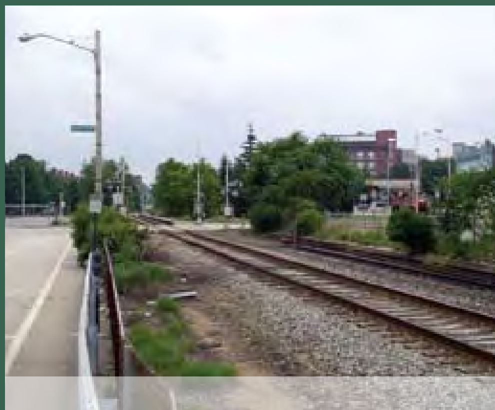

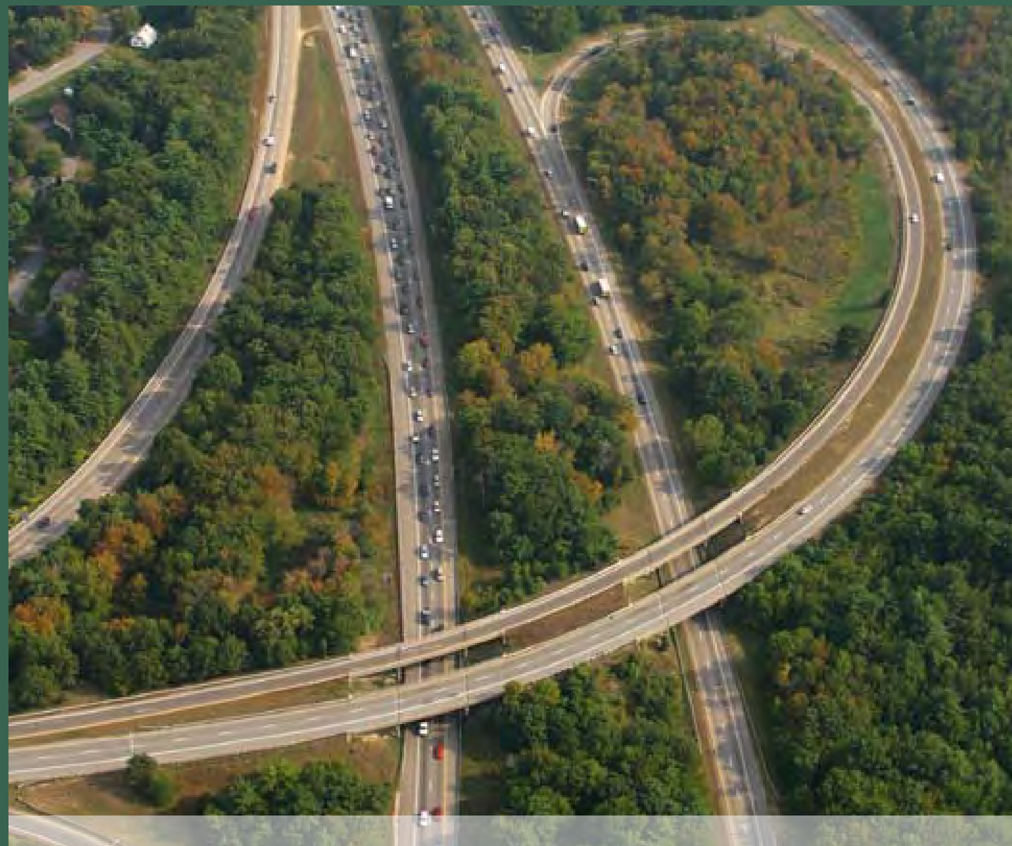

I-93 CORRIDOR MULTI-MODAL TRANSIT INVESTMENT STUDY

SUBMITTED TO:
New Hampshire
Department of Transportation

SUBMITTED BY:
HNTB Corporation

In association with:
Parsons Brinckerhoff Quade & Douglas, Inc.
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KKO & Associates

HNTB

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I-93 Transit Investment Study

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Executive Summary

Introduction

The New Hampshire Department of Transportation (NHDOT), in consultation with the Federal Highway Administration (FHWA) and the Massachusetts Executive Office of Transportation (MA EOT), has undertaken this study of transit alternatives to address future travel demands and to identify potential and feasible transportation modal alternatives for travel between southern New Hampshire and the Greater Metropolitan Boston area, including outlying suburbs along I-93, I-495 and I-95 (Route 128). From this study, the project sponsors seek to determine future transit investments necessary to feasibly meet mobility needs within the study area and to develop a strategic plan for implementation of recommended options.

The need for the study is based on the projected travel demands along the I-93 corridor between greater Manchester, New Hampshire and Metropolitan Boston. On the northern section of this corridor the New Hampshire Department of Transportation is undertaking safety and capacity improvements. Congested traffic conditions along I-93 have led to a parallel Massachusetts study of widening 10 miles of I-93 extending from the New Hampshire border to Andover in Massachusetts. These highway widening efforts both included evaluation of alternative rail and bus improvements along existing transportation corridors that form the basis for the current study.

Project Purpose

The initial purpose of this I-93 Transit Investment Study (TIS) is to identify modal alternatives to increase mobility options for New Hampshire residents to access major employment centers within the project corridor. The transit options evaluated enhance existing transit services or establish additional alternative transportation modes to the single occupant vehicle. This analysis of alternative transportation modes is being undertaken to provide travel choices for commuters and to manage congestion, improve air quality, and conserve natural resources. As the project evolved, it became obvious that transit options in the corridor would benefit Massachusetts residents as well as New Hampshire travelers.

Project Need

The need for the project, which was developed in consultation with the Technical Advisory Committee and the Stakeholder Committee, is presented in a Purpose and Need Report and is summarized below.

- **Levels of roadway congestion are projected to increase along the corridor between New Hampshire and many area employment centers**—The need for travel choices is driven by rapidly expanding population growth in southern New Hampshire and eastern Massachusetts, areas which have experienced some of the highest growth rates of any area throughout the U.S. over the past 30 years. Escalating housing costs in the Boston area have resulted in longer commuting patterns as the highest rates of population growth have spread to areas outside the urban core. At the same time, Greater Boston still dominates the economy in Massachusetts and is an important employment destination for southern New Hampshire residents. Growing employment markets in southern New Hampshire have also contributed to increased travel demands in the Merrimack Valley regions of both states. Recreational trips to destinations (lakes and mountains) in northern New Hampshire and Vermont from Massachusetts are another major factor causing increases in north-south regional travel demands.

This increased interstate travel has placed demands on the existing transportation infrastructure, resulting in proposals for highway widening on the major north-south highways servicing the Merrimack Valley Region in southern New Hampshire and Massachusetts (Interstate 93 and U.S. Route 3/F.E. Everett Turnpike). Beyond the planned safety and capacity enhancements on Interstate 93 (I-93) and recently constructed lane additions on U.S. Route 3/F.E. Everett Turnpike in New Hampshire and Massachusetts, it is recognized that there is very limited opportunity to address transportation needs through further expansion of the highway system.

- **Mobility Options are Limited**—Presently, there is no commuter rail service operating within the Merrimack Valley Region in New Hampshire. However, there are accessible regional and local bus services. The privately operated bus services operating between New Hampshire and Boston offer only minor travel time savings since they operate in the general purpose travel lanes at the same speed as automobiles for most of the trip. Traffic on the principal north-south arterial highways (I-93, U.S. Route 3, and F.E. Everett Highway) has dramatically increased, with growth rates of more than 50 percent since the 1980s.
- **Continued rate of growth of vehicular travel will negatively impact the study area's environment—**Without the infrastructure to support transit-oriented development in the study area, auto-oriented development will continue with its associated environmental and social impacts. [1]
- **Economic Development is Constrained**— Roadway traffic congestion and limited mobility options pose impediments to economic development in many areas within the study area.
- **Lack of implementation strategy for an integrated transportation and land use vision for the area—**The development of a coordinated implementation strategy for expanding transportation options is important for the future of New Hampshire businesses and residents to enhance access to jobs and reduce the growth of traffic congestion.

Project Context

The study area and the traffic model created for the project includes 70 communities in New Hampshire and Massachusetts that host or are influenced by the I-93 network. Between 1980 and 2000, the study area communities in Massachusetts added roughly 120,000 residents, or about 6,000 per year. Over the same time period, New Hampshire study area communities added about 176,000 residents, or approximately 8,800 per year. Most of these communities with the highest historic and projected population gains are located along one or more of the major north-south highways.

The study area includes multiple important north-south transportation corridors which access the study area, including I-93, U.S. Route 3, and the F.E. Everett Turnpike in New Hampshire. The I-93 corridor roughly bisects the study area while two other rail transportation corridors flank I-93 on either side. On the west, the Lowell-Nashua-Concord rail corridor consists of the New Hampshire Main Line (owned by Pan Am Railways) and the MBTA Lowell Line in Massachusetts. On the eastern side of the study area, the Manchester-Lawrence-Boston rail corridor consists of the Manchester & Lawrence (M&L) Branch and the MBTA Haverhill Line (over which Pan Am Railways operates its West Route Main Line) in Massachusetts. The railroad corridors, particularly in the New Hampshire portion of the study area and the M&L Branch railroad, may fairly be

[1] Travel data for this study predates the national economic downturn. This current situation has impacted travel demand, with vehicle miles traveled declining during the past year. However, longer term historic trends suggest that travel demand in the I-93 corridor will continue to increase, albeit at lower rates than illustrated in the model reports used in this study.

characterized as having capacity to accommodate potential transit services. These rail corridors and I-93 were the focus of multi-modal evaluations for the I-93 TIS.

Alternatives Screening

Overview of Alternatives Analysis

The alternatives evaluation involved a phased evaluation to screen a range of the prospective alternatives. A total of fifteen conceptual build alternatives were explored in the first phase of screening analysis.

Alternatives initially identified build upon those identified in previous planning studies for highway improvements within the I-93 corridor. The conceptual build alternatives spanned three travel corridors:

- Eastern Corridor (M&L Branch from Manchester via either the Haverhill Line or the Haverhill Line, Wildcat Branch and Lowell Line to Boston)
- Highway Corridor (I-93, using either a transit reservation or shoulder areas), and
- Western Corridor (New Hampshire Mainline and Lowell Line from Manchester to Boston).

This alternatives evaluation performed for the I-93 Transit Investment Study considered two types of transit: rail alternatives using existing rail lines or the I-93 corridor, and bus transit. The rail alternatives would use existing rights-of-way in the Eastern and Western Corridors and a combination of transit reservation and existing rail corridors in the Highway Corridor. The bus transit alternatives use the highways in each alignment and part of the rail right-of-way in the Eastern Corridor.

All of the rail alternatives were developed with Manchester /Londonderry as the northern terminus and one of five cities – Boston, Woburn (Anderson), Lowell, Andover, or Lawrence -- as the southern terminus. The bus options would all provide service into downtown Boston.

The screening process culminated in selection of a preferred bus and rail options for the final screening.[2] Of the rail options, the eastern rail alignment was selected for further consideration. The western rail alignment, while clearly recognized as a viable candidate for passenger rail service, did not meet I-93 travel demand to as great a degree as the other alternatives. The use of the existing I-93 highway corridor for rail did not provide the same level of service, market penetration and travel times as the eastern rail alignment.

Transportation Systems Management (TSM) is defined as improvements to the efficiency and operation of the existing transportation system. TSM, through use of expanded bus service and other system improvements, is a component of the No Build analysis. The preferred alternative, for expanded bus service operating within the I-93 outside shoulders, incorporates TSM measures to a large degree.

The final alternatives identified as a result of this phased alternatives screening and evaluation process consisted of:

- No Build

[2] The TSM and No build options were combined in the final analysis.

- Bus on Shoulder (BOS) along I-93 using shoulders in New Hampshire and existing HOV lanes approaching Boston (using an Ottawa-style operating plan)
- Commuter Rail Service from Exit 5 to Boston, using the M&L Branch, Haverhill Line, and Wildcat Branch to connect to the Lowell Line.

The environmental screening presented in the report focuses on the differences between the Bus on Shoulder and the Commuter Rail Service alternatives and compares these impacts to the No Build conditions. These alternatives are described below.

No Build

The No Build scenario includes existing bus service between the Manchester Transportation Center and downtown Boston, and commuter bus service from park-and-ride lots along I-93 in New Hampshire. NHDOT has expanded bus service to Boston from the park-and-ride lot at Exit 4 and new park-and-ride lots at Exit 5 (Londonderry) and Exit 2 (Salem).

According to NHDOT, projected total ridership for the new service is approximately 462,000 passenger trips per year. Average daily inbound boardings in 2030 are estimated to range from 1,680 to 1,880. Peak headways from Exit 5 in Londonderry to downtown Boston would be 30 minutes with peak travel time of 64 minutes to/from State Street.

Bus on Shoulder along I-93

The Bus on Shoulder alternative would operate along an exclusive busway to be provided within the shoulder area along the majority of I-93. This approach to providing an “exclusive” lane for buses to improve bus travel times and reliability represents a low-cost strategy that can be implemented relatively quickly and easily in comparison to the expansion of highway travel lanes or right-of-way.

Bus service would pick up and drop off passengers at offline stations in New Hampshire, including the Manchester Transportation Center and park-and-ride lots and town center locations at I-93 Exits 5, 4, 3, and 2 in New Hampshire and Methuen. Buses would travel on I-93 shoulders until entering the Massachusetts HOV lane near Exit 30. Once in Boston, buses from park-and-ride lots would stop in the vicinity of the Massachusetts Bay Transportation Authority (MBTA) State Street Station and other downtown locations en route to the South Station terminal.

The use of shoulders on a regular basis for bus operations in many places requires improvements to the shoulder. Shoulders on many limited-access roadways are 10 feet wide or less and are not constructed to the same design standards of the general purpose travel lanes. Since buses, with mirrors, are typically close to 10 feet wide and are heavy vehicles, regular use of the shoulders without modification would not be advisable. Additionally the grades of the shoulders, drainage side slopes, and catch basin structures also all often require modification. Additional signage and pavement markings should be considered for safe operations.

Two types of operating plans for the I-93 BOS option were considered:

- **Minneapolis-style BOS** would allow buses to operate on the shoulder at a maximum of 35 miles per hour when general flow traffic is moving under 30 miles per hour.
- **Ottawa-style BOS** would allow buses to operate on shoulders at speeds of up to 60 miles per hour without any restrictions, regardless of general traffic flow speed.

The Ottawa version was found to produce to produce an average travel time savings for bus commuters of 13 minutes, and was the operating plan carried forward for the BOS option.

The Bus on Shoulder concept could be built through a phased implementation coinciding with planned improvements along the corridor. As the phasing plan currently proposed would occur over a 22-year period, it will be appropriate to reassess the potential benefits of implementing each phase as it comes time for implementation.

The Bus on Shoulder Alternative appears to have significant levels of travel time and cost advantages that should warrant further consideration for implementation. The estimated average daily ridership for the alternative is approximately 5,000 to 5,500 inbound boardings in 2030. This ridership estimate is based on the full-build of the required I-93 infrastructure, the anticipated growth in population and employment in 2030, and the implementation of an operating plan that includes about 90 daily bus trips in each direction. In addition to the planned services, existing bus services may also be able to use the shoulder facilities, which would result in additional transportation system benefits.

The table below shows the estimated ridership demand in 2030 on each of the transit alternatives considered. The travel demand from the corridor to the Boston core appears to be generally the same regardless of the transit alternative that is implemented. Both the BOS and commuter rail service alternatives show a demand for approximately 5,000 inbound boardings each day. The ridership increases by approximately 700 riders with an extension of the rail service to the Manchsester-Boston Regional Airport and downtown Manchester.

	No Build	**BOS (Ottawa)**	**Rail**
Peak Transit Headway from Exit 5	30	15	30
Peak Travel Time from Exit 5 to Downtown Boston	64	50	65
Ridership	1,680-1,880	4,945-5,545	4,870-5,375
Estimated Capital Cost in millions (2008 dollars)		$112 to $132	$250
Annual Operating and Maintenance Costs (in millions)	3.6	5.9	9.6

The Transportation System User Benefits (TSUB) is a measure that the Federal Transit Administration (FTA) uses to assess benefits that accrue to the users of a transit system resulting from an improvement. An estimate of the FTA's measure of the TSUB for each of the proposed alternatives has been developed. This benefit is typically travel time saved, but can also represent reduced travel costs which are converted to a travel time measure. This table shows hours of daily user benefits in 2030.

	Hours
Commuter Rail Service on M&L Branch Alternative	-149
Bus on Shoulder (BOS) Alternative	1404

The level of user benefit of the BOS Alternative shows that it is a potential candidate for Federal Transit Administration New Starts program funding under the criteria currently in place. If implemented as a single project, the cost per user benefit would be in the range of $10 to $15 per user benefit. This would result in a high to medium-high evaluation in FTA's cost effectiveness evaluation of the project. The negative user benefit of the commuter rail service alternative means that it is not a candidate for Federal Transit Administration New Starts program funding under the current criteria.

Commuter Rail Service along M&L Branch

The Manchester & Lawrence Rail Corridor is an inactive right-of-way in New Hampshire. Currently, only the first mile of the M&L Branch in Lawrence is active for freight service. The railroad right-of-way for the East Rail Corridor along the M&L Branch is largely owned by the State of New Hampshire, with few exceptions, and the MBTA owns the right-of-way (Haverhill Line/B&M West Route Main Line) within Massachusetts. Portions of the right-of-way in Derry and Londonderry are owned by the town and private entities. Commuter rail improvements are proposed to start south of the Manchester-Boston Regional Airport, where the Manchester Airport Authority has acquired 2.2 miles of right-of-way and constructed a runway extension over the right-of-way.

This rail alternative would offer direct service from the northern terminus at Exit 5 in Manchester, NH to the southern terminus of North Station in Boston, MA on the existing M&L Branch, the Wildcat Branch and the Haverhill and Lowell Line MBTA railroads. Service on the Lowell Line operates primarily over the New Hampshire Main Line (NHML) tracks between North Station in Boston and downtown Lowell.

This 47-mile alignment would require five new stations (Londonderry, Derry, Salem, Methuen, and Lawrence) and offers a travel time of 65 minutes. Direct services would also call on the existing Andover and Anderson stations in Massachusetts and travel non-stop between Anderson and Boston. The average peak period headway for the service would be 30 minutes and the off-peak headway would be approximately 60 minutes.

An alternative for extending service to the Manchester-Boston Regional Airport was also evaluated. The Manchester/Airport Extension Alternative incorporated all the same assumptions service plans as the Exit 5 to Boston commuter rail service alternative with the addition of two stations. These include a station at the Airport and one in downtown Manchester. Because of the tunneling that would be required to access and travel under the Manchester-Boston Regional Airport, the portion of the alignment from Exit 5 to Granite Street is projected to cost $232 million, for a total alignment cost of $482 million. For this reason, this airport rail extension was not included in the final alternatives screening.

The 22-mile section of the M&L right-of-way between the MBTA's Haverhill Line at Lawrence and the Manchester-Boston Regional Airport could support track construction and train operations. Major improvements would be necessary on the New Hampshire segments along the M&L Branch, where track structure is not in place north of Salem. The existing track structure would need to be reconstructed as single track over most of the alignment. Along the Massachusetts portion of the M&L Branch, where limited freight service has recently operated, track rehabilitation would be necessary. Although the right-of-way could support rail service, there are several issues that would need to be addressed in some manner to allow that to happen.

- **Road crossings:** There are 45 road crossings, six in Massachusetts and 39 in New Hampshire. Of these, three in Massachusetts and nine in New Hampshire could be characterized as major crossings in terms of traffic volumes and/or nearby intersections that would complicate operating trains across at any speed. To operate a passenger service, each crossing would have to have railroad crossing warning systems installed and the major crossings would need additional measures such as traffic signal pre-emption, geometric roadway improvements and modifications to allow passenger rail operations.

- **Bridges and Culverts:** There are a number of bridges and major culverts carrying the M&L right-of-way over roads or waterways. These bridges would have to be rehabilitated or replaced to make them suitable for railroad passenger service.
- **Windham Rail Trail:** The 3.5-mile bike path along the M&L Branch railroad right-of-way is well patronized. There is insufficient right-of-way to maintain both the trail and an active railroad without property acquisition and significant wetland impacts. The trail would have to be discontinued on the corridor.
- **Downtown Derry:** The extensive public and private development along the M&L Branch rail corridor in the center of Derry would require considerable effort to modify to allow the passage of trains. The rail corridor has almost disappeared under various access roads, drives, walkways and parking areas.
- **Private Ownership:** There have been portions of the right-of-way sold to private developers with apparently no provision in the sale agreements to address possible re-use of the land for transportation purposes. Further development on or too close to the rail corridor would make future use for rail service more difficult.

There are existing single track constrictions on the current MBTA lines that the M&L Branch would connect to that would need to be addressed if additional trains were to be run into Boston. The total distance is just under 11 miles and includes several existing junctions or interlockings. Modifications and upgrades to the Haverhill Line and connection point would be needed, as both the Haverhill Line and Wildcat Branch are single track. Adding new service to the existing trains on those single track segments will require double tracking of the Haverhill Line from Andover Street Interlocking in Lawrence to Wilmington Junction in Andover and the Wildcat to just short of its connection to the New Hampshire Main Line in Wilmington.

The commuter rail alternative would be expected to potentially generate greater economic benefits and secondary transit-oriented development in the vicinity of station sites than the Bus on Shoulder option. However, reactivation of the M&L Branch would incur greater environmental impacts, as land uses and trails have encroached upon portions of the right-of-way. In particularly, the right-of-way in New Hampshire includes public trail uses in Londonderry, Derry, and Windham and is in close proximity to a number of properties. There are plans to pave the remainder of the path from Derry to Salem.

In addition, the NHDOT *Salem to Concord Bikeway Feasibility Study* identifies the M&L Branch as the preferred bicycle route for a proposed recreational bike path. The report states that, given the close proximity to wetlands, particularly in Windham and Derry, it would be difficult to construct a trail with adequate separation from an active rail line ("rail-with-trail") on the M&L Branch.

It is assumed that double-tracking along the Haverhill Line and Wildcat Branch would be performed within the existing railroad right-of-way, although utilities relocations may be required. Further design studies would need to be performed to assess the planned configuration of the double-tracked sections of these active commuter rail lines and the potential effects on adjoining land uses.

Another consideration is potential impacts on cultural resources. In consultation with the NHDHR, the NHDOT performed a cultural resource assessment that determined that portions of the M&L Branch that are relatively intact (Windham and Salem) are potentially eligible for listing on the National Register of Historic Places. The reinstitution of commuter rail service along the M&L

Branch would affect the portions of the M&L Branch that have been determined to be National Register eligible.

Public Outreach

A vigorous public outreach program assisted the development of the strategic implementation plan (Chapter 10). The first phase of public outreach was held in April 2007 with public meetings held in Methuen and Derry, which provided an opportunity for the public to be introduced to the complexity of the region's transportation challenges and the range of options being explored. Public input helped the study team to narrow the field of alternatives to meet travel needs in the corridor. A second round of public meetings was held in November 2007, at which the alternatives analysis was presented. The second round of public meetings provided important public comment about the need for public transit to augment the highway system and the expectations of the public as to what a transit system should provide for the region. These inputs are reflected in the plan.

The project hosted a web site, and fact sheets and a newsletter were prepared and circulated. Formal and informal meetings were held with a wide range of stakeholders (bus operators, communities, regional agencies). Finally, the TAC met on regular basis, and the study team participated in several of NH DOT's Community Technical Assistance Program meetings and workshops that focus on helping the I-93 corridor communities plan for and deal with the anticipated impacts of the highway improvement project.

1. Purpose and Need

Introduction

Southern and central New Hampshire, the I-93 Corridor, has developed rapidly over the past several decades, emerging from a pastoral rural setting to become an area of bedroom communities for the metropolitan regions of Boston, Manchester, and Nashua. In fact, several communities in the corridor have developed economic bases of their own, further increasing pressure on the transportation infrastructure. This growth has led to increased concerns for safety and efficacy of the overall transportation system, and the New Hampshire Department of Transportation (NHDOT) is currently widening and improving I-93 in an effort to meet travel demands spurred by this growth. Concurrently, the NHDOT conducted this I-93 Transit Investment Study through a cooperative agreement with the Massachusetts Executive Office of Transportation (MA EOT) and in cooperation with Federal Highway Administration (FHWA) and Federal Transit Administration (FTA).

The study addresses future travel demands and identifies potential and feasible transportation modal alternatives for travel between southern New Hampshire and the Greater Boston area, including outlying suburbs along I-93, I-495, and I-95 (Route 128) – the Study Area (see Figures 1-5). This study was undertaken to determine future transit investments necessary to meet mobility needs within the study area and develop a strategic plan for funding and phased implementation of recommended options.

Project Purpose

The purpose of I-93 Transit Investment Study (TIS) is to identify solutions to increase mobility options for New Hampshire residents to access major employment centers within the project corridor. The transit options evaluated enhance existing transit services or establish additional alternatives to the single occupant vehicle. This analysis of alternative transportation modes is intended to provide information on travel choices for commuters that also manage congestion, improve air quality, and conserve natural resources.

Project Need

The I-93 Transit Investment Study was initiated to evaluate the feasibility of alternative transportation modes and transportation corridors in the I-93 study area between Boston and Manchester. The need for the project, which was developed in consultation with the Technical Advisory Committee and the Stakeholder Committee, was presented in the Purpose and Need Report (available as a separate report), and is summarized below.

Levels of roadway congestion are projected to increase along the corridor between New Hampshire and many area employment centers.

Travel patterns have dramatically shifted since the 1980s, as escalating housing costs in the Boston area have driven Boston workers to seek out more affordable housing outside of the Boston metropolitan area, resulting in outward migration of commercial and residential growth to the I-95 (Route 128) and I-495 corridor communities. This has resulted in longer commuting patterns as the highest rates of population growth have spread to areas outside the urban core. At the same time, Greater Boston still dominates the economy in Massachusetts and is an important employment destination for southern New Hampshire residents. Growing employment markets in southern New

Hampshire have also contributed to increased travel demands in the Merrimack Valley regions of both states. Recreational trips to destinations (lakes and mountains) in northern New Hampshire and Vermont from Massachusetts are another major factor causing increases in north-south regional travel demands.

This increased interstate travel has placed demands on the existing transportation infrastructure, resulting in proposals for highway widening, on the major north-south highways servicing the Merrimack Valley Region in southern New Hampshire and Massachusetts (Interstate 93 and U.S. Route 3/F.E. Everett Turnpike) (Figure 1). Traffic on these principal north-south arterial highways has dramatically increased, with growth rates of more than 50 percent since the 1980s. North of metropolitan Boston, traffic volumes recorded by MassHighway in 2005 were as high as 90,000 on U.S. Route 3, and I-93 traffic volumes ranged up to 170,000. Projections into the next 20 years indicate that this traffic will continue to grow as population expands in areas beyond the current commuting patterns. Beyond the planned capacity expansions on Interstate 93 (I-93) and recently constructed lane additions on U.S. Route 3/F.E. Everett Turnpike in New Hampshire and Massachusetts, there is very limited opportunity to address transportation needs through further expansion of the highway system.

Mobility options are limited

Presently, there is no passenger rail service operating within the Merrimack Valley Region in New Hampshire. However, there are accessible regional and local bus services, including privately operated bus services to Boston from Manchester, Londonderry, Salem and Nashua. The privately operated bus services operating between New Hampshire and Boston offer only minor travel time savings since they operate in the general purpose travel lanes at the same speed as automobiles for most of the trip.

Although 13% of all work trips made in New Hampshire are made to Massachusetts, the only destination district with a transit mode share (percent using transit) above 3% is the inner core of Boston. This inner core area receives a transit mode share of 11% of New Hampshire residents commuting to Boston with the limited service, as noted above. This percentage indicates the importance of transit for the work link between the Boston Central Business District and New Hampshire.

The combined impacts of longer work trip commuting and accompanying land development patterns has intensified public interest in the development of alternative transportation choices as the continued growth of traffic volumes cannot continue due to physical constraints to the highway system.

Continued rate of growth of vehicular travel will negatively impact the study area

Without the infrastructure to support transit-oriented development in the study area, auto-oriented development will continue with its associated environmental and social impacts. The most notable impact of the existing development pattern is the increase in automobile use, continued and worsening congestion and the degradation of air quality that accompanies increased auto use.

As elaborated in the June 2006 New Hampshire Long Range Transportation Plan, residents of both New Hampshire and Massachusetts are becoming more concerned with the increased consumption of land, the changes to community and downtown character and associated impacts to the natural environment, in addition to environmental impacts.

Economic development is constrained

Roadway traffic congestion and limited mobility options pose impediments to economic development in many areas within the study area. It limits the development capacity and quality of life in developed areas and can restrain emerging areas from reaching their full potential.

The Commonwealth of Massachusetts Long-Range Transportation Plan (2006) notes an important trend: "The combination of high cost of living and increasing congestion, commuting distances, and commute times is threatening Massachusetts' ability to attract and retain workers…The Commonwealth has experienced a net population loss in each of the last two years…While there are many factors that contribute to this decline, access to good employment opportunities and reasonably priced housing are considered primary issues in this outward migration. Transportation planning and investment will have a dramatic impact on both of these. Because preserving our quality of life and economic competitiveness are mutually reinforcing goals, the planning and management of our state's infrastructure must support economic development that is sustainable."

Lack of implementation strategy for an integrated transportation and land use vision

The development of a coordinated implementation strategy for expanding transportation options is important for the future of New Hampshire businesses and residents to enhance access to jobs and reduce the growth of traffic congestion.

Study Goals and Objectives

The I-93 TIS is an effort to identify what should be done in the future to accommodate the travel demands of the future within the corridor between Manchester, NH and Boston, MA. This study will be the basis for broader efforts that will look not only at transportation but also at development, growth and environmental and community protection efforts. The specific goals of the I-93 TIS are to:

- Identify potential feasible opportunities, and establish funding priorities, for bi-state investments in transit (bus and rail),
- Develop a strategic plan for funding and phased implementation of recommended options, incorporating agency, community, and stakeholder inputs,
- Develop alternatives that will support Transit Oriented Development and be consistent with Smart Growth initiatives in both states.

The associated objectives and potential evaluation measures are identified as follows:

- Accommodate Growth in Longer Distance (north-south) Travel Markets
- Increase Mobility Options

  Increasing the mobility options in the study area should result in providing opportunities for residents of New Hampshire and Massachusetts while minimizing the impact to area roadways. This will serve to improve the efficiency and effectiveness of the region's transportation system. Measures that will be helpful in evaluating the value of potential mobility options include:

  - Capital Cost
  - Cost-Effectiveness
  - Ridership

- User Benefits (Travel Time Savings)
- Mode Shift
- Land Use and Development Impacts
- Environmental Impacts
- Public Support

- Improve Economic Development Opportunities
- Support Regional Strategies
- Help Attain Regional Environmental Objectives

Mobility improvements should contribute to the attainment and long-term maintenance of conformity with National Ambient Air Quality Standards. Mobility improvements should improve overall environmental conditions in the study area and minimize adverse affects. Factors to be considered in evaluating environmental impacts of alternatives include:

- Land Use and Zoning
- Vehicular Travel/Congestion
- Regional/Mesoscale Air Quality
- Noise/Vibration
- Historical/Archeological Resources
- Recreation/Parklands
- Water Resources and Wetlands
- Hazardous Materials

Organization of Report

The first phase of the study involved data gathering to forecast future growth and define the purpose and need for the project. This data that is summarized in the detailed Purpose and Need Report (Appendix G) prepared for the project included a comprehensive review of existing and projected future interstate traffic and soceoeconomic (population and employment) conditions. A review was performed of relevant prior state, regional, and local transportation and land use studies, and passenger rail service, freight rail use, and bus services and ridesharing initiatives along prospective transportation corridors.

Chapter 1 describes the Purpose and Need and presents the goals and objectives for the project. Chapter 2 addresses the project context. It summarizes existing conditions, documents the transportation needs and policy context for the project, and reviews prior studies. A detailed review of existing conditions is presented in the Purpose and Need Report (Appendix G).

The alternatives considered include modal (rail and bus) alternatives and reuse of existing transportation (rail and highway) corridors. The development of project plans and multi-modal transportation alternatives took place in consultation with a Technical Advisory Committee that included federal, state, and regional transportation agencies and regional planning commissions from both states. Input into the study was also obtained through meetings held with the public and a Stakeholder Committee.

The second phase of the study involved the identification and screening of alternatives that was performed as an iterative, multi-level alternatives evaluation. Five levels of screening of modal and corridor alternatives were performed. Chapters 3 through 7 document the methodology and results from four levels of alternatives identification and screening.

Chapter 8 presents the final alternatives developed for the project and discusses a phased implementation approach for the preferred alternative. This chapter presents the results of the I-93 transit ridership demand model and travel demand forecasts. It also summarizes service schedules, routes, prospective station sites, and estimated costs and ridership.

Preceding the final screening and selection of alternatives, the analysis performed included an analysis of municipal land use and zoning policies, identification of transit-oriented development (TOD) opportunities, and environmental screening of the conceptual alternatives. Station siting for prospective alternatives was performed to maximize the potential for TOD, and conceptual plans for stations sites incorporating TOD were developed.

Chapter 9 presents an overview of existing land use, socioeconomic, and environmental conditions in the study area and a general comparison of the socioeconomic and environmental impacts for the final alternatives identified for further consideration.

The third and final phase of the study was the development of a Strategic Implementation Plan (Chapter 10). The plan identifies and analyzes a phased approach to implement study recommendations and the preferred alternative. The Strategic Implementation Plan identifies financial requirements for implementation, implementation objectives, strategic issues and strategic action/implementation items, including bi-state actions to be taken to implement recommended improvements.

2. Project Context

Existing Conditions

Study Area

The study area and the traffic model created for the project includes 70 communities in New Hampshire and Massachusetts that host or are influenced by I-93 (Figures 1 through 5). The potential market area, and study area, for the I-93 TIS was defined to include 38 communities within Hillsborough (Manchester area), Rockingham, and Merrimack Counties in southern New Hampshire and 32 communities within Essex, Middlesex, and Suffolk Counties in Massachusetts. The study area includes regions that are covered by four regional planning commissions in New Hampshire: the Central New Hampshire Regional Planning Commission (CNHRPC), the Southern New Hampshire Planning Commission (SNHPC), the Nashua Regional Planning Commission (NRPC), and the Rockingham Planning Commission (RPC) (Figure 5). The three regional planning commissions in Massachusetts are: the Northern Middlesex Council of Governments (NMCOG), the Merrimack Valley Planning Commission (MVPC), and the Metropolitan Area Planning Council (MAPC) (Figure 5).

The study area includes multiple important north-south transportation corridors which access the study area, including I-93, U.S. Route 3, and the F.E. Everett Turnpike in New Hampshire. The I-93 corridor roughly bisects the study area while two other rail transportation corridors flank I-93 on either side. On the west, the Lowell-Nashua-Concord rail corridor consists of the New Hampshire Main Line (owned by Pan Am Railways) and the MBTA Lowell Line in Massachusetts. On the eastern side of the study area, the Manchester-Lawrence-Boston rail corridor consists of the Manchester & Lawrence (M&L) Branch and the MBTA Haverhill Line (which operates on the Pan Am Railways West Route Main Line) in Massachusetts. These rail corridors and I-93 were the focus of multi-modal evaluations for the I-93 TIS.

Population and Employment Growth in the Manchester-Boston Corridor

As the Boston Metropolitan Region continues to evolve, people are migrating north towards and into New Hampshire (Figure 6). This growth can be attributed to the high cost of housing in the Boston region and the growth of economic centers outside of downtown Boston. Southern New Hampshire is already one of the fastest growing regions in New England and this trend is expected to continue (Figures 7 and 8).[3]

Between 1980 and 2000, the study area communities in Massachusetts added roughly 120,000 residents, or about 6,000 per year. Over the same time period, New Hampshire study area communities added about 176,000 residents, or approximately 8,800 per year. In the Massachusetts portion of the study area, the greatest population increases between 1980 and 2000 occurred in Boston, Haverhill, Lawrence, Dracut, Methuen, and Westford. In the New Hampshire portion of the study area, the highest population increases between 1980 and 2000 occurred in Nashua, Manchester, Derry, and Concord. Most of these communities with the highest historic and projected population

[3] Travel data for this study predates the national economic downturn. This current situation has impacted travel demand, with vehicle miles traveled declining in recent years. However, the long term historic trends suggest that travel demand in the I-93 corridor will continue to increase, albeit at lower rates than illustrated in the model reports used in this study.

gains are located along one or more of the major north-south highways (I-93 or U.S. Route 3 and/or F.E. Everett Turnpike corridors).

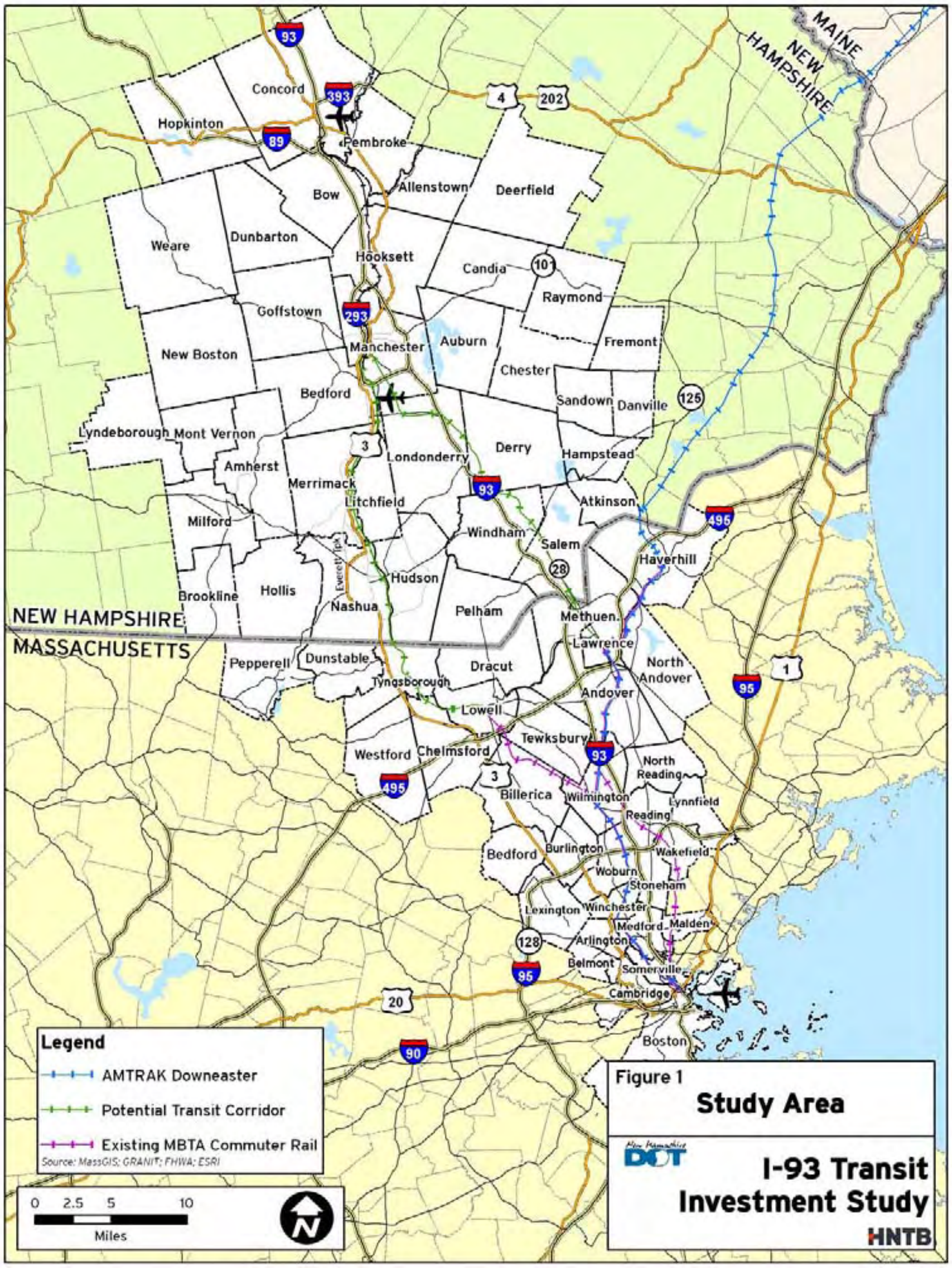


Figure 1 Study Area

Figure 2—Existing Railroad System

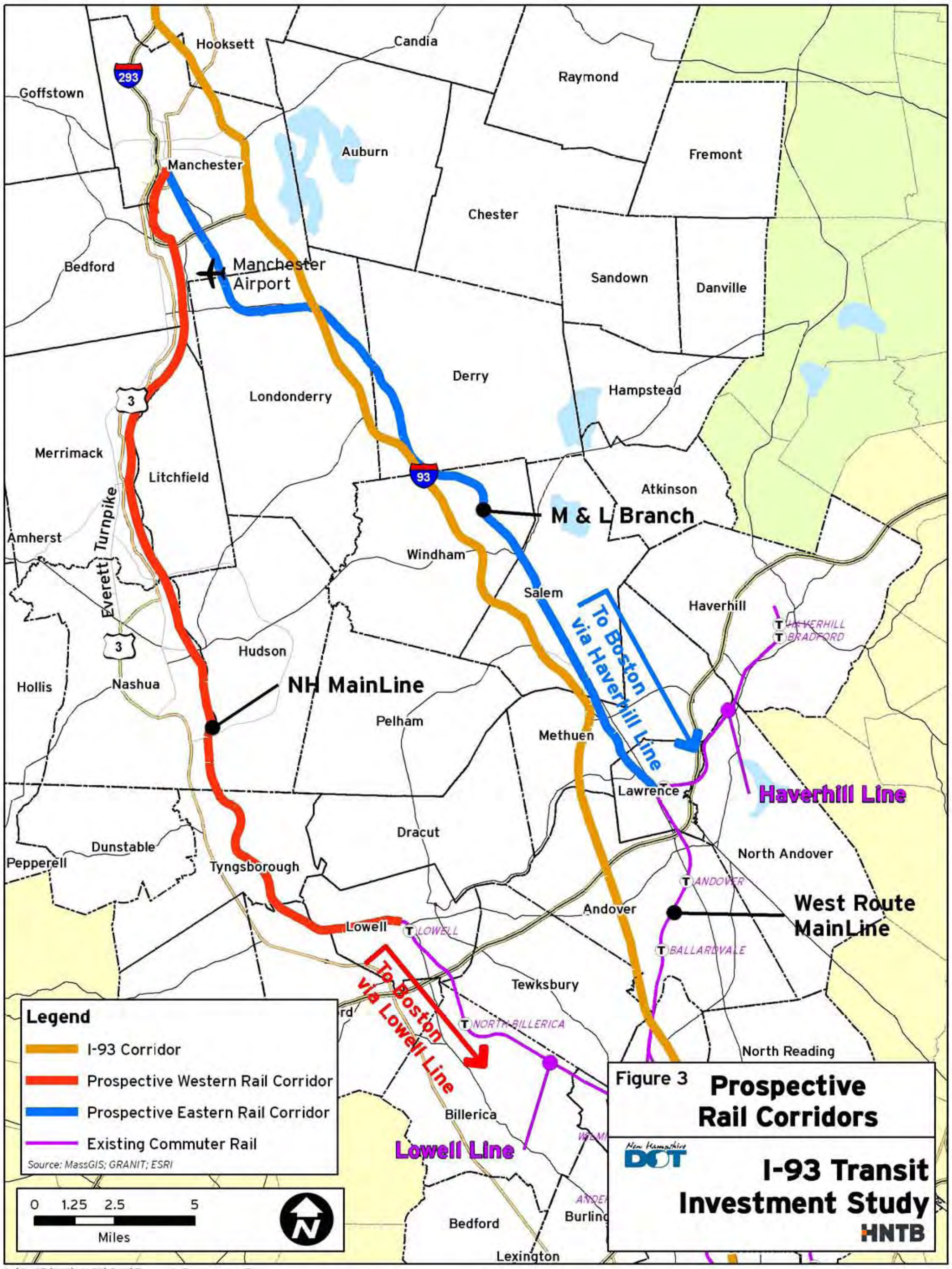


Figure 3—Prospective Railroad Corridors

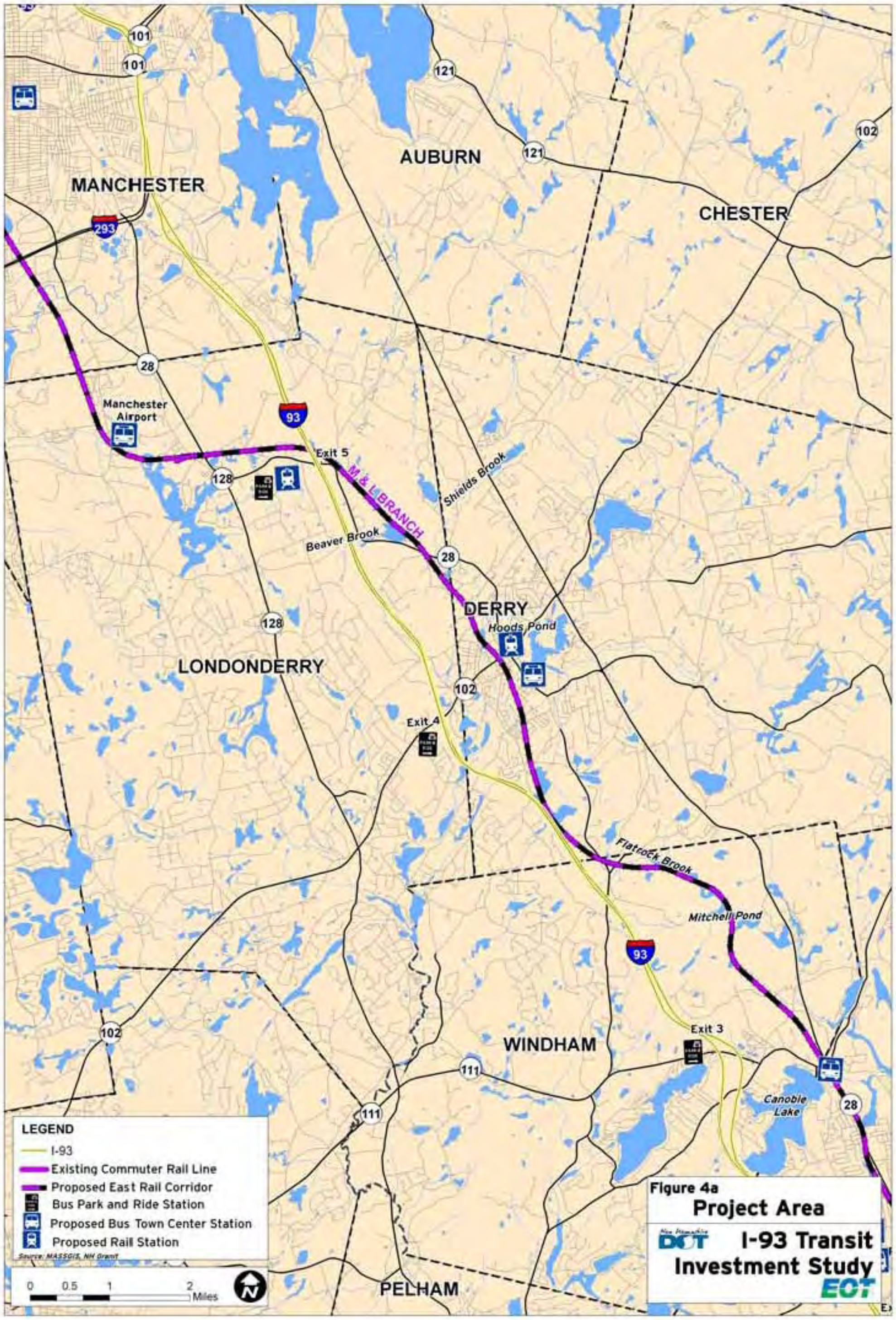


Figure 4a—Project Area

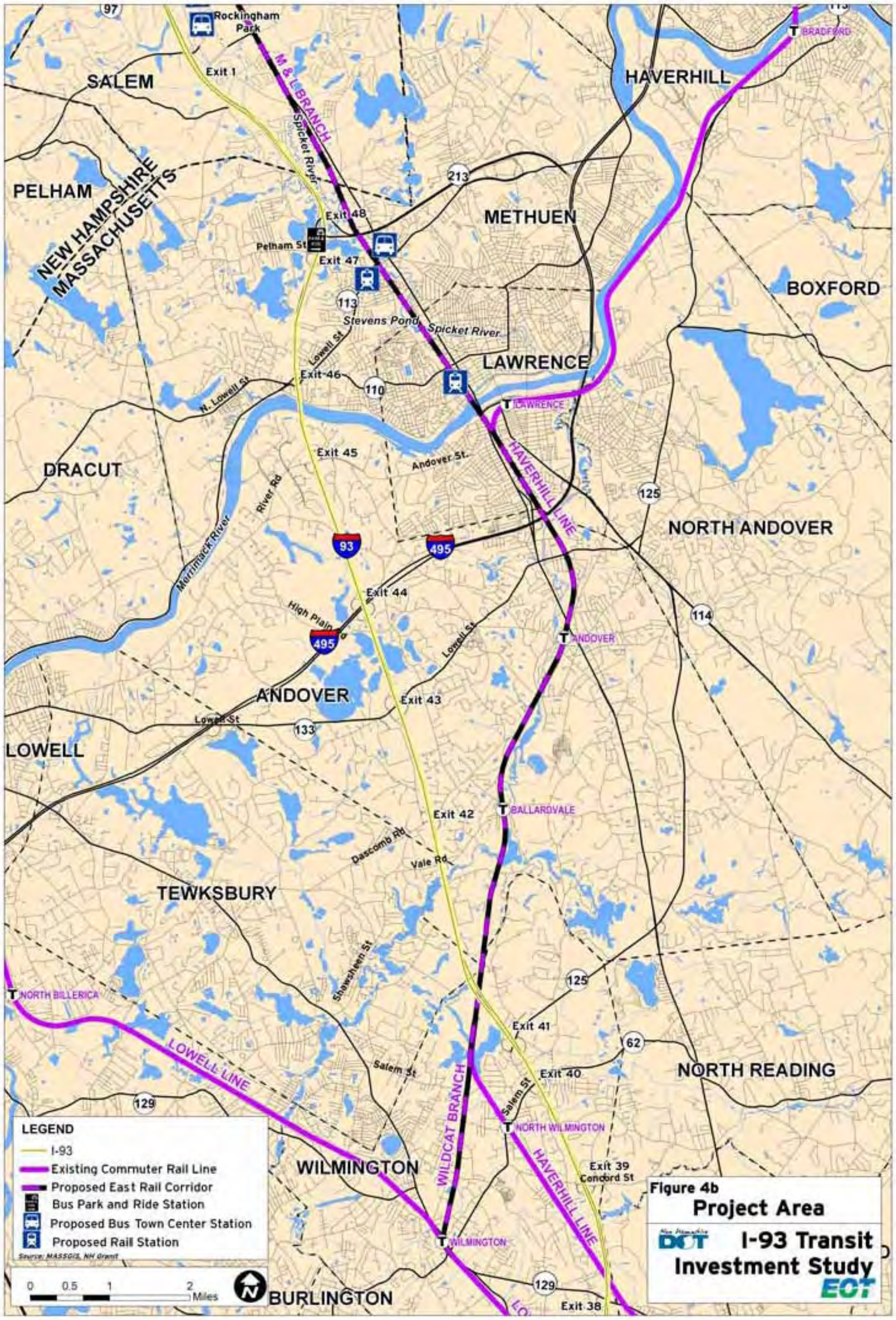


Figure 4b—Project Area

Figure 4c—Project Area

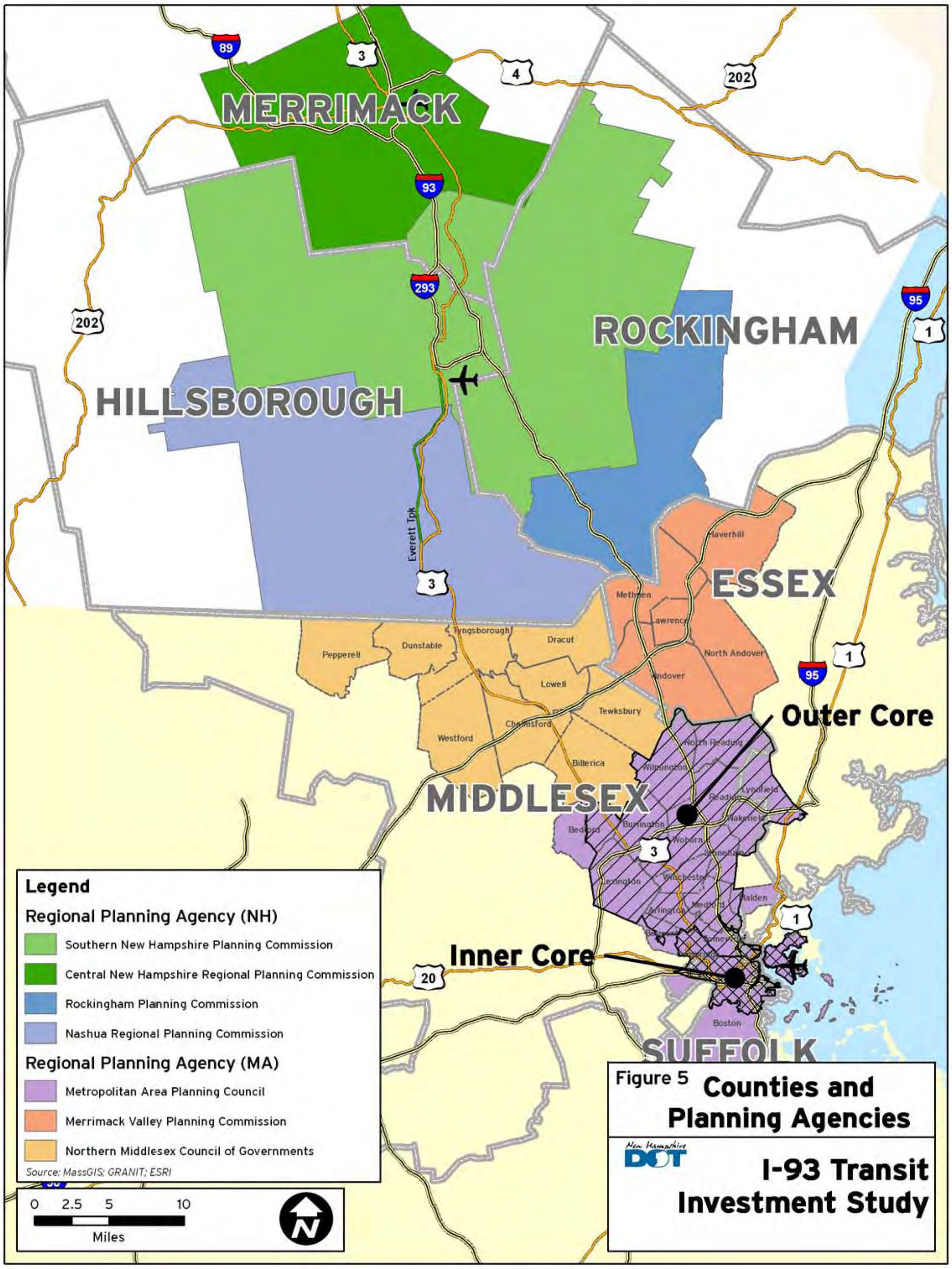


Figure 5—Counties and Planning Areas

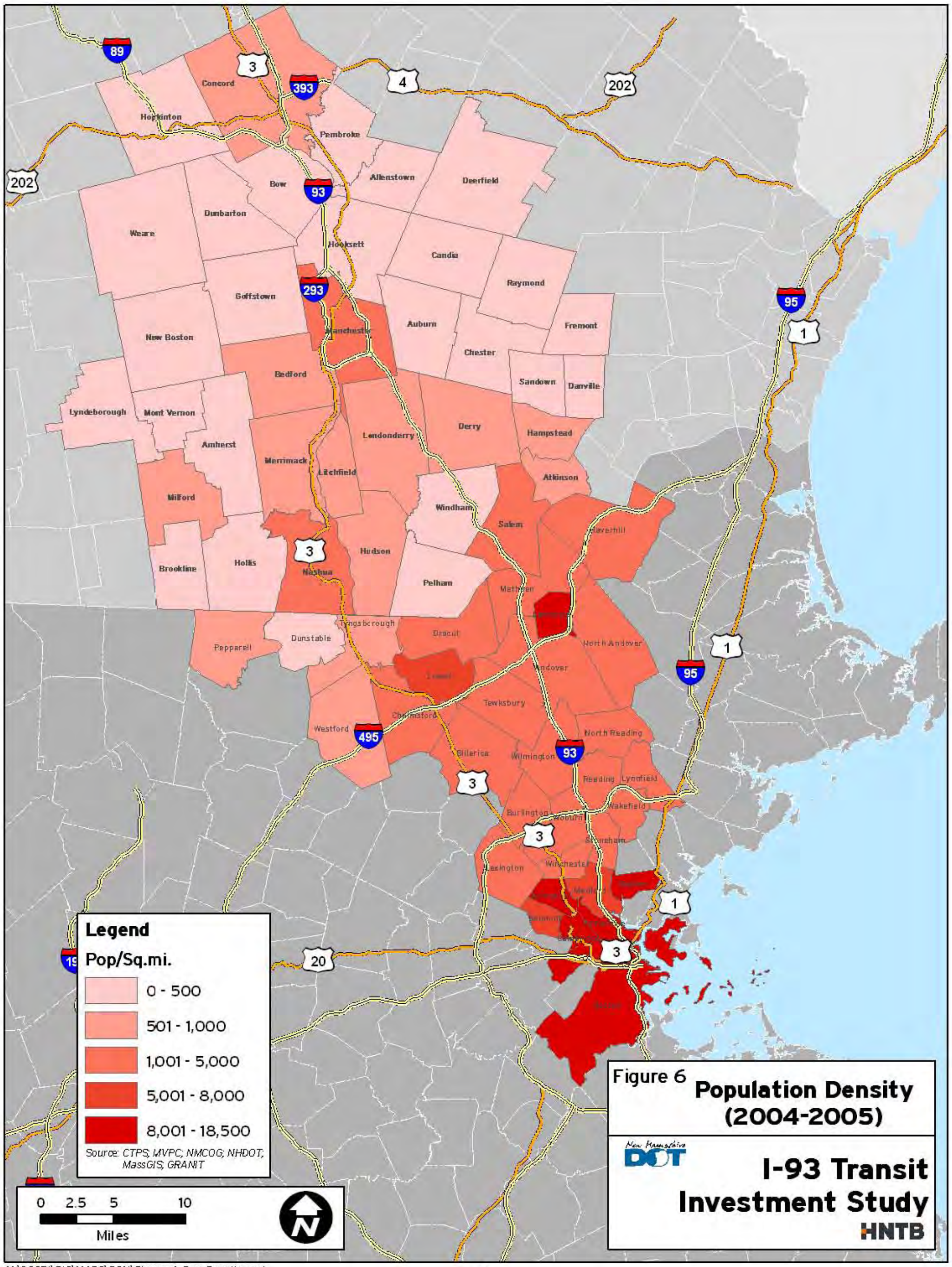


Figure 6-Population Density (2004-2005)

