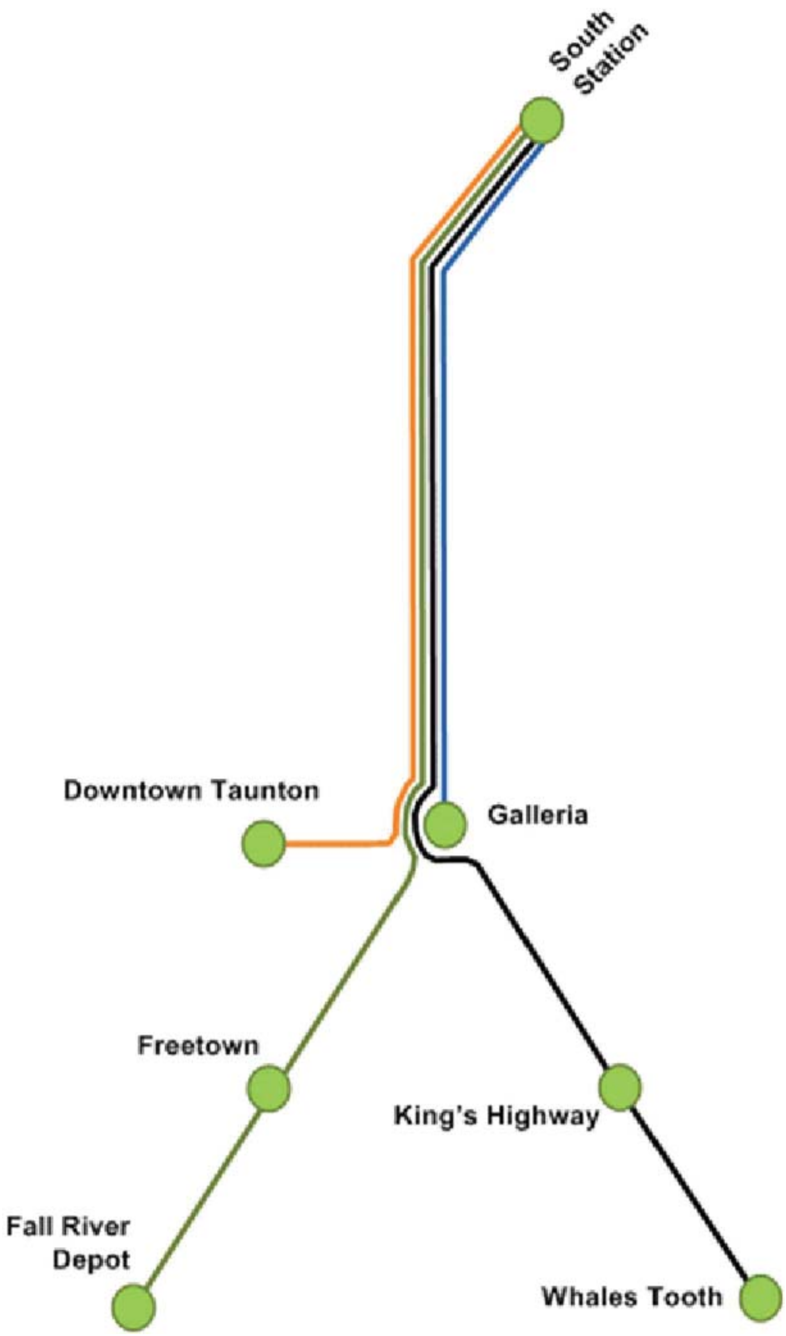
0 3.5 7 Miles

Figure 1

DEIS/DEIR Rapid Bus Alternative

Prepared by: VHB

\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\10111_HOV_Alternative_Routes.dwg Printing Date: 5/24/2012 6:37 AM



Moving Massachusetts Forward. massDOT

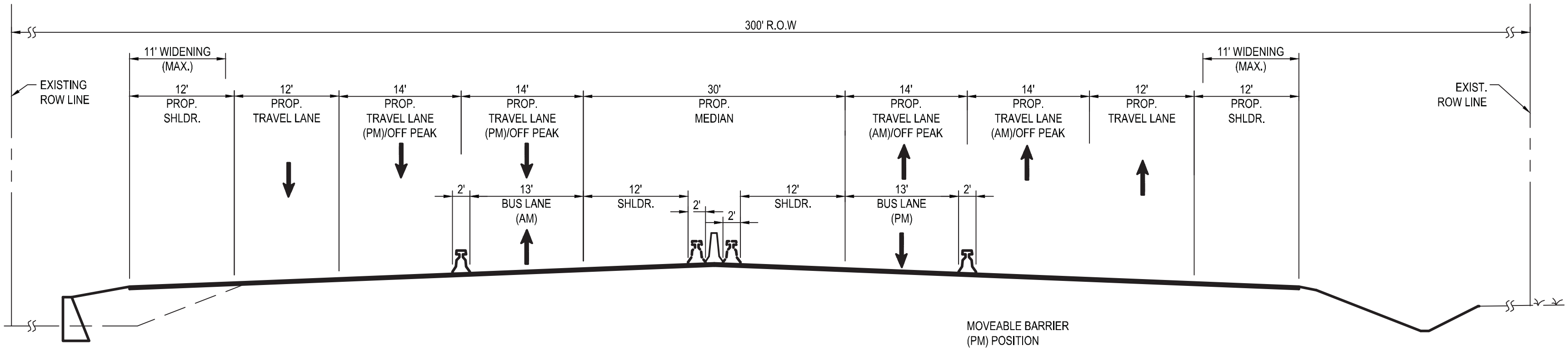
SOUTH COAST RAIL

Figure 2
DEIS/DEIR Rapid Bus Routes

Not to Scale

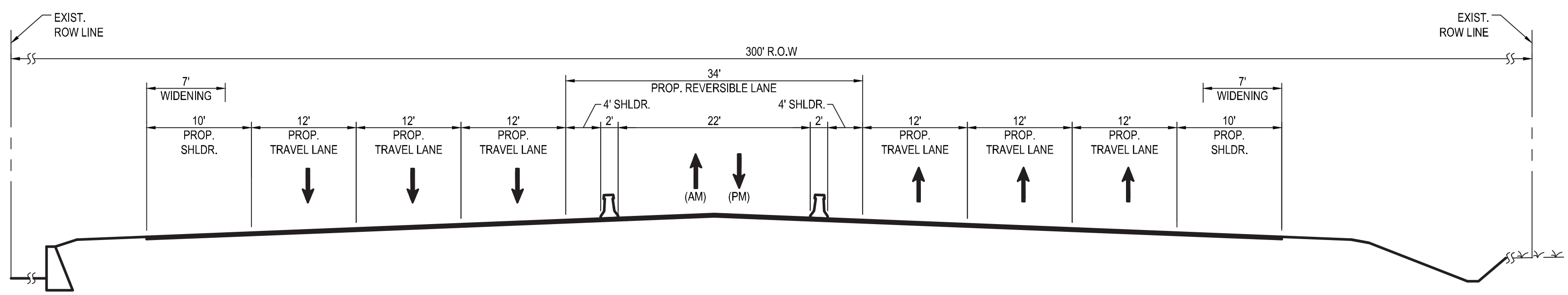
Prepared by: VHB

ROUTE 24



DEIS/DEIR PROPOSED TYPICAL SECTION

N.T.S.



MODIFIED RAPID BUS ALTERNATIVE

N.T.S.

Not to Scale

Moving Massachusetts Forward. massDOT

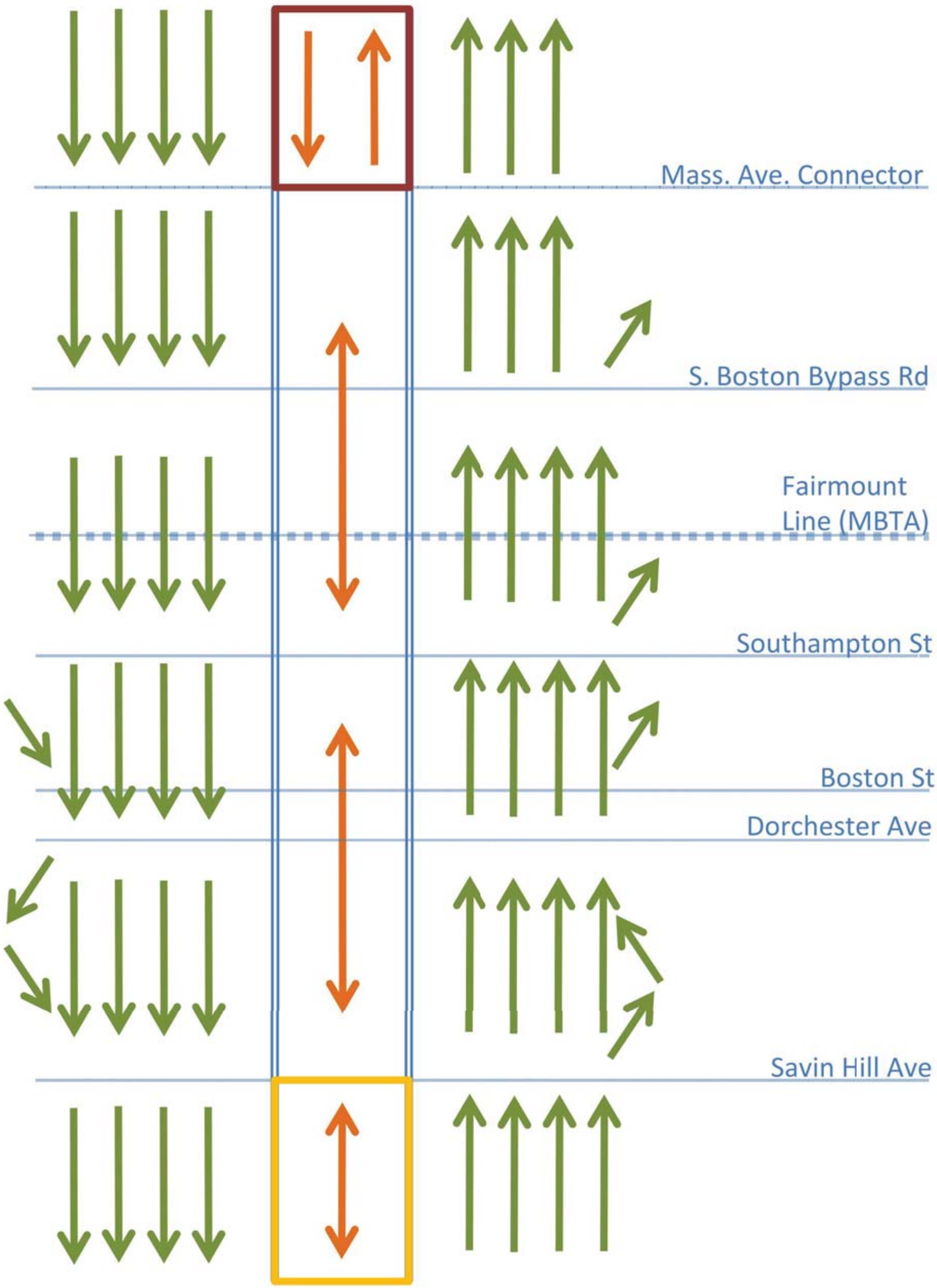
SOUTH COAST RAIL

Figure 3

Route 24 Cross-Section

Prepared by: VHB

\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\Modified_Rapid_Bus_Alt_Figures\10111_HOV_Fig3.dwg Printing Date: 5/24/2012 6:54 AM



\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\Modified_Rapid_Bus_Alt_Figures\10111_HOV_Fig4.dwg Printing Date: 5/24/2012 6:59 AM

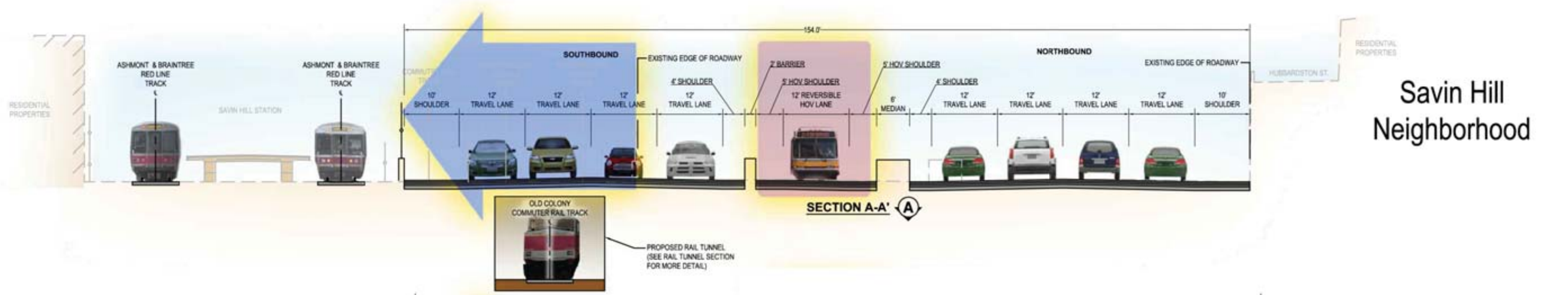
Moving Massachusetts Forward. massDOT

SOUTH COAST RAIL

Figure 4
Configuration and Operation of Alternative 1, "Commitment"

Prepared by: VHB

EXISTING



PROPOSED

massDOT Moving Massachusetts Forward.

SOUTH COAST RAIL

Figure 5
Savin Hill Cross-Section, Alternative 1, "Commitment"

Prepared by: VHB

\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\Modified_Rapid_Bus_Alt_Figures\10111_HOV_Fig5.dwg Printing Date: 5/24/2012 7:54 AM

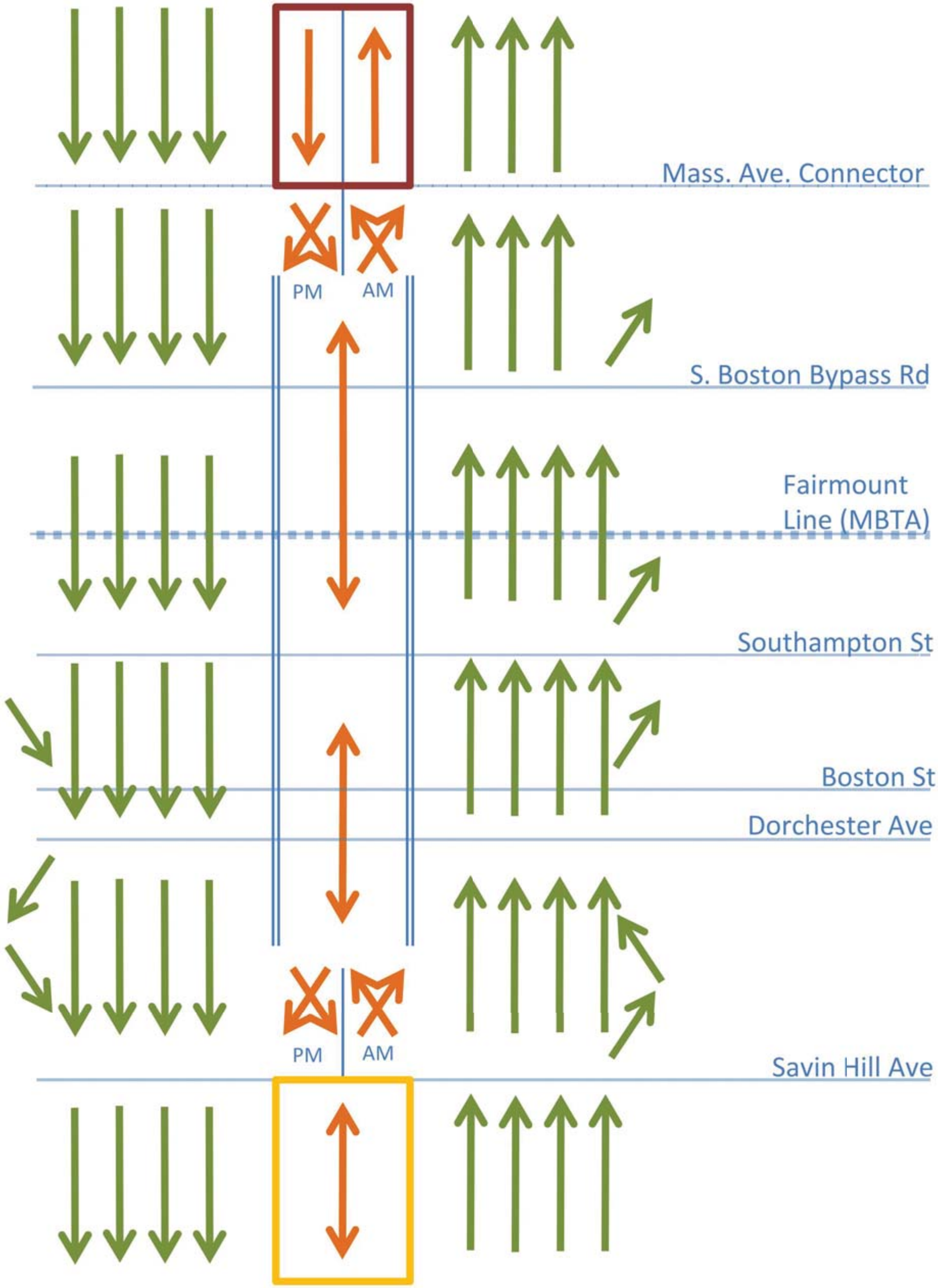


Figure 6
Configuration and Operation of Alternative 2, "Maintain Exit at Savin Hill"

Prepared by: VHB

\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\Modified_Rapid_Bus_Alt_Figures\10111_HOV_Fig6.dwg Printing Date: 5/24/2012 8:21 AM

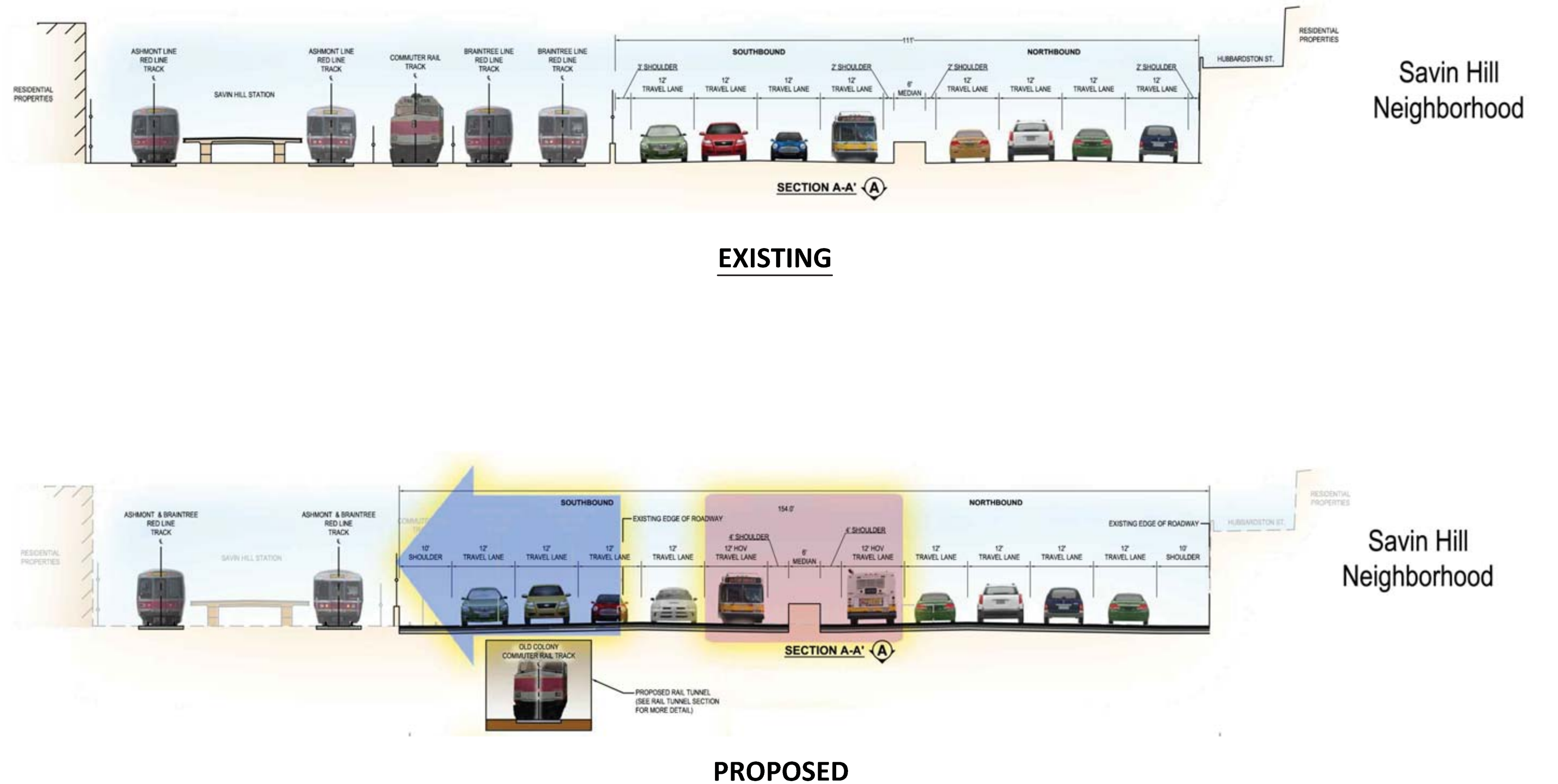
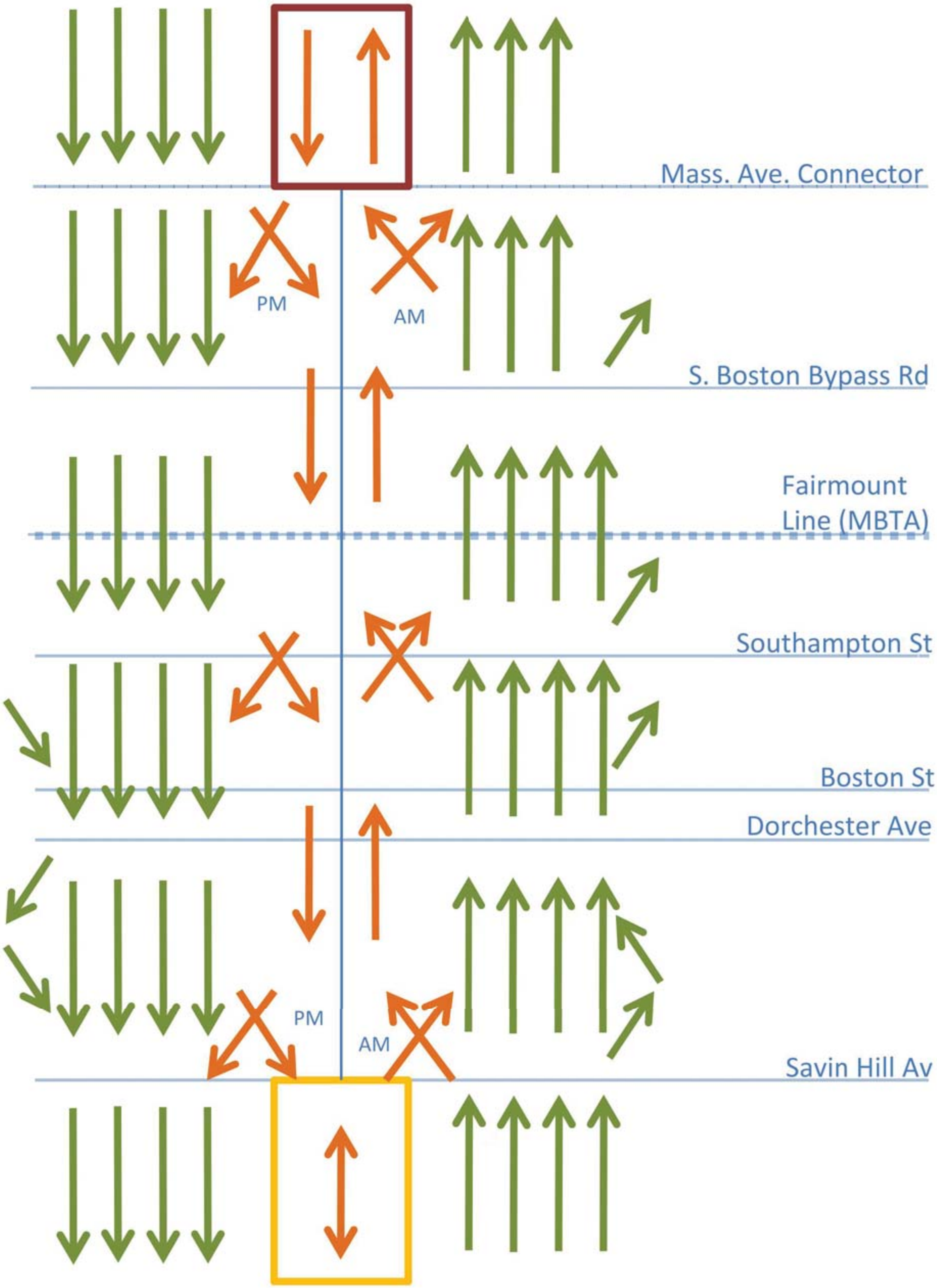


Figure 7
Savin Hill Cross-Section, Alternative 2, "Maintain Exit at Savin Hill"

Prepared by: VHB

\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\Modified_Rapid_Bus_Alt_Figures\10111_HOV_Fig7.dwg Printing Date: 5/24/2012 8:22 AM



\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\Modified_Rapid_Bus_Alt_Figures\10111_HOV_Fig8.dwg Printing Date: 5/24/2012 8:23 AM

Moving Massachusetts Forward. massDOT

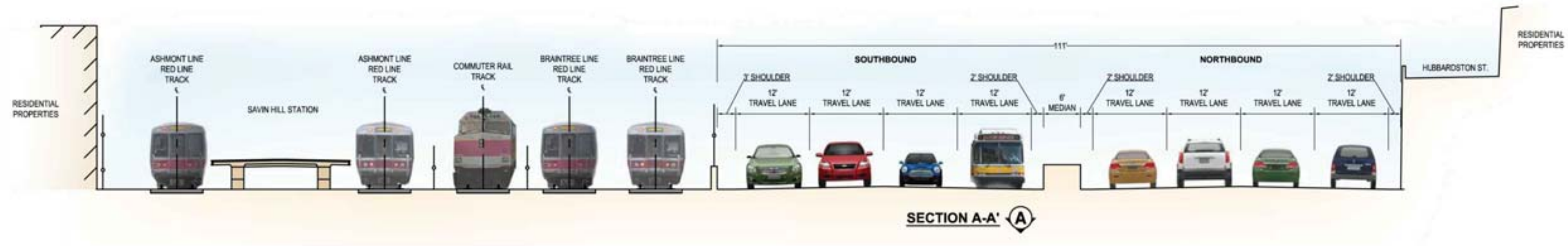
SOUTH COAST RAIL

Figure 8

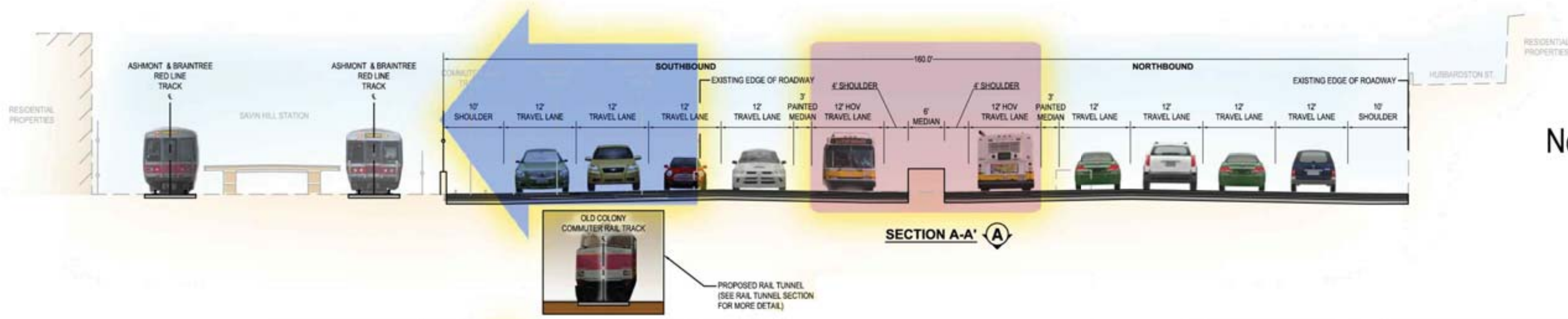
Configuration and Operation of Alternative 3, "HOV Lanes in Both Directions"

Prepared by: VHB

\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\Modified_Rapid_Bus_Alt_Figures\10111_HOV_Fig9.dwg Printing Date: 5/24/2012 8:26 AM



EXISTING



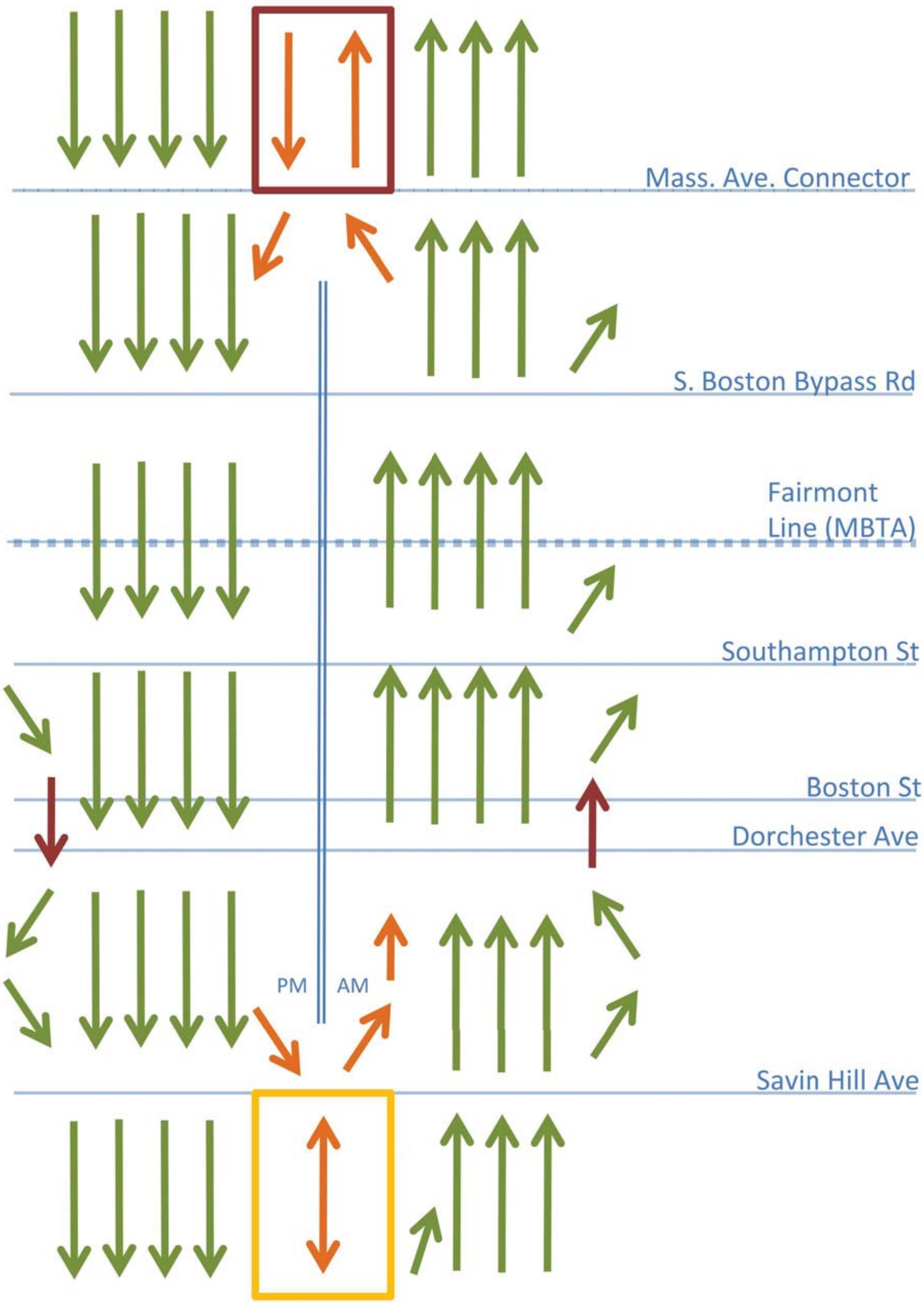
PROPOSED

Moving Massachusetts Forward. massDOT

SOUTH COAST RAIL

Figure 9
Savin Hill Cross-Section, Alternative 3, "HOV Lanes in both Directions"

Prepared by: VHB



Moving Massachusetts Forward. massDOT

SOUTH COAST RAIL

Figure 10
Configuration and Operation of Alternative 4, "Minimalist"

Prepared by: VHB

EXISTING

PROPOSED

Figure 11
Savin Hill Cross-Section, Alternative 4, The "Minimalist"

Prepared by: VHB

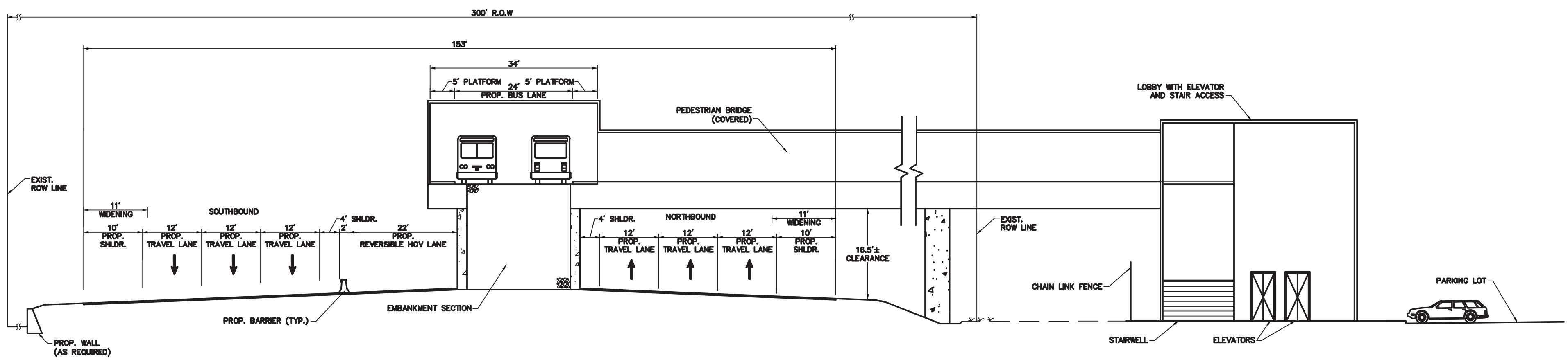
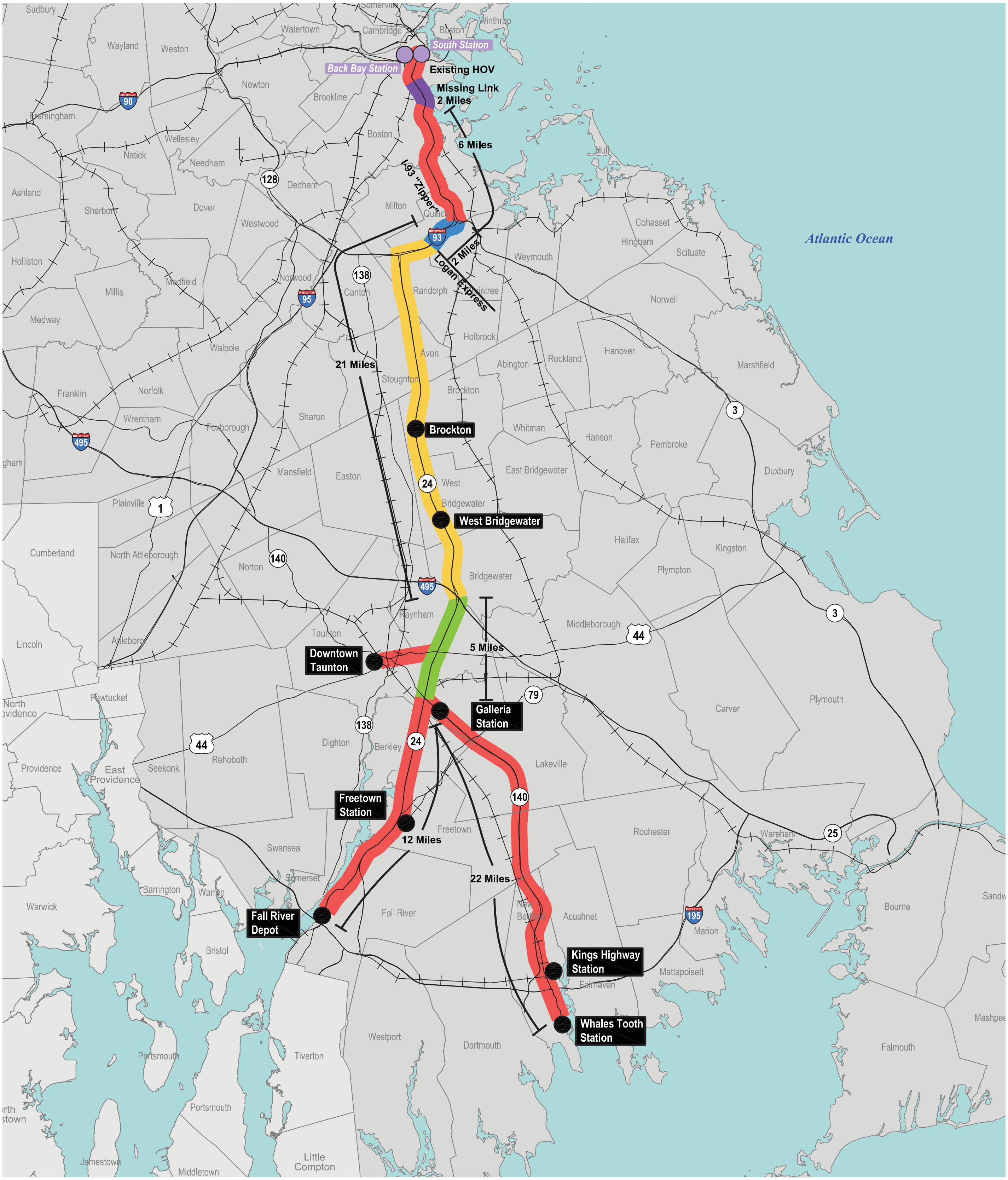


Figure 12
In Line Station
Typical Cross Section

Prepared by: VHB

\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\Modified_Rapid_Bus_Alt_Figures\10111_HOV_Fig12.dwg Printing Date: 5/24/2012 8:31 AM



Moving Massachusetts Forward. massDOT

SOUTH COAST RAIL

Figure 13
Modified Rapid Bus Alternative

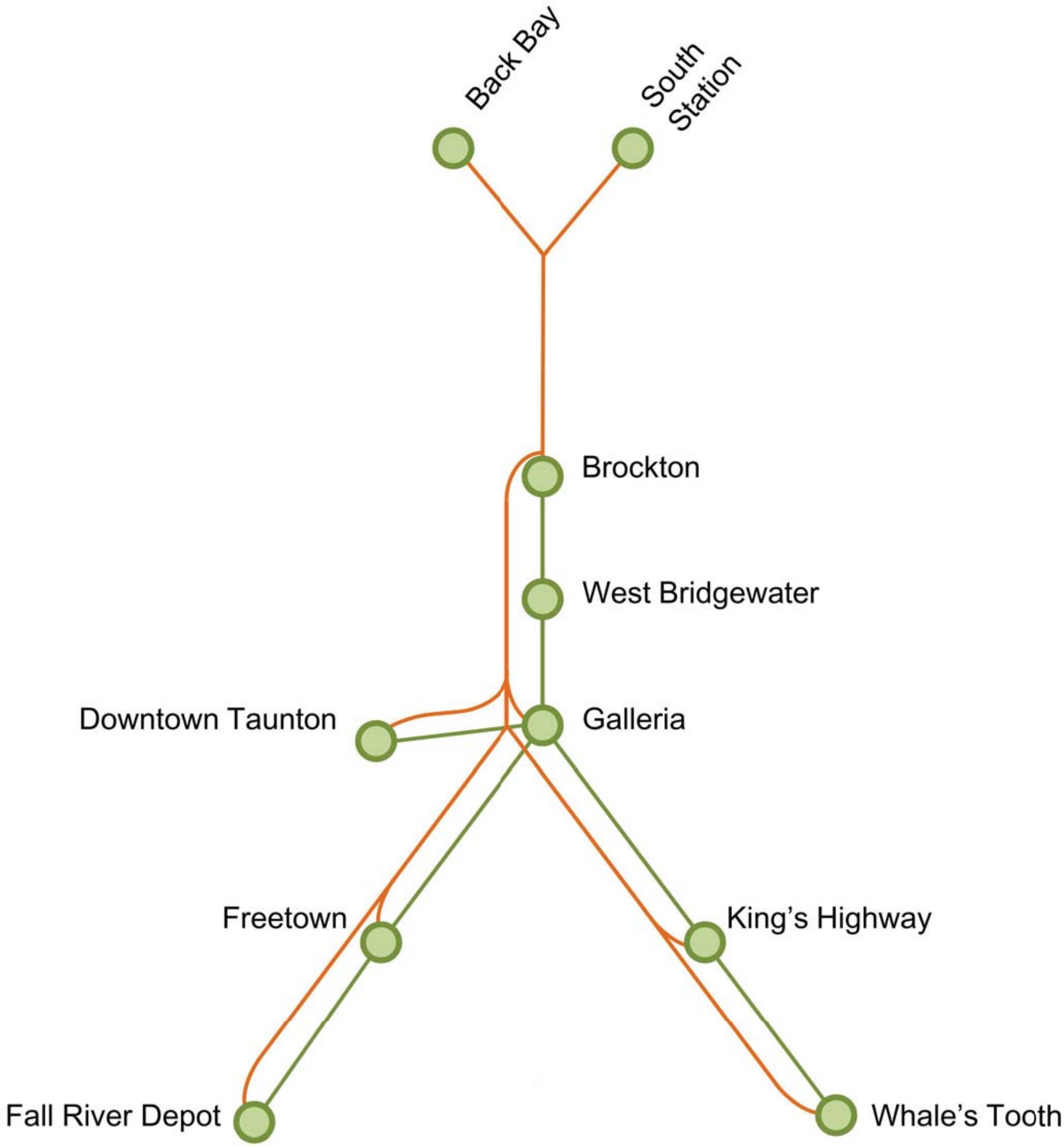
Legend

- No Change
- Expand from 2 to 3 Lanes in Each Direction Bus Uses GP Lanes
- Permanent Reversible (Bus Only in Median)
- Two-Way (Bus Only) in Median
- "Missing Link" (See Figures)

0 3.5 7 Miles

Prepared by: VHB

\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\10111_HOV_FEIR_Alternative_Routes.dwg Printing Date: 5/24/2012 8:52 AM



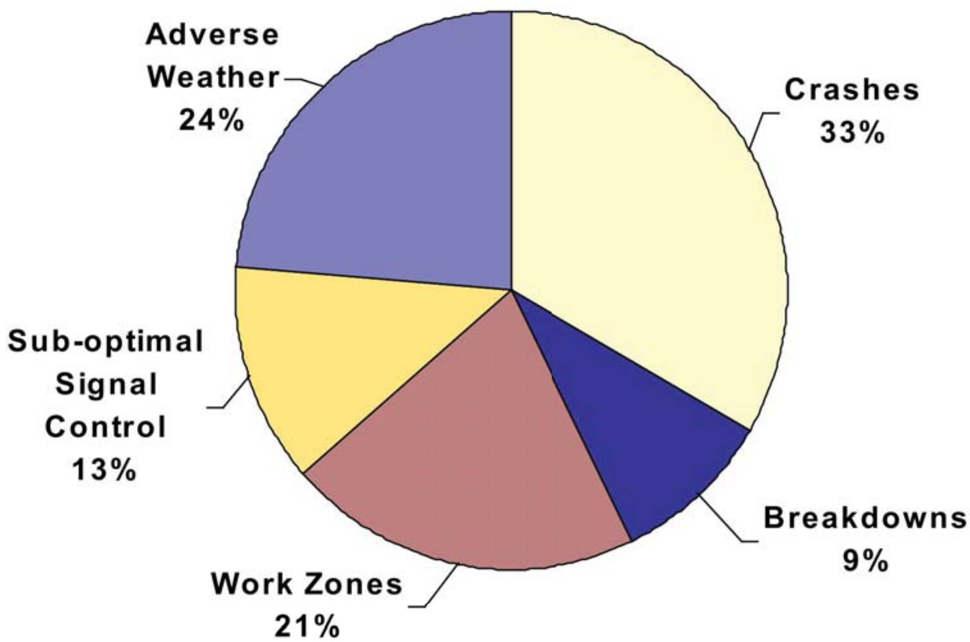
Moving Massachusetts Forward. massDOT

SOUTH COAST RAIL

Figure 14
Modified Rapid Bus Service Plan

Not to Scale

Prepared by: VHB



\\MABOS\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\Modified_Rapid_Bus_Alt_Figures\10111_HOV_Fig15.dwg Printing Date: 5/29/2012 9:00 AM

Not to Scale

Moving Massachusetts Forward. massDOT

SOUTH COAST RAIL

Figure 15
Types of Incidents that Cause Delay on a Highway

Source: "Temporary Losses of Highway Capacity and Impact on Performance" University of Tennessee, March 2002

Modified Rapid Bus Alternative
Technical Memorandum - DRAFT

Modified Rapid Bus

Appendices and Back Up Documentation

Prepared for massDOT

Massachusetts Department of Transportation
10 Park Plaza
Boston, Massachusetts 02116

Prepared by Vanasse Hangen Brustlin, Inc.

99 High Street, 10th Floor
Boston, Massachusetts 02110

SOUTH COAST RAIL

June 2012

List of Appendices

This page intentionally left blank

Modified Rapid Bus Alternative
Technical Memorandum - DRAFT

Appendix A:
Station Siting Analysis

Prepared for massDOT

Massachusetts Department of Transportation
10 Park Plaza
Boston, Massachusetts 02116

Prepared by VHB Vanasse Hangen Brustlin, Inc.

99 High Street, 10th Floor
Boston, Massachusetts 02110

SOUTH COAST RAIL

June 2012

Table of Contents

List of Tables

List of Figures

1

Introduction

This memorandum addressed comments received on the DEIS / DEIR for the South Coat Rail Project that stated that the poor performance of the Rapid Bus Alternative was due to:

- Relatively few stations served
- Longer transfer times between the rapid bus transit lines
- Few new stations provided in growth areas
- Lack of intra-regional connectivity / no intermediate stations

Six Rapid Bus stations were included in the DEIS / DEIR as shown in Table 1.

Table 1 Commuter and Rapid Bus Stations

Commuter Rail	Rapid Bus
Whales Tooth	Whales Tooth
King's Highway	King's Highway
Fall River Depot	Galleria
Freetown	Fall River Depot
Dean Street	Freetown
Raynham Park	Taunton Depot
North Easton	
Easton Village	

This report identifies potential Rapid Bus Stations in the vicinity of North Easton and Easton Village which would serve growth areas north of Taunton and along Route 24.

This Page Intentionally Left Blank

2

Station Design and Evaluation

2.1 Introduction

In order to identify suitable locations for the station locations, a typical station footprint was developed. Four potential station access design options were considered:

- **Option 1:** At-grade Exit and Entrance (buses access station by exiting busway and crossing mixed traffic lanes)
- **Option 2:** Flyover Exit and Entrance (buses access station by via direct ramp from busway into station site)
- **Option 3:** Slip Ramps (buses access station via busway slip ramps from / to existing overpasses)
- **Option 4:** In-line station (buses access station located directly within busway)

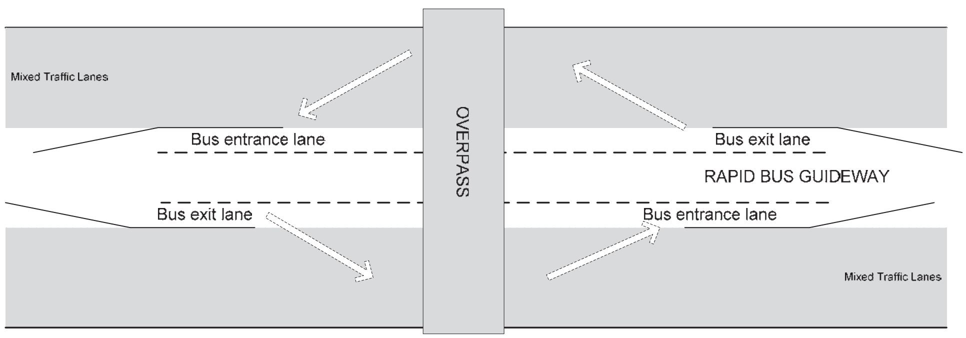
The four options were evaluated on the basis of five factors:

- **Bus Operations:** The operating environment provided the Rapid Buses
- **East of Transfers:** The directness of transfers to the Rapid Bus system
- **Traffic Impacts:** The potential traffic impacts of the options
- **Right-of-Way Required:** The additional land needed to accommodate the access option
- **Interchange reconstruction:** Whether the option would entail reconstruction of existing interchanges

2.2 Option 1: At Grade Exit and Entrance

The least expensive method of getting buses to and from the guideway would be to have them exit across the mixed traffic lanes and return in the same manner. Stations would be located off-alignment, on a site that is available nearby. Buses would access them by exiting the guideway, weaving across multiple lanes of traffic on Route 24 and then traveling on the local road system to the station.

Figure 1 Option 1 - At Grade Exit and Entrance



Bus Operations

The risks of delays and schedule disruptions associated with crossing mixed traffic on Route 24 and navigating local roads with this option would be significant.

Ease of Transfers/Station Access

Rapid Bus patrons would be able to easily access stations and transfer to local buses. However, locating stations away from the Rapid Bus guideway would add time to trips and introduce the risk of delays due to local traffic.

Traffic Effects

There would be significant traffic effects on the highway system caused by buses entering and existing to access the system. The effects to local roads would be minimal and could be lessened with Transit Signal Priority (TSP) treatments for buses.

Right-of-Way Required

Acceleration and deceleration lanes would be required to access and depart the Rapid Bus guideway. The 2 lane widths of additional widening would be in addition to the width needed for the guideway itself.

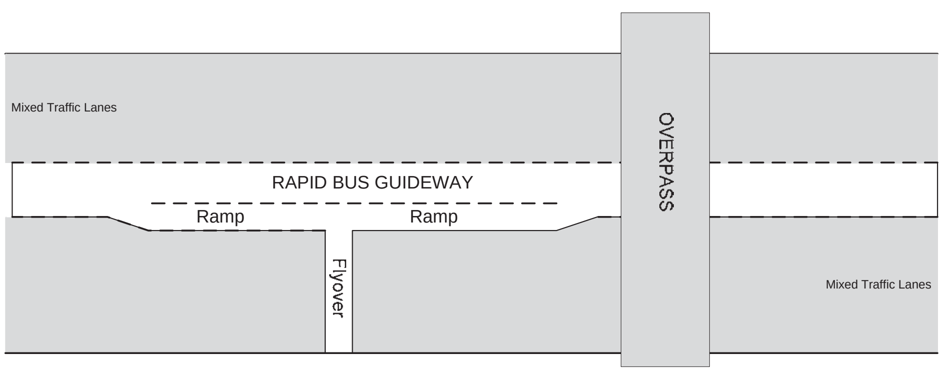
Interchange Reconstruction

This option would not require reconstruction of existing interchanges.

2.3 Option 2: Flyover Exit and Entrance Ramps

Option 2 would include the construction of ramps parallel to the Rapid Bus Guidway, connecting with a new overpass/flyover that would connect either to a station off or immediately adjacent to the existing guidway (depending on the availability of land). Buses would access the stations by exiting the guideway via the new ramps, which would either connect directly with the station or with the local road system (connecting to the station).

Figure 2 Option 2 - Rapid Bus Flyover Lanes



Bus Operations

Option 2 would eliminate the delay and operational problems associated with the merging with highway traffic in Option 1. If an off-alignment station is used in conjunction with this alternative, the delays associated with accessing the station via the local road network would be significant.

Ease of Transfers/Station Access

Rapid Bus patrons would be able to easily access stations and transfer to local buses. If an off-alignment station is used with this option, this would add time and potentially delays to trips.

Traffic Impacts

There would be no impact to highway traffic. If an off-alignment station is used there would be minimal impacts which could be lessened with Transit Signal Priority (TSP) treatments for buses.

Right-of-Way Required

One lane width would be added to the Rapid Bus guideway for the ramp in the median of Route 24. Depending on the direction of traffic in the Rapid Bus guideway, this ramp would be reversed to provide access in the opposite direction. The amount of additional land required for the ramps connecting with the parking area would vary based on site conditions. It is unlikely these ramps could be located adjacent to interchange ramps as they would have to pass over those before descending to grade.

Interchange Reconstruction

This option would require construction of ramps at either end of the flyover as well as construction of a new flyover across mixed traffic lanes. While this would not impact existing interchanges it would require a significant amount of construction.

2.4 Option 3: Slip Ramps

Option 3 would be a variant of Option 2. Ramps would be constructed that connect the Rapid Bus guideway with an existing overpass. Stations would be located off-alignment, on an available site nearby. Buses would access them by exiting the guideway via ramps and then traveling on the local road system.

Figure 3 Option 3 - Rapid Bus Slip Ramps

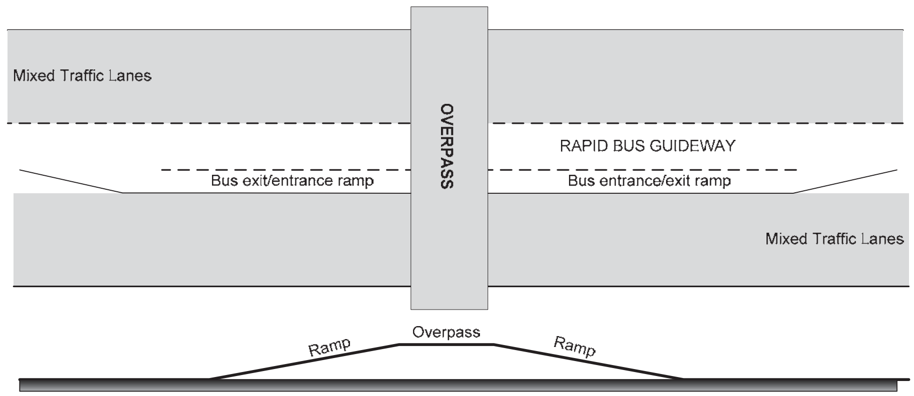


Figure 4 Example of Median Slip Ramp

Bus Operations

The delays associated with accessing the station via the local road network would be significant.

Ease of Transfers/Station Access

Rapid Bus patrons would be able to easily access stations and transfer to local buses. However, locating stations away from the Rapid Bus guideway would add time to trips and introduce the risk of delays due to local traffic.

Traffic Impacts

The effects to local roads would be minimal and could be lessened with Transit Signal Priority (TSP) treatments for buses.

Right-of-Way Required

Because only a single additional lane of width to the Rapid Bus guideway the added width of right-of-way would be limited.

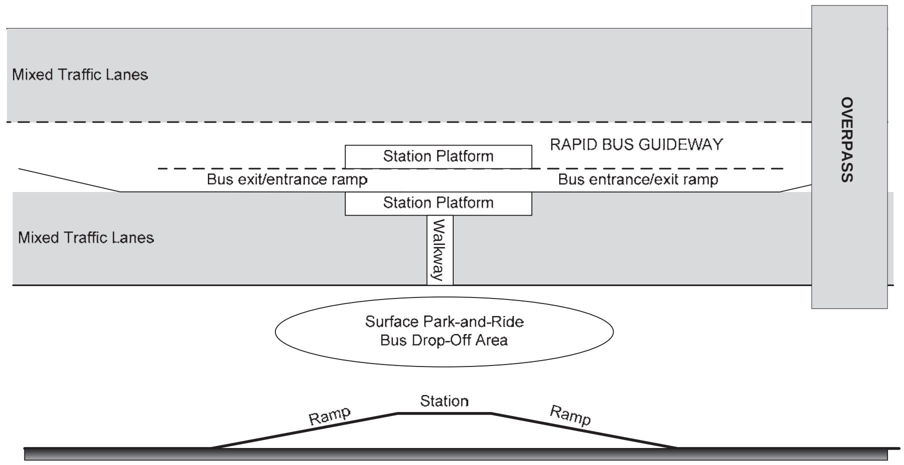
Interchange Reconstruction

While this option would be significantly simpler in terms of the construction required, it would entail creating an intersection in the middle of the existing overpass, most likely with a traffic signal to enable bus access / egress from the ramp into / from the overpass traffic. This would require reconstruction of the overpass.

2.5 Option 4: In-Line Station

This option would construct stations in the median of Route 24 (above mixed traffic / the Rapid Bus guideway). A ramp would be constructed that would provide a connection between the guidway and the station. A pedestrian only connection / overpass would be also be constructed to connect with a parking lot located adjacent to the highway.

Figure 5 Option 4 - In-Line Stations over Route 24



The following figures show an entrance to a BRT station in Ottawa, Canada and an elevated BRT Station in HuoCheZhan China.

Figure 6 Elevated BRT Station

Figure 7 Ottawa BRT Station Entrance

Bus Operations

Option 4 would provide buses with the most direct and shortest possible routing to each station. There would be no traffic interactions, eliminating both routine delays and the risk of occasional serious delays.

Ease of Transfers

While buses would have excellent access to the station platform, patrons transferring from other buses or arriving to the station on their own would have to walk from the drop-off or parking areas via a walkway over the roadway. Depending on the specifics of the site this could range from about 100 feet, which would be convenient, to greater distances. The transfers could be relatively convenient but site conditions could negatively affect transfers if a site immediately adjacent to the roadway is not available.

Traffic Impacts

Option 4 would have no traffic impacts as it would involve no surface street operations.

Right-of-Way Required

Option 4 would require only one lane width of additional median width.

Interchange Reconstruction

No interchange reconstruction would be required as this option would be implemented away from any interchange.

2.6 Conclusions

Table 2 summarizes the performance of the four options.

Table 2 Evaluation of the Options -Station Options Performance Characteristics

Factor	Option 1 At-Grade	Option 2 Flyover	Option 3 Slip Ramp	Option 4 On Line Median
Bus Operations	Poor	Fair	Fair	Very Good
Ease of Transfers	Fair	Good	Fair	Very Good
Traffic Impacts	Very Poor	Very Good	Poor	Very Good
Right-of-Way Required	Very Good	Poor	Good	Very Good
Interchange Reconstruction	Very Good	Fair	Very Poor	Very Good

Based on this analysis, only Option 4 is recommended to be kept. Only Option 4 avoids all of the negatives and is rated as Very Good for each. This analysis resulted in the determination that the in-line station design provided the best design for the following reasons:

- It provides the most efficient and fastest operation for the buses, avoiding delays associated with leaving the Rapid Bus Guideway and potential delays due to operating on surface streets.
- It provides the most convenient access for transit riders, providing access via elevator and a pedestrian overpass to the station platforms.
- It minimizes the footprint of the stations and avoids potential wetland impacts as it would by-and-large be constructed within an existing transportation right-of-way.

- It would avoid the need to reconstruct existing interchanges or construct new interchanges, a significant cost savings.

In –Line Station Structures and Operations

The in-line bus stations would be elevated side-platform stations in the median of Route 24. The stations would be 220 feet long, 34 feet wide, and 22 feet high. Two ramps would provide a connection between the permanent reversible bus lane and the station. The ramps would parallel the highway and would be 700 feet long and 34 feet wide and rise at an average gradient of 3%. Both the station and ramps would be constructed on retained fill. Approaching the ramps from the reversible busway, there would be two 1,000 feet long, 22 feet wide acceleration and deceleration lanes. The total width needed to accommodate the in-line stations and rapid bus lanes at the surface of the roadway would be 52 feet, 26 feet wider than the width needed for the rapid bus guideway alone.

A covered pedestrian walkway with lighting and dynamic signage would be constructed over the northbound side of Route 24 and would connect the station to a bank of elevators/stairs on the other side of the highway. This bank of elevators/stairs would be located adjacent to a field of parking with access to the local road-way system.

In the peak direction, buses stopping at the station would leave the reversible busway via the access ramps and stop at the Rapid Bus Station. Depending on the direction of travel, passengers would board/alight from either the left or right-hand platform. Passengers would be allowed to cross the bus travel lane to access the pedestrian walkway to the parking area. Upon departing the station, buses would travel via the second ramp, accelerate and rejoin the reversible busway.

In the midday and evening, time will be required to change direction of the reversible lane. The lane would be closed, all buses would be cleared, and then it would be prepared for operation in the reverse direction. This alternative therefore assumes that the permanent reversible lane on Route 24 and the in-line stations would not be accessible in the midday and nighttime service periods. During those periods, the Rapid Bus would use the general purpose lanes and passengers would board/alight at the adjacent park and ride facilities.

.

3

Selection of Station Locations

Potential station locations were identified by evaluating existing park and ride locations based on the following:

- Proximity to an existing Route 24 interchange
- Availability of vacant land
- Suitability of the site for a in-line station footprint

The seven existing Park and Ride Locations in the vicinity of the Rapid Bus guideway are shown in Figure 8.

Of these seven alternative locations, numbers 4 (Raynham Taunton Dog Track), 7 (Raynham at Route 138), and 5 (Union Plaza in Taunton) were dismissed for being too far from the Rapid Bus guideway. Constructing stations at these locations would require diverting buses from further south on local roads, increasing their overall trip times for customers coming from Fall River and New Bedford. Location number 7 (Raynham at Route 138) was eliminated from consideration due to the fact that it is less than 10 miles from the proposed station at Taunton Depot. Locating a station so close to another proposed station would result in an overlap of the catchment area for potential riders and would not maximize the potential number of new riders. This left two potential locations, one at Exit 16 (in West Bridgewater) and one at Exit 18 (in Brockton).

The existing park-and-ride lot at Exit 16 has 185 spaces and is served by Bloom Bus on a 30-minute headway during rush hours. Route 106 passes over Route 24. Exit 18 does not have an existing park-and-ride, although buses pick up riders in the Westgate Mall in front of the Dicks Sporting Goods Store. It is assumed the riders park in the shopping center lot. Both of these locations are close to existing highway interchanges which preclude the use of in-line stations. A visual survey was conducted for vacant land adjacent to the highway and far enough from an interchange that would be suitable for the construction of two potential stations.

The two locations identified were the intersection of West Street and Route 24 for Exit 16, in West Bridgewater, and the intersection of Oak Street and Route 24 for Exit 18 in Brockton. These two locations are shown in Figure 9 and Figure 10. A typical footprint for an in-line station was developed for these two locations and placed with special attention being paid to the location of wetlands and other ecologically sensitive lands. The park and ride for the West Bridgewater station would be provided on all or a portion of parcels 36-19, 36-20, 36-33, 29-005 and the park and ride for the Brockton station would be provided on a portion of parcel 014-001. The West Bridgewater station would be 4.79 acres and able to accommodate approximately 600 parking spaces while the Brockton station would be 2.35 acres and able to accommodate approximately 300 parking spaces. The proposed site of the West Bridgewater station is largely undeveloped, while the proposed site of the Brockton station has been previously developed.

The following two images (Figure 11 and Figure 12) show the wetlands in the vicinity of the two station sites and the proposed layout of the stations.

4

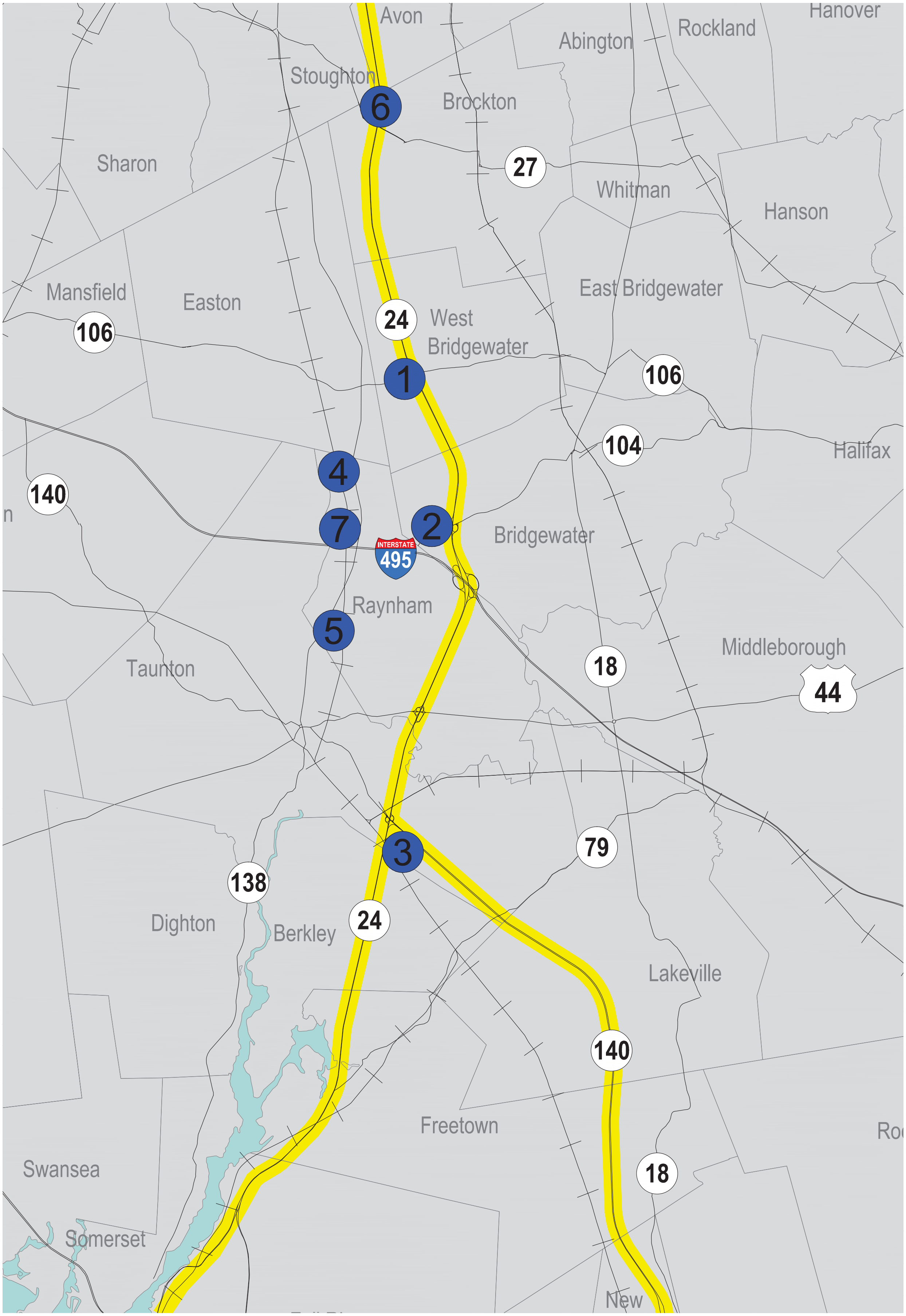
Capital Costs

Information on the capital costs of the proposed in-line stations will be developed further if the Modified Rapid Bus Alternative is advanced in this process. For purposes of order of magnitude estimation, it was assumed that the two stations would cost $15M a piece, and the site work and associated structures (access ramps, parking, etc) would also cost $15M a piece, for a total cost of $55M.

This page intentionally left blank

Figures

This Page Intentionally Left Blank



Legend

1. West Bridgewater P&R
2. Bridgewater at Route 104
3. Taunton Silver City Galleria
4. Raynham Taunton Dog Track
5. Union Plaza in Taunton
6. Brockton at Westgate Mall
7. Raynham at Route 138

0 1 2 Miles

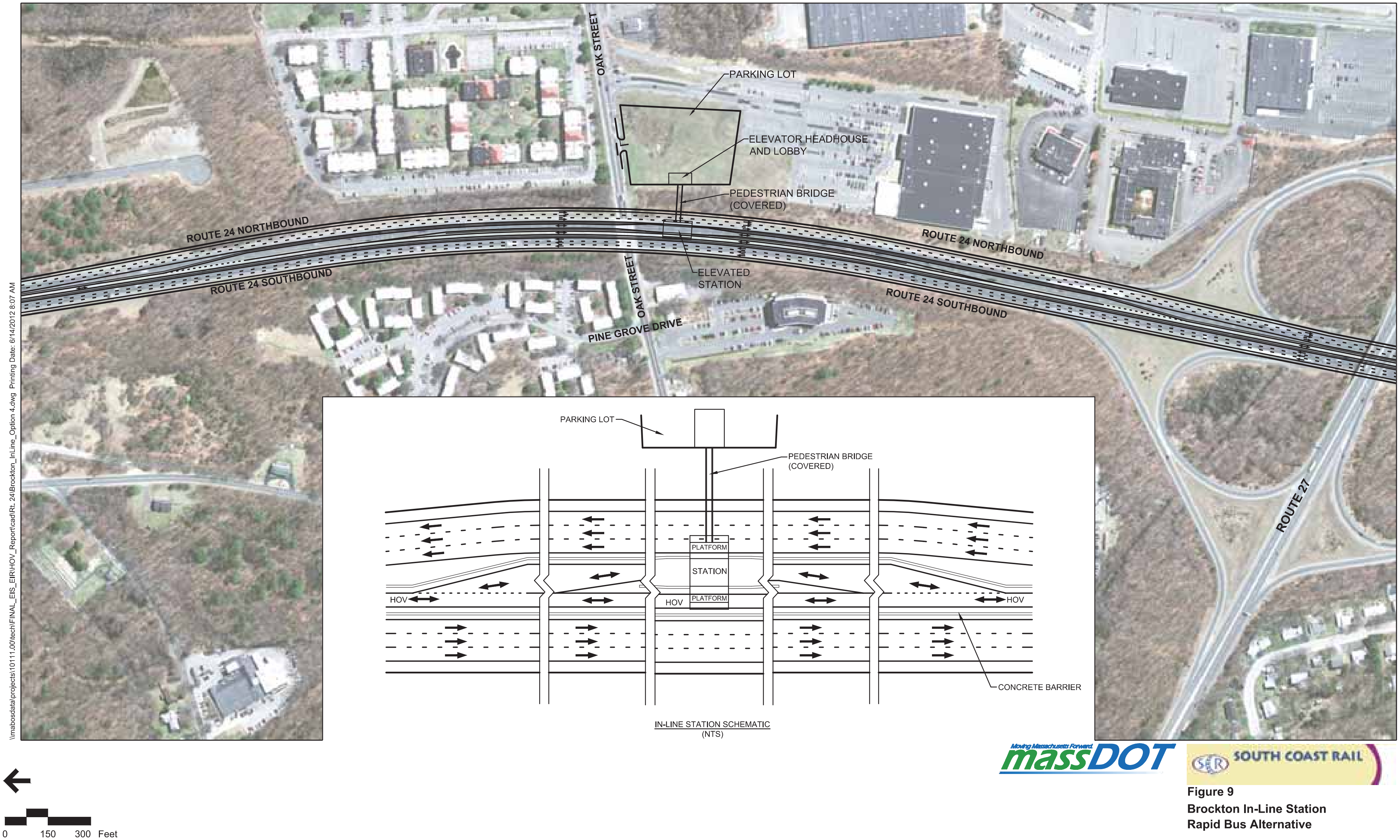
massDOT

SOUTH COAST RAIL

Figure 8
Existing Park and Ride Locations

Prepared by: VHB

\\MABOSDATA\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\10111_Exist_ParkRide.dwg Printing Date: 6/13/2012 5:05 PM



\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Rt. 24\Brockton_InLine_Option 4.dwg Printing Date: 6/14/2012 8:07 AM

Figure 9
Brockton In-Line Station
Rapid Bus Alternative

Prepared by: VHB

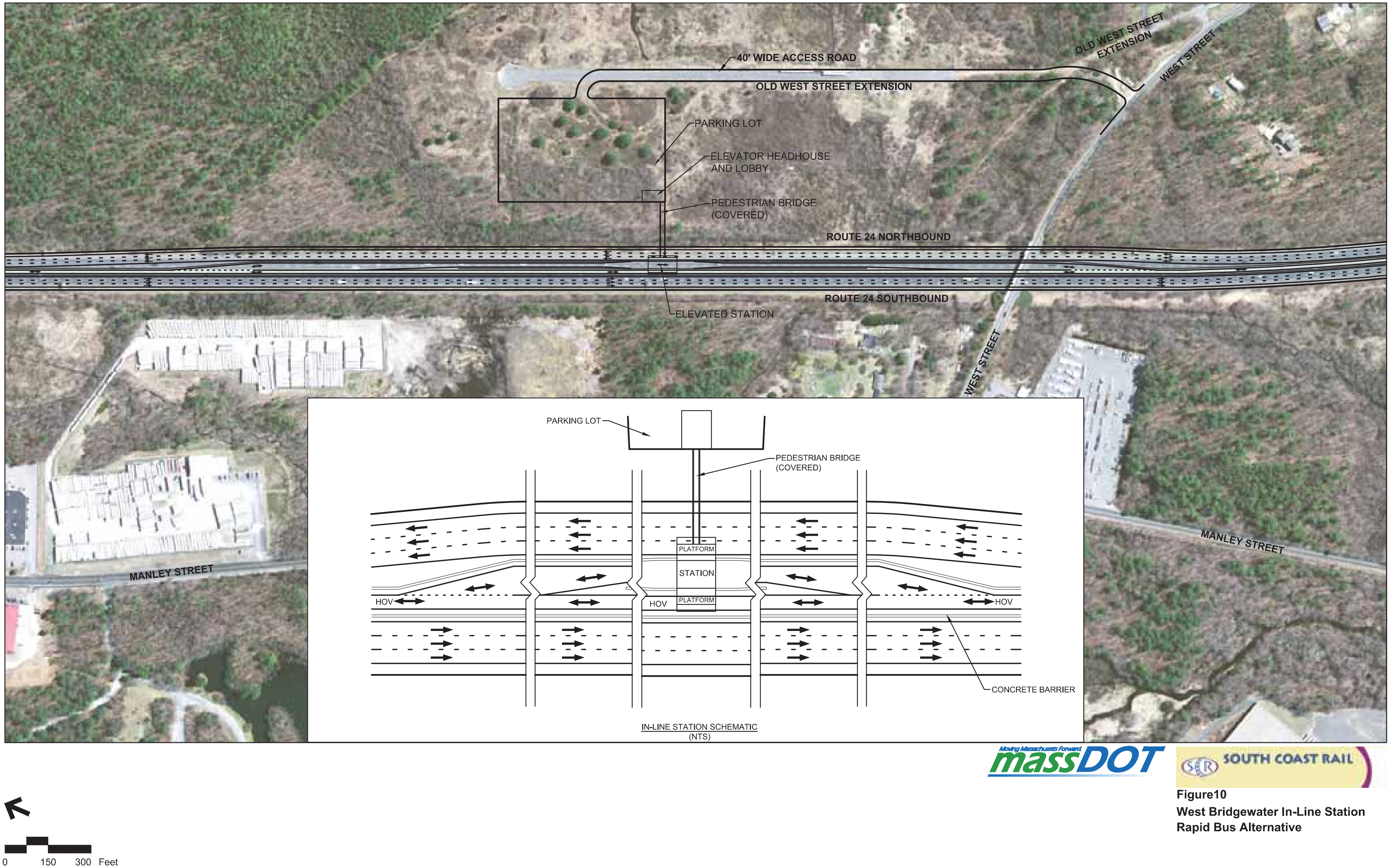
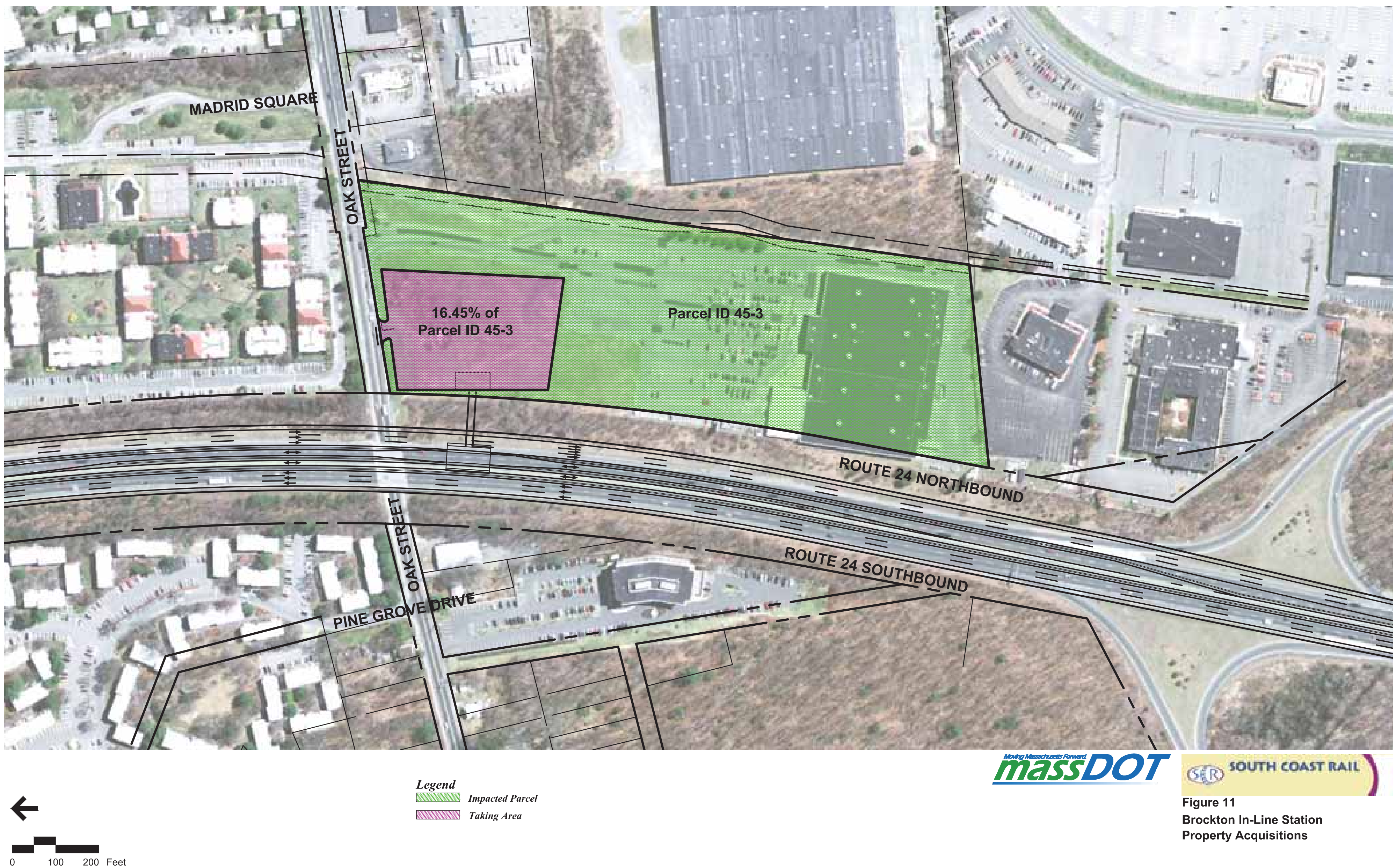


Figure10
West Bridgewater In-Line Station
Rapid Bus Alternative

Prepared by: VHB

\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Rt. 24\W Bridgewater_InLine_Option4.dwg Printing Date: 6/14/2012 8:19 AM



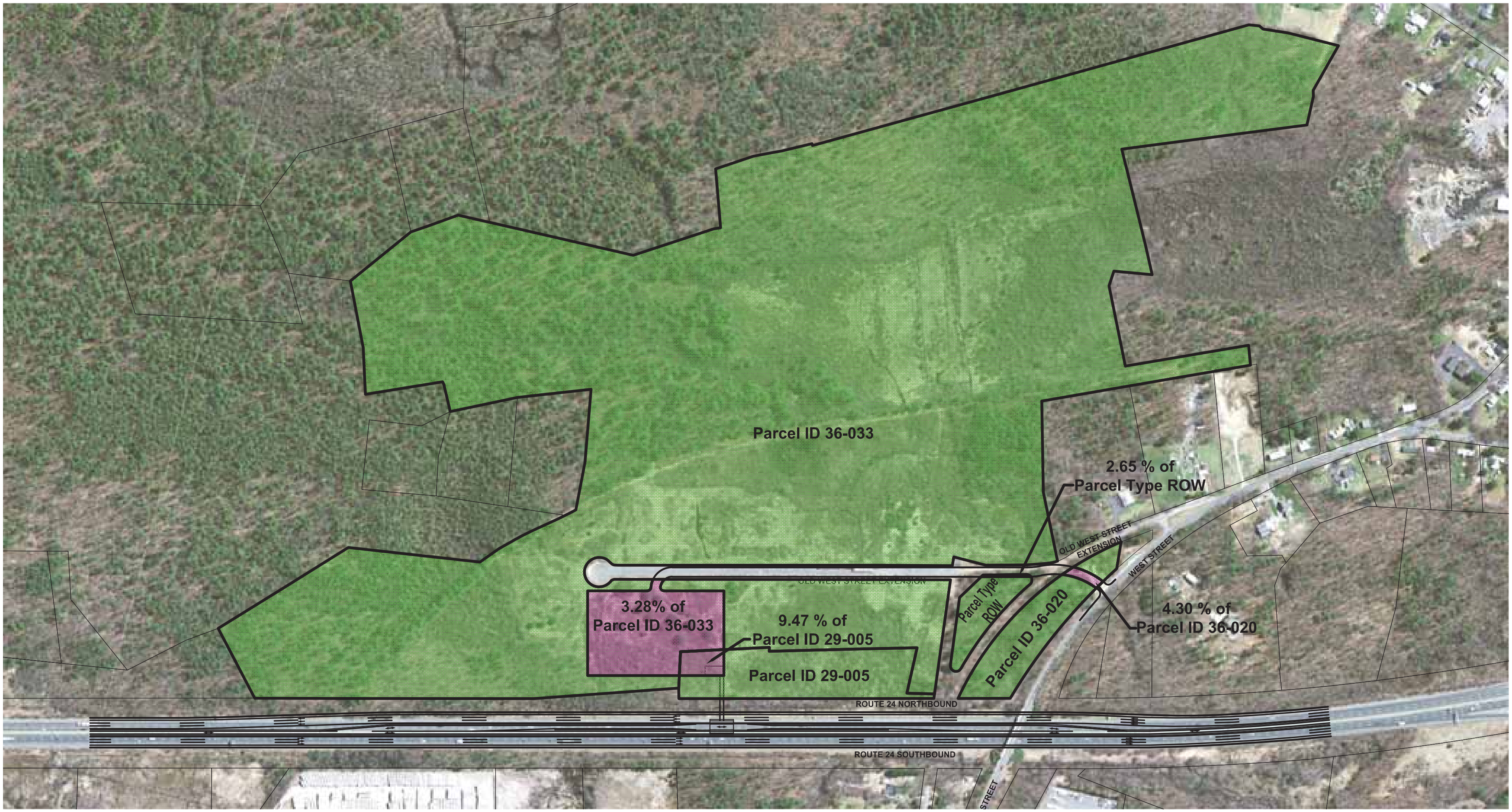
massDOT Moving Massachusetts Forward.

SOUTH COAST RAIL

Figure 11
Brockton In-Line Station
Property Acquisitions

Source: MassGIS, City of Brockton
Prepared by: VHB

\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\10111_Brockton_Inline_Station.dwg Printing Date: 6/14/2012 8:34 AM



Legend

Impacted Parcel

Taking Area

massDOT — Moving Massachusetts Forward.

SOUTH COAST RAIL

Figure 12
West Bridgewater In-Line Station
Property Acquisitions

Source: MassGIS
Prepared by: VHB

\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\10111_WBridgewater_Inline_Station.dwg Printing Date: 6/14/2012 9:13 AM

This page intentionally left blank

Appendix B:
Feeder Bus Service Analysis

Prepared for massDOT

Massachusetts Department of Transportation
10 Park Plaza
Boston, Massachusetts 02116

Prepared by VHB Vanasse Hangen Brustlin, Inc.

99 High Street, 10th Floor
Boston, Massachusetts 02110

SOUTH COAST RAIL

June 2012

Table of Contents

List of Figures

List of Tables

This Page Intentionally Left Blank

1

Introduction

This memo describes the proposed feeder bus service plan for each South Coast Rail station for the Stoughton Commuter Rail alternative and each Rapid Bus station for the Modified Rapid Bus alternative. The following objectives guide this plan:

- Identify potential route modifications to existing bus routes to integrate SCR and local bus services to the extent possible.
- Minimize the number of transfers required by transit riders to use the SCR system.
- Limit route modifications to the extent possible to avoid inconveniencing current bus users.
- For stations served by bus, accommodate buses within the station site and as close as possible to the station platforms.
- Plan for ADA compliant pedestrian connections to bus stops adjacent to the station sites and within the SCR station sites.

Three regional transit authorities, Brockton Area Transit Authority (BAT), the Southeastern Regional Transit Authority (SRTA) and Greater Attleboro Taunton Regional Transit Authority (GATRA) currently provide local bus service to the SCR corridor. On February 8, 2012 a meeting was hosted by SRPEDD with representatives of each of the bus operators to review the draft version of this memorandum. This version reflects their input and suggestions.

This Page Intentionally Left Blank

2

Stations without Feeder Bus Provisions

2.1 North Easton and Easton Village Stations - Rail

The proposed North Easton Station and Easton Village Station areas are not currently served by public transit. In consultation with Brockton Area Transit (BAT), it was concluded that it would not be operationally or economically feasible to extend existing BAT buses to serve either Easton Station as the BAT system operates on a pulse – providing a single location from which all of the buses originate and return to meet at the same time. The added distance to extend existing BAT routes to either Easton station could not be accomplished while maintaining this type of operation. Either the buses serving the Easton stations would fall out of synchronization with the balance of the BAT system or the entire system would have to operate on a schedule dictated by service to these stations – likely forcing longer headways that would reduce service or requiring more buses increasing operating costs throughout the BAT system. For this reason it is not recommended to extend the BAT system to North Easton or Easton Village Station, nor are there other bus systems which could reasonably be extended to serve either.

It may be possible for either or both stations to be served by shuttle bus service, as GATRA has successfully implemented in Mansfield that would provide door-to-door service, but not fixed route feeder bus service.

Figure 1 North Easton Station – Rail

Figure 2 Easton Village Station – Rail

2.2 Raynham Place Station – Rail

The proposed Raynham Park Station area is not currently served by public transit. Bloom Bus operates private commuter bus service from the adjacent Raynham Park entertainment complex to Boston and Taunton, but the SCR connects to both of these locations directly. There are no nearby developments which would be better served by a feeder bus connection. Therefore, no modifications to existing bus service are recommended to serve this station.

Figure 3 Raynham Place Station – Rail

2.3 Taunton Station - Rail

The proposed Taunton Commuter Rail Station is located .75 miles east of Taunton Green (the center of downtown Taunton), just north of Dean Street / Route 44. Of the six GATRA routes serving downtown Taunton, none currently stop in the proposed station area. GATRA Route #7 travels in the vicinity of the proposed station, stopping at the intersection of Longmeadow Road and Dean Street, .4 miles east of the station. In consultation with GATRA it was concluded that modifying Route #7 to directly access the Taunton Station site would require relocating service away from schools and businesses currently served along Longmeadow Road, depriving them of transit service. There are no other GATRA routes in the immediate vicinity that could reasonably be re-routed to serve this location. Because the Taunton Depot Station site is also located within Taunton it was deemed reasonable to focus on that station for feeder bus service.

Figure 4 Taunton Station – Rail

2.4 Battleship Cove Station – Rail and Rapid Bus

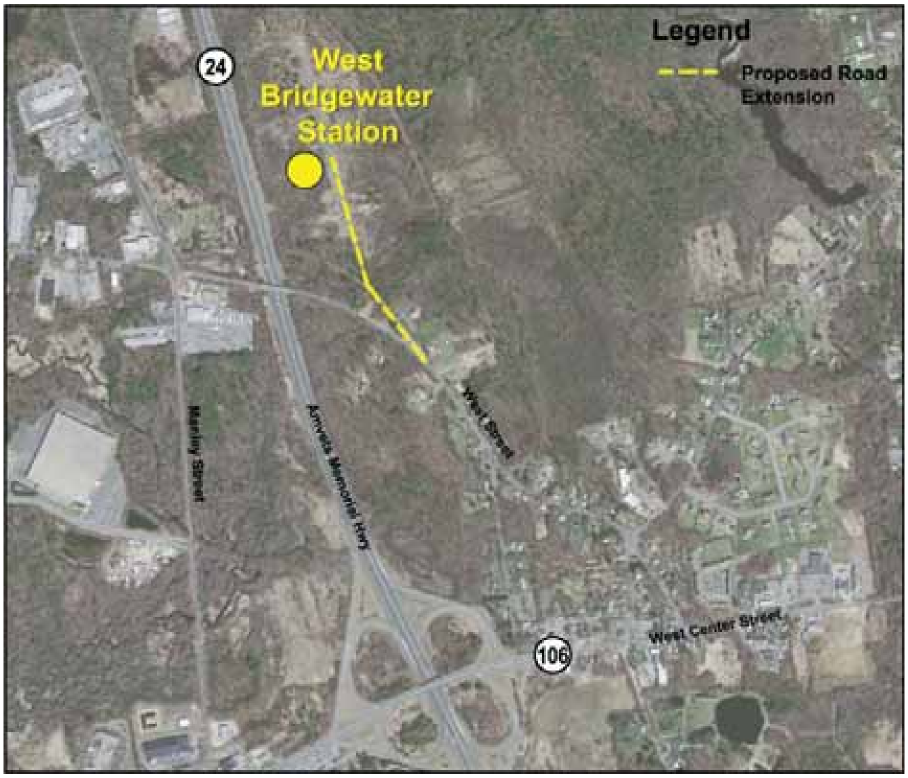
Battleship Cove Station is envisioned as a seasonal station providing access to local tourist attractions (including Battleship Cove). The site is adjacent to Broadway, a divided highway that forms a barrier to pedestrians from or to the east. Buses do not currently operate west of Broadway in this area. Due to the seasonal nature of this station and the proximity of Fall River Depot, no feeder bus service to this station is recommended. It has been noted that as the roadways in the vicinity of Battleship Cove are reconfigured it may prove desirable to revisit this station to assess how feeder bus service might be provided.

Figure 5 Battleship Cove Station - Rail and Rapid Bus

2.5 West Bridgewater – Rapid Bus

The West Bridgewater Station would be located off of West Street where it crosses under Route 24. An access road would be constructed to the station site which would be located as shown to minimize impacts to wetlands. This would be an on-line station, with the Rapid Bus buses rising from the median guideway to access the elevated platforms of the station. There are no buses routes in the vicinity of this station site.

Figure 6 West Bridgewater Station – Rapid Bus



3

Stations with Feeder Bus Provisions

3.1 Taunton Depot - Rail

This proposed station area is served by the GATRA Route #8 bus. The route currently extends from County Street to loop through the Taunton Depot shopping center. Because the walk distance from the front corner of the shopping center building to the station platform is almost 900 feet, it is recommended that a short extension of Route #8 beyond the shopping center and into the station site be provided.

Figure 7 Taunton Depot – Rail

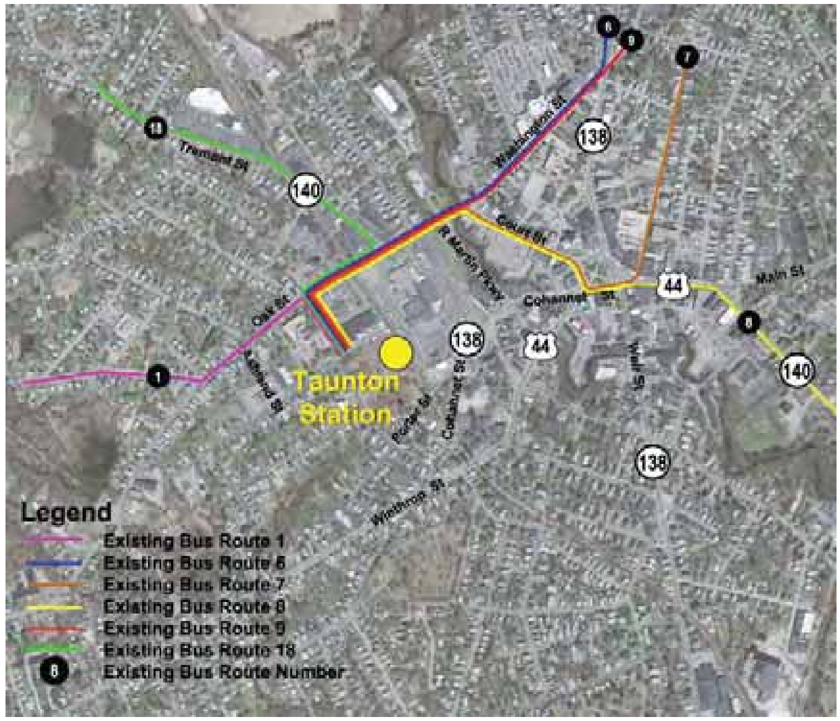
Figure 8 Taunton Depot Feeder Bus Service

3.2 Taunton Depot – Rapid Bus

This proposed Taunton Rapid Bus station is served by the GATRA Routes #1, 6, 7, 8, and 18. The routes extend from the Bloom Bus terminal in downtown Taunton in all directions. No extensions to these routes are proposed as they would be less than ½-mile away from the proposed Rapid Bus station.

Figure 9 Taunton Station – Rapid Bus

Figure 10 Taunton Station - Rapid Bus, Feeder Bus Services



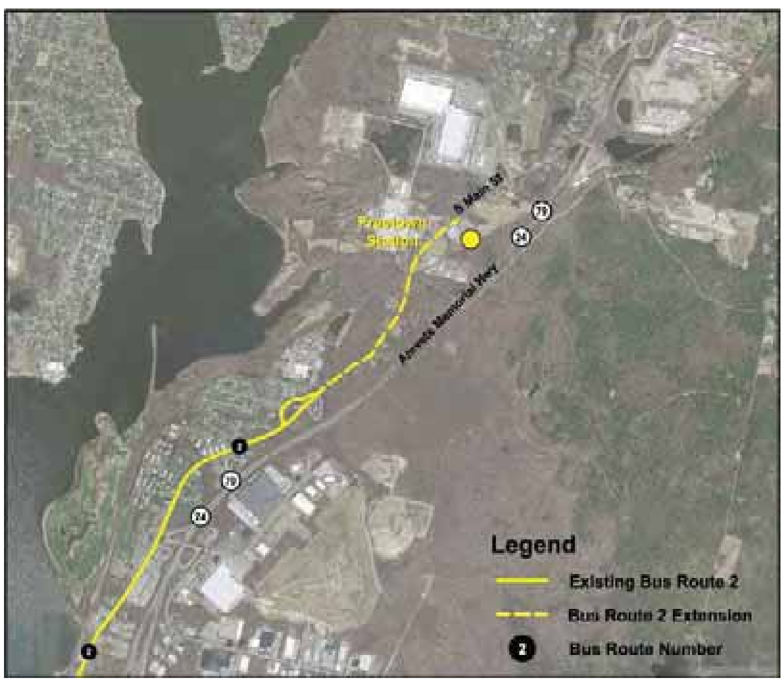
3.3 Freetown Station – Rail and Rapid Bus

The proposed Freetown Station area is not currently served by public transit. SRTA Route #2 (N. Main Street) travels from downtown Fall River to the Freetown town limits. The route operates on half-hour headways between 5:50 AM and 5:50 PM.

A 1-mile extension of SRTA Route #2 along S. Main Street is proposed, terminating at the proposed Freetown station.

Figure 2 Freetown Station – Rail and Rapid Bus

Figure 12 Freetown Station Feeder Bus Service



3.4 Fall River Depot – Rail and Rapid Bus

The Fall River Depot is planned for the former location of the Fall River Station, a location served by two SRTA routes, the Fall River Industrial Park Route and Route #2. These routes run along Main Street and are well within convenient walking distance to the station platform assuming provision of an adequate pedestrian pathway. Baylies Street could be an acceptable pedestrian route if the station site plan were to meet the path at the corner of Durfee Street and Baylies Street.

Figure 3 Fall River Depot – Rail and Rapid Bus

Figure 4 Fall River Depot Close-Up

It was concluded during the review of this station that an adequate pedestrian pathway between Main Street and the station site probably cannot be provided and maintained. Therefore, the Feeder Bus plan is to adjust Route #2 and the FR Industrial Park Route to divert at Odd Street to Durfee Street to Turner Street to N. Davol Street, then via President Avenue to return to Main Street.

It is recommended that a method to alert buses of the presence of passengers at the station as buses will operate at times when there is little likelihood of there being a commuter train in the station. This could be accomplished by dynamic signage but other methods may be equally effective.

Figure 5 Fall River Depot Feeder Bus Service

3.5 King's Highway Station – Rail and Rapid Bus

King's Highway Station is set amid regional shopping destinations separated by expansive parking lots. Access to these stories is from King's Highway / Tarkiln Road. The station site is located between two retail properties.

SRTA Route #8 (Mount Pleasant) connects to the station area at its northern terminus adjacent to the Fieldstone Marketplace. Route #8 travels between the station area and downtown New Bedford. Therefore no modification to Route #8 is needed.

It was noted that a significant concentration of residents exists east of the station location across Church Street. Provisions of a pedestrian connection from the station site to this area is being planned to facilitate people walking to the station.

Figure 6 King's Highway Station – Rail and Rapid Bus

Figure 7 King's Highway Station Feeder Bus Service

3.6 Whale's Tooth Station – Rail and Rapid Bus

Whale's Tooth Station is the eastern terminal station for South Coast Rail Project, located adjacent to downtown New Bedford. A Transit Development Plan (Draft) has been developed for the SRTA bus system that serves New Bedford.

Figure 8 Whale's Tooth Station – Rail and Rapid Bus

As part of that analysis modifications to the proposed SRTA bus system that would link SCR via Whale's Tooth Station to SRTA were recommended. Those recommendations were based in part on the construction of a new dedicated bus / pedestrian bridge across Route 18 from Purchase Street directly into the Whale's Tooth Station site. However, the transit / pedestrian bridge was proposed as part of a TIGER grant application for an expanded Whale's Tooth Station that was not funded. While efforts to secure funding from other sources are on-going, pending receipt of such grants the planning for this station must reflect the existing infrastructure, which lacks the dedicated transit / pedestrian bridge and the intermodal center. The Whale's Tooth Station will still include provisions for transfers, including from buses, those being dropped off and park-and-riders, but site access will be limited to the existing street system.

During the review with SRTA the possibility of an interim service plan, one not dependent on the transit bridge, was explored. Based on that consultation the feeder bus plan for Whale's Tooth Station would modify the two busiest routes, Route #1 (Fort Rodman) and Route #2 (Lund's Corner).

Route #1 – Fort Rodman would now travel through the downtown on the inbound trips via Pleasant Street to the SRTA Downtown Terminal, and then continue northbound, turning right onto Hillman Street. Route #1 would then turn left into Acushnet Avenue and proceed to the Whale's Tooth station. Outbound trips would depart the Whale's Tooth Station traveling south on Acushnet Avenue, turn right onto Hillman Street and then left onto Pleasant Street and continue to the Downtown Terminal.

Route #2 – Lund's Corner interlines with route #1. The route already uses Acushnet Avenue to access downtown, and could stop at Whale's Tooth Station along its current path.

This would provide the Whale's Tooth Station with frequent service (10 minute headways) and riders of the entire SRTA system convenient access to the Whale's Tooth Station via transfer at the downtown terminal. Operationally, all it would require is extending Route #1 from the downtown terminal to Whale's Tooth Station, a distance of 0.7 miles.

Figure 9 Whale's Tooth Station Feeder Bus Services

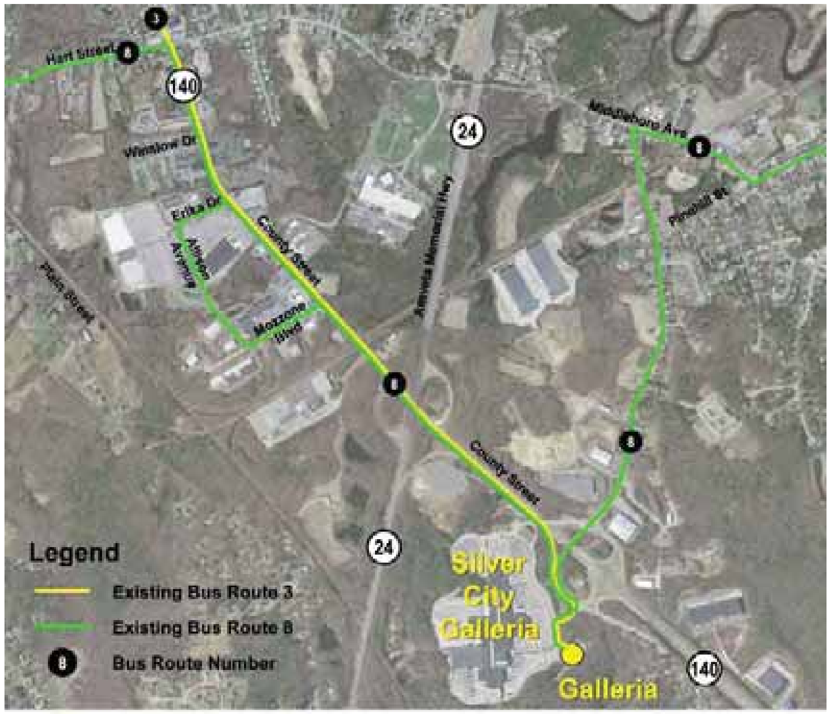
Figure 20 Galleria Station Feeder Bus Services

3.7 Galleria Station – Rapid Bus

The Galleria Station would be located in the current site of the bus park and ride in the Silver City Galleria site. Buses destined for South Station would originate at this station and proceed north on the Rapid Bus guideway to Raynham and Easton Stations before continuing to South Station.

The mall park-and-ride is already served by GATRA routes #3 and #8. GATRA route 8 is described above, Route 3 travels between the Silver City Galleria and the Myles Standish Industrial Park in Taunton.

Figure 10 Galleria Station Feeder Bus Services



3.8 Brockton Station – Rapid Bus

The Brockton Station would be located north of Westgate Mall. This would also be an on-line station, with the Rapid Bus buses rising from the median guideway to access the elevated platforms of the station. BAT routes #4, 4A and 14 currently serve Westgate Mall at the Dick's Sporting Goods store site. The #4 and 4A bus serve downtown Brockton, the #14 bus travels north to Stoughton. It is proposed that these routes would be extended to the Rapid Bus Easton Station as shown in the following site map.

Figure 22 Brockton Station Feeder Bus Services

4

Conclusions

The route extensions planned for the South Coast Rail project would be implemented as funding is identified by the local RTA's responsible for providing the bus service. These feeder bus services were incorporated into CTPS' 2030 model inputs in order to accurately reflect the potential intermodal connections that would be available to SCR passengers.

The projected ridership for these routes (with the Modified Rapid Bus Alternative) is shown below. Information on the potential feeder bus ridership for the Stoughton Electric Alternative is not yet available and will be presented upon completion of the rail ridership modeling results.

Table 1 Feeder Bus Ridership Results

	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Whales Tooth	37	27	29	36	29
Kings Highway	4	3	4	4	3
Fall River	55	47	48	54	48
Freetown	6	5	5	5	5
Galleria	16	12	13	15	13
Taunton	45	37	38	42	35
Brockton Station	8	7	7	7	6
Total	171	138	144	163	139

Source: CTPS

This page intentionally left blank

Modified Rapid Bus Alternative
Technical Memorandum - DRAFT

Appendix C: VISSIM Traffic Simulation Analysis

Prepared for

massDOT
Massachusetts Department of Transportation
10 Park Plaza
Boston, Massachusetts 02116

Prepared by

Vanasse Hangen Brustlin, Inc.
99 High Street, 10th Floor
Boston, Massachusetts 02110

SOUTH COAST RAIL

June 2012

Table of Contents

List of Tables

1

Introduction

VHB/Vanasse Hangen Brustlin, Inc. (VHB) has developed a VISSIM traffic simulation of the northbound Interstate 93 (I-93), the Southeast Expressway, to illustrate how operations may change with the implementation of a Bus Rapid Transit (BRT) line through the South Coast Rail Project.

The proposed BRT line is one implementation alternative being considered for a South Coast Rail line. This alternative would provide service between Fall River and South Station in Boston via Route 24 and I-93 using existing and proposed HOV lanes.

Currently, there are two HOV lanes on northbound I-93 between Braintree and Boston. The southernmost HOV lane extends from Braintree to just south of the Savin Hill Station in Boston and provides alternating northbound and southbound HOV travel in a moveable “zipper” lane. The northern HOV lane begins on I-93 at the Mass Ave Connector and provides connection to Interstate 90 eastbound, South Station and the Kneeland Street at Lincoln Street intersection. In order to provide a more complete BRT service, the 1.9 mile gap between the two existing HOV lanes would be upgraded to improve overall HOV travel times. Additional lanes or improved merge segments will require geometric changes to the expressway at the current merge point for the southern HOV lane at the Savin Hill Station. Four alternatives were developed and are modeled in VISSIM to understand the operational impacts of each.