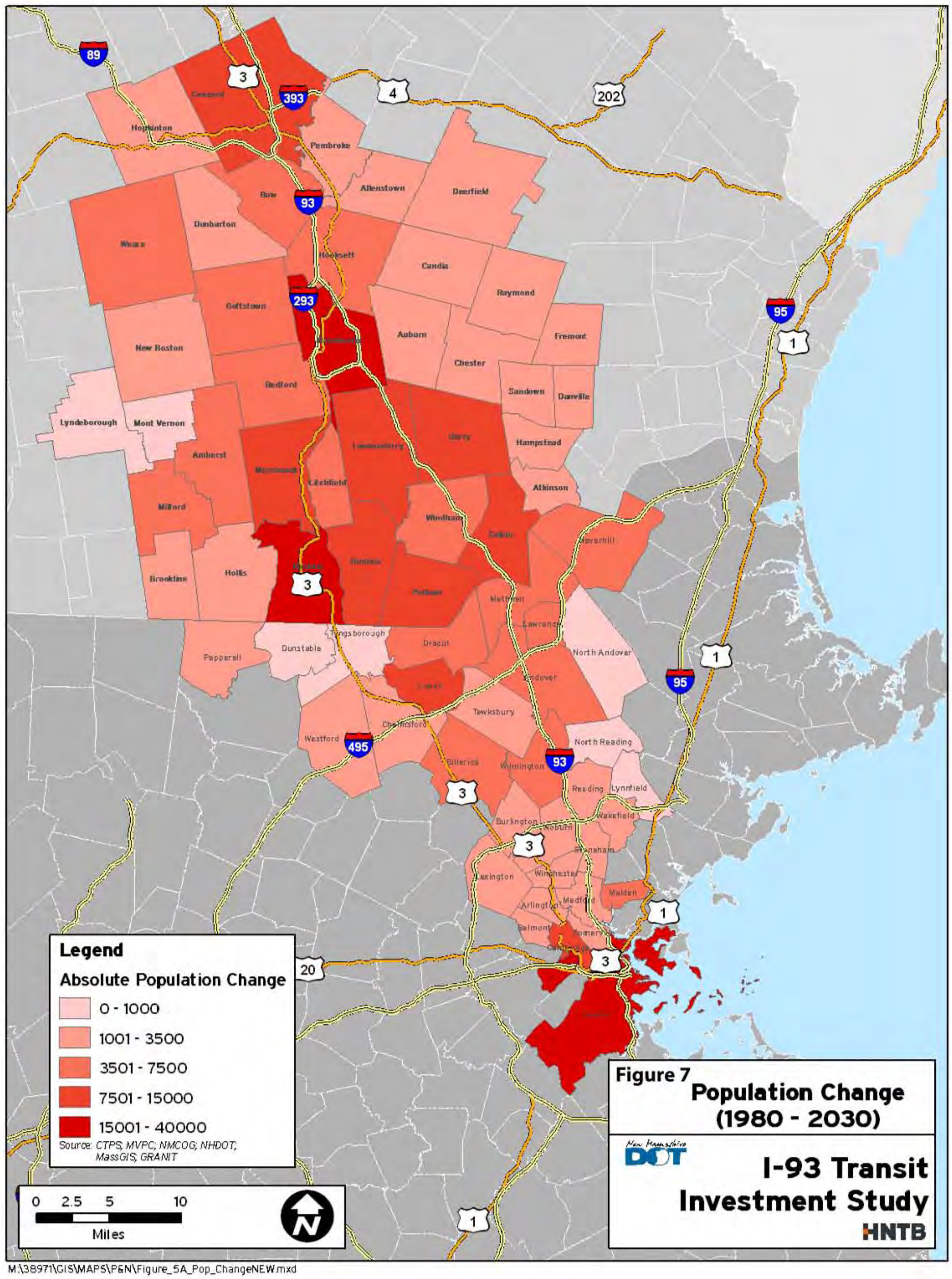


Figure 7-Population (Absolute) Change (1980 to 2030)

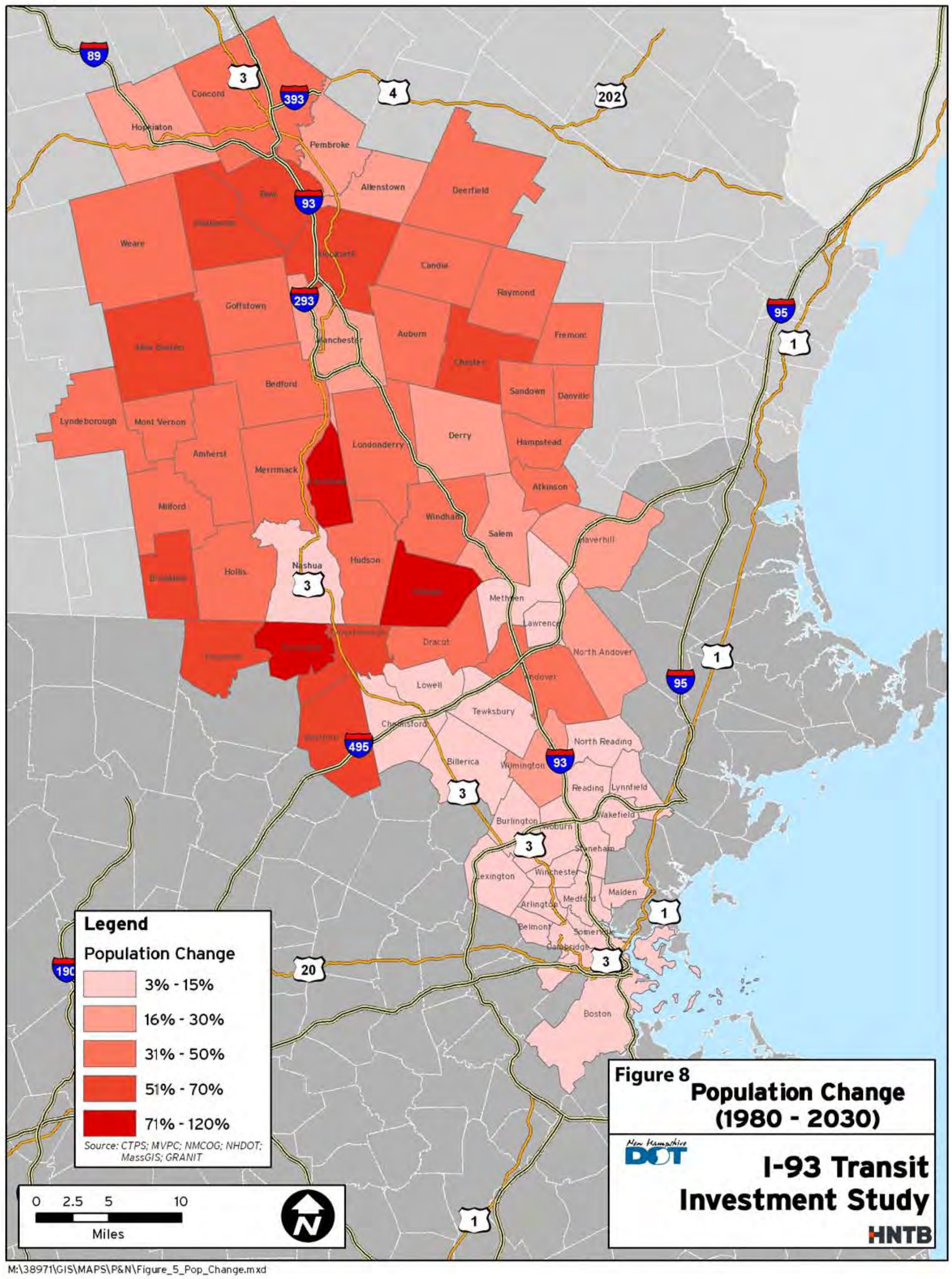


Figure 8-Population (Percentage) Change (1980 to 2030)

In Massachusetts, eastern Massachusetts dominates the state's economy and employment. In New Hampshire, concentrated areas of employment occur in urban centers of Nashua, Manchester, and Concord, which, combined, provided over 170,000 jobs in 2000. Again, those communities with the highest historic and projected employment increases are the Boston Central Business District or are communities predominantly located along the I-93 or U.S. Route 3/F.E. Everett Turnpike corridors.

The *Commonwealth of Massachusetts Long-Range Transportation Plan* (2006) states that employment sites are expected to remain concentrated in areas surrounding metropolitan Boston, with new employment centers extending along the major transportation corridors leading into New Hampshire and Rhode Island. Employment is also projected to be robust in all three counties in the New Hampshire study area. According to the New Hampshire Economic and Labor Information Bureau, Rockingham County is projected to be one of the fastest-growing counties in terms of new jobs over the next decade. Employment growth in Hillsborough County is projected to be the fourth highest of all ten counties in New Hampshire. Employment growth in Merrimack County is expected to be close to that for the state as a whole.

Target Markets

There are many different origin and destination trips throughout the study area. Although not all can be directly addressed, the benefits of increasing mobility options will be shared by many.
The study has specified (5) target markets on which to concentrate. In order of importance they are:

1. Daily Trips: New Hampshire to Boston Central Business District, Boston Metropolitan area, Route 128, Route 495, New Hampshire residents to Logan Airport.
2. Reverse Commute: Massachusetts residents to New Hampshire, Southern New Hampshire residents to Manchester
3. Manchester- Boston Regional Airport: Massachusetts and New Hampshire residents and travelers to the airport.
4. Special Events: civic, arts, cultural and sporting events, into Boston Metro and into Manchester.
5. Weekend Travel: into Boston metropolitan area and into New Hampshire.

Existing Transportation System

a. Transit

The mobility options are dramatically different between the northern and southern portions of the study area. In Massachusetts, the MBTA currently runs service on the Haverhill Line that terminates in Haverhill, on the eastern side of the study area. The MBTA Lowell Line operates on the western side of the study area with service terminating in Lowell. Regional commuter rail services in Massachusetts operated by the MBTA do not extend to the state line and terminate at least 2 to 5 miles south of the New Hampshire border. The Amtrak Downeaster also services the southern portion of the study area with stops in Haverhill and Woburn. Though not within the study area, Amtrak's Vermonter serves the Claremont, NH station with daily service to and from New York City.

In contrast, the only transportation alternative for the northern portion of the study area is bus. There are multiple bus lines servicing the area, but they are mostly private service lines that target a specific ridership. As part of the I-93 Improvements project in New Hampshire, the NHDOT implemented expanded bus service on this corridor to meet the growing demand, address traffic congestion, and help reduce auto emissions in southern New Hampshire and Massachusetts. To provide this expanded service, new park–and-ride lots with bus terminals have been constructed at Exit 2 in Salem and Exit 5 in Londonderry. NHDOT also constructed a bus maintenance and storage facility near Exit 5, and improved the existing commuter bus service at Exit 4 in Londonderry through construction of a bus terminal Bus service began in November 2008; this service is included in the No Build condition evaluated in this study.

b. Railroads

The existing north-south railroads are used for freight operations or are abandoned in the New Hampshire portion of the study area. Along the western railroad corridor, Pan Am Railways owns the New Hampshire portion of the right-of-way (New Hampshire Main Line), and the MBTA (Lowell Line) owns the right-of-way in Massachusetts. The railroad right-of-way for the eastern railroad corridor in New Hampshire along the M&L Branch is largely owned by the State of New Hampshire, with a few exceptions, and the MBTA owns the right-of-way (Haverhill Line/B&M West Route Main Line and Wildcat Branch) within Massachusetts. Portions of the M&L Branch right-of-way in Derry are owned by the town. The Manchester Airport Authority acquired 5.8 miles for the Manchester-Boston Regional Airport, but sold portions to the state, retaining 2.2 miles.

c. Freight Use

The portion of the Haverhill Line extending from Lowell Junction through Lawrence and Andover, Massachusetts, in addition to accommodating MBTA Haverhill Line service, also accommodates heavy freight use. Pan Am Railways, a wholly owned subsidiary of the Guilford Rail System, operates freight service along the line as part of its network that provides freight service to Northern New England. The segment between Lowell Junction (in Wilmington, MA) and Haverhill is a key segment of the second busiest freight line in New England. To the north, along the Manchester & Lawrence Branch, there is limited freight service. In 2000, Guilford filed for abandonment of three miles of the M&L Branch in Salem, NH. In 2003, Guilford filed for abandonment of three additional miles of the branch in Lawrence. Pan Am Railways now operates freight service along less than one mile of the M&L Branch within Lawrence. The M&L Branch in New Hampshire is inactive.

Freight service currently operates north of the Lowell Line along the western railroad corridor, operated as Pan Am's New Hampshire Main Line and Northern Main Line. The route into New Hampshire accommodates two to three coal trains per week (to the Bow power plant), and general freight for customers located in the Nashua, Manchester and Concord regions.

d. Highways and Traffic Demand

The majority of residents in the northern portion of the study area rely on personal vehicles for travel. Principal north-south highways in the study area are I-93 and U.S. Route 3 and the F. E. Everett Turnpike. I-93 was constructed in the early 1960s, when it was expected to carry 20,000 vehicles per day within its design life of 20 years. In 1997, traffic volumes in Salem, north of the Massachusetts border, were exceeding 100,000 vehicles per day. Since I-93 was constructed, traffic volumes have increased by 600 percent in Salem, New Hampshire at the border with Massachusetts. Between 1970 and 1990, Massachusetts transportation officials reported traffic on U.S. Route 3 increased by 300 percent at the state border. By the late 1990s, U.S. Route 3 was experiencing severe congestion along its entire length.

Increased interstate travel has placed demands on the existing highway infrastructure, resulting in proposals for highway widening, on the major north-south highways servicing the Merrimack Valley

Region in southern New Hampshire and Massachusetts (Interstate 93 and U.S. Route 3/F.E. Everett Turnpike) (Figure 1). Chronic congestion along I-93 between Manchester and Boston led to separate studies of widening 20 miles of highway in New Hampshire and widening of 10 miles of highway in Andover and Methuen, Massachusetts. In 1999, construction started on widening U.S. Route 3 in Massachusetts from two to three lanes in each direction over a distance of roughly 21 miles between I-95 (Route 128) and the New Hampshire state line. Route 3/F.E. Everett Turnpike in New Hampshire has also been reconstructed in recent years.

Table 1 displays existing traffic volumes on I-93, U.S. Route 3/F.E. Everett Highway, and major circumferential highways in Massachusetts (I-495 and I-95/Route 128) that also provide access to New Hampshire and points to the north. This congestion is expected to worsen in future years, as economic expansion in the Merrimack Valley continues, along with projected increases in employment and population. Other transportation studies being undertaken to address travel demands in the region include a number of other highway improvements along I-93 in Massachusetts and study of reactivation of railroad service from Boston to Nashua and beyond.

Average Daily Traffic

Highway	Vehicles Per Day (VPD)
I-93 – New Hampshire	
Manchester (between exits 8 and I-293)	71,000 - 101,000
Londonderry (between I-293 and Exit 5)	72,000 - 77,000
Windham (between exits 3 and 4)	73,000
Salem (between exits 1 and 3)	84,000 - 87,000
I-93 – Massachusetts	
Methuen (between state line and exit 46)	101,100 - 126,900
Andover (between exits 45 and 41)	140,400 - 136,400
Wilmington (between exits 41 and 40)	154,900
Woburn (No. of I-95) (between exits 38 and 37)	163,200
Stoneham (between exits 36 and 33)	172,600 - 183,700
Medford (between exits 34 and 30)	166,000 - 177,900
Somerville (between exits 30 and 29)	130,300

Sources: Mass Highway (2004) and NH DOT (2005)

I-95 - Massachusetts	
East of I-93	
Lynnfield, Wakefield (between exits 43 and 39)	131,00 - 135,000
West of I-93	
Woburn, Burlington, Lexington (between exits 37 and 30)	154,300 - 174,200

Source: MassHighway (2005)

Route 3/F.E. Everett Turnpike	
New Hampshire	
Bedford, Merrimack, Nashua (between Bedford Toll to state line)	47,000 - 101,000
Massachusetts	
Tyngsborough, Chelmsford, Billerica (between exits 37 and 28)	60,000 - 86,500

Source: MassHighway (2004) and NHDOT (2003)

I-495 - Massachusetts	
North of I-93	
Haverhill, Methuen, Lawrence, Andover (between exits 50 and 40)	84,100 - 102,500
West of I-93	
Lowell, Chelmsford (between exits 37 and 33)	104,300 - 121,600

Source: MassHighway (2004)

Table 1-Existing Conditions-Highways

Existing Land Use

Due to the substantial size of the study area, land use varies greatly throughout the region. The majority of the study area communities in Massachusetts are already facing capacity issues as large lot developments continue to be the most common style of residential development (outside of the core metropolitan area). The development surge has flowed into New Hampshire and many of these communities are faced with the same land consumption dilemma. This study will explore methods to promote more efficient land use policies that in turn will promote the role of transit services in meeting the mobility needs of the region's residents and businesses.

There are multiple dense population centers within the study area, including the Boston Metropolitan Area, Lawrence, Lowell, Nashua and Manchester. These areas have been population centers for a considerable length of time and have established land use patterns. Major rail corridors service all of these areas and are typically found weaving through their downtown centers. Unfortunately, passenger access to the rail corridors in Nashua and Manchester is now virtually non-existent. Although passenger service has been restored in Lowell and Lawrence, these existing transportation corridors are not being comprehensively utilized. In areas approaching Boston it is evident that there has been a recent push by planners to better incorporate these rail corridors in development. This study will exhibit opportunities for all communities throughout these rail corridors to embrace development that is supportive of transit.

Historically, much of the land use surrounding rail corridors in developed areas focused on industrial and manufacturing. As industry migrated out of developed areas and away from the rail corridors many of the buildings were left behind. These buildings which were once considered eyesores could be viewed as opportunities for growth. One such opportunity is transit-oriented development (TOD), which focuses growth or redevelopment around some form of transit. The most effective developments to date have all centered on rail transit services. Relatively dense mixed-use developments are centered around or near the transit station and typically offer housing as well as a variety of commercial and professional services. Density levels can vary greatly and are intended to blend with the surrounding neighborhoods. These developments have the potential to benefit the residents, the proprietors and the community as a whole. The study team expects that there will be an opportunity for multiple communities in the study area to explore the potential for transit-supportive development along one of several alternatives offered.

Open land is scarce in the study area and the geographic composition of the region further limits the availability of land. Forecasts have shown that the population growth will continue in the study area and unless this growth is managed properly the congestion issues will only be magnified. Both New Hampshire and Massachusetts are currently providing sustainable development guidelines which promote the type of development that is fundamental to this effort.

A description of the specific land uses along the prospective corridors is presented in Chapter 9.

Policy Context

Transit-Oriented Development: Consistency with Smart Growth Principles

In addition to meeting transportation needs within the corridor, a potential benefit associated with the project would be the promotion of sustainable development and support of economic expansion. Development of intermodal transportation service options is considered essential to promote transit-oriented development, which is defined as comparatively dense mix of residential and commercial development within one-half mile (walkable distance) of transit stations. This type of development is seen as more consistent with traditional compact development and historic settlement patterns, in contrast to suburban "sprawl" that is reliant on motor vehicle-dependent mobility and highways. Sprawl or dispersed development is generally viewed as promoting increasing roadway congestion by increasing dependence on automobiles. The national movement towards this type of land use planning is gaining support in New England.

The New Hampshire Office of Energy and Planning, in its 2003 publication *Achieving Smart Growth in New Hampshire*, offered eight principles for Proactive Growth Management, including the following:

- Maintain traditional compact settlement patterns to efficiently use land, resources, and investments in infrastructure.
- Foster the traditional character of New Hampshire downtowns, villages, and neighborhoods by encouraging a human scale of development that is comfortable for pedestrians and conducive to community life.
- Incorporate a mix of uses to provide a variety of housing, employment, shopping, services, and social opportunities for all members of the community.
- Provide choices and safety in transportation to create livable, walkable communities that increase accessibility for people of all ages, whether on foot, bicycle, or in motor vehicles.

The *New Hampshire Long Range Transportation Plan*, *Final Report of the Community Advisory Committee to the Commissioner* (June 9, 2006) states that: "A more comprehensive, statewide initiative is needed encompassing all sources and uses of public and private transportation funding." The plan recognizes institutional impediments to implementing future transit or rail improvements, namely, that the New Hampshire Constitution (Part II, Article 6-a) prohibits of use of funds accrued from gasoline tax for funding railroad or transit improvements.

The *Commonwealth of Massachusetts Long-Range Transportation Plan* (2006) also cites as a guiding principle the mobility of people and goods: "In order to improve the quality of life and provide economic opportunities, the transportation system of Massachusetts shall satisfy the needs of people and freight. The Commonwealth shall satisfy these mobility needs through a comprehensive set of strategies that focuses on system management and demand management, as well as targeted investments in system improvement."

The Massachusetts Long-Range Transportation Plan cites the importance of incorporating multi-modal solutions and encouraging transit-oriented development: "Broadening transportation choices can help mitigate congestion by reducing the amount of travel on a congested mode, shifting travel to off-peak periods, eliminating the need for certain trips, and creating a more balanced transportation network…Of particular importance for sustainability and economic development is the…emphasis on transit-oriented development."

The Massachusetts Office of Commonwealth Development has developed ten principles for sustainable development to guide the Commonwealth's approach to Smart Growth. These include the following:

- **Concentrate development—**Support development that is compact, conserves land, integrates uses, and fosters a sense of place. Create walkable districts mixing commercial, civic, cultural, educational and recreational activities with open space and housing for diverse communities.
- **Provide transportation choice—**Increase access to transportation options, in all communities, including land- and water-based public transit, bicycling, and walking. Invest strategically in transportation infrastructure to encourage smart growth. Locate new development where a variety of transportation modes can be made available.
- **Expand housing opportunities—…**Coordinate the provision of housing with the location of jobs, transit, and services. Foster the development of housing, particularly multi-family, that is compatible with a community's character and vision.
- **Increase job opportunities—**Attract businesses with good jobs to locations near housing, infrastructure, water, and transportation options…Support the growth of new and local businesses.
- **Foster sustainable businesses—…**Strengthen sustainable businesses. Support economic development in industry clusters consistent with regional and local character…

One of the goals of the cooperation between NHDOT and MA EOT in conducting the I-93 Transit Investment Study is to achieve consistency with the Commonwealth's Sustainable Development Principles. In 2004, NHDOT and NH Charitable Foundation created a Citizen Advisory Committee (CAC) to create a one-of-a-kind citizens' transportation plan. The CAC completed and published this report in June 2006. NHDOT will reference the CAC report in its long-range transportation plan..

Transportation Needs in Long Range Transportation Plans

The following project needs have been identified in the New Hampshire and Massachusetts plans:

- The *New Hampshire Long Range Transportation Plan, Final Report* (June 9, 2006) states that: "The southern (especially southeastern) region needs to manage new travel demand and expand transportation choices, in an increasingly urbanized environment. This is especially true in Hillsborough and Rockingham Counties which now represent more than 50 percent of the total state population. The southern areas of the state face a particular challenge: interstate commuting. In 2000, over 82,000 New Hampshire commuters traveled to jobs in Massachusetts daily, while 23,500 Massachusetts commuters traveled to New Hampshire. In these areas, commuters are traveling further which, along with rapid population growth, increases congestion problems."

- The *New Hampshire Long Range Transportation Plan* also points out: "People who don't travel may have even more severe transportation needs than those who do—if the reason they don't travel is because they have no options. A strong majority of public feedback favored the creation of more public transportation options, particularly in the more rural areas and particularly for access on the regional and inter-regional levels. Some sort of basic, statewide public transportation service is needed…A growing percentage of New Hampshire residents do not drive. The percentage of residents who don't have a license, or can't drive due to disability or poor health is about 25% and growing."
- The *New Hampshire Resident Views on the Use, Availability, and Need for Public Transportation* (December 2005) presented survey results that indicated an estimated 34,000 residents had lost or turned down a job because they did not have a reliable ride. Approximately 62,000 had missed a medical appointment because they could not get a ride, with 11,000 having missed four or more appointments in the last 12 months alone.
- The results from the *Granite State Poll, Support for New Hampshire Passenger Rail Service Survey* (February 2007) prepared for the Nashua Regional Planning Commission by the University of New Hampshire showed that 87% of those New Hampshire residents polled favor expanding passenger rail service in New Hampshire. The study also reported strong support (73%) for creating a Rail Authority to oversee potential rail expansion.
- The *Commonwealth of Massachusetts Long-Range Transportation Plan* (2006) states: "A close relationship exists between population and job growth. In recent years, metropolitan Boston has drawn an increasing number of non-resident workers from New Hampshire and Rhode Island, which pushed employment growth faster than population."
- The plan elaborates on this trend: "Some of the highest rates of growth during the last decade occurred in the regions between metropolitan Boston and New Hampshire. The accessibility of these regions via Interstates 93 and 95 and Route 3 to both metropolitan Boston and Nashua, and ample land for development near these highways attracted many new employers and enabled workers to commute long distances from multiple directions. Employment in this area grew by 18 percent…."
- The Massachusetts Long Range Plan states that: "Population and employment growth is projected in most regions, but with much of the growth expected to center in the eastern portion of the Commonwealth, including the Merrimack Valley…There will be a continued need for judicious roadway investments and focused investments in commuter rail, bus, rapid transit, and other systems that can reduce congestion and support dense land-use patterns. There is an opportunity to select transportation investments that will make it easier for growth to occur in urban and developed areas that could potentially support transportation alternatives to the automobile. Providing customers with more choices to driving alone will improve the flexibility and efficiency of transportation service delivery."

Planning Context: Previous Studies

I-93 Salem to Manchester, NH Corridor Improvements

The need for the current study is to address ever increasing travel demands along the section of I-93 that extends north of the border with Massachusetts at Salem, New Hampshire to Manchester, New

Hampshire. This roughly 20-mile section of I-93 is the focus of transportation improvements being undertaken by NHDOT. The proposed I-93 improvements include widening this section of the major north-south interstate highway to four travel lanes in each direction from its current configuration of two lanes in each direction.

The need to further address transit improvements was identified during preparation of the Final Environmental Impact Statement (FEIS) for the I-93 Corridor Improvements. The April 2004 FEIS considered an array of alternatives that included Transportation Demand Management measures and modal alternatives, including a Passenger Rail Service alternative and a Bus Service alternative. During the FEIS preparation and review, a separate bi-state study of future transit investments, separate from the proposal for road-based improvements, was requested by cooperating resources agencies.

The rail alternatives considered as part of the I-93 FEIS included four rail alternatives along three basic rail alignments. These rail alternatives were designed to provide commuter rail service to Boston from Manchester to provide some measure of traffic relief within the I-93 highway corridor during peak travel periods. Alternatives that were identified included alignments following two rail corridors that were once part of the former Boston and Maine (B&M) Corporation system (Figures 2 and 3). These rail corridors extended from Manchester, New Hampshire to Lowell, Massachusetts (West Rail Corridor) and to Lawrence, Massachusetts (East Rail Corridor).

In addition to evaluating service along these existing rail corridors, options to introduce new services along the existing I-93 highway corridor were also considered. The major mode alternatives that were evaluated as part of the I-93 improvements project included:

- **West Rail Corridor from Manchester, New Hampshire via Nashua to Lowell, Massachusetts:** Commuter rail service along the New Hampshire Main Line would include Phase 1 (service between Nashua and Lowell). Phase 2 was considered as a mode alternative for the I-93 corridor and would extend service from Nashua 19 miles north to Manchester. This line would operate as a 31-mile extension of the Massachusetts Bay Transportation Authority (MBTA) Lowell Line, which extends 25 miles from Boston to Lowell. This railroad alignment extends along the west side of the Merrimack River parallel to U.S. Route 3 and the F.E. Everett Turnpike (which splits from U.S. Route 3 in Nashua, New Hampshire) then crossing the river just south of Manchester, and would primarily serve as an alternative for commuters within the F.E. Everett Turnpike and U.S. Route 3 corridors.
- **East Rail Corridor from Manchester, New Hampshire to Lawrence, Massachusetts:** Commuter rail service along 28 miles of the Manchester & Lawrence (M&L) Branch, with two variations near the Manchester-Boston Regional Airport, would connect to the MBTA Haverhill Line in Lawrence. The Haverhill Line in Massachusetts operates predominantly along 32.9 miles of the West Route Main Line tracks extending from North Station in Boston to downtown Haverhill. The line continues north into New Hampshire and Maine and is the route used by Amtrak's Downeaster passenger service between Boston and Portland, Maine. The route is also used by Pan Am Railways for freight service. The Haverhill Line includes a section of single track (13.9 miles) between Lawrence and Reading. Another 3.9-mile single-track section extends between the Boston/Somerville Line and Melrose.

  A constraint to the use of the M&L branch line is that the right-of-way is not exclusively state-owned in New Hampshire. Other public owners of the right-of-way are the Manchester Airport Authority and the Town of Derry. Private interests own portions of the right-of-way in Derry and Londonderry. In Massachusetts, the MBTA owns the right-of-way. Another constraint is that the track structure is in poor condition or non-existent, and new structures (bridges) would be required.

A segment of the right-of-way in Manchester has been paved as a walkway and bikeway. A four-mile segment is paved within the town of Windham and is a bikeway and walking path. The route is also part of the recommended alternative for the Salem to Concord regional bikeway plan. While these segments have been converted to pedestrian and bicycle uses, the state has the legal authority to reclaim these rights-of-way for rail use.

An advantage of the East Rail Corridor is that it closely parallels I-93, and therefore would provide an alternative mode of transportation for I-93 corridor commuters.

- **I-93 Rail Corridor:** Two options for a new light rail service operating within the I-93 highway right-of-way were considered: a Basic and Enhanced Rail Corridor. The Enhanced Rail Corridor would continue service north to the Manchester-Boston Regional Airport. Both rail corridors would involve a connection to the M&L Branch three miles to the south near Exit 5 in Londonderry and light rail service continuing south along I-93 to the Massachusetts state line. The Basic Rail Corridor would extend 23 miles between Londonderry and Lawrence. Over the state line, the Basic Rail Corridor Option would connect to the M&L Branch right-of-way continuing to Lawrence, Massachusetts (Haverhill Line). The Enhanced Rail Corridor would deviate from this alignment in Massachusetts and would continue within the I-93 right-of-way 20 miles south to the Anderson Regional Transportation Center (Lowell Line) in Woburn. The proposed I-93 improvements included accommodating space within the reconstructed highway corridor for potential future rail or other mass transit opportunities. This reserved area within the I-93 right-of-way could accommodate a potential light rail line, but could alternatively provide for high occupancy vehicle (HOV) usage or bus rapid transit (BRT).

- **Bus Service:** An expansion of commuter bus service, operating from Manchester and Londonderry to Boston, was considered. Since bus service was operating only at Exit 4 in Londonderry, the I-93 improvements included expanding service to serve Exit 5 in Londonderry and Exit 2 in Salem. I-93 improvements included providing park and ride facilities at each interchange with bus terminal facilities to facilitate ride-sharing and bus transit usage. An enhanced ride-sharing program, with a commuter incentive program, was also considered.

The mode alternatives in the I-93 Improvements FEIS were considered to provide additional commuting options in the Merrimack Valley region in New Hampshire and Massachusetts. Analysis of alternatives undertaken for the I-93 improvements demonstrated that a passenger rail service would not divert sufficient vehicle trips from I-93 to make a marked improvement in I-93 traffic operations. The mode alternatives studied were intended to provide transportation enhancements that would supplement the highway system, rather than supplant the need for highway improvements. This was formally recognized by the resource and environmental agencies in a Memorandum of Agreement (MOA), signed in September 2001, that established the reasonable range of alternatives to be considered in the FEIS. In this agreement, the U.S. Environmental Protection Agency, the U.S. Army Corps of Engineers, the U.S. Fish and Wildlife Service, the New Hampshire Department of Environmental Services, the New Hampshire Fish and Game Department, the New Hampshire Division of Historical Resources, the FTA, and the FHWA and NHDOT acknowledged that future initiatives to address transportation needs in the broader I-93 corridor (Greater Boston Metropolitan Area to Manchester, NH) would likely not involve further widening but rather some type of transit investment. The parties recognized that these future transit initiatives would likely be required later in time and concurred that regional transit initiatives would best be studied further in a separate study specific to transit conducted in partnership with the Commonwealth of Massachusetts.

The bus transit options identified in the FEIS were to be implemented in conjunction with the highway improvements identified. The preliminary passenger rail options identified were to undergo further evaluation as part of the current I-93 TIS. Although the genesis of this TIS arose from the FEIS, it was recognized that a larger study of regional mobility options not only within the New Hampshire I-93 corridor, but within the entire southern New Hampshire Merrimack Valley Region and extending into Massachusetts, was required. This separate TIS, being undertaken in partnership with Massachusetts, is assessing potential regional transit opportunities and seeking to identify cross-border priorities for future investments that will be required to help meet the long-term mobility needs in the region.

Lowell to Nashua Commuter Rail Extension Project

In 2007, the New Hampshire legislature created the NH Rail Transit Authority, which has responsibility for prioritizing and implementing passenger rail in southern New Hampshire. The Authority, in conjunction with the NHDOT, has identified the Lowell-Manchester-Concord "NH Capitol Corridor" as the top priority for passenger rail in the state. Implementation of rail service along the West Rail Corridor is being actively pursued by the Authority, NHDOT, and other stakeholders.

This passenger service was originally evaluated in the *Major Investment Study for Nashua Passenger Rail Service* (MIS) submitted to FTA in 1999. Subsequently, preliminary engineering work and an environmental assessment were conducted on the commuter rail extension. The state's Congestion Mitigation and Air Quality (CMAQ) Advisory Committee approved funding for purchasing coaches and locomotives, and operating funds, for the project.

The MIS study for this project was used as the basis for the West Rail Corridor alternative evaluated in the I-93 Improvements FEIS.

Subsequently, the project has been promoted by a variety of stakeholders, including representatives from the Nashua and Southern New Hampshire Regional Planning Commissions, the cities of Nashua and Manchester, the Manchester-Boston Regional Airport, and the Greater Nashua and Manchester Chambers of Commerce, working with the Rail Transit Authority and NHDOT.

Northern New England High Speed Rail Corridor

The Northern New England High Speed Rail Corridor has been designated by the U.S. Secretary of Transportation. This federal designation allows states through which the high speed rail corridor passes to receive funds for study, design, and construction and for highway/rail grade crossing safety improvements. The Northern New England High Speed Rail Corridor has two branches in New England. The eastern branch extends between a hub in Boston and Portland, Maine terminating in Auburn, Maine. The western branch connects Boston and Montreal, Quebec, extending through Concord, New Hampshire and Montpelier, Vermont.

The Boston to Montreal High-Speed Rail Planning and Feasibility Study, Phase I Final Report, prepared by the Vermont Agency of Transportation, was completed in April 2003. The report concluded that projected fare revenue and ridership is sufficient to warrant further study and implementation of a Phase II evaluation. The study indicated that implementation of high speed rail would require substantial rail infrastructure improvements that would be compatible with existing and future passenger and freight rail operations. The potential rail corridor identified for further study follows the West Rail Corridor that extends from Manchester through Nashua and Lowell to Boston.

I-93 Corridor Study, Andover and Methuen, MA

In addition to these prior studies performed by NHDOT, the Merrimack Valley Planning Commission in Massachusetts has also evaluated improvements to a roughly 10-mile section of I-93 extending south from New Hampshire to Methuen and Andover. The study area focuses on the section of I-93 that consists of three travel lanes in each direction and continues as a six-lane highway to the New Hampshire border. The southern limit of the study occurs at the reduction from four to three lanes in each direction. In the spring of 1999, Massachusetts Highway Department initiated use of the breakdown lanes for general travel in this highway segment during morning (6 a.m. to 10 a.m.) and evening (3 p.m. to 7 p.m.) peak periods, as an interim measure to relieve severe congestion that occurs along this divided highway.

The *I-93 Corridor Traffic Study, Andover and Methuen, Massachusetts* considered a range of alternatives, including widening I-93 from three to four lanes in each direction. The study also included evaluation of interchange and intersection improvements, including a potential new interchange at Lowell Junction between Exits 41 and 42, as described in the following section.

Experimental bus improvements were also to be implemented in and along the I-93 corridor as part of the project. The study recommended experimenting with adding service in various new areas to determine if a market exists. The study also recommended further evaluation of the potential for valet parking to increase parking capacity at rail stations.

Other options involving shuttle services (commuter rail or bus) to the Anderson Regional Transportation Center, connecting to the Lowell Line, were determined to not be viable alternatives, since ample parking was available at the center. It was recommended that parking conditions at the Anderson Regional Transportation Center be monitored, and these alternatives reconsidered in the event that parking becomes constrained in the future.

The study included the recommendation that improvements be made to the Haverhill Line (through double-tracking) to accommodate increased commuter rail service. The study identified other potential passenger rail alternatives in Massachusetts (including commuter rail or light rail service operating along the M&L Branch, commuter rail through service between Manchester and Boston via the Haverhill Line, and light rail service along I-93) that would require coordination with New Hampshire for implementation. The study also calls for a cooperative study by New Hampshire and Massachusetts to consider options for regional rail service between Boston and Manchester.

I-93 Lowell Junction Interchange, Andover, Wilmington, and Tewksbury, MA

The *I-93 Corridor Traffic Study, Andover and Methuen, Massachusetts* recommended further consideration of a potential new interchange on I-93 in the Lowell Junction area, between Route 125 in Wilmington (Exit 41) and Dascomb Road in Andover (Exit 42). This area includes landlocked parcels and is viewed as having substantial economic development potential, since it currently hosts a number of large area businesses and is a major employment center. These transportation improvements are consistent with plans for expansion by existing large area employers and other private development proposals, which are currently impeded by the lack of direct access to I-93 and recurring traffic congestion. Lack of direct access from I-93 to businesses in the Lowell Junction area contributes to congestion at adjoining interchanges, leading local residents to file suit to stop further development that would increase employment in the area.

The I-93 Lowell Junction Interchange Justification Study is being undertaken as a separate project by the Merrimack Valley Planning Commission, in collaboration with the three communities of

Andover, Tewksbury, and Wilmington. This interchange justification study was completed in 2006 and was submitted by the Massachusetts Executive Office of Transportation to the Federal Highway Administration for review and approval.

In addition, officials from Andover, Wilmington and Tewksbury are now cooperating to identify a shared development strategy for the area. Plans for "The Junction Project" are outlined in *The Junction/Route 93 Development Area: Our Opportunity for Smart Growth and Regional Economic Development in the Merrimack Valley and Northeast Massachusetts* prepared by the Merrimack Valley Economic Development Council. The development envisioned for the area includes a new multi-modal transit center to be located adjacent to the Haverhill Line, with access to be provided by the new I-93 Interchange.

Interstate Memorandum of Agreement

In March 2005, an MOA between the NHDOT and the MA EOT was executed. In the MOA, the agencies agreed to jointly undertake this Transit Investment Study of the Boston to Manchester leg of the I-93 corridor. The study was viewed by both states as an opportunity to jointly address Massachusetts and New Hampshire regional transportation issues.

3. Alternatives Evaluation

Introduction

The purpose of this chapter is to outline the process by which various alternatives were defined and selected. It provides both graphic and narrative descriptions of the alternatives developed and evaluated during this phase in the development of a long-range strategic transportation investment plan. The land use policy and development implications of the screened alternatives will be identified and evaluated, as will the ridership potential, environmental impacts, capital and operating and maintenance costs, and the existence of any “fatal flaws” that would immediately disqualify the alternative from further evaluation.

The information developed from this process was used as data inputs for the evaluation and ranking process, and the evaluations will form the basis for the eventual selection of a locally preferred alternative (LPA).

Methodology

The methodology used to define the alternatives that were considered for the I-93 TIS was composed of the following steps:

- Review and evaluation of recommended alignments and transit modes that were studied in previous corridor and regional transportation studies,
- Completion of a Purpose and Need Statement that addresses the current status of mobility within the study area and projects future transportation needs,
- Development of build alternatives for bus and rail modes that are designed to meet the transportation goals outlined in the Purpose and Need Statement, while rating highly when assessed by the pre-determined evaluation criteria.

The study undertook both high-level and detailed analyses in order to define and evaluate the alignments and mode choices for this study. The initial alternatives were developed with the assistance of the Technical Advisory Committee (TAC), as well as extensive input from key stakeholders, including regional planning commissions, various advocacy groups, and intensive public outreach.

The TAC was composed of representatives of each state's transportation agency, the FTA, FHWA, the U.S. Environmental Protection Agency, and the regional planning commissions. The regional planning commissions represented on the TAC include the Metropolitan Area Planning Council, the Northern Middlesex Council of Governments, the Merrimack Valley Planning Commission in Massachusetts, and the Nashua Regional Planning Commission, the Rockingham Planning Commission, and the Southern New Hampshire Planning Commission in New Hampshire.

Input into the project development was also provided by the Stakeholder Committee, with ongoing coordination with representatives from potentially affected communities, including Manchester, Concord, Windham, Derry, Salem, Londonderry, Hudson, and Merrimack in New Hampshire, and Woburn, Wilmington, Andover, and Methuen in Massachusetts. Other parties represented on the Stakeholder Committee include the New Hampshire Department of Environmental Services and Massachusetts Department of Environmental Protection. The representatives from the transportation industry and business interests on the Stakeholder Committee include:

- Manchester-Boston Regional Airport,
- Merrimack Valley Regional Transit Authority,
- Merrimack Valley Area Transportation Company,
- New England Bus Association,
- New Hampshire Railroad Revitalization Association,
- Pan Am Railways,
- New England Southern Railroad,
- Concord Trailways,
- C&J Bus Lines,
- First Transit,
- ACI (Paul Revere Transportation),
- Massachusetts Office of Business Development,
- Merrimack Valley Economic Development Council,
- Merrimack Valley Chamber of Commerce,
- Greater Manchester Chamber of Commerce,
- Rockingham County Economic Development Corporation,
- Merrimack Valley TMA,
- Junction TMO, and
- 128 Business Council.

The consultant team refined the input gained from this series of conversations and meetings, and developed it within the context of existing infrastructure and the recommendations of previous transportation studies conducted within the study corridor.

Range of Alternatives

The initial alternatives reflected the diversity of alignment and modal technologies that were discussed during stakeholder interviews and public meetings. This initial slate of alternatives included 11 rail options through three rail corridors and four bus alignments . The alternatives were developed in order to consider a wide breadth of transportation system investment opportunities. Major differentiators among the initial alternatives enabled the study team's early evaluation of key tradeoffs between costs and benefits. In some instances, these tradeoffs became key differentiators in the screening process that reduced the initial 15 alternatives to five. The remaining five Build alternatives were analyzed in detail in subsequent evaluation levels of the study and expanded to eight alternatives before being reduced to six and then four final Build alternatives. This section will present the initial 15 alternatives that were developed.

No Build Alternative

The No Build alternative involves maintenance of the existing system without expanding capacity. This includes existing bus service between the Manchester Transportation Center and downtown Boston, and new commuter bus service to Boston from park-and-ride lots at Exits 2, 4, and 5. In Massachusetts, existing MBTA service to Woburn and Burlington and Merrimack Valley Regional Transit Authority (MVRTA) service along Routes 28 and 125 and I-93 would continue.

TSM Alternative

The Transportation Systems Management (TSM) alternative is a short-range moderate cost measure that is aimed at reducing congestion with little or no impact on the existing right-of-way and at relatively low cost. Improved frequency and additional stops would be provided through the expansion of parking facilities at Exit 4, the construction of park-and-ride facilities at Exits 2, 3, and 5, and the preservation of a transit right-of-way in the highway corridor.

NHDOT has implemented bus service from the park-and-ride facilities at Exits 2, 4, and 5, offering half-hourly service during peak travel times and hourly in the off-peak, with as many as 46 daily trips depending on location.

Eastern Alignments

The railroad right-of-way for the East Rail Corridor along the M&L Branch is largely owned by the State of New Hampshire, with few exceptions, and the MBTA owns the right-of-way (Haverhill Line/B&M West Route Main Line) within Massachusetts. Portions of the right-of-way in Derry and Londonderry are owned by the town and private interests. The Manchester Airport Authority acquired 5.8 miles for the Manchester-Boston Regional Airport, but sold portions to the State, retaining 2.2 miles from Harvey Road to Goffs Falls Road.

The Manchester-Lawrence Rail Corridor is an inactive right-of-way in New Hampshire. The corridor, which is central to the focus of the study area, could leverage previous transportation infrastructure investments in order to encourage future transit-oriented development land use patterns.

E1: Direct Rail: Boston Service from Exit 5

This rail alternative offers direct service from the northern terminus at Exit 5 in Londonderry, NH to the southern terminus of North Station in Boston, MA on the existing M&L Branch, the Wildcat Branch and the Haverhill and Lowell MBTA Line (Figure 9). Service on the Lowell Line presently operates primarily over the New Hampshire Main Line (NHML) tracks between North Station in Boston and downtown Lowell. The existing 25-mile route includes nine MBTA rail stations: North Station, Malden Center, Wyoming Hill, Melrose Cedar Park, Melrose Highlands, Greenwood, Wakefield, Reading, Anderson RTC, Wilmington, North Wilmington, Ballardvale, Andover, and Lawrence. This 50-mile alignment would offer a 78 minute travel time to Boston.

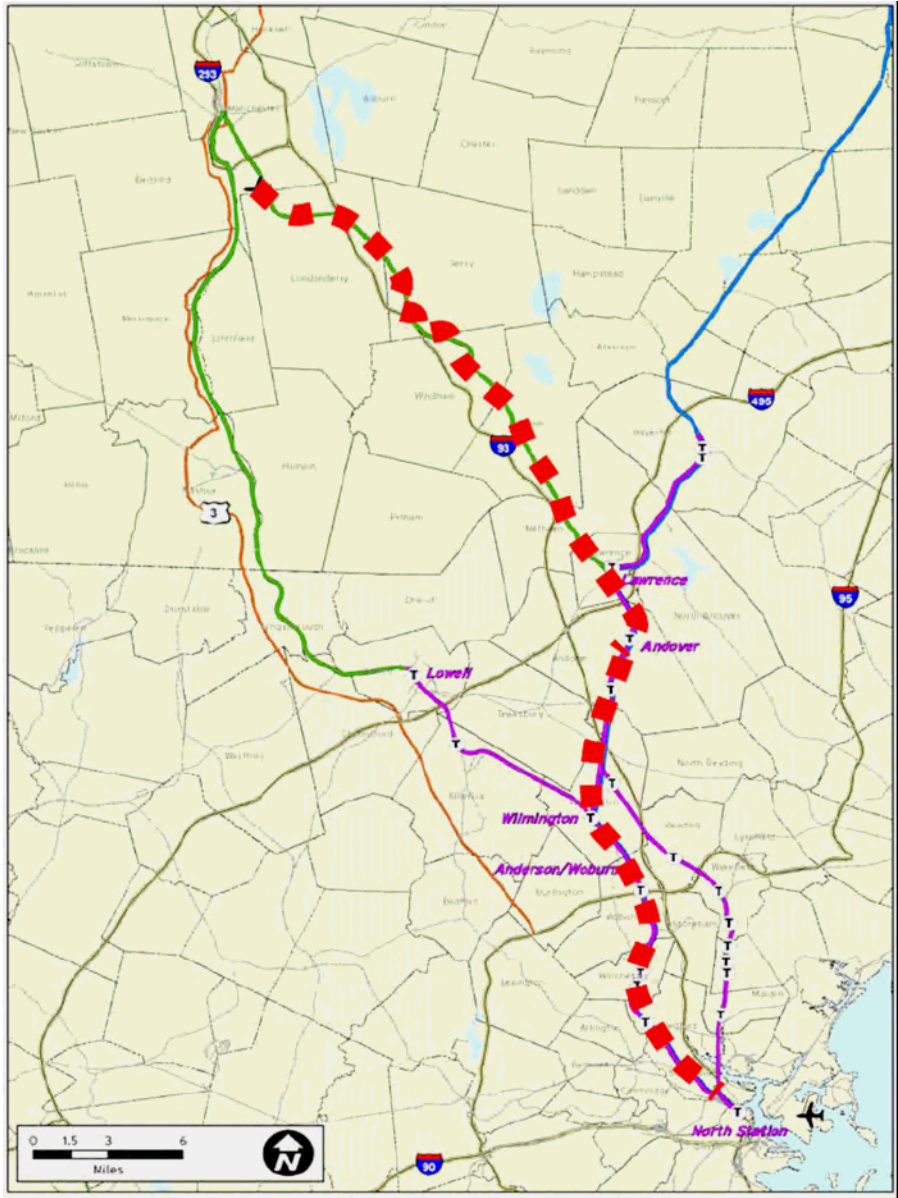


Figure 9: E1: Direct Rail: Boston Service from Exit 5

E2: Transfer Rail: Anderson Service from Exit 5

This alignment (Figure 10) offers service from the northern terminus at Exit 5 in Londonderry, NH to the Anderson RTC on the existing M&L Branch, Haverhill Line, and Wildcat Branch; at Anderson RTC a cross-platform transfer to existing MBTA Lowell trains is required to reach the southern terminus of Boston. The 25-mile route includes nine MBTA rail stations: North Station, West Medford, Wedgemere (Winchester), Winchester Center, Mishawum (Woburn), Anderson RTC (Woburn), Wilmington, North Billerica, and Lowell. This 51-mile alignment offers a travel time of 83 minutes.

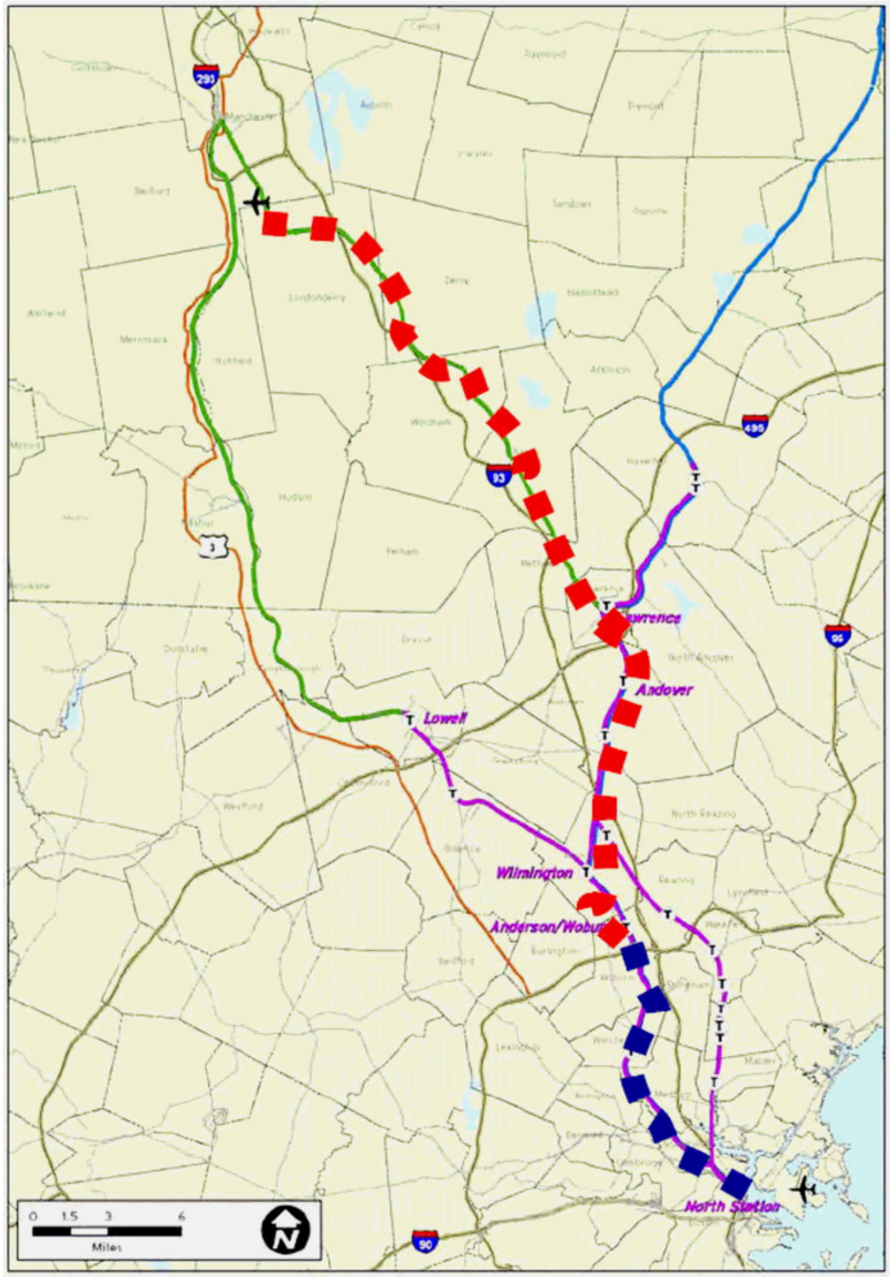


Figure 10: Alignment E2: Anderson Service

E3: Transfer Rail: Andover Service from Exit 5

This alignment (Figure 11) offers service from the northern terminus at Exit 5 in Londonderry, NH to Andover along existing M&L rail tracks; the alignment requires a cross-platform transfer to MBTA trains at Andover, which offers service to the southern terminus of Boston along the Haverhill line. This route includes stops at 11 existing MBTA stations: Andover, Ballardvale, North Wilmington, Reading, Wakefield, Greenwood, Melrose Highlands, Melrose Cedar Park, Wyoming Hill, Malden Center, and North Station. The 53-mile route offers a travel time of 85-97 minutes.

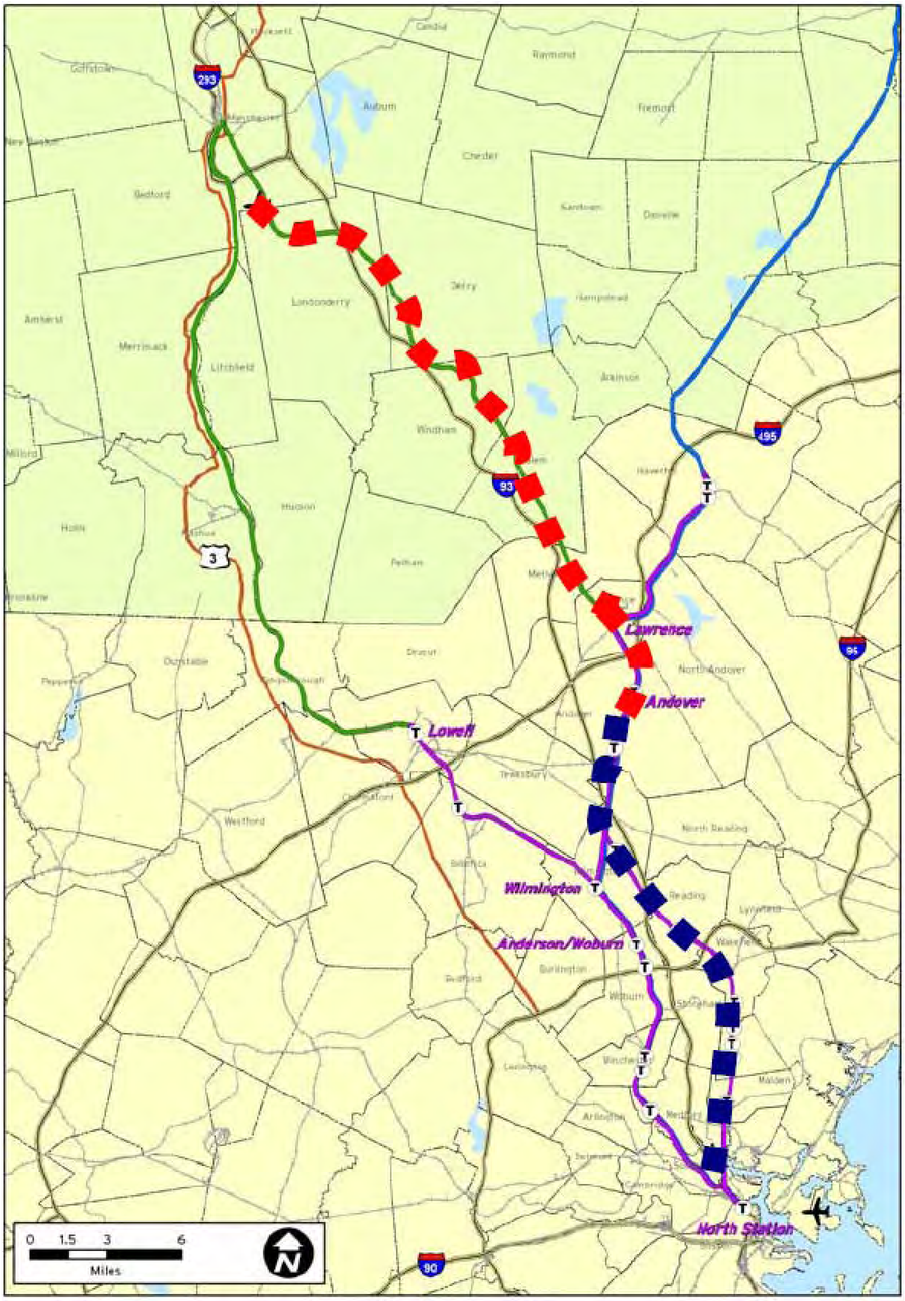


Figure 11: Alignment E3: Andover Service

E4: Transfer Rail: Lawrence Service from Exit 5

This alignment (Figure 12) offers service that is very similar to the E3 alignment, but requires a cross-platform transfer to MBTA trains at the existing Lawrence Station, rather than Andover. Due to existing track alignments, this alternative requires that southbound trains back into the Lawrence Station from the junction of the M&L and Haverhill Lines, then proceed forward to North Station in Boston. This operating characteristic is projected to have a significantly negative impact on travel times and ridership. This 54-mile long alignment offers a travel time of 88-100 minutes.

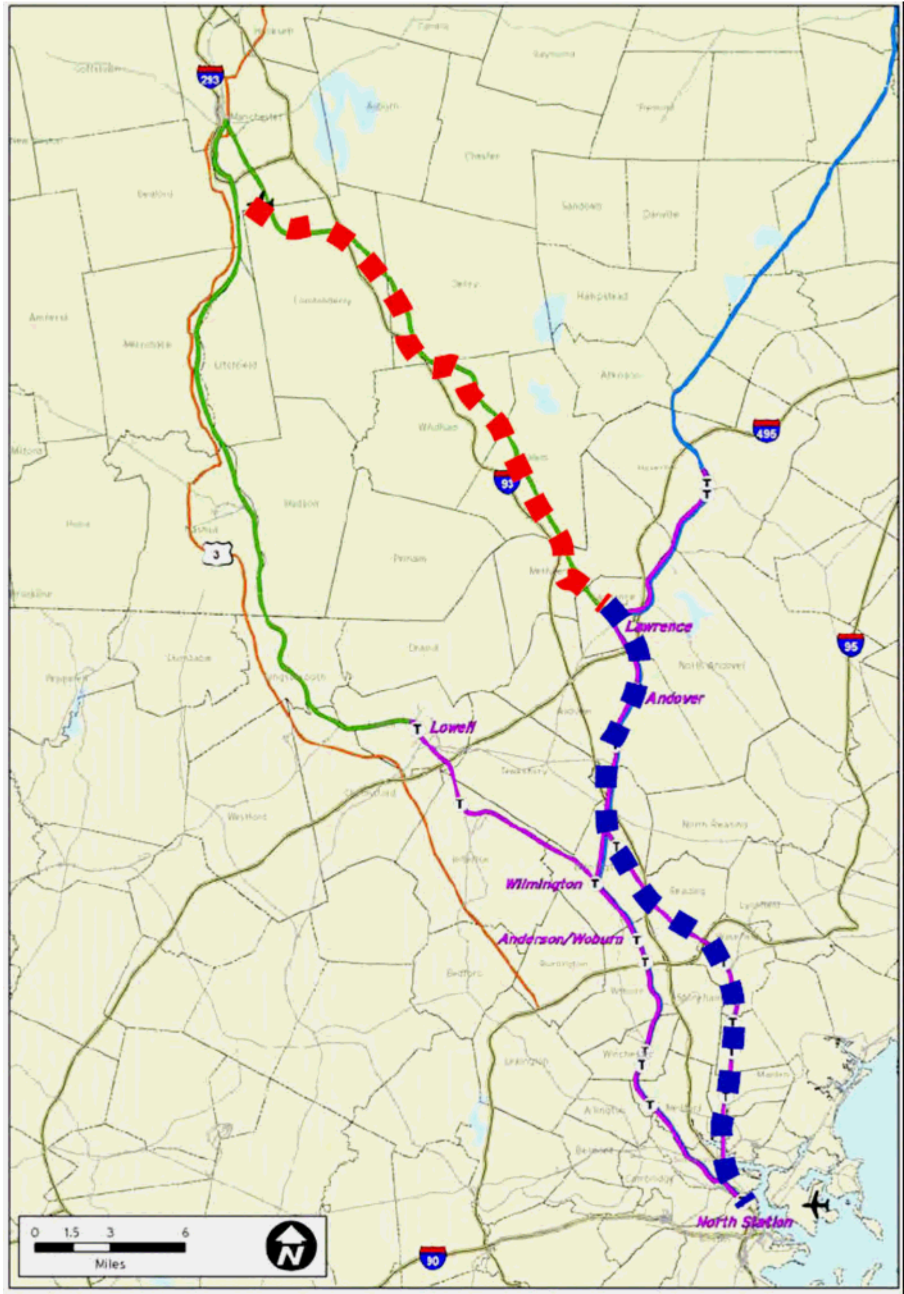


Figure 12: Alignment E4: Lawrence Service

Highway Alignments

An I-93 Transit Corridor would be situated largely within the highway right-of-way owned by the States of New Hampshire and Massachusetts. In New Hampshire, the I-93 highway right-of-way varies from about 150 to 500 feet in width. The median width is typically 70 feet or more, although in some areas it narrows to 30 feet. A potential rail line could be accommodated largely within the median in New Hampshire, crossing to the outer edge of the highway approaching the state line. In Massachusetts, the median width is narrower, and the rail line could either continue within the highway right-of-way (to the west or east of the highway corridor) to the Anderson RTC on the Lowell Line or would involve connections to the M&L Branch.

This alignment would require comparatively more new transit infrastructure than either the Lawrence-Manchester or Nashua-Manchester Rail Corridors and is remote from transit-supportive land uses. The highway right-of-way alignment would physically separate the transit system from surrounding land uses, making the system less effective at catalyzing transit-oriented development.

H1: Direct Rail: Boston Service along Highway ROW

This alignment (Figure 13) offers direct service along the existing highway right-of-way from the northern terminus in downtown Manchester to the Anderson RTC; the alignment then operates along the existing MBTA Lowell Line to the southern terminus at North Station in Boston. This 56-mile alignment offers a travel time of 80 minutes.

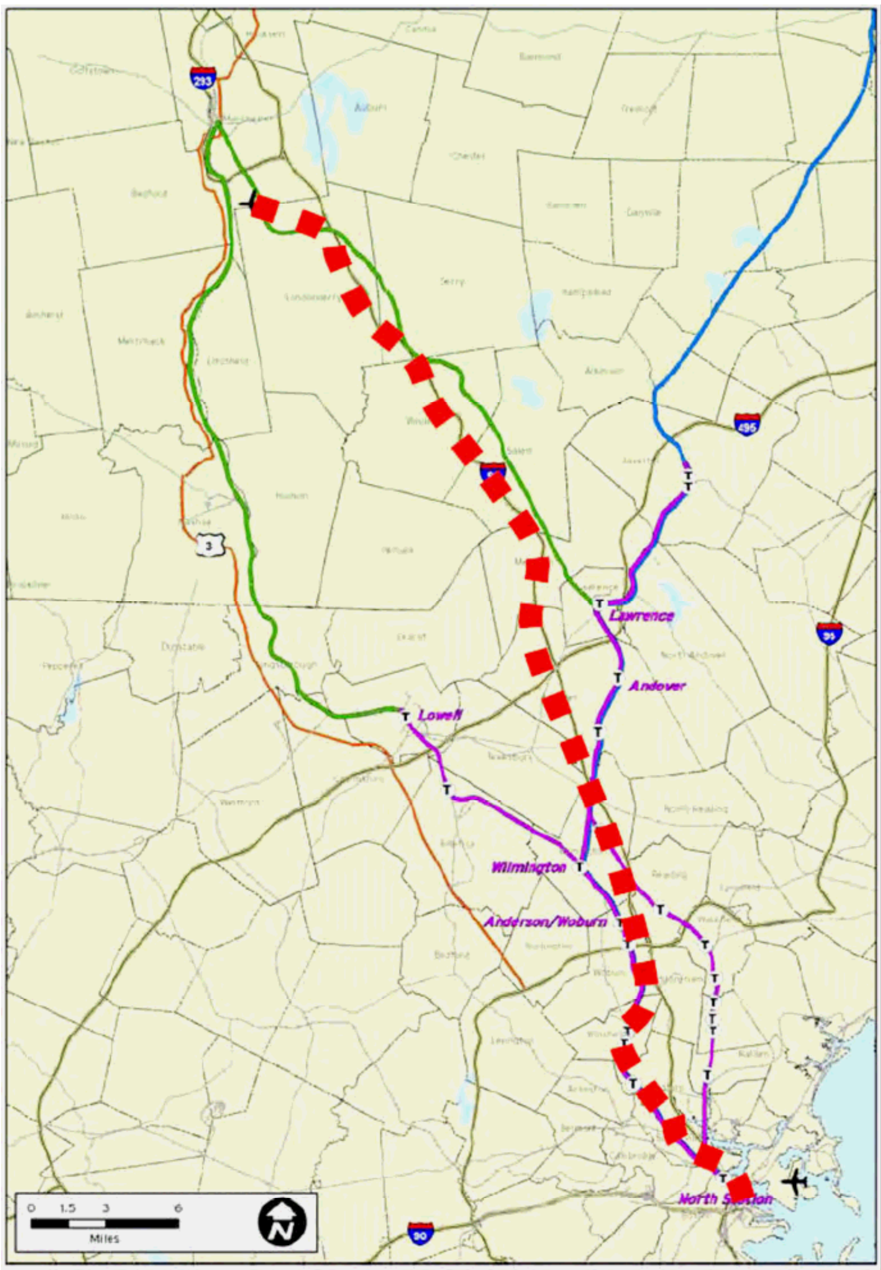


Figure 13: Alignment H1: Boston Service

H2: Transfer Rail: Highway ROW to Anderson Service

This alignment (Figure 14) is very similar to alternative H1: it offers service along the existing highway right-of-way from the northern terminus at Exit 5 in Manchester to Anderson RTC. This alignment will require cross-platforms transfers of Anderson RTC to continue operations along the existing MBTA Lowell Line to the southern terminus at North Station in Boston. This 56-mile alignment offers a travel time of 85 minutes.

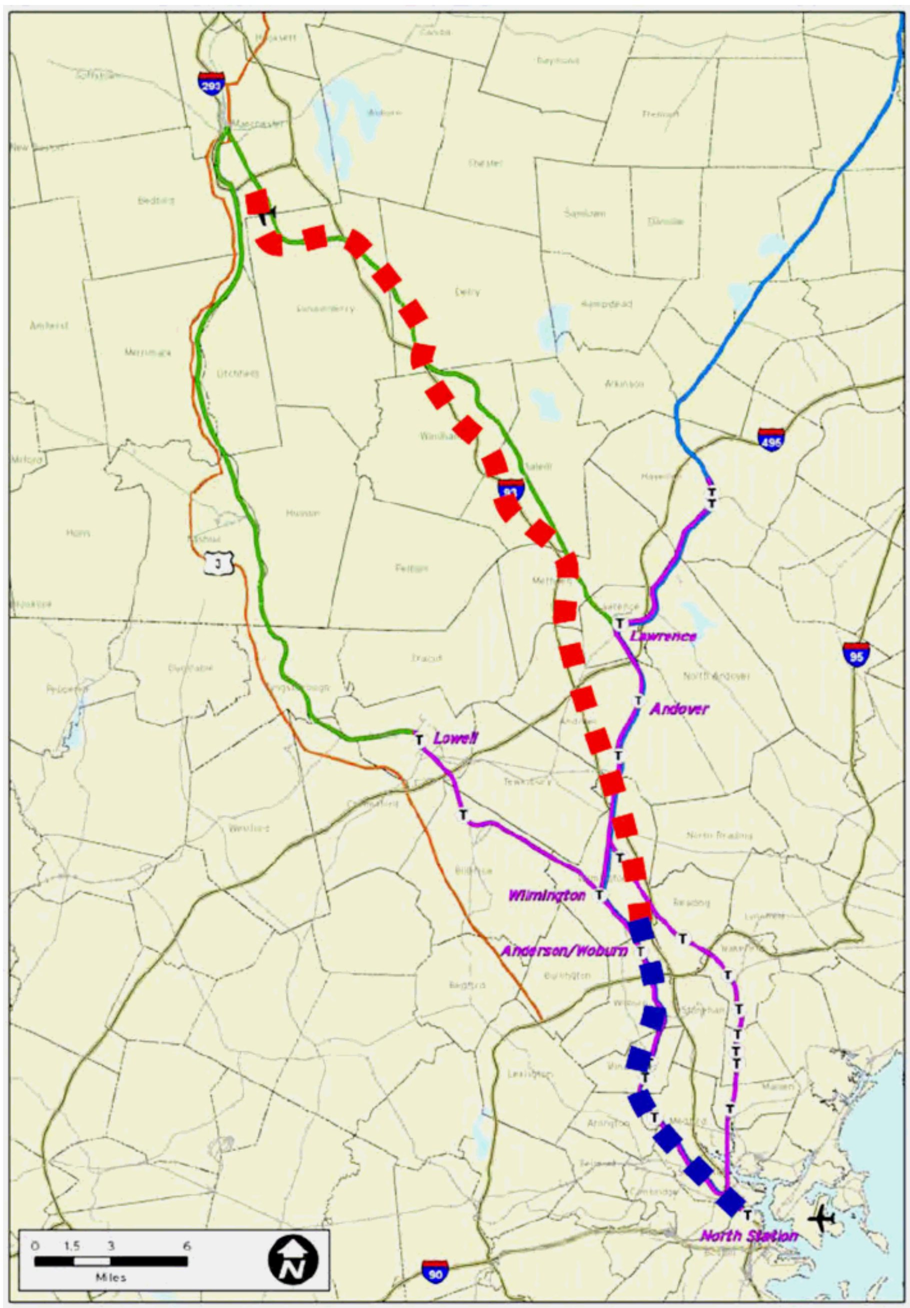


Figure 14: H2: Anderson Service

H3: Transfer Rail: Highway ROW to Andover Service

This alignment (Figure 15) offers connecting service from the northern terminus at Manchester to Salem, NH through the I-93 right-of-way before accessing the existing M&L rail corridor to reach the MBTA station at Andover. Cross-platform transfers to MBTA trains operating on the Haverhill Line at Andover Station would then be required in order to reach the southern terminus at North Station. This 57-mile alignment would offer a travel time of 94-106 minutes.

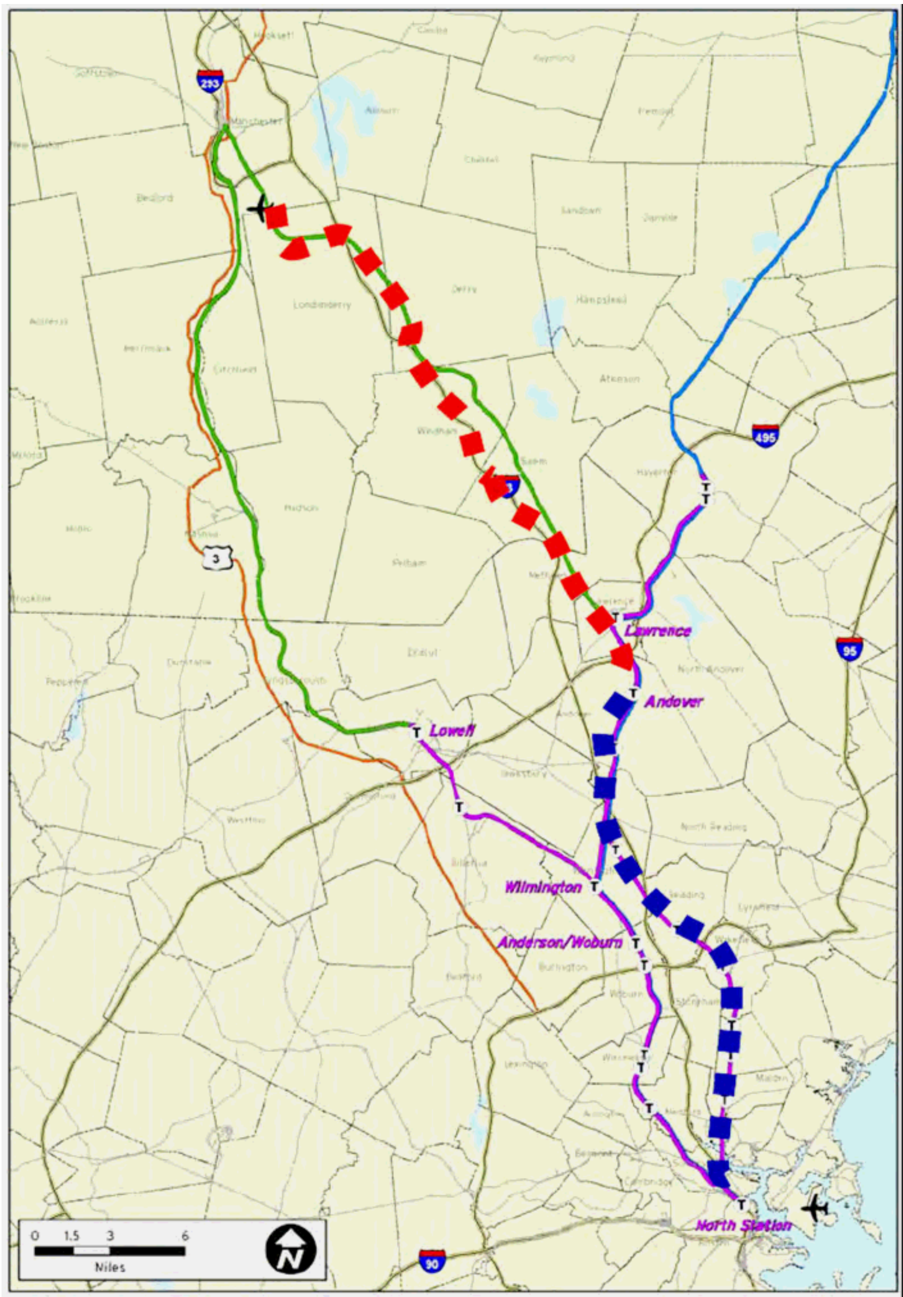


Figure 15: H3: Andover Service

H4: Transfer Rail: Highway ROW to Lawrence Service

This alignment (Figure 16) offers service that is very similar to alternative H3, except that it requires cross-platform transfer to MBTA trains at Lawrence, which then operate along the Haverhill Line to the southern terminus at North Station in Boston. Similar to the E4 alternative, this alignment requires that southbound trains operate in a northerly direction in order to reach the Lawrence Station from the M&L, before continuing in a southerly direction on MBTA track to North Station. This operating characteristic is projected to have a negative impact on travel times and projected ridership. This 59-mile alignment offers a travel time of 99-111 minutes.

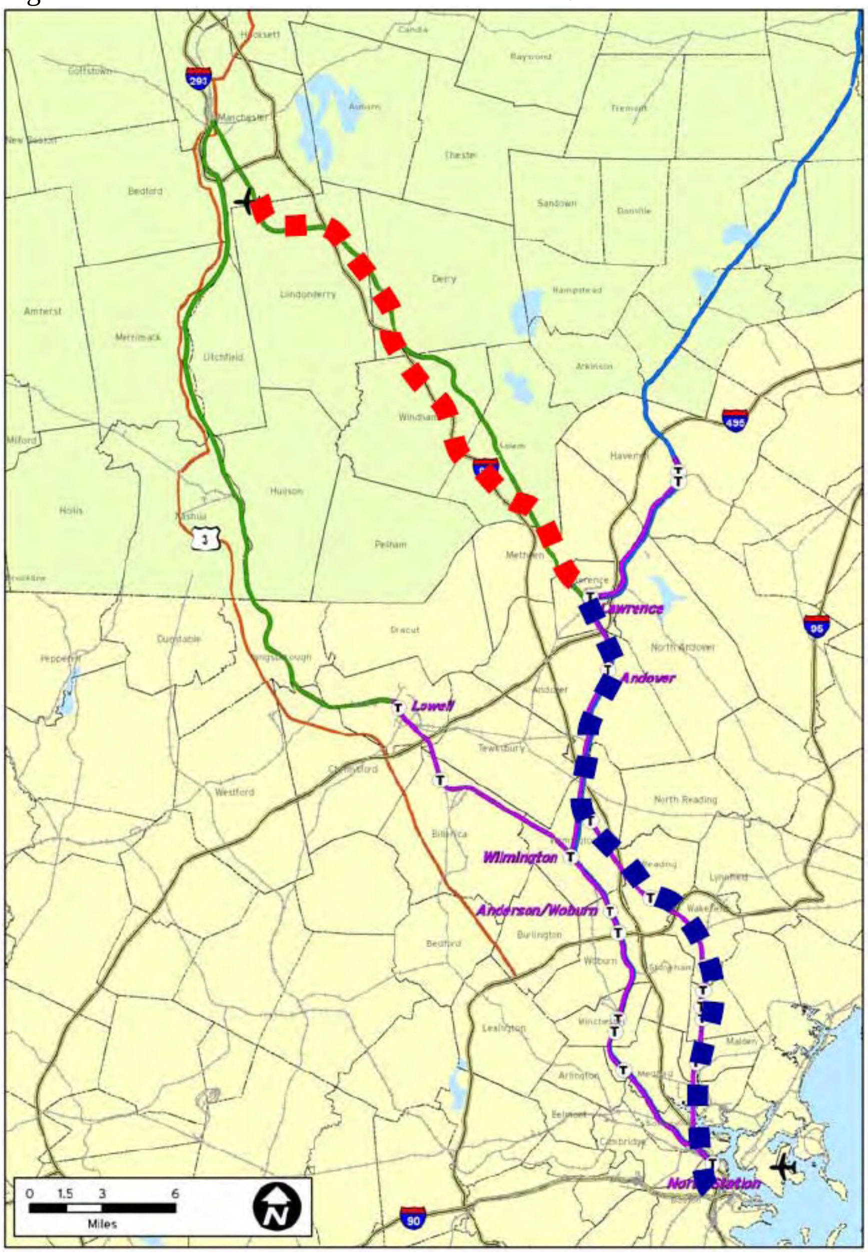


Figure 16: H4: Lawrence Service

Western Alignments

The Western Rail corridor, between Manchester and Boston along the New Hampshire Main Line, is owned by the Boston and Maine Corporation (B&M) within the New Hampshire right-of-way and is owned by the MBTA (Lowell Line) within the Massachusetts right-of-way.

There are plans under development for transit service improvements along this corridor, which is currently an active freight corridor. While this corridor would leverage previous transit investments, it is located approximately 20 miles west of I-93, whose congestion this transit investment study is designed to directly address. This geographic separation would limit the impact of rail service on congestion on I-93.

W1: Direct Rail: Boston Service

This alignment (Figure 17) offers direct service from the northern terminus in Manchester to the southern terminus at North Station in Boston using existing New Hampshire Main Line (NHML) track, serving Merrimack, Nashua, Lowell, and Anderson stations. This 56-mile alignment offers a travel time of 75 minutes.

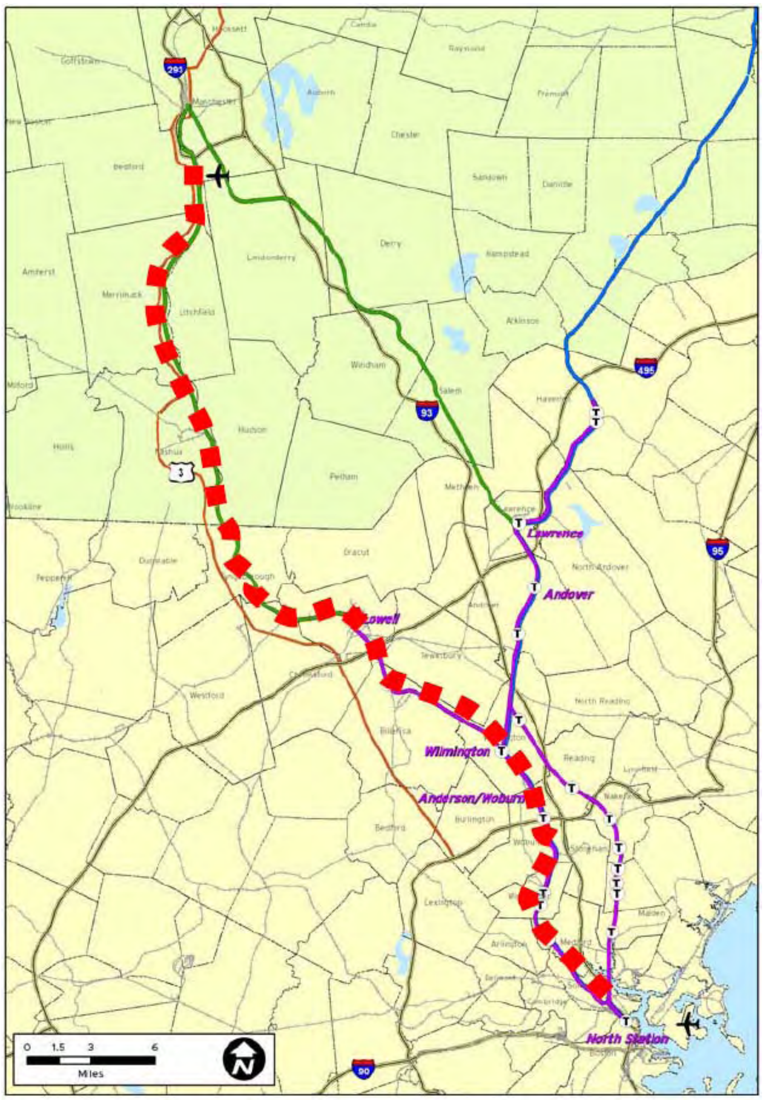


Figure 17: W1: Boston Service

W2: Transfer Rail: Anderson Service

This alignment (Figure 18) offers connecting service from the northern terminus of Manchester to Anderson RTC along existing NHML track, with potential cross-platform transfers to existing MBTA track along the Lowell Line to the southern terminus of North Station in Boston. This 55-mile alignment offers a travel time of 80 minutes.

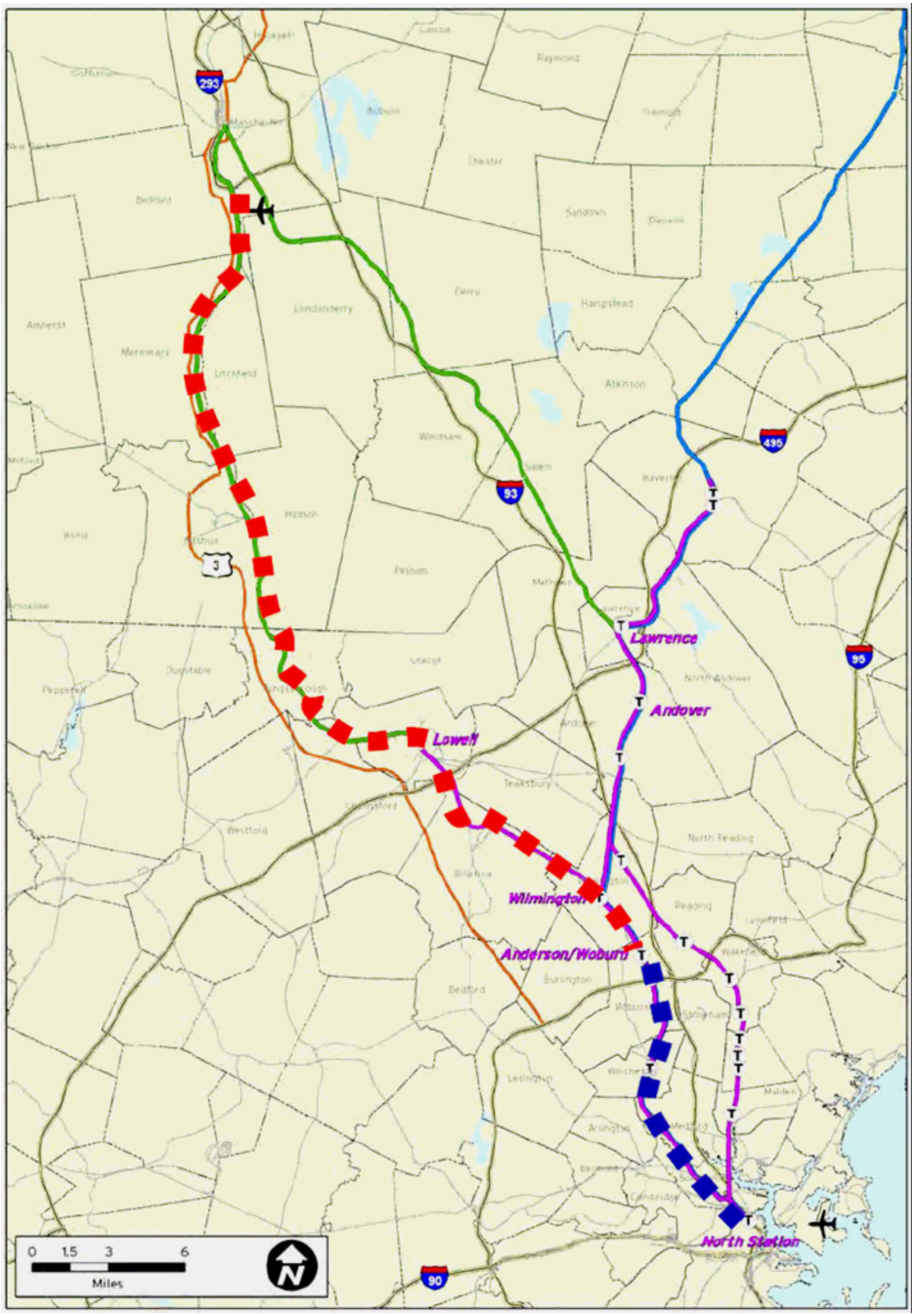


Figure 18: W2: Anderson Service

W3: Transfer Rail: Lowell Service

This alignment (Figure 19) is similar to alternative W2, except that it requires cross-platform transfer to MBTA trains at Lowell Station to the southern terminus at North Station in Boston. This 56-mile alignment offers a travel time of 84-91 minutes.

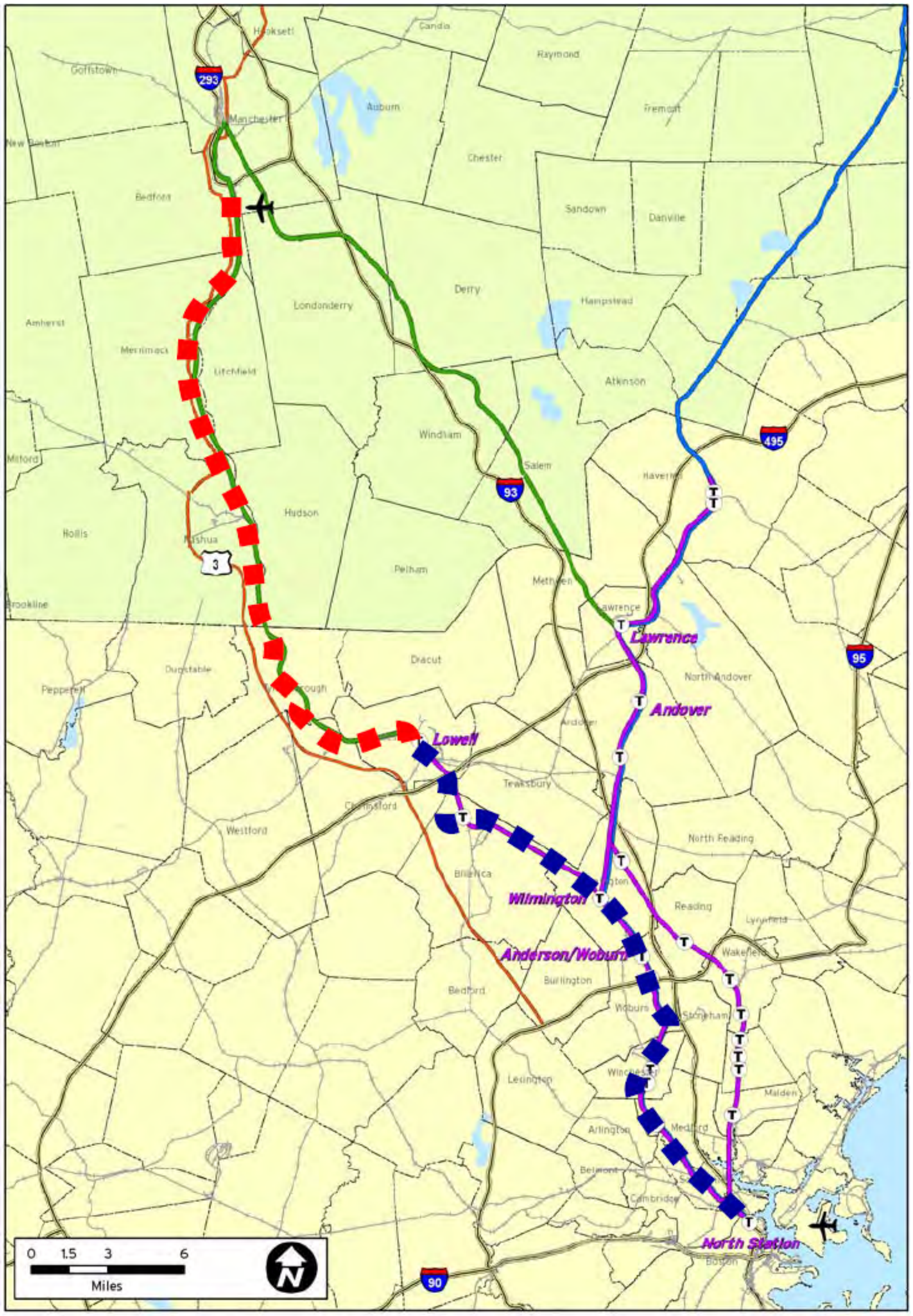


Figure 19: W3: Lowell Service

Bus Alternatives

Principal north-south highways in the study area are I-93 and U.S. Route 3 and the F.E. Everett Turnpike. I-93 was constructed in the early 1960s, when it was expected to carry 20,000 vehicles per day within its design life of 20 years. In 1997, traffic volumes in Salem, north of the Massachusetts border, were exceeding 100,000 vehicles per day. Since I-93 was constructed, traffic volumes have increased by 600 percent in Salem. Historic trends have revealed a five percent annual growth rate in the average daily traffic for I-93 for the segment north of the metropolitan Boston area. The heaviest traffic volumes along I-93 occur in southbound traffic in the morning peak period and northbound in the evening peak period. Peak hour traffic volumes reflect the commuter orientation of the corridor. In New Hampshire, approximately 60 percent of the traffic flow is southbound in the morning peak hour, and northbound in the evening peak hour.

The bus alternatives that were initially identified operate along I-93 either in mixed traffic, in a reserved right-or-way (on the shoulder), or within a rail right-of-way. While buses and bus rapid transit are often considered more attractive transit technologies than rail because of its comparatively lower capital costs, case studies have shown bus systems to have a smaller impact on development and land use patterns than rail transit systems.

B1A: Bus: Highway Alignment: Transit ROW

This alignment offers direct service from the northern terminus in downtown Manchester, NH to the southern terminus of Boston using reserved New Hampshire transit right-of-way on I-93 to the state line. After reaching the Massachusetts state line, the alignment would potentially operate within mixed traffic. This 56-mile alignment has a travel time of 80 minutes.

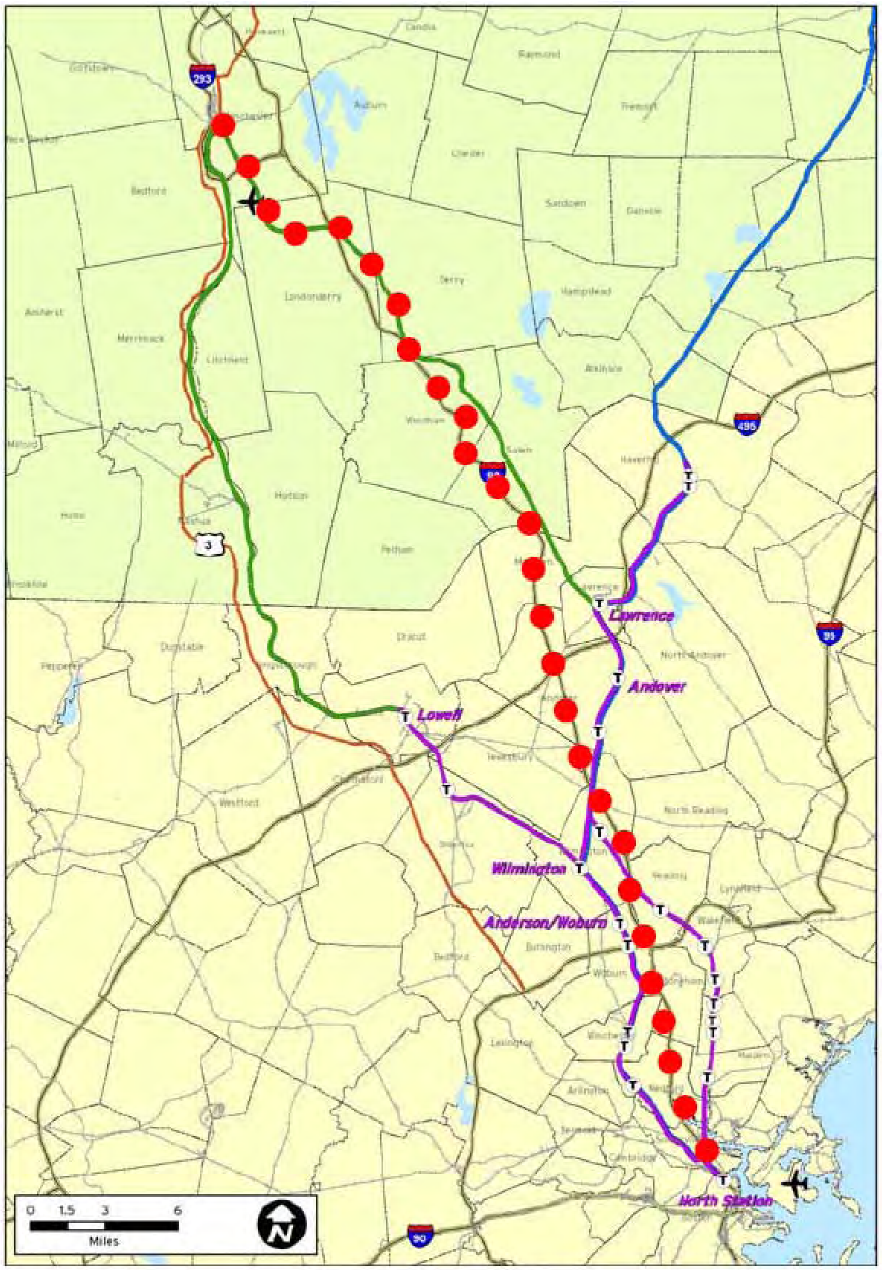


Figure 20: B1A: Bus Highway Alignment: Transit ROW

B1B: Bus: Highway Alignment: Mixed Traffic

This alignment (Figure 21) is identical to alternative B1A, except that buses would not operate within a reserved New Hampshire transit right-of-way. The buses would travel within mixed traffic along the entire alignment. This 56-mile alternative would offer a travel time of 95 minutes.

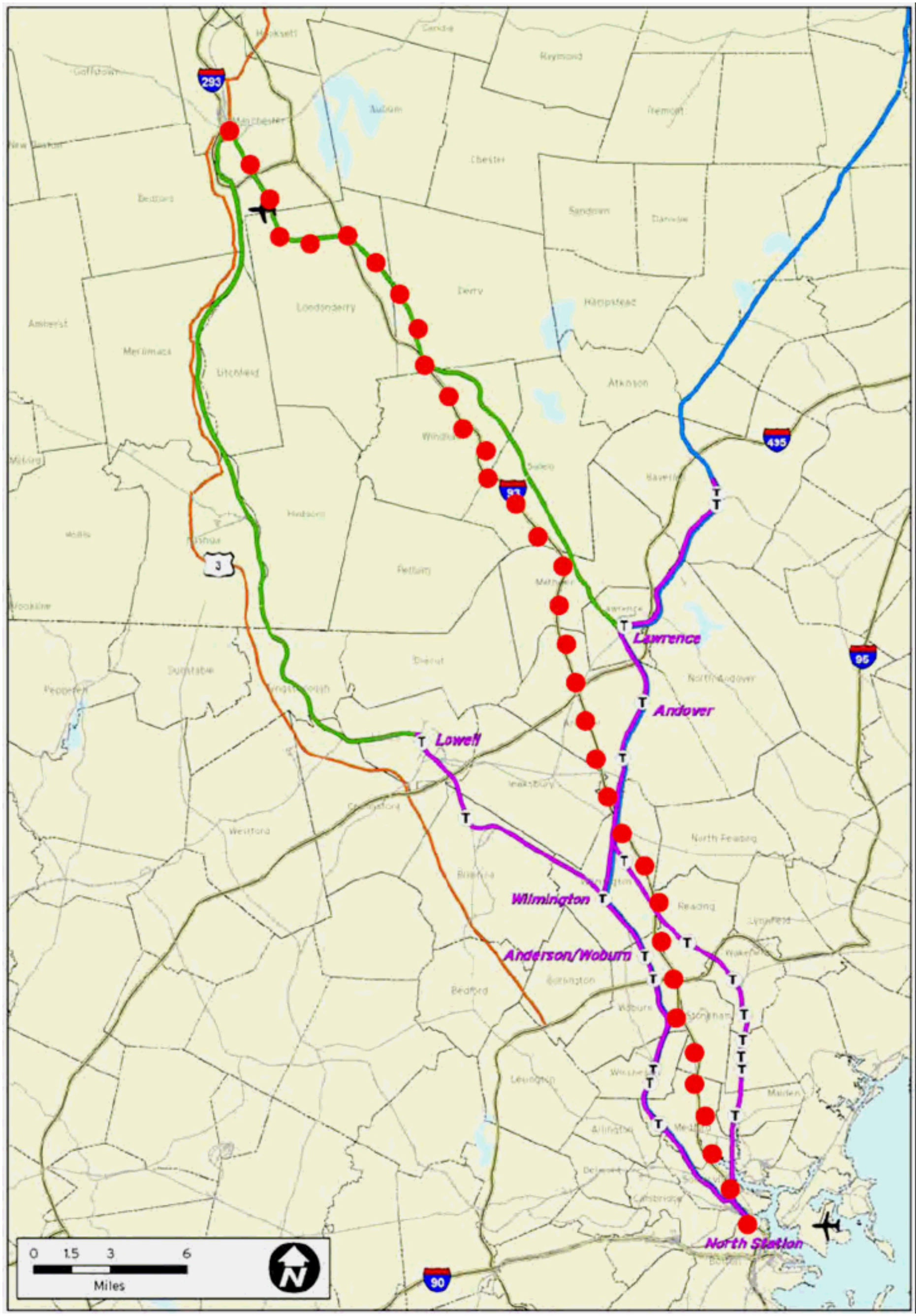


Figure 21: B1B: Highway Alignment: No Transit ROW

B2: Bus: Eastern Alignment

This alternative (Figure 22) offers direct service from the northern terminus of downtown Manchester to the southern terminus of Boston using a reserved right-of-way within the M&L branch corridor, then entering I-93 in Methuen to continue a southerly route to Boston. This 50-mile alignment offers a travel time of 70 minutes.

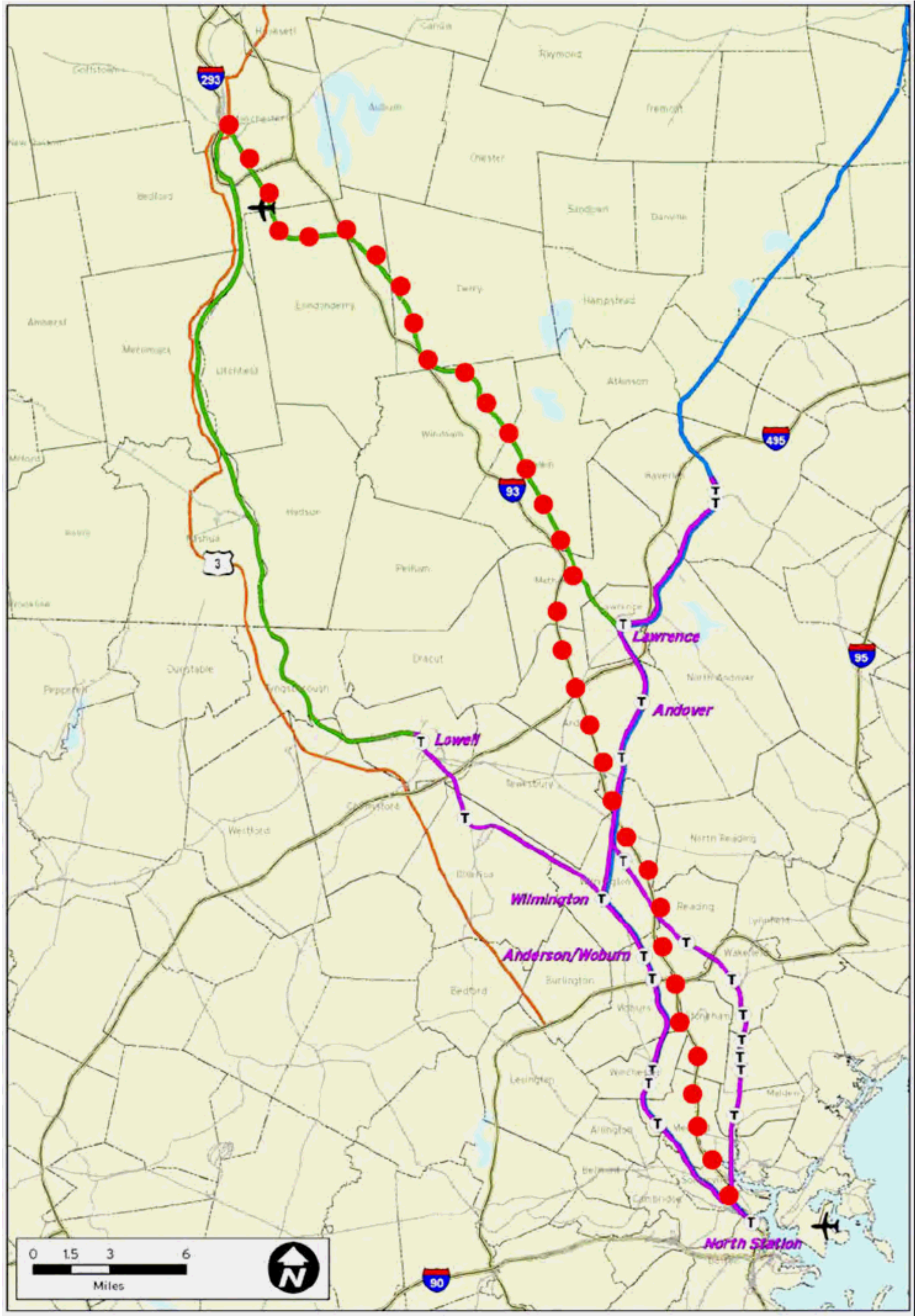


Figure 22: B2: Eastern Alignment

B3: Bus: Western Alignment

This alignment (Figure 23) offers direct service from the northern terminus in Manchester, NH to the southern terminus in Boston using Route 3, Route 128, and I-93. This 61-mile alignment offers a travel time of 105 minutes.