The purpose of this memorandum is to describe the steps taken in the development of the VISSIM model including acquiring data, calibrating the model, and the results of each alternative.

1.1 Background Information

A VISSIM traffic simulation model was developed to simulate operations on I-93 northbound during the 7:00 AM peak hour.[1] The study area begins south of Exit 14: Morrissey Boulevard and ends past the beginning of the existing northern HOV lane. The network includes I-93, HOV lanes, and on- and off-ramps for Morrissey Boulevard, Columbia Road, Southampton Street, Frontage Road, and I-90 / South Station. The network also includes links representing segments of the southeast expressway south of Morrissey Boulevard to allow for queuing past the study area which exists today. Existing conditions is based on available 2010 volumes. These volumes are shown in Figure 1.

VISSIM is a microscopic, time step and behavior-based simulation software model used to assess multi-modal urban traffic and public transit operations. The program uses a vehicle behavior model that replicates individual driver behavior characteristics, providing realistic modeling of lane-changing behavior in various situations and the ability to model parallel vehicle flows. VISSIM can report several types of transportation engineering and planning measures of effectiveness (MOEs), including delay, speed, density, travel time, stops and queues, and therefore can be a useful tool for the evaluation of various alternatives. VISSIM can display results in both 2D and 3D environments. The simulation model was developed using VISSIM Version 5.20-14.

[1] Traffic volumes from 6:00 – 7:00 AM were also included in the model so it would be preloaded with vehicles by the start of the 7:00 – 8:00 AM peak hour.

1.2 Sources of Calibration Data

Roadway links in the VISSIM model were constructed from aerial photographs and coded with information such as the number and width of lanes, vehicle speeds, and traffic restrictions, such as HOV-only lanes. The simulation network was calibrated using volume, travel time, and speed data. All data was provided by the Central Transportation Planning Staff (CTPS) in Boston.

The traffic volume data were obtained from the CTPS transportation planning model for 2010 and 2030 for the expressway, ramps, and the HOV lanes. Volumes were provided for each highway segment and each on- and off-ramp on an hourly basis from 6:00-10:00AM. Additionally, some origin-destination data for HOV drivers was provided to better understand how these drivers will use the alternative geometries being suggested for BRT implementation.

Travel time and speed data were obtained from a data report published by Boston Region Metropolitan Planning Organization.[2] The travel time data was collected through multiple travel time runs between 2003 and 2006 then normalized to determine a representative value. Travel times were provided by segment along I-93. Segments are typically defined by on- and off-ramps or by other defined landmarks such as overpasses. Travel times were provided for 30-minute increments from 6:00-10:00 AM. These travel time values were used to determine link speeds which were also used to calibrate the model. CTPS also provided average travel time data, summarized by ½-hour periods during the morning peak, for the southern HOV lane.

1.3 Key Calibration Measures

Traffic volume, travel time, and speed were all used to calibrate the network. Visual determination of the back of the queue locations from the VISSIM simulations were compared to field observations to validate network operations. All model output and data are based on ten iterations of traffic simulation.

1.3.1 Traffic Volume

Traffic volumes provided by CTPS were used to calibrate the existing conditions model. Volumes were calibrated to within +/-8 percent of the volume data provided for the main line and within +/-13 percent of the provided volume data for the ramp volumes. Table 1 shows the data provided and how closely the simulated volumes match that data.

[2] *Speeds and Travel Times on Limited-Access Highways in the Boston Metropolitan Region 2004-2007,* Central Transportation Planning Staff. Boston, MA February 2008.

Table 1 2010 Existing and Simulated Traffic Peak Hour Volumes

Location	Existing Volume [a]	Simulated Volume	Percent Error
Interstate 93 at:			
Exit 14 off-ramp	6,350	6,879	8%
Zipper Lane, south of merge point	1,300	1,227	-6%
Exit 15 Columbia Rd	6,900	7,277	5%
Exit 16 Southampton St	8,100	8,141	1%
Exit 18 Mass Ave	7,500	7,486	0%
Exit 20 I-90/South Station	6,500	6,479	0%
North of HOV ramp	3,500	3,543	1%
HOV lane, north of I-90/South Station ramp	200	195	-2%

Source: a *Expressway Highway Volumes,* Central Transportation Planning Staff, Boston, MA.

1.3.2 Travel Time and Speed

2003 to 2006 travel times provided by CTPS were used to calibrate the network to ensure that sufficient vehicle volumes were moving through the network and behaving in a way representative of existing Southeast Expressway operations. Travel times on each segment in the study area were calibrated to within +/- 25 percent of the provided travel times while the overall travel time through the study area was calibrated to within +/- 10 percent of the CTPS data. Table 2 shows CTPS travel time values, simulated average travel time values, and minimum and maximum simulated travel time values.

Table 2 Existing and Simulated Peak Hour Travel Times

		7:00-7:30AM			7:30-8:00 AM		
			Simulated			Simulated	
Segment Ends	Segment Length (mi.)	Field Data [a]	Mean	Percent Error	Field Data [a]	Mean	Percent Error
Zipper Lane entry to merge	5.68	11:00	11:12	1.8%	11:45	12:10	3.5%
General Purpose Lanes							
Exit 8 to Zipper Lane merge							
Exit 14 off-ramp to Zipper Lane merge	0.52	1:34	1:29	-4.6%	1:34	1:30	-4.0%
Zipper Lane merge to Exit 15	0.92	1:44	1:20	-23.5%	1:58	1:57	-0.7%
Exit 15 to Exit 16	0.67	2:01	1:42	-15.7%	2:01	1:56	-4.0%
Exit 16 to Exit 18	0.28	0:25	0:26	1.9%	0:26	0:26	1.9%
Exit 18 to Exit 20	0.22	0:18	0:18	-1.2%	0:18	0:20	9.9%
Total Travel time							
Zipper Lane entry to Frontage Road on-ramp							
General Purpose	7.31	20:11	21:57	8.8%	20:45	21:07	1.7%
HOV	7.31	15:30	15:04	-2.8%	16:30	16:27	-0.3%

Source: a Travel Times (m:ss). *Speeds and Travel Times on Limited-Access Highways,* Central Transportation Planning Staff, Boston, MA, February 2008.

CTPS speeds were derived from travel time and location data. In order to calibrate to this data, simulation speeds were derived from the travel time and location data from VISSIM as well. The CTPS speeds and simulation speeds for each segment are shown in Table 3.

Table 3 Existing and Simulated Peak Hour Speeds

	7:00 - 7:30 AM			7:30 - 8:00 AM		
Location	Existing Speed [a]	Simulated Speed	Percent Error	Existing Speed [a]	Simulated Speed	Percent Error
Interstate 93 at:						
Exit 14 off-ramp to HOV lane merge	20	21	5.0%	20	21	5.0%
HOV lane merge to Exit 15	32	42	31.3%	28	28	0%
Exit 15 to Exit 16	20	24	20.0%	20	21	5.0%
Exit 16 to Exit 18	41	40	2.5%	39	38	2.6%
Exit 18 to Exit 20	43	45	4.4%	43	40	7.5%

Source: a Speeds in mph - *Speeds and Travel Times on Limited-Access Highways,* Central Transportation Planning Staff, Boston, MA.

1.3.3 Observations

General observations were made of the existing traffic operations of I-93 and compared to the calibrated simulation results. Beyond the above calibrated MOE's, the simulation results compared favorably to the following operational observations:

- The typical back of the general purpose lane rolling queue extends to just north of the Furnace Brook Parkway off-ramp.
- The HOV lane merge results in rolling queue in the HOV lane that typically extends past the Morrissey Boulevard off-ramp.
- The HOV lane merge impacts the two leftmost general purpose lanes resulting in a rolling queue typically back to the Freeport Street off-ramp.
- The stop-and-go operation of I-93 between Exit 14 and Exit 20, with more free-flow conditions occurring between the end of the southern HOV lane to a point just south of Columbia Road and north of the Dorchester Avenue overpass.

This page intentionally left blank

2

Design Alternatives

The VISSIM tool was used to assess the benefits and impacts of the four Design Alternatives proposed to bridge the gap between the existing Zipper Lane and HOV lane on I-93. To best understand the impacts of constructing each BRT alternative six models were developed: 2010 Existing Conditions, 2030 No-Build Conditions, and four 2030 Build models for each proposed alternatives.

The calibrated Existing Condition model illustrates operations today and provides a model calibration base for projecting future operation as well as a baseline for comparing results. The 2030 No-Build Condition models the future volumes provided by CTPS and makes no geometric changes to the network. For the purpose of the operations analysis the following traffic volume assumptions were made:

- Alternative 1 would connect the existing Zipper and HOV lanes creating an uninterrupted HOV connection between Braintree and South Station, but the alternative would remove egress from and access to the Zipper Lane and northern HOV ramp, respectively. This restriction would result in a shift of 1800 vehicles during the peak hour from the Zipper Lane to the general purpose lanes in order for these vehicles to reach their destinations via off-ramps located south of the Exit 20.
- Alternative 2 would widen the cross-section of the Southeast Expressway and provide a dedicated, reversible lane connecting the existing Zipper and HOV lanes, and allow entry and exit from the Zipper or HOV lanes at the existing points. Therefore some HOV vehicles from the general purpose lanes and Zipper Lane would utilize the new connection if their destination is the northern HOV lane or the Tip O'Neill Tunnel.
- Alternative 3 would widen the cross-section of the Southeast Expressway to provide an additional concurrent HOV lane, or diamond lane in each direction, connecting the existing Zipper and HOV lanes. Mainline and ramp volumes would be the same as the No-Build condition, but HOV vehicles would have access to an additional concurrent HOV lane. About 2250 vehicles would have access to this lane during the peak hour.
- Alternative 4 would modify the mainline configuration of the Southeast Expressway but would not connect the existing Zipper and HOV lanes; therefore, no changes would be made to the No-Build volume conditions.

This page intentionally left blank

3

Results

3.1 Introduction

Once the five different future VISSIM models were developed, each one was simulated for ten iterations. For each iteration of the simulation, volume and travel time data were collected. Volume and travel time results for each alternative are summarized in Table 4 and Table 5, respectively. Table 4 reports the desired amount of peak hour traffic from the CTPS model (demand volume) and the amount of peak hour traffic processed by the simulation (service volume) at two locations; the entry point to the Zipper Lane in Braintree and a location south of the existing Zipper Lane exit . The travel time table shows travel time through the network in three smaller segments and for the entire length of the network.

Table 4 Simulated Peak Hour Traffic Volumes

	2010 Existing Vol.[a]	2030 No-Build Volume			2030 Alternative 1 Volume			2030 Alternative 2 Volume			2030 Alternative 3 Volume			2030 Alternative 4 Volume		
	Dem[b]	Dem[b]	Serv[c]	Dem Served	Dem[b]	Serv[c]	Dem Served	Dem[b]	Serv[c]	Dem Served	Dem[b]	Serv[c]	Dem Served	Dem[b]	Serv[c]	Dem Served
Zipper Lane Entry, Braintree																
General Purpose lanes	7,000	8,790	6,491	74%	1,061 5	6,633	62%	8,790	6,528	74%	8,790	6,648	76%	8,790	6,239	71%
Zipper Lane	1,300	2,030	1,324	65%	241	243	101%	2,066	1,504	73%	2,066	1,484	72%	2,066	1,510	73%
North of Morrissey Boulevard, Boston																
General Purpose lanes	5,900	8,350	6,519	78%	1,017 5	6,575	65%	8,350	6,244	75%	8,350	6,487	78%	8,350	5,494	66%
Zipper Lane	1,300	2,030	1,209	60%	241	245	102%	2,066	1,444	70%	2,066	1,443	70%	2,066	1,506	73%

Sources:
a 2010 *Expressway Highway Volumes,* Central Transportation Planning Staff, Boston, MA, March 2011.
b Dem- Demand volumes for the given alternative expressed in vehicles per hour, 2030 Regional Travel Demand Model, Central Transportation Planning Staff, Boston, MA, January 2012.
c Serv- Volume of vehicles served during the peak hour of simulation expressed in vehicles per hour, VISSIM simulation data.

3.2 Discussion of Results

All of the proposed alternatives are directed at improving operations for the Zipper Lane to provide reliable bus rapid transit service into South Station. All of the alternatives would achieve that goal in some capacity. Unfortunately, none of the alternatives would substantially improve future operations of the general purpose lanes. The projected 2030 traffic demand provided by CTPS reflects annual growth of 1.64 percent for the general purpose lanes and by 2.25 percent for Zipper Lane volumes over the 2010 existing volumes.

Off-ramp volume growth from 2010 to 2030 would be focused on the tightly spaced exit ramps north of Columbia Road. This increase in mainline volumes passing the Columbia Road on-ramp would limit the ability of vehicles to merge in at this point and would affect on-ramp queues. At times, the increase in volume would also create some additional friction at the northern off-ramps.

General purpose lane volumes in 2030 would have grown to an extent that vehicle queues would extend out of the physical limits of the modeled network. The saturation flow rate is approximately 1650 vehicles per hour per lane with low speeds preventing vehicles from entering the network. All alternatives, including No-Build, would be unable to serve all of the volume demanding access to the Southeast Expressway, effectively extending the peak commuting periods and the travel time for all users that enter I-93 south of the Braintree Split.

This queue extension of general purpose lanes would likely impact access to the Zipper Lane in the future. New, dedicated ramp connections from Route 128 to the Zipper Lane, which are included as part of each of the Build alternatives, would minimize this impact for Rapid Bus and Route 128 HOV traffic. In addition, another factor predicted to restrict vehicles from entering the Zipper Lane is the projected saturation flow rate of the Zipper Lane at the entry point. Due to the entry speed, configuration and enforcement, the maximum number of vehicles simulated to enter the Zipper Lane is approximately 1,500 vehicles per hour, about 75 percent of the demand volume. This is a reoccurring problem that limited the improvements for all alternatives, with the exception of Alternative 1.

Table 5 shows the change in travel time through the simulation network for 2010 Existing Conditions, 2030 No-Build Conditions, and each of the four 2030 Alternatives. Changes in travel time for the Zipper or HOV lane varies with each condition while travel times for the general purpose lanes are consistently higher for 2030 conditions than in the existing 2010 condition. Table 5 shows peak hour travel time for vehicles that were served during the peak hour, therefore, the volume of vehicles that are not served are not represented in this table. Table 6 presents the impacts of these vehicles on travel times.

Table 6 summarizes the amount of unmet peak hour volumes and the saturation flow rates for both the general purpose and HOV lanes under each alternative. Additionally, this table estimates the impact that unmet volume and reduced saturation flow rates would have on peak hour operations in the form of peak hour spreading. Peak hour spreading or the additional peak hour travel time is a representation of the minutes that will likely be added to the existing peak hour in order to process all of the volume demand based on the simulated saturation flow rates. The peak hour for the general purpose lane traffic could spread from 60 minutes to a period of between 79 minutes and 96 minutes. These peak hour spreading projections are based on additional travel time needed for the peak hour traffic volume demand to travel through the study area network. If operations on other ramps and facilities on I-93 should degrade then that could result in further peak hour spreading that the modeled network cannot account for.

Table 5 Peak Hour Simulated Travel Times

Travel Times (m:ss)	7:00 - 7:30AM / 7:30 - 8:00AM					
	2010 Existing	2030 No-Build	2030 Alternative 1	2030 Alternative 2	2030 Alternative 3	2030 Alternative 4
via Zipper or HOV lane						
Zipper entry to Zipper exit	11:41	21:23	7:36	12:29	12:49	8:29
Zipper Entry to HOV entry	15:47	24:52	11:10	16:08	16:04	14:14
via General Purpose Lane						
Zipper entry to Zipper exit	16:40	21:45	19:29	20:05	19:35	24:44
Zipper Entry to HOV entry	21:32	26:49	22:49	24:23	25:42	30:47

N/A- Not Applicable: The presence of Zipper or HOV lanes varies depending on the alternative. Zipper or HOV lanes are not present if marked N/A.
Travel Time values presented apply to vehicles served during the peak hour, volume demand that was not served contribute to peak hour spreading.

Table 6 2030 Peak Hour Operational Impacts

	2030 No-Build	2030 Alternative 1	2030 Alternative 2	2030 Alternative 3	2030 Alternative 4
via HOV lane					
Unmet Peak Hour Volume (vehicles)	706	-2	562	582	556
Saturation Flow Rate (vphpl)	1,324	243	1,504	1,484	1,510
Additional Peak Hour Travel Time (minutes)	32	0	22	24	22
via General Purpose Lane					
Unmet Peak Hour Volume (vehicles)	2,299	3,982	2,262	2,142	2,551
Saturation Flow Rate (vphpl)	1,623	1,658	1,632	1,662	1,560
Additional Peak Hour Travel Time (minutes)	21	36	21	19	25

Projections shown are derived from modeled output of the study area network described. Changes elsewhere on Interstate 93 or the ramps serving Interstate 93 can also impact operations through the study area network.

3.2.1 2030 No-Build Condition

The No-Build Condition shows constraints on Interstate 93 in both the general purpose lanes and in the Zipper Lane. During modeling, a visual inspection of queue lengths in the Zipper Lane illustrated that some volume would be unable to enter the network at the Zipper Lane entry point in Braintree. At times, the queuing in the Zipper Lane would prevent vehicles from entering the network, requiring an additional 32 minutes to process the peak hour traffic demand. Zipper Lane volumes would grow at a higher rate than the general purpose lane volumes and that results in the Zipper Lane travel times which surpass general purpose lane travel times during the peak hour of this condition.

Like the Zipper Lane, the general purpose lanes would also suffer from over capacity volumes and would not serve the entire general purpose lane demand volume. The saturation flow rate on the general purpose lanes at the beginning of the network would be 1,623 vehicles per hour per lane for the No-Build condition. This would result in 26 percent of general purpose lane demand not being processed during the No-Build condition peak hour, yielding an estimated peak hour spread of 21 minutes.

3.2.2 2030 Alternative 1

Alternative 1 would provide a continuous HOV lane that connects the existing Zipper Lane to the northern HOV lane into Boston. Zipper Lane volumes would be severely reduced, which would allow the remaining vehicles to move at free flow speeds. Travel times for the Zipper Lane would be improved over No-Build and Existing conditions.

This change, however, would move approximately 1,800 vehicles on the southeast expressway during the peak hour that previously used the Zipper Lane. Without access to the expressway at the current end of the Zipper Lane, these vehicles would no longer reach their destination using the Zipper Lane. This further increase in volume beyond 2030 growth would increase travel times on the expressway. Impacts would be mitigated slightly by the removal of the existing Zipper merge point. By removing the existing merge point on the left side of the expressway the general purpose vehicles would no longer shift from right to left while traveling through this segment, which would result in smoother traffic flow. However, this alternative would have the highest general purpose lane demand and the highest percentage of unmet demand at 38 percent which would result in the largest peak hour spread of an additional 36 minutes to process the additional demand.

3.2.3 2030 Alternative 2

Alternative 2 would provide a reversible bus lane that would connect the existing Zipper Lane to the northern HOV lane into Boston including provision of access points at the current Zipper and HOV lane end points. These access points would allow vehicles to exit the reversible lane and allow general purpose lane vehicles to enter the reversible or HOV lanes. This change in the geometry would provide a greater distance for Zipper Lane vehicles to merge into the general purpose lanes and would allow some vehicles to remain in their lane upon exiting the

Zipper. These factors would maintain travel times in the existing Zipper Lane close to 2010 conditions. However, 28 percent of the HOV traffic demand would not be accommodated in the peak hour which would result in an additional 22 minutes of peak hour spread.

General purpose lane traffic would be maintained close to No-Build conditions with some additional congestion at the Exit 20 off-ramp where the new reversible lane would rejoin the general purpose lanes to allow drivers to enter and exit. Also similar to the No-Build condition, 26 percent of demand would be unmet during the peak hour, which would result in a peak hour spread of 21 minutes.

3.2.4 2030 Alternative 3

Alternative 3 would provide a concurrent HOV lane, or diamond lane, that would connect the existing Zipper Lane to the northern HOV lane into Boston. Despite the additional travel lane, travel times would not be greatly improved over the No-Build condition because of the additional weaving that the new lane would cause. HOV drivers would be more inclined to use the less congested HOV lane instead of the general purpose lanes; however, the challenges of merging into the general purpose lanes would prompt vehicles to remain in the new lane until very late in the trip. Drivers would then be forced to weave across four lanes of traffic in an effort to exit the highway. This maneuver would cause much of the congestion in the general purpose lanes in the vicinity of Exits 18 and 20 to an extent that the existing Zipper Lane would also be impacted by this downstream congestion in the form of queues extending to the Morrissey Boulevard exit.

The source of this queuing would be north of the Columbia Road on-ramp. Existing and projected No-build simulations indicate that traffic flow typically frees up past the Columbia Road on-ramp. However, the projected weaving and lane changing by vehicles in the left most HOV lane to Exits 16 to 20 would cause greater congestion north of Columbia Road in Alternative 3 as compared with other alternatives. Alternative 3 would result in a slight improvement for the general purpose lanes over the No-Build condition with estimated unmet demand of 24 percent and peak hour spread of 19 minutes. Conversely, the travel in the new lane would be least improved over the No-Build condition with a saturation flow rate under 1,500 vehicles per hour and the largest peak hour spread of 24 minutes.

3.2.5 2030 Alternative 4

Alternative 4 would merge general purpose traffic into three lanes south of the existing Zipper Lane northern exit point and allow the Zipper Lane traffic to exit into an empty fourth general purpose lane. No new connections or dedicated HOV lane between the end of the existing Zipper Lane and the northern HOV lane into Boston are proposed in Alternative 4. An auxiliary lane would be added to connect the Columbia Road on-ramp and the Southhampton Street off-ramp which would allow vehicles a greater distance over which to merge onto Interstate 93.

In Alternative 4, travel times for the Zipper Lane would be improved beyond existing conditions but the alternative would still result in a peak hour spread of 22 minutes for HOV traffic. This improvement, however, would be at the cost of the general purpose lane travel time. The lane drop in the general purpose lanes would result in reductions in the service flow rate which would result in queuing past Braintree and the entry to the Zipper Lane. In Alternative 4, the general purpose lanes would have the lowest saturation flow rate – 1560 vehicles per hour per lane. The first three alternatives would be able to maintain a general purpose saturation flow rate that would be comparable to the No-Build condition, while Alternative 4 would not. Unmet demand for the general purpose lane would be 29 percent with vehicle flows lower than Alternative 1. The estimated additional travel time due to peak hour spreading in the general purpose lane would be 25 minutes.

This Page Intentionally Left Blank

4

Summary

All four alternatives would result in significantly improved HOV travel times over the 2030 No-Build HOV travel time (24:52). The reduction in HOV travel time would range from a high of almost 14 minutes (Alternative 1) to a low of almost 9 minutes (Alternatives 2 and 3).

Alternative 1 would present the best travel time (11:10) via the HOV and the best travel time in the general purpose lanes (22:49) through the modeled studied area of the four alternatives. Since this alternative would not permit HOV traffic to enter or leave the HOV lane from the Braintree entry point until Exit 20, over 88 percent of the HOV traffic accommodated in the No-Build alternative would be required to use the general purpose lanes. While the general purpose lane travel times through the simulated area would improve with Alternative 1 due to the complete elimination of the HOV merge, the increased general purpose lane volume would result in the greatest peak hour spread of all the alternatives since the projected demand could not be fully processed with the proposed capacity in the defined peak period. This projected peak hour spreading would likely result in 11 to 17 minutes more of general purpose traffic travel time than the other alternatives.

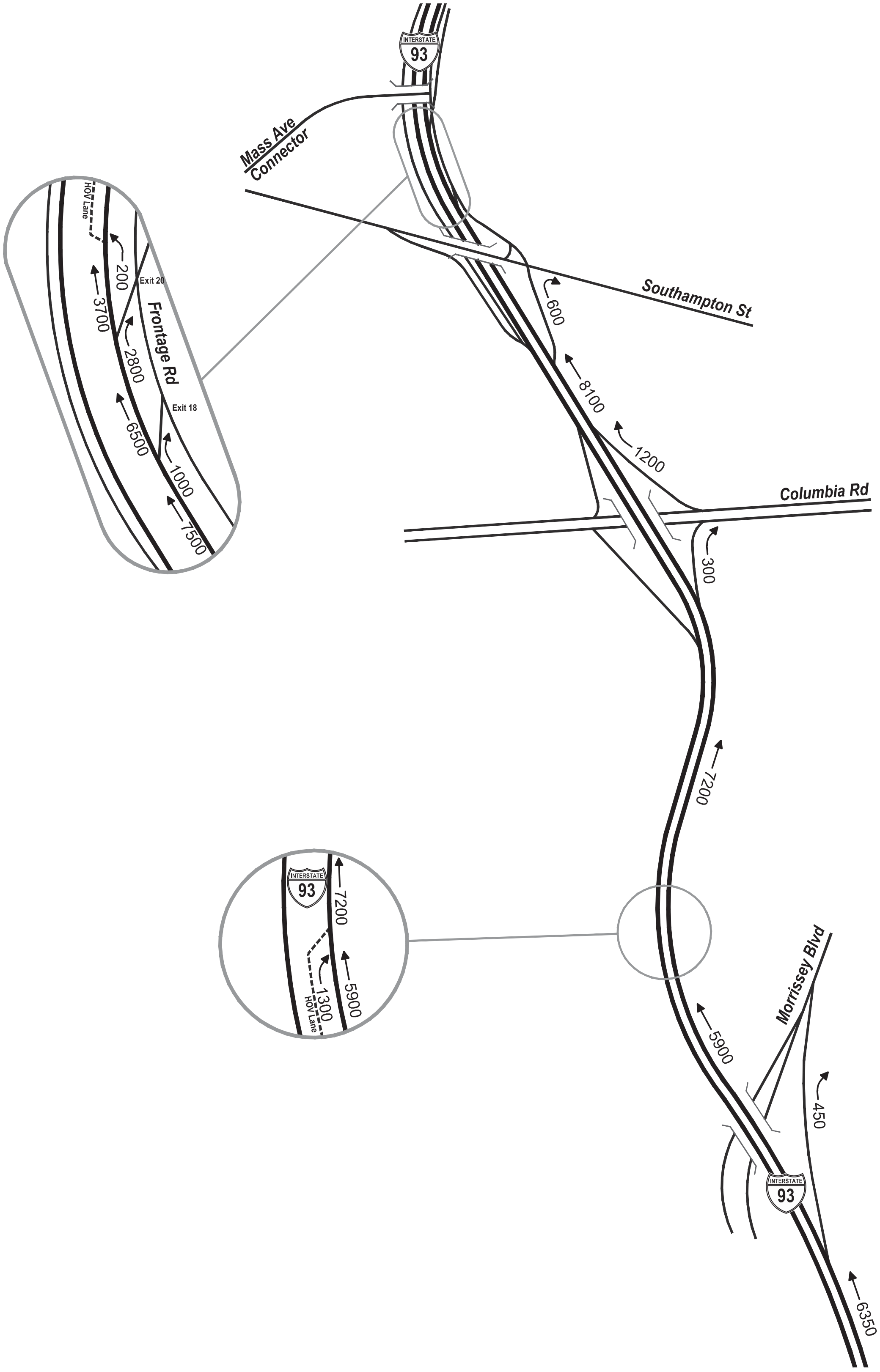
Alternative 2 presented the least HOV travel time reduction of the four alternatives as compared with the No-Build but the second best improvement in general purpose lane travel times. HOV travel time with Alternative 2 would be almost 5 minutes longer than Alternative 1. However, HOV vehicles would retain the ability to exit the HOV lane before Exit 20. The less significant reduction in general purpose lane travel times could be attributed to the two segments of added general purpose lanes where HOV traffic would be able to merge in the general purpose lanes to exit. Alternative 2 would also result in peak hour spread due to unmet demand in the defined peak period but at a much lesser extent than Alternative 1 (a difference of 15 minutes for the general purpose lanes). However, this alternative would result in unmet demand and peak hour spreading for the HOV lane as well due to obstruction of the HOV lane entry by projected general purpose lane queuing through the Braintree Split and the modeled capacity of the HOV lane entry.

Alternative 3 would present similar results to Alternative 2, demonstrating that the segments of permanent, reversible lane proposed in Alternative 2 are no more effective than an HOV diamond lane. The simulation of this alternative illustrated weaving difficulties from the HOV diamond lane to the closely spaced Exits 16-20 off-ramps leading to congestion and delay in the section of highway north of Columbia Road.

Alternative 4 resulted in the second best HOV travel time through the modeled area (14:14) but at the expense of general purpose lane travel times. With Alternative 4, travel times in the general purpose lanes would increase as compared with the No-Build (by 4 minutes), and therefore it is the only alternative that results in a negative travel time impact within the modeled study area. This increase in travel time is the result of the reduction in general purpose lane capacity that is proposed as part of this alternative. Proposed improvements at the exit ramps would offset the decreased lane capacity but not effectively enough to result in a reduction in travel time. Additionally, this alternative would result in peak hour spreading for both the HOV and general purpose lanes.

Figures

This page intentionally left blank



Not to Scale

Vanasse Hangen Brustlin, Inc.

2010 Existing Conditions
7:00-8:00 AM Peak Hour
Traffic Volumes

Figure 1

This page intentionally left blank

Modified Rapid Bus Alternative
Technical Memorandum - DRAFT

Appendix D: I-93 "Missing Link" Design Alternatives

Prepared for massDOT

Massachusetts Department of Transportation
10 Park Plaza
Boston, Massachusetts 02116

Prepared by VHB Vanasse Hangen Brustlin, Inc.

99 High Street, 10th Floor
Boston, Massachusetts 02110

SOUTH COAST RAIL

May 2012

Table of Contents

List of Tables

List of Figures

Figure No.	Description	Page

This Page Intentionally Left Blank

1

Introduction

Currently, there are two, separate HOV facilities on I-93 (Southeast Expressway) between Braintree and Boston. The southernmost HOV facility extends from Braintree to just south of the Savin Hill Station in Boston and provides alternating northbound and southbound HOV travel in a moveable “zipper” lane which “borrows” roadway capacity from a non-peak direction lane during peak periods. The “northern HOV” or “South Station HOV” facility is a fixed (permanent), two-lane (one in each direction) facility that begins on I-93 at the Massachusetts Avenue “Mass Ave” Connector and provides a connection to I-90 eastbound, South Station and Kneeland Street at the Lincoln Street intersection. A gap or “Missing Link” of approximately 2 miles exists between each facility. Figure 1 depicts this infrastructure.

In the DEIS, the Rapid Bus Alternative was proposed to use both of these facilities. However, like all I-93 HOV traffic today, the rapid buses would have to merge into the I-93 general purpose lanes at the northern exit of the Zipper Lane, travel in the general purpose lanes and then enter the northern HOV facility to access South Station. This merge into general traffic currently results in significant congestion in both the Zipper Lane and the general purpose lanes. According to the Central Transportation Planning Staff (CTPS), in 2030, further deterioration of conditions is expected and as a result the Zipper Lane would no longer be able to provide a travel time advantage over the general purpose lanes. As a result, future users, including potential Rapid Bus riders, using either the Zipper Lane or the general purpose lanes would experience longer than desirable travel time. The travel time for the Rapid Bus Alternative, presented in the DEIS/DEIR, reflected this projected congestion. In addition, the existing Zipper Lane HOV facility does not include standard highway shoulders. This less than optimal configuration results in overall slower travel in this section as well as reliability issues, since there is no excess capacity for auto breakdowns or snow removal. Incidents in the Zipper Lane and significant snowfall result in closure of the facility which would affect Rapid Bus system reliability.

The following report presents a summary of existing (2010) I-93 infrastructure and traffic conditions; 2030 No Build conditions; and four potential future (2030) alternative infrastructure improvements that could alleviate deficiencies that would impact the efficiency of a proposed Rapid Bus system as well as all travel on I-93. Three of the alternatives present infrastructure to eliminate the “missing link” between the two existing HOV facilities. A fourth alternative relies on operational reconfigurations at the end of the Zipper Lane to provide improved rapid bus performance. This report details the conceptual designs, performance impacts and costs of each alternative.

To support this analysis, the project team developed VISSIM® traffic models to simulate operations on I-93 northbound. A detailed traffic simulation methodology and results report can be found in Appendix C.

2

Existing Conditions

Today, I-93 is at capacity for the segment from Savin Hill to Massachusetts Avenue. One major issue is created by the northbound vehicles exiting the Zipper Lane and merging with the general purpose traffic, which causes congestion for both HOV travelers and general purpose lane travelers. This capacity issue causes long travel times for general purpose vehicles as well as high-occupancy vehicles. The only way to resolve the current issue in this section of the highway would be to increase capacity.

From the northern end of the existing Zipper Lane to the existing HOV, the I-93 right-of-way is severely constrained and has the following characteristics:

- Located in cut and viaduct sections.
- Comprised of 4-12' lanes in both the northbound and southbound directions with substandard shoulders and a 4'-6" concrete median.
- Includes four exits on the northbound side, and one on the southbound side and two entrances (one on each side).
- Constrained on both sides by dense development and local roadways (such as Frontage Road) and a 1,500 foot retaining wall that supports Hubbardton Street, the Savin Hill neighborhood and the Boston Globe building. Figure 2 depicts the retaining wall. Figures 3 and 4 show the proximity of the surrounding elements.
- Crossed by 10 overgrade bridges, most notably Savin Hill Avenue.
- Crossed by 3 undergrade bridges, most notably the I-93 bridge over the MBTA Ashmont and Braintree Red Line railroad tracks and the MBTA Old Colony Commuter Rail tracks.

- Constrained on the southbound side by the Savin Hill Red Line Station and the Red Line and Old Colony railroad tracks. Figure 5 shows the proximity of the railroad tracks to the edge of the highway.

Figure 2 Savin Hill Retaining Wall

Figure 3 I-93 Looking North

Figure 4 I-93 Looking South

Figure 5 Old Colony Commuter Rail and Red Line Tracks

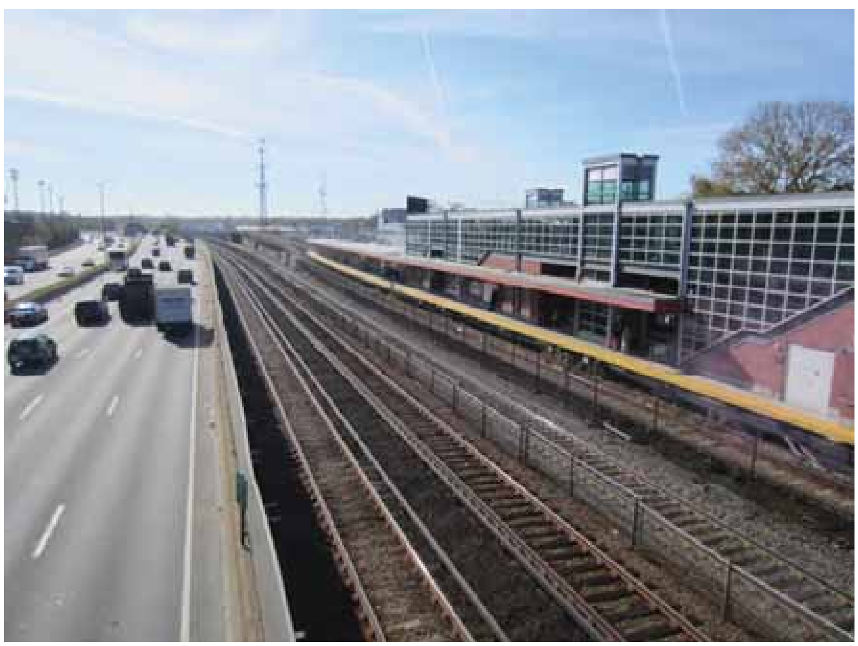


Table 1 summarizes the bridge crossings in this section of I-93. Figure 6 shows typical cross sections at three locations throughout this section of the corridor.

Table 1 Bridge Crossing Summary

No.	Description	Type
1	Savin Hill Avenue	OH
2	*Columbia Road Viaduct*	*UG*
3	*Siding Track to Boston Globe*	*UG*
4	Dorchester Avenue	OH
5	Boston Street	OH
6	Southampton Street	OH
7	Commuter Rail (Fairmont Line)	OH
8	South Boston Bypass Road	OH
9	Massachusetts Avenue Connector	OH

Note: OH= Over-head, UG= Under-grade

Traffic volumes provided by CTPS were used to calibrate the existing conditions traffic simulation model. Results of the calibration are presented in Appendix C.

General observations were made of the existing traffic operations of I-93 and compared to the calibrated simulation results. Beyond the above calibrated measures, the simulation results compared favorably to the following operational observations:

- The general purpose lane rolling queue typically extends to just north of the Furnace Brook Parkway off-ramp.
- The Zipper Lane merge results in rolling queue in the Zipper Lane that typically extends past the Morrissey Boulevard off-ramp.
- The Zipper Lane merge impacts the two leftmost general purpose lanes resulting in a rolling general purpose lane queue typically back to the Freeport Street off-ramp.
- I-93 between Exit 14 and Exit 20 operates with stop and go traffic, with more free-flow conditions occurring between the end of the Zipper Lane to a point just south of Columbia Road and north of the Dorchester Avenue overpass.

3

2030 No Build Alternative

The 2030 No Build Alternative represents future volumes provided by CTPS and makes no geometric or operational changes to I-93. The traffic simulation model prepared for this condition shows that in the 2030 demand for both the I-93 Zipper Lane and the general purpose lanes will exceed available capacity. This condition is described further in Appendix J.

Queuing at the Zipper Lane entry in 2030 will likely extend beyond Exit 14 (Morrissey Boulevard). The configuration of the Zipper Lane entry and queuing resulting from capacity saturation in both lanes would delay vehicles from entering the modeled study area and the Zipper Lane. For both the I-93 general purpose lanes and the Zipper Lane, this projected capacity saturation would result in unmet demand which would lead to lengthened trip times, peak hour spreading and no incentive to use the Zipper lane over the general purpose lanes. This No Build condition propagates through to each of the Build alternatives.

This Page Intentionally Left Blank

4

Design (Build) Alternatives

In order to provide a more complete Rapid Bus service and improve overall Rapid Bus travel times, the 2 mile gap on I-93 between the two existing HOV facilities would need to be upgraded to remove conflict between HOV/Rapid Bus traffic and general purpose traffic. This objective can only be attained by the addition of capacity on I-93 through new lanes or revised merge segments. Capacity additions can only be provided through physical, geometric infrastructure changes to the I-93 at the current merge point and in the 2 mile gap. Operationally, the objective was to provide as close to “free flow” conditions for HOV/Rapid Bus travelers in this segment of I-93, as projected and simulated in 2030. Solutions were investigated to add capacity or provide exclusivity for the HOV traffic, which either added capacity to the I-93 cross section or reassigned capacity from general purpose traffic.

Four alternatives were developed to remove or lessen conflict between I-93's HOV/Rapid Bus traffic and general purpose traffic at the northern end of the existing Zipper lane. The alternatives described below provide varying levels of improvement, impacts and access for future HOV/Rapid Bus commuters and general purpose travelers. Each alternative requires that I-93 be widened. Each alternative was modeled in VISSIM and compared with the 2030 No Build to understand the future 2030 operational impacts of each.

Compliance with design criteria and several other factors guided the development of the Design Alternatives. One major objective was to minimize the number of residential or commercial property takings necessary to enable the widening. Two options for each alternative were analyzed with respect to this objective; widening on alternating sides of the expressway or holding the median and widening equally on both sides of I-93. Based on a preliminary, qualitative analysis that considered the major impacts for each option, the conclusion was made to widen on alternating sides of the highway. Although this option would result in more complicated construction phasing, it would minimize the socio-economic impacts to adjacent neighborhoods as well as limit size of the construction zone that would have been required if construction was conducted on both sides of I-93.

Aside from the design alternatives described below, a few additional alternatives were discussed but were fatally flawed and not analyzed further. These included tunneling the HOV lane under/or elevating the HOV lane above the existing Southeast Expressway. Each of these options would require more complicated construction phasing and would create major delays and impacts to the existing traffic operations on I-93. Although cost estimates were not prepared for these two additional alternatives, it can be assumed that the cost to construct these alternatives would match or greatly exceed the cost of any of the alternatives described below and in addition would have significantly greater impacts to the traveling public for an extended period of time.

The studied alternatives would decrease travel times for the Rapid Bus Alternative as compared with the simulated 2030 No Build and the Rapid Bus Alternative presented in the DEIS/R. Three of the four alternatives would also improve traffic operations and travel times in the I-93 general purpose lanes as compared with 2030 No Build conditions/travel times. The alternatives described below provide varying levels of impacts, access for HOV/Rapid Bus commuters and general purpose travelers.

4.1 Alternative 1 – The “Commitment” Alternative

Alternative 1 would provide a new, 12’ wide reversible lane with two 5’ shoulders in the median of I-93 from the end of the existing Zipper Lane in Savin Hill to the beginning of the South Station HOV lane past the South Bay Plaza. With this alternative, four lanes of general purpose travel will be maintained in both the northbound and southbound directions. These general purpose lanes will be separated from the new, reversible lane by a two foot barrier on one side and a six foot wide median on the other. A ten foot outer shoulder and a four foot inner shoulder will be provided for both the northbound and southbound directions of travel adjacent to the general purpose lanes. Construction of this facility would remove the “missing link” between the end of the existing Zipper Lane and the start of the South Station HOV facility; thereby creating one continuous HOV/Rapid Bus facility comprised of a Zipper Lane, a reversible lane and a two-lane permanent facility. Figure 7 shows three typical cross sections and a plan view for this alternative.

Unlike existing operations, Alternative 1 would restrict access/egress from the HOV facility for its entire length from the existing Braintrain entrance to the Zipper Lane though to the exit from the existing South Station HOV facility (Exit 20: I-

90 / Kneeland / Lincoln). Vehicles that would enter the new, continuous HOV facility in Braintree would be committed to traveling to and exiting at Exit 20.

Due to the restrictions on the northbound side from Savin Hill Station up to immediately following the Columbia Road Exit (Exit #15), I-93 would be widened on the southbound side to make capacity for the new, center permanent reversible lane. This placement would limit the amount of property takings (especially residential) required but would result in impact to the MBTA tracks and bridge crossings. Immediately following this section, I-93 would be widened on the northbound side to provide capacity for the permanent reversible lane. For a similar reason as before, widening the highway in this section on the northbound side would limit the number of property takings required for the construction. Figure 8 shows properties adjacent to the top of the retaining wall for the highway.

Figure 8 Properties Adjacent to Highway Right of Way

Frontage Road (on the eastern side of the highway near South Bay Plaza), Von Hillern Street (on the eastern side of the highway north of the Columbia Road exit) and Sydney Street (on the western side of the highway just south of the Columbia Road exit) would all require reconstruction.

As stated above, construction of Alternative 1 will impact adjacent rail lines. The impact mileage (distance, not trackage) for the Old Colony Commuter Rail line would be approximately 1 mile (south from the siding track at the Boston Globe to Freeport Street); for the Braintree Red Line would be approximately 1.7 miles (Red Line portal at Boston Avenue to Freeport Street); for the Ashmont Red line would be approximately ½ mile (south of Savin Hill Station to Freeport Street); and for the Red Line Yard Lead tracks would be approximately ¾ mile (north of JFK / UMass Station to north of Dorchester Avenue). More details about rail line reconstruction, service disruptions and staging can be found in Chapter 6 of this report.

Alternative 1 results in a continuous HOV / Rapid Bus facility which would operate in peak directions only. As such, one lane of the existing South Station HOV facility would not be required and would be blocked by a moveable barrier in the opposing direction.

Since Alternative 1 would restrict HOV's that enter the Zipper Lane in Braintree to exiting only at Exit 20, HOV demand in the proposed, continuous HOV facility would be severely reduced in 2030. This reduced demand would allow all remaining vehicles, including rapid buses, to move at free flow speeds through the continuous HOV facility. Travel times for the HOV facility would be improved over No Build conditions by over 14 minutes.

This change, however, would move approximately 1,800 vehicles to I-93's general purpose lanes during the peak hour that previously used the Zipper Lane. Without access to the general purpose lanes at the current end of the Zipper Lane, these vehicles can no longer reach their destination using the Zipper Lane. This further increase in general purpose traffic volume beyond 2030 growth would impact travel time in I-93's general purpose lanes. Those impacts would be mitigated slightly by the removal of the existing Zipper / general purpose lanes merge, resulting in improved overall travel time (by 4 minutes) in the general purpose lanes with this alternative as compared with the 2030 No Build. By removing the existing merge point on the left side of the expressway the general purpose vehicles are no longer weaving through this segment, smoothing traffic flow. However, this alternative would have the highest general purpose lane demand and the highest percentage of unmet demand (38 percent) of the Design Alternatives, which would result in the largest peak hour spreading of I-93 demand (an additional 36 minutes needed during the peak hour to process the additional demand.)

Figures 9 – 11 include plan view graphics showing the detailed layout of this alternative.

4.2 Alternative 2 – the "Maintain Exit at Savin Hill" Alternative

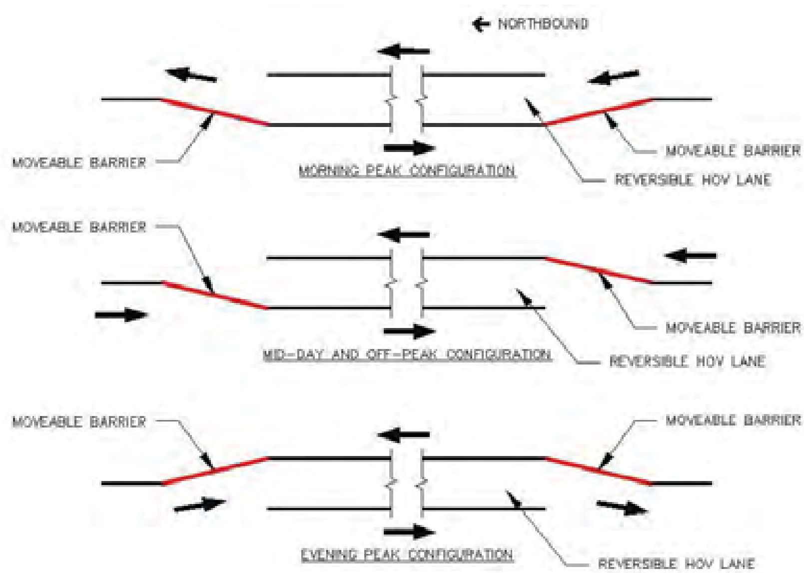
Alternative 2 would widen I-93 to provide a combination of new, general purpose lanes and a new permanent, reversible lane in the median of I-93 between the end of the Zipper Lane and the start of the South Station HOV facility. New general purpose lanes would be constructed on the northbound and southbound sides of I-93 immediately north of the existing Zipper Lane's northbound exit / southbound entrances. HOV / Rapid Bus traffic would exit the Zipper Lane directly into this new lane (approximately 2,400 feet), where the option to merge into a general purpose lane / exit I-93 or stay in the lane would exist. This lane would also be available to general purpose traffic.

Continuing on I-93, the new general purpose lane would feed into a new, reversible HOV-only lane just north of the Savin Hill retaining wall section. Similar to Alternative 1, the reversible lane would be a 12' wide travel lane in the center of I-93 with two 5' shoulders on either side. Four lanes of general purpose travel will be maintained in both the northbound and southbound directions. These general purpose lanes will be separated from the new, reversible lane by a two foot barrier on one side and a six foot wide median on the other. A ten foot outer shoulder and a four foot inner shoulder will be provided for both the northbound and southbound directions of travel adjacent to the general purpose lanes. The reversible HOV lane would extend for approximately 7,200 feet before exiting in another new, general purpose lane. The new, general purpose lane would serve the same function as the previous section, allowing HOV vehicles to stay in the lane or merge / exit with general purpose traffic. General purpose traffic would also have access to this lane. Figure 12 shows three typical cross sections for this alternative. This second section of new general purpose lane, would extend approximately 1,700 feet, before feeding into the existing South Station HOV lane.

Similar to Alternative 1, this alternative's reversible HOV lane would require a rigid moveable barrier at both ends to prevent vehicles from entering the HOV lane with vehicles traveling in the opposite direction. Figure 13below shows a sketch of how this moveable barrier would work for the morning and evening peak hours as well as the midday period. Also similar to Alternative 1, I-93 widening would occur on both the south and north sides of the highway.

Figures 14 – 16 are additional graphics related to this alternative.

Figure 14 Moveable Barrier Configuration



Alternative 2 would provide a permanent, reversible lane that connects the existing Zipper Lane to the South Station HOV lane into Boston but with access points at the current Zipper and HOV lane end points. These access points would allow vehicles to exit the Zipper Lane and would allow general purpose lane vehicles to enter the zipper or HOV lanes. This change in the geometry would provide a greater distance for Zipper Lane vehicles to merge into the general purpose lanes and would allow some vehicles to remain in their lane. These factors would maintain travel times in the existing Zipper Lane close to 2010 conditions and save over eight minutes in Zipper Lane travel time over 2030 No Build Conditions. However, 28 percent of the HOV traffic demand would not be accommodated in the peak hour resulting in 22 minutes of peak hour spreading.

General purpose lane traffic would be maintained close to No Build conditions with some additional congestion at the Exit 20 off-ramp where the new HOV lane rejoins the general purpose lanes to allow drivers to enter and exit. Roughly 2.5 minutes of travel time would be saved in the general purpose lanes. Also similar to the No Build condition, 26 percent of the general purpose lane demand would be unmet during the peak hour, resulting in peak hour spreading of 21 minutes.

4.3 Alternative 3 – the “HOV Lanes in Both Directions” Alternative

Alternative 3 would widen I-93 to provide new HOV Diamond lanes in the median of I-93 between the end of the Zipper Lane and the start of the South Station HOV facility. New HOV Diamond lanes would be constructed on the northbound and southbound sides of I-93 immediately north of the existing Zipper Lane’s northbound exit / southbound entrances. HOV / Rapid Bus traffic would exit the Zipper Lane directly into this new HOV Diamond lane, where the option to merge into a general purpose lane / exit I-93 or stay in the lane would exist. Non-HOV traffic from the general purpose lanes would not be permitted to enter the HOV Diamond lane. Enforcement would be required.

The HOV Diamond lanes would be 12’ wide with a 3’ painted median between the diamond lane and the general purpose lanes. This will provide a visual separation between the lanes and inhibit vehicles from entering the HOV lane. Additionally, as with the previous alternatives, this alternative would provide a 10’ right shoulder and a 4’ left shoulder on both the northbound and southbound directions.

Figure 17 shows three typical cross sections for this alternative. Figures 18 – 20 provide additional graphics related to this alternative.

Alternative 3 would not greatly improve travel times in the general purpose lanes over the No Build condition because of the additional weaving that the HOV Diamond lane would cause. HOV drivers would be more inclined to use the less congested HOV lane instead of the general purpose lanes, however, the challenges of merging into the general purpose lanes would cause vehicles to remain in the HOV lane until very late in the trip. Drivers would then be forced to weave across four lanes of traffic in an effort to exit the highway. This maneuver would cause congestion in the general purpose lanes in the vicinity of Exits 18 and 20 to an extent that the existing Zipper Lane would also be impacted downstream in the form of queues extending to the Morrissey Boulevard exit.

The origin of this queuing would be north of the Columbia Road on-ramp. Existing and projected No-Build simulations indicate that traffic flow typically would free up past the Columbia Road on-ramp. However, with Alternative 3, weaving and lane changing by vehicles caused by vehicles entering / exiting the HOV lane in the section of I-93 from Exit 16 to Exit 20 would cause greater congestion north of Columbia Road as compared with other alternatives. Alternative 3 would result in a slight travel time improvement for the general purpose lanes over the No Build condition with an estimated unmet demand of 24 percent and peak hour spreading of 19 minutes. Conversely, the travel in the HOV lane would be least improved over the No Build condition with a saturation flow rate under 1,500 vehicles per hour and the largest peak hour spreading of 24 minutes. However, travelers in the combined zipper and HOV lane would save roughly 8 minutes over the 2030 No Build travel time, similar to Alternative 2.

4.4 Alternative 4 – the “Minimalist” Alternative

Unlike the previous three alternatives, which proposed widening I-93 to provide new HOV lane facilities, Alternative 4 proposes to reassign the existing lanes on I-93 and provide short areas of new general purpose lane capacity to ease congestion.

Currently, HOV traffic in the I-93 Zipper Lane outlets into four general purpose lanes during the morning peak period. For this alternative, instead of merging the Zipper Lane into the left-most of the four general purpose lanes, it is proposed that the general purpose lanes would merge prior to the end of the Zipper Lane, creating three general purpose lanes and one open exit lane for Zipper Lane vehicles. Therefore, HOV traffic exiting the Zipper Lane would have a clear lane to continue on I-93 and would not be required to merge into existing traffic. This reconfiguration is also proposed on the southbound side of I-93. While the existing merge would be removed by this new configuration, a new merge point would be created within the general purpose lanes south of the Zipper Lane’s northern exit. Essentially, a general purpose lane would be ‘dropped’ with four general purpose lanes combining to three lanes.

This alternative also proposes the widening of I-93 between South Bay Plaza and the Columbia Road exit (Exit 15). I-93 contains two on-ramps and two off-ramps in this section which results in a high level of vehicular weaving and merging. This creates a bottleneck which results in significant delay through this area. In order to mitigate this delay, Alternative 4 would provide an auxiliary lane in both the northbound and southbound directions between the on-ramps and off-ramps. These auxiliary lanes would between the on-ramp northbound at the Columbia Road exit to the off-ramp at the Southampton Street exit and the opposite on the southbound side, from the on-ramp at the South Bay Plaza to the off-ramp at the Columbia Road exit.

Figure 21 shows three typical cross sections for this alternative. Figures 22 – 24 provide additional graphics related to this alternative as well as

With Alternative 4 there would be no new connections or dedicated HOV lane between the end of the existing Zipper Lane and the South Station HOV lane. The "Missing Link" would not be filled with an HOV facility which differentiates this alternative from Alternatives 1-3.

In Alternative 4, travel times for the Zipper Lane would be improved beyond existing conditions and by almost 10 minutes over the 2030 No Build, but the alternative would still result in peak hour spreading of 22 minutes for HOV traffic. This improvement, however, would be at the cost of the general purpose lane travel time. The lane drop in the general purpose lanes would cause reductions in the service flow rate resulting in general purpose lane queuing past the entry to the Zipper Lane and Braintree. The general purpose lanes would have the lowest saturation flow rate of 1,560 vehicles per hour per lane. Travel times in the general purpose lanes would increase by almost 4 minutes over the 2030 No Build. The first three alternatives were able to maintain a general purpose lane saturation flow rate that is comparable to the No Build condition, while Alternative 4 does not. Unmet demand for the general purpose lane is 29 percent with vehicle flows lower than Alternative 1. The estimated additional travel time due to peak hour spreading in the general purpose lane is 25 minutes.

5

Comparison of Design Alternatives

Each of the alternatives, results in the geometric modification of I-93 and improved travel times for vehicles traveling that would be traveling in HOV lane in 2030. Table 2 presents a summary of the infrastructure features of each of the alternatives.

Table 2 Summary of "Missing Link" Alternatives Infrastructure

Alternative	1	2	3	4
Amount of Proposed I-93 Widening	Approximately 2 miles	Same as Alt. 1	Same as Alt. 1	Approximately ½ mile
Amount of Proposed Rail Reconfiguration Required	Commuter Rail: 0.92 miles Braintree Red Line: 1.62 miles Ashmont Red Line: 0.42 miles Red Line Yard Lead Tracks: 0.75 miles	Same as Alt. 1	Same as Alt. 1	None
Proposed HOV Lane Configuration	Zipper + Permanent Reversible + Permanent Lane	Zipper + General Purpose + Permanent Reversible + General Purpose + Permanent Lane	Zipper + HOV Diamond + Permanent Lane	Zipper+ Converted General Purpose Lane + Permanent Lane
Proposed I-93 General Purpose Lane Configuration	No change: 4 lanes	No change: 4 lanes	No change: 4 lanes	3 lanes + Interchange improvements
HOV Accessibility	No access/egress between Braintree and I-93 Exit 20	Access/Egress in General Purpose Lane segments only	Egress from HOV diamond lane to General Purpose Lane only	Access/Egress in General Purpose Lane segments only

Table 3 shows the change in travel time through the simulation network for 2010 Existing Conditions, 2030 No Build Conditions, and each of the four 2030 Design Alternatives. Changes in travel time for the Zipper or HOV lane varies with each condition while travel time for the general purpose lanes is consistently higher for 2030 conditions than it is in the existing 2010 condition. Table 3 shows peak hour travel time for vehicles that were served during the peak hour, therefore, the volume of vehicles that are not served are not represented in this table.

Table 3 Peak Hour Simulated Travel Times

Travel Times (m:ss)	7:00 - 8:00 AM					
	2010 Existing	2030 No Build	2030 Alternative 1	2030 Alternative 2	2030 Alternative 3	2030 Alternative 4
via Zipper and HOV lane						
Zipper entry to Zipper exit	11:41	21:23	7:36	12:29	12:49	8:29
Zipper Entry to HOV entry	15:47	24:52	11:10	16:08	16:04	14:14
via General Purpose Lane						
Zipper entry to Zipper exit	16:40	21:45	19:29	20:05	19:35	24:44
Zipper Entry to HOV entry	21:32	26:49	22:49	24:23	25:42	30:47

N/A- Not Applicable: The presence of Zipper or HOV lanes varies depending on the alternative. Zipper or HOV lanes are not present if marked N/A.
Travel Time values presented apply to vehicles served during the peak hour, volume demand that was not served contributes to peak hour spreading.

Table 4 summarizes the amount of unmet peak hour volumes and the saturation flow rates for both the general purpose and HOV lanes (Zipper plus Missing Link HOV treatment) under each alternative. Additionally, this table estimates the impact that unmet volume and reduced saturation flow rates will have on peak hour operations in the form of peak hour spreading. Peak hour spreading or the additional peak hour travel time is a representation of the minutes that will likely be added to the existing peak hour in order to process all of the volume demand based on the simulated saturation flow rates. The peak hour for the general purpose lane traffic could spread from 60 minutes to a period of between 79 minutes and 96 minutes. These peak hour spreading projections are based on additional travel time needed for the peak hour traffic volume demand to travel through the study area network. If operations on other ramps and facilities on I-93 should degrade then that could result in further peak hour spreading that the modeled network cannot account for.

Table 4 2030 Peak Hour Operational Impacts

	2030 No Build	2030 Alternative 1	2030 Alternative 2	2030 Alternative 3	2030 Alternative 4
via HOV lane					
Unmet Peak Hour Volume (vehicles)	706	-2	562	582	556
Saturation Flow Rate (Vehicles Per Hour Per Lane – VPHPL)	1,324	243	1,504	1,484	1,510
Additional Peak Hour Travel Time (minutes)	32	0	22	24	22
via General Purpose Lane					
Unmet Peak Hour Volume (vehicles)	2,299	3,982	2,262	2,142	2,551
Saturation Flow Rate (VPHPL)	1,623	1,658	1,632	1,662	1,560
Additional Peak Hour Travel Time (minutes)	21	36	21	19	25

Projections shown are derived from modeled output of the study area network described. Changes elsewhere on Interstate 93 or the ramps serving Interstate 93 can also impact operations through the study area network.

All four alternatives would result in significantly improved HOV travel times over the 2030 No Build HOV travel time (24:52). The reduction in HOV travel time would range from a high of almost 14 minutes (Alternative 1) to a low of almost 9 minutes (Alternatives 2 and 3).

Alternative 1 would present the best travel time (11:10) via the HOV and the best travel time in the general purpose lanes (22:49) through the modeled studied area of the four alternatives. Since this alternative would not permit HOV traffic to enter or leave the HOV lane from the Braintree entry point until Exit 20, over 88 percent of the HOV traffic accommodated in the No Build alternative would be required to use the general purpose lanes. While the general purpose lane travel times through the simulated area would improve with Alternative 1 due to the complete elimination of the HOV merge, the increased general purpose lane volume would result in the greatest peak hour spreading of all the alternatives since the projected demand could not be fully processed with the proposed capacity in the defined peak period. This projected peak hour spreading would likely result in 11 to 17 minutes more of general purpose traffic peak hour spreading than the other alternatives.

Alternative 2 would present the least HOV travel time reduction of the four alternatives as compared with the No Build but the second best improvement in general purpose lane travel times. HOV travel time with Alternative 2 would be almost 5 minutes longer than Alternative 1. However, HOV vehicles would retain the ability to exit the HOV lane before Exit 20. The less significant reduction in general purpose lane travel times could be attributed to the two segments of added general purpose lanes where HOV traffic would be able to merge in the general purpose lanes to exit. Alternative 2 would also result in peak hour spreading due to unmet demand in the defined peak period but at a much lesser extent than Alternative 1 (a difference of 15 minutes for the general purpose lanes). However, this alternative would also result in unmet demand and peak hour spreading for the HOV lane due to obstruction of the HOV lane entry by projected general purpose lane queuing through the Braintree Split as well as the modeled capacity of the HOV lane entry.

Alternative 3 would present similar results to Alternative 2, demonstrating that the segments of permanent, reversible lane proposed in Alternative 2 would be no more effective than a HOV diamond lane. The simulation of this alternative illustrated weaving difficulties from the HOV diamond lane to the closely spaced Exits 16-20 off-ramps leading to congestion and delay in the section of highway north of Columbia Road.

Alternative 4 resulted in the second best HOV travel time through the modeled area (14:14) but at the expense of general purpose lane travel times. With Alternative 4, travel times in the general purpose lanes would increase as compared with the No Build (by 4 minutes), and therefore it is the only alternative that would result in a negative travel time impact within the modeled study area. This increase in travel time is the result of the reduction in general purpose lane capacity that is proposed as part of this alternative. Proposed improvements at the exit ramps would offset the decreased lane capacity but not effectively enough to result in a reduction in travel time. Additionally, this alternative would result in peak hour spreading for both the HOV and general purpose lanes.

6

Constructability of Design Alternatives

6.1 Highway Impacts

In order to maintain the current capacity of the Southeast Expressway, the highway would need to be widened on either the northbound or the southbound side, described in the previous section, for Alternatives 1-3. Although there is variation between these three alternatives, the major differences come from the design of the HOV lane. The impacts and overall envelope of the widening are very similar for Alternatives 1-3. Below are the impacts to the highway infrastructure for Alternatives 1-3. Refer to the earlier figures for more detailed graphics of the expressway for these alternatives.

From the end of the existing Zipper Lane to the off-ramp for exit 15 the expressway would need to be widened approximately 40’-50’ on the southbound side of the highway. This would provide enough space for the permanent reversible lane, the diamond lanes or the additional general purpose lanes in the median of the I-93. The widening of the highway would extend up to and through the Columbia Road exit. This means that the on-ramp to the southbound side of the I-93 would be affected. Widening the road by 40’-50’ on the southbound side would require a shift of the on ramp as well. Additionally the off-ramp from the southbound side would be affected in a similar way. It would need to be realigned to accommodate for the additional width of the highway in this section. Since the roadway would only be widened on the southbound side, the northbound off ramp at the Columbia Road exit would be unaffected by this change.

Immediately following the Columbia Road exit, construction of the permanent reversible lane would switch from widening the highway on the southbound side to widening the highway on the northbound side. The amount of widening would be the same, at approximately 40’-50’. This widening would affect the on ramp to the northbound side at Columbia Road in the same way the on ramp to the southbound side was affected by the widening on the southbound side. The on ramp would be extended farther north to allow for the extra width on the northbound side of the I-93. There are no additional on ramps on the northbound side of the expressway, but there are three additional off-ramps at Exit 16, Exit 18 and Exit 20. Two of these three exits connect to roads at a higher elevation than the highway; one connects to Frontage Road at the same elevation. The widening on the northbound side between Columbia Road and the entrance to the existing permanent HOV lane would affect each of these off ramps. For the off-ramps the need to meet the side road at a higher elevation, longer deceleration lanes and an off-ramp extended slightly farther than the existing would accommodate the wider highway and the change in elevation. For the off ramp that connects to Frontage Road at the same elevation the pavement striping would be extended in order to give the vehicles exiting the highway a longer deceleration distance.

The highway infrastructure impacts for Alternative 4 are slightly less than those of Alternatives 1-3 because of more limited construction. Refer to Figures 23-26 for more detailed graphics of the expressway for these alternatives. Below is a summary of the highway infrastructure impacts for Alternative 4.

Since the goal of this alternative is to decrease the delay while minimizing the amount of construction needed, there would only be one area of highway reconstruction. In the location of the auxiliary lanes, between Columbia Road and Southampton Street, on the northbound and southbound side of the highway, the road would need to be widened approximately 20’-22’ to accommodate the new lane.

In addition to widening the highway, a new retaining wall would need to be constructed on the southbound side to support the properties located adjacent to the highway on the embankment.

6.2 Bridge Impacts

From the end of the Zipper Lane to the beginning of the permanent HOV lane there are seven overhead bridges, and two undergrade bridges. The overhead bridges are at Savin Hill Avenue, Dorchester Avenue, Boston Street, Southampton Street, South Boston Bypass Road, Massachusetts Avenue Connector and the Fairmont Line of the Commuter Rail; the undergrade bridges are at Columbia Road where I-93 is up on a viaduct and for the track siding from the Commuter Rail line that leads to the Boston Globe property. Although the highway is only being widened on one side or the other, all of the bridges would need to be reconstructed for Alternatives 1-3. The east or the west abutment for each of the bridges in addition to the bridge piers in the median of the highway would need to be removed and reconstructed. Only two of the nine bridges mentioned above would need to be reconstructed for Alternative 4; Dorchester Avenue and Boston Street.

The current minimum clearance requirement for bridges crossing highways is 16' for all bridges over highways. When one abutment of the bridge requires reconstruction, the entire bridge would be required to be brought up to standards should it currently provide less than 16' of clearance. If additional clearance is required, the whole bridge section over the highway would be raised and would continue out away from the edge of the highway. This would be required so as to not create too steep of a slope on the bridge approach. This is an especially important consideration for the bridge that carries the Commuter Rail Fairmont Line tracks across the highway. Since train tracks cannot accommodate as steep of a grade as roadways, adjusting the height of the bridge would affect the track approach on either side of the highway.

Beginning soon after the existing retaining wall ends on the northbound side, the highway enters an elevated section. The highway is currently raised approximately 25'-30' above the tracks to allow trains to pass under the highway as they enter and exit JFK / UMass Station. Figures 7, 13, and 18 show typical cross sections for Alternatives 1-3 of I-93 as the highway begins the viaduct section and as the train tracks are under the highway. In this section since the highway is being widened on the southbound side, the viaduct would only need to be reconstructed on that side, by adding in piers to support the additional highway width. Immediately south of this viaduct section is a small bridge section with a track siding connection the Boston Globe. Similar to the Columbia Road viaduct, this bridge could also be extended by connecting to the existing bridge structure. This reconstruction is only required in Alternatives 1-3, Alternative 4 does not impact the viaduct section.

6.3 Impacts to Rail Lines

For approximately a mile and a half of this section of I-93, the MBTA Red Line tracks as well as one Old Colony Commuter Rail line run parallel to the highway. From Savin Hill until the highway shifts to the viaduct section, the tracks run parallel on the southbound side. At the location where the highway starts to be on a viaduct section the tracks cross under the highway and continue running parallel on the northbound side. Around the location of the South Bay Plaza the tracks veer off towards South Station and Cabot Yard. This can be seen well in Figure 27 which shows I-93 looking northbound with the tracks directly adjacent to the highway.

Figure 27 Tracks Adjacent to Highway

The additional width that would be required to accommodate the proposed Rapid Bus route (Alternatives 1-3) within I-93 in the area between the MBTA Red Line stations of Savin Hill and JFK / UMass, would result in encroachment onto the railroad right-of-way. Eliminating any tracks in this area will cause significant impacts to existing Red Line and Commuter Rail operations. The rail infrastructure in this segment will need to be modified to accommodate the widened expressway, including relocating the existing Braintree line tracks and the Old Colony commuter rail track.

Multiple alternatives were investigated to determine the most feasible and cost effective solution for the rail lines that would be impacted by the widening of I-93. The first option would be to tunnel two Braintree Line tracks and one Commuter Rail track. This option was determined to be infeasible because the required cross section for the tunnel would extend from the existing Commuter Rail location to well beneath the existing expressway. This would require closure of at least one travel lane in the southbound direction of I-93, which would be infeasible. A second option would enable sharing of the Ashmont line track with the Braintree line. In this option, the Commuter line would be relocated in a tunnel beneath its existing location, and the Braintree line would crossover the top of the tunnel south of Savin Hill Station to tie back in to the existing Braintree line tracks. This option was also determined to be infeasible due to the fact that it would be a permanent condition that created multiple new conflict points between inbound and outbound direction trains. It would significantly limit operations for the Red Line.

The selected, feasible option would require relocation of the Braintree line tracks by merging the Braintree line with the Ashmont Line south of Savin Hill station. A new flyover structure would be constructed for the Braintree line in order to pass over the Old Colony commuter rail line and the inbound track of the Ashmont line. The inbound Ashmont line and the Old Colony commuter rail line would need to be realigned to accommodate the piers for the new flyover structure. A grade-separated junction of the two Red Line branches would be required to cross over the commuter rail track and to avoid operational conflicts on the Red Line. Just south of Savin Hill Station, the railroad cross-section would be reduced from five tracks to three tracks. In order to further reduce the railroad cross-section at Savin Hill Station, a tunnel will be constructed for the commuter rail track, thereby allowing room on the surface for expansion of I-93. The tunnel will require a ventilation system, emergency egress points and a pumping station for stormwater and groundwater infiltration.

Service would be suspended on the Braintree line for the entirety of the railroad-specific construction tasks, approximately 4 years. Ashmont line trains and commuter rail trains would continue normal operation with some service disruptions and weekend outages. Alternative transportation services would need to be provided during these shutdowns. Table 5 below shows a breakdown the alternative transportation needed to service total ridership for the Braintree Red Line. This would create significant impacts to the communities in the South Shore for the duration of the construction phase.

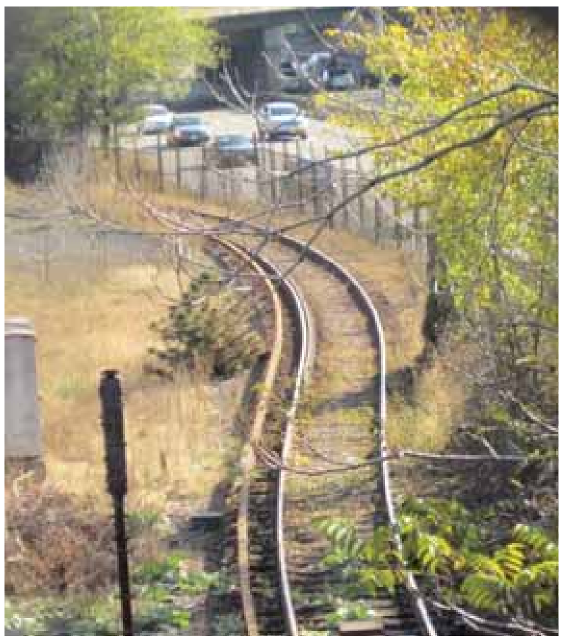
Table 5 Bus/Shuttle Service Summary

ID	Bus/Shuttle Service		Formula
A	Total Riders =	13,518	
B	Riders per Bus =	50	
C	Total Bus Trips Needed during the Peak Hours =	270	A/B
D	Round trip per bus (hr) =	2	
E	Operating Time (hr) =	19	
F	Total Peak Period Time (hr) =	4	
G	Trips per Bus during the Peak Hours =	2	F/D
H	Total Buses Needed =	135	C/G
I	Provide Bus Service for 4 years (4yrs x 365.25=)	1,461	
J	*Total Bus Days =*	*197,494*	H*I

The total number of riders at the affected stations was determined by the total typical weekday entries at each station that would be closed. Peak ridership numbers were determined by assuming 40% of the total weekday entries. An additional 20% is added to the total peak hour entries to account for the existing riders traveling outbound on the Braintree line. It is assumed that the number of buses used during the peak period would be sufficient to service the off-peak ridership. Total bus days is the product of the number of buses used and the number of days the service is running.

Another location where widening I-93 would affect the tracks is between Boston Street and JFK / UMass Station. The track that is the closest to the edge of the highway is a yard lead track for the Red Line as well as a track used for additional storage. This track brings trains from the main line to connect to the yard lead tracks to Cabot yard near South Station. With Alternatives 1-3, the yard lead tracks would be affected by widening the highway. Due to the extent of the proposed widening at this location (40-50'), the yard lead track adjacent to the highway would be eliminated. The three other yard lead tracks would need to be realigned to account for the 10' offset required to any wall or fence. Figure 28 shows the proximity of this yard lead track to the edge of the highway.

Figure 28 Siding Track Proximity to Highway



In order to continue to provide access to Cabot Yard without creating additional conflict points or major operational constraints, the tracks within Columbia Junction would need to be reconfigured. New turnouts would be provided to the Ashmont line tracks north of JFK / UMass Station and would tie in to existing track locations to provide a new alignment to connect to the yard lead tracks. This will provide uninhibited connections between the Ashmont Line tracks, both northbound and southbound, to enter and exit Cabot yard.

The only track impacts that would result from construction of Alternative 4 would be to yard lead adjacent to the highway pictured in Figure 28. Even though the widening of the highway is only approximately 22' in this location, this would still cover the yard lead track and would need to be removed. The same level of access to

Cabot yard that is currently provided would be maintained with this reconstruction. Due to the fact that Columbia Junction is a very congested and compact area, there is little that can be done to add infrastructure at that location without affecting a significant number of the tracks and operations. Currently there are turnouts from the Braintree line to Cabot yard as well as a connection from the outbound Ashmont line track. Two new turnouts can be installed between the inbound track at the Red Line tunnel entrance and the outbound yard lead track adjacent to the inbound Red Line track. Additionally the left hand turnouts just south of the JFK / UMass Station Ashmont platform could be reversed which would provide a connection between the outbound Ashmont track and the inbound track that then connects to the Cabot yard lead track.

6.4 Construction Staging

Physical constraints within the I-93 / railroad corridor limit the options for expansion of transportation facilities connecting Boston with communities in southeast Massachusetts. The width of right-of-way available is a primary constraint when considering widening projects on I-93 or adding more tracks to the railroad corridor. Because of these constraints and the location of the existing infrastructure, construction phasing would play a critical role in determining the cost, schedule and sequence of tasks needed in order to complete the construction of the Rapid Bus Alternative with minimal impact to existing facilities.

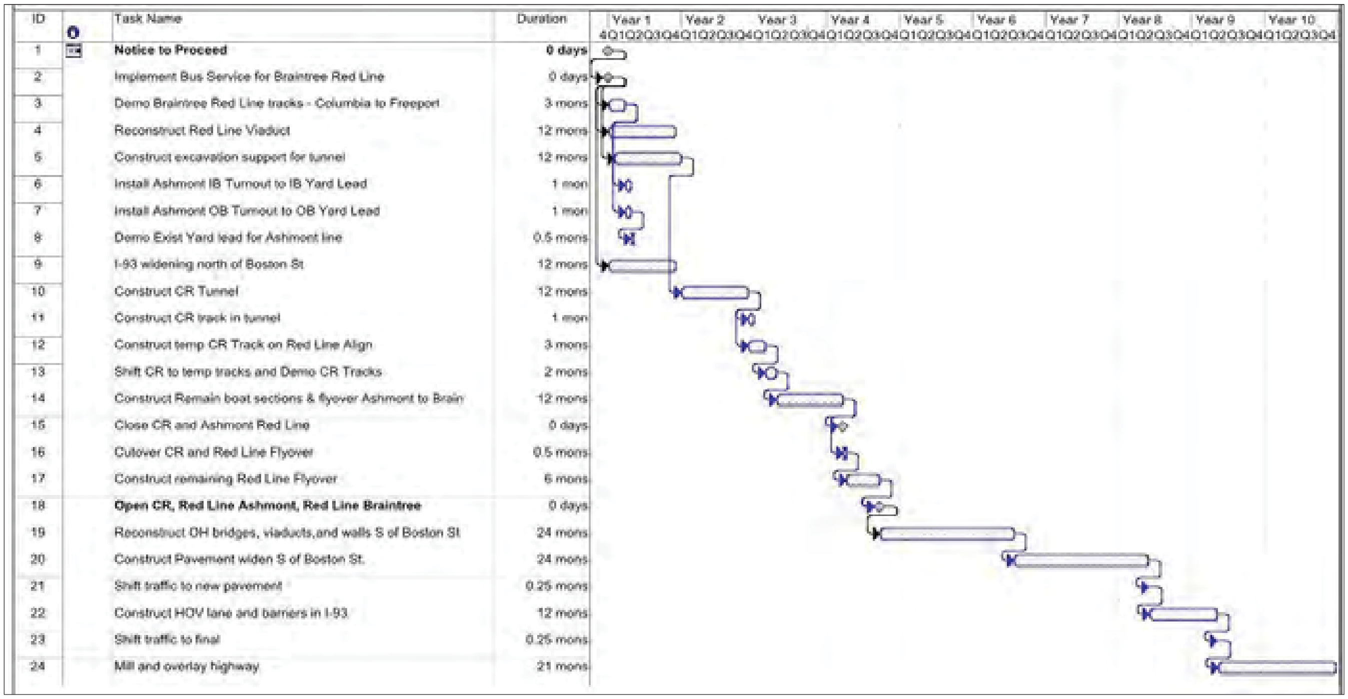
6.4.1 Alternatives 1-3

The first major task needed for the construction of the Rapid Bus infrastructure includes relocating the railroad to make room for the proposed widening of I-93. The two areas where modifications would be needed are the rail corridor between Dorchester Avenue and JFK / UMass, and between JFK / UMass Station and Freeport Street, south of Savin Hill Station. Both locations of rail modification would be constructed simultaneously, as follows:

1. Establish Bus Shuttle Service for Braintree Red Line and close Braintree Red Line Andrew Square Station (*1 day*);
2. Demolish existing Braintree Red Line tracks from Columbia Junction to Freeport Street (*3 months*);
3. Reconstruct Red Line Viaduct. Construct earth support system adjacent to Commuter Rail and I-93 for new tunnel section. Install new facing point turnout on Ashmont Inbound track at Columbia Junction for connection to a Inbound Yard Lead track and install new trailing point right hand turnout on Ashmont Outbound track at Columbia Junction for connection to Outbound Yard Leak track (*1 year*);

4. Demolish existing yard lead track for Ashmont line (*2 weeks*);
5. Begin highway widening and bridge reconstruction unaffected by rail modifications north of Boston Street (*1 year*);
6. Construct cut and cover tunnel and short section of boat section to support temporary skeleton track (*1 year*);
7. Construct track within the tunnel and boat section (*1 month*);
8. Construct temporary skeleton track along Braintree Inbound Red Line alignment from Freeport Street to the Boston Globe siding for Commuter Rail and shift Commuter Rail operations (*3 months*);
9. Demolish Commuter Rail Tracks and shift Commuter Rail to temporary alignment (*2 months*);
10. Construct remainder of boat sections and begin flyover from Ashmont to Braintree Red Line (*1 year*);
11. Close Commuter Rail Line and Ashmont Red Line (*1 day*);
12. Cut over for Commuter Rail and Red Line flyover (*3 weeks*);
13. Construct remainder of Red Line Flyover (*6 months*);
14. Reopen Commuter Rail, Ashmont and Braintree Red Lines (*1 day*).
15. Continue reconstruction overhead bridges, viaduct structure and retaining walls south of Boston Street (*2 years*);
16. Continue constructing additional width of highway pavement south of Boston Street (*2 years*);
17. Shift traffic on to the new pavement area (*1 week*);
18. Construct HOV lane and barriers in the center of I-93 and finish construction of overhead bridges (*1 year*);
19. Shift traffic to final condition (*1 week*);
20. Mill and overlay highway and add permanent striping during off-peak hours (*2 years*).

The entire duration for the construction of these rail modifications and highway construction would be approximately 10 years. Below is a graphic depicting the estimated schedule for Alternatives 1-3:



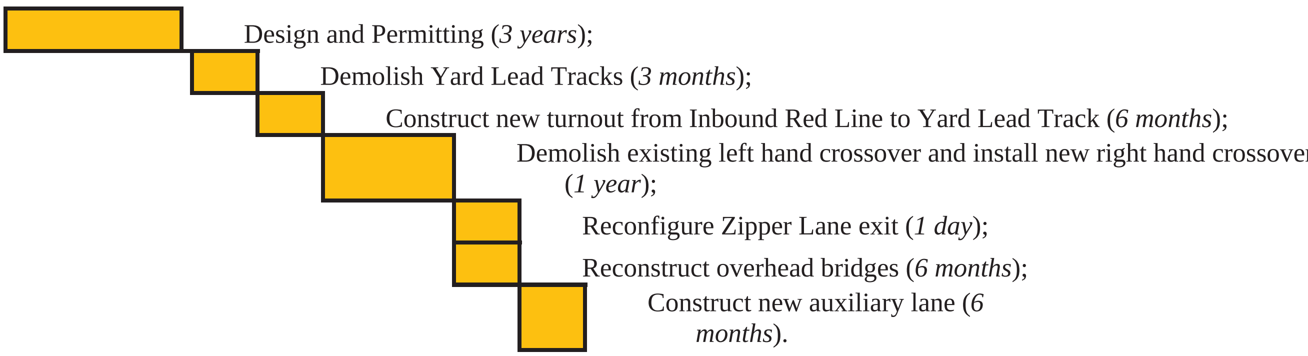
ID	Task Name	Duration
1	**Notice to Proceed**	**0 days**
2	Implement Bus Service for Braintree Red Line	0 days
3	Demo Braintree Red Line tracks - Columbia to Freeport	3 mons
4	Reconstruct Red Line Viaduct	12 mons
5	Construct excavation support for tunnel	12 mons
6	Install Ashmont IB Turnout to IB Yard Lead	1 mon
7	Install Ashmont OB Turnout to OB Yard Lead	1 mon
8	Demo Exist Yard lead for Ashmont line	0.5 mons
9	I-93 widening north of Boston St	12 mons
10	Construct CR Tunnel	12 mons
11	Construct CR track in tunnel	1 mon
12	Construct temp CR Track on Red Line Align	3 mons
13	Shift CR to temp tracks and Demo CR Tracks	2 mons
14	Construct Remain boat sections & flyover Ashmont to Brain	12 mons
15	Close CR and Ashmont Red Line	0 days
16	Cutover CR and Red Line Flyover	0.5 mons
17	Construct remaining Red Line Flyover	6 mons
18	**Open CR, Red Line Ashmont, Red Line Braintree**	0 days
19	Reconstruct OH bridges, viaducts,and walls S of Boston St	24 mons
20	Construct Pavement widen S of Boston St.	24 mons
21	Shift traffic to new pavement	0.25 mons
22	Construct HOV lane and barriers in I-93	12 mons
23	Shift traffic to final	0.25 mons
24	Mill and overlay highway	21 mons

6.4.2 Alternative 4

The construction for Alternative 4 requires less phasing because the construction is limited to a small section of the corridor between Boston Street and Dorchester Avenue. The sequence of construction phases is described below:

1. Demolish Yard Lead track (3 months);
2. Construct new turnouts between Red Line Inbound track and Yard Lead track (6 months);
3. Demolish existing left hand crossover at the southern end of the Ashmont Line platform and construct new right hand crossover with signal modifications (6 months);
4. Implement Zipper Lane exit reconfiguration (1 day);
5. Reconstruct overhead bridges (6 months);
6. Construct new auxiliary lanes (6 months).

The total duration for this construction would be approximately 2-3 years. Below is a graphic depicting the estimated schedule for Alternative 4:



7

Environmental Impact of Design Alternatives

This section provides an evaluation of the environmental impacts of the Design Alternatives.

7.1 Land Use, Zoning and Socioeconomics

This section discusses the impacts of the Modified Rapid Bus Alternatives on land use and zoning, with a focus on the parcels that would have to be acquired to construct each alternative. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to the I-93 Southeast Expressway section.

Table 6 lists the property acquisitions that would be required for each of the four design options considered for the I-93 Southeast Expressway section through Boston's Savin Hill area. As shown on the table, Alternative 1 would require the acquisition of six residential properties, six commercial properties, and one school. Alternatives 2 and 3 would affect the school and six residential properties, as well as seven commercial properties. Alternative 4 would affect four residential and two commercial properties.

The acreages occupied by these parcels have not been determined, and as such the potential property tax loss and socioeconomic impact cannot be calculated for these alternatives.

During Final Design, when actual acquisition requirements are determined, MassDOT will seek to re-zone or obtain a zoning variance for each of the acquired parcels, if necessary.

Table 6 Property Acquisition Requirements

Address	Type of Property	Alternative 1	Alternative 2	Alternative 3	Alternative 4
215 Sydney Street (Boston Collegiate Charter School)	Institutional	Y	Y	Y	N
202 Sydney Street	Residential	Y	Y	Y	N
82 Crescent Avenue	Residential	Y	Y	Y	N
35 Cottrell Street	Residential	Y	Y	Y	N
7 Cottrell Street	Residential	Y	Y	Y	N
3 Cottrell Street	Residential	Y	Y	Y	N
92 Mt. Vernon Street	Residential	Y	Y	Y	N
82 Boston Street	Residential	N	N	N	Y
29 Rawson Street	Residential	N	N	N	Y
34 Rawson Street	Residential	N	N	N	Y
11 Washburn Street	Residential	N	N	N	Y
15 Washburn Street	Residential	N	N	N	Y
750 Dorchester Avenue	Commercial	N	Y	Y	Y
149 Buttonwood Street	Commercial	Y	Y	Y	Y
33 Locust Street	Commercial	Y	Y	Y	N
66 Von Hillern Street	Commercial	Y	Y	Y	N
50 Von Hillern Street	Commercial	Y	Y	Y	N
45 Ellery Street	Commercial	Y	Y	Y	N
400 Southampton Street	Commercial	Y	Y	Y	N
Totals (Residential / Commercial)		6 / 6	6 / 7	6 / 7	5 / 2

7.2 Environmental Justice

This section discusses property acquisitions and noise impacts in environmental justice neighborhoods potentially resulting from improvements to the I-93 HOV lane section. The study area is predominated by environmental justice neighborhoods that may be adversely impacted by the construction or operation of the Rapid Bus Alternative. Environmental justice populations are defined by the Massachusetts Executive Office of Energy and Environmental Affairs Environmental Justice Policy and identified by the US Census Bureau block data in MassGIS mapping. The Environmental Justice Policy is intended to prevent disproportionate adverse impacts to populations disadvantaged because of minority, low income, foreign-born, or English as second language status. Based on MassGIS mapping, environmental justice neighborhoods are present on the east side of I-93 from where the railroad tracks pass under I-93 just south of Columbia Road north to Southampton Street, and on the west side of I-93 for the entire study area except between Southampton Street and the Fairmont Line Commuter Rail. Environmental justice neighborhoods on both sides of the highway include commercial and residential properties. MassGIS mapping does not indicate which environmental justice criteria are met by these neighborhoods.

7.2.1 Property Acquisitions

In the east side environmental justice neighborhoods, three large commercial enterprises (First Electronics Corporation, Olde Bostonian, and Eagle Electric Supply) occupy the space between I-93 and railroad tracks north of Columbia Road, and are accessed by Von Hillern Street. Farther north, 2- and 3-story residential buildings and a range of commercial, industrial, and institutional enterprises (including a church and the Boston Housing Authority) occupy properties east of the railroad tracks, which in this segment abuts the highway alignment.

In the west side environmental justice neighborhoods, commercial and institutional properties between William T. Morrissey Boulevard and Savin Hill Avenue include Yale Electric, Local 103 International Brotherhood of Electrical Workers (IBEW), the Joint Apprenticeship and Training Committee (JATC) for the electrical industry training facility, and the City of Boston Patrick C. Campbell Resource Center (school bus yard). The MBTA Savin Hill Station, which serves this environmental justice neighborhood, is located immediately south of the Savin Hill Avenue bridge over I-93, and several commercial businesses abut the avenue here. A residential neighborhood, consisting of 1-, 2-, and 3-story homes, abuts the highway and then railroad tracks north to Columbia Road, with some interspersed commercial businesses and institutional (Boston Collegiate Charter School and American Legion) properties in the area immediately south of Columbia Road (along Sydney Street). Pedestrian access to the MBTA JFK / UMass Station, an underpass beneath I-93, is also in this area.

North of Columbia Road, one 3-story apartment building and one 2-story residence abut the southbound off-ramp from I-93 to Columbia Road, and additional commercial buildings, such as ATS Auto Equipment and First Trade Union Bank, abut this segment of the highway south of Dorchester Avenue. Two- and 3-story residential and commercial buildings abut Washburn Street Green and General Casimir Pulaski Square immediately north of Dorchester Street, and various commercial enterprises occupy buildings along the south side of Boston Street. The Fortress (storage space), Holiday Inn, and Bickford's Family Restaurant are north of Boston Street, with a frontage road separating the latter two properties from the I-93 corridor south of Southampton Street. North of the Fairmont Line Commuter Rail bridge over I-93, warehouses and a truck shipping center are along the frontage road extending north to the Massachusetts Avenue Connector. A parking garage and additional warehouses are north of the connector, to the end of the study area.

Potential property acquisition impacts to the environmental justice neighborhoods are summarized in the tables below. Tables 7 and 8 identify the number of residential and commercial (including industrial and institutional) buildings, respectively, in environmental justice neighborhoods that would be acquired for each of the four alternatives. For easy geographic reference, the study area is divided into four segments, identified by major street crossings over I-93. For this study, land acquisitions are identified based direct impacts to buildings: if a structure is within the footprint of the widened highway, the parcel or parcels it occupies would be acquired. Acquisitions of vacant parcels, or partial parcel acquisition of portions not occupied by buildings, are not included in this evaluation as they would be unlikely to substantively impact residences, businesses (i.e., jobs), or property tax revenues.

Rapid Bus Alternatives 1, 2, and 3 would require acquisition of six residential and three commercial buildings in environmental justice neighborhoods. The residential buildings are located on the west side of I-93 north of Columbia Road along Mount Vernon Street and Cottrell Street, and would be impacted by the relocated southbound off-ramp from I-93 to Columbia Road. Five of the residential properties are individual units in a row-house building on Mount Vernon Street; one is a multi-family home on Cottreel Street. A 1-story commercial building on Locust Street would also be impacted by this off-ramp. The northbound on-ramp from Columbia Road to I-93, on the east side of the highway, would impact the Eagle Electric Supply building. These alternatives would also impact one school site, which is not a commercial property. The southbound on-ramp from Columbia Road to I-93, also on the west side, would impact the Boston Collegiate Charter School on Sydney Street just south of Crescent Avenue. Rapid Bus Alternative 4 would not impact residential or commercial buildings within environmental justice neighborhoods.

Table 7 Number of Residential Building Acquisitions in Environmental Justice Neighborhoods: I-93 Section

	Alternative			
Segment	1	2	3	4
Morrissey Boulevard to Savin Hill Avenue	0	0	0	0
Savin Hill Avenue to Columbia Boulevard	0	0	0	0
Columbia Boulevard to Dorchester Avenue	6	6	6	0
Dorchester Avenue to Massachusetts Avenue Connector	0	0	0	0
TOTAL	6	6	6	0

Table 8 Number of Commercial Building Acquisitions in Environmental Justice Neighborhoods – I-93 Section

	Alternative			
Segment	1	2	3	4
Morrissey Boulevard to Savin Hill Avenue	0	0	0	0
Savin Hill Avenue to Columbia Boulevard	0	0	0	0
Columbia Boulevard to Dorchester Avenue	2	2	2	0
Dorchester Avenue to Massachusetts Avenue Connector	0	0	0	0
TOTAL	2	2	2	0

Acquiring residential or commercial property for the project would be conducted in accordance with the Uniform Relocation Act. The loss of commercial buildings could result in a loss of jobs for the local environmental justice neighborhoods, depending whether the businesses would relocate within the local community or not. The number of potential job losses has not been investigated for this evaluation. The municipalities would realize a loss of property tax revenues when the privately held properties are transferred to public ownership. The property tax revenue losses have not been calculated for this evaluation. The potential job losses and property tax revenue decreases would be associated with Rapid Bus Alternatives 1, 2, and 3, but not Alternative 4.

7.2.2 Noise Impacts

Each of the Rapid Bus alternatives would move the highway closer to residences, increasing noise levels for occupants. For Rapid Bus Alternatives 1, 2, and 3, this impact would be somewhat offset by noise level reductions resulting from moving the railroad tracks into a tunnel for a portion of these segments. Table 9 identifies the length of highway widening segments that would move the highway closer to environmental justice residential neighborhoods, again for each alternative and divided into four segments.

Rapid Bus Alternatives 1, 2, and 3 would move the highway closer to environmental justice residential neighborhoods for a total distance of approximately 3,950 feet on the west side of I-93 for the segment from the MBTA Savin Hill Station north to Columbia Road, and from Dorchester Avenue to Boston Street. Alternative 4 would move the highway closer to environmental justice residential neighborhoods for a total distance of approximately 550 feet on the west side of I-93 for the segment from Dorchester Avenue to Boston Street.

Table 9 Length of Highway Segment Closer to Residential Properties in Environmental Justice Neighborhoods – I-93 Section

	Alternatives			
Segment	1	2	3	4
Morrissey Boulevard to Savin Hill Avenue	0[1]	0	0	0
Savin Hill Ave. to Columbia Boulevard	3,800	3,800	3,800	0
Columbia Boulevard to Dorchester Avenue	150	150	150	0
Dorchester Avenue to Massachusetts Avenue Connector	0	0	0	550
TOTAL	3,950	3,950	3,950	550

1 Length in feet

7.2.3 Transit Access

The qualtitative analysis of impacts to environmental justice populations focused on temporary reductions in transit service that could result from constructing the railroad tunnel, land acquisition required for widening the highway to accommodate constructing the improvements necessary for each Rapid Bus alternative, and potential impacts (such as increases in noise) that may result from moving the highway closer to environmental justice neighborhoods. Reductions in service were based on a review of the MBTA's Ridership and Service Statistics, Thirteenth Edition (known as the 2010 Blue Book) for the affected light rail and commuter rail lines.

As described in Chapter 6, "Constructability of Design Alternatives," construction of Alternatives 1-3 would require tunneling MBTA tracks underneath the Southeast Expressway. This construction activity would require the cessation of MBTA Red Line Braintree Branch service for an undetermined period of time. This cessation would adversely impact subway riders for this period. There would be no service to the five Braintree Branch stations south of the JFK / UMass Station: North Quincy, Wollaston, Quincy Center, Quincy Adams, and Braintree. An average of approximately 28,000 riders per weekday board or alight at these stations, according to the 2010 Blue Book. Alternative transportation would be sought by these current Braintree Branch customers.

Disrupting transit service for a long term can adversely impact environmental justice populations, who typically rely on transit more than non-environmental justice populations to access jobs, schools, and health care services. The MBTA Red Line

Braintree predominantly serves communities meeting one or more environmental justice criterion. An average of nearly 38,000 riders per day use this line south of the project area, some portion of which are members of environmental justice neighborhoods. Environmental justice populations would be disproportionately impacted by a disruption of these transit services under Rapid Bus Alternatives 1, 2, or 3. Because the tunnel would not be required for Rapid Bus Alternatives 4, environmental justice populations would not be impacted by these alternatives.

7.3 Visual

This section discusses the visual impacts of the Modified Rapid Bus Alternatives. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to the I-93 Southeast Expressway HOV section.

Beginning in Boston at South Station, along I-93, the highway alignment passes through concentrated commercial and industrial development in the vicinity of the Route 3 interchange. These properties would be visible to bus riders. The highway in this segment is a divided multi-lane road, but with no median.

The modifications to I-93 and the adjacent rail corridor in the I-93 Southeast Expressway HOV would potentially change the visual and aesthetic environment. The Southeast Expressway section would introduce new visual elements that would be visible to motorists on I-93, commuter and Red Line riders, and residents of adjacent neighborhoods. These visual elements would be consistent with the existing developed, transportation nature of the corridor, and would include new traffic lanes, a new retaining wall and in some cases, new rail flyovers. The Old Colony Commuter Rail line would be placed in a tunnel, resulting in adverse visual impacts for commuter rail riders.

The changes within the I-93 Southeast Expressway HOV section would not have an adverse visual impact, although commuter rail passengers would have views of the highway replaced with views of a tunnel.

7.4 Noise

New highway construction is not expected to result in noise impacts because there are few receptor locations adjacent to the major roadways, they are located substantial distances away from the roadways, and most of the roadway is boarded by ledge, and hills, and thick wooded areas that reduce highway noise, and the relatively small increase in sound levels that will be generated by the increased bus traffic on the major roadways.

7.5 Vibration

Using the FTA vibration curve (adjusted for speed) for rubber tired vehicles (buses), the vibration assessment indicated that for buses traveling at a speed of 60 mph, the impact distance for a vibration level of 80 VdB is 15 feet. Using the FTA vibration impact criterion of 72 VdB for frequent events (greater than 70 events per day), the impact distance is 40 feet. Since there are no receptors located within these distances of the highway, no vibration impacts are expected to occur from the Rapid Bus Alternatives.

7.6 Cultural Resources

This section discusses the impacts of the Modified Rapid Bus Alternatives on cultural resources.

7.6.1 Historic Resources

Project work items for the Modified Rapid Bus Alternatives consist of roadway and interchange modifications primarily within or immediately adjacent to the existing right-of-way. No historic resources are present within the highway corridor rights-of-way where project improvements are planned. Therefore work within the rights-of-way will have no potential direct impacts to historic resources.

There are no historic properties located within the 50 foot APE of the I-93 section which would be affected by visual or noise impacts.

7.6.2 Archaeological Resources

The Modified Rapid Bus Alternatives Area of Potential Effect (APE) includes the existing highway corridor rights-of-way, interchange reconfigurations, bridge reconstructions, and any other work areas that would involve earthmoving outside of the existing highway rights-of-way.

There are no recorded archaeological sites or identified sensitive areas within the highway corridor rights-of-way where project improvements are planned. No direct impacts to archaeological resources in the previously disturbed highway rights-of-way are anticipated.

The archaeological survey was not conducted for the interchange reconfigurations, bridge reconstructions, and other work areas that would involve earthmoving outside of the previously disturbed highway rights-of-way within the APE. These project elements are located in geographical areas that contain or are in proximity to recorded sites and have the potential to contain unrecorded sites in sensitive areas.

7.7 Air Quality

The effectiveness of a Rapid Bus system is directly dependent upon the roadway treatment of the 1.9 mile gap between the existing zipper lane and the northern HOV lane into Boston. Four alternatives have been evaluated for their impacts on traffic, which in turn directly affects their impact on air quality. Each of these alternatives provides a different treatment of how the vehicle in the zipper lane proceed to the HOV lanes, back into the general purpose lanes, and how traffic from the general purpose lane proceed into the HOV lanes. The weaving action from each of these alternatives either favors the zipper lane or the general purpose lanes. It should be noted that the majority of emissions in this study area are from the vehicles in the general purpose travel lanes.

Alternative 1 reduces travel time as compared to the 2030 No Build Condition for both the zipper and general purpose lanes, but results in a substantially longer time of peak congestion. Alternatives 2 and 3 reduce travel time for the zipper lane, but the travel time for the general purpose lanes and the time of peak congestion remain about the same as the 2030 No Build Condition. Alternative 4 reduces travel time as compared to the 2030 No Build Condition for the zipper lane, but results in a longer travel time for the general purpose lanes and the time of peak congestion.

Automobile emissions of the ozone precursor emissions (VOCs and NOx) and CO are expected to be reduced for Alternatives 2 and 3 as compared to the 2030 No Build Condition because the zipper lane travel time would be improved and the general purpose lane travel time and the time of peak operation will be the same. Alternative 4 is expected to result in small air quality benefits due to zipper lane travel time improvements, however, automobile emissions are expected to increase for Alternative 4 as compared to the 2030 No Build Condition because, while the zipper lane travel time would be improved, the general purpose lane travel time and the time of peak operation would be greater.

7.8 Open Space

This section discusses direct impacts to public open space (parks, conservation lands, recreation lands, and wildlife refuges), which are protected under Article 97 of the Massachusetts Constitution, and to publicly-owned wildlife sanctuaries and refuges. Although the South Coast Rail Project is currently not anticipated to require review or funding by a federal transportation agency, this criterion also includes those properties protected under Section 4(f) of the federal Department of Transportation Act because the FTA and FHWA are cooperating agencies under NEPA. Should the FHWA be required to review the Rapid Bus Alternative under NEPA or Section 4(f), the impacts of the interchange improvements and the HOV Alternative 4 would require a Section 4(f) Evaluation.

Several public open spaces are proximate to the highway alignment within the I-93 Southeast Expressway HOV section of the project area, including (from south to north):

- McConnell Park, a sports field facility east of I-93 and south of Savin Hill Avenue;
- Shannon's Park, an open space west of I-93 and between Columbia Road and Mt. Vernon Street;
- Washburn Street Green, an open space west of I-93 and between Washburn Street and Dorchester Avenue; and
- General Casimir Pulaski Square, a memorial park between I-93 and Power Street, south of Boston Street.

Each of these facilities is adjacent to existing transportation corridors (I-93, railroads, and surface streets) with high ambient noise levels and a highly developed visual environment. None of the alternatives would move the highway closer to McConnell Park. Alternatives 1, 2, and 3 would move the southbound off-ramp for Columbia Road approximately 50 to 55 feet closer to Sharon's Park. Relocating the highway closer to this facility would not affect the use of it. Alternative 4 would not move the highway.

Alternatives 1, 2, and 3 would not require acquisition of any portion of these public open spaces. Alternative 4 would impact the Washburn Street Green and General Casmir Pulaski Square for widening the highway. Washburn Street Green is owned by the City of Boston, and at least a portion of the site would have to be acquired by the MBTA. General Casimir Pulaski Square is on part of a parcel owned by the Commonwealth of Massachusetts so the parcel would not need to be acquired from another entity. However, using a portion of the Washburn Street Green and all of General Casimir Pulaski Square to widen the highway for Alternative 4 would impact the public's use of these properties and could trigger Article 97 review. Washburn Street Green's function as a recreation area and buffer from the highway would be diminished. General Casimir Pulaski Square would be entirely taken, removing this facility from public use unless replaced.

As mentioned above, Article 97 of the Massachusetts Constitution protects all publicly owned lands used for conservation or recreation purposes. Similarly, Section 4(f) of the US DOT Act protects parks and recreation areas under certain circumstances. Acquiring portions of the Washburn Street Green for Alternative 4 would likely be subject to Article 97 and Section 4(f) requirements. The General Casimir Pulaski Square likely does not qualify for Article 97 protection because it is not used for conservation or recreation purposes. This site likely qualifies for Section 4(f) protection if the project were subject to approval by one of the federal Department of Transportation agencies (FHWA, FTA, FRA).

In addition to those protections, the locations of these two facilities within environmental justice communities mean that the loss of their use for Alternative 4 could be considered a disproportionate impact to the environmental justice populations, since there would not be similar losses in non-environmental justice neighborhoods. The Washburn Street Green is location-specific and its function as a neighborhood resource could not be replaced by a similar facility at another location without acquiring and demolishing residences. Replacement of this facility is considered infeasible. The General Casimir Pulaski Park is a memorial to a Revolutionary War hero of Polish descent, and is located adjacent to the Polish America Citizen Club. Replacement of this facility may require negotiation with the local citizens, given its apparent affiliation with the Polish community.

7.9 Hazardous Materials

Detailed Phase I Environmental Site Assessments have not been conducted for the properties potentially affected by the I-93 Southeast Expressway HOV section alternatives, or for any area requiring modification of existing highways.

7.10 Biodiversity, Threatened and Endangered Species, Wetlands, Water Resources, and Coastal Zones/Chapter 91 Areas

The proposed improvements along the I-93 Southeast Expressway HOV section would be entirely within a developed transportation corridor in an urban area and would not affect any of these resources.

This Page Intentionally Left Blank

8

Ridership of the Design Alternatives

In order to assess the effectiveness of each I-93 Design Alternative, ridership projections were developed for the year 2030. Using the same model used to project ridership for the DEIS/DEIR, CTPS developed ridership projections for the entire Modified Rapid Bus Corridor (including the proposed improvements along Route 24, additional stations, and added service). In addition to the four I-93 Design Alternatives, a "No-Build" alternative that included all Modified Rapid Bus Improvements, except for those in the I-93 corridor. The development of ridership and the results are described in more detail in Appendix H. [NOTE: Appendix H will be provided by CTPS directly]

Using the No-Build alternative as a base-line, it is possible to determine the overall benefit attributable to each of the four Design Alternatives. This is shown in Table 10. Alternative 1 would have the greatest ridership, with Alternative 4 being the least effective at attracting riders.

Table 10 2030 Ridership Projections

Alternative	Total Ridership	Ridership Associated with I-93 Design Alternative
1	12610	2278
2*	13626	3294
3*	13569	3237
4	12021	1689
No Build	10332	0

* Extrapolated based on travel time

This Page Intentionally Left Blank

9

Costs

9.1 Capital Costs

Costs for the four build alternatives were developed using the methodology presented in the DEIS/DEIR. As shown in Table 11, Alternatives 1-3 would have capital costs comparable to that of the DEIS/DEIR Rapid Bus Alternative. Only Alternative 4, which includes minimal improvements to I-93, would be close in capital cost to the DEIS/DEIR Rapid Bus Alternative.