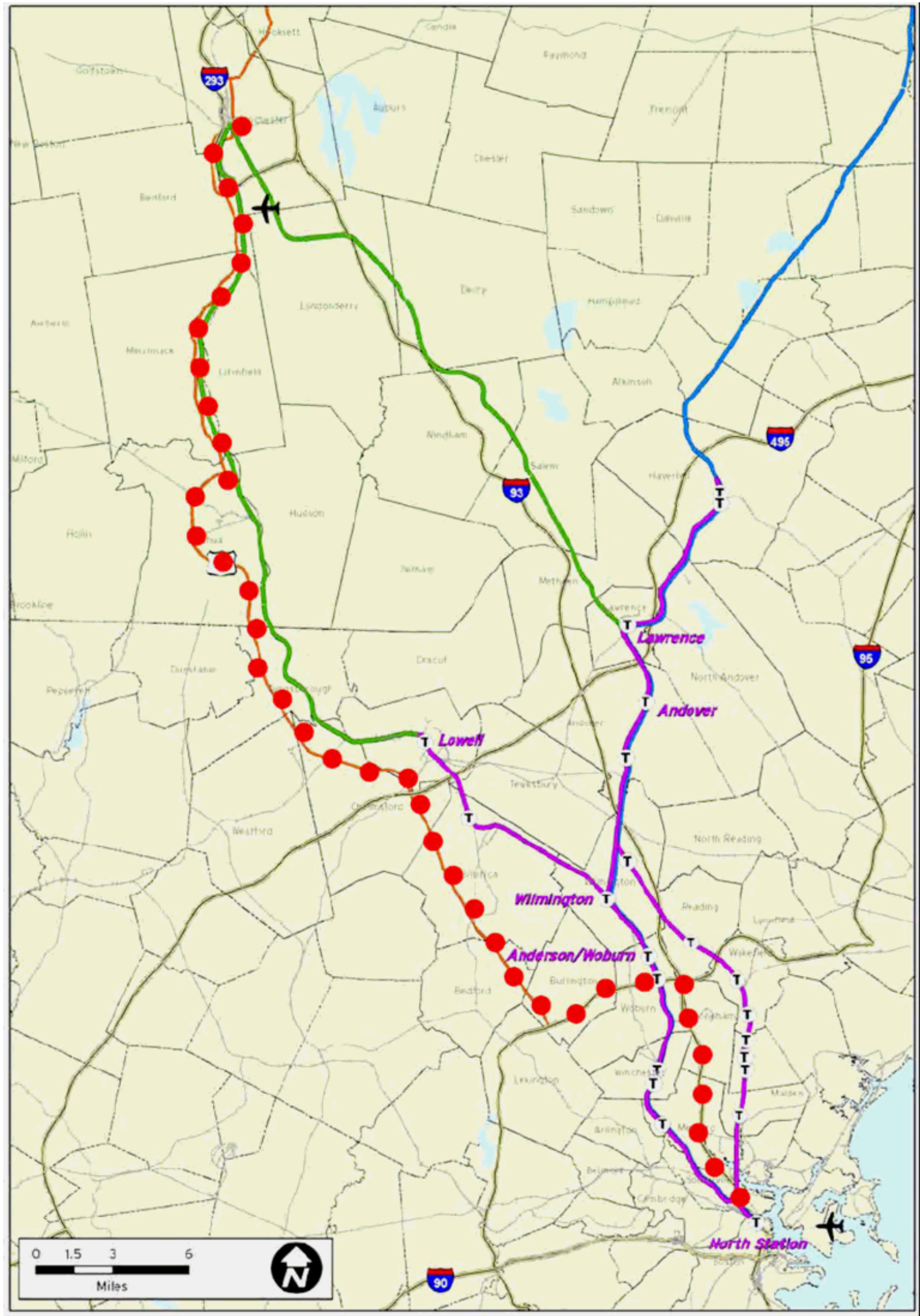


Figure 23: B3: Western Alignment

4. Level 1 Screening Process

This initial set of alternatives included a diversity of alignments and modal types whose unique operating characteristics facilitated the early screening of a number of alternatives. Study team members employed their professional judgment to undertake the initial screening of the 15 alternatives based on the key differentiators of:

- Service levels,
- Congestion mitigation: impact on I-93,
- Travel time savings, and
- Capital costs.

This analysis resulted in a set of recommended alternatives that the study team made to the Technical Advisory Committee (TAC), MA EOT, and NHDOT. The MA EOT and NHDOT then gave final approval for these selected alternatives to be carried forward into further levels of refinement and analysis. This section will present the performance of each alternative when evaluated on the basis of the key differentiators.

Service Levels

The service level differentiator includes the following attributes: frequency of service and necessity for transfers. These service attributes, along with transit travel times, have an impact on ridership levels. While travel time savings may be an output of the level of service, this differentiator measures a broader array of inputs into a transit rider's experience. For instance, it is estimated that passenger wait time is perceived by passengers to be two to four times longer than travel times[4], and that transfers are estimated to impose penalties equivalent to five to 15 minutes of Alternatives E2 and H2, this operating characteristic resulted in-vehicle travel time. This reflects the physical and mental effort involved in transferring as well as the insecurity in making the required connections. At this stage of evaluation all alternatives were estimated to be capable of operating on approximately 30-minute headways.

This differentiator was used to screen out Alternatives E3, E4, H3 and H4. Alternatives E3 and E4 both required cross-platform transfers at the Anderson RTC. Alternatives E4 and H4 were also recommended for elimination because of a required cross-platform transfer at the MBTA's Lawrence Station. The transfers at Lawrence Station had a further complication in that the existing track alignments required trains to travel in a contra-directional manner in order to reach the Lawrence Station. The study team projected that this operating characteristic would have further negative impacts on ridership. Although Alternatives E2 and H2 also required transfers, it was assessed that the transfer penalty at Anderson may be overcome by the potential for travelers destined to the Anderson RTC area and the increased number of MBTA trains on which to transfer (10 during the peak period versus six peak period trains at Andover and Lawrence). Based on this evaluation, the study team determined that these alternatives were not competitive, and recommended that they be eliminated from subsequent levels.

Congestion Mitigation: Impact on I-93

One focus of this study was to evaluate future transit investments that would function to reduce existing levels of vehicular congestion in the I-93 corridor and avoid increases beyond the projected 2030 traffic volume and level of congestion. The three rail alternatives along the Western Alignment

[4] TCRP Report 95: Transit Scheduling and Frequency, Transit Research Board, Washington, DC, 2004.

operated on the New Hampshire Main Line tracks, which are located approximately 20 miles west of I-93. This 20-mile geographic separation was determined to significantly lessen the I-93 congestion-minimizing effects of a transit system. In addition to these rail alternatives, the western alignment of the bus alternatives was projected to have a similarly minimal impact on I-93 traffic congestion. In others words, it was determined to be unlikely that drivers on I-93 would substitute a rail line 20 miles to the west for their current commute. As a result of this assessment, Alternatives W1, W2, W3, and B3 were recommended for elimination from subsequent levels of refinement and screening.

Travel Time Savings

Travel times are a reflection of an alignment's operating characteristics. As discussed above, the unique operating characteristics of the initial 15 alternatives resulted in the early identification of a number of key differentiators, including travel time savings. While Alternatives E3, H3, E4, and H4 were recommended for elimination based on the need for transfers, these alternatives also had comparatively longer travel times than the remaining alternatives.

Travel times were estimated for each of the alternatives using a combination of existing highway travel times, estimations of bus speeds for dedicated lanes, existing MBTA commuter rail travel times and estimates of travel times using a train performance calculator which computes travel times based on route alignment, train acceleration and station stops. The following are the preliminary estimates of travel times for each of the alternatives.

- E1: Direct Rail: Boston Service from Exit 5 (78 minutes),
- E2: Transfer Rail: Anderson Service from Exit 5 (83 minutes),
- E3: Transfer Rail: Andover Service from Exit 5 (85-97 minutes),
- E4: Transfer Rail: Lawrence Service from Exit 5 (88-100 minutes),
- H1: Direct Rail: Boston Service along Highway ROW (80 minutes),
- H2: Transfer Rail: Highway ROW to Anderson Service (85 minutes),
- H3: Transfer Rail: Highway ROW to Andover Service (94-106 minutes),
- H4: Transfer Rail: Highway ROW to Lawrence Service (99-111 minutes),
- W1: Direct Rail: Boston Service (75 minutes),
- W2: Transfer Rail: Anderson Service (80 minutes),
- W3: Transfer Rail: Lowell Service (84-91 minutes),
- B1A: Bus: Highway Alignment: Transit Right-of-Way (80 minutes).
- B1B: Bus: Highway Alignment: No Transit Right-of-Way (95 minutes),
- B2: Bus: Eastern Alignment (65 minutes), and
- B3: Bus: Western Alignment (105 minutes).

Alternative B1B had a comparatively longer travel time than Alternative B1A because it would not operate within a reserved right-of-way within New Hampshire. Because of the comparatively longer travel time, Alternative B1B was eliminated from further screening.

Capital Costs

While this level of analysis does not include detailed capital and operating cost estimates, unique operating characteristics can identify an alignment whose capital costs would be prohibitively high. Alternative B2 utilized the M&L Branch rail corridor in addition to traveling along I-93. The rail corridor portion of the alignment would have increased capital costs to those associated with the construction of fixed guideway systems. The study team recommended the elimination of this alternative from further consideration based on the high capital costs.

Summary

As a result of these four key differentiators, the following alternatives were eliminated from further refinement and screening:

- E3: Transfer Rail: Andover Service from Exit 5 (service levels, travel times),
- E4: Transfer Rail: Lawrence Service from Exit 5 (service levels, travel times),
- H3: Transfer Rail: Highway ROW to Andover Service (service levels, travel times),
- H4: Transfer Rail: Highway ROW to Lawrence Service (service levels, travel times),
- W1: Direct Rail: Boston Service (congestion mitigation),
- W2: Transfer Rail: Anderson Service (congestion mitigation),
- W3: Transfer Rail: Lowell Service (congestion mitigation),
- B1B: Bus: Highway Alignment: No Transit Right-of-Way (travel times),
- B2: Bus: Eastern Alignment (capital cost), and
- B3: Bus: Western Alignment (congestion mitigation).

The remaining alternatives were given further evaluation:

- E1: Direct Rail: Boston Service from Exit 5,
- E2: Transfer Rail: Anderson Service from Exit 5,
- H1: Direct Rail: Boston Service along Highway ROW,
- H2: Transfer Rail: Highway ROW to Anderson Service, and
- B1A: Bus: Highway Alignment: Transit Right-of-Way.

5. Level 2 Screening Process

Range of Alternatives

The study team conducted a number of TAC, MA EOT, NHDOT, stakeholder, and public meetings to present their analysis and subsequent conclusions. Based on this dialogue, and with the approval of the MA EOT and NHDOT, the study team carried forward the two Eastern Rail alignments identified in the first level of screening (E1 and E2), two Highway rail alignments identified in the first level (H1 and H2), and one bus alignment (B1A). Based on input from stakeholders and operational refinements, the bus alignments were expanded to include four alternatives: two bus-on-shoulder alternatives and two dedicated lane alternatives. The resulting eight alternatives considered in the second level of screening are described below.

Eastern Rail Alignment: ERB: Boston Service

This alignment offers direct service from I-93 Exit 5 to the southern terminus in Boston using the M&L Branch, Haverhill MBTA track, the Wildcat Branch, and the MBTA Lowell Line. This alignment (identified as E1 in the list of initial alternatives) would require five new stations (Exit 5, Derry, Salem, Methuen, and Lawrence – Essex Street).

Eastern Rail Alignment: ERA: Anderson Service

This alignment offers service from Exit 5 in New Hampshire to Anderson RTC with transfers available to MBTA Lowell commuter trains and employment site shuttle buses. This alternative was designed to provide access points for office park employees who work at lower-density sites throughout the I-495 and Route 128 corridors. This alignment (identified as E2 in the list of initial alternatives) would require five new stations (Exit 5, Derry, Salem, Methuen, and Lawrence – Essex Street).

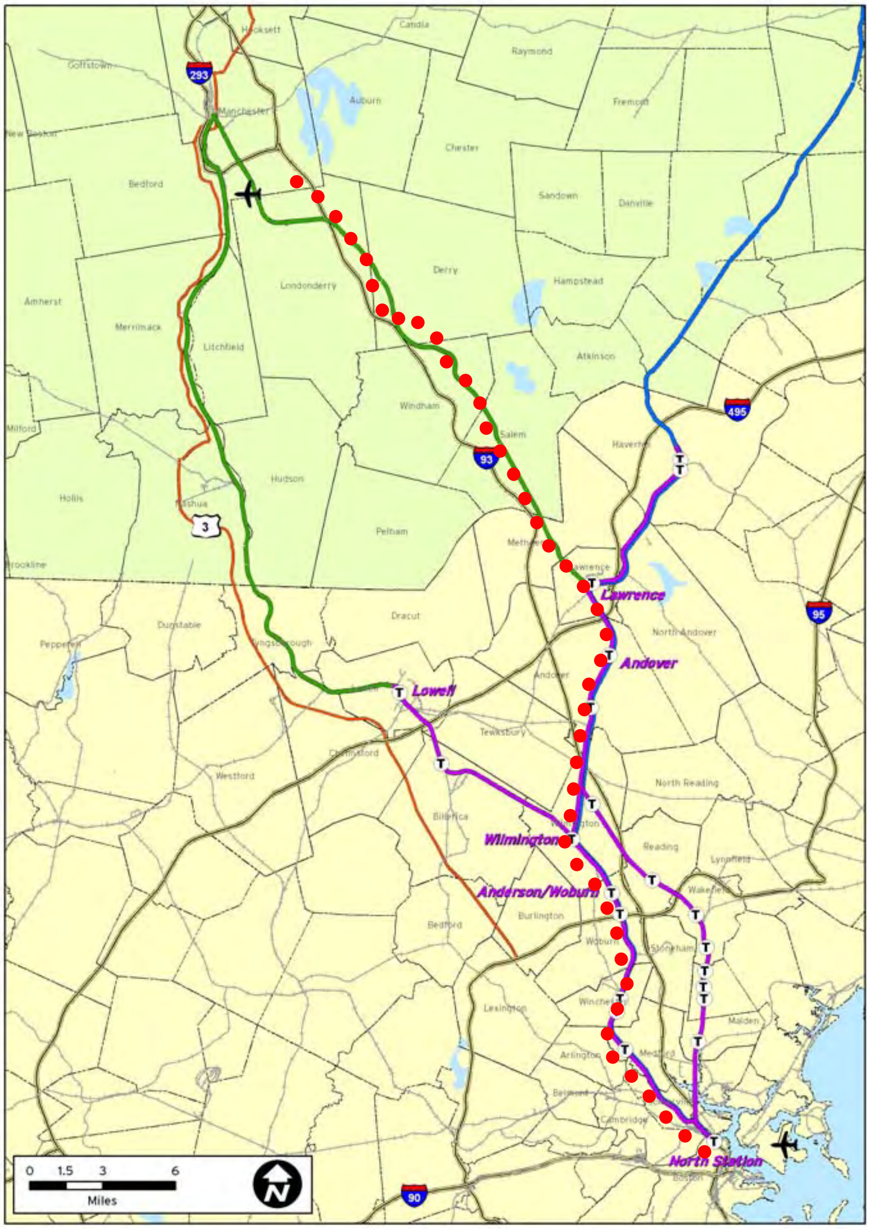


Figure 24: ERB and ERA

Highway Rail Alignment: HRB: Boston Service

This rail alignment offers direct service from Exit 5 in New Hampshire to the southern terminus in Boston using a transit reservation lane along I-93, the M&L Branch, the MBTA Haverhill Line, the Wildcat Branch, and the MBTA Lowell Line. This alignment (a variation of the H1 alternative in the initial list of alternatives) would include six new stations (Exit 5, Exit 4, Exit 3, Exit 2, Methuen, and Lawrence – Essex Street).

Highway Alignment: HRA: Anderson Service

This alignment offers service from Exit 5 in New Hampshire to Anderson RTC, with transfers available to MBTA Lowell commuter trains and employment site shuttle buses. Similar to the ERA Alternative, this alternative was designed to provide access points for office park employees who work at lower-density sites throughout the I-495 corridor. This alignment (H2 in the initial list of alternatives) would include six new stations (Exit 5, Exit 4, Exit 3, Exit 2, Methuen, and Lawrence – Essex Street).

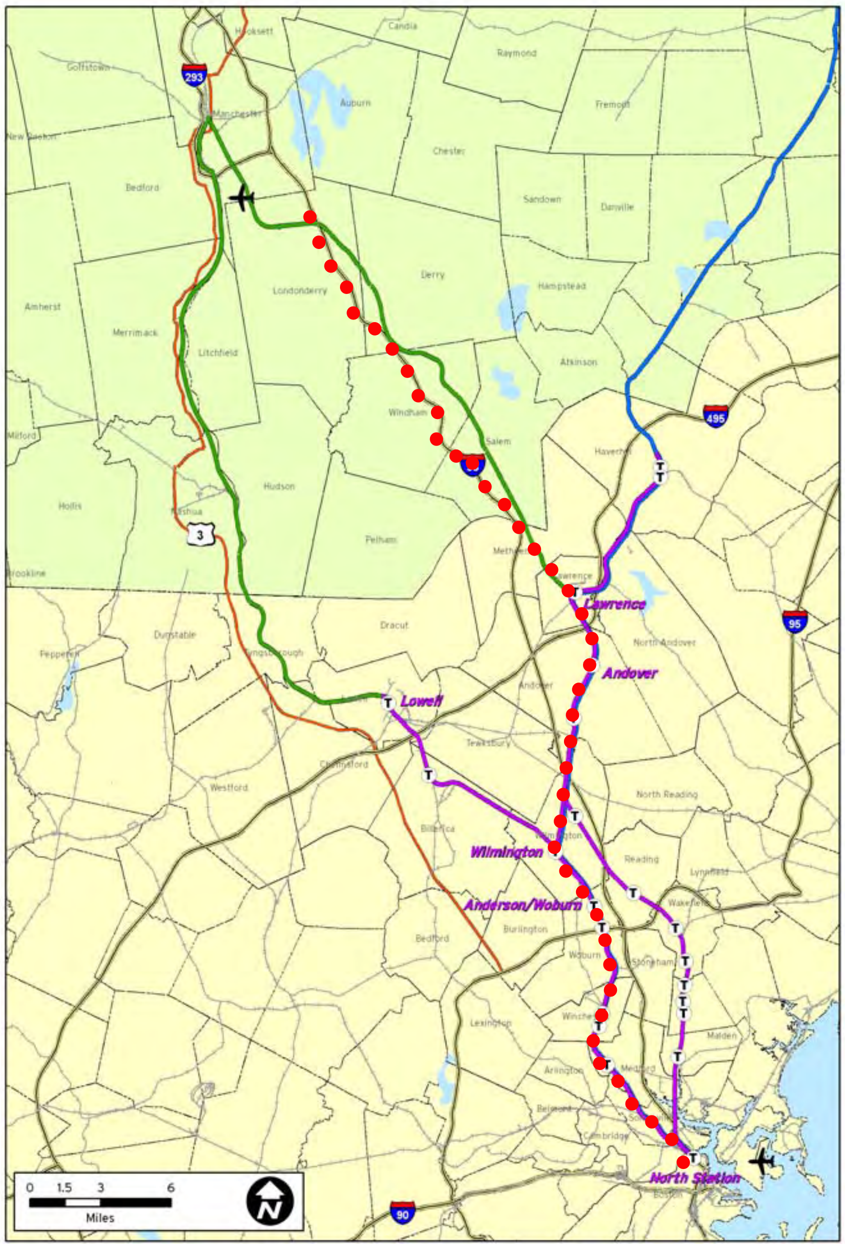


Figure 25: HRB and HRA

Bus on Shoulder Alternatives

Bus service that operates on highway shoulders has existed in North America for over 15 years. This system allows professional drivers the discretion to drive within highway shoulders to reduce travel times and increase the reliability of transit service. Many agencies, including those in Minneapolis, Minnesota and Ottawa, Canada, have demonstrated that bus on shoulder (BOS) operations can safely and cost-effectively improve transit service on congested roadways.

Highway shoulders, generally used as an emergency breakdown lane and for emergency response vehicles, can be easily adapted to allow transit operators to safely use the shoulder as an express bus lane in addition to its other functions. The key design requirements are a minimum lane width of ten feet (12 feet preferred), adequate shoulder pavement strength, drainage inlets level with the roadway, and signage. Conflicts with the pavement edge rumble strips and lateral obstructions adjacent to shoulders sometimes need to be addressed. The costs for these upgrades vary widely, but are modest compared with most highway widening and interchange reconstruction costs.[5]

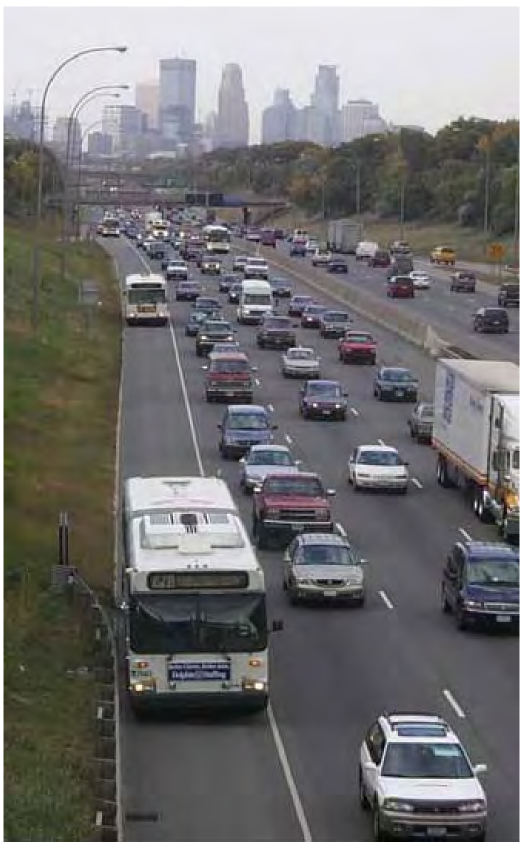


Figure 26: BOS in Minneapolis

Figure 27: BOS in Ottawa

[5] Martin, Peter C. (2006). *TCRP Synthesis 64: Bus Use of Shoulders, A Synthesis of Transit Practice*, Transportation Research Board, National Research Council, Washington, D.C. 2006: 100.

Two of the earliest and most extensive BOS networks are operated in Minneapolis and Ottawa. Both systems have been in operation for more than 15 years. In Ottawa, buses can use the shoulders of limited access highways at any time with maximum allowable speeds of 62 mph. The more conservative Minneapolis system allows buses to use the shoulder of the highway when the speed of general traffic drops below 35 mph. Buses on the shoulder may operate at speeds 15 mph faster than travel in other lanes, to a maximum of 35 mph. The more liberal Ottawa approach is consistent with the current general purpose vehicle use of highway shoulders on I-93 and I-95 in Greater Boston, where both automobiles and buses are allowed to travel at 65 mph in the shoulder during peak periods.

While the Twin Cities and Ottawa examples, with over 250 miles of BOS operations, are the most extensive North American BOS networks, many North American communities have implemented BOS systems. As of 2006, transit buses were also operating on shoulders in Virginia, Maryland, Washington, New Jersey, Georgia, Delaware, California, Florida, and Ontario. New BOS lanes are currently being developed in Ohio, Illinois, and Kansas, in addition to studies on the feasibility of BOS that are in progress nationwide.

The range of benefits that is achievable at a comparatively-low cost makes BOS projects an attractive transit alternative. The direct benefits include reduced travel times and increased service reliability. Indirect benefits may include reduced highway congestion, increased transit service, increased transit patronage, and decreased operational costs.

In New Hampshire and Massachusetts, BOS operations appear to be a cost-effective near-term strategy for substantially enhancing commuter service on I-93. Preliminary estimates of travel time savings are in excess of 30 minutes on BOS routes. I-93 in New Hampshire is currently proposing reconstruction to add two general purpose lanes in each direction as a congestion mitigation and safety enhancement measure. The proposed reconstruction will further enhance the condition of the shoulders along I-93 so that improvements necessary to modify the shoulders for BOS operations will be minimal. Travel is not currently permitted on the shoulders.

I-93 in Massachusetts is three lanes in either direction between the state line and Exit 41 (Route 125) in Andover. South of Exit 41, an additional general travel lane is available in each direction. Vehicles are already traveling at 65 mph on the shoulder of I-93 north of Exit 41 to Route 213 near the state line. Traffic flow in the peak periods is facilitated by the use of the shoulder in the peak direction between 6 and 10 a.m. and between 3 and 7 p.m. The hard shoulder is not currently used by any transit vehicles or commercial buses. Use of the breakdown lane for travel was instituted in 1999 after Massachusetts State Representative Barry Finegold convened legislators and officials from both Massachusetts and New Hampshire to address I-93 congestion issues. Permission to use the breakdown lane for full-speed general purpose traffic operations was extended by the Federal Highway Administration (FHA) as an interim measure until a fourth lane is added north of Exit 41. BOS operations would preclude private automobiles from traveling in the shoulder north of Exit 41. Consequently, BOS operations may require the acceleration of plans to widen I-93 in northern Essex County to allow for the implementation of BOS for the 12 miles of I-93 in Massachusetts north of Exit 41.

It is envisioned that express buses from New Hampshire would travel along the I-93 shoulder in New Hampshire when use of the shoulder would be faster than travel in the general purpose lanes. South of the New Hampshire – Massachusetts state line, buses would continue to have the option of traveling in the highway shoulder. Near Exit 30, all buses would cross three lanes to enter the existing HOV lane leading to the Zakim Bridge. Once in Boston, buses would stop in the vicinity of the MBTA's State Street station and other downtown locations en route to the South Station terminal.

Morning peak travel times on I-93 southbound between the state line and Boston are 63 minutes on average and can be as high as 83 minutes, while free flow travel time is 29 minutes.[6] The 20-minute difference between average and maximum peak travel times highlights the improvement in service reliability achievable with BOS. Travel time calculations for BOS routes traveling from Manchester to Boston, assuming Ottawa-style 60 mph operations, indicate that BOS operations could save commuters 39 minutes compared to travel by private auto. Assuming MnDOT-style operations with 35 mph maximum shoulder speeds, it is very roughly estimated that BOS operations could save commuters from Manchester to Boston 16 minutes compared to travel by private auto.

Enhancing highway shoulders for BOS would also provide benefits for Massachusetts transit services that operate on I-93. These services, including the MVRTA's Boston Commuter Bus and the MBTA's express buses from Burlington and Woburn, could take advantage of bus-only shoulders for travel to Boston saving in excess of 30 minutes of travel time under Ottawa-style operations. Assuming that these Massachusetts services could double in frequency due to decreased travel times, the frequency of Massachusetts and New Hampshire buses in the shoulder of I-93 in Massachusetts would be approximately every two minutes during the peak. While this level of service would be frequent enough to make BOS a highly visible practice, it would not be so frequent as to obstruct the bus operator's view or place undue stress on automobile drivers in the general purpose lanes.

Bus on Shoulder Alternative: HBBS: Boston Service

This alternative offers direct service from Manchester, NH to Boston using the highway shoulders from Exit 5 until Exit 30 in Massachusetts, at which the alignment would continue in an existing HOV lane. This 55-mile alignment would offer a travel time of 56 minutes. While there would be five bus terminals in New Hampshire, each peak hour bus route would serve only one of these stations and then run a direct, or express, route to Boston.

Bus on Shoulder Alternative: HBAS: Anderson Service

This alignment offers service from Manchester to Anderson RTC using the highway shoulders from Exit 5 to Exit 37C in Massachusetts. At Anderson RTC, transfers would be available to MBTA Lowell commuter trains and employment bus site shuttles. This 42-mile alignment would offer a travel time between Exit 5 and Boston of 75 minutes. While there would be five bus terminals in New Hampshire, each peak hour bus route would serve only one of these stations and then run a direct, or express, route to Anderson RTC.

[6] Smartraveler web site, http://www.smartraveler.com,

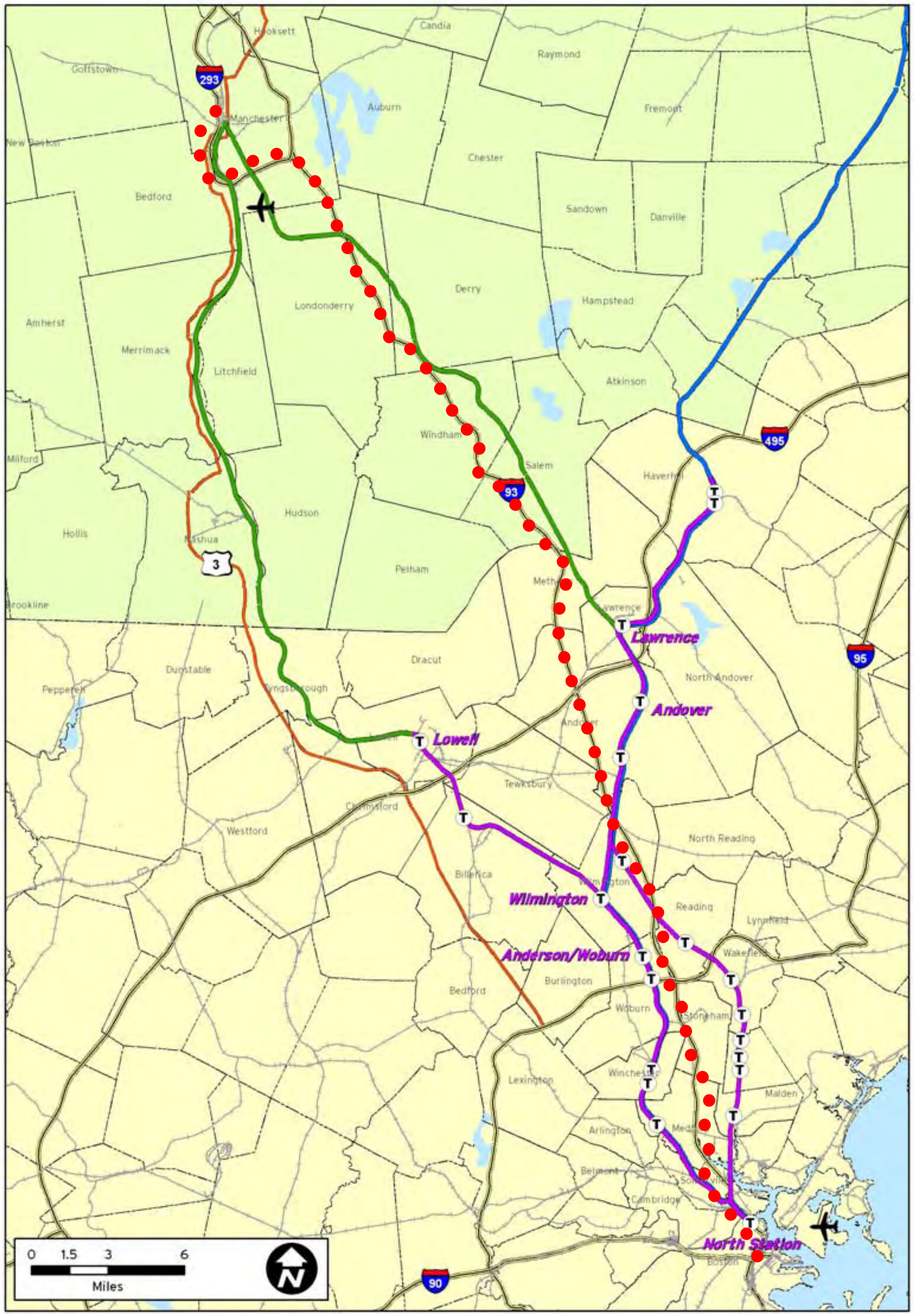


Figure 28: HBBS and HBAS

Dedicated Busway Alternatives: HBBR: Boston Service

This alternative offers direct service from Manchester, NH to Boston using a dedicated busway within the I-93 right-of-way in New Hampshire and HOV lanes and the shoulder of I-93 in Massachusetts. This alignment (similar to B1A in the initial list of alternatives) would include five stations in New Hampshire, and buses would service all stations along the route.

Dedicated Busway Alternatives: HBAR: Anderson Service

This alternative offers direct service from Manchester, NH to Anderson RTC using the dedicated busway within the I-93 right of way in New Hampshire and the HOV lane and shoulder in Massachusetts. This alignment would also include five stations in New Hampshire, and buses would service all stations along the route. This 44-mile alignment would offer a travel time of 79 minutes.

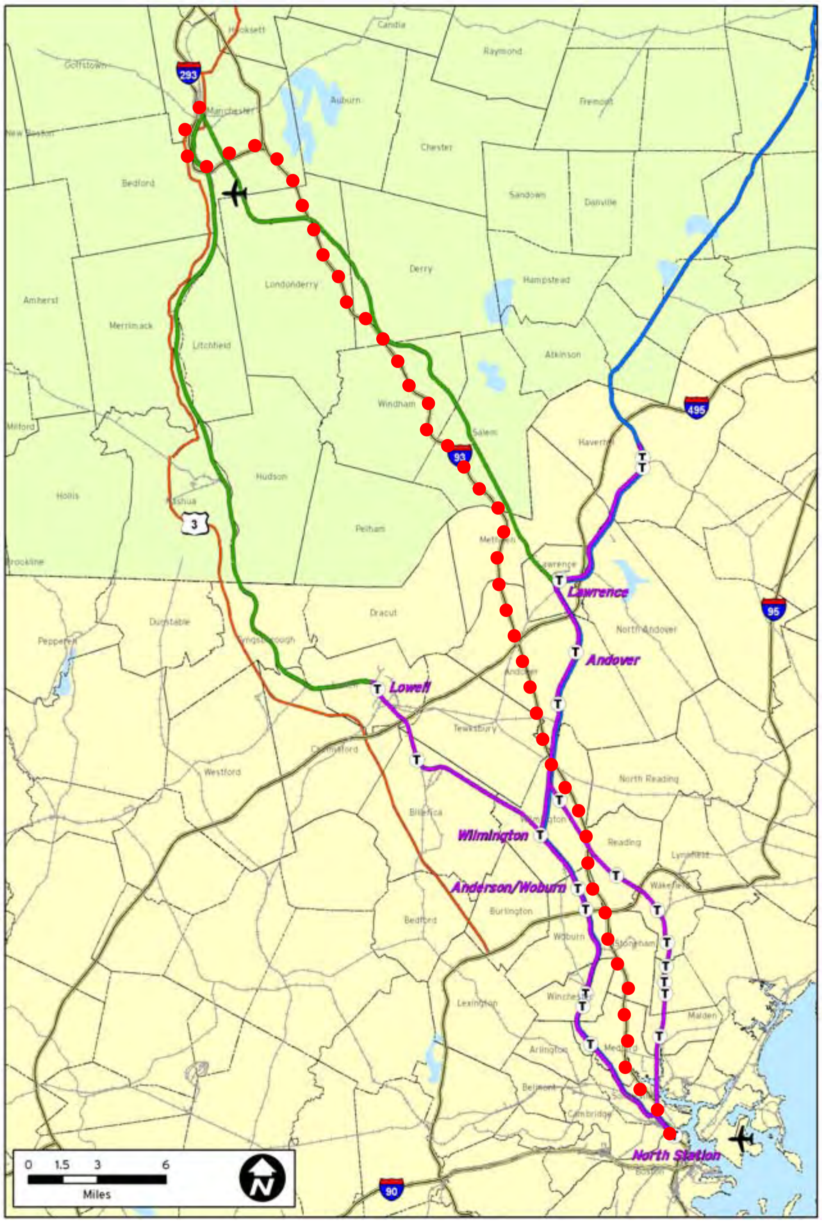


Figure 29: HBBR and HBAR

Evaluation and Screening Results

The eight Level Two alternatives were subjected to a more rigorous level of screening than the Level One alternatives: preliminary service schedules and headway times (amount of time between transit mode arrivals at a station) were defined for the direct service rail alternatives, headways were determined for the bus alternatives, and travel times were compared.

(ERB/HRB) Weekdays			
Arrivals in Boston		***Departures from Boston***	
6:45 am	12:45 pm	7:00 am	4:00 pm
7:15	1:45	8:00	4:30
7:45	2:45	9:00	5:00
8:15	3:45	10:00	5:30
9:45	4:45	11:00	6:00
10:45	5:45	12:00 pm	7:00
11:45	6:45	1:00	9:00
	7:45	2:00	10:00
	8:45	3:00	11:00
	9:45		
	10:45		
Daily Round Trips = 19			

Weekends & Holidays	
Arr. in Boston	***Dep. from Boston***
7:45 am	8:00 am
9:15	9:30
10:45	11:00
12:15 pm	12:30 pm
1:45	2:00
3:15	3:30 p
4:45	5:00
6:15	6:30
7:45	8:00
9:15	9:30
10:45	11:30
Daily Round Trips = 11	

Table 2 - Conceptual Direct Rail Service Schedule

	HBBS	**HBAS**	**HBBR**	**HBAR**
Week days				
First arrival	7 a.m.	7 a.m.	7 a.m.	7 a.m.
Last departure	11 p.m.	11 p.m.	11 p.m.	11 p.m.
Peak headways	15 to 30 minutes	15 to 30 minutes	4 minutes	20 minutes
Off-peak headways	60 minutes	60 minutes	15 minutes	20 minutes
Weekends/holidays				
First arrival	8 a.m.	8 a.m.	8 a.m.	8 a.m.
Last departure	12 a.m.	12 a.m.	12 a.m.	12 a.m.
Peak headways	--	--	--	--
Off-peak headways	--	--	--	--

Table 3 - Conceptual bus headways

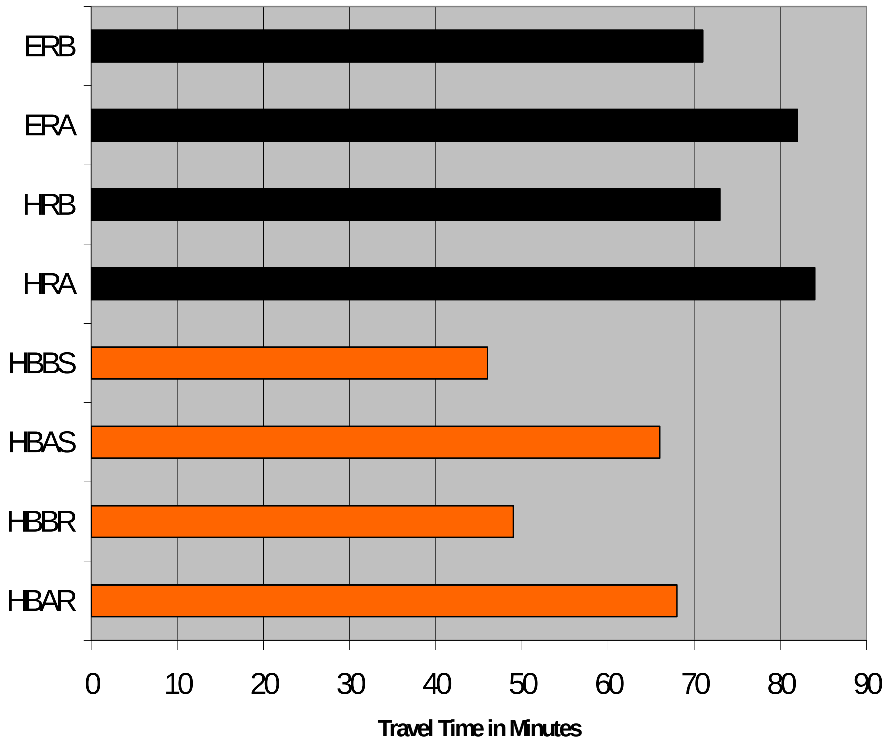


Figure 30: Comparison of Travel Times between Northern Terminus and Boston

Based on the results of this level of evaluation, the Eastern Rail Alignments, the Highway Rail Alignments, and HBBS were carried forward into the next level of analysis. The three other bus alternatives were screened out at this stage because of the two key differentiators of level of service and travel time savings.

Service Level

As mentioned previously, this differentiator measures such factors as frequency of service, passenger wait time, and necessity for transfers. Both HBAS and HBAR required transfers at Anderson RTC in order to continue a southern route to Boston, which negatively impacts the service level and would negatively impact ridership projections. The combination of the inconvenience of the transfer and the added perceived travel time due to the transfer would result in the bus alternatives that would have the longest perceived travel times.

Travel Time Savings

Alternative HBBR was recommended for elimination because, when compared to the similar alignment of HBBS, it is projected to have slightly longer travel times. This would mean that there would be no travel time or service level advantage to overcome the added cost of constructing a dedicated busway in New Hampshire. The travel times of Alternatives HBAS and HBAR also fared comparatively poorly. The travel times for each of the Alternatives (which include an estimate of actual transfer times) include:

- HBAS: Anderson Service (75 minutes)
- HBBS: Boston Service (56 minutes)
- HBAR: Anderson Service (79 minutes)

- HBBR: Boston Service (61 minutes)
- ERB: Boston Service (71 minutes)
- ERA: Anderson Service (82 minutes)
- HRB: Boston Service (73 minutes)
- HRA: Anderson Service, (84 minutes)

Summary

As a result of these two key differentiators, the following alternatives were eliminated from further refinement and screening:

HBAS: Anderson Service (level of service, travel time)
HBAR: Anderson Service (level of service, travel time)
HBBR: Boston Service (travel time)

The remaining Build alternatives recommended for further evaluation were:

ERB: Boston Service
ERA: Anderson Service
HRB: Boston Service
HRA: Anderson Service
HBBS: Boston Service

6. Level 3 Screening Process

Moving into Level Three of the screening process, the study team considered the four rail alternatives and one bus alternative from Level Two, and modified and expanded the bus alternative to evaluate both a shoulder bus alternative and a median bus alternative in response to feedback from the TAC. The busway, or median, bus alternatives were developed as a bus alternative that is comparatively less expensive than a new rail system while still offering travel time savings. Additionally, bus alternatives could be utilized as an interim step towards a future long-term investment in a fixed guideway transit system.

Preliminary Rail Alternatives

Alternative	Stations	Route		Service
ER1 Rail to Boston on M&L	**Online Stations :** Exit 5, Derry, Rockingham Park, Methuen, Lawrence	NH I-93 Exit 5 – Lawrence	M&L	Each train would stop at all M&L stations and some existing stations en route to Anderson and North Station.
		Lawrence – Wilmington Jct	Haverhill Line	
		Wilmington Jct - Wilmington	Wildcat Branch	
		Wilmington - Boston	Lowell Line	
ER2 Rail to Anderson Transportation Center on M&L	**Online Stations :** Exit 5, Derry, Rockingham Park, Methuen, Lawrence	NH I-93 Exit 5 – Lawrence	M&L	Each train would stop at all M&L stations and some existing stations en route to Anderson. At Anderson, travelers would be offered convenient transfers to Boston rail service and to bus shuttles to nearby employment sites.
		Lawrence – Wilmington Jct	Haverhill Line	
		Wilmington Jct - Wilmington	Wildcat Branch	
		Wilmington – Anderson RTC	Lowell Line	
HR1 Rail to Boston in Transit Reservation	**Online Stations :** Exit 5, Exit 4, Exit 3, Exit 2, Methuen, Lawrence	NH I-93 Exit 5 – Exit 1	NH I-93 transit reservation	Each train would stop at all M&L stations and some existing stations en route to Anderson and North Station.
		Exit 1 – Lawrence	M&L	
		Lawrence – Wilmington Jct	Haverhill Line	
		Wilmington Jct - Wilmington	Wildcat Branch	
		Wilmington - Bos	Lowell Line	
HR2 Rail to Anderson Transportation Center in Transit Reservation	**Online Stations :** Exit 5, Exit 4, Exit 3, Exit 2, Methuen, Lawrence,	NH I-93 Exit 5 – Exit 1	NH I93 transit reservation	Each train would stop at all M&L stations and some existing stations en route to Anderson. At Anderson, travelers would be offered convenient transfers to Boston rail service and to bus shuttles to nearby employment sites.
		Exit 1 – Lawrence	M&L	
		Lawrence – Wilmington Jct	Haverhill Line	
		Wilmington Jct - Wilmington	Wildcat Branch	
		Wilmington – Anderson RTC	Lowell Line	

Table 4: Preliminary Rail Alignments

Bus Alternatives

Alternative	Stations	Route		Service
HB1 Bus to Boston on Shoulder	**Offline Stations :** Manchester, Exit 5, Exit 4, Exit 3, Exit 2	Manchester - I-93	293 GP lane	Each bus would serve one offline Park & Ride station before expressing to Boston. For off-peak service, buses may serve more than one station.
		293 - I93 NH Exit 5	I93 GP lane	
		Exit 5 - NH/MA State Border	NH I-93 HOV lane	
		NH/MA State Border – MA Exit 30	MA I93 shoulder	
		MA Exit 30 - Boston	MA I93 HOV lane	
HB2 Bus to Boston in Transit Reservation	**Offline stations** *:* Manchester **Online stations** : Exit 5, Exit 4, Exit 3, Exit 2	Manchester - I-93	293 general purpose (GP) lane	Each bus would begin in Manchester and stop at each online station en route to Boston.
		293 - I93 NH Exit 5	I93 GP lane	
		NH Exit 5 – NH/MA State Border	NH I93 transit reservation	
		NH/MA State Border – MA Exit 30	MA I93 shoulder	
		MA Exit 30 - Boston	MA I93 HOV lane	
HB3 Bus to Anderson Transportation Center on Shoulder	**Offline Stations :** Manchester, Exit 5, Exit 4, Exit 3, Exit 2	Manchester - I-93	293 GP lane	Each bus would serve one Park & Ride station before expressing to the Anderson RTC. For off-peak service, buses may serve more than one station. At Anderson, travelers would be offered convenient transfers to Boston rail service and to bus shuttles to nearby employment sites.
		293 - I93 NH Exit 5	I93 GP lane	
		293 - I93 NH Exit 5	I93 GP lane	
		Exit 5 - NH/MA State Border	NH I-93 HOV lane	
		NH/MA State Border – Anderson RTC	MA I-93 shoulder	
HB4 Bus to Anderson Transportation Center in Transit Reservation	**Offline stations** *:* Manchester **Online stations** : Exit 5, Exit 4, Exit 3, Exit 2	Manchester - I-93	293 GP	Each bus would begin in Manchester and stop at each online station en route to Anderson. At Anderson, travelers would be offered convenient transfers to Boston rail service and to bus shuttles to nearby employment sites.
		293 - I93 NH Exit 5	I93 GP lane	
		NH Exit 5 – NH/MA State Border	NH I93 transit reservation	
		NH/MA State Border – Anderson RTC	MA I93 shoulder	

Table 5: Bus Alignment Characteristics

Weekdays	
Arrivals in Boston	Departures from Boston
6:45 AM	7:00 AM
7:15 AM	8:00 AM
7:45 AM	9:00 AM
8:15 AM	10:00 AM
8:45 AM	11:00 AM
9:45 AM	12:00 PM
10:45 AM	1:00 PM
11:45 AM	2:00 PM
12:45 PM	3:00 PM
1:45 PM	4:00 PM
2:45 PM	4:30 PM
3:45 PM	5:00 PM
4:45 PM	5:30 PM
5:45 PM	6:00 PM
6:45 PM	7:00 PM
7:45 PM	8:00 PM
8:45 PM	9:00 PM
9:45 PM	10:00 PM
10:45 PM	11:00 PM
Daily RTs =	19

Saturdays	
Arrivals in Boston	Departures from Boston
7:45 AM	8:00 AM
9:15 AM	9:30 AM
10:45 AM	11:00 AM
12:15 PM	12:30 PM
1:45 PM	2:00 PM
3:15 PM	3:30 PM
4:45 PM	5:00 PM
6:15 PM	6:30 PM
7:45 PM	8:00 PM
9:15 PM	9:30 PM
10:45 PM	11:30 PM
Daily RTs =	11

Sundays and Holidays	
Arrivals in Boston	Departures from Boston
7:45 AM	8:00 AM
10:45 AM	11:00 AM
1:45 PM	2:00 PM
4:45 PM	5:00 PM
7:45 PM	8:00 PM
10:45 PM	11:00 PM
Daily RTs =	6

Table 6: Conceptual Bus Service Schedule

Evaluation and Screening Results

Screening Criteria

At this level in the screening process, the study team evaluated the remaining six alternatives on the basis of six key criteria:

- **Capital Cost:** This includes the cost of constructing the system, including the acquisition of vehicles.
- **Operating and Maintenance Costs:** This includes the cost of operating the system and performing regular maintenance to vehicles, tracks, and stations.
- **Weekday Trips:** A sketch-level, or preliminary, forecast of ridership was performed and translated into values of high, medium, medium-low, and low.
- **Environment:** Each alternative was evaluated for its projected effect on the natural environment, and whether there are any outstanding environmental issues significant enough to be key differentiators.
- **Land Use:** This criterion measures the degree to which each alternative would encourage efficient and transit-supportive land use.
- **Fatal Flaws:** The alternatives were evaluated to determine whether any fatal flaws, meaning flaws that are considered significant enough to warrant the immediate disqualification of an alignment from further consideration, exist.

In order to begin the screening process, the study team performed an analysis to determine the projected peak travel times for both the rail and bus alternatives (Figures 31 and 32).

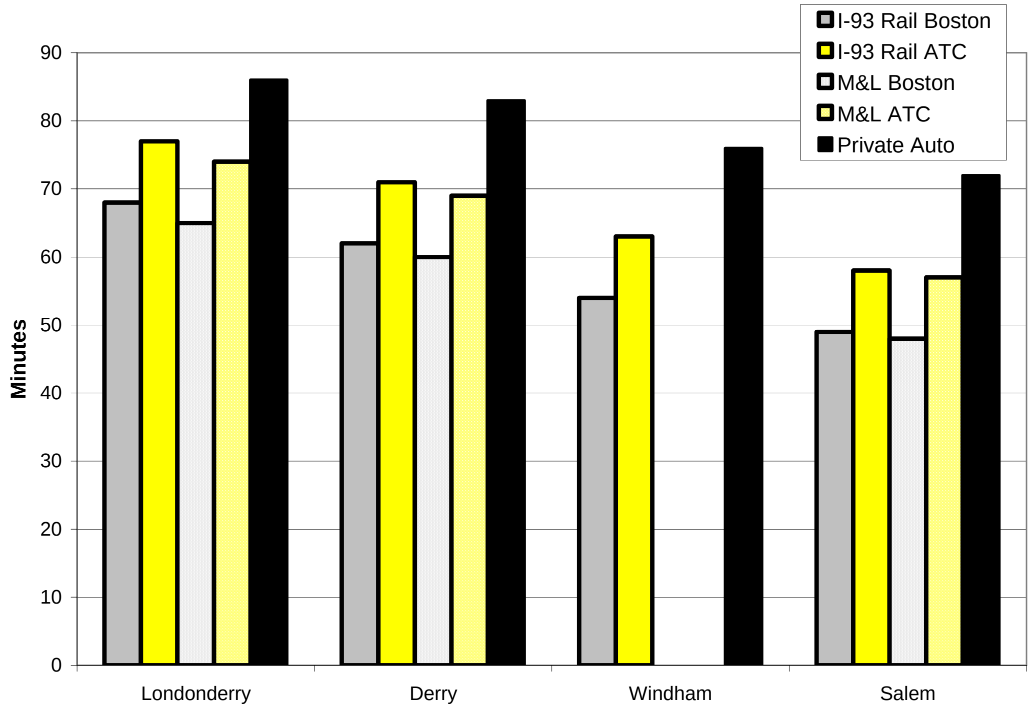


Figure 31: Comparison of Rail Alternatives Peak Travel Times in Minutes to Boston

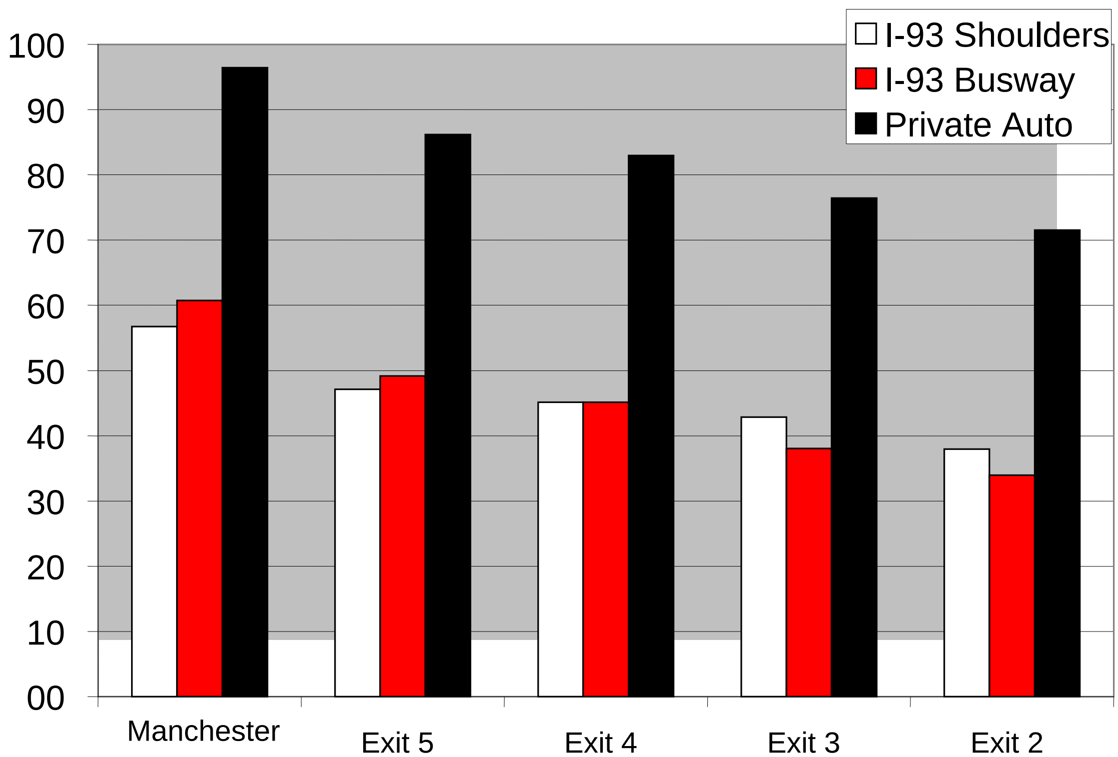


Figure 32: Bus Alternatives Peak Travel Times in Minutes to State Street Station in Boston

Following the completion of this travel time analysis, the study team conducted an evaluation of each alternative for each of the six criteria listed above. The results are illustrated in Figure 33

Screening Results

Option	Capital Cost	O&M Cost	Weekday Trips	Environment	Land Use	Fatal Flaws
M&L Boston	$168	$9.2	medium	◕	●	
M&L ATC	$186	$7.5	low	◕	●	Yes
I-93 Rail Boston	$197	$9.2	medium	◕	◔	
I-93 Rail ATC	$194	$7.5	low	◕	◔	Yes
Shoulder Bus	$88	$4.9	medium	●	◕	
Median Busway	$166	$2.7	medium-low	◕	◔	

● ◕ ◑ ◔ ○

Best Worst

Figure 33: Evaluation Summary of All Alternatives

Upon completion of the overall evaluation, the study team chose not to focus on each individual result, but evaluated the alternatives based on their noteworthy performance as major differentiators, as indicated by the shaded boxes in Figure 33. It is important to note that the rail alternatives in this comparison terminate at Exit 5, while the bus alternatives terminate in Manchester.

Capital Costs

The BOS alternative is projected to have significantly lower capital costs than the other alternatives, all of which are estimated to cost between $165 and $195 million. Specifically, the BOS alternative is projected to have capital costs that are less than half of any rail alignment. Because the Median Busway Alternative would require construction work within the I-93 median right-of-way, its capital costs are more than twice as much as those projected for the Shoulder Bus Alternative. Both of the rail alignments that required transfers at Anderson RTC were determined to have fatal flaws based on their comparatively high capital costs and lower ridership.

Operating and Maintenance Costs (O&M)

Both bus alternatives performed well in the operating and maintenance categories when compared to the rail alignments. The Median Busway is projected to have O&M costs that are approximately one-third of the rail alignments.

Weekday Trips - Ridership

To identify the potential for ridership of each alternative, a sketch ridership model was used to identify the differences in service attributes that would result in ridership impacts. The sketch model used is based primarily on station area attributes and the speed and travel time to downtown Boston. These primary attributes of a transit station along with a few others transportation system attributes are used in a multi-variable regression model.