Table 11 Total Cost for I-93 Infrastructure

Description		Alternative 1	Alternative 2	Alternative 3	Alternative 4
Permanent Single Reversible Lane Construction		$625,447,000	$624,395,000	$624,597,000	$14,659,000
Real Estate Cost		$10,697,000	$11,823,000	$11,823,000	$5,067,000
Engineering Services	13.55%	$84,749,000	$84,606,000	$84,633,000	$1,987,000
Contingencies	50.00%	$312,724,000	$312,198,000	$312,299,000	$4,647,000
Total Cost - Alternative 1		$1,033,617,000	$1,033,022,000	$1,033,352,000	$26,360,000

9.2 Operating and Maintenance Costs

The only operating and maintenance (O&M) costs directly associated with the I-93 section would be the maintenance of the "missing link" alternative treatments (i.e. permanent reversible lanes). This would include repaving the added lane miles, snow plowing, and other required maintenance. Alternative 1-3 would have essentially the same incremental O&M cost, while Alternative 4 would have less (due to the fewer lane miles). The cost of operating bus service would be irrelevant as the I-93 segment is only a small portion of the overall project.

10

Conclusions

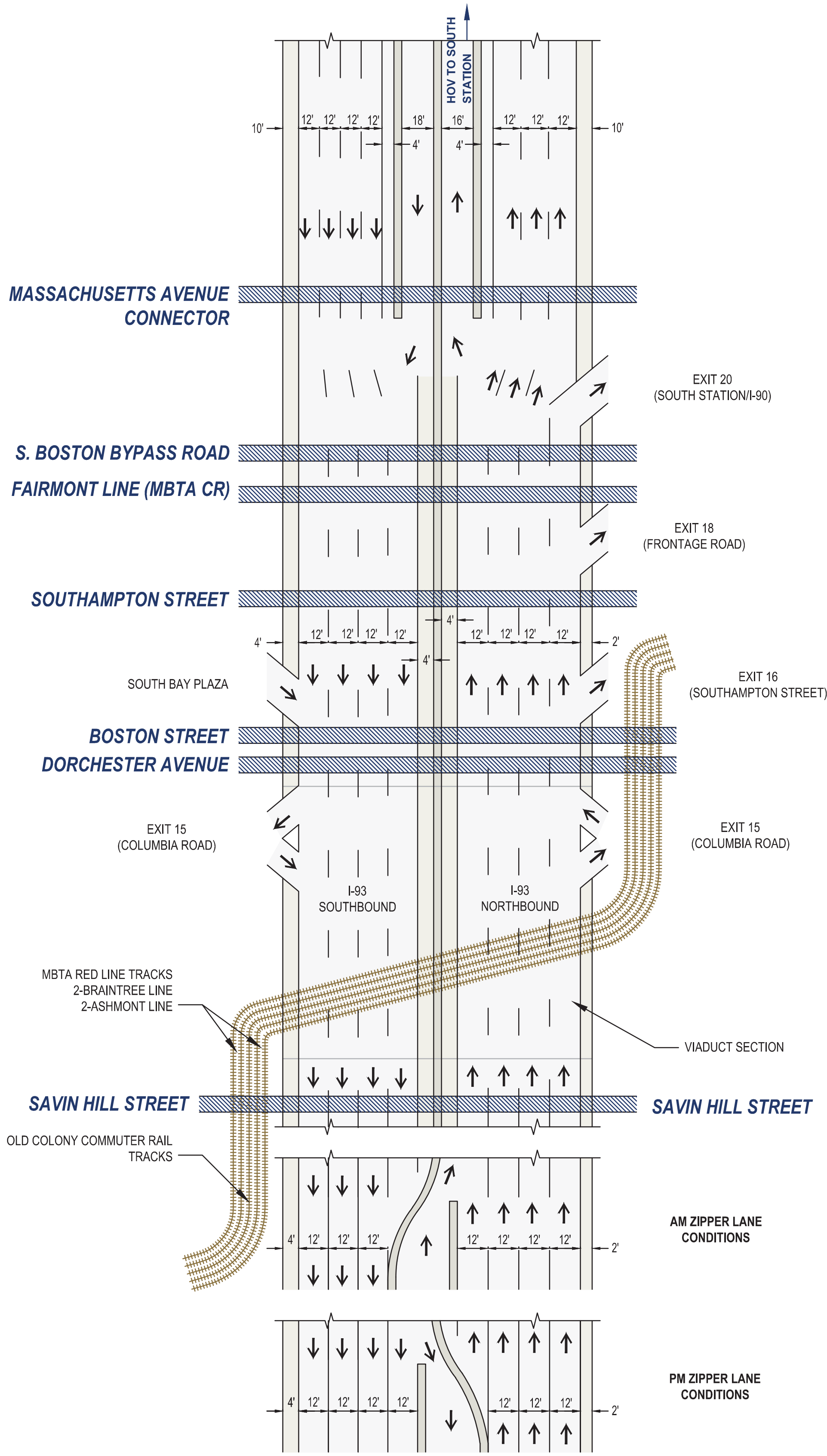
It was concluded that the alternatives that require widening the highway and tunneling the Commuter Rail (Alternative 1, 2 and 3) would cause unacceptable impacts to regional transportation and environmental justice communities while significantly increasing the construction costs. These alternatives, therefore, would be impracticable for the Modified Rapid Bus Alternative. Alternative 4 would increase general purpose travel time, which would have regional transportation impacts and regional air quality impacts that make that operational change alone also impracticable for the Modified Rapid Bus Alternative. In addition, MassDOT is committed to make no alterations I-93 that that would have negative impacts on regional transportation and air quality.

For these reasons, the Modified Rapid Bus Alternative would not include any of the infrastructure or operational changes considered here to close the I-93 HOV gap; in terms of this gap, the Modified Rapid Bus Alternative would be unchanged from the DEIS/DEIR Rapid Bus Alternative.

This Page Intentionally Left Blank

Figures

This Page Intentionally Left Blank

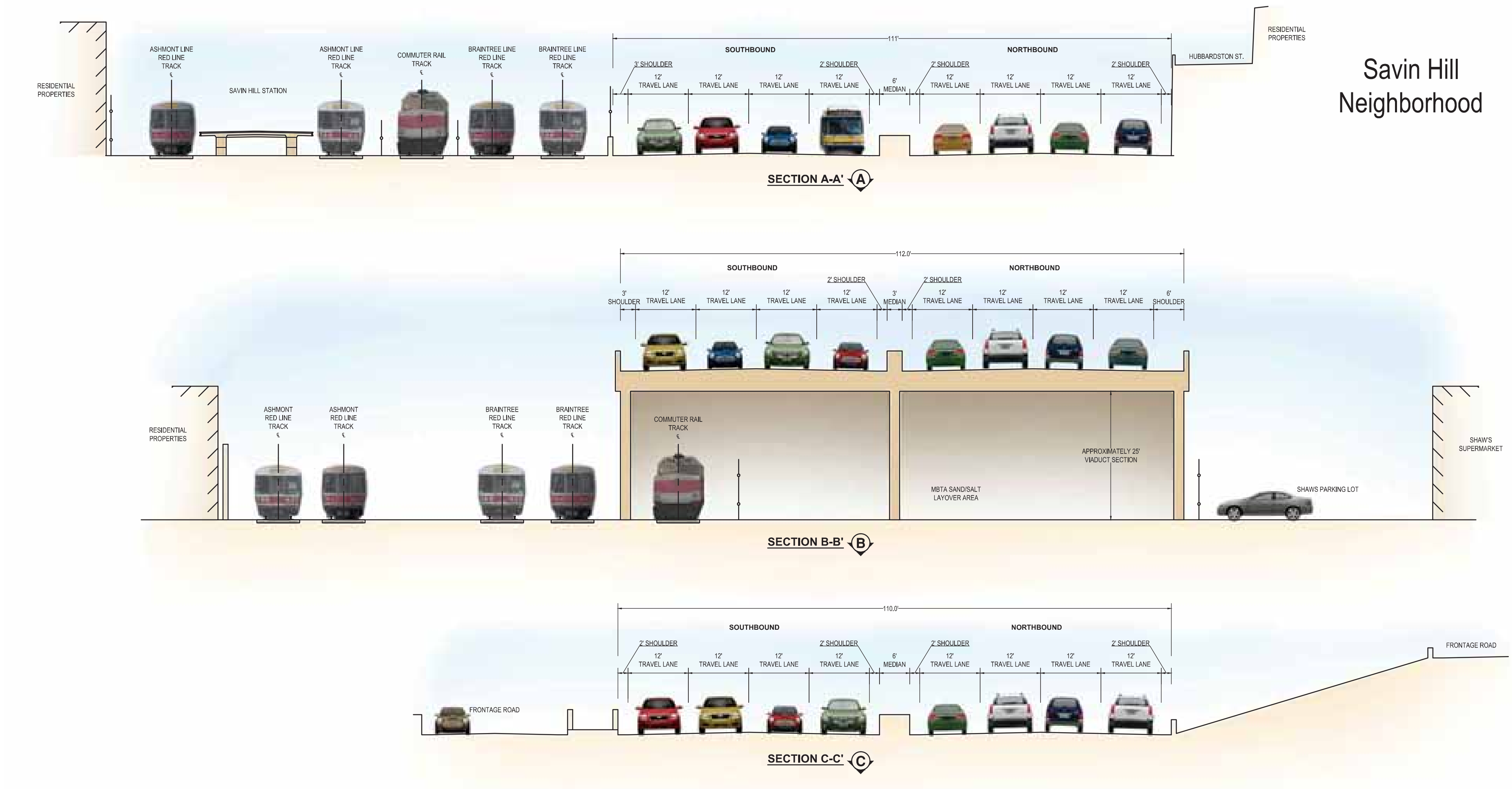


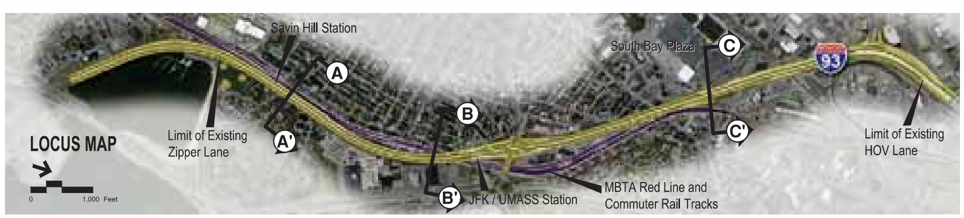
NOT TO SCALE

\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\Alternatives_Schematics.dwg Printing Date: 6/14/2012 10:24 AM

Figure 1
I-93 HOV Extension Schematics
Existing Conditions

Prepared by: VHB





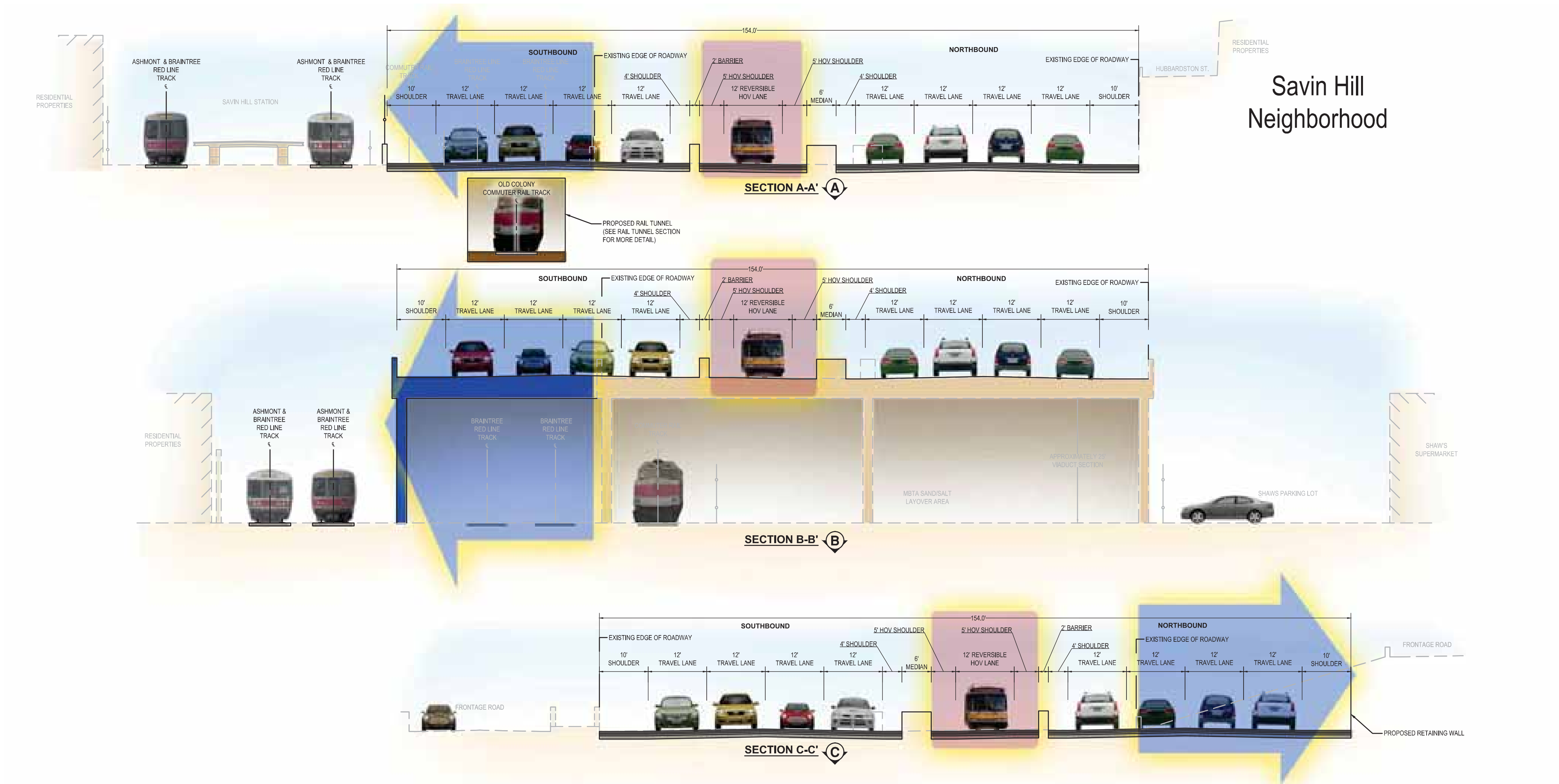
massDOT
Moving Massachusetts Forward

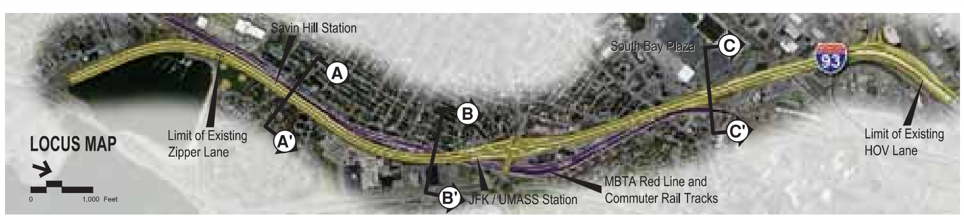
SOUTH COAST RAIL

Figure 6
Southeast Expressway Existing Conditions Sections

MassGIS
Prepared by: VHB

\\mabosdata\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\HOV_X-SEC.dwg Printing Date: 6/14/2012 10:29 AM





massDOT

SOUTH COAST RAIL

Figure 7
Southeast Expressway
Alternative 1 Sections
The "Commitment" Alternative

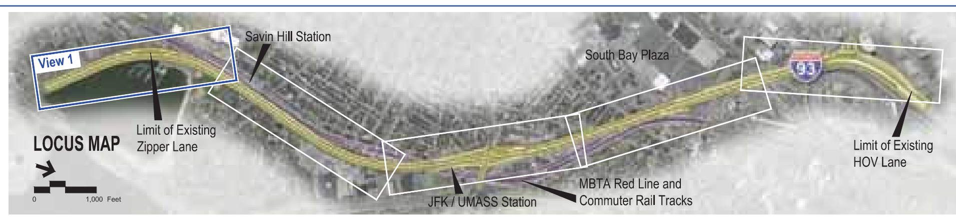
MassGIS
Prepared by: VHB

\\MABOS\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\HOV_X-SEC.dwg Printing Date: 6/14/2012 8:42 AM

View 1: AM Zipper Lane Configuration

View 1: PM Zipper Lane Configuration

0 100 200 Feet



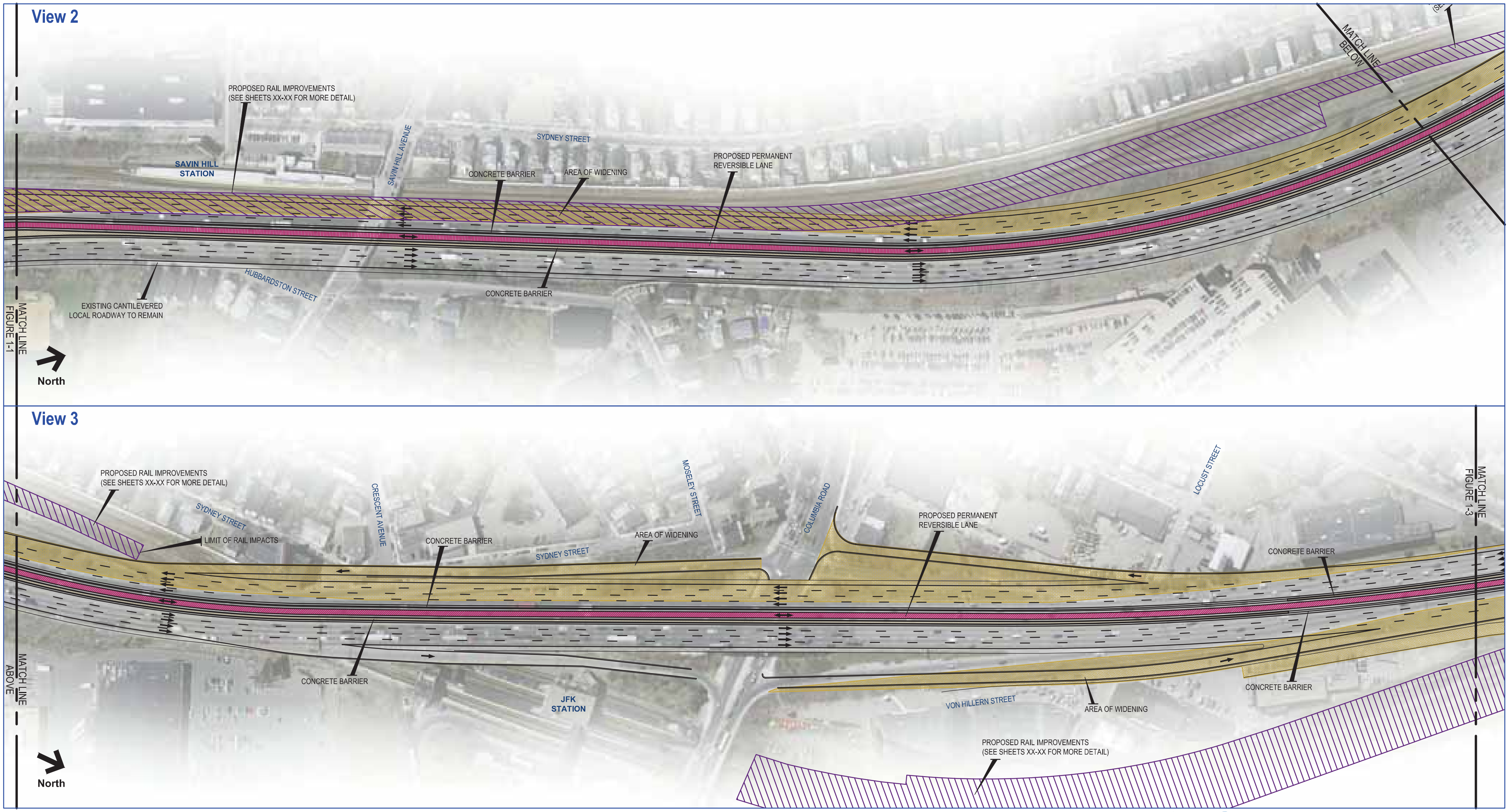
Moving Massachusetts Forward. massDOT

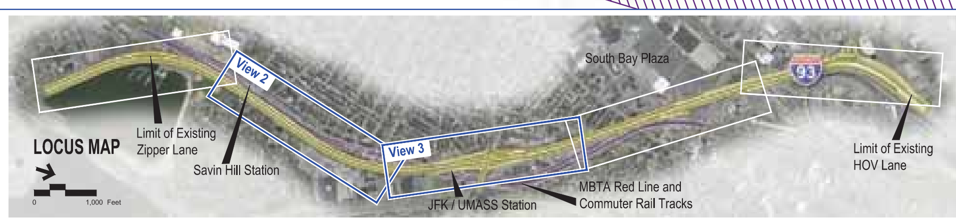
SOUTH COAST RAIL

Figure 9
Alternative 1
The "Commitment" Alternative

Zipper Lane Operations
MassGIS
Prepared by: VHB

\\MABOS\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\01_HOV Extension_Alt1.dwg Printing Date: 6/14/2012 8:47 AM





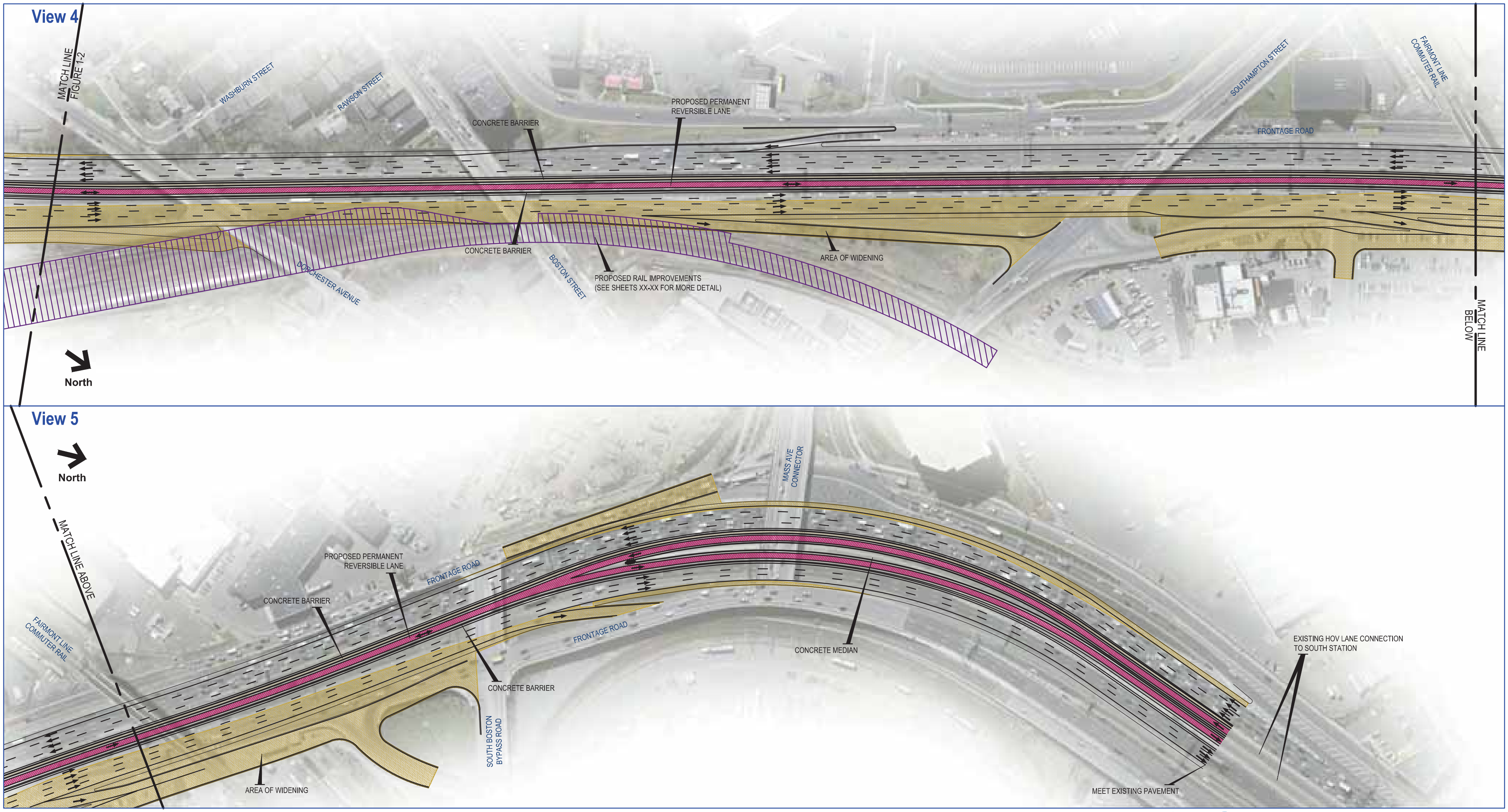
massDOT — Moving Massachusetts Forward.

SOUTH COAST RAIL

Figure 10
Alternative 1
The "Commitment" Alternative

MassGIS
Prepared by: VHB

\\MABOS\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\01_HOV Extension_Alt1.dwg Printing Date: 6/14/2012 8:48 AM



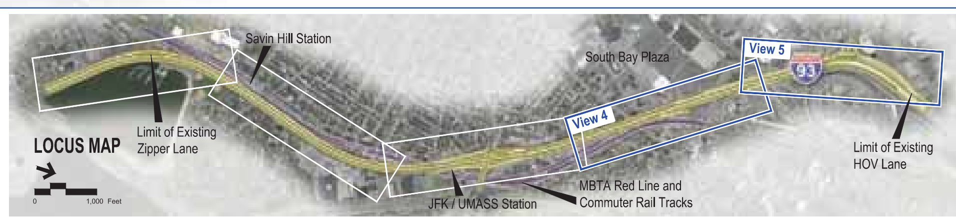
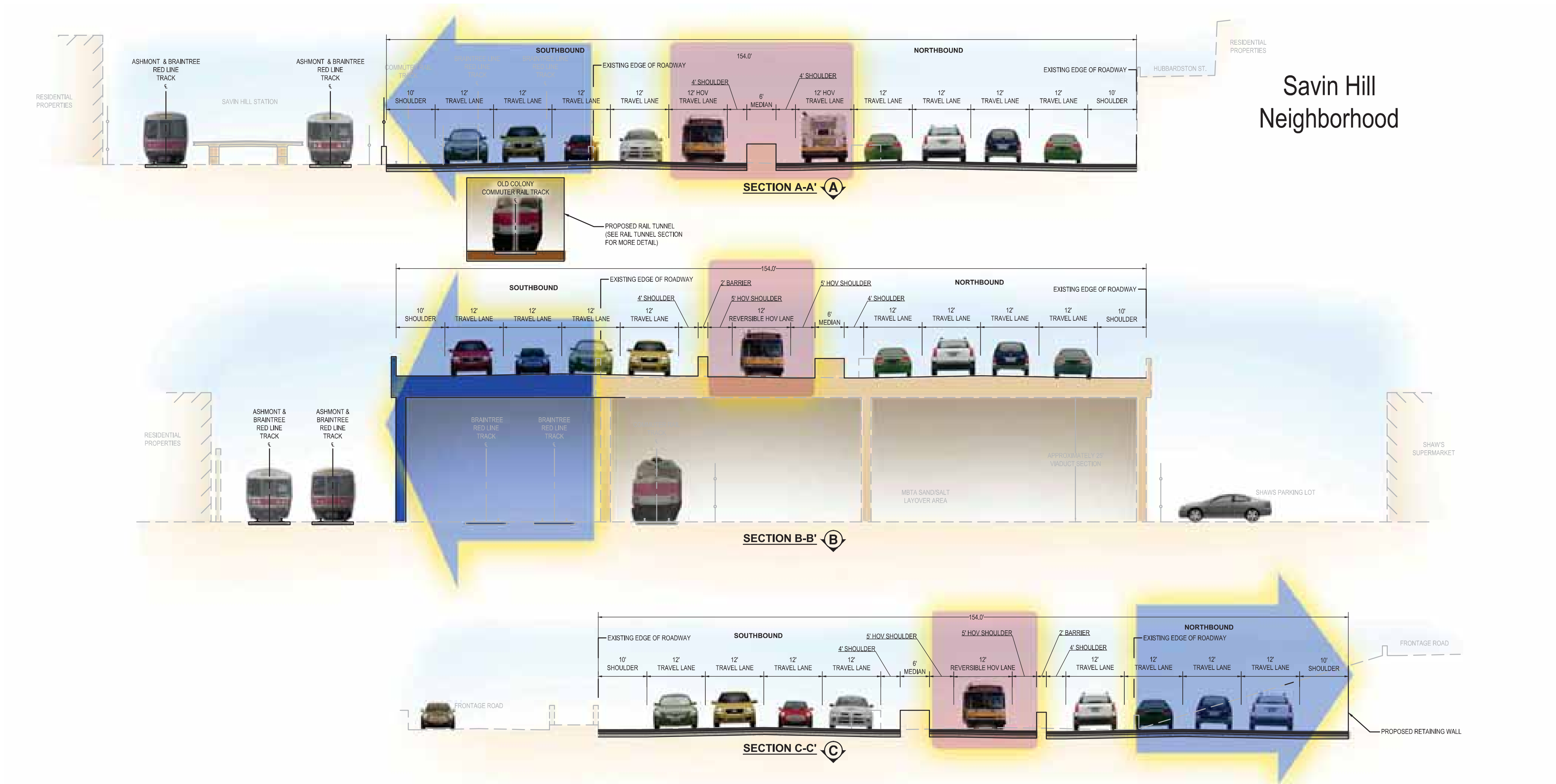
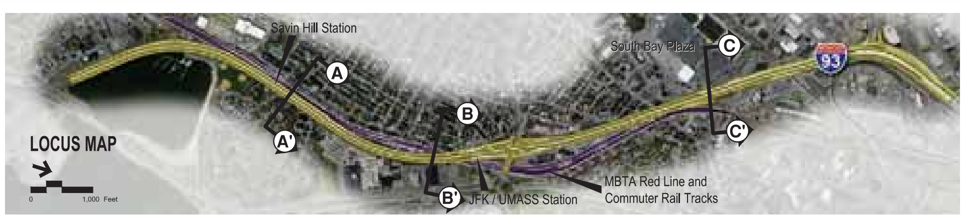


Figure 11
Alternative 1
The "Commitment" Alternative

MassGIS
Prepared by: VHB

\\MABOS\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\01_HOV Extension_Alt1.dwg Printing Date: 6/14/2012 8:50 AM





massDOT

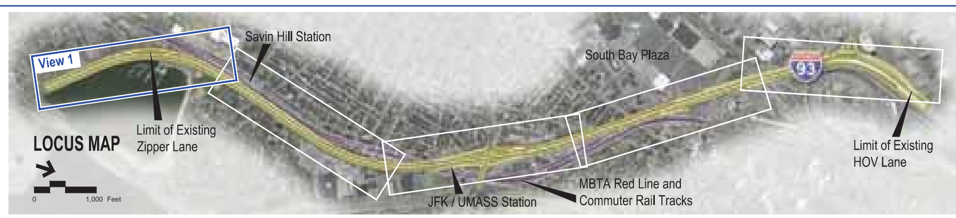
SOUTH COAST RAIL

Figure 12
Southeast Expressway Alternative 2 Sections The "Maintain Exit at Savin Hill" Alternative
MassGIS
Prepared by: VHB

View 1: AM Zipper Lane Configuration

View 1: PM Zipper Lane Configuration

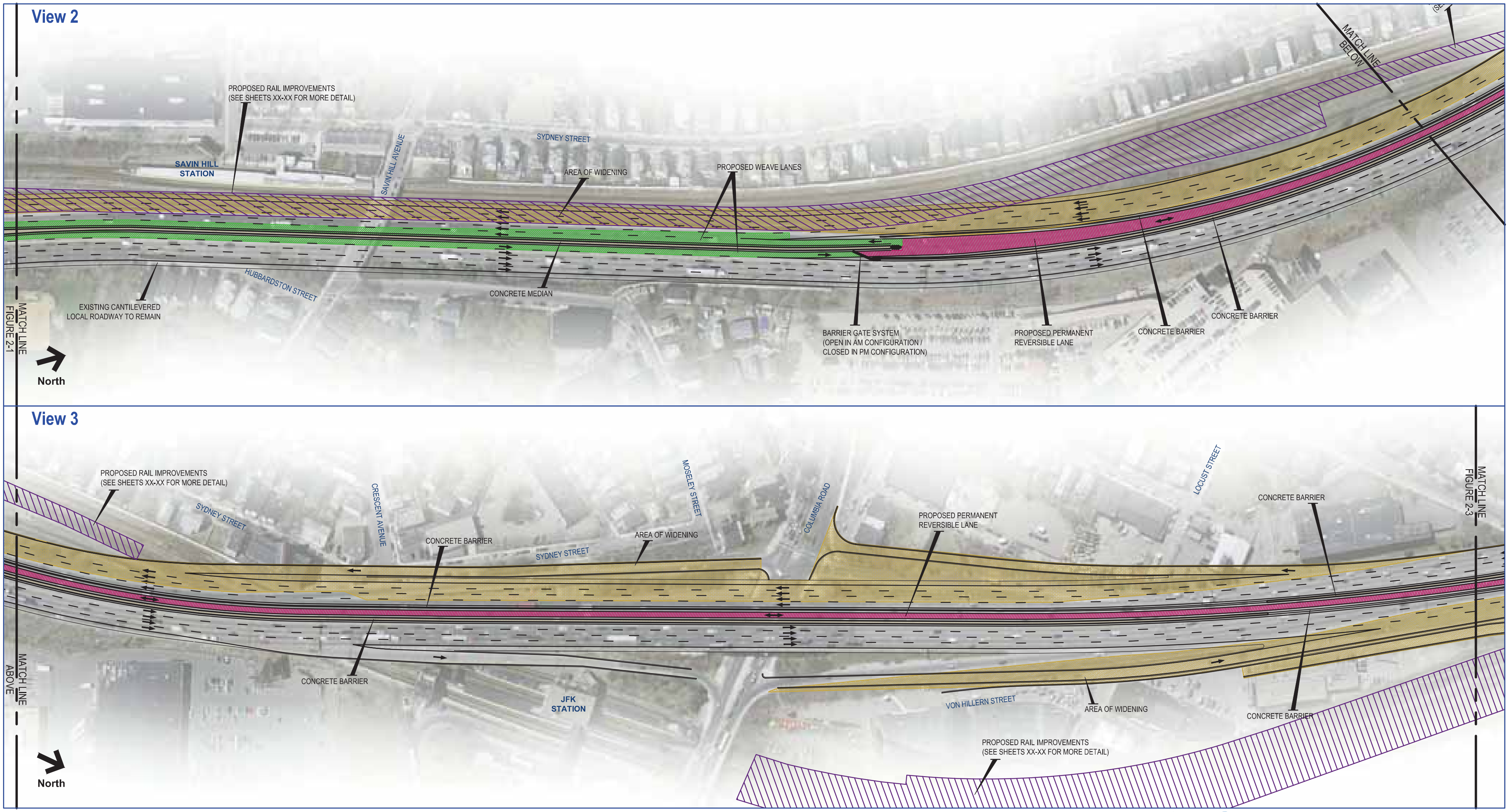
0 100 200 Feet

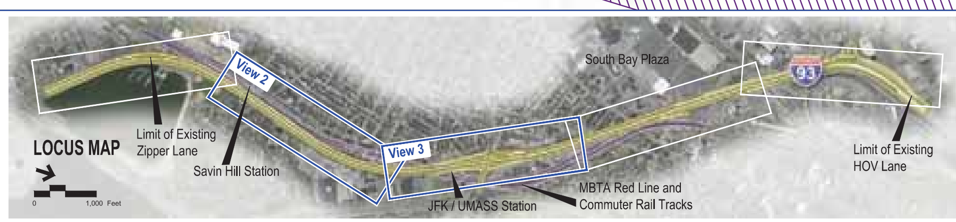


massDOT
SOUTH COAST RAIL

Figure 14
Alternative 2
The "Maintain Exit at Savin Hill" Alternative Zipper Lane Operations
MassGIS
Prepared by: VHB

Y:\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\02_HOV Extension_Alt2.dwg Printing Date: 6/14/2012 10:27 AM





Moving Massachusetts Forward. massDOT

SOUTH COAST RAIL

Figure 15
Alternative 2
The "Maintain Exit at Savin Hill" Alternative

MassGIS
Prepared by: VHB

Y:\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\02_HOV Extension_Alt2.dwg Printing Date: 6/14/2012 10:25 AM

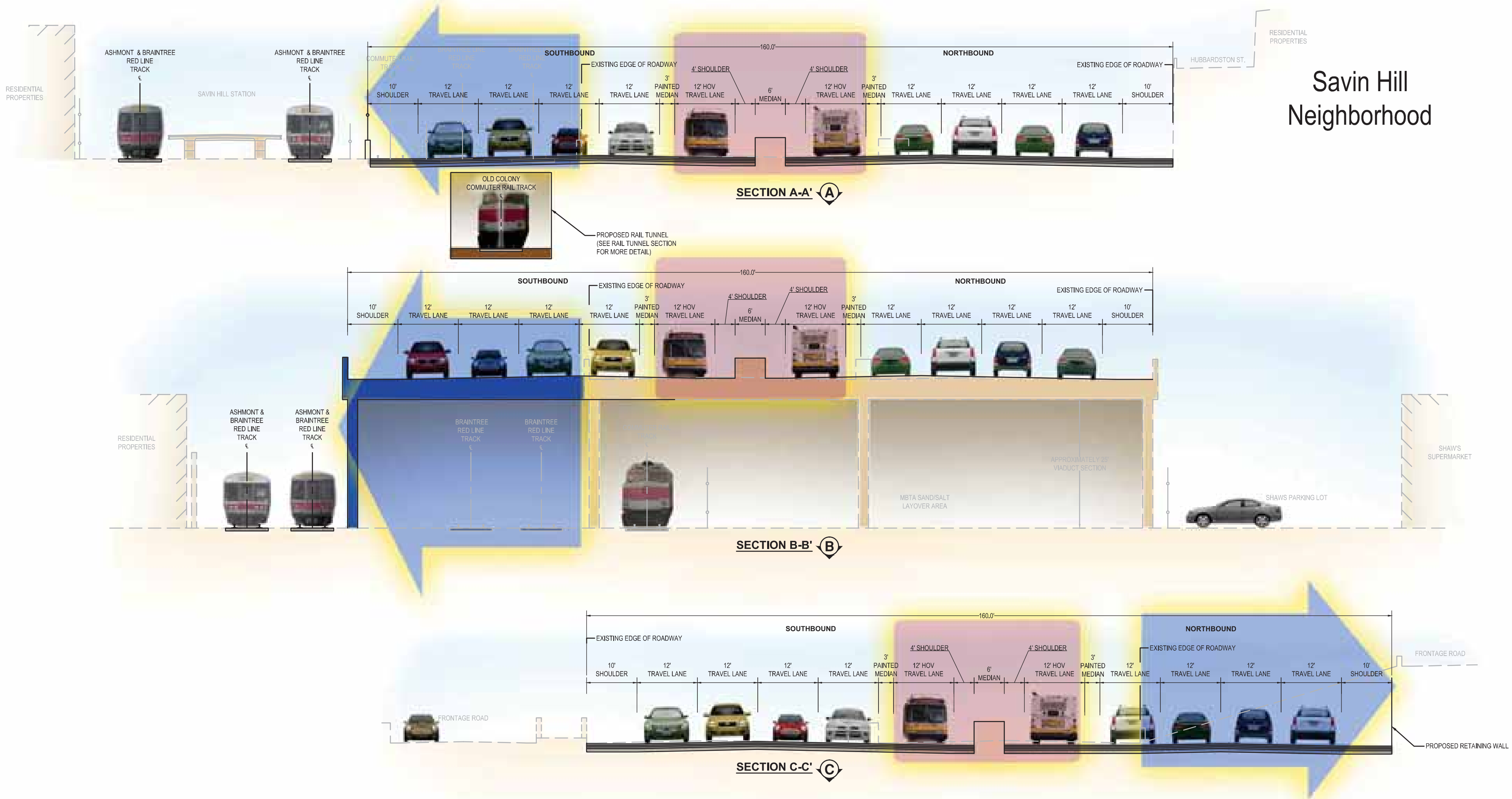
Moving Massachusetts Forward. massDOT

SOUTH COAST RAIL

Figure 16
Alternative 2
The "Maintain Exit at Savin Hill" Alternative

MassGIS
Prepared by: VHB

Y:\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\02_HOV Extension_Alt2.dwg Printing Date: 6/14/2012 10:24 AM



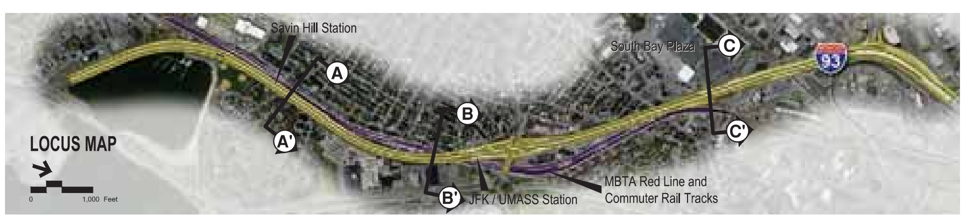
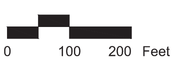


Figure 17
Southeast Expressway Alternative 3 Sections The "HOV Lanes in Both Directions" Alternative
MassGIS
Prepared by: VHB

\\MABOS\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\HOV_X-SEC.dwg Printing Date: 6/14/2012 9:41 AM



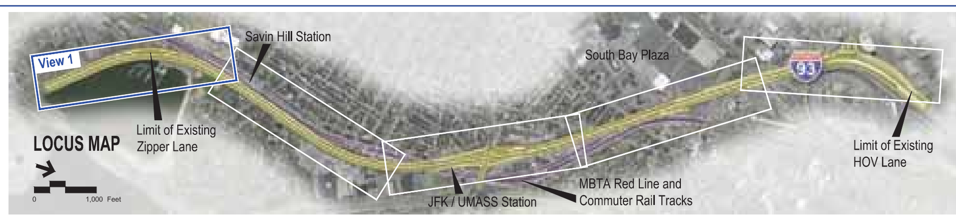


Figure 18
Alt. 3 - The "HOV Lanes in Both Directions" Alternative Zipper Lane Operations

MassGIS
Prepared by: VHB

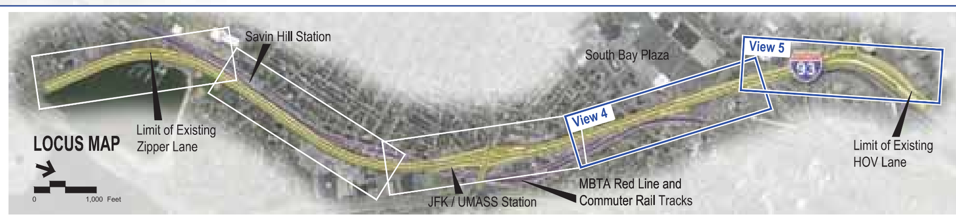
\\MABOS\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\03_HOV Extension_Alt3.dwg Printing Date: 6/14/2012 9:13 AM

Moving Massachusetts Forward. massDOT

SOUTH COAST RAIL

Figure 19
Alt. 3 - The "HOV Lanes in Both Directions" Alternative Zipper Lane Operations

MassGIS
Prepared by: VHB



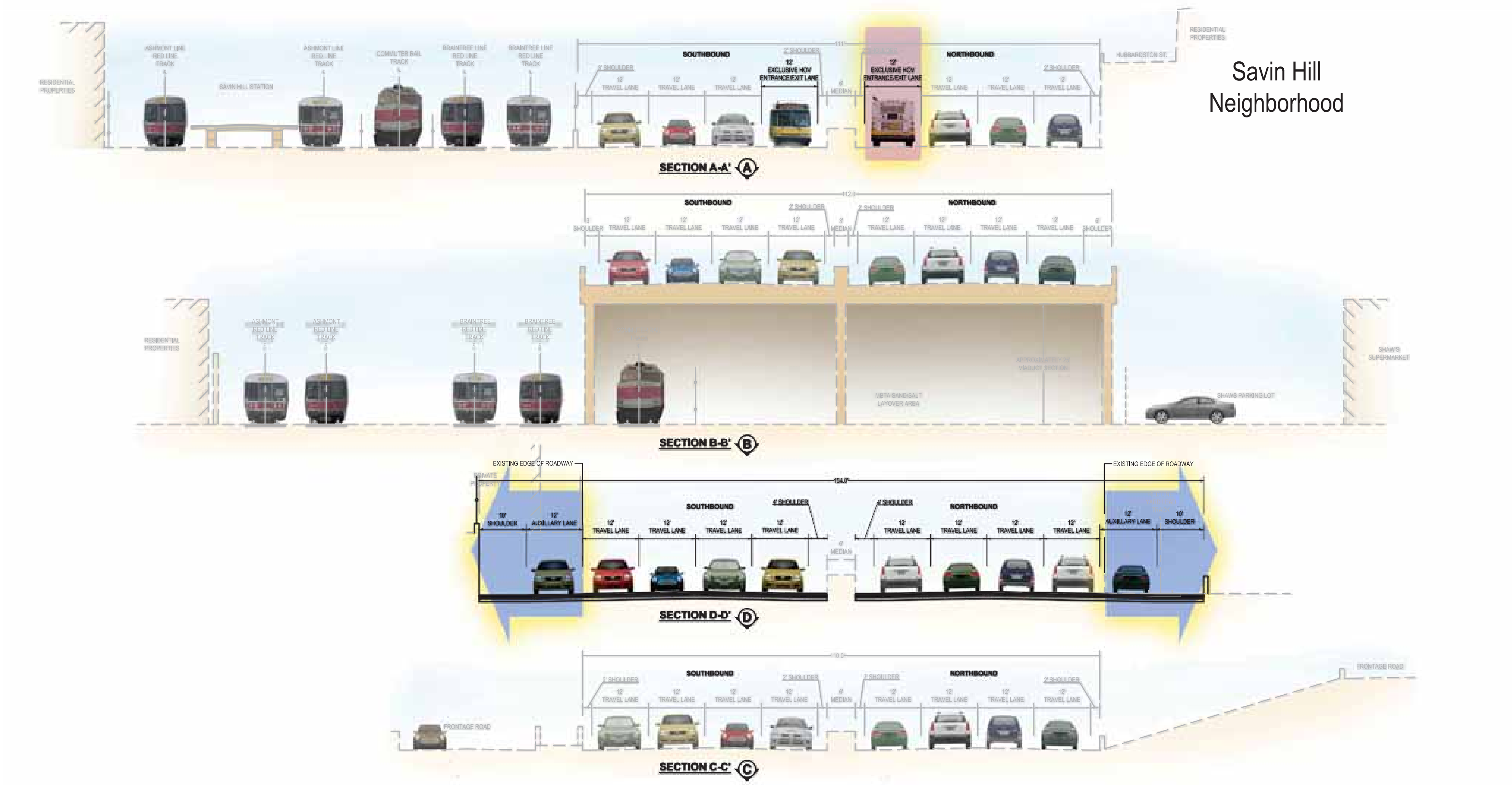
massDOT

SOUTH COAST RAIL

Figure 20
Alt. 3 - The "HOV Lanes in Both Directions" Alternative Zipper Lane Operations

MassGIS
Prepared by: VHB

\\MABOS\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\03_HOV Extension_Alt3.dwg Printing Date: 6/14/2012 9:19 AM



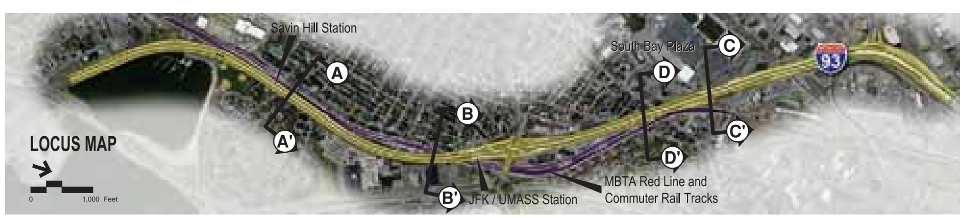


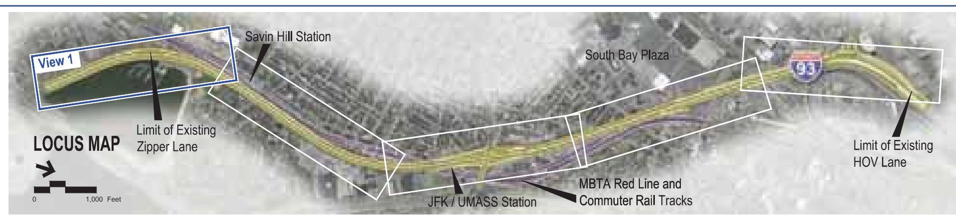
Figure 21
Southeast Expressway
Alternative 4 Sections
The "Minimalist" Alternative

MassGIS
Prepared by: VHB

View 1: AM Zipper Lane Configuration

View 1: PM Zipper Lane Configuration

0 100 200 Feet



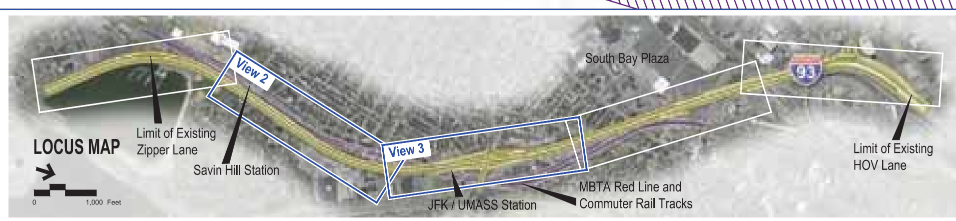
Moving Massachusetts Forward. massDOT

SOUTH COAST RAIL

Figure 22
Alternative 4
The "Minimalist" Alternative
Zipper Lane Operations

MassGIS
Prepared by: VHB

0 100 200 Feet



Moving Massachusetts Forward. massDOT

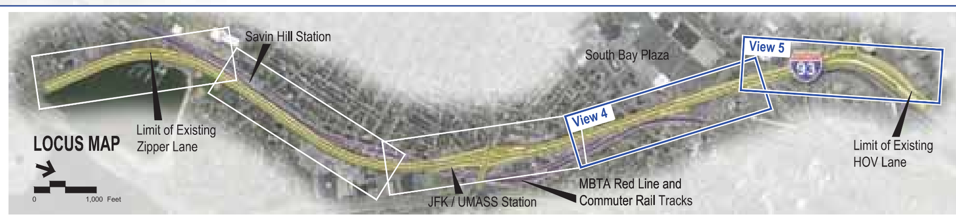
SOUTH COAST RAIL

Figure 23
Alternative 4
The "Minimalist" Alternative

MassGIS
Prepared by: VHB

\\MABOS\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\04_HOV Extension_Alt4.dwg Printing Date: 6/14/2012 9:32 AM

0 100 200 Feet



massDOT
SOUTH COAST RAIL

Figure 24
Alternative 4
The "Minimalist" Alternative

MassGIS
Prepared by: VHB

\\MABOS\projects\10111.00\tech\FINAL_EIS_EIR\HOV_Report\cad\Figures\04_HOV Extension_Alt4.dwg Printing Date: 6/14/2012 9:34 AM

Modified Rapid Bus Alternative
Technical Memorandum - DRAFT

Appendix E: Back Bay Connection Analysis

Prepared for massDOT

Massachusetts Department of Transportation
10 Park Plaza
Boston, Massachusetts 02116-3969

Prepared by Vanasse Hangen Brustlin, Inc.

99 High Street, 10th Floor
Boston, Massachusetts 02110-2354

SOUTH COAST RAIL

June, 2012

Table of Contents

List of Tables

List of Figures

1

Initial Station Evaluation

The Rapid Bus Alternative presented in the Draft EIS/EIR was envisioned to provide express service to South Station where a transfer to the Red Line, Silver Line, and local bus service would be available. A connection to the Orange Line was not included, which would have resulted in remote, indirect and ineffective Rapid Bus access to Back Bay. Based on comments received on the DEIS/DEIR, this memorandum presents and evaluates potential alternatives to providing this connection, the feasibility and opportunities of providing it, recommendation of the preferred connection among the considered routes, and the potential impacts.

1.1 Evaluation

The Rapid Bus Alternative is planned to serve the South Coast Rapid Bus stations proposed in Fall River, New Bedford, Taunton (Galleria), Downtown Taunton, West Bridgewater and Brockton Stations. So that the Rapid Bus Alternative is highly competitive with the studied rail alternatives and since high ridership is expected, two separate routes destined for either South Station or Back Bay/the Orange Line are planned. A single route serving both areas would increase travel times for passengers and decrease service efficiency and attractiveness of the Rapid Bus alternative.

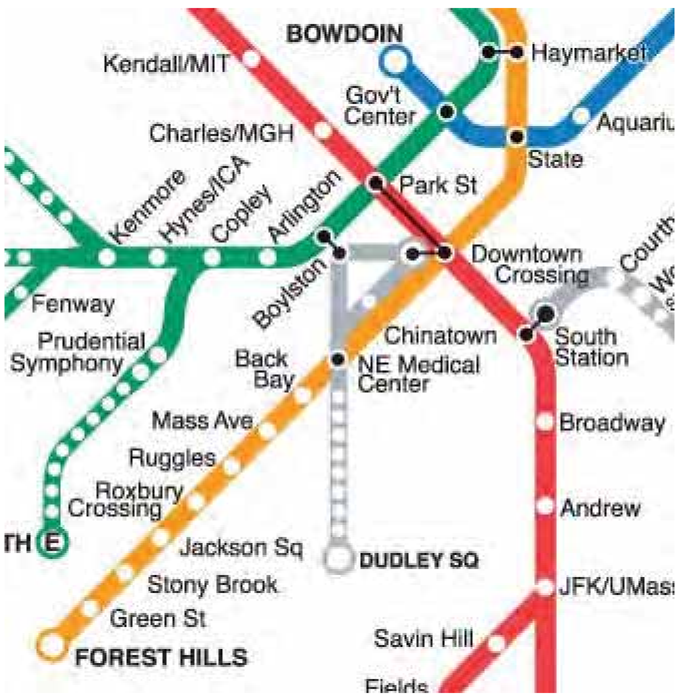
In order to provide the Rapid Bus connection to the Back Bay area, direct and indirect access was studied via transfers to Orange Line stations. Except for Back Bay Station, all connections would be indirect and would require a transfer to the Orange Line.

Eight stations were evaluated and screened, including:

- Ruggles
- Massachusetts Avenue
- Back Bay
- Tufts Medical Center
- Chinatown
- Downtown Crossing
- State Street
- Haymarket

These stations are illustrated in **Figure 1.**

Figure 1 Orange Line Stations



Factors considered in the screening included ease of access from Rapid Bus Alternative right-of-way (I-93), connectivity to additional transit services, availability and type of facility for bus staging, and station attractiveness (ridership ranking). A summary of the initial evaluation is provided in Table 1.

Table 1 Evaluated Orange Line Connections – Initial Assessment Summary

Station	Access	Existing Bus Staging Opportunities	Public Transportation Connections	Orange Line Station Entries* (Rank)	Evaluate further?
Haymarket	Located within 1 mile of I-93; access to the station uses congested urban streets	Off-Street Bus Turnaround	Green Line 16 Bus Routes	6,019 (10th)	N
State Street	Located within 1 mile of I-93; access to the station uses congested urban streets	On-Street	Blue Line 5 Bus Routes Local Private Shuttles	7,323 (9th)	N
Ruggles	Located within 2 miles of I-93; access to the station uses congested urban streets	Off-Street Bus Turnaround	3 Commuter Rail Lines 14 Bus Routes Local Private Shuttles	8,378 (6th)	Y
Massachusetts Avenue	Located within 2 miles of I-93; access to the station uses congested urban streets	On-Street	2 Bus Routes	5,248 (14th)	N
Back Bay	Located within 2 miles of I-93; access to the station uses congested urban streets	Off-Street Bus Turnaround	4 Commuter Rail Lines 3 Bus Routes 1 Amtrak Regional	16,769 (1st)	Y
Tufts Medical Center	Located within 1 mile of I-93; access to the station uses congested urban streets	On-Street	Silver Line 3 Bus Routes	5,684 (13th)	N
Chinatown	Located within 1 mile of I-93; access to the station uses congested urban streets	On-Street	Silver Line 1 Bus Route	5,822 (12th)	N
Downtown Crossing	Located within 2 miles of I-93; access to the station uses congested urban streets	On-Street	Red Line Silver Line 17 Bus Routes	11,563 (3rd)	Y

*MBTA Ridership and Service Statistics, Thirteenth Edition 2010

1.2 Station Locations Selected for Further Evaluation

Of the eight evaluated stations, three were considered for further evaluation based on initial review including Downtown Crossing, Back Bay, and Ruggles. It was determined that these stations would be most attractive based on proximately to Back Bay, existing transit connections and ridership.

1.2.1 Alternative 1 – Ruggles Station

Ruggles Station is located south of Downtown Boston, approximately 1.5 miles from I-93. This station provides connections to the Orange Line, Commuter Rail, 14 local bus routes, and private shuttles serving the Longwood Medical and Academic Area (LMA) and Northeastern University. It is ranked 6th in ridership and provides an off-street dedicated bus staging area via Ruggles Street.

1.2.2 Alternative 2 – Back Bay Station

Back Bay Station experiences the highest ridership of all Orange Line stations. It is located in the Back Bay business and retail district and is considered the most desirable location next to South Station for Rapid Bus riders. Although Rapid Bus customers would not have to transfer to the Orange Line if service terminated directly at the station, connections to the Commuter Rail, Amtrak Regional, and three local bus routes are available. There is a dedicated off-street bus staging area on Clarendon Street.

1.2.3 Alternative 3 – Downtown Crossing

Downtown Crossing is the closest to I-93 (within ½-mile) of all the stations considered. At Downtown Crossing connections can be made to the Red Line, Silver Line and 17 local bus routes. The Downtown Crossing Orange Line Station has the third highest ridership, indicating that it could be attractive to possible new ridership from the Rapid Bus Alternative. Multiple buses stage on-street in and around Downtown Crossing on Franklin, Washington, and Summer Streets.

2

Travel Routes

Travel routes between I-93 and the three station alternatives were chosen using the shortest path available for buses. As Rapid Buses would all travel the same path from the South Coast up to the northern end of the Zipper Lane, this assessment only includes the local travel time.

Travel routes are shown in the attached Figures 2 through 5. A summary of the proposed routing is provided below.

2.1 Downtown Crossing

Serving the Downtown Crossing Station would require Rapid Buses to travel the shortest distance on local streets. The buses would utilize the zipper lane to its fullest extent, the planned HOV extension on I-93 North between the end of the zipper lane and the existing I-93 HOV lane and exit to Lincoln Street. The bus would continue straight on to Lincoln Street, turn slightly-left onto Summer Street, and then right on Devonshire Street. At the end of Devonshire Street the bus would turn left onto Franklin Street and arrive at the Downtown Crossing on-street bus stop at the corner of Franklin Street and Washington Street. The inbound local travel distance would be approximately 1.5 miles on local streets.

The outbound route would continue on Franklin Street to Bromfield Street and then turn left onto Tremont Street. At Essex Street the bus would turn left and use the dedicated on-street bus lane for a segment of the road that allows the bus to advance ahead of queued traffic at the traffic signals (though a substantial travel time advantage is not provided). The bus would next turn right onto Surface Road and continue to just south of Kneeland Street where it would be able to access the southbound HOV lane.

The overall outbound route is approximately 1.5 miles on local streets. Rapid Bus passengers traveling to Back Bay would alight from the bus at the station, travel through the station to the fare array, pay an additional fare to access the Orange Line and travel one station south / west to Back Bay. This would take approximately 10 minutes from the point where the passengers exited the bus to the point when they arrived at Back Bay Station.

2.2 Back Bay

Two alternatives were analyzed for Rapid Bus access to Back Bay Station– one that uses the shortest distance (via Massachusetts Avenue) and one that uses the existing I-93 HOV lane (via Kneeland Street).

2.2.1 Option 1 (via Kneeland Street)

Option 1 would allow the Rapid Buses to utilize the zipper lane to its fullest extent, the planned HOV extension on I-93 North between the end of the zipper lane and the existing I-93 HOV lane, exiting to Kneeland Street. The route would then continue on Kneeland Street, right on Charles Street, through Park Plaza to St. James Avenue, arriving at the off-street Back Bay bus terminal on Clarendon Street. The inbound travel distance is approximately 2 miles on local city streets.

In the outbound direction this route would reverse but use streets parallel to the inbound routing due to a one-way street network in the area. The outbound travel distance is slightly shorter traveling approximately 1.5 miles on local streets to the I-93 HOV lane.

2.2.2 Option 2 (via Massachusetts Avenue)

Option 2 for Back Bay Station is more direct than Option 1, as the bus does not have to travel North to South Station, and then backtrack to get to Back Bay. This route would exit I-93 North earlier at Exit 18 (Mass Ave), before the entrance to the South Station HOV. The route would then continue on the Frontage Road to East Berkeley Street, St. James Avenue and then Clarendon Street. The inbound route travels approximately 2 miles on local streets.

The outbound route would differ due to a one-way street network in the Back Bay area. The buses would exit the terminal and turn left onto Columbus Avenue. The buses would then travel south on Arlington Street and continue onto Herald Street, where the bus would access I-93. The outbound route is shorter than the inbound route traveling approximately 1.2 miles on local streets.

No transfer to the Orange Line would be required since passengers would alight at Back Bay, the preferred destination.

2.3 Ruggles Station

Buses traveling to Ruggles Station would also exit I-93 North at Exit 18 (Mass Ave.), before the entrance to the South Station HOV. The buses would then follow the Frontage Road to the Mass Ave Connector before merging into Melnea Cass Boulevard. Continuing on Melnea Cass Blvd., buses would turn left onto Tremont Street and then immediately right onto Ruggles Street where the off-street Ruggles Station bus staging area is located. Exiting the station, the Rapid Buses would reverse this route to I-93 South. The overall distance for travel between I-93 and Ruggles Station is approximately 2 miles in each direction.

Upon alighting from the bus at Ruggles station, passengers would travel through the station to the fare array, pay an additional fare to access the Orange Line and travel one station north / east to Back Bay. This would take approximately nine minutes from the point where the passengers exited the bus to the point when they arrived at Back Bay Station.

2.4 Travel Times

The total travel time to Back Bay Station for each Orange Line alternative was estimated for the year 2030. The total travel time includes the following:

- Local travel times previously presented with an adjustment for increased congestion in the future.
- Any time needed for passengers to transfer between the bus stations and the Orange Line if applicable.
- Travel time between Orange Line Station and Back Bay Station if applicable.

2.4.1 Local Travel Times

Each of the alternative Orange Line stations are in the city of Boston and the street network around them experiences congestion during the peak hours.

Traffic congestion and signal delays result in longer travel times compared to calculating travel time using distance alone. For this reason, a travel time study was conducted to determine real-time travel between I-93 and the stations during the peak hours. The study focused on the following days and peak times:

- Tuesday, January 17, 2012: 7:00 – 9:00 AM and 4:00 – 6:00 PM
- Wednesday, January 18, 2012: 7:00 – 9:00 AM and 4:00 – 6:00 PM
- Thursday, January 19, 2012: 7:00 – 9:00 AM and 4:00 – 6:00 PM

Averaged results of the travel time study between I-93 and the alternative stations are shown in Table 2 for the peak direction (inbound in the AM and outbound in the PM).

Table 2 Existing Local Travel Time Summary (minutes)*

Station	AM Peak – Inbound	PM Peak - Outbound
Downtown Crossing	6:51	6:28
Back Bay – Option 1 (via South Station)	8:35	13:13
Back Bay – Option 2 (Exit 28)	10:28	8:36
Ruggles	11:19	16:14

*Includes averaged travel times between I-93 and station

The local travel time runs were then adjusted to account for increased congestion by the year 2030. This adjustment was made using data provided by CTPS. The data provided by CTPS suggests that travel times will increase by 9 -30 percent between 2012 and 2030. These increases vary by direction as shown in Table 3.

Table 3 Increased Travel Time (2012 to 2030)

Route	Travel Time Increases
Ruggles - Inbound	12 %
Ruggles - Outbound	14 %
Downtown Crossing – Inbound	20 %
Downtown Crossing - Outbound	30 %
Back Bay Option 1 - Inbound	11 %
Back Bay Option 1 - Outbound	9 %
Back Bay Option 2 - Inbound	14 %
Back Bay Option 2 - Outbound	20 %

Source: CTPS

2.4.2 Orange Line Travel Time/Transfer Penalty

Next, a transfer penalty was added to the Downtown Crossing and Ruggles Station routes to allow for passengers to transfer to the Orange Line and complete their trip to Back Bay Station. During peak periods, Orange Line trains are scheduled to arrive every five minutes. The penalty assumes an average wait time equal to half of the scheduled headway, or 2.5 minutes for each transfer plus an additional 2.5 minutes to account for the inconvenience of having to transfer.[1] No transfer penalty was added to the Option 1 or 2 Back Bay alternatives.

A summary of the projected 2030 travel times are provided in Tables 4 for the AM peak hour. Overall, the Rapid Bus alternative to Back Bay Station via South Station (Option 1) is the shortest travel route during both the morning and evening peak hours.

Station	Local Travel Time	Transfer Penalty[1]	Time to Back Bay Station	Total Time to Back Bay Station
Downtown Crossing	7	5	5	17
Back Bay – Option 1	9	0	0	9
Back Bay – Option 2	11	0	0	11
Ruggles	12	5	4	21

[1] Transfer Penalty provide by CTPS

2.5 Bus Stops/Staging

The characteristics of the three alternative stations vary greatly. This section describes station locations, amenities, accessibility, and current buses using the proposed bus staging areas.

Figure 6 Back Bay Station

As shown in Figure 6, Back Bay Station has a dedicated off-street bus staging area. This area, located off Clarendon Street, provides a direct connection into Back Bay Station. The Back Bay bus stop connection to the Orange Line platform is the most convenient of the three alternatives. Passengers would disembark the buses and enter Back Bay Station at the same level as the Orange Line Station and walk through the fare array. A centralized elevator is provided to access the shared Orange Line platform below.

Currently, there are two MBTA bus routes that use the Back Bay bus terminal staging area. Only one of these buses uses the drop-off during the peak hours:

- **Route 39** – provides services from Forest Hills Station to Back Bay Station via Huntington Avenue. This route uses articulated buses. Headways are approximately 5-10 minutes during the peak hours.
- **Route 170** – provides late evening services between Dudley Square and Central Square in Waltham. This bus does not make peak hour stops at the Back Bay bus terminal.

The Back Bay bus terminal also provides reserved employee parking spaces. Relocation of these spaces would afford additional bus staging area, and would probably be required.

Figure 7 Downtown Crossing

There are several bus stops that serve the Downtown Crossing Station. The existing stop at Franklin Street and Washington Street, shown in Figure 7, was chosen since it is the closest stop to both the inbound and outbound Orange Line platforms. Stairs are provided on the other side of Franklin Street to both the inbound and outbound platforms. Elevator service is provided to the outbound platform only at Franklin Street. Inbound elevator service requires passengers to travel down Washington Street to a second Orange Line entrance at the corner of Washington Street at Winter Street. Rapid bus services to this location may require street-level improvements to make the Franklin Street pedestrian crossings ADA accessible between the bus stops and station entrances.

The Downtown Crossing stop at Franklin Street and Washington Street provides a limited, on-street, bus staging area. This section of Devonshire Street is restricted to buses, taxis, and emergency vehicles only during the daytime. There is no formal bus shelter for passengers; however, shelter is available in the covered retail plazas adjacent to the bus stop. The following bus routes currently use this bus stop:

- **Route 92** – provides service between Assembly Square Mall and Downtown via Sullivan Square Station, Main St. and Haymarket Station. Headways during peak hours are approximately 15 minutes.
- **Route 93** – provides service between Sullivan Square Station and Downtown via Bunker Hill Street and Haymarket Station. Headways during peak hours are approximately 7-10 minutes.

Figure 8 Ruggles Station

Ruggles Station provides an off-street bus terminal on Ruggles Street, shown in Figure 8. This station provides passengers with covered sheltered from inclement weather. This station serves 13 MBTA buses including:

- **CT2** – this route provides services between Sullivan Station and Ruggles Station via Kendall / MIT. Headways during peak hours are approximately 23 minutes.
- **CT3** – provides services between Beth Israel Deaconess Medical Center and Andrews Station. Headways during peak hours are approximately 25 minutes.
- **Route 8** – provides services between Harbor Point / UMass Boston and Kenmore Station via Boston University Medical Center. Headways during peak hours are approximately 25 minutes.
- **Route 15** – serves Kane Square or Fields Corner Station and Ruggles Station via Uphams Corner. Headways during peak hours are approximately 9 minutes.
- **Route 19** – provides service between Fields Corner Station and Kenmore Square or Ruggles Station via Grove Hall. Headways during peak hours are approximately 25 minutes.
- **Route 22** – serves Ashmont Station and Ruggles Station via Talbot Avenue and Jackson Square. Headways during peak hours are approximately 8 minutes.

- **Route 28** – provides services between Mattapan Station and Ruggles Station via Dudley Station. Headways during peak hours are approximately 8 minutes.
- **Route 29** – provides off-peak evening service to Mattapan Station and Jackson Square via Seaver Street and Columbus Avenue. Headways during peak hours are approximately 15-20 minutes.
- **Route 42** – travels between Forest Hills Station and Dudley Station or Ruggles Station. Headways during peak hours are approximately 25 minutes.
- **Route 43** – serves Ruggles Station and Park Station via Tremont Street. Headways during peak hours are approximately 12 minutes.
- **Route 44** – travels between Jackson Square Station and Ruggles Station via Seaver Street and Humboldt Avenue. Headways during peak hours are approximately 12 minutes.
- **Route 45** – provides service between Franklin Park Zoo and Ruggles Station via Blue Hill Avenue. Headways during peak hours are approximately 12 minutes.
- **Route 47** – travels between Central Square in Cambridge and Broadway Station via Boston University Medical Center. Headways during peak hours are approximately 22 minutes.

Passenger connections from the bus stop to the Orange Line platform requires passengers to use either stairs or elevator services to reach the station's fare array. Passengers must then use another set of stairs or an elevator to descend to the shared Orange Line platform below.

2.6 Route Comparison

A detailed comparison of the four Orange Line alternatives is provided in Table 5.

Table 5 Orange Line Station Alternatives

Route	Travel Time Ranking	Available Alternative Local Route	Bus Staging Area	Public Transportation Connections	Orange Line Station Entries* (Rank)	Accessibility Between Bus Stop & Orange Line
Downtown Crossing	2nd – Inbound 2nd – Outbound	No – Inbound Yes – Outbound	Limited on-street. Indirect access to Orange Line.	Red Line Silver Line 17 Bus Routes	11,563 (3rd)	Fair - may require improvements
Back Bay – Option 1	1st – Inbound 1st – Outbound	Yes – Inbound Yes – Outbound	Off-street bus staging area. No pedestrian shelter. Ability to expand queuing area.	4 Commuter Rail Lines 3 Bus Routes 1 Amtrak Regional	16,769 (1st)	Good
Back Bay – Option 2	3rd – Inbound 4th – Outbound	Yes – Inbound Yes – Outbound	Off-street bus staging area. No pedestrian shelter. Ability to expand queuing area.	4 Commuter Rail Lines 3 Bus Routes 1 Amtrak Regional	16,769 (1st)	Good
Ruggles Station	4th – Inbound 3rd - Outbound	No – Inbound No – Outbound	Off-street bus staging area. Covered passenger waiting area.	3 Commuter Rail Lines 14 Bus Routes 1 LMA Shuttle	8,378 (6th)	Good

*MBTA Ridership and Service Statistics, Thirteenth Edition 2010

3

Conclusions

The conclusion of this analysis is that the Back Bay Option 1 connection is most attractive for the Rapid Bus. This alternative makes maximum use of the I-93 HOV infrastructure. While this station does not provide the greatest number of commuter connections, it does provide the most overall benefits.

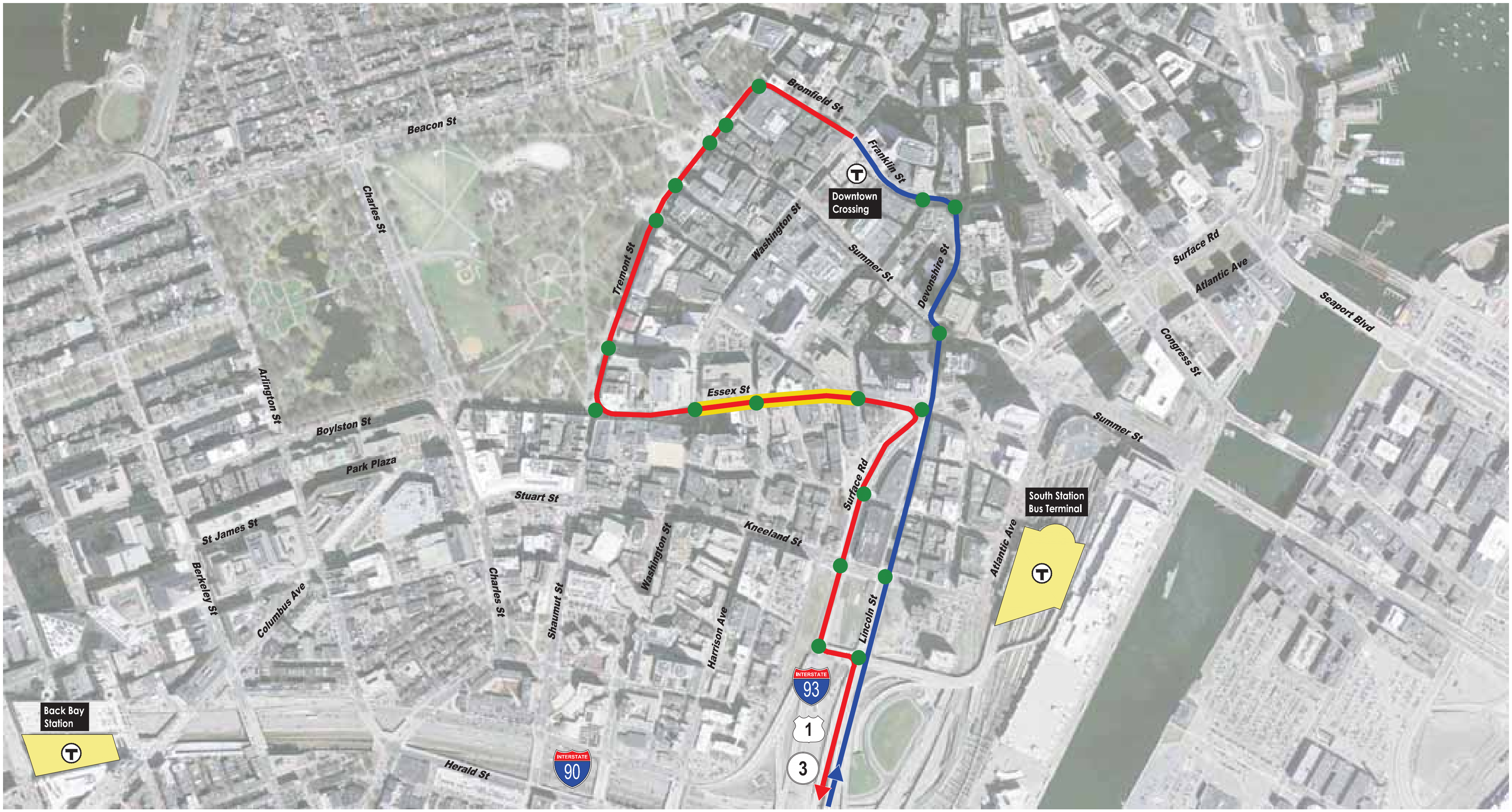
Key factors in this decision are:

- Back Bay Station Option 1 provides the shortest travel time for riders to the Back Bay in both the inbound and outbound direction;
- Back Bay Option 1 works better with the preferred alternatives for improving the connection between the existing I-93 Zipper Lane and South Station HOV Lane;
- There is a dedicated off-street bus terminal at Back Bay Station which services only one local bus route during the peak hours;
- No transfer to the Orange Line would be necessary to access the Back Bay area;
- There is the ability to expand the bus queuing area at Back Bay Station if needed by relocating employee parking; and
- Back Bay Station has the highest station entries, and is therefore the most desirable, Orange Line Station.

This Page Intentionally Left Blank

Figures

This page intentionally left blank



massDOT Moving Massachusetts Forward

SOUTH COAST RAIL

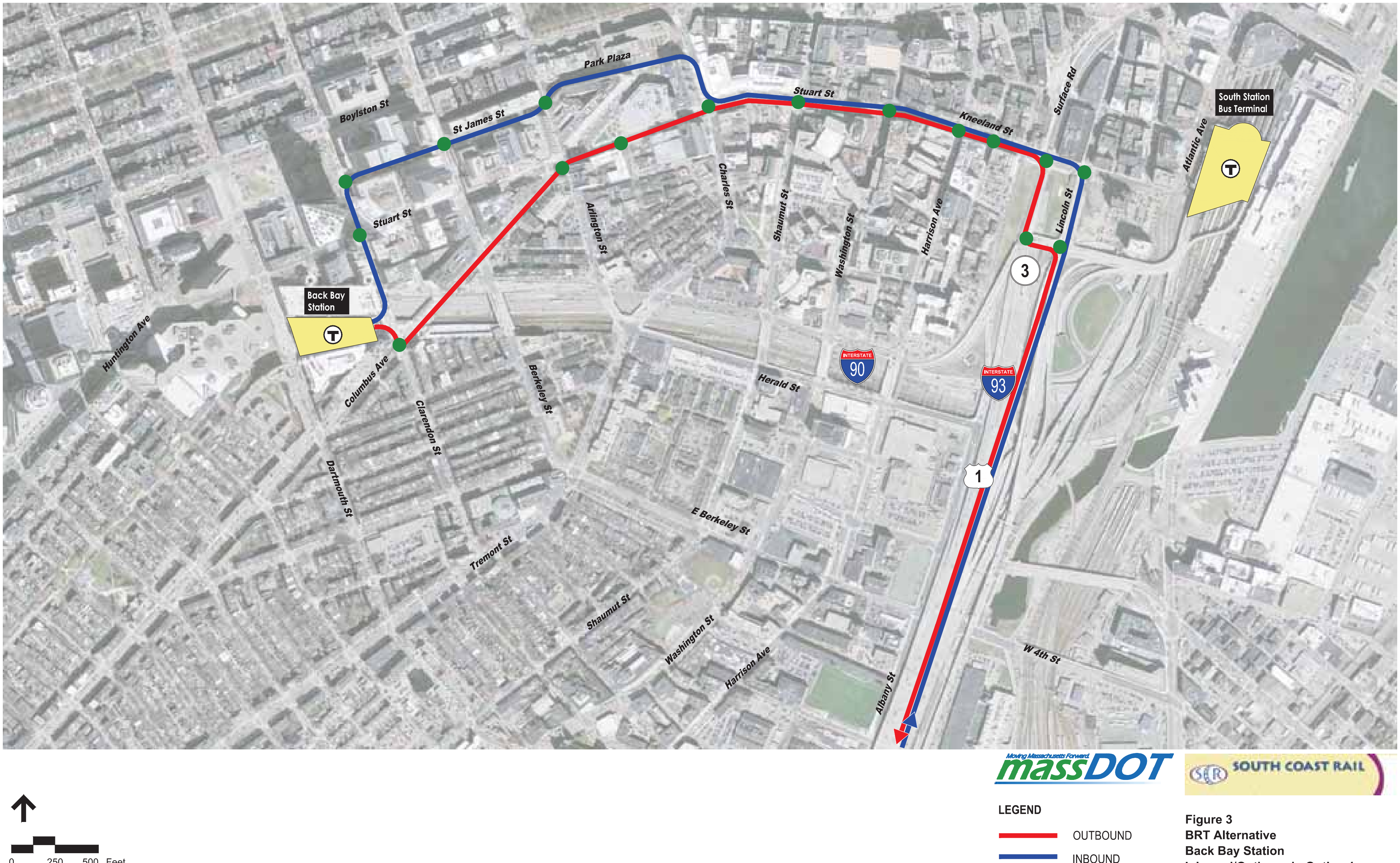
LEGEND

- OUTBOUND
- INBOUND
- TRAFFIC SIGNAL
- DEDICATED BUS LANE

Figure 2
BRT Alternative
Downtown Crossing
Inbound/Outbound

Prepared by: VHB

\\vhb\proj\Boston\10111.00\tech\FINAL_EIS_EIR\HOV_Report\Orange Line Connection AA\Figures\10111_DowntownCrossing.dwg Printing Date: 4/11/2012 1:35 PM



Moving Massachusetts Forward massDOT

SOUTH COAST RAIL

LEGEND

OUTBOUND

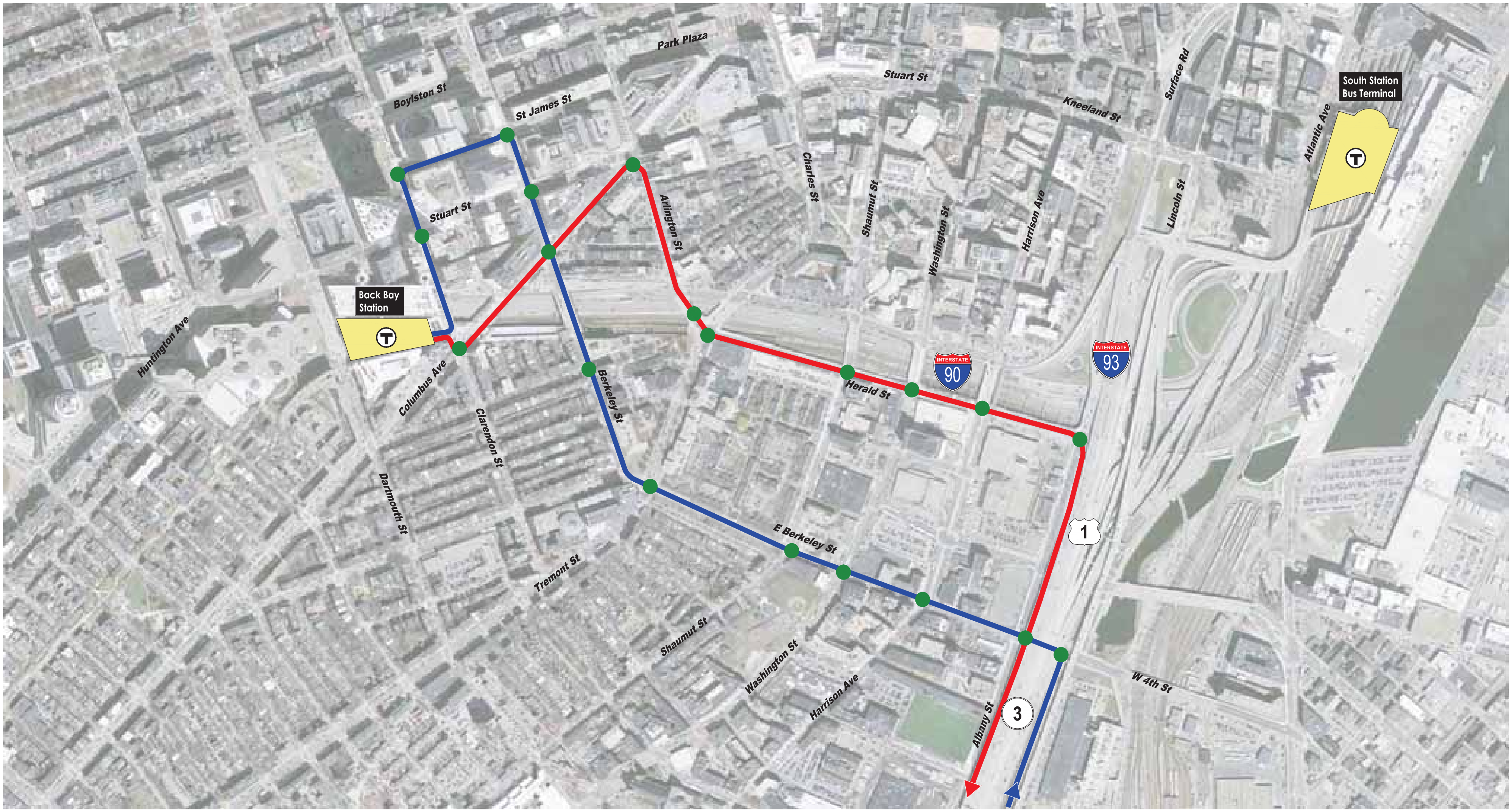
INBOUND

TRAFFIC SIGNAL

Figure 3
BRT Alternative
Back Bay Station
Inbound/Outbound - Option 1

Prepared by: VHB

\\vhb\proj\Boston\10111.00\tech\FINAL_EIS_EIR\HOV_Report\Orange Line Connection AA\Figures\10111_BackBay.dwg Printing Date: 4/11/2012 1:41 PM



massDOT Moving Massachusetts Forward

SOUTH COAST RAIL

LEGEND

OUTBOUND

INBOUND

TRAFFIC SIGNAL

Figure 4
BRT Alternative
Back Bay Station
Inbound/Outbound - Option 2

Prepared by: VHB

\\vhb\proj\Boston\10111.00\tech\FINAL_EIS_EIR\HOV_Report\Orange Line Connection AA\Figures\10111_BackBay.dwg Printing Date: 4/11/2012 1:41 PM

massDOT Moving Massachusetts Forward

SOUTH COAST RAIL

LEGEND

OUTBOUND

INBOUND

TRAFFIC SIGNAL

Figure 5
BRT Alternative
Ruggles Station
Inbound/Outbound

Prepared by: VHB

\\vhb\proj\Boston\10111.00\tech\FINAL_EIS_EIR\HOV_Report\Orange Line Connection AA\Figures\10111_Ruggles.dwg Printing Date: 4/11/2012 1:43 PM

Modified Rapid Bus Alternative
Technical Memorandum - DRAFT

Appendix F: Environmental Analysis

Prepared for

massDOT

Massachusetts Department of Transportation
10 Park Plaza
Boston, Massachusetts 02116

Prepared by

VHB Vanasse Hangen Brustlin, Inc.

99 High Street, 10th Floor
Boston, Massachusetts 02110

SCR South Coast Rail

June 2012

Table of Contents

List of Tables

1

Environmental Impacts

This section provides an evaluation of the environmental impacts of the Modified Rapid Bus Alternative, and compares the modified alternatives' environmental impacts to the DEIS/DEIR Rapid Bus Alternative.

As described in the main report, "Modified Rapid Bus Alternative" the DEIS/DEIR was modified to improve its overall performance. This included modifications to the infrastructure along Route 24, and additional stations along Route 24. As described in Appendix D "I-93 'Missing Link' Design Alternatives," no modifications were made to the segment of I-93 between Route 24 and South Station. The six bus stations identified in the DEIS/DEIR will be retained (Downtown Taunton, Fall River Depot, Freetown, Galleria, Kings Highway, Whale's Tooth) and two new "in-line" stations would be added within the Route 24 median at West Bridgewater (Exit 16) and Brockton (Exit 18). With the optimization of the Rapid Bus Alternative, a new bus maintenance and layover facility and expansion of the Logan Express lot would be required. The location for this new bus maintenance and layover facility has not yet been identified and the environmental impacts of this facility would need to be analyzed in further work.

1.1 Land Use and Zoning

This section discusses the impacts of the Modified Rapid Bus Alternatives on land use and zoning, with a focus on the parcels that would have to be acquired to construct this alternative. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to Route 24.

1.1.1 Highway Elements

Land uses and public or private ownership of the parcels that would be acquired along the highway alignments for the Rapid Bus Alternative are listed in Table 1.

The Route 24 improvements would require the use of two undeveloped public parcels (4.52 acres) and four undeveloped private parcels (0.42 acres).

Table 1 Rapid Bus: Route 24 Highway Alignment Acquisition Parcel Land Uses (DEIS/DEIR)

City/Town	Public Ownership		Private Ownership					
	Number of Parcels	Area (acres)	Number of Parcels	Land Use Area (acres)				
				Residential	Commercial	Industrial	Undeveloped	Subtotal
Highway Alignments								
Bridgewater	1	0.19						
Raynham	1	4.33	4				0.42	0.42
TOTAL	2	4.52	4				0.42	0.42

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).

1.1.2 Stations

The land use impacts of the Rapid Bus Alternative to construct stations would not differ from those in the DEIS/DEIR, except for the two new in-line stations which would require property acquisition for the parking lots and access roads.

Fall River Depot

The Fall River Depot Station site is a previously developed parcel surrounded by commercial and industrial development. Land uses and zoning designations of the parcels that would be acquired to construct the Fall River Depot Station are listed in Table 2.

Table 2 Fall River Depot Station: Acquisition Parcel Land Uses

Parcel	Ownership	Generalized	General	Area
O-15-1	Private	Industrial	Industrial	0.82
O-15-2	Private	Industrial	Industrial	0.32
O-15-8	Private	Industrial	Industrial	0.38
O-15-18	Private	Industrial	Industrial	1.52
O-15-20	Public	Industrial	Industrial	0.17
O-22-5	Private	Commercial	Commercial	0.12
O-22-6	Private	Residential	Residential	0.10
O-22-7	Private	Commercial	Commercial	0.06
O-22-11	Private	Industrial	Industrial	0.47
TOTAL				3.96

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).

Freetown

The Freetown Station site is a previously developed parcel surrounded by commercial and low density residential development and undeveloped land. The land use and zoning designation of the parcel that would be acquired to construct the Freetown Station are listed in Table 3.

Table 3 Freetown Station: Acquisition Parcel Land Uses

Parcel Number	Ownership	Generalized Zoning	General Land Use	Area (acres)
233-19	Private	Other	Forest	4.18

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).

Galleria

The Galleria Station is an existing bus station that would serve the Rapid Bus Alternative. It is located at the Silver City Galleria Mall, near the intersection of Routes 140 and 24 in Taunton. The Galleria Station would be restriped to improve traffic flow and parking for the Rapid Bus Alternative, but no land acquisition would be required. Accordingly, no changes to land use would result at this location.

King's Highway

The King's Highway Station site is a previously developed parcel surrounded by industrial development. The land use and zoning designation of the parcel that would be acquired to construct the King's Highway Station are listed in Table 4.

Table 4 King's Highway Station: Acquisition Parcel Land Uses

Parcel Number	**Ownership**	**Generalized Zoning**	**General Land Use**	**Area (acres)**
123-43	Private	Industrial	Commercial	3.89

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).

Brockton Station

The Brockton Station site is an undeveloped portion of a parcel with commercial development. The land use and zoning designation of the portion of the parcel that would be acquired to construct the Brockton Station are listed in Table 5.

Table 5 Brockton Station: Acquisition Parcel Land Uses

Parcel Number	Ownership	Generalized Zoning	General Land Use	Area (acres)
45-3	Private	Commercial	Undeveloped	2.35

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).

West Bridgewater Station

The West Bridgewater Station site is comprised of portions of four undeveloped parcels and is surrounded by undeveloped land. The land use and zoning designation of the parcels that would be acquired to construct the West Bridgewater Station are listed in Table 6.

Table 6 West Bridgewater Station: Acquisition Parcel Land Uses

Parcel Number	Ownership	Generalized Zoning	General Land Use	Area (acres)
29-005	Private	Industrial	Undeveloped	0.45
36-020	Private	Industrial	Undeveloped	0.16
36-021	Private	Industrial	Undeveloped	0.04
36-033	Private	Industrial	Undeveloped	4.84
TOTAL				5.49

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).

Whale's Tooth

The Whale's Tooth Station site is a previously developed parcel surrounded by industrial development. The City of New Bedford recently constructed a parking lot at this site in anticipation of the proposed South Coast Rail project. Land uses and zoning designations of the parcels that would be acquired to construct the Whale's Tooth Station are listed in Table 7.

Table 7 Whale's Tooth Station: Acquisition Parcel Land Uses

Parcel Number	Ownership	Generalized Zoning	General Land Use	Area (acres)
66-101	Public	Industrial	Transportation/	1.92
66-121	Public	Industrial	Industrial	0.38
66-133	Public	Industrial	Transportation/	3.38
66-133A	Private	Industrial	Transportation/	0.05
66-157	Public	Industrial	Transportation/	0.26
TOTAL				5.99

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).

1.1.3 Summary

The Rapid Bus Alternative would be comprised of the elements listed in Table 8 which also summarizes the acquisition requirements and affected land uses potentially resulting from implementing this alternative.

Based upon preliminary engineering plans and excluding a bus layover facility, part or all of eight publicly owned parcels comprising 16.95 acres of land, and part or all of 15 privately owned parcels comprising 12.50 acres of land would be acquired for the Rapid Bus Alternative. Affected private land uses would be principally industrial or undeveloped land, with little effect to residential or commercial land use. All of this land would be converted to transportation / utilities use and be publicly owned if this alternative is selected.

Table 8 Summary of Land Acquisition Requirements for the MODIFIED Rapid Bus Alternative

City/Town	Public Ownership		Private Ownership					
				Land Use Area (acres)				
	Number of Parcels	Area (acres)	Number of Parcels	Residential	Commercial	Industrial	Undeveloped	Subtotal
Highway Alignments								
Reversible Bus Lanes	2	4.52	4				0.42	0.42
Stations								
Taunton Depot	1	6.32						
Galleria								
Freetown			1				4.18	4.18
Fall River Depot	1	0.17	8	0.10	0.18	3.68		3.96
King's Highway			1			3.89		3.89
Whale's Tooth	4	5.94	1			0.05		0.05
Brockton			1		2.35			2.35
West Bridgewater			4				5.49	5.49
SUMMARY/TOTAL[1]	8	16.95	16	0.10	2.53	7.62	10.09	20.34
Maintenance Facility (site to be determined)								

1- Excludes maintenance facility because a site has not been selected. Does not include the HOV lane Alternatives.

1.2 Socioeconomics

This section discusses the impacts of the Modified Rapid Bus Alternatives on social and economic factors, with a focus on the parcels that would have to be acquired to construct this alternative. The analysis includes the information provided in the DEIS / DEIR with additional information based on modifications to the Route 24 section.

1.2.1 Highway Elements

The number, area, public or private ownership, and general land use of parcels that would be acquired along the highway alignments for the Rapid Bus Alternative are summarized in Table 1 and Table 2.

All of the affected private land along the Route 24 highway alignment rights-of-way would be undeveloped property, totaling 0.42 acres in Raynham. There would be no impacts to residential, commercial, or industrial land. Approximately 4.33 acres of public land would be acquired for the interchange reconfiguration in Raynham and a small area in Bridgewater. No residential, business, or community facility displacements would result from these acquisitions along the Rapid Bus Alternative alignments.

All of the land in Bridgewater and Raynham that would be acquired for the Rapid Bus right-of-way consists of partial takings of either publicly or privately owned parcels. Property tax revenue losses for small acquisitions cannot be calculated at this phase.

1.2.2 Stations

The land use impacts of the Rapid Bus Alternative to construct stations would not differ from those in the DEIS/DEIR. The two new in-line stations would require property acquisition for the parking lots and access roads.

Fall River Depot

The Fall River Depot Station site is a previously developed parcel including and surrounded by commercial and industrial development. Parcels that would be acquired and converted to transportation/utilities land use to construct the Fall River Depot Station are listed in Table 9.

Table 9 Fall River Depot Station: Land Acquisition

Parcel Number	Ownership	Generalized Zoning	General Land Use	Property Tax Revenue Loss	Job Loss	Area (acres)	Percent Acquisition
O-15-1	Private	Industrial	Industrial	$6,203.70	Yes	0.82	100.0
O-15-2	Private	Industrial	Industrial	$5,346.69	No	0.32	100.0
O-15-8	Private	Industrial	Industrial	$7,653.62	Yes	0.38	100.0
O-15-18	Private	Industrial	Industrial	$5,122.82	No	1.52	100.0
O-15-20	Public	Industrial	Industrial	-	No	0.17	100.0
O-22-5	Private	Commercial	Commercial	$3,725.37	Yes	0.12	100.0
O-22-6	Private	Residential	Commercial	$5,138.56	No	0.10	100.0
O-22-7	Private	Commercial	Commercial	$3,592.69	Yes	0.06	52.4
O-22-11	Private	Industrial	Industrial	$3,627.43	Yes	0.47	100.0
TOTAL				$40,410.88		3.96	

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).

The Fall River Depot Station would require 3.96 acres of land, comprised of 3.79 acres (eight parcels) of privately owned land and 0.17 acres (one parcel) of publicly owned land. Business displacements would result from these acquisitions. Commercial or industrial buildings on five of the parcels listed above would be acquired to construct this station. Businesses present include a flooring store, electrical company, tire service shop, and automobile detail service. Job losses from businesses occupying these buildings would be expected. No residential or community facility displacements would result from these acquisitions for the Fall River Depot Station.

Parcel number O-15-20 is owned by the City of Fall River; no property tax revenue loss would result from acquiring this parcel. All other parcels are privately owned and would be acquired in whole or in excess of 50 percent; property tax revenue losses for the City of Fall River are estimated at $40,410.88 per year, in 2009 dollars.

Freetown

The Freetown Station site is a previously developed parcel surrounded by low density residential development and undeveloped land. The parcel that would be acquired and converted to transportation / utilities land use to construct the Freetown Station is listed in Table 10.

Table 10 Freetown Station: Land Acquisition

Parcel Number	Ownership	Generalized Zoning	General Land Use	Property Tax Revenue Loss	Job Loss	Area (acres)	Percent Acquisition
233-19	Private	Undeveloped	Undeveloped	TBD	No	4.18	16.6

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).
TBD: To be determined.

The Freetown Station would require acquisition of 4.18 acres (one parcel) of privately owned land. No residential, business, or community facility displacements would result from this acquisition for the Freetown Station.

Less than 50 percent of parcel number 233-19 would be acquired for the Freetown Station and, accordingly, property tax revenue loss cannot be determined at this phase.

Galleria

The Galleria Station is an existing parking lot that would serve the Rapid Bus Alternative. It is located at the Silver City Galleria Mall, near the intersection of Routes 140 and 24 in Taunton. The Galleria Station would be expanded to meet the expected parking needs for the Rapid Bus Alternative, but no land acquisition would be required. There would be no direct effects to land uses or the social and economic environment at this location.

King's Highway

The King's Highway Station site is a previously developed parcel surrounded by industrial development. This station would share a parking lot with adjacent businesses; no land acquisition would be required. There would be no direct effects to land uses or the social and economic environment at this location.

Whale's Tooth

The Whale's Tooth Station site is a previously developed parcel surrounded by industrial development. The City of New Bedford recently constructed a parking lot at this site in anticipation of the proposed South Coast Rail project. Parcels that would be acquired and converted to transportation / utilities land use to construct the Whale's Tooth Station are listed in Table 11.

Table 11 Whale's Tooth Station: Land Acquisition

Parcel Number	Ownership	Generalized Zoning	General Land Use	Property Tax Revenue Loss	Job Loss	Area (acres)	Percent Acquisition
66-101	Public	Industrial	Industrial	-	No	1.92	100.0
66-121	Private	Industrial	Industrial	TBD	No	0.38	26.6
66-133	Public	Industrial	Industrial	-	No	3.38	100.0
66-133A	Private	Industrial	Industrial	$1,227.47	No	0.05	100.0
66-157	Public	Industrial	Industrial	-	No	0.26	100.0
TOTAL				$1,227.47[1]		5.99	

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).

TBD: To be determined.

1: Additional property tax revenue losses may result from small and/or partial acquisitions that cannot be determined at this phase.

The Whale's Tooth Station would require 5.99 acres of land, comprised of 0.43 acres (two parcels) of privately owned land and 5.56 acres (three parcels) of publicly owned land. No residential, business, or community facility displacements would result from these acquisitions for the Whale's Tooth Station.

Parcel numbers 66-101, 66-133, and 66-157are owned by the City of New Bedford; no property tax revenue loss would result from acquiring these parcels. EOT may lease, rather than acquire, these parcels from the City of New Bedford. Less than 50 percent of parcel number 66-121 would be acquired and, accordingly, property tax revenue loss cannot be determined at this phase. Over 50 percent of parcel number 66-133A would be acquired; property tax revenue losses for the City of New Bedford are estimated at $1,227.47 per year, in 2009 dollars. Additional property tax revenue losses could result from the partial acquisition.

Brockton Station

The Brockton Station site is an undeveloped portion of a parcel otherwise developed for commercial use surrounded by other commercial and residential development. The portion of the parcel that would be acquired and converted to transportation / utilities land use to construct the Brockton Station is listed in Table 12.

Table 12 Brockton Station: Land Acquisition

Parcel Number	Ownership	Generalized Zoning	General Land Use	Property Tax Revenue Loss	Job Loss	Area (acres)	Percent Acquisition
45-3	Private	Commercial	Undeveloped	TBD	No	2.35	15.8

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).
TBD: To be determined.

The Brockton Station would require acquisition of 2.35 acres (15.8 percent of one parcel) of privately owned land. No residential, business, or community facility displacements would result from this acquisition for the Brockton Station.

Less than 50 percent of parcel number 014-001 would be acquired for the Brockton Station and, accordingly, property tax revenue loss cannot be determined at this phase.

West Bridgewater Station

The West Bridgewater Station site is comprised of portions of four undeveloped parcels and is surrounded by other undeveloped land. The portions of the parcels that would be acquired and converted to transportation / utilities land use to construct the West Bridgewater Station are listed in Table 13.

Table 13 West Bridgewater Station: Land Acquisition

Parcel Number	Ownership	Generalized Zoning	General Land Use	Property Tax Revenue Loss	Job Loss	Area (acres)	Percent Acquisition
29-005	Private	Industrial	Undeveloped	TBD	No	0.45	9.47
36-020	Private	Industrial	Undeveloped	TBD	No	0.16	4.30
36-021	Private	Industrial	Undeveloped	TBD	No	0.04	2.65
36-033	Private	Industrial	Undeveloped	TBD	No	4.84	3.28
TOTAL						5.49	

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).
TBD: To be determined.

The West Bridgewater Station would require acquisition of 4.79 acres (portions of four parcels) of privately owned land. No residential, business, or community facility displacements would result from these acquisitions for the West Bridgewater Station.

Less than 50 percent of the parcels that would be acquired for the West Bridgewater Station and, accordingly, property tax revenue loss cannot be determined at this phase.

1.2.3 Summary

The Rapid Bus Alternative would require land acquisition with direct effects to land uses and the social and economic environment, respectively, potentially resulting from implementing this alternative.

Based upon preliminary engineering plans (but excluding layover facilities until site selection and parcels of which less than 50 percent would be acquired), privately owned land that would be acquired for the Rapid Bus Alternative would result in property tax revenue losses in Taunton, West Bridgewater, Freetown, Fall River and New Bedford. Additional property tax revenue losses may result from small and/or partial acquisitions that cannot be determined at this phase. Job losses would be expected in Fall River.

1.3 Environmental Justice

This section discusses the impacts of the Rapid Bus Alternative on environmental justice communities. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to the Route 24 section.

1.3.1 Highway Elements

The Rapid Bus Alternative alignment from Braintree to Taunton passes through environmental justice neighborhoods in Randolph, Stoughton, and Brockton. Randolph and Brockton are outside of the South Coast Rail environmental justice study area and are not further considered here. The direct acquisition, neighborhood fragmentation, noise level, and air quality impacts to the environmental justice populations in Stoughton potentially resulting from upgrading and using the highway alignments through Stoughton are described below. South of the I-93 Southeast Expressway HOV Section

The Rapid Bus Alternative would use existing highway rights-of-way for new construction between Braintree and Taunton. Interchange ramp improvements at some locations would require work outside of the existing right-of-way, acquiring adjoining parcels. No environmental justice neighborhood land would be acquired for upgrading the current or reconstructing the existing highway alignments or interchanges. No jobs or residences would be lost for these alternatives.

Because the Rapid Bus Alternatives would use existing, active highway alignments, fragmentation of environmental justice neighborhoods, or any other neighborhoods, would not result from adding Rapid Bus service to these alignments.

The Rapid Bus Alternatives would use existing highway alignments, modified for dedicated bus use. The existing sound environment consists of heavy traffic on an active major highway system. The noise level study concluded that adding Rapid Bus service to the existing highways would not appreciably change the sound environment. There would be no impacts to environmental justice populations from the Rapid Bus Alternatives.

Changes in other resources that would result from using the existing highway alignments for the Rapid Bus Alternative may affect environmental justice populations:

- No vibration impacts are expected from the rubber-tired buses operating on public roads.i There would be no adverse vibration impacts to environmental justice populations along the Rapid Bus Alternative alignments.
- The Rapid Bus Alternative's impact to air quality would be very small (less than a 1.5 percent increase in pollutant levels) and would not result in air pollutant concentrations in excess of the NAAQS.ii There would be no air quality impacts to environmental justice populations along the Rapid Bus Alternative alignments.
- Protected open space would be acquired in West Bridgewater, Bridgewater, and Raynham along the Rapid Bus Alternative alignment.iii However, none of these acquisitions would be within environmental justice neighborhoods. No publicly owned parcels in ACECs would be acquired for the Rapid Bus Alternative.
- No cultural resource sites in environmental justice neighborhoods along the Rapid Bus Alternative alignments would be adversely impacted.iv Use of the existing highway alignments is not anticipated to result in the loss of any historic property, known archaeological resource, or known / documented traditional cultural resource.
- The Corps is undertaking NHPA Section 106 consultation with the Native American tribes to determine if the South Coast Rail alternatives would have an adverse effect on any undocumented traditional cultural resources of significance to the tribes. If such adverse effects were found to occur, there could be a disproportionate adverse impact to an environmental justice community.