This model is based on actual ridership data from 1,216 U.S. light rail and commuter rail stations. It was developed by PB Americas and is documented in a paper titled “Sketch Models to Forecast Commuter and Light Rail Ridership: Update to TCRP Report 16” by Clayton Lane, Mary DiCarlantonio and Len Usvyat. This sketch planning tool was most recently applied by PB for a proposed MARC (Maryland Rail Commuter Service) extension. This model is an update of one that has been in use for a decade and that was included in “Commuter and Light Rail Transit Corridors: the Land Use Connection” Transit Cooperative Research Program (TCRP) Report 16, Volume 1, Part II. The new sketch planning tool refined the consistency of the data and has also incorporated the sensitivity of ridership to mid-day service.

The model is entirely for the purposes of screening of alternatives, as the inputs to the model are limited and therefore only measure the impact of those particular attributes on potential ridership. Furthermore, the ridership estimates are based on current year travel times and 2000 population data. During the following phases of the study ridership estimates were developed using a regional travel demand model that more accurately accounts for the many influences on travel patterns and route/mode choices.

The results of the sketch modeling effort identified that the two rail alignments that required transfers at Anderson RTC scored the lowest in the category of projected weekday ridership because of the negative impact of transfers on service levels and subsequent ridership figures.

The ridership estimates are as follows with the Low being 1,000 to 1,500 daily inbound trips, Medium-Low being 1,500 to 2,500 daily inbound trips, and Medium being 2,500 to 3,500 inbound trips.

- Eastern Rail Alignment to Boston on the M&L branch, (Medium)
- Eastern Rail Alignment to Anderson RTC (Low),
- I-93 Median Rail Alignment to Boston, (Medium)
- I-93 Median Rail to Anderson RTC (Low),
- I-93 Median Bus to Boston (Medium-Low),
- I-93 Median Bus to Anderson RTC (Low).
- Shoulder Bus to Boston (Medium).
- Shoulder Bus to Anderson RTC (Low).

Any of the alternatives that required transfers at Anderson RTC were determined to have fatal flaws based on their low ridership numbers.

Environment

The alternatives located within the median or the I-93 right-of-way would, in general, involve lesser environmental impacts. The eastern rail alternatives would involve the greatest impacts, due to development that has encroached upon the right-of-way (including recreational trails) and proximity to adjoining land uses. A detailed comparison of environmental impacts associated with alternatives advanced for further consideration are presented in Chapter XIV.

Land Use

The rail alignments that would operate along the existing M&L branch were judged to have the most positive economic impact and secondary impact on land use patterns because of their proximity to the surrounding communities and their capacity for encouraging transit-supportive land use patterns. However, these rail alignments would also involve the greatest direct impacts and would result in displacements of existing uses that have encroached upon the right-of-way in a number of locations. A discussion of existing land use and economic and land use impacts is presented in Chapter 9.

The rail alignments that would operate within the I-93 median would have a comparatively smaller impact on land use because of their geographic separation from the surrounding communities. Case studies from around the country have shown that bus alignments in general, and those that would operate in a highway median in particular, have a comparatively smaller impact on land uses than rail transit systems. This difference is attributed to the fact that developers perceive rail transit systems as having a more permanent commitment to a corridor by a municipality than a bus line. The permanency of the rail line investment creates a more stable environment for developer investment than a bus corridor, which could easily be discontinued or relocated. Additionally, as compared to bus systems, rail transit typically attracts the kind of “choice” riders that are necessary to encourage and sustain transit-oriented development.

Transit-oriented development (TOD) refers to a pattern of higher-density, mixed residential, retail, commercial, and office space uses whose design is meant to maximize access to transit systems and encourage transit ridership. TOD is not a single parcel or project located next to a transit station, but a comprehensive vision for the neighborhood within a quarter- to half-mile radius of the station, a distance that is considered comfortably walkable. TOD has become increasingly popular in the United States as a means of addressing a number of urban (and increasingly suburban) issues, including traffic congestion, affordable housing shortages, air pollution, and sprawl.

The mixed-use, higher density, human-scale development that is associated with TODs is a return to a more traditional pattern of town center development. This pattern of development, while not called TOD, is commonly found in older cities along the East Coast and the Midwest. This pattern of development, which previously has occurred naturally, is now being planned as TOD. The simultaneous demise of the streetcar and rise of the automobile during the middle of the twentieth century encouraged the contemporary suburban, auto-oriented style of sprawl development. As we move into the twenty-first century, however, this pattern of development has become increasingly unsustainable from an economic, environmental, and social perspective. The cost of infrastructure investment, the negative impact of greenfield development on the environment, and an increasing interest in a “walkable” lifestyle have combined to create a greater market demand for TOD.

Summary

The final three Build alignments that the study team recommended be carried forward into further refinement and evaluation were:

- Eastern Rail Alignment to Boston on the M&L Branch,
- I-93 Median Rail Alignment to Boston, and
- Bus I-93 Shoulder Alignment.

The following alignments were not carried forward for further evaluation:

- Eastern Rail Alignment to Anderson RTC (low ridership),
- I-93 Median Rail to Anderson RTC (low ridership, limited land use impact),
- I-93 Median Bus to Boston (capital cost),
- Bus on Shoulder to Anderson RTC (low ridership), and
- I-93 Median Bus to Anderson RTC (low ridership, capital cost).

The three Build alternatives listed above, the Eastern Rail Alignment, the I-93 Rail Alignment and the I-93 Bus on Shoulder, were recommended for further evaluation by the study team because they achieved the highest rankings based on their overall performance in all six criteria. The Bus on Shoulder alternative has two potential operating plans: The Minneapolis model and the Ottawa model. The Minneapolis model allows buses to operate on the shoulder at a maximum of 35 miles per hour when general flow traffic is moving under 30 miles per hour. The Ottawa version allows buses to operate on shoulders at speeds of up to 62 miles per hour without any restrictions, regardless of general traffic flow speed.

7. Level 4 Screening Process

Moving into the fourth level of screening, the study team undertook more detailed development and analysis of capital costs and travel times for the Eastern Rail Alignment, the I-93 Rail Alignment to Boston, and the I-93 Bus on Shoulder Alignment. The study team also evaluated the possibility of extending the Eastern Rail Alignment north from Exit 5, through a tunnel under the Manchester-Boston Regional Airport to Granite Street in downtown Manchester. The Bus on Shoulder Alignment was also evaluated on the basis of the two different operating plans, the Minneapolis model and the Ottawa model, as outlined above, and TSM and No Build alternatives. At this level of analysis, the key differentiators were:

- Capital costs (rail),
- Land use impacts (rail), and
- Travel time (bus).

Evaluation and Screening Results

Screening Criteria

Capital Costs

The Eastern Rail Alignment travels from North Station in Boston to one of two northern termini: Exit 5 or Granite Street in downtown Manchester. The estimated capital cost for the alignment from North Station to Exit 5 in New Hampshire is $250 million. The study team estimated the capital costs of the alignment from Exit 5 to Granite Street in Manchester. Because of the tunneling that would be required to access and travel under the Manchester-Boston Regional Airport, the portion of the alignment from Exit 5 to Granite Street is projected to cost $232 million, for a total alignment cost of $482 million. This analysis is provided in detail in Appendix B.

The Bus Build alternatives are projected to have a capital cost of $88 million.

Land Use Impacts

The I-93 Rail Median Alternative was determined to have the least positive economic impact and secondary land use development because of its location within the highway median. However, it would also result in fewer direct impacts or displacements. The highway would function as a geographic barrier between the transit line and surrounding land uses, unlike the Eastern Rail Alignment or the Bus Alternatives, which would immediately abut or travel through the surrounding communities.

Travel Times

Two types of operating plans terminating at State Street Station in Boston, chosen because it is in a central location and approximately midpoint in the downtown circulation pattern, were evaluated for the Build Bus alternatives: Minneapolis-style and Ottawa-style. The operating plans of these two types of service had a direct impact on travel times.

Minneapolis-style Bus on Shoulder

The buses for this alignment would be allowed to travel on the shoulder of I-93 when running between Manchester and Boston, but shoulder operations would cease near Exit 30. At this point, southbound buses would cross three lanes to enter Massachusetts' HOV lane. Buses would be permitted to travel on the shoulders only when the speed of general flow traffic falls below 35 mph. The maximum speed for buses operating on the shoulders would be 10 mph above the general flow of traffic, up to a maximum speed of 35 mph.

MVRTA buses from Lawrence and Andover and MBTA buses from Burlington and Woburn would also be allowed to use the shoulders under the same conditions as the buses from New Hampshire and Methuen.

Ottawa-style Bus on Shoulder

This operating plan would permit buses to travel up to 60 mph on shoulders at any time. Travel times became the key differentiator when evaluating the two operating plans of the bus on shoulder alternatives. The maximum bus traveling speed allowed under each of the plans directly influences travel times as noted below.

P&R Station	No Build	Minneapolis BOS	Ottawa BOS
Manchester	75	75	61
Exit 5	64	64	50
Exit 4	62	61	47
Exit 3	53	52	40
Exit 2	50	49	37
Exit 47	44	43	31

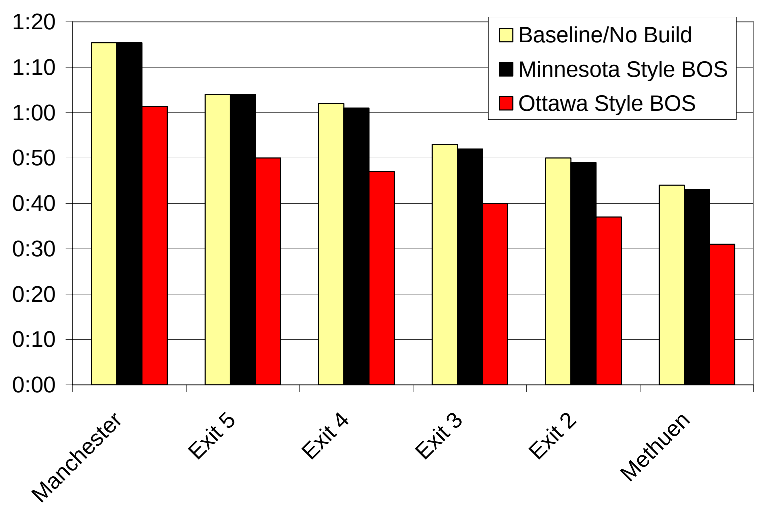


Figure 34: 2030 Peak Period Travel Time to State Street Station

While Ottawa-style bus was estimated to save I-93 Merrimack Valley and New Hampshire bus commuters an average of 13 minutes travel time, models of Minneapolis-style bus did not find substantial travel time benefits. On average, the forecasts indicate that Minneapolis-style bus is one minute faster than the No Build alternative using general purpose lanes.

No Build

The No Build scenario includes existing bus service between the Manchester Transportation Center and downtown Boston, and commuter bus service from new park-and-ride lots along I-93 in New Hampshire. NHDOT has implemented improved service to Boston from the park-and-ride lot at Exit 4 and from park-and-ride lots at Exits 5 and 2.

Bus service picks up and drops off passengers at offline stations in New Hampshire, including the Manchester Transportation Center and park-and-ride lots at I-93 Exits 5, 4, and 2. Buses travel within general purpose lanes on I-93, until entering Massachusetts' HOV lane near Exit 30. The modeling screening included buses stopping in the vicinity of the MBTA's State Street Station and other downtown locations en route to the South Station terminal.

Modeling for buses from Manchester retained their current route in Boston, stopping at South Station and Logan Airport with no other downtown Boston stops. The Manchester service originates in Concord, with three trips a day in each direction. For the No Build scenario, it was assumed that the combined service to Manchester, Concord and other New Hampshire towns would maintain current operations. The modeling also considered a potential Exit 3 park and ride facility.

In Massachusetts, present MVRTA service from Methuen, Lawrence and Andover via Routes 28, 125 and I-93 to Boston would continue and benefit from shoulder running operations. Present service is limited to two roundtrips per day. MBTA service on Routes 352, serving Burlington, and 354 and 355, serving Woburn, would continue current operations.

Route	Station	Peak Headway (minutes)	Off-Peak Headway (minutes)
1	Manchester: 119 Canal Street	60	120
2	Exit 5	30	60
3	Exit 4	30	120
4	Exit 3	30	None
5	Exit 2	60	60

Summary Analysis

	No Build	Ottawa BOS
Number of Stations Served (does not include Boston)	5	11
Peak Range Headway (min)	30-60	15-30
Number of Peak Buses Required	28	50
Fare Structure	MBTA Rail	Current Bus
Daily Parking Fee	None	$2.00
Benefits Existing MVRTA and MBTA Bus Services	No	Yes
Annual Vehicle Hours	41,519	76,809
Annual Vehicle Miles	1,269,162	2,413,111

Summary

Based on this level of analysis, NHDOT and MA EOT decided to select the Eastern Rail Alignment to Boston and the Ottawa-style Bus on Shoulder Bus Alternative as the two final Build Alternatives. The following alternatives were not retained for further consideration:

- Eastern Rail Alignment from downtown Manchester to Boston (capital cost),
- I-93 Median Rail Alignment to Boston (limited land use impact), and
- Minneapolis-style Bus on Shoulder Bus (travel times).

The complete group of final alternatives is:

- Eastern Rail Alignment from Exit 5 in New Hampshire to Boston,
- Ottawa-style Bus on Shoulder Bus from Manchester to Boston, and no Build.

Selection of the Preferred Implementation Strategy

In April 2008, NHDOT and MA EOT identified the Ottawa-style Bus on Shoulder from Manchester to Boston with potential future rail service on the M&L branch from Exit 5 in Londonderry to Boston as the preferred implementation strategy for this transit investment study.

The Bus on Shoulder option allows for a phased implementation process, which would not be an option when constructing a rail transit line. Over the course of this phased implementation, if certain conditions have been met, including access to funding sources, municipal actions to increase the number of transit-supportive land use policies, and increased community support for commuter rail, the activation of the M&L branch for commuter rail service could be pursued. BOS operations could therefore serve to generate ridership interest in anticipation of a potential transition to commuter rail service.

The screening process that led to this strategy is summarized in Table 7 and the text that follows.

LEVEL OF SCREENING	Alternatives Into Screening	Reasons Alternatives Screened Out
LEVEL ONE: 15 alternatives screened to 5 Build + No Build	**Eastern Rail Direct to Boston (E1)**	
	Eastern Rail RTC to Boston (E2)	
	Eastern Rail Andover to Boston (E3)	service levels, travel times
	Eastern Rail Lawrence to Boston (E4)	service levels, travel times
	Highway Rail Direct to Boston (H1)	
	Highway Rail RTC to Boston (H2)	
	Highway Rail Andover to Boston (H3)	service levels, travel times
	Highway Rail Lawrence to Boston (H4)	service levels, travel times
	Western Rail Direct to Boston (W1)	congestion mitigation
	Western Rail RTC to Boston (W2)	congestion mitigation
	Western Rail Lowell to Boston (W3)	congestion mitigation
	Bus Highway Transit ROW (B1A)	
	Bus Highway Mixed Traffic (B1B)	travel times
	Bus Eastern Alignment (B2)	capital cost
	Bus Western Alignment (B3)	congestion mitigation
	No Build	
LEVEL TWO: 8 alternatives screened to 5 Build + No Build	**Eastern Rail Direct to Boston (ERB)**	
	Eastern Rail RTC to Boston (ERA)	
	Highway Alignment Direct to Boson (HRB)	
	Highway Alignment to Anderson (HRA)	
	Shoulder Bus Direct to Boston (HBBS)	
	Shoulder Bus RTC to Boston (HBAS)	level of service, travel time
	ROW Bus Direct to Boston (HBBR)	travel time
	ROW RTC to Boston (HBAR)	level of service, travel time
	No Build	
LEVEL THREE: 8 alternatives screened to 3 Build + TSM and No Build	**Eastern Rail Direct to Boston (ER1)**	
	Eastern Rail RTC to Boston (ER2)	low ridership
	Highway Rail to Boston in Median (HR1)	
	Highway Rail RTC to Boston in Median (HR2)	low ridership and limited land use impact
	HOV Bus Direct to Boston (HB1)	
	Transit Reservation Bus to Boston (HB2)	capital cost
	HOV Bus to RTC (HB3)	low ridership because of transfer
	Transit Reservation Bus to RTC (HB4)	capital cost
	TSM	
	No Build	
LEVEL 4: 3 Build alternatives (including 2 operating plans) screened to 2 Build +TSM and No Build	**Eastern Rail Direct to Boston from Exit 5 (ER1)**	
	Eastern Rail from downtown Manchester (ER1)	capital cost
	Highway Rail to Boston in Median (HR1)	capital cost, limited land use impact
	HOV Bus Direct to Boston	
	Bus Minneapolis-Style	travel time
	Bus Ottawa-Style	
	TSM	
	No Build	
FINAL ALTERNATIVES		
RESULTS	**Eastern Rail Direct from Exit 5 in Manchester to Boston (HR1)**	
	I-93 Bus on Shoulder, Ottawa-Style	
	TSM	
	No Build	
PREFERRED INVESTMENT STRATEGIES		
	I-93 Bus on Shoulder, Ottawa-Style	**PHASED IMPLEMENTATION**
	Eastern Rail Direct from Exit 5 in Manchester to Boston (HR1)	

LEGEND	
Alternatives in shaded lines were carried forward into the next level of screening	
(blue)	Eastern Rail
(light yellow)	Highway Rail
(orange)	Bus
(gray)	TSM and No Build

Table 7: Screening Process of Alternatives

The alternatives evaluation involved a phased evaluation (Levels 1 through 4) to screen the prospective alternatives. The results of this evaluation are presented in the November 2008 *Definition of Alternatives and Evaluation*. A total of fifteen Level 1 conceptual build alternatives were explored in the first phase of screening analysis.

Alternatives initially identified build upon those identified in previous planning studies for highway improvements within the I-93 corridor. The conceptual build alternatives spanned three travel corridors that were originally identified in the NHDOT *Final Environmental Impact Study: Interstate 93 Improvements Salem to Manchester* (April 2004) and the *I-93 Corridor Traffic Study, Andover and Methuen, Massachusetts* (October 2005):

- Eastern Corridor (M&L Branch from Manchester via either the Haverhill Line or the Haverhill Line, Wildcat Branch and Lowell Line to Boston)
- Highway Corridor (I-93, using either the transit reservation or shoulder areas), and
- Western Corridor (New Hampshire Mainline and Lowell Line from Manchester to Boston).

This alternatives evaluation performed for the I-93 Transit Investment Study considered two types of transit: rail alternatives, using existing rail lines or the I-93 corridor, and Bus Transit. The rail alternatives use existing right-of-way in the Eastern and Western Corridors and a combination of transit reservation and existing rail corridors in the Highway Corridor. The Bus Transit alternatives use the highways in each alignment and part of the rail right-of-way in the Eastern Corridor.

Eleven conceptual rail alternatives were developed, four each on the Eastern and Highway Corridors, and three on the Western Corridor. All of the rail alternatives were developed with Manchester as the northern terminus and one of five cities – Boston, Woburn (Anderson), Lowell, Andover, or Lawrence as the southern termini as summarized below. The initial Level 1 rail alternatives consisted of:

- **Eastern Alignment** Using the Manchester and Lawrence (M&L) Branch
  - To Boston (via Haverhill and Lowell Lines)
  - To Anderson Transportation Center in Woburn (via Haverhill and Lowell Lines)
  - To Andover (via Haverhill Line)
  - To Lawrence (via Haverhill Line)
- **Highway Alignment** Within the Transit Reservation (I-93 median)
  - To Boston (via Lowell Line)
  - To Anderson Transportation Center in Woburn (via Lowell Line)
  - To Andover (via M&L Branch and Haverhill Line)
  - To Lawrence (via M&L Branch and Haverhill Line)
- **Western Alignment** Using the New Hampshire Main Line
  - To Boston (via Lowell Line)
  - To Anderson Transportation Center in Woburn (via Lowell Line)
  - To Lowell (via Lowell Line)

Four initial Level 1 Bus Rapid Transit alternatives were considered, two on the Highway Corridor, and one each on the Eastern and Western Corridors as summarized below.

- **Eastern Alignment Bus Rapid Transit** Using the Manchester and Lawrence (M&L) Branch
  - To Boston Haymarket (via I-93)
- **Highway Alignment Bus Rapid Transit** on I-93 Alignment
  - To Boston Haymarket (using transit reservation to state line)
  - To Boston Haymarket (using general purpose lanes or shoulders to state line)
- **Western Alignment Bus Rapid Transit**

  - To Boston Haymarket (via Route 3, Route 128, and I-93).

The Level 1 Alternatives were screened using the following criteria:

- Impact on travel along I-93,
- Demand for travel to Boston,
- Institutional feasibility,
- Capital cost.

In the screening of alternatives, bus rapid transit and rail options along the western rail corridor were not carried forward, as they did not have as great an impact on I-93 travel. Moreover, a separate study is underway to serve Boston to Nashua travel demands as part of the Lowell to Nashua Commuter Rail Extension Project. Initial screening identified four rail alternatives on two potential rail alignments for further evaluation:

- **Eastern Rail Alignment** Using the Manchester and Lawrence (M&L) Branch
  - To Boston
  - To Anderson Transportation Center
- **Highway Alignment** Using the Transit Reservation (I-93 median)
  - To Boston
  - To Anderson Transportation Center

The initial (Level 1) screening identified four bus transit alternatives on two bus alignments for further evaluation:

- **Highway Alignment** Within I-93 high-occupancy vehicle (HOV) Lanes and Shoulders
  - To Boston
  - To Anderson Transportation Center
- **Highway Alignment** Within the Transit Reservation (I-93 median)
  - To Boston
  - To Anderson Transportation Center

These Build alternatives were further evaluated in Level 2 and Level 3 screening, which included evaluation of service performance and preliminary costs, as documented in the *Preliminary Definition of Alternatives and Evaluation*. Preliminary service schedules and headway times for the rail service alternatives, headways for the bus alternatives, and travel times for each alternative were compared. The Level 3 screening included evaluation of operating and maintenance costs, environmental effects, compatibility with transport-supportive land uses, and fatal flaws. The final three Build alignments recommended to be carried forward at the end of the Level 3 screening for further refinement and evaluation were:

- **Eastern Rail Alignment** (via M&L Branch, Haverhill Line, Wildcat Branch, Lowell Line) to Boston
- **I-93 Median Rail Alignment** to Boston (via M&L Branch, Haverhill Line, Wildcat Branch, Lowell Line), and
- **Bus on I-93 Shoulder (BOS) Alignment**.

The Level 4 screening included further development of the alternatives under consideration. This included evaluation of a tunnel option for the eastern rail alignment that would extend under runways of the Manchester-Boston Regional Airport to downtown Manchester. Due to the large capital costs associated with a tunnel under the runway, the preferred eastern rail option identified at the conclusion of Level 4 screening provides service from Exit 5 in Londonderry, south of the airport.

The type of rail service assumed was commuter rail, since 50 mile per hour operating speeds on light rail are not competitive with automotive travel for the distances served and is not compatible with the regional rail network for a one-seat ride to Boston.

Level 4 analysis also included evaluation of two types of operating plans for the I-93 BOS option that would largely operate within the I-93 shoulders in New Hampshire and northern Massachusetts and would operate within the HOV lanes approaching Boston:

- **Minneapolis-style BOS** would allow buses to operate on the shoulder at a maximum of 35 miles per hour when general flow traffic is moving under 30 miles per hour.
- **Ottawa-style BOS** would allow buses to operate on shoulders at speeds of up to 60 miles per hour without any restrictions, regardless of general traffic flow speed.

The Ottawa version was found to produce to produce an average travel time savings for bus commuters of 13 minutes, and was the operating plan carried forward for the BOS option.

8. Final Alternatives

The final alternatives that were identified as a result of this phased alternatives screening and evaluation process consisted of:

- No Build,
- Bus on Shoulder (BOS) along I-93 using shoulders in New Hampshire and existing HOV lanes approaching Boston (using Ottawa-style operating plan), and
- Commuter Rail Service from Exit 5 to Boston, using the M&L Branch, Haverhill Line, and Wildcat Branch to connect to the Lowell Line.

The following sections focus on the differences between the Bus on Shoulder and Commuter Rail alternatives and compare their impacts to those of the No Build conditions.

No Build

The No Build scenario includes existing bus service between the Manchester Transportation Center and downtown Boston, and commuter bus service from three park-and-ride lots along I-93 in New Hampshire. NHDOT has implemented improved service to Boston from park-and-ride lots at Exit 4, Exit 5 and Exit 2.

At the outset of the service, projected ridership is approximately 462,000 passenger trips per year. Average daily inbound boardings in 2030 are estimated to range from 1,680 to 1,880. Peak headways from Exit 5 in Londonderry to downtown Boston would be 30 minutes with peak travel time of 64 minutes to/from State Street.

The No Build Alternative consisted of this bus service that would pick up and drop off passengers at offline stations in New Hampshire, including the Manchester Transportation Center and park-and-ride lots at I-93 Exits 5, 4, and 2, and potentially at a future Exit 3 park and ride. Buses would travel within general purpose lanes on I-93, until entering the Massachusetts HOV lane near Exit 30. Once in Boston, buses from park-and-ride lots would stop in the vicinity of the Massachusetts Bay Transportation Authority (MBTA) State Street Station and other downtown locations en route to the South Station terminal.

Buses from Manchester would retain their current route in Boston, stopping at South Station and Logan International Airport with no other downtown Boston stops. The existing Manchester service originates in Concord, with three trips a day in each direction serving New Hampshire towns as far as three hours north of Concord. For the No Build scenario, it was assumed that the combined service to Manchester, Concord, and other New Hampshire towns would maintain current operations. Actual operating schedules have varied somewhat from this service.

In Massachusetts, present Merrimack Valley Regional Transit Authority (MVRTA) service from Methuen, Lawrence and Andover via Routes 28, 125 and I-93 to Boston would continue. Present service is limited to two roundtrips per day. MBTA service on Routes 352, serving Burlington, and 354 and 355, serving Woburn, would continue current operations.

Route	Station	Location	Peak Headway (minutes)	Off-Peak Headway (minutes)
1	Manchester: 119 Canal Street	119 Canal Street	60	120
2	Exit 5 Londonderry P&R	Rockingham Road & Symmes Drive	30	60
3	Exit 4 Derry P&R	End of Garden Lane (existing)	30	120
4	Exit 3 Windham P&R	Between Range Road & I-93 NB	30	None
5	Exit 2 Salem P&R	Near the end of Fairmount Road	60	60

Bus on Shoulder along I-93: Manchester to Boston

The Bus on Shoulder alternative would operate along an exclusive busway to be provided within the shoulder area along the majority of I-93. This concept is described in more detail below.

Bus on Shoulder Concept

Bus bypass shoulder use or Bus on Shoulder (BOS) services have been in operation for more than 10 years in parts of the United States. This approach to providing an "exclusive" lane for buses to improve bus travel times and reliability represents a low-cost strategy that can be implemented relatively quickly and easily in comparison to the expansion of highway travel lanes or right-of-way. Use of the low-speed (outside) shoulders also promotes "rapid transit" like service with buses easily exiting and entering the highway network in stark contrast to bus use of HOV lanes.

Typical concerns about BOS operations include traffic safety (interchange conflicts, speed differentials, sight distances), loss of intended shoulder use (debris hazards, removal and storage of disabled vehicles, emergency vehicle access), physical design requirements and cost. It has been demonstrated that:

- The operation of transit vehicles on the shoulder is safe,
- Most BOS operations offer buses 10 feet of shoulder clearance without causing safety concerns, and
- Buses minimally impact the intended use of shoulders because no barrier is created between the shoulder and the general purpose lanes.

The use of shoulders on a regular basis for bus operations in many places requires improvements to the shoulder. Shoulders on many limited-access roadways are 10 feet wide or less and are not constructed to the same standards of the general purpose lanes. Since buses, with mirrors, are typically close to 10 feet wide and are heavy vehicles, regular use of the shoulders without modification would not be advisable. Additionally the grades of the shoulders, drainage side slopes, and catch basin structures also all often require modification. Additional signage and pavement markings should be considered for safe operations.

This section focuses on the physical design requirements and the infrastructure changes that may be necessary along the I-93 Corridor to permit Bus on Shoulder operations.

Typical Cross-Section Requirements

The Bus on Shoulder (BOS) approach that is being considered as an alternative for the I-93 Corridor is modeled on the operation parameters that are currently utilized in Ottawa, Ontario.

In Ottawa, 14 miles of limited access roadway shoulders are available for bus use. No special speed restrictions are defined and buses are allowed to operate up to the posted speed at their discretion. Buses are allowed to operate at speeds up to 62 mph. The two roadways in the Ontario area on which bus on shoulder use is permitted include a 16.4-foot shoulder and an 11.5-foot bus-use shoulder with an additional 3.2-foot shoulder. A maximum 2% cross-slope is allowed for the bus lane. The roadway designed with the 11.5-foot bus travel lane/shoulder was instituted more recently than that with the wider bus travel lane/shoulder, presumably after some years of bus operating experience on the shoulder of the first roadway.

In the United States, the standards for shoulder widths on interstate highways have been established by the American Association of State Highway and Transportation Officials (AASHTO) in the publication *A Policy on Design Standards - Interstate System*. These standards include a minimum outside (right) paved shoulder width of 10 feet and inside (left) shoulder width of 4 feet. It is recommended that highways with three or more lanes in each direction, as I-93 will have by 2030, the inside paved shoulder should be at least 10 feet wide or 12 feet if the roadway is heavily used by truck traffic.

Using the Ottawa example as a template, and the design guidelines for Interstate Highways, the conceptual cross-section design for the bus travel lane/shoulders along the I-93 Corridor have been identified to be as follows:

- Minimum Inside Shoulder: 4 feet
- Preferred Inside Shoulder: 10 to 12 feet
- Minimum Outside Bus Lane/Shoulder 12 feet
- Preferred Outside Shoulder: 13 feet (12 foot Bus Lane/Shoulder plus additional 3 foot shoulder)

Cross slope requirements should be consistent with adjacent general purpose travel lanes (typically 2%).

Pavement on most interstate highway shoulders is not as thick as found in the general purpose lanes. This appears to be the case throughout the length of the I-93 study corridor. Prior to use of the shoulder by buses, the shoulders would need to be reassessed to identify the existing pavement materials and determine the appropriate pavement structure necessary to accommodate the use of the shoulder for regular bus use. It is assumed that all shoulders along the corridor will require repaving.

In many locations, it has been identified that bridge structures are wide enough to accommodate the existing general purpose lanes plus the minimum shoulder widths identified above (4 foot inside shoulder, 12 foot outside shoulder). This does not leave any additional room for bus operation clearance from those structures. As bus use of shoulders is a new and evolving use of interstate highways, the specific standards and requirements for such an operation has not yet been established. Therefore, the bridge clearance requirements and conditions may need to be revisited as the project advances. Although the clearances appear to be a viable condition for this new type of shoulder use it also is a substandard condition as compared to current design standards.

Service Operations

The Bus on Shoulder alternative would serve Manchester and the park and ride lots with improved frequency and additional stops would be added at town centers near Exits 5, 4, 3, 2 and Methuen and at a park and ride lot off of I-93 in Methuen. Buses would travel at speeds of up to 60 mph on the shoulders at any time when congestion warranted. For modeling purposes it was assumed that all buses would utilize the shoulders during peak periods between Londonderry, NH and Medford, MA, during off-peak periods it was assumed that buses would travel in general purpose lanes. Near Exit 30, in Medford, buses would enter the existing HOV lane. Once in Boston, buses would stop in the vicinity of the MBTA's State Street Station as well as other downtown locations en route to the South Station terminal.

Bus service would pick-up and drop-off passengers at stations in New Hampshire including the Manchester Transportation Center, park and ride lots at Exits 5, 4, 3, 2 and Exit 47 and near town centers in Derry, Windham, Salem and Methuen. The buses stopping at the Exit 5 park and ride lot could also serve the Manchester-Boston Regional Airport. Since travel times increase significantly with each station served (time to exit and return to I-93), it was assumed that each peak bus would serve one town center, then one park and ride station and travel directly between that Park & Ride station and Boston. The table below displays the stations served by, and the peak headway associated with, each of the five peak routes. The bus serving the Manchester station would use I-293 to travel between Manchester and I-93 and would not serve a park and ride lot or any other New Hampshire stations. Travel between the airport and the Exit 5 park and ride would be via North Perimeter Road and Route 28.

During the off-peak, the six peak routes would be combined into three routes. The Off-peak routes would be operated on 60 minute headways on weekdays and 90 minute headways on weekends. Off peak Route 1 would serve Manchester station, Manchester airport and the Exit 5 Park & Ride lot before entering I-93 for travel to Boston. Buses would travel I-293 and Route 3A between Manchester and the Manchester Airport.

Limited MVRTA express bus service from Lawrence and Andover and MBTA service from Burlington and Woburn would continue to use I-93 as operated today. No changes to MVRTA or MBTA service frequencies were assumed.

Route	Town Center Station	Park & Ride Station	Peak Headway (minutes)
1	Manchester: 119 Canal Street	None	30
2	Airport/Londonderry: Manchester Airport	Exit 5	15
3	Derry: Broadway near Railroad Square	Exit 4	15
4	Windham: North Broadway and Lake Street	Exit 3	30
5	Salem: South Broadway at Rockingham Park	Exit 2	15
6	Methuen: Broadway and High Street	Pelham Street	30

Corridor Definition

The roadway examined for the potential for the addition of bus use of the shoulders was I-93 between Exit 26 (U.S. Route 3 split) in Boston, MA and Exit 6 in Manchester, NH (see Figures 4a, 4b, and 4c).

Based on results of travel demand modeling it was identified that the segment of I-293 in New Hampshire that is planned for use by buses (between I-93 and Exit 5 -Granite Street) is not projected to experience significant congestion in 2030 and therefore has not been included in the segment considered for bus use of shoulders.

Anticipated Projects Along I-93 Corridor

There are multiple improvement projects anticipated along the study corridor that will impact the configuration of the shoulders and the requirements for improvements related to bus use of shoulders. The following is that list of projects that are anticipated to be completed prior to 2030, the planning year for this study.

- **Interstate 93 Improvements – Salem to Manchester, NH:** This would add two travel lanes (increase from two to four lanes) in each direction. A Final Environmental Impact Statement has been prepared, and a Supplement Environmental Impact Statement (SEIS) is in preparation at the time of writing. The SEIS is expected to be published in 2010, and general long-term estimate for completion is 2025 to 2030.
- **I-93 Widening – Andover to Methuen, MA (from "lane drop" at Andover/Wilmington town line to New Hampshire border):** This would add one travel lane (increase from three to four lanes) in each direction and would restore shoulder lane peak-period travel use to emergency use only. The project is identified as a high priority project in Merrimack Valley MPO Regional Transportation Plan. This project has been partially incorporated in the Lowell Junction project below. General long-term estimate for completion is 2025.
- **I-93 "Lowell Junction" Interchange between Exits 42 and 43:** This would construct a new interchange (full access to the east, partial access to the west). An Environmental Notification Form under the Massachusetts Environmental Policy Act has been filed, and an EIR and EIS is required. The Merrimack Valley Economic Development Council estimates that 700 acres that are either landlocked or poorly accessed inside the Lowell Junction area could potentially support 3.6 million square feet of development and 12,000 jobs. The estimate for construction start by 2013, completion by 2016.
- **I-93/Route 125 Improvements at Exit 41, Wilmington:** This project is complete. It has added a reconfigured on-ramp from 125 SB to I-93 NB.
- **I-93/I-95 Interchange Transportation Improvements Project at Exit 37, Reading, Woburn, Stoneham:** Implement June 2007 study recommendations, including new direct connection ramps (I-95 NB to I-93 NB, and I-95 SB to I-93 SB), and add a lane on I-95 from Exit 38 to Exit 40 northbound and Exit 38 to Exit 39 southbound.. An Environmental Notification Form has been filed, awaiting required EA/EIS and EIR . General long-term estimate for completion is 2025. See www.9395info.com
- **Route 110/113 Methuen Rotary Improvements at Exit 46, Methuen:** Implement April 2008 study recommendations, including eliminating the rotary and constructing a partial cloverleaf interchange (Preferred Alternative 3A) Joint EA/EIR filed, construction start estimated fall 2014, completion in 2017.

Each of these projects has the potential to incorporate into its design the improvements to facilitate the operation of bus services on the shoulders of I-93 to meet the requirements described in Appendix A.

Bus Lane Improvement Locations

The following are the locations that have been identified as requiring improvements to facilitate the operation of buses on shoulders.

- **Segment 1: Manchester, NH to MA State Line**– This 20 mile segment is currently being redesigned to accommodate additional general purpose lanes between the Massachusetts State Line and the I-293 interchange. This outside shoulder being designed and built in this segment does not currently meet the width and pavement depth requirements for the full length of the segment. This segment will require the outside shoulders to be widened from between 0 and 5 feet along with full-depth repaving of the shoulder.
- **Segment 2: State Line to Wilmington –** This segment is programmed to be widened to add an additional travel lane and a new outside shoulder. This project is currently defined as only building a 10 foot wide outside shoulder in this segment. Similar to the widening of the highway segment in New Hampshire, the roadway would require the outside shoulders to be widened by approximately 2 to 5 feet from what is currently planned. It is assumed that the additional widening could be designed into the project with only marginal impacts to the overall cost of the project.
- **Segment 3: Wilmington/Woburn** – This 6.3 mile segment which stretches approximately from the Lowell Line Railroad Bridge in Wilmington to West Street in Reading, would need to have the outside shoulders widened by approximately 2 to 5 feet throughout most of the segment. This should be possible by shifting constructing additional roadway surface on the inside shoulder and the travel lanes. This would avoid any impacts outside of the existing highway corridor. Additionally this segment incorporates the area where improvements related to the I-93/Route 129 Interchange Improvement Project will occur. It is assumed that in that segment of I-93, the improvements required for bus operation on the shoulders could be incorporated into the project design with marginal impacts to the overall cost of the project.
- **Segment 4: I-95 Interchange Area –** The segment that encompasses the I-95 Interchange has been the subject of a planning study over the past couple of years. The recommendation of the study is to make improvements to the configuration of the interchange, which would include the segment from West Street in Reading to Salem Street in Winchester. It is assumed that the design of this segment could include the necessary shoulder widening and roadway configuration to accommodate bus operations on the shoulder with only marginal impacts to the overall cost of the project.
- **Segment 5: I-95 Interchange to Mystic River** – The segment between Salem Street in Winchester and the Mystic River has varying shoulder widths that would need to be modified to accommodate use of the buses. The overall width of the roadway is a minimum of 64 feet, with the typical section being 68 feet wide in each direction. This includes four twelve-foot wide lanes and varying widths of inside and outside shoulders. The bridge plans have been reviewed in this segment and it appears that work necessary to the bridges would be limited. The available widths under or across the bridges are close to the 64 foot minimum required. Addition detailed survey and study would be necessary to identify any specific modification that may be necessary to the bridge structures.

Similar to the segments identified above, the use of the shoulder in other areas would require, at a minimum, the repaving of the shoulder so that the pavement depth would be appropriate for the new intended use. In addition to the repaving the general purpose lanes would need to be shifted up to four feet on the roadway to eliminate any impact at the existing bridge abutments. This shift would require full-depth reconstruction to both the inside and outside shoulders, reconstruction of the drainage structures on the inside shoulders, and the modification of some sign poles that currently encroach in the area that would be required for the new travel lane locations.

It appears that all of the necessary work could be conducted generally within the existing edges of pavement, however where feasible it may be desired to widen the shoulders beyond the 12 foot minimum to allow extra shoulder width as this segment is anticipated to be the most widely used by buses.

- **Segment 6: Mystic River to Exit 30 (Somerville)** – The segment stretches between the Mystic River and Exit 30, where the High Occupancy Vehicle (HOV) lane begins on the southbound side of I-93. This 1.25 mile section contains 3 heavily used interchange ramps in each direction, thereby resulting in few segments of the shoulder which could truly be used exclusively by bus services. In addition, as buses travel southbound, it is within this 1.25 mile segment they would need to merge back into the general purpose lanes from the bus shoulder and cross three lanes of traffic to access the HOV lane. Due to the complexity of traffic weaving occurring in this relatively short segment and the resultant minimal time savings it was concluded that the bus use of the shoulder should not occur in this segment.
- **Segment 7: Exit 30 (Somerville) to Exit 26 (Boston)** – The segment between Exit 30 in Somerville and Exit 26 in Boston is primarily on an elevated structure or within a tunnel. In the southbound direction the buses traveling this segment would utilize the existing HOV lane and therefore no use of the shoulder would be necessary. In the northbound direction, there is minimal width available where shoulders could be made wide enough to accommodate bus service. Given these two considerations bus use of shoulders were not considered for this segment.

Ramp Improvement Requirements

In addition to the construction requirements for BOS, many of the interchange ramps will also require modification. The existing configuration and design of the ramps did not contemplate the active use of the shoulder. At many of the on-ramps along the corridor the slopes and grade changes of the shoulder would not be acceptable to operate over at travel speeds. It is anticipated that approximately seven on-ramps and one off-ramp will require work regrading the length of the ramp to eliminate the grade changes and slopes along the shoulders.

Bus Maintenance Facility

A new bus maintenance and storage facility would also be required due to the anticipated size of the bus fleet. The facility would include a maintenance building for washing and fueling buses as well as covered space for the overnight storage of buses. Typical maintenance facilities include office space as well as a location for parts storage. A specific site has not been identified but ideally would be located near an I-93 exit.

Bus Stations

Bus station locations are shown in the following table, and would be the same as for the No Build alternative.

Peak Route	Community	1. Town Center Station	2. Park & Ride Station
1	Manchester	119 Canal Street	None
2	Londonderry	Manchester-Boston Regional Airport	Exit 5
3	Derry	Broadway near Railroad Avenue	Exit 4
4	Windham	North Broadway and Lake Street	Exit 3
5	Salem	South Broadway at Rockingham Park	Exit 2
6	Methuen	Broadway and High Street	Exit 47 (Pelham St)

Other Improvements

In addition to the physical improvement that are required to the shoulders and roadway, other costs may be incurred for the preparation of the roadway for bus use of shoulders. One such cost includes signage and striping to notify roadways users that buses may be using the shoulder. Other considerations may be the implementation of Intelligent Transportation Systems (such as bus GPS units, increased video monitoring of travel speeds or shoulder use) or the addition of additional shoulder "breakdown areas" at certain points along the corridor. Until further discussion and identification of specific issues and concerns related to the use of shoulders for bus operations in the I-93 corridor with all stakeholders, detailed costs for any additional improvements cannot be estimated.

Implementation and Estimated Costs

A benefit of implementation of the BOS Alternative is that the entire project does not need to be implemented at one time. The capital improvements and service improvements could be phased so that improvements could be implemented as funds are available or as conditions permit/warrant.

The following provides a potential strategy for the phasing and implementation of the BOS Alternative.

One of the primary considerations in the development of the phasing plan is the coordination with the schedules of other improvements planned in the corridor. Many of the BOS improvements are conceptualized as additions to these previously planned projects. The phasing of the BOS required improvements so that they can be implemented in conjunction with other projects will minimize costs and construction disruptions.

Another primary consideration in the phasing plan was the implementation of segments where improvements will be most beneficial. The benefits of the BOS Alternative improvements will occur in locations where general traffic speeds are the slowest. In general traffic speeds are slower in the southern segments of the corridor and are projected to be generally faster further north in the corridor.

The following is a proposed phasing strategy for the BOS Alternative.

Phase 1—Corridor Interchange Project Design Incorporation/Modification

- **Scope:** Incorporate the necessary shoulder improvements into the design of the following projects.
  - **Route 110/113 Methuen Rotary Improvements (Methuen, MA)** – The next phase of design is anticipated to begin during 2008. Construction is currently projected to

take place between 2014 and 2017. Although the cost for the design and construction modifications to the project is not known at this time it is not anticipated to be substantial.

- **I-93 Lowell Junction Interchange (Andover/Tewksbury/Wilmington) –** The next phase of this project will include additional environmental studies and design. Construction is currently projected to take place between 2013 and 2018. Although the cost for the design and construction modifications to the project is not known at this time it is not anticipated to be substantial.
- **I-93/I-95 Interchange Transportation Improvements Project (Reading/Woburn/Stoneham)** - The next phase of this project will include additional environmental studies and design. Construction is currently projected be completed by 2025. Although the cost for the design and construction modifications to the project is not known at this time it is not anticipated to substantially increase the cost of the project.
- **Time Frame:** The environmental / design efforts are projected to occur during the next five years. 2008 – 2013.

- **Cost:** The cost of incorporating the necessary shoulder improvements are not anticipated to substantially increase the overall cost of any of the projects.

Phase 2 – I-95 to Medford Improvements

- **Scope:** Design and construction of BOS required improvements to I-93 in the segment between I-95 (Woburn, MA) and the Mystic River in Medford, MA. Making improvements to this segment will allow both existing and planned bus services to realize travel time savings. It is anticipated that at a minimum bus services operated by the following agencies could utilize the shoulders:
  - MBTA (Routes 352 and 354/355)
  - Massport (Logan Express)
  - MVRTA
  - NHDOT

It is not anticipated that the full operating plan envisioned in the BOS alternative (90 trips in each direction) would be implemented at this time.

- **Time Frame:** The environmental, design, funding and construction efforts necessary to complete the project would likely take a minimum of 3 to 5 years. This would result in the earliest potential completion of the improvements in this section by approximately 2013.
- **Cost:** The anticipated capital cost of incorporating the necessary shoulder improvements are estimated to be approximately $25 million (in 2008$). Assuming construction in 2012-2013, the anticipated cost in "Year of Expenditure" dollars is $29 million[7].

Phase 3 – Corridor Interchange Project Construction

- **Scope:** Incorporate the necessary shoulder improvements into the construction of the following projects. The design of the bus improvements to be incorporated during Phase 1. This will allow implementation of bus shoulder operation between Medford north of the I-95 interchange.

[7] Year of Expenditure (YOE$) costs escalated assuming 3.25% annual inflation

  - Route 110/113 Methuen Rotary Improvements (Methuen, MA)
  - I-93 Lowell Junction Interchange (Andover/Tewksbury/Wilmington)
  - I-93/I-95 Interchange Transportation Improvements Project (Reading/Woburn/Stoneham)
- **Time Frame:** The construction of the above listed projects is anticipated to occur between 2013 and 2025.
- **Cost:** The cost of incorporating the necessary shoulder improvements are not anticipated to substantially increase the overall cost of any of the projects.

Phase 4 – I-95 to State Line /Bus Services/Bus Stations

- **Scope:** The completion of the I-95/I-93 interchange will allow for the extension of bus shoulder use in the segments between I-95 and the NH/MA border. This phase will incorporate modifications to the planned improvements of I-93 in the Merrimack Valley (Segment 2) as well as the necessary improvements to the corridor in the segment in Wilmington and Woburn (Segment 3). With the bulk of the capital improvements necessary for the project made during this phase, it is anticipated that implementation of the operating plan envisioned in the BOS alternative (90 trips in each direction) would be implemented with the completion of this phase. Implementation of this additional service would necessitate the need to make improvements at the planned stations, purchase buses and provide a bus maintenance facility.

- **Time Frame:** The construction of the I-93 widening project (Segment 2) is projected to be completed in 2025. The associated BOS improvements in that segment would be made as part of that project. The improvements to Segment 3, bus stop improvements, bus maintenance facility and new vehicles are anticipated to be made during the same time frame.

- **Cost:** The anticipated construction cost of incorporating the necessary shoulder improvements are estimated to be approximately $39 to $49 million (in 2008$). Assuming the construction would occur in the 2020-2025 timeframe, the anticipated cost in YOE dollars is approximately $61 to $77 million. In addition to the construction cost, new buses may be required to operate the planned service. Utilizing Federal Transit Administration’s (FTA’s) standard cost of $433,000 per bus and the need for approximately 55 new buses, this would cost about $24 million (in 2008$), or about $38 million(YOE$) when adjusted for inflation.

Phase 5 – New Hampshire Improvements

- **Scope:** Upon completion of the BOS improvements in Massachusetts, it could then be advantageous to make the improvements to the New Hampshire segment. The identified improvements would include the widening of the shoulder and installation of emergency pull-out areas.
- **Time Frame:** The improvements to the New Hampshire segment would be made following completion of the Massachusetts segments. It would therefore be anticipated that improvement would be made in the NH segment in the 2025 to 2030 time frame.
- **Cost:** The cost of incorporating the necessary shoulder improvements in the New Hampshire segment are estimated to cost approximately $24 to $34 million (in 2008$), or $44 to $62 million (YOE$) when adjusted for inflation.

Phasing/Improvement Reevaluation

As the phasing plan, as currently proposed, is to occur over a 22 year period, it will be appropriate to reassess the potential benefits of implementing each phase as it comes time for implementation. This will be most appropriate in the segments in the northern portion of the corridor (Merrimack Valley and New Hampshire) as the assumptions made in this study regarding population and employment projections, traffic congestion, and associated project implementation may need to be modified and therefore will impact the potential benefits of use of the shoulder as compared to bus use of general purpose lanes along the corridor.

Service Comparison

The Bus on Shoulder (BOS) Alternative appears to have significant levels of travel time and cost advantages that should warrant further consideration for implementation. The estimated average daily ridership for the alternative is approximately 5,000 to 5,500 inbound boardings in 2030. This ridership estimate is based on the full-build of the required infrastructure, the anticipated growth in population and employment in 2030, and the implementation of the operating plan that includes about 90 daily bus trips in each direction. In addition to the planned services, existing bus services may also be able to use the shoulder facilities, which would result in additional transportation system benefits.

Table 8 below compares bus service under the No Build and the proposed Bus on Shoulder service (Ottawa service).

	No Build	BOS (Ottawa)
Number of Stations Served (does not include Boston)	5	11
Peak Range Headway (min.)	30-60	15-30
Number of Peak Buses Required	28	50
Fare Structure	Current Bus	MBTA Rail
Daily Parking Fee	None	None
Benefits Existing MVRTA and MBTA Bus Services	No	Yes
Annual Vehicle Hours	41,519	76,809
Annual Vehicle Miles	1,269,162	2,413,111
Travel time to State Street, Boston from Manchester Station (in minutes)	75	61
Travel time from State Street, Boston from Exit 5 park & ride	64	50
Travel time to State Street, Boston from Exit 4	62	47
Travel time to State Street, Boston from Exit 3	53	40
Travel time to State Street, Boston from Exit 2	50	37
Travel time to State Street, Boston from Exit 47	44	31
Weekday Daily Trips	110	179
Weekend Daily Trips	24	72
Peak Vehicles Required	28	50
Base Vehicles	8	10

Table 8: Comparison of Bus Service under No Build and Bus on Shoulder Alternatives

Commuter Rail Service along M&L Branch: Exit 5 to Boston

Rail Corridor

The railroad right-of-way for the East Rail Corridor along the M&L Branch is largely owned by the State of New Hampshire, with few exceptions, and the MBTA owns the right-of-way (Haverhill Line/B&M West Route Main Line) within Massachusetts. Portions of the right-of-way in Derry and Londonderry are owned by the town and private interests. The commuter rail improvements are proposed to start south of the Manchester-Boston Regional Airport, where the Manchester Airport Authority has acquired 2.2 miles of right-of-way and constructed runways over the right-of-way from Harvey Road to Goffs Falls Road.

The Lawrence-Manchester Rail Corridor is an inactive right-of-way in New Hampshire. Currently, only the first mile of the M&L Branch in Lawrence is active for freight service, serving a plastic products company in Lawrence.

This rail alternative would offer direct service from the northern terminus at Exit 5 in Manchester, NH to the southern terminus of North Station in Boston, MA on the existing M&L Branch, the Wildcat Branch and the Haverhill and Lowell Line MBTA railroads. Service on the Lowell Line operates primarily over the New Hampshire Main Line (NHML) tracks between North Station in Boston and downtown Lowell.

Service Operations

The commuter rail service alternative would use the M&L line from a station near I-93 Exit 5 in Londonderry to the Haverhill line in Lawrence, Massachusetts. Trains would switch from the Haverhill Line to the Wildcat Branch at Wilmington Junction, and then to the Lowell line near Wilmington Station. Trains would remain on the Lowell line for access to Boston North Station.

This 47-mile alignment would require five new stations (Londonderry, Derry, Salem, Methuen, and Lawrence) and offers a travel time of 65 minutes. Direct services would also call on the existing Andover and Anderson stations in Massachusetts and travel non-stop between Anderson and Boston.

The station stops would include the following:

Community	Station Location	New/Existing
Londonderry	Exit 5 P&R	New M&L
Derry	Near Broadway & Railroad Ave	New M&L
Windham	None	New M&L
Salem	Near South Broadway & Rockingham Park Blvd	New M&L
Methuen	Pelham & Railroad Streets	New M&L
Lawrence	Near Lowell & Winter Streets	New M&L
Andover	17 Railroad Street	Existing MBTA
Anderson/Woburn	185 Atlantic Ave, Woburn	Existing MBTA
Boston, North Station	135 Causeway Street	Existing MBTA

The average peak period headway for the service would be 30 minutes and the off-peak headway would be approximately 60 minutes, as shown in the table below

	AM Peak (Inbound, Arriving Boston before 9 am)	**AM Reverse Peak** (Outbound, Departing Boston before 9 am)	**Midday** (Arriving or Departing Boston 9 am to 4 pm)	**PM Peak** (Outbound, Departing Boston 4 pm to 7 pm)	**PM Reverse Peak** (Inbound, Arriving Boston 4 pm to 7 pm)	**Night** (Arriving or Departing Boston after 7 pm)	**Total One-way Trips**
Number of Trips	5	2	14	5	2	10	38
Average Headway	0:30	1:16	1:00	0:33	0:58	0:56	

An alternative for extending service to the Manchester-Boston Regional Airport was also evaluated. The Manchester/Airport Extension Alternative incorporated all the same assumptions service plans as the Exit 5 to Boston commuter rail service alternative with the addition of two stations. These include a station at the Manchester-Boston Regional Airport and one in downtown Manchester. All other service parameters remained unchanged.

Transit Fares

The fares established for the build alternatives are based on the MBTA fare structure of 2000, the calibration year of the travel demand model. The table below shows the fares for the No-Build Alternative, which are derived from the fares for existing bus services in 2000. All fares (along with the other travel costs) were escalated in the model at the rate of inflation.

Origin	**No-Build Alternative Daily One-way Adult Fares ($2000 dollars)**	**Build Alternatives Daily One-way Adult Fares ($2000 dollars)**
Manchester	$10.00	$5.75
Londonderry	$9.00	$5.75
Derry	$8.00	$5.75
Windham	$7.00	$5.00
Salem	$6.00	$4.50
Methuen	$5.00	$4.25
Lawrence	$5.00	$4.25

Parking Fees

No parking fees are assumed at the new stations. Parking fees in effect in 2000 at existing stations are assumed. Although parking fees may be a prudent and necessary component of project funding, eliminating parking fees from the ridership modeling provides a projection of demand for the trip without the influence of parking fees.

M&L Branch Improvements

The 22-mile section of the M&L right-of-way between the MBTA's Haverhill Line at Lawrence and the Manchester-Boston Regional Airport limits could support track construction and train operations. Major improvements would be necessary on the New Hampshire segments along the M&L Branch, where track structure is not in place north of Salem. The existing track structure would need to be reconstructed as single track over most of the alignment. Along the Massachusetts portion of the M&L Branch, where limited freight service has recently operated, track rehabilitation would be necessary. Although the right-of-way could support rail service, there are several exceptions and issues that would need to be addressed in some manner to allow that to happen.

- **Road crossings:** There are 45 road crossings, six in Massachusetts and 39 in New Hampshire. Of these, three in Massachusetts and nine in New Hampshire could be characterized as major crossings in terms of traffic volumes and/or nearby intersections that complicate operating trains across at any speed. To operate a passenger service, each crossing would have to have railroad crossing warning systems installed and the major crossings would need additional measures such as traffic signal pre-emption, geometric roadway improvements and modifications to allow passenger rail operations. Even at that, some of these crossings will impose operational restrictions and scheduling limitations.
- **Bridges and Culverts:** There are a number of bridges and major culverts carrying the M&L right-of-way over roads or waterways. These bridges would have to be rehabilitated to make them suitable for railroad passenger service. The timber trestles would need to be replaced completely. The new roadway that cuts across the right-of-way at MP 9.25 in Windham would require a new railroad bridge constructed to cross where currently there is only a bicycle/pedestrian bridge.
- **Windham Rail Trail Bicycle Path:** The 3.5-mile bike path along the M&L Branch railroad right-of-way between Roulston Road and Windham Road is well patronized. There is insufficient right-of-way to maintain both the trail and an active railroad without property acquisition and significant wetland impacts. The trail would have to be discontinued.
- **Downtown Derry:** The extensive public and private development along the M&L Branch rail corridor on both sides of Broadway, the center of Derry, will require considerable effort to modify to allow the passage of trains. The rail corridor has almost disappeared under various access roads, drives, walkways and parking areas.
- **Private Ownership:** There are portions of the right-of-way sold to private developers with apparently no provision in the sale agreements to address possible re-use of the land for transportation purposes. Further development on or too close to the rail corridor will make future use for rail service more and more costly to rectify. These segments will need to be reacquired for public use by eminent domain or other acquisition process and any recent construction either removed or adapted.

In addition, other facilities such as one or more double track sections to allow trains to meet and pass, appropriate station locations with access roads and parking, a layover facility to store train sets overnight, a signal system and communications systems will also need to be provided.

Haverhill Line/Wildcat Branch Improvements

If a new passenger service on the M&L Branch were to connect to the present MBTA Haverhill Line in Lawrence, there are modifications and upgrades to that line and connection point that need to be addressed. The major issue is that the Haverhill Line is single track from the connection point (Andover Street Interlocking in Lawrence) to Ash Street in Reading, a distance of about 14 miles. However, the new service could operate over a shorter segment of the Haverhill Line to Wilmington Junction, about 7.8 miles, diverting there to the so-called "Wildcat" route that in effect crosses trains over to the MBTA's New Hampshire Main Line (Lowell Line) at Wilmington. However, the Wildcat is also single track over its 2.99 mile length, resulting in almost 12 miles of single track operation from Lawrence to Wilmington. Adding the trains of a new service to and from the M&L

Branch to the existing trains on those single track segments will require double tracking of the Haverhill Line from Andover Street Interlocking in Lawrence to Wilmington Junction in Andover and the Wildcat to just short of its connection to the New Hampshire Main Line in Wilmington. These single track segments are addressed below.

The I-93 Andover to Methuen Corridor Study identified the need for station improvements to accommodate double-tracking at the Andover and Ballardvale Stations. Additional platforms would need to be constructed at Andover Station, and, at Ballardvale, part of an existing platform would need to be removed and a new platform added to accommodate double-tracking.

There are existing single track constrictions on the current MBTA lines that the M&L Branch would connect to that would need to be addressed if additional trains were to be run into Boston. The total distance is just under 11 miles and impacts several existing junctions or interlockings.

Since passage of the ARRA, the Commonwealth and MBTA have considered the double tracking of the segments of this route with stimulus funding. Should that funding be available, a major cost factor in the M & L alternative will be addressed.

Estimated Cost

This section presents preliminary cost estimates to put the Manchester and Lawrence rail line back into service as a single track, commuter rail operation, with passing sidings, between the connection to the existing MBTA Merrimac or Haverhill Main Line in Lawrence to Exit 5 in Londonderry, a distance of about 21.5 miles. Also included is the cost to double-track the existing MBTA Wildcat Branch and the Haverhill Line between Wilmington Station and Andover Street in Lawrence, an additional 11 miles.

This cost includes:

- The M&L Branch will remain single track except passing tracks will be provided about in the middle and at the north end near North Londonderry.
- New stations will be built at Lawrence, Methuen, Salem, Windham, Derry and Londonderry.
- Station platforms that that have high level platforms.

This estimate does not include:

1. Any required land acquisition such as re-purchase of privately owned right-of-way in Derry, town owned right-of-way or additional land for stations, parking and access drives.
2. Environmental permitting and possible mitigation measures beyond minimal amounts estimated.
3. Noise/vibration mitigation
4. Any municipal requirements

The estimated costs include:

- **Double Track Wildcat Branch 2.99 miles from Wilmington to Wilmington Junction –** $11 million
- **Double Track 7.9 miles of Haverhill Line Wilmington Junction to Andover Street, Lawrence –** $46 million
- **Rehabilitate 3.7 miles of M&L Branch in Massachusetts –**$33 million
- **Rehabilitate 18.5 miles of M&L Branch from Massachusetts State Line to Londonderry, NH –** $106 million

- **Equipment Costs--**$50 million

TOTAL ESTIMATED PROJECT $247 million (2008 dollars)

The study team estimated the capital costs of the alignment from Exit 5 in Londonderry to Granite Street in Manchester, to be able to evaluate the incremental costs and ridership of that segment. Because of the tunneling that would be required to access and travel under the Manchester-Boston Regional Airport, the portion of the alignment from Exit 5 to Granite Street is projected to cost $232 million with limited additional ridership, for a total alignment cost of $479 million.

Travel Demand, Ridership, and User Benefits

The following sections reviews the I-93 corridor travel trends and compares the projected ridership for the alternatives under consideration, and the transportation system user benefit analysis required by FTA.

2000 to 2030 I-93 Corridor Travel Trends

In order to assess the feasibility of alternative transportation modes, it is first necessary to assess the expected changes in the corridor travel in the future. Future travel is influenced by changes in population and employment in the corridor, as well as by the configuration and performance of the corridor transportation networks. A travel demand forecasting model was developed for the I-93 corridor, in order to provide estimates of future travel demand through the use of detailed base year and future information about socioeconomic and transportation network conditions. This section presents the changes in travel demand expected in the I-93 corridor between the year 2000 and 2030. The information on these trends is derived from the I-93 corridor travel demand forecast model

Figure 1 shows the towns included in the I-93 corridor model, which extends from Boston in the south, as far north as Concord, NH. The corridor includes I-93, as well as the all major transit rail and bus routes. In order to concisely present information on model input assumptions and output forecasts, a set of districts for the I-93 corridor were defined. These districts were based on the regional planning agency boundaries in New Hampshire and Massachusetts, though in some cases only a portion of the regional planning area is included in the corridor. Figure 5 illustrates the I-93 corridor districts, which are referenced in the following tables.

Travel demand is primarily driven by the location of households, population, workers and employment. It is also influenced by the performance of transportation networks. Table 9 summarizes the expected changes in the population between 2000 and 2030 for the districts shown in Figure 5. The population and employment assumptions were provided by the State of New Hampshire (for New Hampshire portions of the model), and by the Central Transportation Planning Staff (for Massachusetts portions of the model), and are consistent with the assumptions used in the 2007 New Hampshire Statewide Travel Model System and the Supplemental Environmental Impact Statement for the I-93 improvements in New Hampshire. This table illustrates that growth in population is expected along the entire extend of the corridor, with significant growth in population in real terms expected in the SNHPC planning area, the NRPC planning area, and in the core. In relative terms, the CNHRPC area is also expected to experience significant growth in population.

District	2000	2030	Change	%
CNHRPC	64,869	87,309	22,440	35%
SNHPC	248,838	309,579	60,741	24%
RPC	92,543	118,924	26,381	29%
NRPC	192,047	242,774	50,727	26%
MVPC	233,250	262,032	28,782	12%
NMCOG	280,983	314,577	33,594	12%
Outer Core	573,148	614,136	40,988	7%
Inner Core	326,233	371,163	44,930	14%

Table 9: Change in Population by District

Employment growth is also expected to be robust throughout the entire corridor, as shown in Table 10. This growth is expected to be more pronounced at the northern and southern ends of the corridor, in the CNHRPC and SNHPC planning areas and in the core.

District	2000	2030	Change	%
CNHRPC	54,403	76,440	22,037	41%
SNHPC	118,565	160,699	42,134	36%
RPC	38,897	52,351	13,454	35%
NRPC	105,065	121,580	16,515	16%
MVPC	109,762	115,506	5,744	5%
NMCOG	121,195	135,267	14,072	12%
Outer Core	283,838	314,061	30,223	11%
Inner Core	588,470	647,387	58,917	10%

Table 10: Change in Employment by District

The location and growth of households and population has a direct affect on the amount of trips predicted by the travel demand forecast model. Table 11 illustrates the expected growth in trips for all purposes, including working, shopping, school, and other purposes.

District	2000	2030	Change	%
CNHRPC	255,044	343,168	88,124	35%
SNHPC	976,768	1,216,653	239,884	25%
RPC	370,987	476,785	105,798	29%
NRPC	759,605	960,525	200,920	26%
MVPC	835,249	946,900	111,651	13%
NMCOG	1,043,690	1,188,834	145,145	14%
Outer Core	2,130,568	2,323,783	193,215	9%
Inner Core	999,891	1,131,843	131,952	13%

Table 11: Change in Trip Productions by District

The focus of the I-93 alternatives analysis was on work trips, because the vast majority of trips using transit alternatives are for the work purpose. After predicting the total number of trips produced by and attracted to different areas of the corridor, the I-93 corridor model then "connects" these work trip productions and attractions, producing work trip flows. These flows change in the future, reflecting changes in the locations of population and jobs, as well as changes in the transportation network performance. Tables 12 through 14 show the year 2000 commute flows, as calibrated to the Census "Journey-to-Work" data, the year 2030 commute flows, reflecting changes in population, jobs, and network conditions, and the change in commute flows expected between the year 2000 and the year 2030.

Table 14 illustrates that the Boston core, as well as Nashua, Manchester, and Concord are expected to experience noticeable increases in the commute trips. Much of this growth is expected to be "intra-district" meaning that many of the new trips to Manchester are also coming from New Hampshire. However, there is some growth in interstate commuting from New Hampshire planning areas to Massachusetts planning areas, with approximately 9,300 more trips in 2030 than in 2000 – an increase of about 13%.

From/to	Inner Core	Outer Core	NMCOG	MVPC	NRPC	RPC	SNHPC	CNHRPC	Other	Total
Inner Core	133,770	14,630	2,060	1,040	160	320	60	10	30,400	182,450
Outer Core	134,400	167,440	11,080	5,230	2,530	810	2,190	110	82,660	406,450
NMCOG	13,700	36,260	86,530	12,210	7,220	2,590	2,050	180	34,440	195,180
MVPC	10,160	16,680	11,300	75,320	1,260	8,290	1,210	330	26,750	151,300
NRPC	3,080	6,690	13,380	3,600	88,050	2,380	17,950	1,170	10,010	146,310
RPC	2,760	5,030	3,450	15,360	2,930	21,460	6,960	480	14,280	72,710
SNHPC	3,850	4,520	3,200	5,830	25,150	8,970	119,340	9,750	5,400	186,010
CNHRPC	380	150	90	250	2,170	480	10,820	33,360	430	48,130
Other	388,280	113,680	26,970	30,160	7,760	7,470	5,910	810	917,580	1,498,620
Total	690,380	365,080	158,060	149,000	137,230	52,770	166,490	46,200	1,121,950	2,887,160

Table 12: Year 2000 Work Trip Distribution by District

From/to	Inner Core	Outer Core	NMCOG	MVPC	NRPC	RPC	SNHPC	CNHRPC	Other	Total
Inner Core	153,890	16,010	2,160	1,100	170	400	80	10	32,890	206,710
Outer Core	148,770	183,010	12,690	5,370	2,610	980	2,780	130	88,170	444,510
NMCOG	15,690	41,940	96,130	13,410	8,830	3,640	2,880	270	40,060	222,850
MVPC	12,020	19,930	13,000	80,100	1,530	11,600	1,920	480	30,800	171,380
NRPC	3,710	8,070	15,480	4,530	105,190	3,860	28,910	1,980	12,660	184,390
RPC	3,450	5,950	3,930	16,380	3,700	29,670	11,050	840	18,450	93,420
SNHPC	4,470	5,090	3,230	5,500	26,860	10,650	155,130	14,200	6,580	231,710
CNHRPC	440	180	130	340	2,380	720	14,260	45,660	610	64,720
Other	421,870	126,970	30,750	31,410	9,140	9,690	8,730	1,160	1,022,620	1,662,340
Total	764,310	407,150	177,500	158,140	160,410	71,210	225,740	64,730	1,252,840	3,282,030

Table 13: Year 2030 Work Trip Distribution by District

From/to	Inner Core	Outer Core	NMCOG	MVPC	NRPC	RPC	SNHPC	CNHRPC	Other	Total
Inner Core	20,120	1,380	100	60	10	80	20	0	2,490	24,260
Outer Core	14,370	15,570	1,610	140	80	170	590	20	5,510	38,060
NMCOG	1,990	5,680	9,600	1,200	1,610	1,050	830	90	5,620	27,670
MVPC	1,860	3,250	1,700	4,780	270	3,310	710	150	4,050	20,080
NRPC	630	1,380	2,100	930	17,140	1,480	10,960	810	2,650	38,080
RPC	690	920	480	1,020	770	8,210	4,090	360	4,170	20,710
SNHPC	620	570	30	-330	1,710	1,680	35,790	4,450	1,180	45,700
CNHRPC	60	30	40	90	210	240	3,440	12,300	180	16,590
Other	33,590	13,290	3,780	1,250	1,380	2,220	2,820	350	105,040	163,720
Total	73,930	42,070	19,440	9,140	23,180	18,440	59,250	18,530	130,890	394,870

Table 14: 2000-2030 Change in Work Trip Distribution by District

After predicting the work travel flows, the I-93 corridor model then predicts the specific travel mode used, such as drive alone (DA), shared ride (SR2, SR3), transit, and walk. These choices are influenced by travel times, travel costs (including parking costs), accessibility, transit service frequencies, and many other relevant factors. Table 15 shows the year 2000 overall work trip mode shares for each district. New Hampshire areas are highly oriented towards driving, with transit mode shares of 0%-2%. Closer to the core, transit shares increase significantly, reflecting higher levels of transit service provision, as well as decreased travel speeds for auto. Table 16 summarizes the mode shares for the year 2030 No Build condition. Table 17 shows the change in transit mode shares between 2000 and 2030, with drive mode shares generally decreasing and transit mode shares increasing, primarily reflecting the effect of region wide increases in roadway congestion in the future.

DIST	DA	SR2	SR3	TRANSIT	WALK
CNHRPC	87%	8%	2%	1%	2%
SNHPC	85%	8%	2%	2%	3%
RPC	88%	9%	2%	0%	0%
NRPC	86%	8%	2%	1%	3%
MVPC	83%	8%	2%	3%	4%
NMCOG	83%	8%	2%	3%	4%
Outer Core	67%	8%	2%	17%	8%
Inner Core	23%	3%	1%	38%	36%

Table 15: Year 2000 Work Trip Mode Share

DIST	DA	SR2	SR3	TRANSIT	WALK
CNHRPC	86%	8%	2%	0%	4%
SNHPC	83%	8%	2%	3%	5%
RPC	87%	9%	2%	2%	0%
NRPC	85%	8%	2%	2%	4%
MVPC	79%	8%	2%	6%	6%
NMCOG	81%	8%	2%	5%	4%
Outer Core	60%	7%	1%	22%	10%
Inner Core	17%	2%	0%	42%	39%

Table 16: Year 2030 Work Trip Mode Share

DIST	DA	SR2	SR3	TRANSIT	WALK
CNHRPC	-1%	0%	0%	0%	1%
SNHPC	-2%	0%	0%	1%	1%
RPC	-1%	0%	0%	1%	0%
NRPC	-1%	0%	0%	1%	0%
MVPC	-4%	0%	0%	3%	2%
NMCOG	-2%	0%	0%	2%	1%
Outer Core	-7%	-1%	0%	6%	3%
Inner Core	-6%	-1%	0%	4%	3%

Table 17: Percentage Change in Work Trip Mode Share 2000-2030

The alternatives tested as part of the I-93 study were primarily oriented towards providing increased transit service to the regions core, through the provision of express bus service and the expansion of commuter rail service. Table 18 shows the expected change in commute to the core for each of the regional planning areas. Growth from New Hampshire districts to the core is expected to be approximately 13%-20%.

	2000	2030	Diff	% Diff
CNHRPC	380	430	50	13%
SNHPC	3,830	4,340	510	13%
RPC	2,750	3,260	510	19%
NRPC	2,810	3,360	550	20%
MVPC	9,730	11,060	1,330	14%
NMCOG	11,590	12,990	1,400	12%
Outer Core	125,820	136,620	10,800	9%

Table 18: Change in Work Trip Mode Share 2000-2030

Table 19 summarizes the change in transit mode share expected between the 2000 base year and the 2030 "no build" alternative. This table indicates that the portion of commuters using transit to get to the core from southern New Hampshire is expected to grow significantly. Areas further north are not expected to experience such robust growth in transit mode share.

District	2000	2030	Change
CNHRPC	23%	20%	-2%
SNHPC	14%	25%	11%
NRPC	6%	27%	20%
RPC	10%	47%	38%
MVPC	20%	40%	20%
NMCOG	21%	30%	9%
Outer Core	39%	50%	9%

Table 19: Percentage Change in Commute to Core Transit Mode Share by District

Ridership

The purpose of the ridership forecasting was to develop estimates of future year station boardings reflective of the various transit alternatives under consideration. The future horizon year for the forecasts is 2030. The transit alternatives analyzed include a No-Build Alternative and two build alternatives, which are a Bus Alternative utilizing the shoulders of I-93, and a Rail Alternative utilizing the Manchester & Lawrence Line.

The build alternatives have some variations in frequency of service, travel times and stations served due to the characteristics of the mode, however efforts were taken to try to keep the alternatives as similar as possible so that they could be compared effectively. It is anticipated that proposed services will be primarily used by commuters who work and live in the corridor between Manchester and Boston, and to a lesser extent for travel within the corridor for other (non-commute purposes) such as by air passengers traveling to or from the Manchester airport.

Forecasts of commute travel were prepared using the I-93 corridor model. The demand estimates for the transit services have been based on commute travel demand. Although there would be some ridership generated from non-work travel, surveys of commuter rail services in the region indicate the demand is limited to below 10% to a maximum of 15% of total daily trips. This type of travel is highly variable and dependent on specific circumstances such as sports event schedules. Since this level of detail is not available for the future year of these projections, and there is not reliable data available to calibrate the model against, non-work trips have not specifically been included in the forecasts, but can be assumed to be included in the range of estimated provided. Forecasts of air passenger travel if the commuter rail extension to the Manchester-Boston Regional Airport were also produced.

Table 20 shows the estimated ridership demand in 2030 on each of the transit alternatives considered. The travel demand from the corridor to the Boston core appears to be generally the same regardless of the transit alternative that is implemented. Both the BOS and commuter rail service alternatives show a demand for approximately 5,000 inbound boardings each day. The ridership does increase by approximately 700 riders with the extension of the rail service to the Airport and Manchester. Figures 35 and 36 show the distribution of boardings for both the M&L Alternative and the BOS Alternative.

The ridership demand for the BOS Alternative is predominantly generated at the park and ride station locations. These station locations as compared to the stations located in the downtown areas have the benefit of a faster trip into Boston. The model predicts that far more riders benefit from the faster travel time of the park and ride location than from the ability to walk to a station in the downtown. Although the downtown station is likely to provide benefits to the community the demand estimates indicate that most users of the BOS Alternative access it from the highway.

	No Build	**BOS (Ottawa)**	**Rail**
Peak Transit Headway from Exit 5	30	15	30
Peak Travel Time from Exit 5 to Downtown Boston	64	50	65
Ridership	1,680-1,880	4,945-5,545	4,870-5,375
Estimated Construction Cost (in $millions (2008 dollars))		$112 to $132	$250
Annual Operating and Maintenance Costs (in $ millions)	3.6	5.9	9.6

Table 20: Summary of Alternatives

The model results also indicate that an overwhelming majority of the riders would be destined to Boston. The BOS Alternative shows 100% of the riders destined to Boston. Since this is an express service focused on providing direct service between New Hampshire park and ride locations and Boston, it does not easily facilitate reverse commute opportunities or shorter trips. The commuter rail service alternative has about 6% of its daily inbound ridership getting off the train prior to reaching Boston. Most of these passengers are destined to the Lawrence or Anderson area. The percentage of non-Boston riders increased with the extension to the Airport and Manchester with a number of riders destined to the Airport and to downtown Manchester work locations.

The distribution of ridership demand in the build alternatives is spread along the corridor serving both New Hampshire and Massachusetts station patrons, with a higher percentage of rail ridership in Massachusetts (65%) and a higher percentage of bus ridership (54%) in New Hampshire. Table 21 shows the distribution of boardings for both the commuter rail service and the BOS alternative.

<table>
<tr><th rowspan="2">Alternative</th><th colspan="10">New Hampshire Stations</th><th colspan="5">Massachusetts Stations</th><th rowspan="2">Total</th></tr>
<tr><th>Manchester</th><th colspan="2">Exit 5/ Londonderry</th><th colspan="2">Exit 4/ Derry</th><th colspan="2">Exit 3/ Windham</th><th colspan="2">Exit 2/ Salem</th><th>Methuen</th><th>Lawrence</th><th>Andover</th><th>Anderson</th><th>Boston Alightings (%)</th></tr>
<tr><td>Rail on M&L</td><td>N/A[1]</td><td colspan="2">475-525</td><td colspan="2">485-540</td><td colspan="2">N/A</td><td colspan="2">830-910</td><td>760-840</td><td>1,310 – 1,450</td><td>550-610</td><td>460 - 500</td><td>94%</td><td>4,870 – 5,375</td></tr>
<tr><td>Rail on M&L (with Airport Tunnel)</td><td>410-450 downtown 390-560 Airport</td><td colspan="2">230-250</td><td colspan="2">485-540</td><td colspan="2">N/A</td><td colspan="2">830-910</td><td>760-840</td><td>1,310 – 1,450</td><td>550-610</td><td>460 - 500</td><td>89%</td><td>5,425 – 6,110</td></tr>
<tr><td rowspan="2">Bus On Shoulder
Note 2</td><td rowspan="2">650-725</td><td colspan="2">865-965</td><td colspan="2">260-315</td><td colspan="2">360-410</td><td colspan="2">560-620</td><td>2,250-2,510 [3]</td><td rowspan="2">N/A</td><td rowspan="2">N/A</td><td rowspan="2">N/A</td><td rowspan="2">100%</td><td rowspan="2">4,945 - 5,545</td></tr>
<tr><td>55-65</td><td>810-900</td><td>50-55</td><td>210-260</td><td>10-20</td><td>350-390</td><td>0</td><td>560-620</td><td>100-120 / 2,150-2,390</td></tr>
<tr><td>No Build</td><td>380-420</td><td colspan="2">530-590</td><td colspan="2">120-140</td><td colspan="2">120-140</td><td colspan="2">530-590</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>N/A</td><td>1,680 – 1,880</td></tr>
</table>

Notes: 1. – Bus service from Manchester is estimated to have 700 daily inbound boardings.
2. – Ridership for specific bus stops are included. Number to left is "town center" (or Airport) stop, number to right is park and ride stop.
3. – Ridership realized would be less than estimated demand due to capacity constraints.

Table 21: Estimated Average Daily Ridership Demand (2030) Inbound Boardings

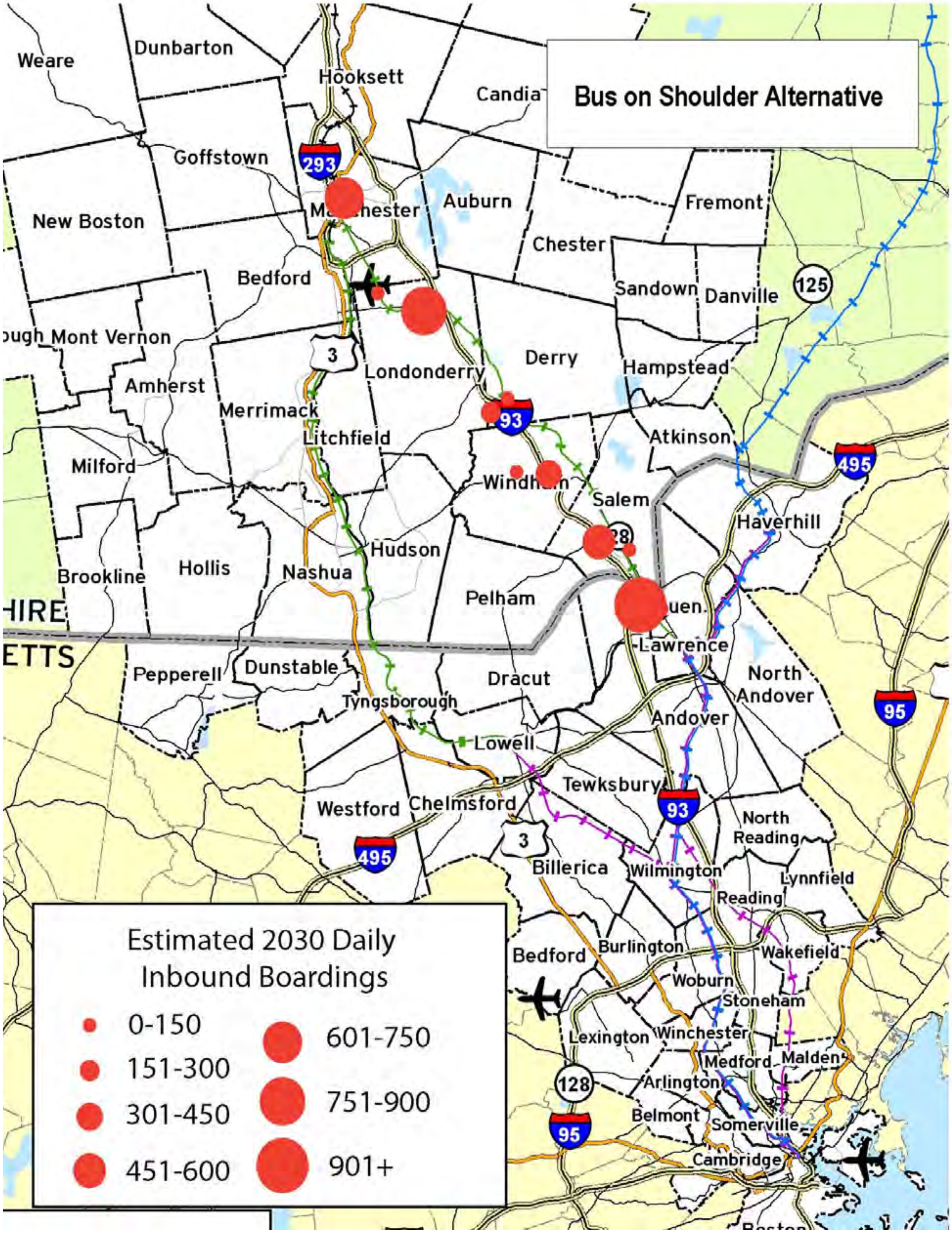


Figure 35: Bus on Shoulder Alternative Ridership Demand Distribution

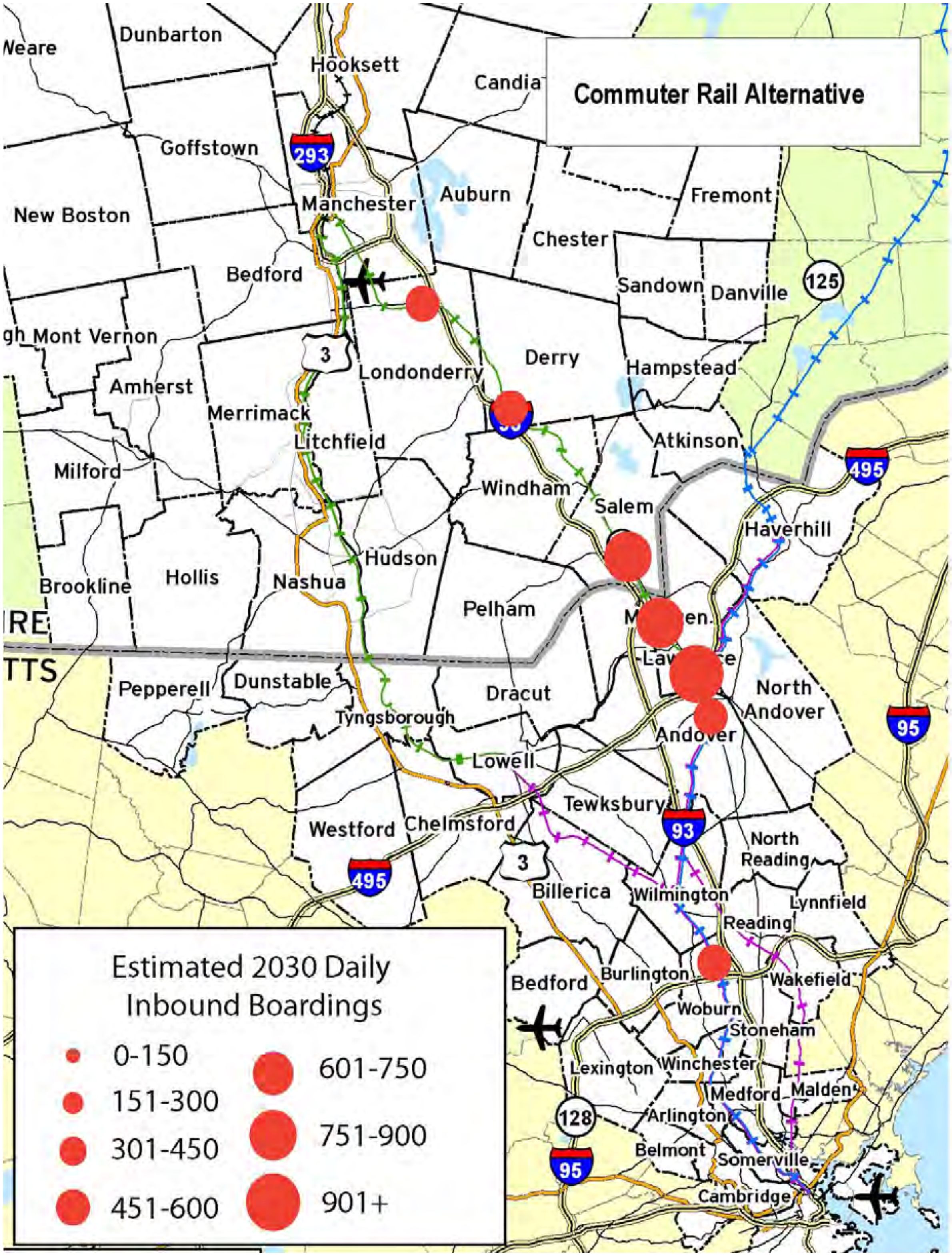


Figure 36: Manchester & Lawrence Alternative Ridership Demand Distribution

Transportation System User Benefits

For ridership forecasting, a travel demand model has been utilized that was developed to comply with accepted Federal Transit Administration methodology. This methodology is conservative in nature and does not take into account changes to travel patterns and volumes that may occur due to the existence of the service (i.e. new development or induced demand) or from outside factors (i.e. gas price inflation).

An estimate of the FTA's measure of the Transportation System User Benefits (TSUB) for each of the proposed alternatives has been developed. The TSUB is a unit that the Federal Transit Administration (FTA) uses to assess benefits that accrue to the users of a transit system resulting from an improvement. This benefit is typically travel time saved, but can also represent reduced travel costs which are converted to a travel time measure.

FTA uses the TSUB along with the projected costs for a project to determine its overall cost effectiveness. They have established certain cost effectiveness thresholds for funding projects and therefore understanding the cost effectiveness of various alternatives may be instructive in how to advance the project utilizing FTA capital grant funding. In addition to the development of the TSUB values, the process of running SUMMIT, the software that calculates the user benefit, also generates mapping that displays the distribution of project benefits can be more easily understand than a large spreadsheet.

Calculation of the User Benefits first requires the development of an FTA "Baseline Alternative," which is typically a low capital cost bus service that serves the same stations as the proposed build alternative project (similar to the No Build expanded bus service). The FTA Baseline Alternative is used to identify and compare the cost effectiveness of the project and various alternatives.

Each of the primary build alternatives was compared to the FTA Baseline Alternative in order to generate estimates of user benefits associated with each alternative. These estimates of user benefits are based on the 2030 forecasts in order to reflect the long-term benefits of the project. Table 22 summarizes these user benefits.

	Hours
Commuter Rail Service on M&L Branch Alternative	-149
Bus on Shoulder Alternative	1404

Table 22: 2030 Hours of Daily User Benefits

Commuter Rail Service on M&L Branch: Exit 5 to Boston

The alternative for commuter rail service on the M&L Branch has a negative user benefit when compared to the Baseline Alternative. This negative user benefit indicates that there is not any travel time (or cost) savings that occur to users of the transit system with the implementation of this alternative vs. implementation of the FTA Baseline Alternative. The primary reason for the negative user benefit is the longer overall travel times between downtown Boston destinations and the origins of many of the commuters. This increase in travel time occurs on both ends of the trip with the station to station trip time is generally equivalent between the alternatives. On the northern end of the trip many of the rail station locations (in the downtowns) require greater travel times for a greater number of riders, as compared to the highway accessible park and ride lot station locations of the Baseline Alternative. Although this appears to be counter intuitive to many of the smart growth or Transit-Oriented Development (TOD) benefits of rail, the existing dispersed pattern of development in New Hampshire leads many transit riders to need to access the stations via highways. On the other end of the transit trip, the rail alternative terminates at North Station. Since the highest density of employment locations is in Boston's financial district, the State Street Station and South Station locations that can be directly served by the Baseline Alternative decrease the overall trip time by about 10 to 15 minutes.

The negative user benefit of the commuter rail service alternative means that it is not a candidate for Federal Transit Administration New Starts program funding under the current criteria. Although the travel time benefits that result from the capital improvements do not meet FTA's evaluation criteria, the service would have ridership that is comparable to many stations on the MBTA commuter rail system and other funding sources may be used to fund the service.

Bus on Shoulder Alternative

The BOS Alternative has a positive user benefit of approximately 1,400 daily hours when compared to the Baseline Alternative. This level of user benefit indicates that there is substantial travel time savings that occurs to users of the transit system with the implementation of this alternative vs. implementation of the Baseline Alternative.

The travel time savings that can be realized from the use of the highway shoulders is estimated to be on average approximately 10 to 15 minutes for each trip. Since the travel time is the only difference between the Baseline Alternative (which could be achieved without major capital improvements) and the BOS Alternative the advantages are clear.

The level of user benefit of the BOS Alternative means that it is a potential candidate for Federal Transit Administration New Starts program funding under the current criteria. If implemented as a single project, the cost per user benefit would be in the range of $10 to $15 per user benefit. This would result in a high to medium-high evaluation in FTA's cost effectiveness evaluation of the project.

9. Socioeconomic, Land Use, and Environmental Considerations

Socioeconomic Considerations

Population and Employment

The potential market area, and study area, for the I-93 TIS was defined to include 38 communities within Hillsborough (Manchester area), Rockingham, and Merrimack Counties in southern New Hampshire and 32 communities within Essex, Middlesex, and Suffolk Counties in Massachusetts (see Figures 1 & 5). A detailed assessment of existing and future projected population and employment in the study area is presented in the Purpose and Need Report (Appendix G). Between 1980 and 2000, the study area communities in Massachusetts added roughly 120,000 residents, or about 6,000 per year. Over the same time period, New Hampshire study area communities added about 176,000 residents, or approximately 8,800 per year. Between 1980 and 2030, population is projected to increase by roughly 18% in Massachusetts and by approximately 92% in New Hampshire.

Massachusetts study area communities are expected to add roughly 153,000 new residents between 2000 and 2030, or about 5,000 new residents per year. New Hampshire study area communities are expected to add approximately 200,000 new residents over the same time period, or roughly 6,700 new residents per year. By 2030, total population is expected to increase by roughly 9% in Massachusetts and by approximately 36% in New Hampshire. According to *Vital Signs 2006: Economic and Social Indicators for New Hampshire, 2001-2004* (January 2006), prepared by the New Hampshire Economic and Labor Market Information Bureau, the majority of people relocating into New Hampshire come from Massachusetts. From 2000 to 2003, Rockingham County accommodated 7,300 new residents, Merrimack County accommodated 5,300 new residents, and Hillsborough County accommodated 2,400 new residents from Massachusetts.

Massachusetts study area communities are expected to add roughly 111,000 jobs by 2030, or approximately 3,700 jobs a year. This compares to approximately 135,000 new jobs created in New Hampshire study area communities over the same time period, or roughly 4,500 jobs a year. These represent employment increases of about 10% in Massachusetts study area communities and 48% in New Hampshire study area communities.

Most of the communities with the highest population and employment gains in both Massachusetts and New Hampshire are located along the I-93, U.S. Route 3, or F.E. Everett Turnpike corridors.

Potential Economic Impacts

The potential economic impacts associated with the I-93 Transit Investment Study were assessed by conducting a literature review of published studies on the economic impacts of transit and by examining other case studies of relatively recent or proposed transit extensions in New England. The largest beneficial property impact was seen in areas with transit supportive zoning and land use policies. Higher increases in property values and positive redevelopment impacts were noted in areas where transit-supportive zoning and land use policies (Transit Oriented Development) were implemented. In addition, improving pedestrian accessibility to station sites and designing stations to reduce potential nuisance factors such as noise and aesthetic impacts were also recommended to contribute to positive property impacts. The accessibility that new transit service provides can act as an economic stimulus to the communities served and focal point for development, particularly when implemented in conjunction with land use policies and zoning that encourage transit-oriented development. Economic impacts can be pronounced where transit provides the opportunity for redevelopment to occur at a higher density or encourages the use of underutilized or undeveloped parcels.

Summary of Literature Review

The results of a literature review of published studies on the land use and economic effects of transit are presented in Appendix E and summarized below.

- Land use impacts of transit are influenced by zoning and land use policy decisions, with positive impacts largely attributed to transit supportive zoning.
- Market forces must be in place for TOD to work.
- Property and land use effects of fixed rail transit are generally greater than for bus transit, and the effects on property values were determined to be greater for commuter rail or heavy rail than for light rail or bus.
- Property value and land use effects can be more pronounced in suburban areas than in the central city. The greatest land use impacts can be seen at end-of-the-line stations, rather than central city, since these are typically least developed and least accessible and leave the most room for development.
- However, other studies that also evaluated commercial property have identified a higher price premium associated with introduction of transit in densely populated area.
- Results on reviews of changes in housing values near transit have produced variable results, but most of the studies indicate a positive impact on housing prices.
- Impacts on residential property values were found to be larger than intensity of development
- Population effects of commuter rail are more localized around station sites, and represent intra-regional shifts, rather than wholesale migrations

Case Study Examples

Commuter rail extensions for the Massachusetts Bay Transportation Authority implemented within the last 15 years provide case study examples for the impacts of transit on land use and growth. The Old Colony Railroad Rehabilitation Project restored commuter rail service on three rail lines from Boston on 80 miles of track serving more than 30 communities on the South Shore. Prior to the railroad restoration, this area of Southeastern Massachusetts was not served by dedicated transit lines from Boston. The two rail lines to Middleborough and Plymouth were activated 10 years ago, and the third line, the Greenbush Line, was only recently reactivated. Large property impacts in suburban, end-of-the-line locations is evident when looking at residential property values and building permits issued for communities at the ends of the Old Colony Middleborough and Plymouth Lines. The Middleborough and Plymouth Lines went into operation in 1997, after which median housing sale prices in Middleborough and neighboring

Lakeville at the end of the Middleborough Line started to rise. Although median housing prices in Lakeville and Middleborough remained stable during the 7-year period preceding the commuter rail service, prices more than doubled in the following 7 years. A marked increase in the number of building permits issued in Plymouth, at the end of the Plymouth Line, can also be seen in the years after commuter rail service was instituted. Further information on a case study review of the land use and growth impacts of the Old Colony Railroad Rehabilitation project by the Southeastern Regional Planning and Economic Development District are presented in Appendix E.

The Worcester Commuter Rail Extension Project involved extending commuter rail service 23 miles from Framingham west to Worcester. The Framingham/Worcester Line extends a total of 44 miles between New England's two largest cities in Massachusetts: Boston and Worcester. Service on the line beyond Framingham began operating with six trains a day in 1994, and service was expanded in 2001 to 20 trains (20 roundtrips). Increases in property values for single-family homes can also be seen in reviewing median residential sale prices for outlying communities served by the Framingham-Worcester Line (Westborough, Grafton, Millbury, Worcester). Commuter rail service from Boston beyond Framingham to Worcester was instituted in 1994, and a station stop in Grafton was added in 2001. Median residential sale prices more than doubled in the four communities at the western end of the line in the 12 years after commuter rail service was instituted. A review of the annual number of housing units permitted for the same communities along the Framingham/Worcester Line provides less clear evidence for impacts on intensity of development. Although a general upward trend can be seen in this data over time for Westborough, Millbury, Grafton, and Worcester, this increase is less pronounced than the increase in property values.

A study of 43 communities commissioned by the Great American Station Foundation found that the presence of an active train station has considerable economic advantages for small cities. Northeast cities included in the study included Boston South Station; Exeter, NH; Portland, ME; and Haverhill, MA, and recent intercity rail studies evaluated included the Boston to Portland service. The study concluded that, when high-density housing generates the need for sufficient upgrades to public transportation systems, the economic benefits can increase an area's employment rolls, household incomes and property taxes as well as property values.

This study quantified economic impacts based on city size and corridor density. The study found that these were the two factors that determined the level of use of transit and rail systems in any corridor. Using the model developed in this study, the project area for improvements to the M&L Branch and Haverhill Line/Wildcat Branch would be classified as a Rural Density corridor, with a large city (population over 500,000), Boston, on one end and small cities and towns (population between 100,000 and 250,000) along the route. For a corridor of this population density, Table 23 presents the increases projected to occur in employment, annual household income, property values, and property tax revenues in communities along the M&L Branch corridor with a station revitalization that improves the transportation system.

City Size	Increase in Employment (# of Jobs)	Increase in Annual Household Income	Increase in Property Values (millions)	Increase in Property Tax (millions)
Town (range) *(average)*	45-135 89	$80-$235 $157	$5-$10 $8	$.25-$.5
Very Small (range) *(average)*	115-350 232	$85-$250 $168	$10-$35 $23.5	$.5-$1.75
Small (range) *(average)*	170-510 338	$140-$425 $282	$15-$40 $28	$.75-$2.0
Medium (range) *(average)*	190-575 384	$155-$465 $309	$15-$45 $31	$.75-$2.25
Large (range) *(average)*	260-775 518	$175-$520 $348	$25-$80 $52	$1.25-$4.0
Note: Towns (less than 50,000 population),Very small city (50,000-100,000 people), Small city (100,000-250,000), Medium city (250-000-500,000), Large city (500,000 to 2 million people)				

Source: *Economic Impact of Station Revitalization,* Great American Station Foundation, 2001.

Table 23: Predicted Economic Benefits from Train Service

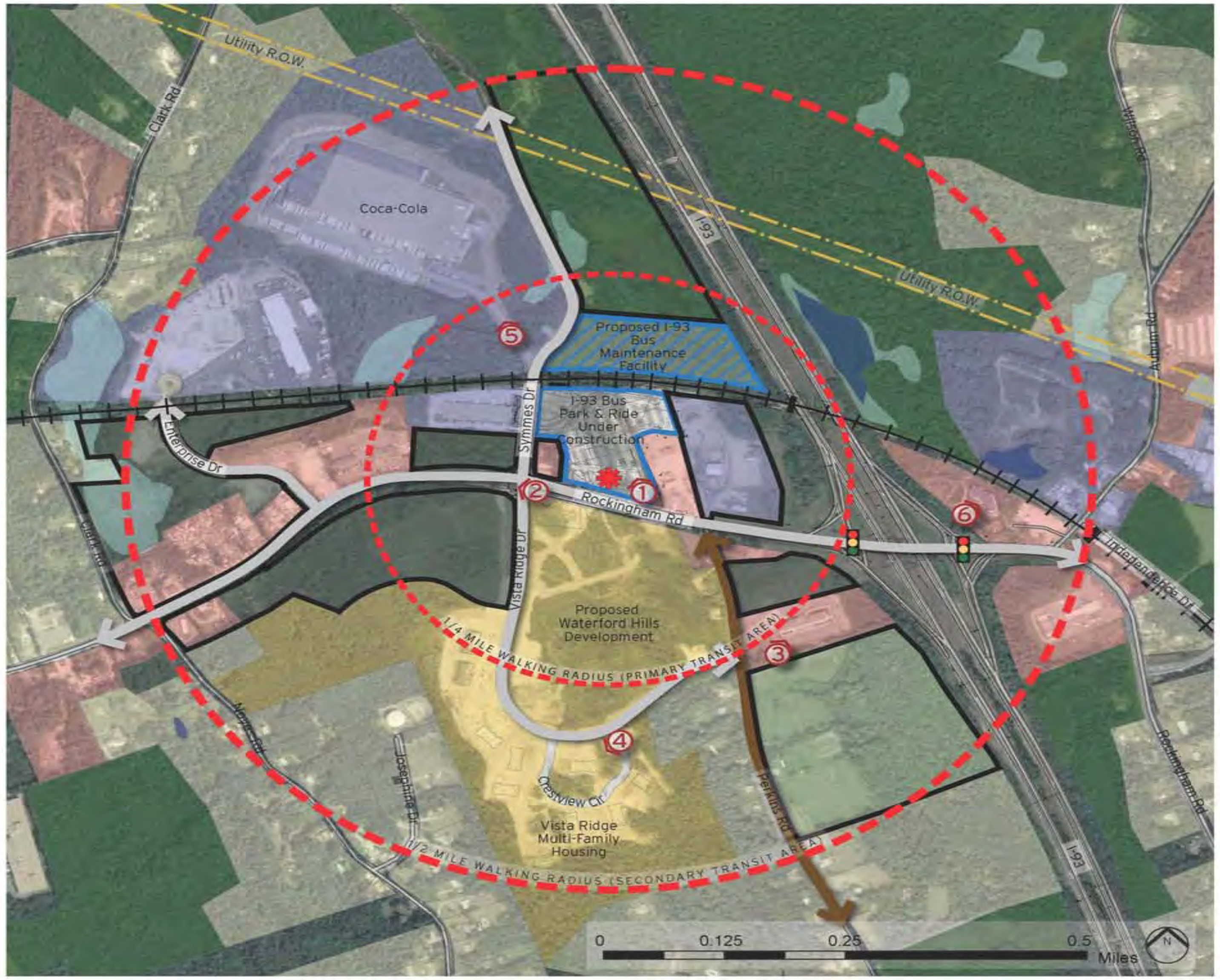
Land Use and Zoning

Overview

The M&L Branch railroad corridor, which is central to the focus of the study area, could leverage previous transit investments in order to encourage future transit-supportive land use patterns. Institution of new rail service along the M&L Branch could be expected to have positive land use development the extent of which would depend on the siting of the station stops and proximity to community centers and developed areas. Other factors that would influence land use impacts include the presence or implementation of zoning to support transit oriented development and market demand for new development.

Potential station stops have been identified at Exit 5 in Londonderry on the northern end (bus and rail station), at the historic rail depot location in Derry, at Salem Rockingham Park, in downtown Methuen near the historic depot, and in Lawrence. Figures 37-44 depict issues associated with bus or rail station development at these locations in Londonderry, Derry, and Salem. Figures 45a through 45h show community center areas, as delineated in New Hampshire and Massachusetts, and community and environmental resources for the entire I-93 project area.

I-93 TRANSIT STUDY: STATION AREA OPPORTUNITIES AND CONSTRAINTS
Londonderry, NH - I-93 Bus Station with Park & Ride Alternative



General Station Area Comments:

- The bus station and park & ride facility is located approximately one-half mile from the I-93 interchange. It serves as an alternative commuting option, but provides few opportunities to affect the station area's pre-existing land use patterns.
- Existing vacant properties provide opportunities for the town to continue attracting retail, service, office, and industrial uses that are auto-oriented and depend on convenient access to the interstate.
- Existing under-utilized properties along Rockingham Road contain aging buildings and site improvements that do not represent high quality development, and may provide future redevelopment opportunities for more modern uses.

General Station Area Analysis

NHDOT is constructing a major transit improvement–bus station and park & ride lot–to serve as a commuter alterative to driving along I-93. Commuters using this facility may provide additional demand for local retail and service uses.

NHDOT is widening portions of Rockingham Road to accommodate new turning lanes, interchange ramps, and bridges for the I-93 widening project. These improvements reinforce the area's existing highway-oriented environment.

A new hotel adjacent to exit 5 indicates the town's desire to provide highway-oriented retail and service uses for I-93 travelers. According to its 2004 Master Plan, this "gateway commercial" area should continue attracting such uses.

The Vista Ridge condominiums provide multi-family housing for residents whose commuting patterns likely depend on I-93 access. Although Vista Ridge has sidewalks, the area's auto-oriented environment is not conducive for walking.

A Coca-Cola production center is a major employment and distribution facility that utilizes convenient access to I-93. The current expansion of its facilities indicates that the area is a quality location for distribution-based land uses.

New professional offices provide local employment opportunities and commercial services with convenient interstate access. Based on its occupancy, there may be additional demand for quality office space near the interstate.

EXISTING LAND USE LEGEND

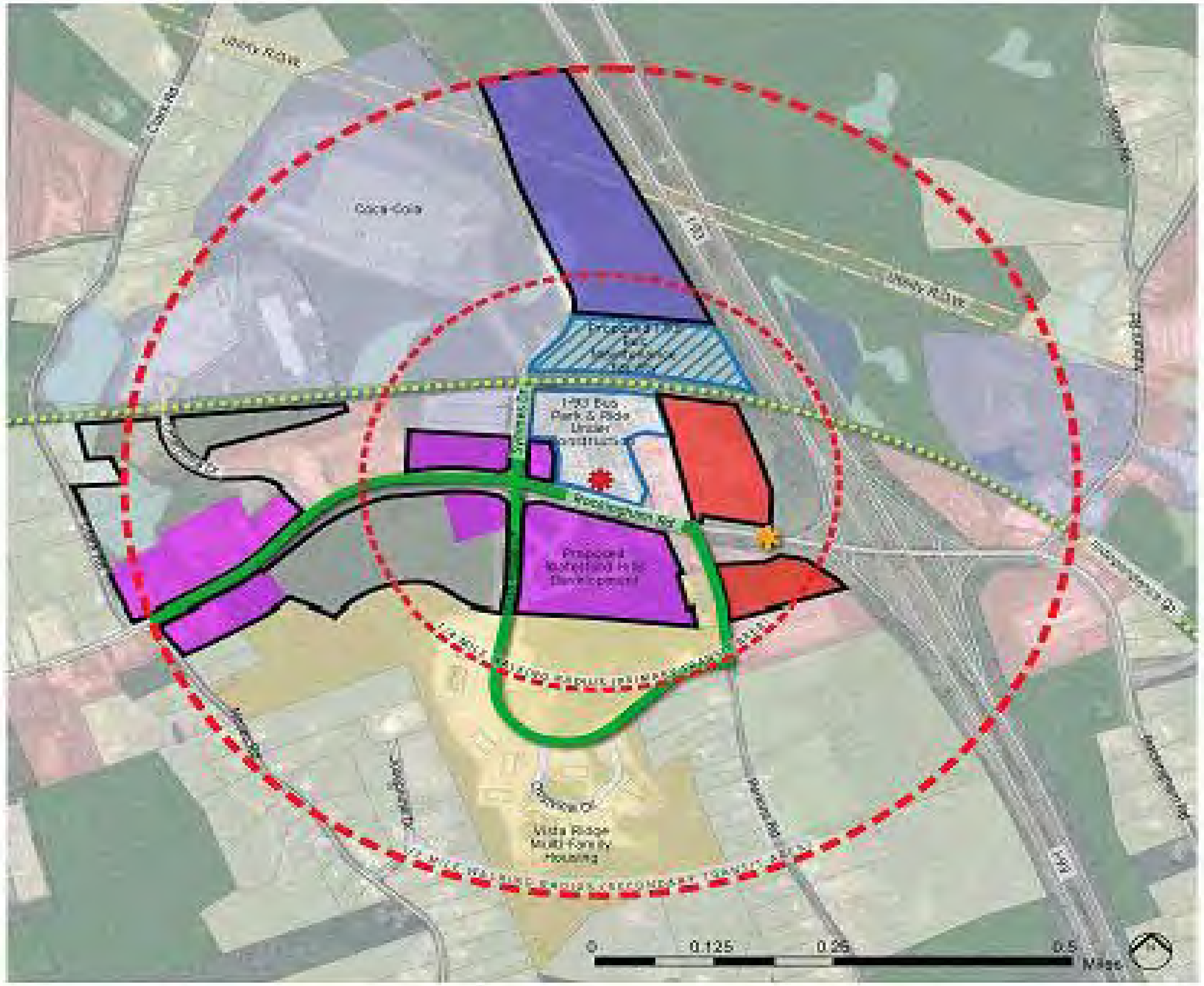
- Single Family
- Multi-Family
- Mobile Home
- Commercial
- Light Industrial
- Public/Institution
- Open Space/ Recreation
- Forested
- Agriculture
- Vacant
- Water
- Wetland

OPPORTUNITIES AND CONSTRAINTS LEGEND

- Bus Station with Park & Ride (Under Construction)
- M&L Railroad Corridor
- Signalized Intersection
- Auto-Oriented Streetscape
- Rural Streetscape
- Future Redevelopment Opportunity Site
- Station Area Photos

Figure 37

I-93 TRANSIT STUDY: STATION AREA PLAN RECOMMENDATIONS
Londonderry, NH - I-93 Bus Station with Park & Ride Alternative



PROPOSED RECOMMENDATIONS LEGEND

- Bus Station with Park & Ride (Under Construction)
- Future Redevelopment Opportunity Site
- Future Multi-Family Residential (Senior Housing)
- Future Commercial (Retail)
- Future Commercial (Office)
- Future Industrial
- Proposed Streetscape Improvement
- Proposed Rails-to-Trail
- Proposed Gateway Feature

EXISTING LAND USE LEGEND

- Single Family
- Multi-Family
- Mobile Home
- Commercial
- Light Industrial
- Public/Institution
- Open Space/ Recreation
- Forested
- Gravel Pits and Quarry
- Vacant
- Water
- Wetland

General Station Area Recommendations:

- Londonderry could adopt design standards for its gateway commercial area that encourage rural building styles, imparts a unified environment, and provides pedestrian amenities such as sidewalks, streetlamps, and landscaping.
- Additional office and retail uses would be appropriate for future redevelopment sites along Rockingham Road in order to provide local goods and services to residents and commuters.
- A "rails-to-trail" path could potentially be established along the inactive Manchester & Lawrence railroad corridor to provide recreational options for local residents, subject to protection of this right-of-way for future transit use.