1.3.2 Stations

The environmental justice impacts of the Rapid Bus Alternatives to construct stations would not differ from those in the DEIS / DEIR. The two new in-line stations would be within developed industrial areas and would have no environmental justice impacts.

Fall River Depot

The Fall River Depot Station site is partially within and would therefore serve an environmental justice neighborhood in Fall River, and would also serve environmental justice populations in nearby Swansea. The adjacent neighborhood meets environmental justice minority and low income criteria. The following subsections describe the direct and indirect impacts to environmental justice populations in Fall River and Swansea potentially resulting from constructing and using the Fall River Station along the Fall River Secondary.

Direct

Portions of four parcels within an environmental justice neighborhood would be acquired for the Fall River Depot Station, as listed in Table 14.

Table 14 Fall River Depot Station: Environmental Justice Land Acquisition

Municipality	Parcel Number	Ownership	Generalized Zoning	General Land Use	Environmental Justice Categories	Area (acres)
Fall River	O-22-5	Private	Industrial	Commercial	Income, Minority	0.12
Fall River	O-22-6	Private	Industrial	Commercial	Income, Minority	0.10
Fall River	O-22-7	Private	Industrial	Commercial	Income, Minority	0.06
Fall River	O-22-11	Private	Industrial	Industrial	Income, Minority	0.47
Total						0.75

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).

Five other parcels outside of the environmental justice neighborhood boundary would also be acquired. The nine parcels that would be acquired for the Fall River Depot Station are privately owned and used for commercial or industrial purposes. Acquiring these nine parcels would result in a property tax revenue loss of $40,411 for the City of Fall River, directly affecting the financial resources available for the surrounding environmental justice neighborhood.

Commercial or industrial buildings on some of the parcels listed above would be acquired to construct this station. The businesses present include a flooring store (Jay Vee's Discount Flooring), electrical companies (GEMCO electrical contractors and Cotter Electrical, tire service shop (Jimmy's Used Tires), and automobile detail service (Auto Accent). No readily available information suggests that these businesses are owned by environmental justice populations. Employees may be residents of the surrounding environmental justice neighborhoods. Job losses from these businesses would be expected and would adversely impact the surrounding environmental justice neighborhood. It is not known if these businesses are likely to relocate nearby.

Indirect

The Fall River Depot Station site would not require redevelopment of an undeveloped area and has adequate infrastructure to serve the station and support nearby redevelopment. It is located 1 mile north of downtown Fall River, close to a dense residential neighborhood and aging shopping plaza, and across from a redeveloping waterfront along Route 79. This site is close to employment opportunities and environmental justice neighborhoods. The station could also catalyze redevelopment in that it offers a classic TOD opportunity that fits with the City's plans for redeveloping the waterfront. This redevelopment opportunity could spur growth in the proximate environmental justice neighborhoods.

Property values in environmental justice neighborhoods surrounding the Fall River Depot Station site may increase due to a perceived market value of residences or businesses close to a transit center. Additionally, TOD in the vicinity of the site could further enhance property values.

Statistical information suggests that the Fall River environmental justice populations may benefit from access to transit services at the Fall River Depot Station. As noted above, 57.3 percent of the Fall River population is defined as living in environmental justice neighborhoods. The site is close to (within 0.5 mile of) neighborhoods meeting environmental justice income and / or minority criteria. Approximately 50.2 percent of the population (4,652 persons) within 0.5 mile of the Fall River Station site resides in a designated environmental justice neighborhood. Neighborhoods meeting a full range of environmental justice criteria are near the Fall River Station site.

Approximately 20.7 percent of the households in Fall River had no registered motor vehicles in 2000, compared to a statewide average of 12.7 percent. Based on these data, this portion of the environmental justice population in Fall River in particular is likely to realize an improvement in local employment and access to transit services for employment and / or educational opportunities both inside and outside the community.

The Fall River Depot Station site is also approximately 4 miles from downtown Swansea, where 5.7 percent of the population is defined as living in environmental justice neighborhoods. The environmental justice neighborhoods in Swansea meet income criteria. Approximately 4.5 percent of the households in Swansea had no registered motor vehicles in 2000, compared to a statewide average of 12.7 percent. Based on these data, the majority of the environmental justice population in Swansea is likely to possess the means to commute via automobile to the Fall River Depot Station but is not within walking distance. If any of the rail alternatives or the Rapid Bus Alternative are selected, the Swansea environmental justice population would likely realize an improvement in access to transit services for employment and / or educational opportunities outside the community.

Freetown

The Freetown Station site is not within or near any environmental justice neighborhoods. An analysis of direct or indirect impacts to environmental justice populations from constructing and using the Freetown Station was not performed.

Galleria

The Galleria Station site is not within or near any environmental justice neighborhoods, but the station could serve environmental justice populations in nearby Taunton. The nearby neighborhoods meet environmental justice low income and/or minority criteria. The following subsections describe the direct and indirect impacts to the environmental justice populations in Taunton potentially resulting from using the Galleria Station for the Rapid Bus Alternative.

Direct

There are no environmental justice neighborhoods close to the Galleria Station and, therefore, there would be no land acquisition impacts to environmental justice populations.

Indirect

The Galleria Station site would not require redevelopment of an undeveloped area and has adequate infrastructure to serve the station and support nearby redevelopment. It is close to employment opportunities, but not environmental justice neighborhoods. The station could catalyze further transit-oriented development of the adjacent Silver City Galleria Mall, and the site has potential for future mixed-use development. However, the distance of this site from environmental justice neighborhoods limits the potential growth-inducing effects that this station may have on those neighborhoods.

As noted above, no environmental justice neighborhoods are present within 0.5 mile of the Galleria Station. However, statistical information suggests that the Taunton environmental justice populations may benefit from the Galleria Station. The station is approximately 2.5 miles from downtown Taunton, where 12.7 percent of the population is defined as living in environmental justice neighborhoods. These neighborhoods are identified as meeting minority and/or low income environmental justice criteria.

Only 9.3 percent of the households in Taunton had no registered motor vehicles in 2000, compared to a statewide average of 12.7 percent. Based on these data, the this portion of the environmental justice populations in Taunton in particular would likely realize an improvement in local employment and incremental improvement to access to transit services for employment and/or educational opportunities both inside and outside the community as bus service is expanded south to Fall River and New Bedford, and north into Boston.

King’s Highway

The King’s Highway Station site is not within but is near to environmental justice neighborhoods in New Bedford. This station would also serve environmental justice populations in nearby Fairhaven. The following subsections describe the direct and indirect impacts to environmental justice populations in New Bedford and Fairhaven potentially resulting from constructing and using the King's Highway Station along the New Bedford Main Line.

Direct

There are no environmental justice neighborhoods close to the King's Highway Station and, therefore, there would be no land acquisition impacts to environmental justice populations.

Indirect

The King's Highway Station site would not require development of an undeveloped area and has adequate infrastructure to serve the station and support nearby redevelopment. The site is near employment opportunities and environmental justice neighborhoods. The station could also catalyze redevelopment in that it offers an opportunity to revitalize an aging shopping plaza by redeveloping it into a mixed-use neighborhood or lifestyle center. The site also presents an opportunity for joint development. This redevelopment opportunity could spur growth in the nearby environmental justice neighborhoods.

Property values in environmental justice neighborhoods surrounding the King's Highway Station site may increase due to a perceived market value of residences or businesses close to a transit center. Additionally, TOD in the vicinity of the site could further enhance property values.

In New Bedford, 68.2 percent of the population is defined as living in environmental justice neighborhoods. The site is near (within 0.5 mile of) one neighborhood meeting environmental justice income criteria. Approximately 20.9 percent of the population (1,213 persons) within 0.5 mile of the King's Highway Station site resides in a designated environmental justice neighborhood. Neighborhoods meeting a full range of environmental justice criteria are outside of the 0.5-mile radius around the King's Highway Station site.

Approximately 21.7 percent of the households in New Bedford had no registered motor vehicles in 2000, compared to a statewide average of 12.7 percent. Based on these data, this portion of the New Bedford environmental justice populations in particular is likely to realize an improvement in local employment or access to transit services for employment and / or educational opportunities inside or outside the community.

The King's Highway Station site is approximately 6.75 miles from downtown Fairhaven, where 9.7 percent of the population is defined as living in an environmental justice neighborhood. The environmental justice population in Fairhaven meets income criteria.

Approximately 7.0 percent of the households in Fairhaven had no registered motor vehicles in 2000, compared to a statewide average of 12.7 percent. Based on these data, this portion of the environmental justice population in Fairhaven in particular is likely to realize an improvement in access to transit services for employment and / or educational opportunities outside the community.

Whale’s Tooth Station

The Whale’s Tooth Station site is located within and near environmental justice neighborhoods in New Bedford. This station may also serve environmental justice populations in nearby Fairhaven and Dartmouth. The following subsections describe the direct and indirect impacts to environmental justice populations in New Bedford, Fairhaven, and Dartmouth potentially resulting from constructing and using the Whale’s Tooth Station for the New Bedford Main Line or Rapid Bus Alternative of the South Coast Rail Project.

Direct

Portions of four or five parcels (depending upon the alternative chosen) within an environmental justice neighborhood would be acquired for the Whale’s Tooth Station, as listed in Table 15.

Table 15 Whale's Tooth Station: Environmental Justice Land Acquisition

Municipality	Parcel Number	Ownership	Generalized Zoning	General Land Use	Environmental Justice Categories	Area (acres)
New Bedford	66-101	Public	Industrial	Industrial	Income, Minority	1.92
New Bedford	66-1211	Public	Industrial	Industrial	Income, Minority	0.38
New Bedford	66-133	Public	Industrial	Industrial	Income, Minority	3.38
New Bedford	66-133A	Private	Industrial	Industrial	Income, Minority	0.05
New Bedford	66-157	Public	Industrial	Industrial	Income, Minority	0.26
Total						5.99

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).

1 This parcel would be acquired for the train station (all rail alternatives) but not the bus station (Rapid Bus Alternative). The bus station would require acquisition of 5.61 acres of environmental justice neighborhood land.

Four of the parcels that would be acquired for the Whale's Tooth Station are publicly owned and one is privately owned. All are zoned for industrial purposes and the general land use is industrial; they are all used for transportation / utilities. None are used for residential purposes. One of the publicly owned parcels, number 66-121, would only be acquired for the train station and would not be acquired for the bus station. The total area that would be acquired for the bus station would therefore be 5.61 acres. EOT may lease, rather than acquire, the publicly owned parcels from the City of New Bedford. All of the land would be used a parking lot for the station. There would be no impacts to environmental justice populations because no residences or jobs would be lost.

Indirect

The Whale's Tooth Station site would not require development in an undeveloped area and has adequate infrastructure to serve the station and support nearby redevelopment. The site is close to the New Bedford waterfront, downtown New Bedford, and the Hicks Logan redevelopment area. The station would be in near employment opportunities and environmental justice populations. Immediately adjacent to the state site are old mill buildings in the process of being converted to homes. The station could also catalyze TOD. The Hicks Logan area presents an opportunity to develop a mixed-use waterfront neighborhood that would be served by rail. This redevelopment opportunity could spur growth in the nearby environmental justice neighborhoods.

Property values in environmental justice neighborhoods surrounding the Whale's Tooth Station site may increase due to a perceived market value of residences or businesses close to a transit center. Additionally, TOD in the vicinity of the site could further enhance property values.

Statistical information suggests that environmental justice populations may benefit from the Whale's Tooth Station. In New Bedford, 68.2 percent of the population is defined as living in environmental justice neighborhoods. The site is within a neighborhood meeting environmental justice income and minority criteria, and is close to (within 0.5 mile of) other neighborhoods meeting foreign-born, minority, and / or income criteria. Approximately 85.6 percent of the population (8,937 persons) within 0.5 mile of the Whale's Tooth Station site resides in a designated environmental justice neighborhood.

Approximately 21.7 percent of the households in New Bedford had no registered motor vehicles in 2000, compared to a statewide average of 12.7 percent. Based on these data, this portion of the environmental justice population in New Bedford in particular is likely to realize an improvement in local employment and access to transit services for employment and / or educational opportunities both inside and outside the community.

The Whale's Tooth Station site is also approximately 2 miles from downtown Fairhaven, where 9.7 percent of the population is defined as living in environmental justice neighborhoods. The environmental justice populations in Fairhaven meet income criteria. Approximately 7.0 percent of the households in Fairhaven had no registered motor vehicles in 2000, compared to a statewide average of 12.7 percent. Based on these data, this portion of the environmental justice population in Fairhaven in particular is likely to realize an improvement in access to transit services for employment and / or educational opportunities outside the community.

The Whale's Tooth Station site is approximately 4 miles from downtown Dartmouth, where 11.8 percent of the population is defined as living in environmental justice neighborhoods. The environmental justice populations in Dartmouth meet foreign born and / or income criteria. Approximately 6.4 percent of the households in Dartmouth had no registered motor vehicles in 2000, compared to a statewide average of 12.7 percent. Based on these data, this portion of the environmental justice population in Dartmouth in particular is likely to realize an improvement in access to transit services for employment and / or educational opportunities outside the community.

1.3.3 Summary

As described above, the majority of the land acquisitions for the Rapid Bus Alternative would not impact environmental justice populations. Property acquisition at one location, the Fall River Depot Station site, in an environmental justice neighborhood would result in job losses, as described above. No other private property acquisitions within environmental justice neighborhoods would result in residence or job losses.

The Rapid Bus Alternative's Route 24 highway segment would not require any environmental justice neighborhood land that would result in job loss or neighborhood fragmentation, and air quality would not be impacted. Noise levels along each segment would not increase appreciably.

The private property acquisitions required for the Fall River Depot Station described above for the Attleboro Electric Alternative are the same for the Rapid Bus Alternative. No other station sites within environmental justice neighborhoods would result in residence or job losses.

The indirect effects to environmental justice populations near the stations that would be serviced by the Rapid Bus Alternative would be primarily realized at new stations within or near environmental justice neighborhoods. These stations would be Downtown Taunton, Fall River Depot, King's Highway, and Whale's Tooth. The environmental justice populations would be expected to see benefits from TOD, increased property values, and improvements in access to transit.

Overall indirect effects to environmental justice populations in terms of improvements in transit access to jobs, colleges, and hospitals, and travel times to Boston for environmental justice populations in Taunton, Fall River, and New Bedford are provided in the CTPS report (Appendix). For the Rapid Bus Alternative, average improvements in each of these metrics would be realized for environmental justice populations at higher percentages than for non-environmental justice populations.

1.4 Visual Resources

This section discusses the visual impacts of the Rapid Bus Alternative. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to the Route 24 section.

1.4.1 Highway Elements

The visual impacts of the Rapid Bus Alternative would be unchanged from those identified in the DEIS/DEIR.

Land uses where the highway enters Quincy, transitions from developed land to the open space of the Blue Hills Reservation. The broad median here is forest or grass. The visual environment in this brief segment is of forested or landscaped areas. The highway alignment passes through the Route 28 interchange and then diverges from I-93 to Route 24 entering Randolph. Adjacent property in this short segment includes the Blue Hills Reservation and the Fowl Meadow and Ponkapoag Bog ACEC with a forested median, but views of these adjacent open spaces from the highway are compromised by the extensive existing transportation corridor. The highway alignment then narrows, with a narrow un-vegetated median, and passes by residential, commercial, and undeveloped land in Randolph, Canton, Stoughton, Avon, and Brockton; some adjacent forested land is visible from the highway. Visible open space predominates along the east side of the highway alignment in West

Bridgewater, including the West Bridgewater State Forest. Land use to the west is a mixture of visible commercial, agricultural, and industrial properties.

Approaching the Route 106 interchange, the alignment enters the Hockomock Swamp ACEC and Wildlife Management Area, and visible surrounding land use is undeveloped, agricultural, residential, and industrial land in West Bridgewater and Bridgewater. Forested views predominate outside of the transportation corridor. The median in this segment continues as a narrow, un-vegetated strip.

The highway alignment passes into Raynham at the I-495 interchange. The broad median through the interchange is forested. South of the interchange in this segment, the narrow un-vegetated median returns but forested adjacent open spaces with adjoining residential development are visible. This general visual character continues into Taunton, concluding at the Route 24 / Route 140 interchange.

Components of the highway alignment construction for the Rapid Bus Alternative that would potentially change the visual and aesthetic environment are:

- Dedicated bus lane construction;
- Mixed-use traffic lane construction; and
- Interchange reconstruction

Constructing the bus and mixed-use traffic lanes within the existing highway alignment would affect the visual environment along this previously disturbed corridor. As described above, much of the highway alignment consists of a multi-lane roadway with a narrow un-vegetated median. The dedicated bus lanes would be constructed within the median. The mixed-use traffic lanes would be constructed on the outer side of the existing lanes. All work along the roadway itself would be conducted within the existing right-of-way. The right-of-way is generally 300 feet wide through most of the highway alignment, and the existing roadway occupies only a portion of the right-of-way. Roadway widening would typically range between 20 and 50 feet on either side of the current constructed roadway. Vegetation would likely be removed in some segments of the alignment to accommodate the greater road width. If reversible lanes are used, the movable barriers and moving equipment would be introduced into the visual environment.

The overall visual effect to motorists is expected to be minimal. Impacts to the visual environment would be an incremental addition to the existing disturbed environment rather than a substantive change in the visual character along the highway. The actual impacts will be determined during final design if this alternative is selected. Any changes would be visible to bus passengers as well as motorists, but would likely be minimally visible to occupants of nearby properties.

Interchange improvements would include modifying ramp geometry to accommodate the widening along Route 24, removal of the inner loop off ramps to eliminate weaving along the main line, intersection improvements along the local roads to accommodate the removal of the inner loop ramps, and bridge replacements where the proposed Route 24 roadway cannot be accommodated. At most locations, these improvements can be accomplished within the existing right-of-way, with little impact to the existing visual environment. At selected locations, ramp improvements would extend outside the existing right-of-way, requiring acquisition of some adjacent parcels. These improvements, too, would have little impact on the existing visual environment. Any vegetation present would be removed to accommodate the highway infrastructure. The visual environment at the interchanges would be altered from its current condition, but the new construction would be an incremental addition to the current visual environment rather than a change in visual character. These changes would be visible to bus passengers as well as automobile drivers and passengers, and occupants of nearby properties.

1.4.2 Stations

The visual impacts of the Rapid Bus Alternative to construct stations would not differ from those in the DEIS/DEIR. The two new in-line stations would be within developed industrial areas or undeveloped land and would have no visual impacts.

Downtown Taunton

The Downtown Taunton Station site is a previously developed, currently vacant parcel surrounded by commercial development. The site is adjoined by facilities for the Greater Attleboro Taunton Regional Transit Authority (GATRA) and the Bloom Bus, as well as associated parking. These structures are in fair visual condition. The site is visible from nearby streets and adjoining properties, but the view is somewhat obstructed by vegetation.

The Downtown Taunton Station would be affected by replacing the existing vacant lot with a new parking lot, with a new canopy and platform constructed adjacent to the existing GATRA facilities. The station would be visible to users, occupants of nearby properties, and passers-by. Its appearance would be in keeping with the existing developed visual environment. Impacts to the visual environment in the vicinity of the Downtown Taunton Station would be minimal.

Fall River Depot

The Fall River Depot Station site is a previously developed site surrounded by commercial and industrial development. Numerous commercial/industrial buildings in poor to fair visual condition are present on-site. The existing parking lots are also in poor condition. This site is visible from adjacent roads and nearby properties.

The Fall River Depot Station would favorably affect the visual environment by replacing the existing vacant commercial buildings and parking lot with a new canopy, platform, and parking deck. The station would be visible to users, passers-by, and occupants of nearby buildings. Its appearance would be an improvement compared to the existing vacant buildings and parking lots. Impacts to the visual environment in the vicinity of the Fall River Depot Station would be moderately beneficial.

Freetown

The Freetown Station site is behind a self-storage facility with associated parking; immediately adjacent properties are open land and forest. A cellular phone tower site is also adjacent. Low-density residential development is nearby. The self-storage facility contains four buildings in fair visual condition, and can be viewed from adjacent roads and residences. The self-storage facility and cell tower would remain at the site.

The Freetown Station would affect the visual environment by adding a new access road, canopy, platform, and parking lot north and east of the existing self-storage facility. A bus drop-off loop would be included at this location. The station would be partially visible to users, passers-by, and occupants of nearby buildings, although off-site views would be obstructed by the existing buildings and surrounding vegetation. Impacts to the visual environment in the vicinity of the Freetown Station would be minimal.

Galleria

The Galleria Station is an existing parking lot that would serve the Rapid Bus Alternative. It is located at the Silver City Galleria Mall, near the intersection of Routes 140 and 24 in Taunton. The Galleria Station improvements would include re-surfacing and re-striping existing pavement to improve traffic flow and meet the expected parking needs for the Rapid Bus Alternative. No impacts to the visual environment would result from using the Galleria Station for the Rapid Bus Alternative.

King’s Highway

The King’s Highway Station site is along the railroad right-of-way behind the King’s Highway Plaza, a traditional strip mall (commercial development). The site is visible from adjacent roads and some of the commercial buildings. The existing retail establishments are in a variety of sizes and visual conditions.

The King’s Highway Station would affect the visual environment by adding a new canopy and platform. Parking would be shared with the existing, surrounding commercial businesses. The station would be partially visible to users, passers-by, and occupants of adjacent buildings. Its appearance would be in keeping with the nearby developed visual environment. Impacts to the visual environment in the vicinity of the King's Highway Station would be minimal.

Whale's Tooth

The Whale's Tooth Station site is at an existing parking lot surrounded by industrial development. The site is visible from adjacent roads and properties, as well as nearby residences at higher elevations.

The Whale's Tooth Station would minimally affect the visual environment with a new canopy and platform constructed at the existing parking lot. The station would be visible to users, occupants of nearby properties, and passers-by. Its appearance would be in keeping with the surrounding developed visual environment. Impacts to the visual environment in the vicinity of the Whale's Tooth Station would be minimal.

Brockton Station

The Brockton Station would be along Oak Street, in front of an existing parking lot and industrial building. The new parking lot would be visible from Oak Street and from a residential apartment/condominium complex but would be consistent with the visual character of Oak Street.

West Bridgewater Station

The West Bridgewater Station would be in an undeveloped area approximately 1,500 feet north of West Street. The parking lot would not be visible from any residential or developed area, and would not be visible from West Street.

1.4.3 Summary

The Rapid Bus Alternative would be comprised of the elements listed in Table 16, which also summarizes the direct effects to visual and aesthetic resources potentially resulting from implementing this alternative.

In general, the Rapid Bus Alternative presents minimal impacts to the visual environment. The visual impacts would vary locally and by individual component, and this alternative would utilize existing infrastructure (with new construction in the existing right-of-way). Vegetation removal in narrow strips along the right-of-way to accommodate highway widening would minimally change the visual character for occupants and users of adjoining properties, and these changes would be highly visible. Most impacts to the visual environment would be incremental additions to an existing, disturbed landscape with active highway (including bus) use.

Table 16 Summary of Potential Direct Effects to Visual and Aesthetic Resources from the Rapid Bus Alternative

Element/Component	Change in Visual Environment	Visual Impact
Highway Alignments		
Dedicated Bus Lanes and Mixed-Use Traffic Lanes	New lane construction in existing median and widened automobile lanes within right-of-way in developed transportation corridor	Minimal
Interchanges	New traffic ramp construction within right-of-way in developed transportation corridor	Minimal
Stations		
Downtown Taunton	New station construction in developed area	Minimal
Galleria	None	None
Freetown	New station construction in partially developed/ undeveloped area	Minimal
Fall River Depot	New station construction in developed area	Moderate (beneficial)
King's Highway	New station construction in developed area	Minimal
Whale's Tooth	New station construction in developed area	Minimal
West Bridgewater	New station in median	Minimal
Brockton	New station in medial	Minimal
Layover Facility		
Logan Express	None	None

1.5 Noise

This section discusses the noise impacts of the Rapid Bus Alternative. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to the Route 24 section.

1.5.1 Highway Elements

New highway construction is not expect to result in noise impacts because there are few receptor locations adjacent to the major roadways, they are located substantial distances away from the roadways, and most of Route 24 is boarded by ledge, hills, and thick wooded areas that reduce highway noise, and the relatively small increase in sound levels that will be generated by the increased bus traffic on the major roadways.

The increase of bus traffic on the local roadways near bus station locations will range from 8 to 4 buses over the peak hour. The volume of buses will be reduced during off-peak time periods. The change in peak hour sound levels at the nearest residential locations to the bus stations will be less than 1 dBA. A change of 1 dBA will not be noticed by the receptor locations because it takes an increase of 3 dBA or greater to be perceived by the human ear.

1.6 Vibration

This section discusses the impacts of the Rapid Bus Alternative on environmental justice communities. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to Route 24.

The Rapid Bus Alternative would provide commuter bus service to South Station via Route 140, Route 24, and I-93. South of the I-495 interchange in Raynham, buses would travel in the general purpose lanes with mixed traffic. North of I-495, buses would use a combination of new zipper bus lanes, new reversible bus lanes, existing zipper HOV lanes, and existing HOV lanes, along with a short section in mixed traffic. Using the FTA vibration curve (adjusted for speed) for rubber tired vehicles (buses), the vibration assessment indicated that for buses traveling at a speed of 60 mph, the impact distance for a vibration level of 80 VdB is 15 feet. Using the FTA vibration impact criterion of 72 VdB for frequent events (greater than 70 events per day), the impact distance is 40 feet. Since there are no receptors located within these distances of the highway, no vibration impacts are expected to occur from the Rapid Bus Alternative.

1.7 Cultural Resources

This section discusses the impacts of the Rapid Bus Alternative on cultural resources. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to the Route 24 section.

1.7.1 Highway Elements

A cultural resources reconnaissance survey was partially completed for the Rapid Bus Alternative elements, and impacts to identified resources are presented below.

Historic Resources

The impacts to historic resources of the Rapid Bus Alternative may be permanent or temporary, direct or indirect. Two (n=2) historic districts are located within the Rapid Bus working Area of Potential Effect (APE). The working APE was defined as 50 feet from edge of road right-of-way, and is different from the Corps APE which was defined later.

Direct Impacts

Project work items for the Rapid Bus Alternative consist of roadway and interchange modifications primarily within or immediately adjacent to the existing right-of-way. No historic resources are present within the highway corridor rights-of-way where project improvements are planned. Therefore work within the rights-of-way will have no potential direct impacts to historic resources. Stations are discussed in Section 3.10 below.

Indirect Impacts

The majority of work for the Rapid Bus Alternative is proposed within or immediately adjacent to the existing rights-of-way. No visual and noise impacts are anticipated to occur to the two historic properties identified within the 50 foot APE. These two properties are:

- Blue Hills MRA (Map No. Ca.E, De.A, Qu.A, Br.A, Ra.A; Appendics B-9, B-23, B-24) in Quincy, Braintree, Milton, Randolph, Dedham, and Canton; and
- Daniel Waldo Field Park (Map No. Av.A, Appendix B-26) in Avon.

Potential project impacts to historic resources in the Rapid Bus APE may be reassessed at a future date as plans are developed.

Archaeological Resources

The Rapid Bus APE includes the existing highway corridor rights-of-way, interchange reconfigurations, bridge reconstructions, and any other work areas that would involve earthmoving outside of the existing highway rights-of-way.

There are no recorded archaeological sites or identified sensitive areas within the highway corridor rights-of-way where project improvements are planned. No direct impacts to archaeological resources in the previously disturbed highway rights-of-way are anticipated.

The archaeological survey has not yet been conducted for the interchange reconfigurations, bridge reconstructions, and other work areas that would involve earthmoving outside of the previously disturbed highway rights-of-way within the APE. These project elements are located in geographical areas that contain or are in proximity to recorded sites and have the potential to contain unrecorded sites in sensitive areas. Project impacts to archaeological resources in the Rapid Bus APE will be assessed at a future date.

1.7.2 Stations

The environmental justice impacts of the Rapid Bus Alternative to construct stations would not differ from those in the DEIS/DEIR. The two new in-line stations would be within the Route 24 ROW and would have no cultural resources impacts. The two new in-line stations would have no impact on historic structures, but have not been evaluated for potentially sensitive archaeological resources.

Downtown Taunton

Downtown Taunton Station in Taunton is proposed on Oak Street behind the existing GATRA bus station. There are no historic resources on the site; therefore, there will be no direct impacts to historic resources.

However, the Taunton Car Manufacturing Company Building (Map No. Ta.206) is located at 3 Myrtle Street within the station APE. The introduction of a new station could have indirect visual effects on this historic property through the introduction of modern station structures and parking that alter the historic setting. However, the effect will not be adverse because of the existing dense urban character of the surrounding area and the original transportation function of the historic building. Noise, vibration, traffic, atmospheric, and cumulative effects are anticipated to be minimal.

There are no recorded archaeological sites within the 11-acre project parcel, but it is assessed as having areas of moderate and high archaeological sensitivity for post-contact Euro-American industrial and railroad-related structures.

The current conceptual plan indicates that the proposed parking lot and subsurface stormwater management area will be constructed in the southern portion of the parcel assigned high archaeological sensitivity. An intensive (locational) archaeological survey is needed to identify any archaeological sites. Project impacts will be assessed once the intensive survey is completed.

Fall River Depot

There are no historic resources on the site of the proposed Fall River Depot Station on the Fall River Secondary. Therefore, there will be no direct impacts to historic resources.

The proposed Station is located across the rail right-of-way from the Pearce-Durfee Street Area (Map No. FR.L) and across Route 138 from the 800 Davol Street Inn (Map No. FR.073). Both of these historic properties are recommended eligible to the NRHP. The introduction of a new station will have indirect visual effects on these two historic properties through the introduction of modern station structures and parking that could alter the historic setting. However, the effect would not be adverse due to the industrial character of the adjacent part of the Pearce-Durfee Street Area and the presence of the highway. Noise, vibration, traffic, atmospheric, and cumulative effects are anticipated to be minimal.

There are no recorded archaeological sites or identified archaeologically sensitive areas within the 8-acre project parcel. No project impacts to archaeological resources are anticipated by the construction of this proposed station.

Freetown

The Freetown Station does not have any historic resources on the proposed site or within the APE. Therefore, there would be no impacts to historic resources.

The proposed Freetown Station lies within the Lower Taunton River Basin Archaeological District. The 18-acre project parcel contains areas of moderate and high archaeological sensitivity for pre-contact Native American habitation and resource procurement / processing sites.

The current conceptual plan indicates that the proposed parking lot and subsurface stormwater management area will be constructed in the southern portion of the parcel assigned high archaeological sensitivity. An intensive (locational) archaeological survey is needed to identify any archaeological sites. Project impacts will be assessed once the intensive survey is completed.

Galleria

The Galleria Station in Taunton is an additional station proposed at an existing park and ride. The Galleria Station does not have any historic resources on the proposed site or within the APE. There will be no impacts to historic resources.

No archaeological survey was conducted for the proposed improvements to the existing Galleria Station Park and Ride bus station because no ground surface impacts are planned. Assuming that no impacts are proposed, there would be no impacts to archaeological resources.

King's Highway

The King's Highway Station does not have any historic resources on the proposed site or within the APE. There will be no impacts to historic resources.

The 55-acre project parcel contains areas of moderate archaeological sensitivity for pre-contact Native American habitation and resource procurement / processing sites. In addition, buildings are documented as present between 1895 and 1911. Though these buildings have been razed, undocumented archaeological deposits related to this period of site use may be present in the north part of the parcel.

The current conceptual plan indicates that the proposed work will be contained within the existing paved shopping plaza in areas assigned low archaeological sensitivity. No project impacts to archaeological resources are anticipated in these previously disturbed areas.

Whale's Tooth

The parcel that will be used for the Whale's Tooth Station does not have any historic properties on it. There will be no direct impacts to historic resources.

The proposed Whale's Tooth Station on the New Bedford Main Line is across John F. Kennedy Highway from the New Bedford Textile School (Map No. NB.069). The introduction of a new station may have indirect visual effects on the New Bedford Textile School; however, due to the intervening highway, the effect will not be adverse. Noise, vibration, traffic, atmospheric, and cumulative effects are anticipated to be minimal.

The entire 8.7-acre project parcel lies within the Achusnet Avenue Waterfront Industrial historic area and because of location is assessed as having a high archaeological sensitivity for pre-contact Native American habitation and resource procurement/processing sites and documented nineteenth century industrial and commercial sites. The archaeologically sensitive strata, if present, would be located below the raised and capped paved parking lot and the capped superfund site soils.

The current conceptual plan indicates that the proposed work will be contained within the existing disturbed paved parking lot. No project impacts to archaeological resources are anticipated.

The Rapid Bus Alternative would be comprised of the elements listed in Table 23. As the table shows, this alternative would not result in adverse effects to any known historic or archaeological resource. Additional investigation of areas of potential archaeological sensitivity would be required at any interchange proposed to be reconfigured, and at two proposed station locations.

Brockton Station

This station would be located in a disturbed area between Oak Street and an industrial building and parking lot. There are no structures on or adjacent to the site, and development would have no effect on historic resources. Archaeological sensitivity has not been evaluated.

West Bridgewater Station

This station would be located in an undeveloped area east of Route 24, and north of West Street. There are no structures on or adjacent to the site, and development would have no effect on historic resources. Archaeological sensitivity has not been evaluated.

1.7.3 Summary

Impacts to cultural resources resulting from the Rapid Bus Alternative are incomplete at this time since both historic and archaeological reconnaissance survey of most project elements are outstanding. The summary of potential impacts that would result from the implementation of this alternative would be determined once the cultural resources reconnaissance surveys have been completed.

1.8 Air Quality

The Air Quality study included three elements. A mesoscale analysis was completed for the regional study area, as shown in Table 1.9-1. A microscale analysis was conducted based on the traffic study that identified the intersections in the vicinity of bus stations that would be affected by the Rapid Bus Alternative. The intersections were ranked based upon congestion following EPA's guidelines. The Build Alternative with the highest projected ridership at each station was used to evaluate the impacts in the areas around proposed station locations. Separate microscale analyses were not conducted for the Rapid Bus Alternative because the lower projected ridership for this alternative would result in equal or less impact than the analysis using the other alternatives with higher ridership. The microscale analysis evaluated for the other alternatives represent the highest concentrations for each intersections. All of the pollutant concentrations at the receptors for each of the study intersections are below the NAAQS standards for the other alternatives. Since the emissions at these intersections, which represent the worst-case scenario (i.e. highest volumes and delays), are well below the NAAQS standards, it is expected that the remainder of the study area will also fall below the NAAQS air quality standards.

The effects of alternative fuels were also reviewed, and are summarized below.

1.8.1 Mesoscale Analysis

The predominant sources of air pollution anticipated from the proposed South Coast Rail project include emissions of carbon monoxide (CO), nitrogen oxides (NOx), and volatile organic compounds (VOCs) from locomotive engines and from motor vehicles traveling to and from the train stations. A mesoscale analysis evaluated the regional air quality impacts (VOCs, NOx, CO, and PM emissions) from the proposed project by determining the change in total ozone precursor emissions (volatile organic compounds and nitrogen oxides) for the existing and future conditions within the study area; the microscale analysis calculated the CO and PM concentrations for the same conditions at congested intersections near the proposed stations.

Table 17 Air Quality Beneficial Effects Comparison

	DEIS/DEIR Stoughton Electric	DEIS/DEIR Rapid Bus	Modified Rapid Bus
NOX Reduction (kg/day)	(43.3)	0.0	(39.3)
$PM_{2.5}$ Reduction (kg/day)	(1.7)	0.0	(1.4)
PM_{10} Reduction (kg/day)	(6.1)	1.7	(5.3)
VOCs Reduction (kg/day)	(55.9)	(9.3)	(50.9)
CO_2 Reduction (tons/year)	(62,333.7)	(6,588.0)	(48,416.3)

As shown in Table 17, while improved from the DEIS/DEIR Rapid Bus Alternative, the Modified Rapid Bus Alternative would still have fewer Air Quality benefits than the DEIS/DEIR Stoughton Electric Alternative. The Modified Rapid Bus Alternative would also reduce the greenhouse gas CO2 by 48,416.3 tons/year compared the DEIS/DEIR Stoughton Electric Alternative, which would reduce CO2 by 62,333.7 ton/year.

1.8.2 Alternative Fuels

Alternative fuels were also evaluated for the Rapid Bus Alternative The following is a discussion of these emission impacts of these fuels.

- **Diesel** -The EPA has established regulations to reduce the amount of sulfur in diesel fuel. Heavy-duty trucks and buses are primary emitters of NOx and PM emissions from mobile sources. Over the past ten years, these regulations have reduced NOx and PM emissions from heavy duty engines by 90 percent. EPA expects to continue the program to regulate fuels and vehicle technologies into the future. The impact of this program will be to reduce annual emissions of NOx, VOCs, and PM by a projected 2.6 million, 115,000 and 109,000 tons, respectively in 2030.
- **Biodiesel** -EPA evaluated biodiesel fuels in 2002 and compiled data set on biodiesel tailpipe emissions from heavy-duty engines. This study concluded that biodiesel decreases emissions of PM, CO, and hydrocarbons (HC) commensurately with its blend level. Later studies have shown that biodiesel PM emissions are not only reduced but are less toxic. These studies are analyzed the impact of biodiesel fuels on air quality and human health, which concluded that the PM from B100 (100 percent biodiesel) and B20 (20 percent biodiesel, 80 percent diesel) is 20 percent and 5 percent, respectively, less toxic than PM from diesel. A lifecycle analysis completed by the National Renewable Energy

Laboratory found that carbon dioxide emissions for B100 were 78.5 percent less than those from petroleum diesel.

- **Natural Gas** -Natural gas is stored on vehicles in two forms: compressed and liquefied. Tailpipe emissions are the same for either form of natural gas in light-duty vehicles (LDVs), and evaporative emissions are negligible for both forms since the fuel systems in natural gas vehicles were built to accommodate their extremely low evaporation temperature and pressure. While the use of natural gas would substantially reduce particulate matter, it would significantly increase the emission of methane. Natural gas is largely comprised of methane, which is 23 times more potent as a GHG than CO2. Table 18 presents the changes in emissions of CNG as compared to gasoline in light duty vehicles (LDV).

Table 18 Changes in CNG as Compared to Gasoline in LDVs

Pollutant	Percent Change
Volatile Organic Compounds (VOC)	10%
Carbon Monoxide (CO)	20% to 40%
Oxides of Nitrogen (NOx)	0%
Particulate Matter (PM)	80%
Methane	+ 400%

This analysis assumes that the Rapid Bus Alternative would use diesel fuel. EPA has and continues to achieve substantial reductions in VOC, NO_X, CO, CO_2, $PM_{2.5}$, and PM_{10} emissions from diesel fuel. The existing buses currently run on diesel and have the infrastructure in place to serve additional buses. If the Rapid Bus Alternative is selected as the Preferred Alternative, EOT would evaluate the use of alternative technologies (hybrid) or fuels.

1.9 Open Space

This section discusses the impacts of the Rapid Bus Alternative on protected public open space. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to the Route 24 section.

1.9.1 Highway Elements

Two ACECs are present along this corridor, the Fowl Meadow and Ponkapoag Bog ACEC and the Hockomock Swamp ACEC. The Rapid Bus highway alignment passes through the Fowl Meadow and Ponkapoag Bog ACEC for a short segment at the I-93/Route 24 interchange, and through the Hockomock Swamp ACEC from near the Route 24/Route 106 interchange to the Route 24/I-495 interchange.

The Rapid Bus alignment also passes through or is adjacent to several protected open spaces, but avoids incursions into the Blue Hills Reservation. No publicly owned parcels in ACECs would be acquired for constructing the Rapid Bus Alternative. The estimated area of protected open space acquisition required for constructing the Rapid Bus Alternative is listed in Table 19. This area would be used for the widened right-of-way necessary for the interchange ramp improvements.

Table 19 Rapid Bus Alternative Protected Open Space Acquisition

City/Town	Name	Ownership	Use	Acquisition Area (acres)
West Bridgewater, Bridgewater	Hockomock Swamp WMA	Public	Conservation	0.19
Raynham	Woodland Conservation Area	Public	Conservation	4.31
Total				4.50

Sources: MassGIS 2002, 2005; municipal data 2009, aerial mapping, and online research (various).

These parcels are owned by the Commonwealth of Massachusetts and the Town of Raynham for conservation purposes, and would therefore be considered Article 97 land subject to the provisions of the EEA's Article 97 Land Disposition Policy.

Traffic delays on highways through and near the protected open spaces and ACECs may occur when constructing the bus or traffic lanes, or constructing new ramps at the interchanges, but the construction activities are not expected to impact streets directly accessing these sites. Access to protected open spaces and ACECs are not anticipated to be substantively impacted by implementing the Rapid Bus Alternative.

1.9.2 Stations

The environmental justice impacts of the Rapid Bus Alternative to construct stations would not differ from those in the DEIS/DEIR. The two new in-line stations would be within the Route 24 ROW and would have no impacts on public open space.

Downtown Taunton

The Downtown Taunton Station site is a previously developed parcel that is near the Mill River Park protected open space in Taunton, but is neither within or near any ACECs. No protected open space land would be acquired for constructing the Downtown Taunton Station.

Local traffic may use Oak Street to access Mill River Park, passing the Downtown Taunton Station site. Temporary traffic congestion on Oak Street during peak usage periods may result from commuters accessing the Downtown Taunton Station, minimally changing traffic patterns on local streets and / or delaying access to Mill River Park. The level of service at the intersection of Washington Street and Court Street, near Mill River Park, would degrade one level at both the morning and evening weekday peak hours. However, the level of service on other nearby streets would not change and peak traffic usage (morning and evening commute times) would not coincide with likely park recreational use (mid-day).

Fall River Depot

The Fall River Depot Station site is a previously developed parcel that is near five protected open spaces. This site is not within or proximate to any ACECs. No protected open space land would be acquired for constructing the Fall River Depot Station.

Local traffic is unlikely to use the surface streets in the immediate vicinity of the Fall River Depot Station site to access the nearby protected open spaces, all of which are separated from the site by major highways (Routes 138 and 79) or the existing Fall River Secondary, and have better access from other streets. No changes in access to the protected open spaces are expected.

Freetown

The Freetown Station site is a previously developed parcel that is near the Freetown-Fall River State Forest protected open space. It is not proximate to or within any ACECs. No protected open space land would be acquired for constructing the Freetown Station.

The portion of the Freetown-Fall River State Forest proximate to the Freetown Station site is an isolated parcel, separated from the main body of the state forest by Route 24 and the existing Fall River Secondary. The isolated parcel is also separated from the Freetown Station site by the Fall River Secondary. Access to this isolated parcel is unlikely to be affected by constructing or using the Freetown Station.

Galleria

The Galleria Station site is developed as an existing transit facility that is not within or near any protected open spaces or ACECs. No direct or indirect effects to protected open spaces or ACECs would result from using the Galleria Station for the Rapid Bus Alternative.

King's Highway

The King's Highway Station site is a previously developed parcel that is near two protected open spaces: the Charles S. Ashley School and Brooklawn Park. This location is not within or near any ACEC. No protected open space land would be acquired for constructing the King's Highway Station.

The nearby protected open spaces are a school and a neighborhood park, both with several surface street access options. Commuter automobile traffic to and from the King's Highway Station would be using different routes and generally moving away from, rather than toward, these protected open spaces. And, peak traffic usage (morning and evening commute times) would not coincide with likely park recreational use (mid-day). Access to the protected open spaces would not be impacted by the reconfigured intersection or the King's Highway Station.

Whale's Tooth

The Whale's Tooth Station site is a previously developed parcel that is near the New Bedford Whaling National Historic Park, Fisherman's Wharf Pier #3, State Pier, Clasky / Common Park, and the John Avery Parker School protected open spaces. Several un-named protected open spaces are also proximate to this site. No ACECs are near the Whale's Tooth Station site. No protected open space land would be acquired for constructing the Whale's Tooth Station.

Local traffic may use Acushnet Avenue, Hillman Street, or the nearby Herman Melville Boulevard to access the New Bedford Whaling National Historic Park and the adjoining Fisherman's Wharf Pier #3 or State Pier. Commuter traffic to and from the Whale's Tooth Station may temporarily increase congestion on these roads during high usage periods, causing temporary delays in accessing these protected open spaces. However, peak traffic periods (morning and evening commute times) are unlikely to coincide with use of these protected open spaces (mid-day). No changes in access to the other proximate protected open spaces are expected.

1.9.3 Summary

The Rapid Bus Alternative would be comprised of the elements listed in Table 20, which also summarizes the direct effects to protected open spaces and ACECs potentially resulting from implementing this alternative.

Table 20 Summary of Potential Direct Effects to Protected Open Spaces and ACECs from the Rapid Bus Alternative

Element/Component	Direct Effects: Acquisition Area (acres)	Direct Effects: Number of Parcels
Highway Alignments		
Reversible Bus Lanes	0	
Interchange Improvements	4.5	2
Stations		
Downtown Taunton	0	
Galleria	0	
Freetown	0	
Fall River Depot	0	
King's Highway	0	
Whale's Tooth	0	
TOTAL	4.5	2

For the Rapid Bus Alternative, approximately 4.5 acres of land would be acquired from protected open spaces. No publicly owned parcels of ACEC land would be acquired. Access to protected open spaces and ACECs would not be significantly impacted by constructing, reconstructing, or using the highway alignments or stations.

The Rapid Bus Alternative's impacts to ACEC key functions and values would be:

- **Biodiversity:** The Rapid Bus Alternative is not anticipated to adversely affect biodiversity in the Hockomock Swamp ACEC other than a small loss of habitat immediately adjacent to the existing Route 24.
- **Farmland soils**: The Rapid Bus Alternative would not impact any mapped areas of designated farmland soils within an ACEC.
- **Historic and archaeological resources**: The Rapid Bus Alternative would not affect any areas of archaeological sensitivity within ACECs.
- **Rare species**: The Rapid Bus Alternative would potentially impact the Fowl Meadow and Ponkapoag Bog ACEC and the Hockomock Swamp ACEC, which encompass most of Priority and Estimated Habitat polygons (PH454/EH350), and (PH1392/EH59), respectively. Approximately 0.3 acres of habitat potentially used by marbled salamander would be impacted within the Fowl Meadow and Ponkapoag Bog ACEC; and approximately 22 acres of habitat potentially used by eastern box turtle would be impacted within the Hockomock Swamp ACEC. An additional 11 state-listed species occur within the Hockomock Swamp polygon (PH1392/EH59). Other species and their habitat may occur within the polygons or within the contiguous ACECs.
- **Water resources**: The Rapid Bus Alternative would discharge to the Neponset River within the Fowl Meadow and Ponkapoag Bog ACEC. Discharges to the Town River in Bridgewater, within the Hockomock Swamp ACEC, from the proposed Rapid Bus Alternative route would also be expected. Stormwater management for these discharges would be explored through the design process.

- **Wetlands:** Potential permanent wetland impacts along the Route 24 include the loss of 4.03 acres within the Hockomock Swamp ACEC, out of 8,260 total acres of wetlands within this ACEC.

1.10 Hazardous Materials

This section discusses the potential for the Rapid Bus Alternative to encounter hazardous materials, contaminated soil, or contaminated groundwater. The analysis includes the information provided in the DEIS/DEIR for station sites. It is assumed that bus stations would have to be constructed at each station location, with the exception of the proposed Galleria Station. Because no soil disturbance would occur at the proposed Galleria Station, a Phase I ESA was not prepared. Recognized Environmental Conditions were identified at each of the station location for the Rapid Bus Alternative consisting of Fall River Depot, Freetown, Galleria, King's Highway, Downtown Taunton and Whale's Tooth. A total of eight structures would be demolished for station construction. For this alternative, a total of 15 RECs were identified. Four of the RECs were evaluated as having a "high" impact, six RECs were evaluated with "medium" impacts and five RECs were evaluated as having "low" impacts.

In summary, there is a substantial likelihood that contamination would be encountered and would need to be addressed at Fall River Depot and Downtown Taunton stations. There is a moderate likelihood that contamination would be encountered and would need to be addressed at the King's Highway station. It is unlikely that contamination would be encountered at the Freetown station. An engineered barrier was constructed at the Whale's Tooth site and contaminated soil was left in place beneath the barrier. There are potential impacts related to exposure during the future excavation or construction at this site.

1.11 Biodiversity

This section discusses the impacts of the Rapid Bus Alternative on environmental justice communities. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to the Route 24 section.

1.11.1 Highway Elements

Impacts to biodiversity can be characterized as direct (the direct loss of biological resources) or indirect (losses of ecosystem function that may affect populations of plants or animals over time). The proposed Brockton and West Bridgewater in-line stations would be constructed within the Route 24 median and would have no direct or indirect effects on biodiversity. The parking areas for these stations would have a minimal impact on biodiversity as the properties required are semi-developed.

Direct

The Rapid Bus Alternative would require filling approximately 2.26 acres of wetlands containing 72 Potential Vernal Pools (Table 21), and would result in the loss of upland forested habitat within 100 feet of four Potential Vernal Pools, with a loss of approximately 4.33 acres of this habitat (8 percent). This could affect the function of the vernal pool by reducing shading or detrital inputs. There would be a loss of upland forested non-breeding habitat within 750 feet of 70 Potential Vernal Pools, with a loss of approximately 14.93 acres of habitat (2 percent).

Table 21 Rapid Bus Alternative - Impacts to Vernal Pools

	Direct Impacts		
Number of Vernal Pools	**Fill to VPH[1]**	**Loss of Buffer Habitat[2]**	**Loss of Upland Habitat[3]**
72	2.26	4.33	14.93

1 Fill to VPH (Vernal Pool Habitat) was calculated as the loss of wetland where a vernal pool occurs.
2 Loss of forested upland within 100 feet of VPH.
3 Upland Habitat loss was calculated for forested upland habitat between 100 and 750 feet of a vernal pool.

The Rapid Bus Alternative would also result in the loss of natural plant communities and wildlife habitat, as shown in Table 22. A total of 334.13 acres of natural habitats would be lost. This area consists largely of narrow strips of forested uplands (126.89 acres) and upland shrub habitats (184.16 acres) along the edges of the highways or within interchanges.

Table 22 Rapid Bus Alternative – Loss of Habitat

Cover Type[1] (acres)											
			PFO			UF	USS	AG	P	CL	
OW	PEM	PSS	WSC	WSD	WSM						Total
0.10	4.22	0.74	0.00	12.22	4.19	126.89	184.16	0.00	0.38	1.23	334.13

1 Cover type abbreviations:
OW= open water, PEM = Palustrine Emergent Marsh, PSS = Palustrine Shrub Scrub, PFO = Palustrine Forested WSC = Wooded Swamp Coniferous, WSD = Wooded Swamp Deciduous, WSM = Wooded Swamp Mixed, UF = upland forested, USS = upland scrub shrub, AG = agricultural, P = powerline, CL = cleared land (*e.g.,* gravel pit).
Source: MassGIS and VHB. Based on orthophoto aerial interpretation of Study Area cover types.

Indirect

The analysis of indirect impacts evaluates the effects of the Rapid Bus Alternative on key elements of biodiversity. Because the Rapid Bus Alternative's impacts on natural communities would occur entirely along the edge of, or in the median of, heavily-traveled highways, indirect impacts to natural communities, wildlife or fisheries are anticipated to be minor and restricted to the edges of these communities.

Biomap Core Habitats

The existing highways (I-93 and Route 24) cross three Biomap Core Habitats (Blue Hills State Reservation, Fowl Meadow and Ponkapoag ACEC, and the Hockomock Swamp ACEC). Constructing the bus lanes in the median of I-93 and the northern part of Route 24 would not result in new barriers to wildlife movement, although there could be a negligible increase in the barrier effect (caused by the 8-lane highway) associated with the loss of vegetation in the median. Constructing a reversible bus lane in the median of Route 24 could require minor widening of the highway fill footprint, with some loss of natural habitats adjacent to the shoulder of the highway. This work would not affect the ability of the Hockomock Swamp to support wildlife or plant communities.

Living Waters

The Rapid Bus Alternative does not cross any Living Waters.

Fisheries Habitat

The Rapid Bus Alternative crosses five waterways that provide important fisheries habitat: the Blue Hill River, Beaver Brook, the Town River, Dam Lot Brook, and the Taunton River. Adding a dedicated bus lane in the median of I-93 or Route 24 would require that these existing bridges be widened. Widening would maintain the hydraulic opening and would not affect the substrate, and could increase shading of the waterway. This would not adversely affect the ability of each waterway to provide fisheries habitat or fish passage.

Vernal Pools

Vernal pool complexes, composed of potential vernal pools, are mapped adjacent to Route 24 in several locations:

- West of Route 24, south of Maple Street (West Bridgewater);
- West of Route 24, north of Orchard Street adjacent to Dam Lot Brook (Raynham);
- Both sides of Route 24 near the Taunton River (Raynham).