Future Development Examples


The new bus station constructed at the I-93 Exit 4 park and ride lot is a bus station prototype that could be used for the I-93 Exit 5 park and ride lot.


Multiple office uses built within a village setting would provide a unique development framework for Londonderry's gateway commercial area west of the I-93 interchange.


New individual commercial buildings could mimic traditional small-town architecture and provide a quality alternative to conventional highway oriented development.

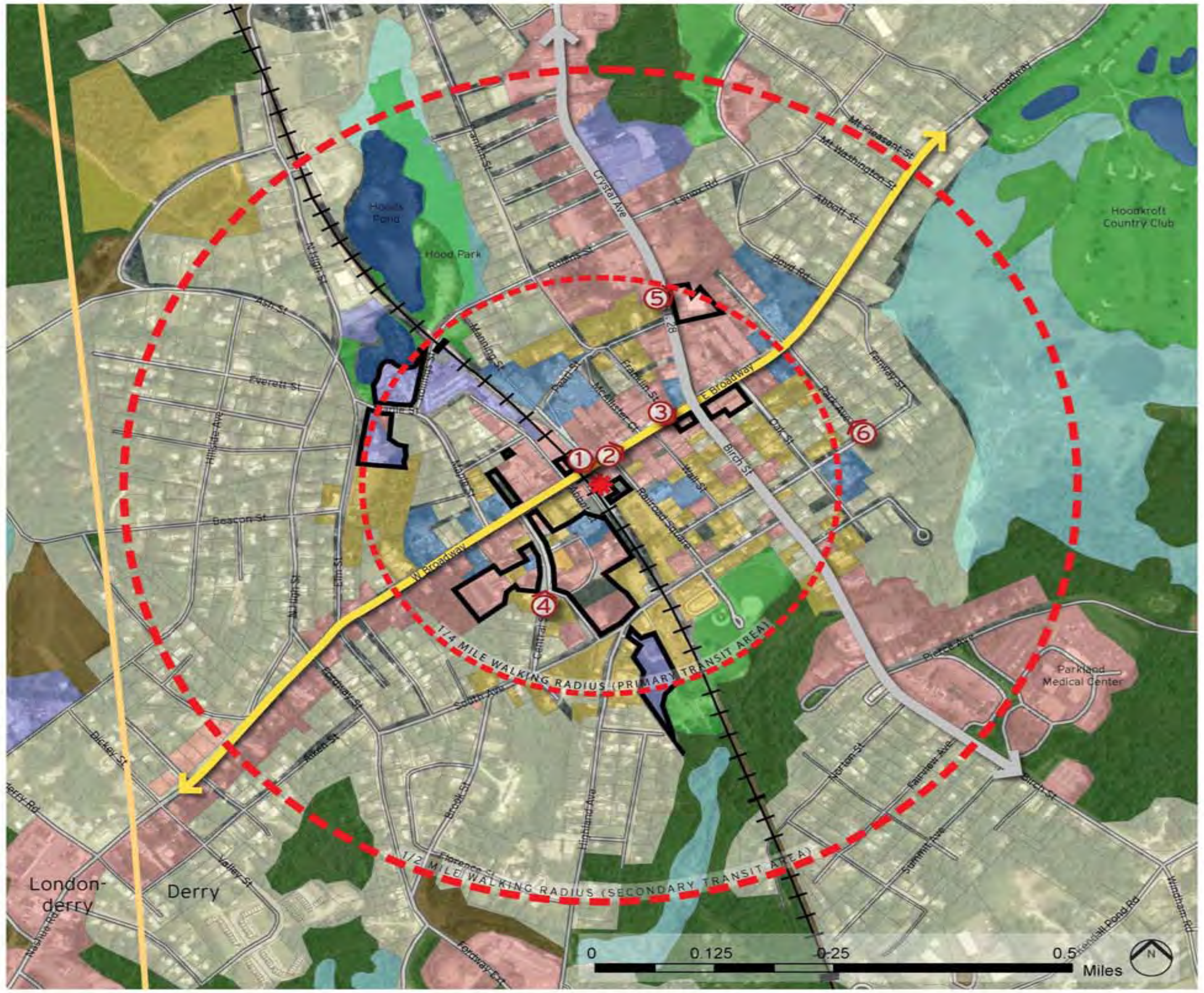

Londonderry could encourage national retailers that use traditional small-town architecture to locate within its gateway commercial area.


Londonderry could encourage local retailers to use traditional small-town architecture by adopting design guidelines for new construction.


Senior housing that mimics farmhouse buildings could be appropriate for future redevelopment of agricultural lands that are adjacent to single family homes.

Figure 38

I-93 TRANSIT STUDY: STATION AREA OPPORTUNITIES AND CONSTRAINTS
Derry, NH - I-93 Commuter Rail Station Alternative



EXISTING LAND USE LEGEND

- Single Family
- Multi-Family
- Mobile Home
- Commercial
- Light Industrial
- Public/Institution
- Open Space/ Recreation
- Forested
- Gravel Pits and Quarry
- Vacant
- Water
- Wetland

OPPORTUNITIES AND CONSTRAINTS LEGEND

- Potential Commuter Rail Station
- Potential Commuter Rail Corridor
- Signalized Intersection
- Auto-Oriented Streetscape
- Pedestrian-Oriented Streetscape
- Future Redevelopment Opportunity Site
- Station Area Photos
- Municipal Boundary

General Station Area Comments:

- Future commuter rail service could potentially be re-established along the inactive Manchester & Lawrence railroad alignment if current access and land use constraints are overcome. The town's historic station location could be utilized while maintaining its current use.
- Derry could focus on future commuter rail service as a catalyst for additional infill development, revitalization and redevelopment, and adaptive reuse of historic structures. Future transit-supportive development depends on rail service, density, and walkability.
- Many communities throughout the country are capitalizing on commuter rail service to generate additional downtown development. With or without commuter service, Derry could use transit-supportive development policies to strengthen its downtown market.

General Station Area Analysis

Derry's historic train station serves as popular local restaurant. The train station could potentially retain its role as a gathering place if future commuter rail service is provided along the adjacent Manchester and Lawrence railroad alignment.

The historic train station is centrally located in Downtown Derry along West Broadway, a vibrant mixed-use downtown shopping district. Based on national and regional trends, commuter rail service could serve as a catalyst for additional mixed-use development.

Broadway contains several underutilized properties due to building age and obsolescence, site improvements, and/or parcel size. These properties could provide future transit-supportive development opportunities.

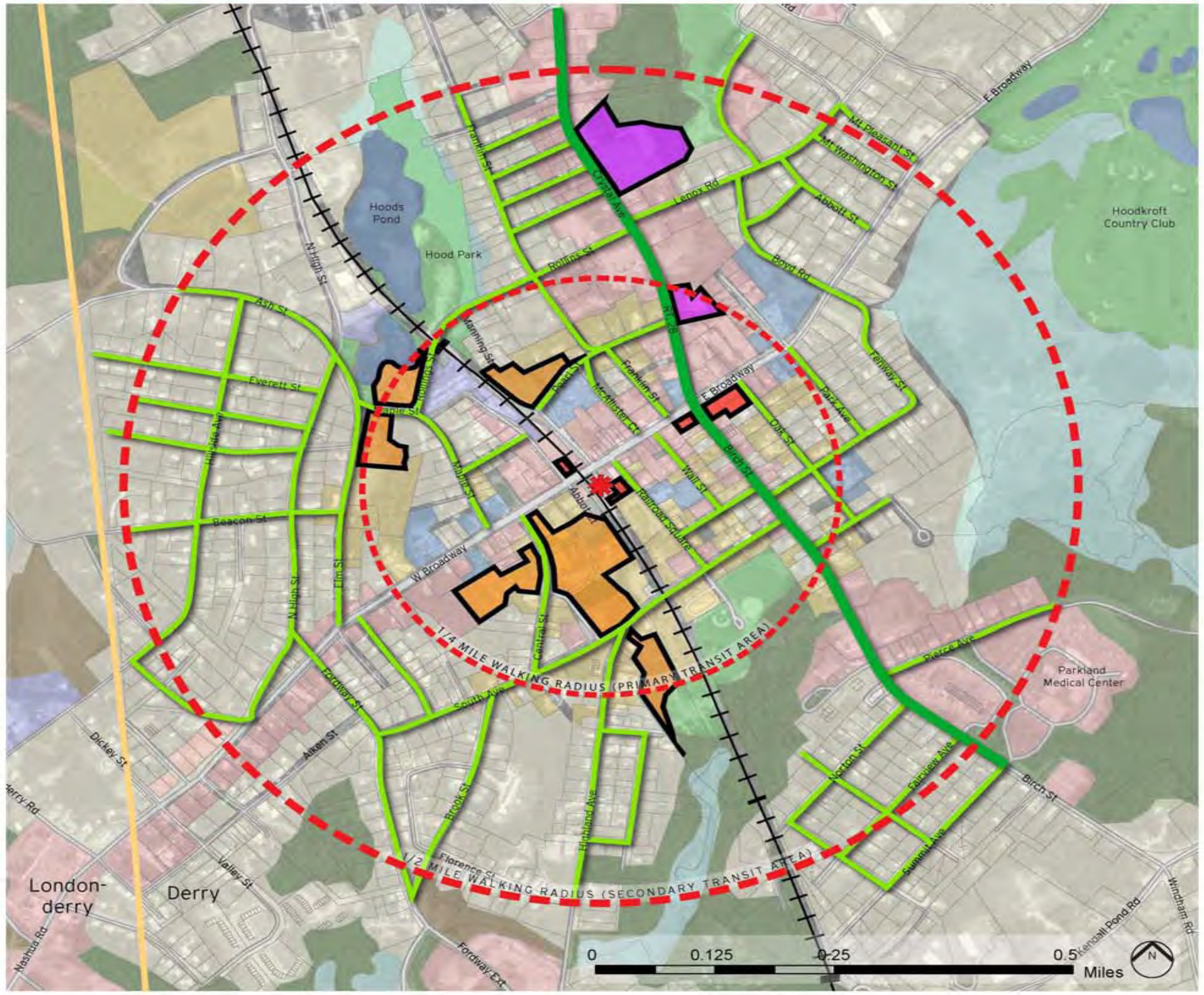
Several properties along Central Street and Central Court appear vacant and underutilized. Depending on parcel consolidation, these properties could provide future transit-supportive development opportunities.

Aging commercial buildings within a half mile of the potential commuter station could serve as future redevelopment sites that increase adjacent property values.

West of Birch Street, stable single-family residential neighborhoods are integrated within Downtown Derry through a pedestrian-friendly street and sidewalk network.

Figure 39

I-93 TRANSIT STUDY: STATION AREA PLAN RECOMMENDATIONS
Derry, NH - I-93 Commuter Rail Station Alternative



PROPOSED RECOMMENDATIONS LEGEND

- Proposed Commuter Rail Station
- Proposed Commuter Rail Corridor
- Future Redevelopment Opportunity Site
- Future Multi-Family Residential
- Future Commercial
- Future Mixed-Use Commercial
- Proposed Business Improvements (concrete/brick sidewalks, street trees, and pedestrian lights)
- Proposed Neighborhood Improvements (one concrete or brick sidewalk per street)
- Existing Municipal Boundary

EXISTING LAND USE LEGEND

- Single Family
- Multi-Family
- Mobile Home
- Commercial
- Light Industrial
- Public/Institution
- Open Space/ Recreation
- Forested
- Gravel Pits and Quarry
- Vacant
- Water
- Wetland

General Station Area Recommendations:

- Several sites along West and East Broadway could serve future redevelopment purposes for mixed-use commercial and residential buildings, which could provide modern retail space and new housing options near the proposed commuter station.
- Based on infill residential trends in Downtown Derry, there are several larger sites that could be redeveloped for multi-family residential uses depending on the ease of parcel consolidation and any potential need for environmental remediation.
- Derry could implement new streetscape standards along Crystal Avenue and a new residential streets program within the station area to encourage walking to the proposed commuter station and downtown businesses.

Future Development Examples:

Derry's recently constructed municipal building provides a new precedent for modern architecture, construction, and design within the downtown.

Large-scale, mixed-use buildings may be appropriate for future redevelopment of primary corner sites along West and East Broadway.

Small-scale, mixed-use buildings may be appropriate for future redevelopment of mid-block infill sites along West and East Broadway.

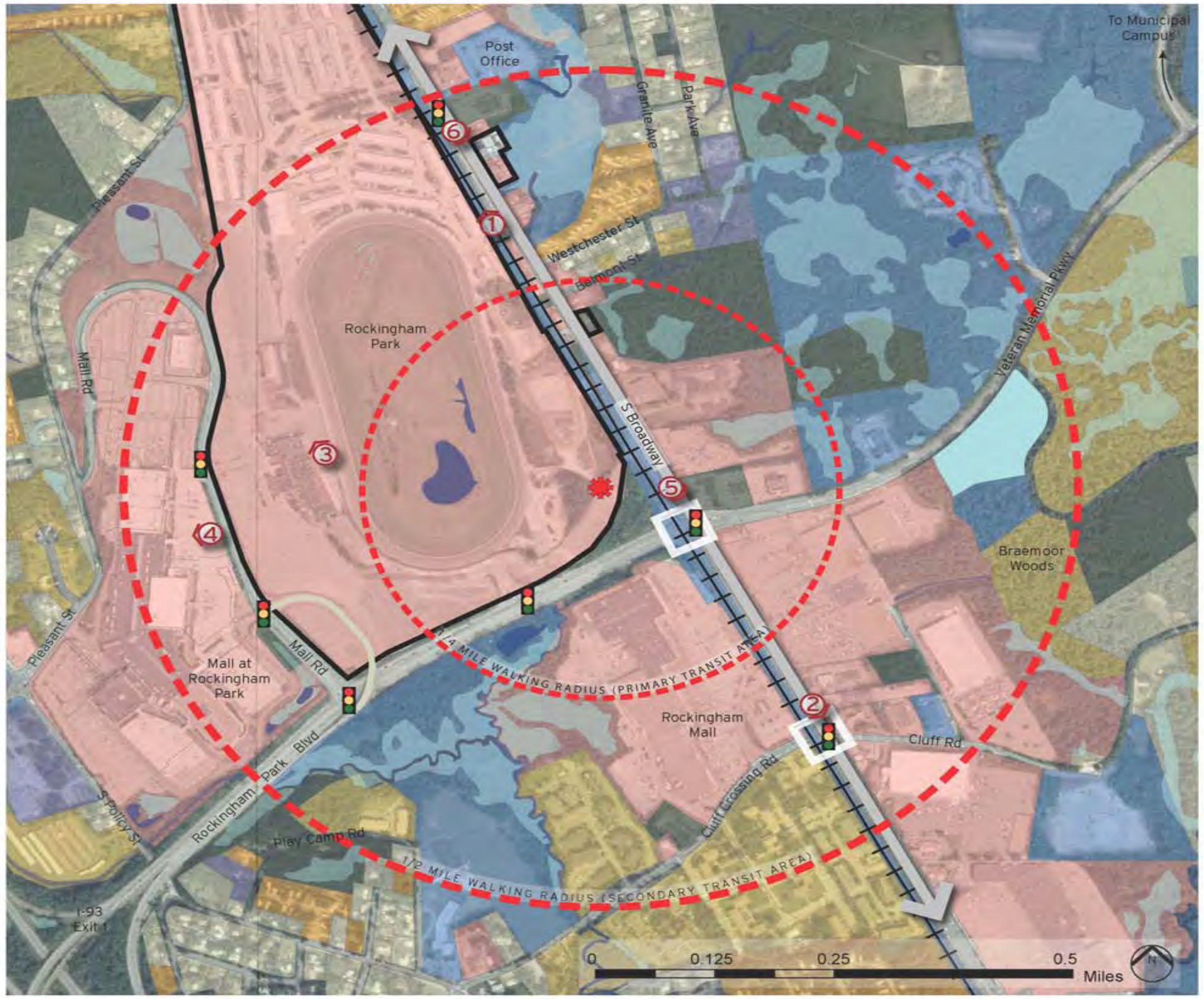
Townhouses may be appropriate for future multi-family redevelopment sites within a five-minute walking distance of the proposed train station.

Additional streetscape improvements, such as regularly spaced street trees and landscape planters, could enhance the pedestrian-friendly atmosphere along West Broadway.

A more defined pedestrian realm with street trees, sidewalks, landscaping, and minimal building setbacks would provide a pedestrian-friendly atmosphere along Crystal Avenue.

Figure 40

I-93 TRANSIT STUDY: STATION AREA OPPORTUNITIES AND CONSTRAINTS
Salem, NH - I-93 Commuter Rail Station Alternative



EXISTING LAND USE LEGEND

- Single Family
- Multi-Family
- Mobile Home
- Commercial
- Light Industrial
- Public/Institution
- Open Space/ Recreation
- Forested
- Agriculture
- Vacant
- Water
- Wetland

OPPORTUNITIES AND CONSTRAINTS LEGEND

- Potential Commuter Rail Station
- Potential Commuter Rail Corridor
- Signalized Intersection
- Auto-Oriented Streetscape
- Future Redevelopment Opportunity Site
- Station Area Photos
- Potential At-Grade Railroad Crossing

General Station Area Comments:

- Future commuter rail service and a station along South Broadway north of Rockingham Park Boulevard could be utilized as a catalyst for the redevelopment of the Rockingham Park Racetrack into a mixed-use commercial, residential, and entertainment district.
- The existing auto-oriented street network within the proposed station area would require significant improvements, such as a landscaped boulevard environment for South Broadway, to create a transit supportive environment that encourages pedestrian activity.
- There are several underutilized properties along South Broadway that contain aging buildings and site improvements that do not represent a high quality business district, and may provide future redevelopment opportunities for more modern commercial uses.

General Station Area Analysis

1 The inactive Manchester & Lawrence railroad alignment traverses the station area and provides an opportunity for future commuter rail service and transit-oriented development if current access and land use constraints could be overcome.

2 Regional shopping malls and big-box retailers have established an auto-oriented highway environment along South Broadway that presents significant access and land use constraints for future commuter rail service.

3 Rockingham Park Racetrack was a vibrant entertainment land use in the heyday of horse racing as an America pastime. Rockingham Park may have significant redevelopment potential in the future as a mixed-use regional center with transit supportive land uses.

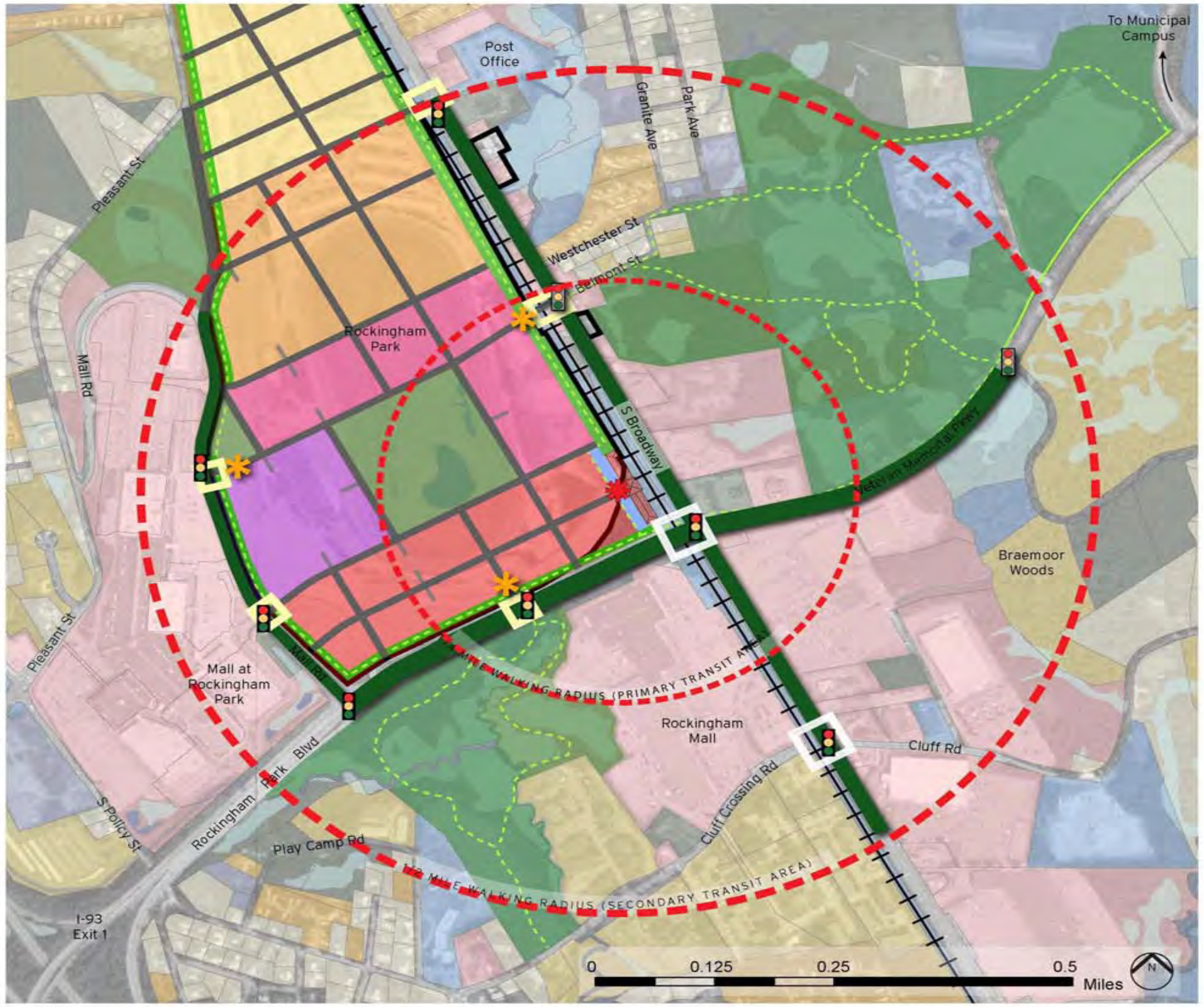
4 The Mall at Rockingham Park is a regional suburban mall that is adjacent to I-93 Exit 1 and auto-oriented in nature. Depending on the racetrack's future use, the Mall could be unified to the racetrack site with new mixed uses and pedestrian paths.

5 The intersection of South Broadway and Rockingham Park Boulevard is designed for auto-accessibility to I-93 and the area's regional shopping destinations. The area's auto-oriented environment would not be transit supportive without new pedestrian amenities.

6 Aging commercial developments adjacent to new modern developments along South Broadway indicate the potential for future commercial redevelopment that would create a more unified commercial corridor.

Figure 41

I-93 TRANSIT STUDY: STATION AREA PLAN RECOMMENDATIONS
Salem, NH - I-93 Commuter Rail Station Alternative



PROPOSED RECOMMENDATIONS LEGEND

- Potential Commuter Rail Station
- Potential Commuter Rail Corridor
- Signalized Intersection
- Future Redevelopment Opportunity Site
- Potential At-Grade Railroad Crossing
- Proposed Signalized Intersection
- Proposed Pedestrian Crossing Improvement
- Mixed-Use "Main Street" District
- Office, Hotel or Entertainment
- Mixed-Use Commercial with Residential
- Multi-Family Residential
- Single-Family Residential
- Proposed Open Space
- Proposed Boulevard-Type Streetscape Improvements
- Proposed Open Space Buffer
- Proposed Street Network
- Proposed Gateway Feature
- Existing Bike Path
- Proposed Bike Path

EXISTING LAND USE LEGEND

- Single Family
- Multi-Family
- Mobile Home
- Commercial
- Light Industrial
- Public/ Institution
- Open Space/ Recreation
- Forested
- Gravel Pits and Quarry
- Vacant
- Water
- Wetland

General Station Area Recommendations:

- Based on Salem's 2001 Master Plan, a future land use alternative for the Rockingham Park Racetrack could be the creation of a new pedestrian-oriented downtown district with mixed uses, including retail, office, entertainment, hotel, convention center, and housing.
- The proposed commuter rail station at the M&L railroad could be sited adjacent to a pedestrian-oriented downtown district within the Rockingham Park Racetrack site and provide a highly integrated transit-supportive environment.
- A network of multi-use paths could provide an alternative to access the proposed train station, unify a new downtown district at the Rockingham Park Racetrack, and connect the area's natural open spaces as a recreational amenity.

Future Development Examples


A pedestrian-friendly downtown district at the racetrack site could provide new opportunities for local and regional residents to live, work, shop, and visit.


A recent evolution in retail development is the "lifestyle" center that provides mixed uses in a pedestrian-friendly downtown environment.


The racetrack site would be appropriate for new multi-family residential uses, such as condominiums, lofts, or apartments, which are connected with a downtown district.

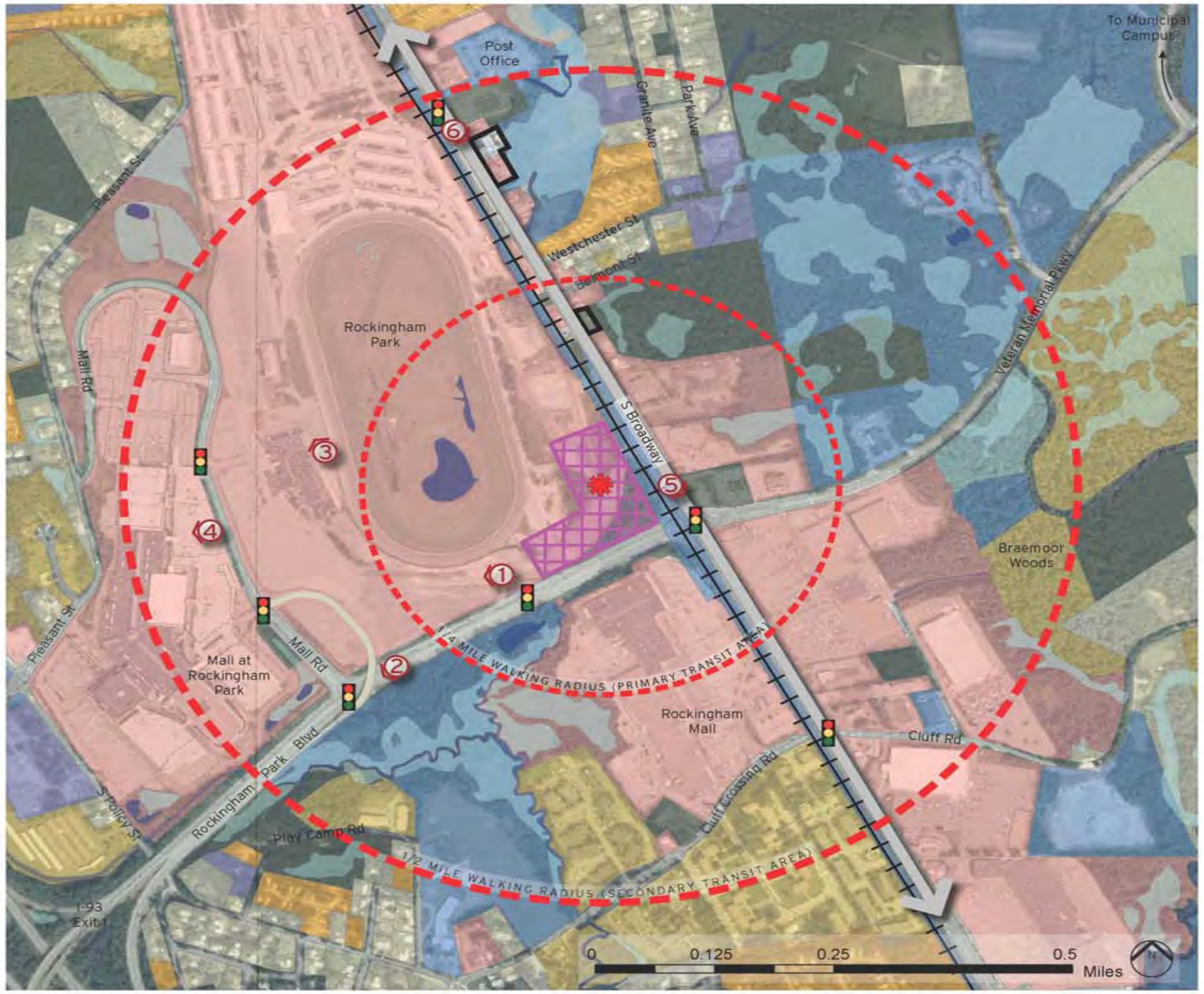

Townhouses would be another appropriate multi-family residential use at the racetrack site, and could be connected with a downtown district.


Multi-use paths could be constructed for recreational and transportation purposes throughout the station area and with the area's natural open spaces.

A portion of the Rockingham Park Racetrack could serve as a major public park or "village green" within a mixed-use downtown district.

Figure 42

I-93 TRANSIT STUDY: STATION AREA OPPORTUNITIES AND CONSTRAINTS
Salem, NH - I-93 Bus Station with Park & Ride Alternative



EXISTING LAND USE LEGEND

- Single Family
- Multi-Family
- Mobile Home
- Commercial
- Light Industrial
- Public/Institution
- Open Space/ Recreation
- Forested
- Agriculture
- Vacant
- Water
- Wetland

OPPORTUNITIES AND CONSTRAINTS LEGEND

- Potential Bus Station
- Potential Park & Ride Lot
- Signalized Intersection
- Auto-Oriented Streetscape
- M&L Railroad corridor
- Future Redevelopment Opportunity Site
- Station Area Photos

General Station Area Comments:

- A future I-93 bus station and park-and-ride lot could potentially be located within an underutilized portion of the Rockingham Park Racetrack, which would require an appropriate lease agreement between the property owner and the NHDOT.
- A future I-93 bus station would have a minimal impact on future land uses, but nevertheless could be connected with adjacent land uses through pedestrian and bike paths and amenities.
- The Rockingham Park Racetrack may remain as an entertainment land use. Alternatively, the Racetrack could serve as a future mixed-use commercial, residential, and entertainment district.

General Station Area Analysis

Underutilized land within the Rockingham Park Racetrack property could potentially serve as a future location for an I-93 station and park & ride lot. The best options exist along Rockingham Park Boulevard, which is a secondary park entrance.

Rockingham Park Boulevard could serve as the primary access route to and from I-93 and the potential location for a bus park-and-ride lot. This location is approximately three-quarters of a mile from the I-93 interchange.

Rockingham Park Racetrack was a vibrant entertainment land use in the heyday of horse racing as an America pastime. Rockingham Park may have significant redevelopment potential in the future as a mixed-use regional center with transit supportive land uses.

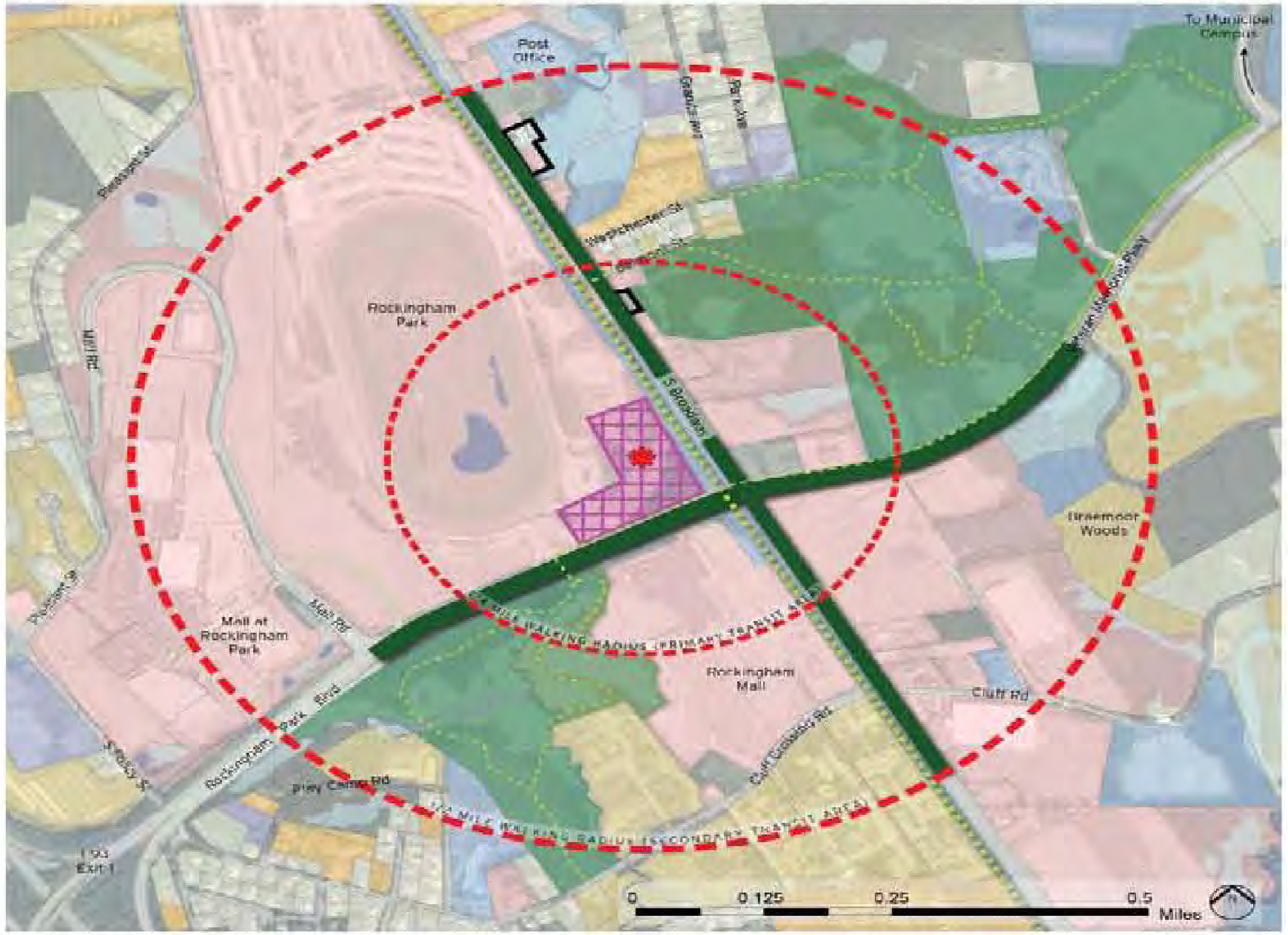
The Mall at Rockingham Park is a regional suburban mall that is adjacent to I-93 Exit 1 and auto-oriented in nature. Depending on the racetrack's future use, the Mall could be unified to the racetrack site with new mixed uses and pedestrian paths.

The intersection of South Broadway and Rockingham Park Boulevard is designed for auto-accessibility to I-93 and the area's regional shopping destinations. The area's auto-oriented environment would not be transit supportive without new pedestrian amenities.

Aging commercial developments are adjacent to new modern developments along South Broadway, indicate the potential for future commercial redevelopment that would create a more unified commercial corridor.

Figure 43

I-93 TRANSIT STUDY: STATION AREA PLAN RECOMMENDATIONS
Salem, NH - I-93 Bus Station with Park & Ride Alternative



PROPOSED RECOMMENDATIONS LEGEND

- Proposed Bus Station
- Proposed Park & Ride Lot
- Future Redevelopment Opportunity Site
- Proposed Public Open Space
- Proposed Boulevard Type Streetscape Improvements
- Proposed Rails-to-Trail Path
- Proposed Multi Use Path

EXISTING LAND USE LEGEND

- Single Family
- Multi-Family
- Mobile Home
- Commercial
- Light Industrial
- Public/Institution
- Open Space/Recreation
- Forested
- Gravel Pits and Quarry
- Vacant
- Water
- Wetland

General Station Area Comments:

- A bus station and park-and-ride could be considered within the Rockingham Park Racetrack site due to its proximity to I-93 Exit 1 and its visibility from Rockingham Park Boulevard.
- Rockingham Park Boulevard and South Broadway could be reconstructed in the future to appear as landscaped boulevards with medians, sidewalks, and street trees.
- A network of multi-use paths could provide a transportation alternative for accessing the proposed bus station and connect the area's natural open spaces as a recreational amenity.

General Station Area Analysis

The new bus station constructed at the I-93 Exit 4 park-and-ride lot is a bus station prototype that could be used for the proposed I-93 Exit 1 park-and-ride lot.

New boulevard-type streetscape improvements with a landscaped median could provide an appealing "gateway" corridor along Rockingham Park Boulevard.

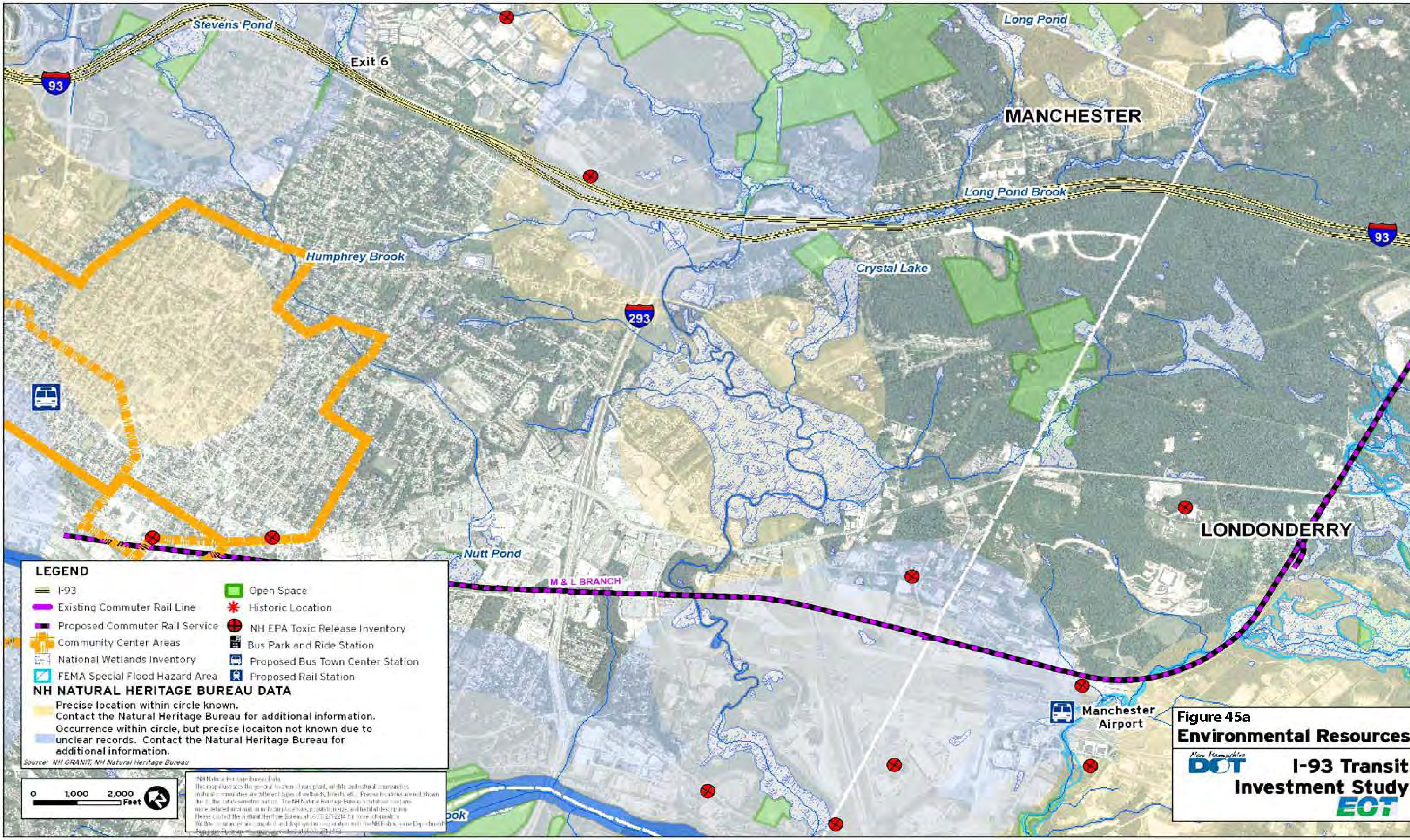
New boulevard-type streetscape improvements with a landscaped median could provide a more visually appealing and unified business environment along South Broadway.

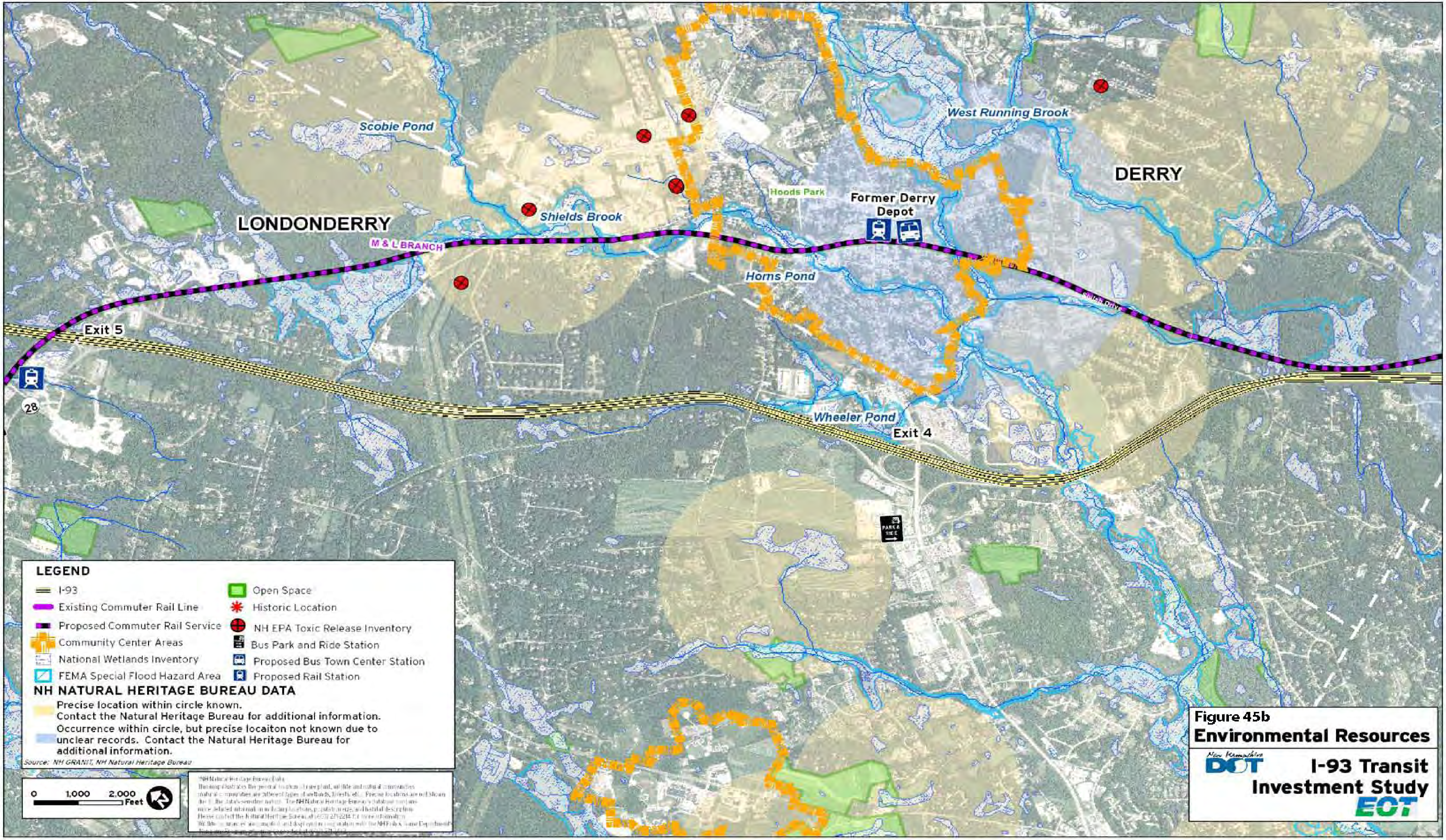
New streetscape improvements along South Broadway could include new street trees, sidewalks, and crosswalks in order to provide a more pedestrian-friendly environment.

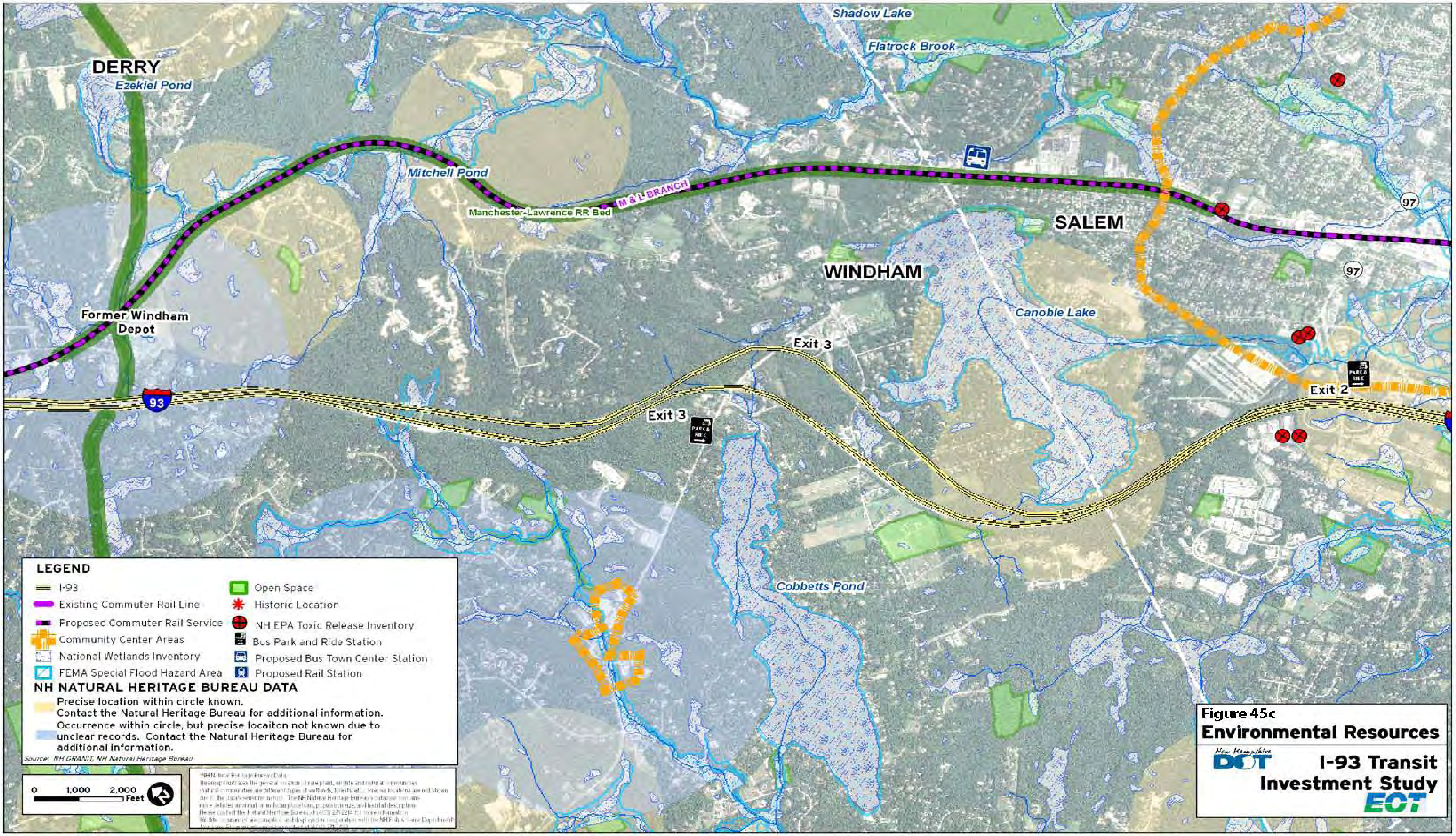
Site development standards could be improved so that new developments provide parking lot landscaping and streetscape amenities, such as sidewalks and pedestrian lights.

Recreational multi-use paths could be constructed through the area's natural open spaces that cannot be developed based on environmental constraints, such as streams or wetlands.