Constructing a reversible bus lane in the median of Route 24 at these locations could require minor widening of the highway fill footprint, with some loss of natural habitats adjacent to the shoulder of the highway. This work would not create a new barrier to wildlife movement, and would result in a negligible loss of upland areas used by vernal pool amphibians for non-breeding habitat.

Other Important Habitat Areas

In addition to the Biomap Core Habitats, there are several large undeveloped areas and wetland complexes adjacent to Route 24. The potential minor widening of the highway footprint would not affect wildlife movement and would not decrease the ability of these large areas to support diverse wildlife and plant communities.

1.11.2 Stations

The biodiversity impacts of the Rapid Bus Alternative to construct stations would not differ from those in the DEIS/DEIR. The two new in-line stations would be within the Route 24 ROW and would have no biodiversity impacts. The only biodiversity impacts would occur at the Freetown Station.

Freetown Station would be a new train or bus station constructed to serve the Fall River Secondary for all rail alternatives or the Rapid Bus Alternative. The proposed station site would fragment an undeveloped corridor of forest and fields that extends from the Copicut Road/Route 24 intersection to South Main Street, along the west side of the active freight tracks. Although there is development along the frontage of South Main Street, this development has left substantial back land intact. Constructing the proposed station would fragment this area and reduce habitat value of the remaining portions. Approximately 4.33 acres of habitat would be lost, largely upland shrub habitat.

1.11.3 Summary

The Rapid Bus Alternative would require constructing dedicated bus lanes, and could require minor widening along the perimeter of Route 24 and Route 128/I-93. The majority of the proposed stations for this alternative would be located in previously developed areas and would not impact natural plant or animal communities.

The Rapid Bus Alternative would result in the loss of 316.98 acres of upland habitat and 21.48 acres of wetland habitats, some of which is within the Hockomock Swamp ACEC. These areas are adjacent to the existing highways, or are within highway interchanges. The Rapid Bus Alternative would not create a new barrier to wildlife movement, although it could slightly exacerbate the existing barrier caused by Route 24.

1.12 Threatened and Endangered Species

This section discusses the impacts of the Rapid Bus Alternative on Threatened or Endangered Species. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to the Route 24 section.

1.12.1 Highway Elements

Impacts to biodiversity can be characterized as direct (the direct loss of biological resources) or indirect (losses of ecosystem function that may affect populations of plants or animals over time). The proposed Brockton and West Bridgewater in-line stations would be constructed within the Route 24 median and would have no direct or indirect effects on priority habitats.

The Rapid Bus passes through one NHESP Priority Habitat (PH1392/EH59) and is adjacent to four Priority Habitats (PH229/EH111, PH454/EH350, PH451/EH328, and PH282/EH179). These Priority Habitats include land within the Fowl Meadow and Ponkapoag ACEC (Blue Hills Reservation) as well as the Hockomock Swamp ACEC. The following sections describe both direct and indirect impacts as they relate to this alternative.

Direct

The majority of the proposed work would be within the existing highway right-of-way and would not impact rare species and their habitat. However, minor temporary and permanent impacts may occur within narrow strips immediately adjacent to the highway right-of-way during roadway widening and construction.

The Rapid Bus Alternative could result in the loss of potential habitat of five state-listed species (Blanding's turtle, eastern box turtle, blue-spotted salamander, marbled salamander, and gypsywort). These species are known to be present within the Priority Habitats crossed by this roadway.[1]

The Rapid Bus would potentially impact rare species habitat within the Fowl Meadow and Ponkapoag Bog ACEC and the Hockomock Swamp ACEC, which encompass most of Priority and Estimated Habitat polygons (PH454/EH350), and (PH1392/EH59) respectively. Approximately 0.3 acres of habitat potentially used by marbled salamander would be impacted within the Fowl Meadow and Ponkapoag Bog ACEC; and approximately 22 acres of habitat potentially used by eastern box turtle would be impacted within the Hockomock Swamp ACEC. An additional 11 state-listed species occur within the Hockomock Swamp polygon (PH1392 / EH59). Other rare species and their habitat may occur within the polygons or within the contiguous ACECs.

Indirect

The Rapid Bus Alternative is located along the existing highway corridors of Route 24 and I-93. Existing culverts carry streams beneath the highway and may provide migratory habitat to wildlife species. The highway itself does not provide suitable habitat for any of the rare species and restricts movement between areas of suitable habitat except through the culverts. Potential suitable foraging, breeding, and nesting habitat for amphibians and reptiles could be found adjacent to the highway. This alternative would result in minor habitat losses from roadway widening. Table 23 lists the species found within the Priority Habitat polygons and the potential habitat functions that could be impacted.

The majority of the proposed work would be within the existing highway right-of-way median and would not impact rare species and their habitat. However, there would only be a minor loss of habitat along the periphery of the Priority and Estimated Habitats polygons. This minor loss of habitat is not likely to affect the persistence of rare species populations.

Table 23 Impacts to Rare Species Habitat Functions – Rapid Bus Alternative

		Habitat Functions			
Polygon #	**Species**	**Migration**	**Foraging**	**Breeding/Nesting**	**Wintering**
PH 454/EH 350	Marbled Salamander	No loss	Minor loss	No loss	Minor loss
PH 1392/EH 591	Blue-Spotted Salamander	No loss	Minor loss	No loss	Minor loss
	Blanding's Turtle	No loss	Minor loss	No loss	Minor loss
	Eastern Box Turtle	No loss	Minor loss	No loss	Minor loss
	Gypsywort	--	--	--	--
PH 282/EH 179	Eastern Box Turtle	No loss	Minor loss	No loss	Minor loss

1 Habitat Priority Habitat (PH1392) includes an additional 11 state-listed species which do not occur adjacent to the highway

The Rapid Bus Alternative would adversely affect habitat of three state-listed species (marbled salamander, Blanding's turtle, and eastern box turtle) and result in loss of approximately 16.2 acres within natural areas of three Priority and Estimated Habitat polygons. Impacts would occur where the highway needs to be widened to accommodate the bus lane.

The majority of the proposed work would be within the existing highway right-of-way median and would not impact rare species and their habitat. In locations where the proposed work occurs outside of the existing developed area, there would only be loss of habitat along the periphery of the Priority and Estimated Habitats polygons. This minor loss of habitat is not likely to affect the persistence of rare species populations. None of the proposed station sites would impact Priority and Estimated Habitat.

Two ACECs that contain two Priority and Estimated Habitats (PH454/EH350 and PH1392/EH59) would be impacted by the Rapid Bus Alternative. Based on EOT's analysis, approximately 0.3 acres of habitat would be impacted within the Fowl Meadow and Ponkapoag Bog ACEC; and approximately 22 acres of habitat would be impacted within the Hockomock Swamp ACEC. Other rare species and their habitat may occur within the polygons or within the contiguous ACECs.

1.13 Wetlands

This section discusses the impacts of the Rapid Bus Alternative on wetlands. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to the Route 24 section.

1.13.1 Highway Elements

The Rapid Bus Alternative would result in temporary and permanent impacts to wetland areas adjacent to the existing Route 24, I-95, and Route 128 corridors. Impacts are associated with the construction of a one-way reversible lane, redesigns of ramps for safety, and the widening of stream crossings. The following sections describe both direct and indirect impacts that would occur if the Rapid Bus alternative were selected.

Direct

The Rapid Bus Alternative crosses through 11 municipalities. Table 24 summarizes direct wetland resource impacts by town, as presented in the DEIS/DEIR.

Table 24 Direct Wetland Impacts – Rapid Bus Alternative (from the DEIS/DEIR)

Station	Bank (lf)		BVW (ac)		BLSF (ac)		ORWs (ac)	
	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary	Permanent	Temporary
Avon	--	240	1.96	0.69	8.58	0.72	--	--
Braintree	--	112	0.05	0.02	0.69	0.41	--	--
Bridgewater	--	--	1.37	0.72	3.55	0.55	1.15	0.42
Brockton	--	192	0.93	0.53	1.48	0.20	--	--
Canton	--	64	--	--	--	--	--	--
Quincy	--	96	0.02	0.01	0.35	0.12	--	--
Randolph	--	64	1.05	0.21	5.64	1.50	--	--
Raynham	--	96	7.51	1.24	1.30	0.13	0.53	0.60
Stoughton	--	--	0.70	0.26	0.54	0.10	--	--
Taunton	--	64	3.97	1.05	2.46	0.20	0.11	0.04
West Bridgewater	--	192	3.91	3.92	6.06	0.39	0.36	0.37
Total	--	1,120	21.47	8.65	30.65	4.32	2.15	1.43

As shown in Table 52, the greatest temporary impacts to Bank would occur in Avon (240 linear feet). The largest permanent impacts to BVW would occur within Raynham (7.51 acres), the largest permanent impacts to BLSF would occur in Avon (8.58 acres), and the largest permanent impacts to ORWs would occur in Bridgewater (1.15 acres).

Bank

The existing culverts and stream crossings of the existing roadways used by the Rapid Bus alternative would be maintained or extended, as necessary to accommodate lane additions. Permanent impacts to Bank would be calculated through the final design process once the preferred alternative is selected. Existing culverts associated with established roadways would generally be improved in place and would not result in additional permanent impacts except along Route 24 where existing culverts would not be replaced but would be extended as needed. Approximately 1,120 linear feet of temporary bank impacts are anticipated where culvert or bridge replacement / extension is proposed. Additional impacts to Bank would be calculated during the final design process once the preferred alternative is selected. There would be no impacts to Coastal Bank along this alternative.

Bordering Vegetated Wetlands (BVW)

The Rapid Bus Alternative would permanently impact approximately 21.47 acres of BVW and temporarily impact approximately 8.65 acres. The bulk of these impacts are concentrated in locations along Route 24 where wetlands located within or adjacent to existing interchanges would be impacted during the reconfiguration of the interchange. Approximately 4.03 acres of permanent impact and 3.19 acres of temporary impact would occur within the Hockomock Swamp ACEC in Bridgewater and West Bridgewater. Additional information regarding impacts to ACECs can be found in the Environmental Consequences Technical Report – Protected Open Space and Areas of Critical Environmental Concern.2

Table 25 summarizes permanent impacts to wetlands by cover type within each municipality along the Rapid Bus Alternative. Greatest wetland impacts would occur within areas of wooded swamp (16.41 acres), with relatively large impacts also occurring within areas of mixed (coniferous and deciduous) wooded swamp (4.19 acres). The wetland delineations created using the GIS model are expected to overestimate the size of the wetland and therefore the impacts. Wetland impacts would be re-evaluated once the preferred alternative is selected and wetland boundaries have been delineated in the field.

Table 25 Permanent BVW Impacts by Cover Type

		Cover Type[1] (acres)						
		OW	PEM		PSS	PFO		
Municipality	Total Area (acres)	Open Water	Deep Marsh	Shallow Marsh	Shrub Scrub	WSC	WSD	WSM
Avon	1.96	--	--	1.20	0.11	--	0.65	--
Braintree	0.05	--	--	--	--	--	0.05	--
Bridgewater	1.37	--	0.08	0.76	--	--	0.52	0.01
Brockton	0.93	--	0.01	0.23	0.12	--	0.57	--
Canton	--	--	--	--	--	--	--	--
Quincy	0.02	--	--	0.02	--	--	--	--
Randolph	1.05	--	--	0.23	--	--	0.82	--
Raynham	7.51	0.10	--	--	--	--	5.26	2.15
Stoughton	0.70	--	0.08	0.02	0.02	--	0.58	--
Taunton	3.97	<0.01	--	--	<0.01	--	2.08	1.89
West Bridgewater	3.91	--	0.08	1.51	0.49	--	1.69	0.14
Total (subcategory)	21.47	0.10	0.25	3.97	0.74	--	12.22	4.19
Totals (Cowardin)	21.47	0.10	4.22		0.74	16.41		

1 Cover type abbreviations:
Cowardin types: PEM = Palustrine Emergent Marsh, PSS = Palustrine Shrub Scrub, PFO = Palustrine Forested
Ecological sub-category: WSC = Wooded Swamp Coniferous, WSD = Wooded Swamp Deciduous, WSM = Wooded Swamp Mixed.
Source: MassGIS and VHB. Based on orthophoto aerial interpretation of Study Area cover types.

The estimated areas of wetland impacts created by the construction of the Rapid Bus Alternative have been revised since the publication of the DEIS/DEIR and are summarized in Table 26 below. As shown, the total direct wetland impacts (loss) are identical to the Rapid Bus Alternative evaluated in the DEIS/DEIR, although there are minor differences in some categories. An additional 9 acres of wetlands would be temporarily altered for construction.

Table 26 Direct Wetland Impacts

Wetland Type	Total Impacted Area (acres)	DEIS/DEIR Total Impacted Area (acres)
Wooded Swamp Deciduous	13.25	12.22
Wooded Swamp Mixed Trees	2.73	4.19
Shrub Swamp	0.94	0.74
Deep Marsh	0.25	0.25
Shallow Marsh Meadow or Fen	4.20	3.97
Open Water	0.11	0.1
Total	21.48	21.47

Sources: MassGIS 2002, 2005; municipal data 2009.

Bordering Land Subject to Flooding (BLSF)

Approximately 30.65 acres of BLSF would be permanently impacted and approximately 4.32 acres of BLSF would be temporarily impacted as a result of the Rapid Bus alternative. Any fill that would be placed within BLSF would occur along the edges of existing roadways and would not restrict flood flows. Impact areas mostly occur in locations where the mapped 100-year floodplain overlays existing areas of Route 24. Because of the previous disturbance from the existing roadway, construction would not impact important wildlife habitat in these areas. The impact estimates for BLSF represent the areal extent of potential floodplain impacts based on FEMA flood mapping and do not take into account the volume of flood storage that potentially would be lost. Prior to the final design process, more accurate mapping and flood elevation contours would be generated. This information would be used during the final design process to accurately calculate potential loss of flood storage volume and to provide adequate compensatory flood storage mitigation. This alternative would not impact any Land Subject to Coastal Storm Flowage.

Riverfront Area

There are 13 perennial streams that cross the Rapid Bus Alternative. At each of these perennial stream crossings, there would be impacts to Riverfront Area. Because the most of the work associated with the Rapid Bus Alternative is reconstruction in the median or the addition of a traffic lane, the majority of the work would occur in previously developed Riverfront Area. Additional Riverfront Area impacts are expected where the Blue Hill River flows within the I-93/Route 128 median. Exact impacts would be calculated during the final design process once the preferred alternative is selected.

Outstanding Resource Waters (ORWs)

Wetlands containing five potential vernal pools would be impacted along this segment; these impacts constitute impacts to ORWs. Approximately 2.15 acres of ORWs would be permanently impacted and approximately 1.43 acres of ORWs would be temporarily impacted along this alternative. Impacts to ORWs are estimated using the wetland boundaries created in the GIS model. These boundaries are expected to overestimate the size of the wetland and, therefore, the associated impacts to ORWs. Impacts to ORWs would be re-evaluated once the preferred alternative has been chosen to more accurately represent actual loss of ORWs in part through field work to determine if potential vernal pools would be certifiable.

Indirect

The Rapid Bus Alternative follows existing, active roadways that have been in service for decades. Indirect impacts, such as fragmentation of wetland habitat or hydrologic alterations of upgradient and downgradient wetlands, may have been caused by the construction of these roadways in the past. The wetland impacts that are associated with the proposed lane additions, intersection reconfigurations, or work in the medians occur largely within the existing disturbed footprint of the roadway and involve narrow linear impacts that have negligible indirect impacts to the affected wetland systems. However, some loss of wetland function would occur in proportion to the amount of wetland area that would be lost as a result of the project. Additional impacts, such as noise impacts that effect sensitive species and barriers to wildlife migration are anticipated to be negligible because the roadway is already present and in heavy use by motor vehicles. Indirect impacts are further discussed in the Environmental Consequences Technical Report – Biodiversity3 and the Environmental Consequences Technical Report – Water Resources. 4

1.13.2 Stations

The wetland impacts of the Rapid Bus Alternative to construct stations would not differ from those in the DEIS/DEIR. Construction of the Freetown Station and the proposed Brockton Station parking lot could impact wetlands.

Freetown Station

Freetown Station would permanently impact approximately 0.01 acres of wooded swamp deciduous (PFO) wetlands and temporarily impact approximately 0.04 acres of BVW associated with the unnamed brook that runs along the southern side of the station site. Potential Bank impacts to the brook associated with the reconstruction of the railroad corridor are accounted for under the Fall River Secondary impacts. No Riverfront Area or BLSF impacts are anticipated at this site. The wetland delineations created using the GIS model are expected to overestimate the size of the wetland and therefore the impacts. Wetland impacts would be re-evaluated once the preferred alternative is selected and wetland boundaries have been delineated in the field.

West Brockton Station

The MassGIS wetland mapping indicates that a small wetland is present in the southeast corner of the proposed parking lot, adjacent to the existing private parking lot. Construction of the parking lot could impact approximately 6,000 square feet of this wetland. Wetland impacts would be re-evaluated once the preferred alternative is selected and wetland boundaries have been delineated in the field.

1.13.3 Summary

The Rapid Bus Alternative would permanently impact 21.48 acres of BVW, 30.65 acres of BLSF, and 26 locations with Riverfront Area. The bulk of these impacts are concentrated in locations along Route 24 where wetlands located within existing interchange cloverleaves would be impacted during the reconfiguration of the interchange. Additional impacts would be distributed along the corridor where wetlands are present at the edge of the existing roadway embankment and could not be avoided where lane additions occur. These impacts are common to all of the Rapid Bus Alternatives

Due to the impacts described above, this alternative would result in the largest amount of direct impact (as compared with the DEIS/DEIR alternatives) within the Hockomock Swamp ACEC, 4.03 acres. Indirect impacts would occur along this portion of the Rapid Bus Alternative, would be minimized because work would include roadway improvements to an existing roadway corridor. Impacts such as fragmentation have already occurred through the initial construction of the roadway and hydrology would be maintained through the use of existing bridges and culverts. Additionally, approximately 2.15 acres of impacts to ORWs would occur along the Rapid Bus Alternative.

1.14 Water Resources

This section discusses the impacts of the Rapid Bus Alternative on water resources. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to the Route 24 section.

1.14.1 Highway Elements

Table 27 lists waterbodies near the Rapid Bus Alternative corridor and identifies the waterbodies that would receive stormwater discharges from the highways used for this alternative. The Rapid Bus Alternative would add approximately 174.8 acres of impervious area to the existing highways to accommodate the new bus traffic. These highways have largely closed drainage systems that remove suspended solids from stormwater runoff and convey the runoff to nearby wetlands and streams. Based on the design of I-93 / Route 128 and Route 24, this analysis assumes that the highways discharge to all named streams they cross, including the Blue Hill River, Dam Lot Brook, Lovett Brook, the Taunton River, and the Town River. Since the existing stormwater drainage system would be retained, with capacity upgrades where necessary, these streams areas would receive additional stormwater discharges under this alternative due to the increased pavement. Additional stormwater discharges would occur in wetlands adjacent to the proposed corridor.

The highways are assumed to discharge to the Zone A areas currently crossed by the highways, which are associated with Blue Hill River, Brockton Reservoir, Farm River, and the Richardi Reservoir. The refined drainage design for the Rapid Bus Alternative will attempt to discharge any new or increased stormwater water flows outside of Zone A areas in order to comply with the proposed Massachusetts Stormwater Management Regulations (314 CMR 21.00). If this drainage design proves impractical, the Rapid Bus Alternative may require a variance from MA DEP to allow a new or increased stormwater discharge in a Zone A area.

Table 27 Stormwater Discharges for the Rapid Bus Alternative

Waterbody	Highway	Municipality	ACEC/ORW	Stormwater Discharges Proposed
Blue Hill River (includes Zone A)	I-93/Route 128	Quincy, Randolph	No	Yes[1]
Brockton Reservoir (Zone A only)	Route 24	Avon	No	Yes (Zone A only)[1]
Dam Lot Brook	Route 24	Raynham	No	Yes[1]
Farm River (Zone A only)	I-93/Route 128	Quincy, Randolph	No	Yes (Zone A only)[1]
Lovett Brook	Route 24	Brockton	No	Yes[1]
Richardi Reservoir (Zone A only)	I-93/Route 128	Quincy, Randolph	No	Yes (Zone A only)[1]
Taunton River	Route 24	Raynham	No	Yes[1]
Town River	Route 24	Bridgewater, West Bridgewater	Yes[2]	Yes[1]

1 Based on the highway design, these waterbodies and/or Zone A areas are assumed to receive stormwater discharges from the existing highway drainage system. The Rapid Bus Alternative would reuse the existing drainage system and discharge points, but there would be additional impervious area discharging to these waterbodies.

2 Hockomock Swamp ACEC.

The highways along this alternative intersect the Zone II areas for 11 existing and proposed Public Water Supply Wells, including nine wells operated by the Raynham Center Water District and two inactive wells operated by the West Bridgewater Water Department. There would be stormwater discharges in the Zone II areas for these wells. The individual wells, their protection zones, and potential impacts are listed in Table 28. No Zone I areas would be affected by the Rapid Bus Alternative.

Table 28 Construction and Stormwater Discharges in Public Water Supply Well Protection Areas for the Rapid Bus Alternative

Well	Distance from Proposed Limit of Work (miles)	Water System	Location of Protection Zone Crossings	Construction in Protection Zones	Stormwater Discharges in Protection Zones
Gushee Pond Well #1	0.6	Raynham Center Water District	Bridgewater, Raynham	Zone II	Zone II
Gushee Pond Well #2	0.6		Bridgewater, Raynham	Zone II	Zone II
Gushee Pond Well #3	0.7		Bridgewater, Raynham	Zone II	Zone II
Lake Nip Well #1A	0.9		Bridgewater, Raynham	Zone II	Zone II
Lake Nip Well #1B	0.9		Bridgewater, Raynham	Zone II	Zone II
Lake Nip Well #2	0.9		Bridgewater, Raynham	Zone II	Zone II
Lake Nip Well #2A	0.9		Bridgewater, Raynham	Zone II	Zone II
Lake Nip Well #2B	0.9		Bridgewater, Raynham	Zone II	Zone II
Fountain Well1	0.8		Bridgewater, Raynham	Zone II	Zone II
Manley St Well #3A	0.2	West Bridgewater Water Department	Brockton, West Bridgewater	Zone II	Zone II
Manley St Well #3B	0.1		Brockton, West Bridgewater	Zone II	Zone II

1 Proposed well

Although the Rapid Bus Alternative would use highways near multiple waterbodies and ground water protection areas, the road upgrades and new traffic would not introduce new pollutant sources because they would occur within and along existing highways. The increased paved area proposed under the Rapid Bus Alternative would only increase pollutant loading if the new pavement increased the amount of traffic on the road. Based on the change in vehicle miles traveled (VMT) at the peak hour, the Rapid Bus Alternative would reduce roadway use by approximately 0.3 percent. Since this alternative would actually decrease the total automotive traffic conveyed along the corridor by approximately one percent, the additional paved area would not increase loading of roadway contaminants such as metals, hydrocarbons, salt, and sediment. The primary potential for water resource impacts would be from increased runoff rates due to increased paved area. The highway drainage systems would need to be expanded or modified to accommodate the extra runoff from additional pavement and still meet the Massachusetts Stormwater Management Standards. Existing pipes and discharge points would be reused wherever possible however, these discharges will be inspected to determine whether they should be redirected away from sensitive resources.

Existing bridges and culverts for stream crossings would be expanded as necessary to accommodate new travel lanes and to meet stream flow recommendations. The operation of the Rapid Bus Alternative would not be expected to contribute contaminants that would impair any of the waterbodies or drinking water sources along the line.

1.14.2 Stations

The water resources impacts of the Rapid Bus Alternative to construct stations would not differ from those in the DEIS/DEIR. The two new in-line stations would not affect sensitive water resources.

Downtown Taunton

The Downtown Taunton is undeveloped and would require a new stormwater drainage system. Infiltration may not be practicable on this site due to soil contamination. A stormwater management area is proposed on the east side of the site that would discharge to the local municipal system. The system modifications would be designed to maintain peak flows into the local stormwater system and to remove suspended solids. With the proposed capacity upgrades to the stormwater management system (if needed), reconstructing the station would have no impacts to the municipal drainage system or to surface or ground water resources.

Fall River Depot

Under the Rapid Bus Alternative, the station would include approximately 468 surface parking spaces and would result in a net increase of 4.41 acres of impervious area. Drainage inside the garage (under the rail alternatives) would discharge to the sanitary sewer as required by health codes, while outdoor stormwater would be discharged to the municipal stormwater system. The limits of work would not affect any waterbodies or drinking water protection areas.

The Fall River Depot station site would redevelop a developed site and would actually decrease the total impervious area under the Rapid Bus Alternative. Given the existing industrial character of the local waterfront and the other highways and parking areas nearby, the station would not be expected to increase the potential for water pollution. Existing peak flows into the municipal stormwater system would be maintained through the sizing of the closed drainage system and, if necessary, by the addition of subsurface detention chambers. With a stormwater design to prevent flooding and remove suspended solids, there would be no impacts to the local stormwater system or to surface or ground water resources.

Freetown

Under the Rapid Bus Alternative, the station would include approximately 215 parking spaces and a net increase of 3.01 acres of impervious area. The site is partially surrounded by wetland areas, including an unnamed stream on the northeast edge and another unnamed stream on the southwest edge. However, the limits of work would not intersect any named waterbodies or drinking water protection areas.

Given that this portion of the site is undeveloped, a new stormwater drainage system would be required. A stormwater management area would be included at the west end of the site to treat and manage stormwater flows from the west portion of the parking lot. This stormwater management area would discharge to the wetland southwest of the site. A second and third management area would be included at the northeast portion of the site to treat and manage stormwater flows from the entrance roadways and east portion of the parking lot. These stormwater management areas would discharge to the wetland north of the site. With proper design of the stormwater management system, there would be no impacts to surface or ground water resources.

Galleria

The Galleria station is an existing bus station that would be expanded to serve the Rapid Bus Alternative. It is located at the Silver City Galleria Mall, near the intersection of Routes 140 and 24 in Taunton. The improvements to this facility would take place within the existing paved footprint and would result in 486 total parking spaces and no change in impervious area. Since neither the use of the site nor the paved area would change, no changes would be required to the stormwater drainage system. The limits of work would not affect any waterbodies or drinking water protection areas. No impacts are anticipated to any surface or ground water resources.

King’s Highway

The station would include approximately 387 existing shared parking spaces under the Rapid Bus Alternative. The King’s Highway station site would reuse a developed area and would cause no net increase in impervious area. Since there would be no increase in impervious area and no change in use, there would be no modifications required to the stormwater drainage system and no impacts to water resources. The limits of work would not affect any waterbodies or drinking water protection areas. No impacts are anticipated to any surface or ground water resources.

Whale’s Tooth

Under the Rapid Bus Alternative, the station would include approximately 677 parking spaces and would have no change in impervious area. The limits of work would not affect any waterbodies or drinking water protection areas. New Bedford

Harbor is east of the site and is separated from the site by existing industrial development.

Given the existing industrial character of the local waterfront and the benign nature of the proposed use, the station would not be expected to increase the potential for water pollution. The existing parking lot has an underground drainage system that discharges near the tracks. This drainage system would remain in place for the station and may not require any upgrades to provide effective stormwater management, as the site improvements would occur almost entirely within the existing built footprint. No impacts are expected to surface or ground water resources.

Brockton Station

The Brockton Station would include approximately 300 parking spaces, and approximately 2.5 acres of new pavement. A new stormwater drainage system would be required to treat and manage stormwater flows. With proper design of the stormwater management system, there would be no impacts to surface or ground water resources.

West Bridgewater Station

The West Bridgewater Station would include approximately 600 parking spaces, and approximately 4.5 acres of new pavement. A new stormwater drainage system would be required to treat and manage stormwater flows. With proper design of the stormwater management system, there would be no impacts to surface or ground water resources.

1.14.3 Summary

The Rapid Bus Alternative would involve construction within two Zone A areas and within Zone II areas for 11 wells. These areas would be disturbed only temporarily and would not receive any long-term impacts. This alternative would also require stormwater discharges to two Zone A areas, Zone II areas for 11 wells, and five different waterbodies, including Town River in the Hockomock Swamp ACEC. The Rapid Bus Alternative may require a variance from MA DEP unless the proposed stormwater discharges in Zone A areas can be removed or relocated in the final design.

Since the entire highway corridor for this alternative already conveys automotive traffic under existing conditions, the Rapid Bus Alternative would not add any new potential pollutant sources. While paved highway area would increase by 163 acres under the Rapid Bus Alternative, overall vehicular travel is expected to decrease by approximately 0.3 percent based on vehicle miles traveled (VMT) during the peak hour. Although it is anticipated that the additional pavement would not increase pollutant loading in stormwater runoff since traffic would decrease, an increase in impervious surface of this magnitude will require consultation with DEP to determine whether groundwater recharge and treatment measures have been met.

1.15 Coastal Zone Management – Chapter 91 Resources

This section discusses the impacts of the Rapid Bus Alternative on the coastal zone and Chapter 91 waterways. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to the Route 24 section.

1.15.1 Highway Elements

The reversible busway would include new construction only within inland communities and therefore not include any work within filled tidelands, flowed tidelands or the Massachusetts Coastal Zone. The construction (on the Route 24 section) includes work within two non-tidal rivers and streams presumed subject to Chapter 91.

This alternative includes crossings of three non-tidal rivers or streams reviewed for potential jurisdiction under Chapter 91, two of which may be jurisdictional under Chapter 91. These crossings are the Taunton River in Raynham and the Town River in East Bridgewater. Table 29 lists each crossing and provides a summary of the jurisdictional status of each.

Table 29 Non-Tidal River and Stream Crossings – Rapid Bus Alternative

Waterbody	Municipality	Jurisdictional	Rationale	Presently Licensed	Anticipated Ch. 91 approval	Improvements
Blue Hill River	Quincy	No	Not navigable during any season	No	None	Construction of new pavement within median.
Town River	East Bridgewater	Potentially	Navigable during at least part of the year	No. Presumed authorized by legislation for construction of Rt. 24	Minor project modification if the improvements do not expand the footprint of the existing structure greater than 10 percent.	Construction of new travel lanes within existing bridge footprint.
Taunton River	Raynham	Potentially	Navigable year round; presumed public funds expended for stream clearance, channel improvement or flood control	No. Presumed authorized by legislation for construction of Rt. 24	Minor project modification if the improvements do not expand the footprint of the existing structure greater than 10 percent.	Construction of new travel lanes within existing bridge footprint.

The Town River crosses Route 24 at the East Bridgewater / Bridgewater boundary. The existing structure is a modern highway overpass with a concrete deck supported by concrete abutments. The deck is a single structure accommodating the entire roadway cross section and median. The river is potentially jurisdictional because it is navigable during at least part of the year and the likelihood of public expenditure of funds for flood control upstream or downstream of Route 24. The jurisdictional status would be confirmed through consultation with DEP.

Should the river be confirmed jurisdictional, proposed work may be authorized by DEP as maintenance or a minor modification for previously authorized uses if the reversible bus way can be built within the footprint of the existing structure, or at a minimum does not require an increase in the footprint by greater than 10 percent. If the work increases the footprint by greater than 10 percent, a new license is anticipated because the work would not meet the regulatory criteria established by 310 CMR 9.22.

The Taunton River crosses Route 24 at the Taunton / Raynham boundary. The existing structure is a modern highway overpass with a concrete deck supported by concrete abutments. The deck is a single structure accommodating the entire roadway cross section and median. The river is potentially jurisdictional because it is navigable during at least part of the year and the likelihood of public expenditure of funds for flood control upstream or downstream of Route 24.

The proposed work may be authorized by DEP as maintenance or a minor modification if the reversible bus way can be built within the footprint of the existing structure, or at a minimum does not require an increase in the footprint by greater than 10 percent. If the work increases the footprint by greater than 10 percent, a new license is anticipated because the work would not meet the regulatory criteria established by 301 CMR 9.22.

1.15.2 Stations

The Coastal Zone or Chapter 91 impacts of the Rapid Bus Alternative to construct stations would not differ from those in the DEIS/DEIR. The two new in-line stations would not be within the Coastal Zone or Chapter 91 waterways.

Fall River Depot

Fall River Depot station would not be located within filled tidelands and would not be subject to Chapter 91. At the Fall River Depot Station site, Davol Street is the first major transportation infrastructure adjacent to the coast. As a result, the first 100 feet of the site's frontage on Davol Street are located within the coastal zone associated with the Taunton River. The majority of the station site is located landward of the coastal zone boundary.

The proposed station construction would require a Federal Consistency Certification under the Coastal Zone Management Program because it includes work within the Massachusetts Coastal Zone. Preliminary consultation with representatives of the MZCMP indicates that the proposed station construction would be consistent with the regulatory policies.

Freetown Station

The Freetown station would not be located within filled tidelands and therefore would not be subject to Chapter 91. At the Freetown station site, South Main Street is the first major transportation infrastructure adjacent to the coast. As a result, the first 100 feet of the site's frontage are located within the coastal zone associated with the Taunton River (the entrance driveway). The majority of the station site is located landward of the coastal zone boundary.

The proposed driveway station construction would require a Federal Consistency Certification under the Coastal Zone Management Program because it includes work within the Massachusetts Coastal Zone. Preliminary consultation with representatives of the MZCMP indicates that the proposed station construction would be consistent with the regulatory policies.

Whale's Tooth Station

The majority of the Whale's Tooth station would be located on landlocked filled tidelands because the station site was entirely separated from the existing mean high water mark of New Bedford Harbor by interconnected public ways on January 1, 1984, and is at least 250 feet landward of the existing mean high water mark. Accordingly, the station would not require a Waterways license. However, the station would require a Public Benefit Determination.

The station would be located entirely within the Coastal Zone associated with New Bedford Inner Harbor but outside the New Bedford/Fairhaven DPA. The proposed station construction would require a Federal Consistency Certification under the Coastal Zone Management Program because it includes work within the Massachusetts Coastal Zone. Preliminary consultation with representatives of the MZCMP indicates that the proposed station construction would be consistent with the regulatory policies.

1.16 Indirect and Cumulative Impacts

This section discusses the impacts of the Rapid Bus Alternative on environmental justice communities. The analysis includes the information provided in the DEIS/DEIR with additional information based on modifications to the Route 24 section.

As described in the DEIS/DEIR, the total induced growth for the Rapid Bus Alternative under Scenario 2 would be the same as in Scenario 1. The Rapid Bus Alternative is expected to result in a total induced growth of 1,310 households, a 1.8-percent increase over the No-Build Alternative regional growth of 74,371 households. The distribution of the growth (induced and baseline) would shift to be concentrated in the PDAs. New growth would be largest in Fall River, Foxborough, New Bedford, Taunton. The Smart Growth scenario would shift growth (induced and baseline) out of rural communities such as Acushnet, Berkley, Lakeville, Rehoboth, Wareham and Westport, as well as more developed communities (Mansfield).

The Rapid Bus Alternative is not anticipated to result in station area TOD development at any of the stations. The change to the project (with the addition of two in-line stations) would not change the indirect or cumulative impacts of the Rapid Bus Alternative.

Modified Rapid Bus Alternative
Technical Memorandum - DRAFT

Appendix G:

Modified Rapid Bus Service Plan and Operating and Maintenance Cost Methodology

Prepared for

massDOT

Massachusetts Department of Transportation
10 Park Plaza
Boston, Massachusetts 02116

Prepared by

VHB Vanasse Hangen Brustlin, Inc.

99 High Street, 10th Floor
Boston, Massachusetts 02110

SOUTH COAST RAIL

June 2012

Table of Contents

List of Tables

List of Figures

1

Introduction

This memo documents both the service plan and operating and maintenance cost estimation for the South Coast Rail Modified Rapid Bus Alternative. The O&M model was developed in accordance with US Department of Transportation Federal Transit Administration "Estimation of Operating and Maintenance Costs for Transit Systems," December 1992.

An integral component of the development of O&M costing is the integration with the ridership forecasts and service plan developed for a project (the ridership estimation is discussed further in Appendix H and will be provided directly from CTPS). Iterating ridership, the service plan and the O&M cost ensures that the costs for the project adequately reflect the demand and projected usage of a transit service.

This Page Intentionally Left Blank

2

Service Plan

The proposed span of service for the Rapid Bus Alternative was designed to be comparable with that of the rail alternative. Bus service would run from approximately 6:00 AM to Midnight, every weekday. The weekend span of service would be similar to weekdays.

2.1 Stopping Patterns and Headways

Eighteen routes were developed for the Rapid Bus Alternative. These routes and their stopping patterns were designed to provide travel times that are most competitive with the rail alternatives. Service is available from each station to both terminals in Boston (South Station and Back Bay) as shown in Figure 1. Express (non-stop) service to Boston is available from every station but West Bridgewater (which is served by all local routes and stops at Brockton before operating non-stop to Boston).

Preliminary headways were developed and were designed to be competitive with those of the rail alternatives, and to closely match those of the DEIS/DEIR Rapid Bus alternative. In the peak period and peak direction, each station (except West Bridgewater) was assumed to be served by an express route and a local route at 30 minute headways to each terminal in Boston. This level of service provides a combined minimum of at least one bus every fifteen minutes to each Boston terminal.

In the off-peak period, or off-peak direction (during the peak-period), all buses were assumed to operate all-stop local from each Boston terminal to either Fall River, or New Bedford at 60 minute service headways.

Consistent with standard practice, the initial service plan was used as an input in the ridership model (described in Appendix H). Information on ridership by line was used to adjust the service plan in order to accommodate the projected ridership demand.

Stopping patterns, as well as preliminary and final headways are showing below in Table 1.

Figure 1 Modified Rapid Bus Stopping Schematic

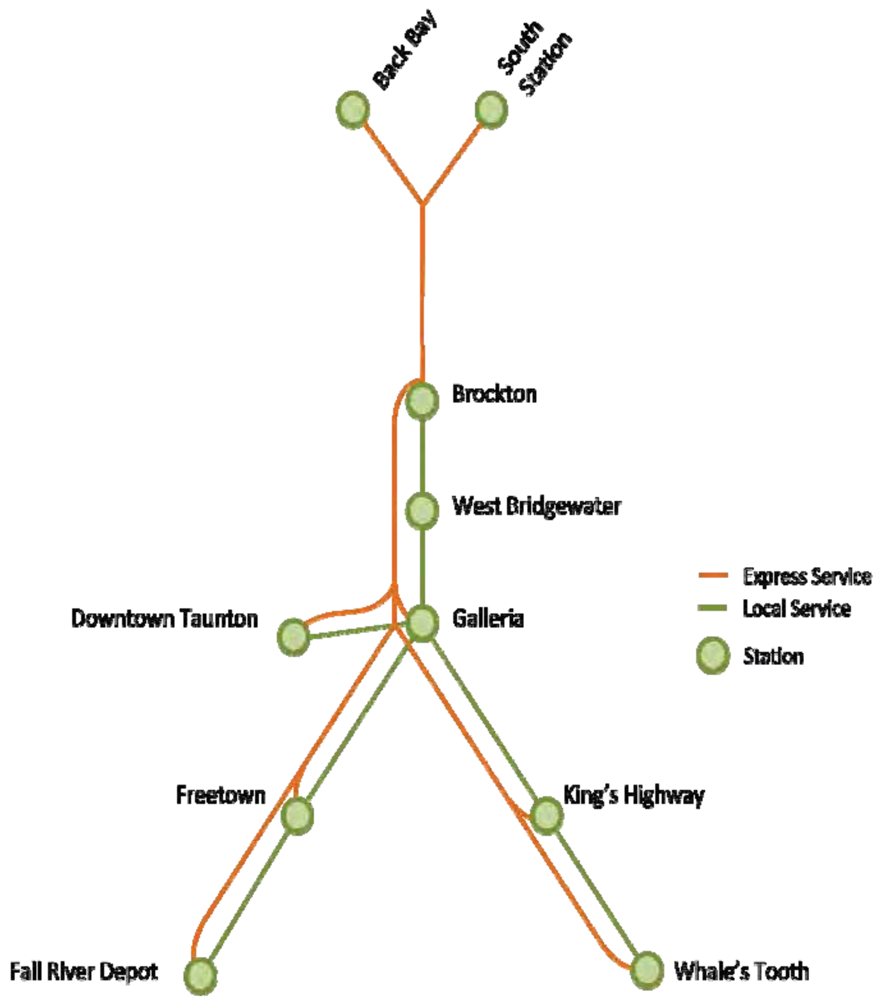


Table 1 Modified Rapid Bus Stopping Patterns and Headways

		EXPRESS ROUTES										LOCAL ROUTES											
STATION		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Whale's Tooth		x	x											x	x					x		x	
Kings Highway				x	x									x	x					x		x	
Fall River Depot						x	x									x	x				x		x
Freetown								x	x							x	x				x		x
Galleria										x	x			x	x	x	x			x	x	x	x
Downtown Taunton												x	x					x	x	x	x	x	x
West Bridgewater														x	x	x	x	x	x	x	x	x	x
Brockton														x	x	x	x	x	x	x	x	x	x
South Station		x		x		x		x		x		x		x		x		x		x	x		
Back Bay			x		x		x		x		x		x		x		x		x			x	x
Initial Headways (un-adjusted for ridership demand)																							
Peak Direction	Peak Period	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	30	Service Does Not Operate			
	Off-Peak Period	Service Does Not Operate																		60	60	60	60
Off-Peak Direction	Peak Period	Service Does Not Operate																		60	60	60	60
	Off-Peak Period	Service Does Not Operate																		60	60	60	60
Final Headways (adjusted for ridership demand)																							
Peak Direction	Peak Hour*	30	30	<u>20</u>	30	<u>15</u>	30	30	30	30	30	30	30	<u>15</u>	30	<u>7.5</u>	<u>20</u>	<u>12</u>	30	Service Does Not Operate			
	Off-Peak Period	Service Does Not Operate																		60	60	60	60
Off-Peak Direction	Peak Period	Service Does Not Operate																		60	60	60	60
	Off-Peak Period	Service Does Not Operate																		60	60	60	60

*** Frequencies were adjusted only in the peak hour, and remain unadjusted during the remaining peak period**

<u>Denotes frequencies that change between initial and final set of headways</u>

2.2 Running Times

Running times were developed for each proposed station assuming based on the proposed improvements described in other sections of this report. Table 2 presents this data.

Table 2 Modified Rapid Bus Station-to-Station Travel Times

				Brockton	West Bridgewater *	Galleria	Downtown Taunton	Freetown	Fall River	Kings Highway	New Bedford
Modified Rapid Bus Alternative	South Station	Travel Time (Mins)	Local	36	42	61	64	65	86	74	90
			Express	N/A	N/A	56	60	60	71	69	78
	Back Bay		Local	44	50	69	72	72	93	82	97
			Express	N/A	N/A	64	68	67	78	77	85
DEIS/DEIR Rapid Bus Alternative	South Station	Travel Time (Mins)	Local	N/A	N/A	66	68	Not Calculated	91	Not Calculated	103
			Express	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Back Bay		Local	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
			Express	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stoughton Electric Alternative	South Station	Travel Time (Mins)	Local	N/A	N/A	N/A	57	68	75	77	82
			Express	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	Back Bay		Local	N/A	N/A	N/A	56	67	74	83	88
			Express	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

3

Vehicle Requirements and Maintenance/Layover Space

Vehicle requirements were calculated based on the information developed for the service plan. The Modified Rapid Bus project would use standard over-the-road coaches with a capacity of 50 people per bus. A spare factor (the number of buses held out of service for maintenance and repairs) of 15 percent was assumed.

The DEIS / DEIR Rapid Bus Alternative would have required 50 vehicles total, with mid-day storage space for 35-40 vehicles.

144 vehicles would be required for the Modified Rapid Bus Alternative. Of the 144 vehicles, 110 would need to be stored during the mid-day between the AM and PM peak hours (the remaining would either be used for reverse peak service or be kept out of service for maintenance / inspections).

The DEIS / DEIR identified the Logan Express Park and Ride lot on Forbes Road in Braintree as a suitable mid-day layover location. Given the number of vehicles that would need to be stored there in the mid-day (110), a parking structure would need to be constructed to accommodate displaced single-occupancy vehicle parking.

The DEIS / DEIR assumed that the Rapid Bus Alternative would be contracted out to a private carrier with facilities in the South Coast Region, and that maintenance and overnight storage would occur at their facilities. Given the sheer number of vehicles required for the Modified DEIS / DEIR a separate maintenance facility / overnight storage location would need to be identified. This effort was not undertaken as part of this evaluation and would need to happen if the Modified Rapid Bus Alternative advanced further.

This Page Intentionally Left Blank

4

O&M Cost Model Development

In keeping with current FTA practice, the resource build-up approach was used to develop O&M costs. This approach assumes that each expense incurred by a transit system is driven by a key supply variable, such as revenue hours, revenue miles, among others. Every effort was made to make this model comparable to the one used the development of the DEIS/DEIR Rapid Bus Alternative.

Line item costs will be calculated using the following equation: **TC = US x UC**

- TC = Total Annual Cost
- US = Unit of Service; operating statistics such as vehicle hours
- UC = Unit Cost; the price for each unit of service

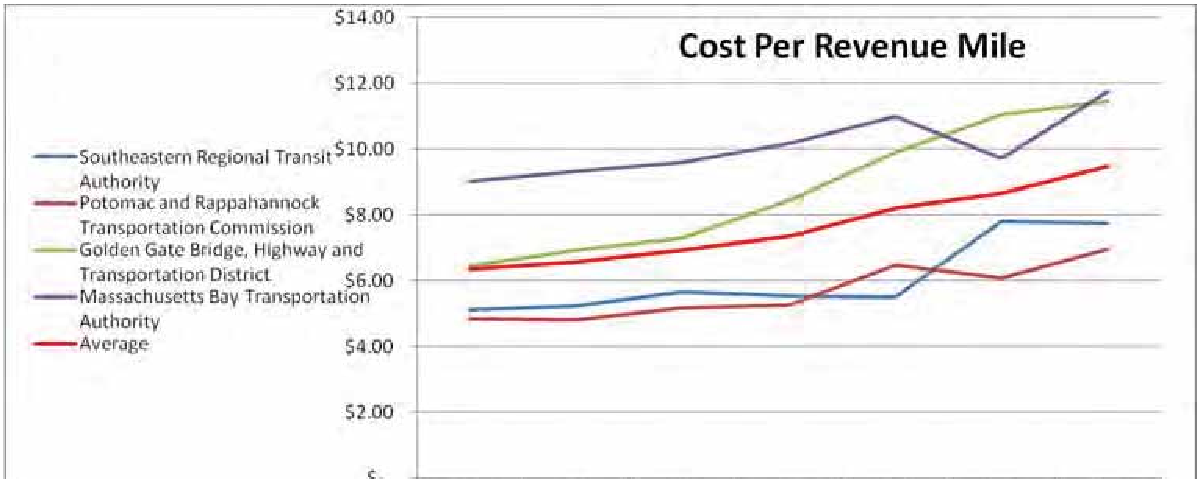
Wherever necessary, costs were escalated to 2009 dollars, using an assumed three percent annual escalation rate.

3.1 Bus Operations and Maintenance

This element includes the variable cost of providing bus service, as well as the variable and fixed costs associated with maintaining the buses required for service. Cost Factors for this element were derived from information used in the development of the DEIS/DEIR Rapid Bus Alternative.

This cost factor was developed using information from Southeastern Regional Transit Authority, Potomac and Rappahannock Transportation Commission, Golden Gate Bridge, Highway and Transportation District, and the Massachusetts Bay Transportation Authority. All of these operators are similar to the proposed SCR Rapid Bus service in terms of either geography or type of operation. Historical information on the total costs for operations and maintenance for these agencies were obtained from the Federal Transit Administration’s National Transit Database.

Table 3 Cost per Revenue Mile for Bus Service



	2000	2001	2002	2003	2004	2005	2006
Southeastern Regional Transit Authority	$5.11	$5.25	$5.65	$5.52	$5.49	$7.80	$7.75
Potomac and Rappahannock Transportation Commission	$4.85	$4.81	$5.18	$5.26	$6.47	$6.08	$6.95
Golden Gate Bridge, Highway and Transportation District	$6.45	$6.93	$7.32	$8.45	$9.90	$11.05	$11.46
Massachusetts Bay Transportation Authority	$9.01	$9.31	$9.59	$10.16	$10.98	$9.72	$11.75
Average	$6.36	$6.57	$6.93	$7.35	$8.21	$8.66	$9.48

The annual cost was then divided by revenue miles operated and averaged to get an appropriate cost-factor for the Modified Rapid Bus alternative, in this case $9.48 per revenue mile of service (which when escalated to 2009 dollars is $10.36 / revenue mile).

3.2 Busway Maintenance

This element includes the cost of maintaining the new bus-only lanes that would be constructed as part of the Rapid Bus Alternative. Included in this are the cost of maintenance (including snow removal and resurfacing), the cost of day-to-day busway operations, and costs related to the overall safety of the busway. To be consistent with the DEIS / DEIR, the same cost factors (which were received from MassHighway) were used.

These cost factors include the following:

- Annual cost per snow removal and other maintenance: $7,600 / lane mile ($7,828 in 2009 dollars).
- Annual cost per square foot for pavement resurfacing $1.43 / square yard ($1.47 in 2009 dollars).

3.3 Stations Operation and Maintenance

Outside of the terminals in Boston, there would be two types of stations for the Rapid Bus Alternative: major stations, such as the in-line ones at West Bridgewater and Brockton and minor ones such as the stations at Taunton Galleria, Kings Highway, and Freetown. All stations would include a platform for loading/unloading of buses, and a parking area. Major stations would include a structure to access the station located in the middle of the highway, as well as elevators and other vertical circulation elements. It was assumed that all stations would be unmanned.

The DEIS/DEIR methodology included O&M costs only for South Station. Given the minimal infrastructure required at other stations (parking areas and a small shelter), this was appropriate. The addition of substantially larger and more complex stations at West Bridgewater and Brockton necessitated revisiting this assumption. Elevator maintenance is particularly complicated, and maintenances of these structures would be costly.

To determine a cost factor for this element, an average of two costs were used:

- *The MBTA's cost for an unmanned Green Line Station: $9,330*
- *Boston Express' cost for its South Londonderry Terminal: $48,247*

Average cost per station: $28,788

This Page Intentionally Left Blank

5

Results/Conclusions

The only factors that were changed from what was included in the DEIS/DEIR methodology are the costs for Busway Maintenance and Operations and the inclusion of a cost for the Operations and Maintenance of West Bridgewater and Brockton stations. The removal of the Zipper Lane on Route 24 changed the overall nature of busway operations and costs associated with the maintenance of the Route 24 Zipper Lane are no longer included. A cost for the stations in Brockton and West Bridgewater was also included since these two in-line stations would include maintenance-intensive features such as elevators and structures that would not exist at the other rapid bus stations. The cost factors and their sources are listed in Table 4.

Table 4 O&M Cost Factors

Factor	Unit Cost (2009$)	Source
Bus Operations and Maintenance	$10.36/hour of service (daily)	Average of Costs for Southeastern Regional Transit Authority, Potomac and Rappahannock Transportation Commission, Golden Gate Bridge, Highway and Transportation District, and Massachusetts Bay Transportation Authority
Busway Maintenance and Operations	$7,828 / lane mile $1.47 / square yard	MassHighway maintenance costs
Operations and Maintenance of West Bridgewater and Brockton Stations	$24,768/Station (Annual)	Average of Green Line and Boston Express Stations maintenance costs
Operations and Maintenance at South Station	$40,686/bay (annual)	Newmark Knight Frank Global Management Services (Managing Company for South Station Bus Terminal)

Note: Numbers presented represent the cost factor in 2008$, which have been adjusted for inflation (3% per year)

Using the service plans developed for each alternative, the annual O&M cost for each alternative was developed. Supply variables for each cost factor, along with the annual costs for that supply variable are listed below. For comparison, information is also presented for the DEIS/DEIR Rapid Bus Alternative, as shown in Tables 5.

Table 5 Rapid Bus O&M Costs

Alternative	Movement of Vehicles And Their Maintenance		Maintenance of Busways		O&M Cost for South Station		O&M Cost for Brockton and West Bridgewater Stations		Total O&M Cost
	Annual Revenue Miles	Annual Cost ($2009)	Distance/Area	Annual Cost ($2009)	Number of Bays Required	Annual Cost ($2009)	Number of Stations	Annual Cost ($2009)	
DEIS/DEIR Rapid Bus	3,648,575	$35,679,161	23 Miles 91,140 Sq Yards*	$3,553,865	8	$325,486	N/A	N/A	$39,558,512
Modified Rapid Bus Alternative	6,930,953	$71,798,100	33 Miles 464,757 Sq Yards	$942,181	10	$406,857	2	$49,536	$74,486,484
Stoughton Electric	424,780	$33,393,866	N/A	N/A	N/A	N/A	N/A	N/A	$28,060,648

* The DEIS/DEIR also included the cost for staff to man a barrier transfer machine for a new proposed "Zipper Lane" on Route 24 that is not applicable to this analysis as this element was removed from the proposed alternatives.