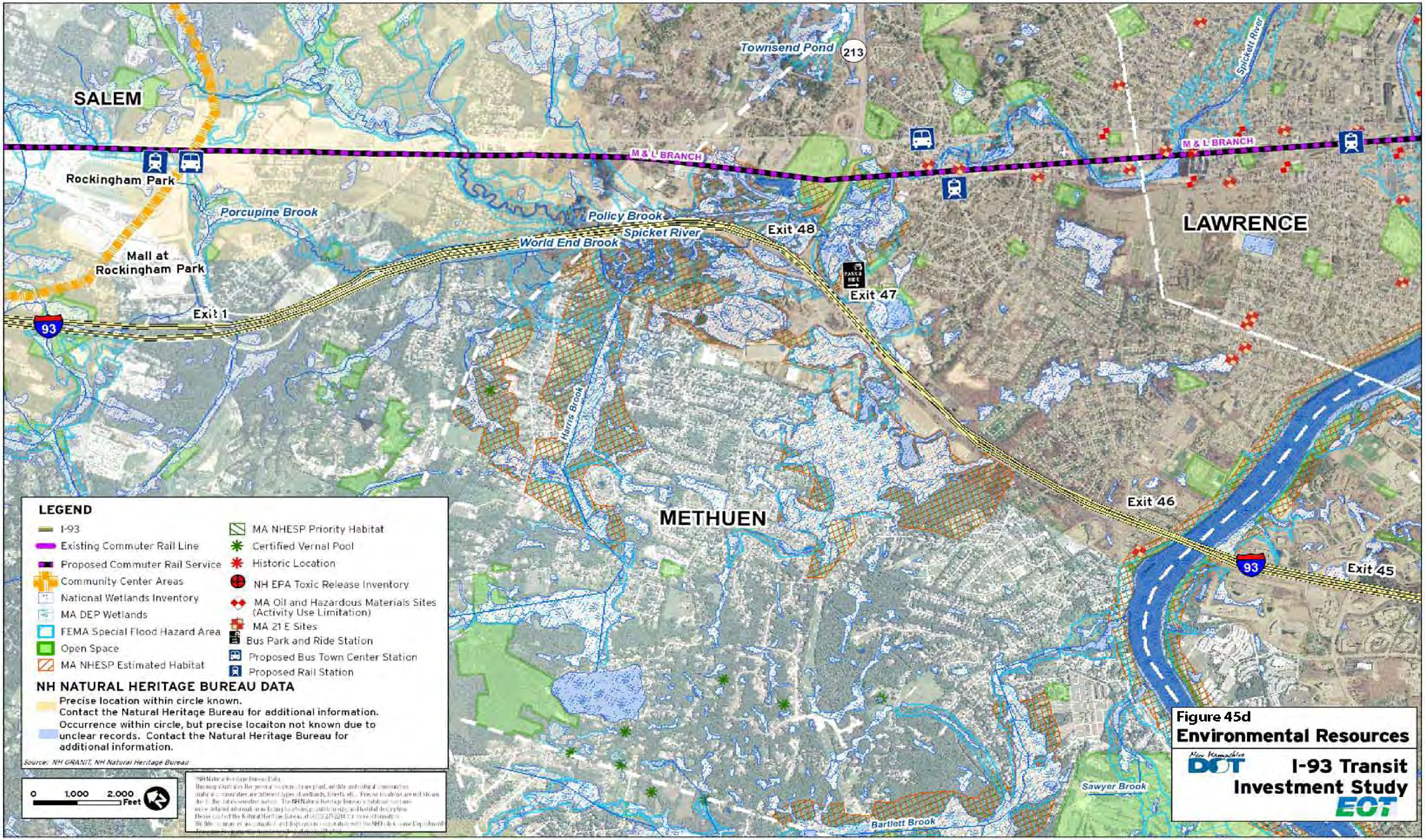
Figure 44


Stevens Pond
Exit 6
93
MANCHESTER
Long Pond
Long Pond Brook
Humphrey Brook
Crystal Lake
293
Nutt Pond
M & L BRANCH
LONDONDERRY
Manchester Airport
LEGEND
I-93
Existing Commuter Rail Line
Proposed Commuter Rail Service
Community Center Areas
National Wetlands Inventory
FEMA Special Flood Hazard Area
Open Space
Historic Location
NH EPA Toxic Release Inventory
Bus Park and Ride Station
Proposed Bus Town Center Station
Proposed Rail Station
NH NATURAL HERITAGE BUREAU DATA
Precise location within circle known.
Contact the Natural Heritage Bureau for additional information.
Occurrence within circle, but precise locaiton not known due to
unclear records. Contact the Natural Heritage Bureau for
additional information.
Source: NH GRANIT, NH Natural Heritage Bureau
0 1,000 2,000 Feet
Figure 45a
Environmental Resources
I-93 Transit
Investment Study

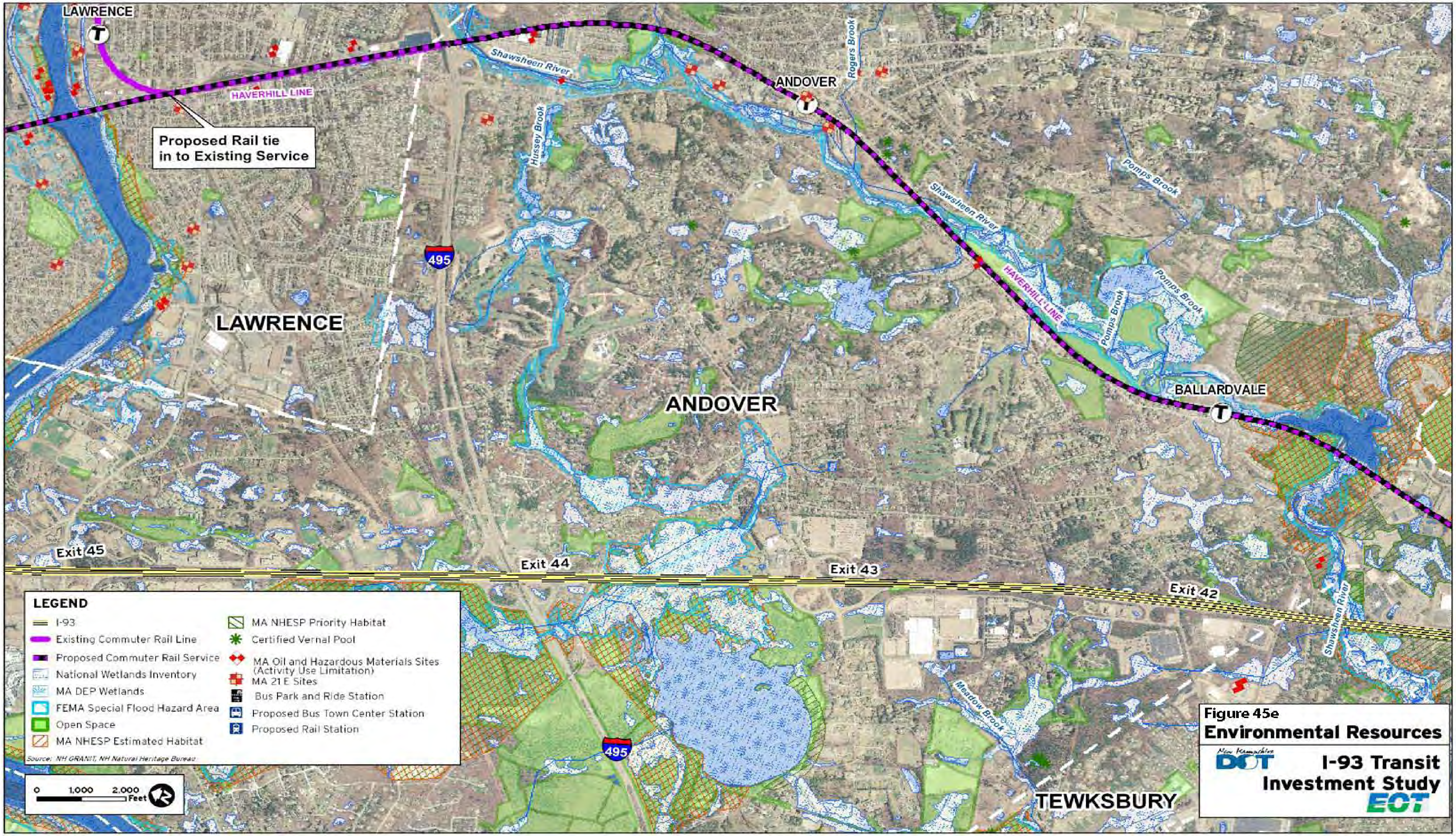

Scobie Pond
West Running Brook
DERRY
LONDONDERRY
Shields Brook
Hoods Park
Former Derry Depot
M & L BRANCH
Horns Pond
Exit 5
28
Wheeler Pond
Exit 4
LEGEND
I-93
Existing Commuter Rail Line
Proposed Commuter Rail Service
Community Center Areas
National Wetlands Inventory
FEMA Special Flood Hazard Area
Open Space
Historic Location
NH EPA Toxic Release Inventory
Bus Park and Ride Station
Proposed Bus Town Center Station
Proposed Rail Station
NH NATURAL HERITAGE BUREAU DATA
Precise location within circle known. Contact the Natural Heritage Bureau for additional information.
Occurrence within circle, but precise locaiton not known due to unclear records. Contact the Natural Heritage Bureau for additional information.
Source: NH GRANIT, NH Natural Heritage Bureau
0 1,000 2,000 Feet
Figure 45b
Environmental Resources
I-93 Transit Investment Study

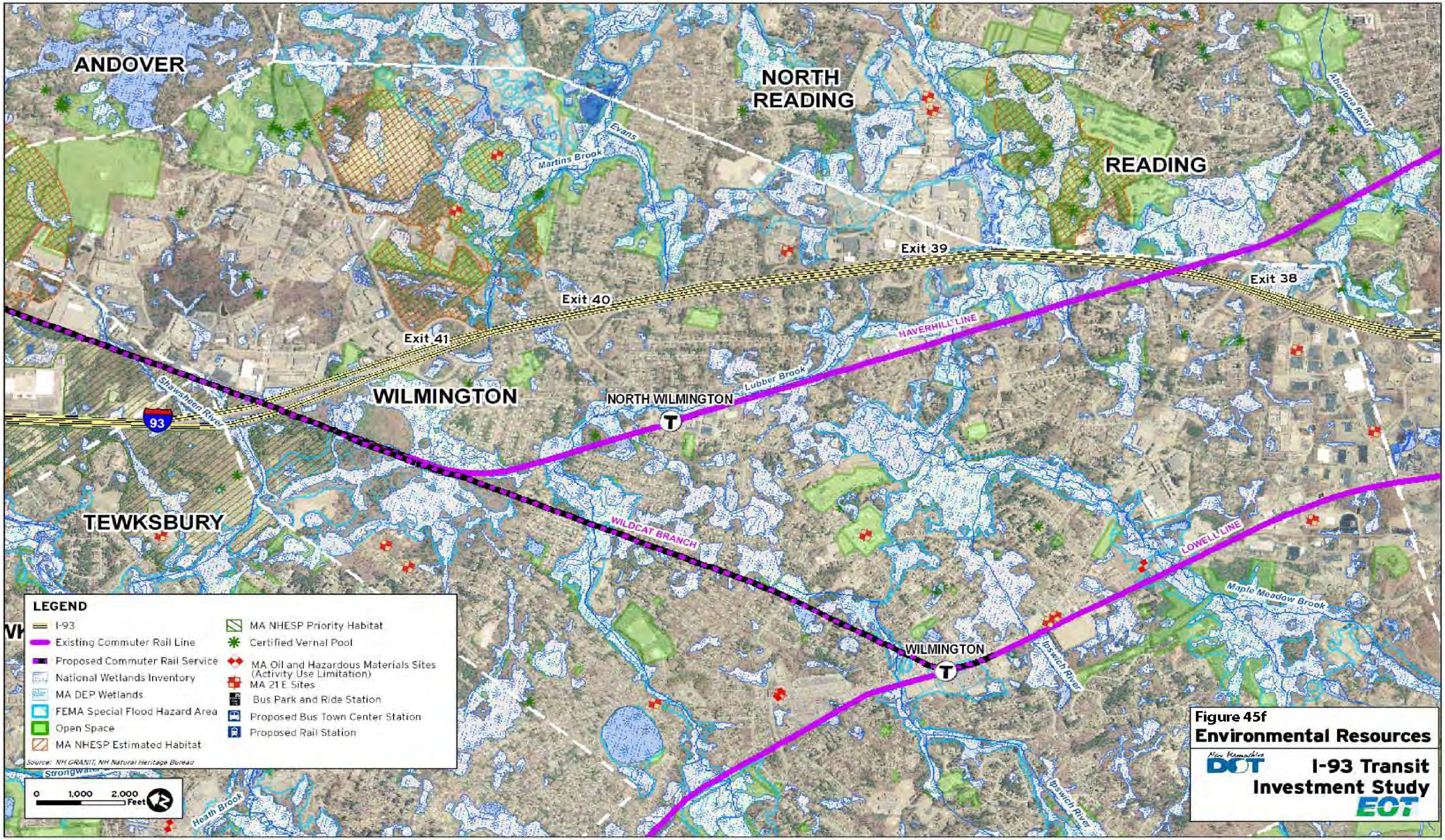


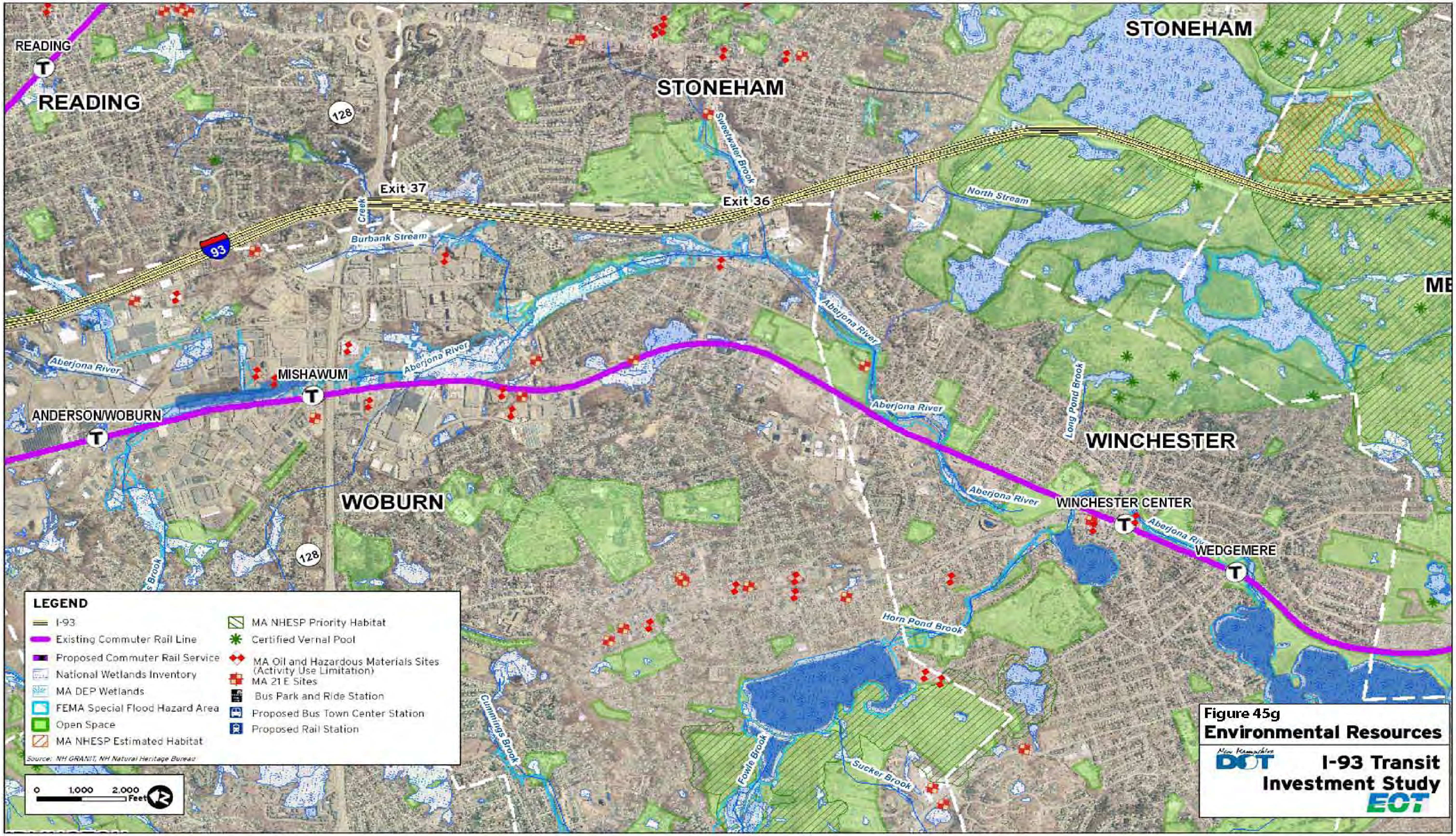
DERRY
Ezekiel Pond
Shadow Lake
Flatrock Brook
Mitchell Pond
M & L BRANCH
Manchester-Lawrence RR Bed
SALEM
WINDHAM
Former Windham Depot
Canobie Lake
Exit 3
Exit 3
Exit 2
93
97
97
Cobbetts Pond
LEGEND
I-93
Existing Commuter Rail Line
Proposed Commuter Rail Service
Community Center Areas
National Wetlands Inventory
FEMA Special Flood Hazard Area
Open Space
Historic Location
NH EPA Toxic Release Inventory
Bus Park and Ride Station
Proposed Bus Town Center Station
Proposed Rail Station
NH NATURAL HERITAGE BUREAU DATA
Precise location within circle known. Contact the Natural Heritage Bureau for additional information.
Occurrence within circle, but precise locaiton not known due to unclear records. Contact the Natural Heritage Bureau for additional information.
Source: NH GRANIT, NH Natural Heritage Bureau
0 1,000 2,000 Feet
Figure 45c
Environmental Resources
I-93 Transit Investment Study

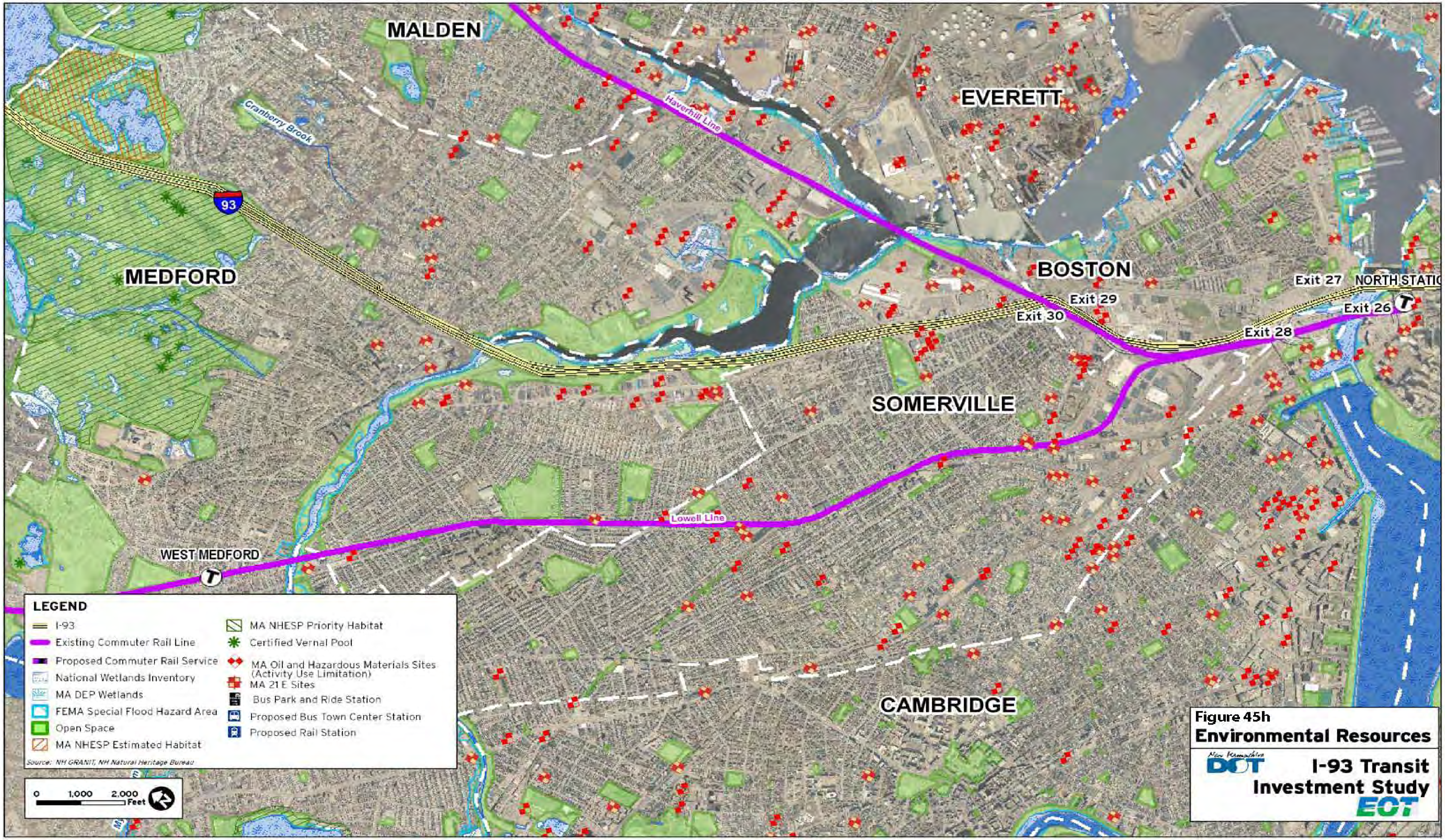


SALEM
Rockingham Park
Mall at Rockingham Park
Porcupine Brook
Policy Brook
World End Brook
Spicket River
Townsend Pond
213
M & L BRANCH
Exit 48
Exit 47
Exit 1
93
LAWRENCE
Spickett River
Harris Brook
METHUEN
Exit 46
Exit 45
Sawyer Brook
Bartlett Brook
LEGEND
I-93
Existing Commuter Rail Line
Proposed Commuter Rail Service
Community Center Areas
National Wetlands Inventory
MA DEP Wetlands
FEMA Special Flood Hazard Area
Open Space
MA NHESP Estimated Habitat
MA NHESP Priority Habitat
Certified Vernal Pool
Historic Location
NH EPA Toxic Release Inventory
MA Oil and Hazardous Materials Sites (Activity Use Limitation)
MA 21 E Sites
Bus Park and Ride Station
Proposed Bus Town Center Station
Proposed Rail Station
NH NATURAL HERITAGE BUREAU DATA
Precise location within circle known. Contact the Natural Heritage Bureau for additional information.
Occurrence within circle, but precise locaiton not known due to unclear records. Contact the Natural Heritage Bureau for additional information.
Source: NH GRANIT, NH Natural Heritage Bureau
0 1,000 2,000 Feet
Figure 45d
Environmental Resources
DOT
I-93 Transit Investment Study
EOT


LAWRENCE
HAVERHILL LINE
Proposed Rail tie in to Existing Service
Shawsheen River
ANDOVER
Rogers Brook
Hussey Brook
Pomps Brook
495
LAWRENCE
ANDOVER
BALLARDVALE
Exit 45
Exit 44
Exit 43
Exit 42
Meadow Brook
TEWKSBURY
LEGEND
I-93
Existing Commuter Rail Line
Proposed Commuter Rail Service
National Wetlands Inventory
MA DEP Wetlands
FEMA Special Flood Hazard Area
Open Space
MA NHESP Estimated Habitat
MA NHESP Priority Habitat
Certified Vernal Pool
MA Oil and Hazardous Materials Sites (Activity Use Limitation)
MA 21 E Sites
Bus Park and Ride Station
Proposed Bus Town Center Station
Proposed Rail Station
Source: NH GRANIT, NH Natural Heritage Bureau
0 1,000 2,000 Feet
Figure 45e
Environmental Resources
I-93 Transit Investment Study


ANDOVER
NORTH READING
READING
WILMINGTON
TEWKSBURY
Martins Brook
Evans
Aberjona River
Exit 39
Exit 38
Exit 40
Exit 41
HAVERHILL LINE
Lubber Brook
NORTH WILMINGTON
Shawsheen River
93
WILDCAT BRANCH
LOWELL LINE
Maple Meadow Brook
WILMINGTON
Ipswich River
Heath Brook
LEGEND
I-93
Existing Commuter Rail Line
Proposed Commuter Rail Service
National Wetlands Inventory
MA DEP Wetlands
FEMA Special Flood Hazard Area
Open Space
MA NHESP Estimated Habitat
MA NHESP Priority Habitat
Certified Vernal Pool
MA Oil and Hazardous Materials Sites (Activity Use Limitation)
MA 21E Sites
Bus Park and Ride Station
Proposed Bus Town Center Station
Proposed Rail Station
Source: NH GRANIT, NH Natural Heritage Bureau
0 1,000 2,000 Feet
Figure 45f
Environmental Resources
I-93 Transit Investment Study
New Hampshire DOT
EOT


READING
STONEHAM
WINCHESTER
WOBURN
MISHAWUM
ANDERSON/WOBURN
WINCHESTER CENTER
WEDGEMERE
Exit 37
Exit 36
Burbank Stream
Aberjona River
North Stream
Sweetwater Brook
Long Pond Brook
Horn Pond Brook
Sucker Brook
Fowle Brook
Cummings Brook
LEGEND
I-93
Existing Commuter Rail Line
Proposed Commuter Rail Service
National Wetlands Inventory
MA DEP Wetlands
FEMA Special Flood Hazard Area
Open Space
MA NHESP Estimated Habitat
MA NHESP Priority Habitat
Certified Vernal Pool
MA Oil and Hazardous Materials Sites (Activity Use Limitation)
MA 21 E Sites
Bus Park and Ride Station
Proposed Bus Town Center Station
Proposed Rail Station
Source: NH GRANIT, NH Natural Heritage Bureau
0 1,000 2,000 Feet
Figure 45g
Environmental Resources
I-93 Transit Investment Study


MALDEN
EVERETT
MEDFORD
BOSTON
SOMERVILLE
CAMBRIDGE
WEST MEDFORD
Cranberry Brook
Haverhill Line
Lowell Line
93
Exit 26
Exit 27
Exit 28
Exit 29
Exit 30
NORTH STATIO
LEGEND
I-93
Existing Commuter Rail Line
Proposed Commuter Rail Service
National Wetlands Inventory
MA DEP Wetlands
FEMA Special Flood Hazard Area
Open Space
MA NHESP Estimated Habitat
MA NHESP Priority Habitat
Certified Vernal Pool
MA Oil and Hazardous Materials Sites (Activity Use Limitation)
MA 21E Sites
Bus Park and Ride Station
Proposed Bus Town Center Station
Proposed Rail Station
Source: NH GRANIT, NH Natural Heritage Bureau
0 1,000 2,000 Feet
Figure 45h
Environmental Resources
I-93 Transit Investment Study

A comprehensive review of local zoning ordinances and recommendations for implementing transit support zoning and transit oriented development within the study area is outlined in Appendix E. Reinstitution of railroad service on unused portions of the M&L Branch would affect both the existing and planned future use of the corridor as a bike path and trail and land uses in close proximity to the right-of-way.

Existing Land Uses and Zoning

The following provides a brief overview of existing land uses, trail uses, and zoning patterns. For a more detailed review of zoning ordinances and recommendations for implementing transit-supportive zoning, refer to Appendix E. Since the rail corridor alternative will involve greater impacts on land uses than the Bus on Shoulder alternative, the following discussion of existing conditions focuses primarily on the railroad corridor. The Bus on Shoulder improvements would largely be contained within the I-93 right-of-way and would largely occupy existing paved area. The discussion below focuses on the largely unused portions of the M&L Branch, since the improvements in Massachusetts along the West Route Main Line, Haverhill Line and Wildcat Branch would occur along active passenger and freight rail corridors. It is assumed that there is adequate right-of-way where the Haverhill Line and Wildcat Branch will be double-tracked, to accommodate the proposed rail improvements. Those portions of the M&L Branch extending from Londonderry Exit 5 to the junction with the Haverhill Line in Lawrence that are largely unused or accommodate light freight use (in Lawrence) are described below, from north to south. Appendix B provides a more extensive discussion, with aerial photographs, of the condition of the M&L Branch and the estimated cost of rebuilding it for rail service.

Londonderry

The I-93 and railroad corridors in Londonderry south of Exit 5 are relatively undeveloped, with the exception of development clustered around road crossings. The proposed station site (both for the bus park and ride station and rail station alternatives) would be located at the existing Exit 5 park and ride/bus terminal. The town center station for the bus transit option would be located at the Manchester-Boston Regional Airport, located northwest of Exit 5. Industrial and commercial development are clustered around Exit 5 off Route 28 (Rockingham Road), and adjoining parcels include undeveloped, underutilized properties. Industrial development along Liberty and Independence Drive extends along the right-of-way, east of I-93. South of Independence Drive, the M&L Branch right-of-way extends through primarily undeveloped lands, until it approaches industrial development along Commercial Lane. The next road crossing is at Route 28 (Rockingham Road) at the south end of town, which includes residential development and commercial buildings.

Portions of the M&L Branch right-of-way are owned by private interests in Londonderry. Delaware Rock, Inc., a developer, owns the 1.6 miles of right-of-way extending south of Route 28 to High Street in Derry. There is no apparent requirement for the owner to maintain the transportation use along the corridor. The Route 28 corridor in Londonderry and areas east of the M&L Branch, south of Exit 5, are zoned for commercial and industrial uses, and the remainder of Londonderry along both the M&L and I-93 project corridors is zoned for agricultural and residential uses.

In Londonderry, 3.3 miles of the M&L Branch right-of-way is used as a recreational trail and is part of the Manchester/Lawrence Recreational Trail maintained by the New Hampshire Trails Bureau.

Derry

In Derry, the M&L Branch extends through more densely clustered commercial and residential development along B Street, the Franklin Street Extension and North High Street in the north part of town. Along and west of North High Street, the railroad embankment extends under a lawn for an apartment complex, posted with no trespassing signs. This portion of the right-of-way is privately owned, with no provision to maintain the railroad corridor for potential transportation reuse. The Town of Derry owns the M&L Branch right-of-way south of High Street to the Windham Town line. The Town's agreement with the State requires that a 30-foot corridor be protected for future transportation use unless otherwise approved by the State. The railroad embankment extends between Hoods Pond and Horns Pond in Hood Park. In downtown Derry, the right-of-way extends in close proximity to businesses and residences on the western side of town. Portions of the right-of-way were paved over with construction of roads and sidewalks extending over the railbed. The railroad extends through the heart of the downtown business district in Derry, and passes by the Derry Depot, currently occupied by a restaurant, that was purchased by the Town of Derry in 1999. According to the town's 2001 Master Plan, reuse options for the depot were being evaluated by the town. Portion of the right-of-way in Derry are owned by the Town of Derry and private owners. The remainder of the corridor in Derry extends through primarily residential areas. In the developed areas of Derry, the right-of-way extends under parking areas, sidewalks, access roadways, and lawns. South of downtown Derry, where the right-of-way extends along Chelmsford Hardy Place, it adjoins a town-owned baseball field, the O'Hara Memorial Field. Land use patterns follow zoning, with commercial zoning in downtown Derry on the west side of town and residential zoning through the remainder of the corridor to the southeast. The area in the southernmost portion, where the railroad and I-93 corridors converge, includes industrial zoning. This area of town is relatively undeveloped and includes a few scattered businesses along Windham Road, approaching the Windham town line.

South of where the right-of-way extends between residences along Shilah Drive and Pelican Circle, south of Kendall Pond Road, the M&L Branch right-of-way extends through wooded, undeveloped lands. This section, less than 2 miles in length, crosses over Bowers Road, and extends into Windham.

The M&L Branch right-of-way accommodates a bike trail in Derry south of Hood Park. The railroad right-of-way is barricaded with metal guardrail south of where it extends on embankment between Horns Pond and Hood Pond at Hood Park. South of this point, bike trail signs extend along the right-of-way where it extends toward downtown Derry. The railroad corridor is paved south of the Derry Depot for less than a mile to Kendall Pond Road as part of the Derry Bike Path that loops in the downtown area. Plans are underway by the Derry Rail Trail Alliance to pave the remainder of the railbed to connect to the Windham Bike Path, 3.6 miles to the south. In Derry, the I-93 corridor extends through relatively undeveloped lands in the southwest corner of town. The potential BOS park and ride station facilities would be located at the existing park-ride facility at Exit 4, and a town center station would be located on Broadway near Railroad Avenue.

Windham

Both the I-93 and the M&L Branch railroad right-of-way in Windham extend through areas that are predominantly rural. The proposed facilities for the bus transit option would be located at the existing park-ride facility at I-93 Exit 3, and the town center station would be located within the commercial zone at the south end of town on Route 28 (North Broadway) and Lake Street.

At the north end of Windham, the M&L path crosses over North Lowell Road/Windham Road and Depot Road, in the area of town named for the former train stop, Windham Depot. This area includes small businesses, including a gas station adjoining the start of the paved section of the Windham Rail Trail, and is zoned for Neighborhood Businesses. The former Windham Depot, adjoining the south side of Depot Road, is used for storage by the Windham Department of Public Works. The remainder of the right-of-way extends through undeveloped rural areas, extending by a few residential neighborhoods in a few locations, but the next road crossing is at Roulston Road, near the Salem Town Line. Areas along Route 28 approaching Salem and Canobie Lake are zoned for Professional, Business, Technical uses and Commercial zoning extends along Route 28.

The State of New Hampshire owns the right-of-way from the Derry Town line to the Massachusetts state line, but has granted the Town of Windham rights to construct and maintain a multi-use trail within the Town of Windham. The area south of North Lowell Road is part of the Windham Rail Trail, a paved bike trail that extends most of the 4.24 miles through Windham.

Salem

In Salem, most of the 5.11 miles of the M&L Branch right-of-way extends adjacent to, and in close proximity to, the Route 28 commercial corridor. Along the northern roughly 1-mile section of the right-of-way, the west side of Route 28 adjoins residential areas that are largely shielded from view by forest vegetation, and the east side includes businesses and commercial uses. The remaining section of the railroad right-of-way adjoins predominantly commercial development, including a number of retail outlets, shopping malls, services, and other strip development along Route 28. Route 28 is North Broadway in the north part of town becomes South Broadway south of Route 97 (Main Street). At Route 97, buildings, including the former depot, have been constructed in close proximity to the right-of-way (see photo below). The proposed station site is located at Rockingham Park, which accommodates seasonal (spring/summer) harness racing, on Rockingham Park Boulevard.

The I-93 corridor parallels Route 28 to the west, extending through areas that are somewhat less developed than the Route 28 corridor. The proposed bus facilities would be located at the existing park-ride facility at Exit 2, and the town center station would be located at Rockingham Park.

The land use patterns roughly follow the zoning in Salem. The area west of Route 28 and north of Route 97 (Main Street) is zoned for residential use. The remainder of the Route 28 corridor is zoned for commercial/industrial uses.

Much of the railroad trackage is in place in Salem, with the exception of the grade crossings. There are at least 16 roadway crossings or private drives in Salem, some of which include crossing up to nine lanes of traffic (Rockingham Park Boulevard). Many of these crossing roadways intersect Route 28 in close proximity to the tracks. Several of these are entrances for Rockingham Park from Route 28 (see photograph above). There is no recreational use on this section of the M&L Branch.

Methuen

Just south of the New Hampshire border, the railroad right-of-way adjoins property for the Greater Lawrence Educational Collaborative located on Route 28 (Broadway). In Methuen, the northern portion of the M&L Branch right-of-way extends through conservation areas along the Spicket River, west of commercial uses along the Route 28. A parcel owned by the Massachusetts Society for the Prevention of Cruelty to Animals that houses the Nevins Farm Animal Care and Adoption Center is north of Route 213, and the city-owned Nevins Bird Sanctuary extends south of Route 213 to the Spicket River. South of the Spicket River, the railroad extends through a mix of commercial and residential areas before entering the Methuen central business district. The proposed rail station is located at the five-way intersection of Railroad Street with Route 113 (Lowell Street), and Pelham Street/Osgood Street. This location is north of the former depot along Railroad Street, which is being used as an office. The intersection includes the fire station, church and preschool, a gas station, and other businesses. South of the proposed rail station, the railroad right-of-way extends through residential neighborhoods and commercial areas, before extending by the Gill Avenue playground on Railroad Avenue and a cemetery on the west side and the Spicket River and industrial uses on the east. The Gill Avenue playground includes ballfields and playground area and is separated from the railroad right-of-way by Railroad Avenue.

Land use patterns follow zoning, with business district zoning on the north end of the city and conservancy zoning along the Spicket River. Where the railroad extends through the downtown area, zoning is for Central Business District on the east and residential zoning on the west. South of downtown, both sides of the railroad are zoned for residential uses. The cemetery area is zoned for conservancy uses, on the west side of the railroad, and the east side is industrially zoned in the south end of the city.

The tracks are in place along the Methuen portion of the railroad right-of-way, although vegetation growth has occurred since the rail line has not been in use in the past several years.

The I-93 corridor also extends over the Spicket River and through developed portions of Methuen. The proposed bus facility improvements at Exit 47 (Pelham Street) would be located at an existing park and ride facility, and the town center station would be located within downtown Methuen in the residential neighborhood at Broadway and High.

Lawrence

On the north end of Lawrence, the railroad right-of-way extends east of the cemetery and west of the Sergeant Lucien Bourgoin Playground and the Lawrence Family Development Charter School. The Sergeant Lucien Bourgoin Playground includes ballfields and playground area and adjoins the right-of-way. In Lawrence, the railroad right-of-way extends through the multi-family housing and industrial areas. The density of development along this section of the railroad corridor is more concentrated than in areas to the north. In many areas, buildings have been constructed in close proximity to the tracks. The proposed rail station location at Lowell and Winter Streets include available undeveloped land adjacent to the tracks, in contrast to the built-up nature of the remainder of the right-of-way in Lawrence. This station location is surrounded by underutilized mill buildings, multi-family housing, and businesses, and is located one block west of the Route 28 (Broadway) commercial district. To the north of Lowell Street, a freight siding for Eastern Packaging Company, apparently the only remaining freight use on the line, is still in use. The M&L Branch railroad extends to the south, extending through primarily industrial/commercial areas. The railroad crosses Water Street/Canal Street at grade, a canal, and Route 28 (Broadway) at a skewed at-grade crossing before extending over the Merrimack River. The railroad crosses an island and the south canal, before crossing Merrimack Street at-grade and merging with the Haverhill Line near the Lawrence MBTA station.

The land use patterns follow zoning, with residential and high-density residential zoning on the north side of the city, west of the railroad, and the remainder of the railroad adjoining primarily industrially zoned areas, with some areas of high-density residential zoning and secondary business zoning extending along the east side of the railroad.

Along the remainder of the rail corridor, the railroads accommodate passenger rail, and existing MBTA rail stations would be used.

Impacts

a. No Build

Land use impacts associated with bus operation under the No Build Condition would be minimal, since the majority of improvements would be largely located at existing park and ride lots along I-93. This bus transit is expected to have minimal effects on land use and development patterns along the corridor.

b. Bus on Shoulder along I-93: Manchester (Exit 6) to Boston

Impacts associated with Bus on Shoulder Transit operation would be minimal, since the majority of shoulder improvements would largely be performed within the existing highway right-of-way. Park and ride lots with bus terminals have been built at Exit 2, 4, and 5 along I-93, further minimizing potential impacts. Figures 38 and 44 present station area plan recommendations for the Londonderry Exit 5 site and Salem Rockingham Park site, consistent with best practices for land use planning.

c. Commuter Rail Service on M&L Branch: Exit 5 to Boston

The development of the proposed rail stations in Londonderry, Derry, Salem, and Lawrence could result in some land use displacements. However, these facilities have also been sited to maximize opportunities for transit-oriented development, with siting in town centers or developed areas, and also would allow for redevelopment or development of underutilized parcels in Londonderry, Salem, and Lawrence. Figures 37 through 44 shows how potential transit oriented development and accommodations to encourage TOD, such as pedestrian accommodations, could be incorporated into the station and site design at Londonderry and Salem.

In addition to the impacts related to station development, the rail use on the unused portions of the M&L Branch would involve a number of property impacts, particularly where the right-of-way extends through lawns, access drives, parking areas, and sidewalks. Private ownership of the line occurs along portions of Londonderry and Derry, and the Town of Derry owns portions of the line. The highly urbanized nature of the areas adjoining the right-of-way in Derry and Salem pose particular challenges for reinstitution of rail service. Although station sites in these two communities could provide positive economic benefits, in concert with transit oriented development, the rail reactivation would incur direct property impacts on a number of public and private properties, as described in the preceding sections.

It is assumed that doubletracking along the Haverhill Line and Wildcat Branch will be performed within the existing railroad right-of-way, although utilities relocations may be required. Further design studies would need to be performed to assess the planned configuration of the double-tracked sections of these active commuter rail lines and the potential effects on adjoining land uses.

Another issue is the displacement of existing recreational usage on the portions of the M&L Branch that extend through Londonderry, Windham, and Salem. The Towns of Derry and Windham have paved the path for recreational use, and the recreational trail is maintained by the New Hampshire Trails Bureau. There are plans to pave the remainder of the path extending from the Derry Bike Trail to the Windham Bike Trail.

In addition, the NHDOT *Salem to Concord Bikeway Feasibility Study* identifies the M&L Branch as the preferred bicycle route for the proposed recreational bike path. The report states that, given the close proximity to wetlands, particularly in Windham and Derry, it would be difficult to construct a trail with adequate separation from an active rail line along the M&L Branch.

If the project is advanced, impacts on publicly owned wildlife refuges, parks and recreational areas will require further evaluation under Section 4(f) of the U.S. Department of Transportation Act. Public parks and recreation areas that may be affected by the commuter rail alternative in New Hampshire include Hood Park and the O'Hara Memorial Field in Derry and the bike trails in use on the right-of-way in Londonderry, Derry, and Windham (although agreements for these trails include reservations or termination clauses to allow rail restoration). In Massachusetts, the M&L Branch adjoins or is proximal to the Nevins Bird Sanctuary, Gill Avenue Playground, Bourgoin Park, and Lawrence Riverfront State Park.

In addition, the portion of the Haverhill Line proposed to be double-tracked adjoins a number of conservation lands in Andover, including several parcels along the Shawsheen River. The Wildcat Branch, which would be double-tracked as part of the Eastern Commuter Rail Alternative also adjoins several parcels of conservation land owned by the Town of Wilmington.

Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, directs federal agencies to avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects on minority and low-income populations.

The Commonwealth of Massachusetts uses the following criteria for the 2000 U.S. Census data in identifying Environmental Justice communities. The criteria used are as follows:

- 25% or more are minority,
- 25% or more are foreign-born,
- 25% or more are lacking English proficiency,
- Households earn 65% or less of the statewide median income.

Using this criteria, Lawrence and Methuen are considered to be Environmental Justice communities. Lawrence meets criteria for all four criteria, and Methuen meets all criteria, except for English proficiency. The railroad right-of-way extends in close proximity to the Greater Lawrence Educational Collaborative in Methuen and the Lawrence Family Development Charter School. The Greater Lawrence Educational Collaborative is a public educational agency serving the school districts of Andover, Boxford, Haverhill, Lawrence, Lowell, Methuen, Middleton, North Andover, Topsfield and the Greater Lawrence Technical School. The collaborative provides academic and therapeutic programs for special needs students in elementary, middle, and high school at its Methuen location. The Lawrence Family Development Charter School is geared towards immigrant families and houses approximately 500 students, grades K through 8.

None of the New Hampshire communities would be classified as Environmental Justice communities using these criteria.

Overall, the rail alternative would involve greater environmental justice impacts than the bus transit and No Build/Baseline options, as reactivation of an unused or lightly used rail corridor for passenger service would pass through the environmental justice communities of Methuen and Lawrence. The Bus on Shoulder alternative would operate along the existing highway corridor and would not have as great an effect on these communities. The No Build and Baseline options also would not involve as great an effect on environmental justice communities.

Environmental justice issues would require further consideration, including census block-level analysis, as the project is advanced and as project designs and station and facility siting are finalized. Targeted outreach to disadvantaged populations and schools and community programs geared towards disadvantaged populations potentially affected by the project should be incorporated in environmental justice communities such as Methuen and Lawrence.

Cultural Resources

Section 106 of the National Historic Preservation Act provides for protection of historic and archaeological resources. Cultural resources in the study area include the M&L Branch railroad, which was constructed in 1847 to 1849. Cultural resources in the area of the project were identified by reviewing studies performed for the I-93 improvement projects in New Hampshire and Massachusetts and reviewing available NH GRANIT and MassGIS data. A meeting with the New Hampshire Division of Historical Resources (NHDHR) was held in March 2008.

A cultural resource assessment has determined that portions of the M&L Branch that are relatively intact (Windham and Salem) are potentially eligible for listing on the National Register of Historic Places. For these portions of the railroad that are National Register eligible, affiliated structures, including substantially unaltered depots, bridges, and drainage culverts, may also be considered part of the resource and may also be subject to protection. The reinstitution of commuter rail service along the M&L Branch would affect the portions of the M&L Branch that have been determined to be National Register eligible.

There is also a potential for the bus transit option to involve cultural resource impacts, however, these impacts are expected to be nominal, given that the shoulder additions would extend between 0 and 5 feet beyond existing or proposed pavement widths. The cultural resources along I-93 in New Hampshire were evaluated in the NHDOT *Final Environmental Impact Study: Interstate 93 Improvements Salem to Manchester* (2004 FEIS) and the Draft Supplemental Environmental Impact Statement (2009).

The bus transit alternative would involve a marginal increase in widening over that evaluated in the FEIS (up to 0 to 5 feet in places). The incremental increase in pavement width for accommodation of BOS operations could result in impacts to resources not previously affected, particularly for archaeological resources.

The additional pavement added would be marginal in the Massachusetts project segments as well (up to 2 to 5 feet). The *I-93 Corridor Traffic Study, Andover and Methuen, Massachusetts* (October 2005) did not identify cultural resource impacts associated with widening I-93 in Massachusetts, based on review of MassGIS data. Widening in the Massachusetts portion could be incorporated into the project designs being developed for the I-93 Corridor Improvements in Andover-Methuen and for other interchanges improvement projects being undertaken along I-93. Advancement of these other projects along I-93 will also require consideration of cultural resource impacts.

Moreover, the proposed bus station park-ride facilities will largely be sited at existing park and ride lots along I-93. The No Build, similar to the BOS alternative, would largely involve improvements based at existing park-ride facilities, and would involve marginal cultural resource impacts.

In addition to the M&L Branch itself, and National Register listed sites, there may be other historic buildings or archaeological deposits that are potentially eligible for the National Register that may be affected by the proposed project. A cultural resource assessment, including a Phase I Archaeological Investigation, would be required if the project is advanced for further consideration. Further consideration of potential impacts to historic sites would also be required under Section 4(f) of the U.S. Department of Transportation Act.

Wetlands and Floodplains

Protection of wetlands and floodplains is mandated under federal and state laws and regulations. Wetlands are defined as areas that are subject to inundation during a substantial period of the growing season, and that exhibit characteristic wetland vegetation, hydrology, and soils. National Wetland Inventory Mapping was obtained for the entire study corridor, and mapping prepared by the Massachusetts Department of Environmental Protection was also used in the Massachusetts portion of the study area. Wetlands and floodplain mapping for the project area is shown on Figures 45a through 45h.

Floodplains are defined and mapped by the Federal Emergency Management Agency. The 100-year flood is defined as the storm event that has a 1% chance of occurring in any given year. The FEMA mapping for the project area was obtained from NH GRANIT and MassGIS.

Substantial portions of the M&L Branch railroad embankment extend through wetland and floodplain areas, particularly in the relatively undeveloped portions of the study area in New Hampshire. The section of the right-of-way extending south of Independence Drive in Londonderry, approximately 1.4 miles to Route 28 (Rockingham Road) includes areas of open water, wetlands, and 100-year floodplain. The embankment crosses over Shields Brook and areas of open water.

In Derry, extensive areas of the railroad right-of-way cross over ponds, waterways, wetlands, and floodplains. This includes crossings of Beaver Brook and its tributaries and a crossing between Hoods Pond and Horn Pond in Hood Pond Park.

In Windham, there are extensive areas of wooded, undeveloped areas and multiple crossings of waterway, wetland, and floodplain. The rail embankment extends over or adjacent to Flatrock Brook and its tributaries and wetlands along Mitchell Pond.

In Salem, due to the developed nature of the commercial corridor along Route 28, there are fewer wetland crossings. The railroad corridor includes a crossing of the Spicket River.

In Methuen, the railroad embankment extends adjacent to or through wetland/floodplain areas along the Spicket River over a distance of approximately ½ mile. The railroad crosses the Spicket River again to the south approaching the Lawrence town line. In Lawrence, the railroad extends along a portion of Spicket River and Stevens Pond, and crosses two canals and the Merrimack River on bridge structures.

Impacts to these waterways, wetlands, and floodplains will need to be considered in the development of design plans for the railroad alternative, including impacts at station sites, passing tracks, bridges, and culvert crossings. Reactivation of railroad service along the M&L Branch would require bridge rehabilitation or replacement where the right-of-way crosses rivers and streams. Due to the proximity of waterways, wetlands, and floodplains in many locations, temporary impacts to adjoining natural resource areas may also occur during construction. Final siting and design for station sites and other ancillary facilities will also need to be performed to minimize impacts to natural resources. It is estimated that the majority of wetlands alterations will occur with reconstruction of unused portions of the M&L Branch in the New Hampshire portion of the study area. It is assumed that double-tracking along the Haverhill Line and Wildcat Branch will not involve substantial impacts, although further design studies would need to be performed to determine the extent of potential impacts.

The bus transit alternatives would most likely involve lesser impacts on waterways, wetlands, and floodplains, since the increase in existing or proposed paved area would be incremental (up to 5 feet). Proposed bus park and ride stations are also located at existing park and ride lots. There may be incremental wetland impacts from the shoulder improvements, station site design, and ramp improvements. The 2004 FEIS for I-93 Salem to Manchester Improvements estimated that park and ride facilities would impact up to approximately 3.2 acres at Exits 2, 3, and 5. The improvements to roughly 10 miles of I-93 from Andover to Methuen corridor would result in wetlands alterations, although detailed environmental impact studies have not yet been performed.

If the project is advanced for further consideration, wetland delineations at potentially impacted sites will need to be performed to assess the full extent of wetland impacts. Coordination with federal and state agencies will be required to obtain required approvals under Section 404 of the U.S. Clean Water Act, under the New Hampshire Wetlands Bureau rules, and the Massachusetts Wetlands Protection Act.

Threatened and Endangered Species

The U.S. Fish and Wildlife Service, New Hampshire Natural Heritage Bureau, and Massachusetts Natural Heritage and Endangered Species Program were consulted regarding the presence of federally and state-protected species in the project area. This review focused on the presence of endangered species along the unused portions of the M&L Branch, where new construction on inactive rail line would be required, and on the portions of the Haverhill Line and Wildcat Branch where double-tracking would be required. Rare species along the I-93 corridor were identified in the 2004 FEIS and *the I-93 Corridor Traffic Study, Andover and Methuen, Massachusetts* (October 2005).

The U.S. Fish and Wildlife Service indicated, in correspondence of March 24, 2008, that, based on information currently available, no federally listed or proposed, threatened, or endangered species or critical habitat are known to occur in the vicinity of the Eastern Railroad corridor.

The state-protected or rare species that were identified by the New Hampshire Natural Heritage Bureau and the Massachusetts Natural Heritage and Endangered Species Program along the Eastern Railroad Corridor (M&L Branch and the sections of the Haverhill Line and Wildcat Branch proposed to be double-tracked) are shown in Figures 45a through 45h and are listed in Table 17.

Development of project plans will require further consideration of rare species habitats, including avoidance of habitat impacts to the extent possible and, if necessary, evaluation of potential impacts and mitigation, as appropriate.

Site Location/ Identifier	Common Name	Scientific Name	Listing Status	Location
Derry, NH (Peppermint Corner)	Grasshopper Sparrow	*(Ammodramus savannarum)*	New Hampshire threatened	Project vicinity
Salem, NH (Noyes Terrace)	River Birch	(*Betula nigra*)	New Hampshire threatened	Spicket River
Methuen, MA (PH 217/EH 613)	Blanding's Turtle	(*Emydoidea blandingii*)	Massachusetts threatened	Spicket River
Lawrence, MA (PH 1222/ EH 819)	Bald Eagle	(*Haliaeetus leucocephalus*)	Massachusetts endangered	Merrimack River
Andover, MA (PH 299/ EH 616)	Twilight moth	(*Lycia rachelae*)	Massachusetts endangered	Shawsheen River
Wilmington, MA (PH 380)	New Jersey Tea Inchworm	(*Apodrepanulatrix liberaria*)	Massachusetts endangered	Shawsheen River

Table 24: State-Protected Species

Source: New Hampshire Natural Heritage Bureau and Massachusetts Natural Heritage and Endangered Species Program

Air Quality

The U.S. Clean Air Act, amended in 1990, established National Ambient Air Quality Standards for pollutants to protect the environment and human health. The study area is located within the portions of New Hampshire and Massachusetts that are in nonattainment for ozone. Southeast New Hampshire and Eastern Massachusetts areas are classified by the U.S. Environmental Protection Agency as moderate non-attainment areas. The U.S. Clean Air Act Amendments require that these areas reduce emissions of volatile organic compounds (VOCs) and nitrogen oxides (NO2), which are the main precursors to ozone.

Both bus transit vehicles and diesel railroad locomotives used in commuter rail largely operate on diesel fuel, which emit hydrocarbons, nitrogen oxides, fine particulate matter, and carbon monoxide. Under the No Build, there would be a total of 55 daily buses operating in each direction, compared to 90 daily buses in each direction under the Bus on Shoulder. Under the commuter rail operations, there would be a total of 38 one-way trips. However, the transit operation would provide an air quality benefit through reduced vehicle miles of travel.

Estimated total daily inbound boardings in 2030 are estimated to total as follows:

- 1,680-1,880 for No Build,
- 4,945-5,545 for I-93 bus on shoulder operations,
- 4,870-5,375 for commuter rail on the M&L Branch.

Under all of the project options, the increased emissions from buses or railroad locomotives would be more than offset by reductions in automobile trips. Further advancement of the project would require an air quality analysis to assess localized emissions and address conformity of the project to regional air quality plans and the State Implementation Plan.

Noise

Ambient noise environments in the project area range from rural, relatively quiet residential areas, particularly in the northern portion of the New Hampshire project area, to high-density commercial development along heavily traveled highways in portions of the southern New Hampshire and Massachusetts project segments. Existing noise sources include the highways and railroads in the project area.

The No Build and Bus on Shoulder alternatives would involve nominal increases in noise, as buses would operate within the existing I-93 highway corridor. The I-93 corridor is heavily traveled, with upwards of 100,000 vehicles a day. Under the No Build and Bus on Shoulder alternatives, increases of between 55 to 90 daily bus trips in each direction will occur and would not result in perceptible increases in noise levels.

The M&L Branch Railroad has been largely unused in New Hampshire, and reactivation of commuter rail service would introduce a new noise source along the railroad corridor. Introducing commuter rail service along the M&L Branch would affect a number of noise-sensitive land uses in the project area. The M&L Branch in New Hampshire extends through rural residential areas in Londonderry and Windham, the downtown Derry business district, and the commercial district in Salem. The unused portion of the M&L Branch in Massachusetts extends through industrial and residential areas of Methuen and Lawrence. The increased service along the Haverhill Line and Wildcat Branch would occur along an active railroad line. Although this increase in service would not introduce a new noise source to adjoining neighborhoods, these areas may also experience a noise impact due to increases above ambient or threshold noise levels. The commuter rail alternative would result in 38 one-way trips (or 76 two-way trips), with service operating as frequently as every half hour during peak periods resulting in locomotive horn and other new noise impacts.

Noise impacts are typically defined as substantial increases above ambient noise levels or projected future noise levels that will exceed established criteria for noise abatement. A detailed noise assessment in accordance with FTA requirements would be required during further design and planning studies to characterize the noise impacts and identify appropriate noise mitigation measures.

Hazardous Waste

An initial hazardous waste assessment was performed by reviewing available information on waste sites from NH GRANIT and MassGIS. Figures 45a through 45d shows the sites identified by NH GRANIT and the U.S. Environmental Protection Agency (U.S. EPA) that are listed on the Toxic Release Inventory. Under the U.S. Emergency Planning and Community Right-to-Know Act, businesses are required to report chemicals stored on-site, and states and the U.S. EPA are required to collect and make available to the public information on releases and transfers of certain toxic chemicals at industrial facilities.

In Massachusetts, the Massachusetts Contingency Plan (MCP) and M.G.L. Chapter 21E establish a regulatory program for remediating oil and hazardous waste sites. Figures 45d through 45h show the sites that have been identified or tier-classified under the MCP by the Massachusetts Department of Environmental Protection that are active 21E sites. These figures also display sites that have been remediated under the 21E program, but have oil or hazardous materials remaining after cleanup (sites with Activity Use Limitations).

As the project is advanced, a more detailed assessment of federal and state databases of listed sites would need to be performed.

10. Strategic Implementation Plan

Introduction

As discussed in detail in the Definition and Evaluation of Alternatives (2008), it is recommended that both the bus-on-shoulder (BOS) and the Manchester & Lawrence commuter rail alternatives be implemented in the short and long term. However, there are significant differences regarding the potential timing of actual operations. Early implementation of BOS service between Manchester and Boston is recommended, along with immediate steps to preserve the option of M&L service at some future date, that date depending primarily on the rapidity of and nature of development in southeastern New Hampshire and the resultant demand for transit services.

This section of the final study report includes recommendations for implementation of BOS and possible implementation of the M&L, as well as the rationale for those recommendations. It focuses on both transportation infrastructure investments and policy recommendations for local and state governments in both New Hampshire and Massachusetts. It is important to note that although the early focus of this study was primarily on the New Hampshire concerns and potential benefits, the analysis showed that the proposed transit improvements would benefit Massachusetts as well. As these efforts move forward, both states will work closely to ensure that implementation responsibilities are shared evenly and fairly.

M&L: Benefits, Challenges and Implementation Implications

The study team concluded that passenger rail service on the M&L from Exit 5 to the MBTA Haverhill line at Lawrence and then into Boston's North Station is physically feasible and could provide a wide range of substantial benefits, including transportation, land use and environmental. The line's expected daily weekday ridership of approximately 10,000 one-way passenger trips compares favorably to that of recent and planned commuter rail start ups in the United States. However, for reasons of cost effectiveness, it was considered impractical to extend the service north from Exit 5 to the airport and into downtown Manchester, since this extension would have added only 700 daily one-way passenger trips while more than doubling the capital cost.

It is important to note that benefits from the M&L service are strongly bi-state. About 67 percent of southbound M&L passengers would board trains in Massachusetts due to the reduced travel times created by more express commuter rail service to Boston from Lawrence and Methuen. In addition, 89 percent of southbound passengers leaving trains would do so at North Station. Finally, additional trackage in Massachusetts required for M&L service would permit improvements to both MBTA Haverhill line service and Amtrak's Boston-Portland Downeaster service.

While the transportation benefits, including ridership, expanded modal options and impacts on I-93 traffic are about the same as those of BOS, the major difference between the M&L and BOS – in fact, between the M&L and any alternative focusing on the I-93 right-of-way – is in the area of land use and development. In the United States, fixed route rail transit has shown a greater proclivity for fostering more compact development in the vicinity of stations than express bus strategies, with a resulting higher level of ridership. This is the type of development that is widely seen as producing environmental and community benefits that result from reduced automobile usage. This is also a conclusion reflected in state development policies and objectives in both New Hampshire and Massachusetts.

Despite those benefits compared with BOS, it should be emphasized that the cost differences between the two options are substantial. Capital costs are estimated at $247 million for the M&L (to Exit 5 in Londonderry) and $95.5 million for BOS. The annual operating costs are about $9 million and $6 million respectively.

It is assumed, as is typically the case at this stage of project development, that approximately one-half of the capital cost of either project would come from the federal government through the Federal Transit Administration (FTA). Current evaluation criteria emphasize cost effectiveness, a function of costs and travel time savings. Under current FTA guidelines, it is unlikely that the M&L alternative would qualify for federal funds.[8]

In addition to that financial concern, public outreach efforts identified some community concerns in New Hampshire about restoring service on the M&L, despite the fact that the state does control use of most of the right-of-way in the state. First, several communities, including Windham and Derry, have constructed bicycle/pedestrian paths on the right-of-way. Even though the state retained the right to use the alignment for transit purposes, there could be community opposition to such reversion. Second, there are numerous grade crossings on the line, and although this is a common situation on existing and planned U.S. commuter rail systems, it does raise public concerns about safety at the crossings. Noise could be an added issue related to these crossings. Use of approved safety strategies at grade crossings could obviate the need for train horns, but diesel-powered trains expected to be utilized for this service do emit noise. Finally, the current conditions along the M&L right-of-way would require serious mitigation efforts related to wetlands and habitats.

Despite those understandable concerns, evolving conditions could support future implementation of rail service on the M&L corridor. Specifically, such a decision would depend primarily on demographic and development patterns in the study corridor as well as evolving land-use policies at state and local levels in New Hampshire. If population growth continues at a rapid pace, especially with strong immigration from transit-heavy Massachusetts, and if denser residential development occurs near the M&L, those trends could boost ridership potential, making the line more cost-effective. That is more likely to occur if state and local policies support and encourage such concentrated growth, for example by implementing recommendations in the New Hampshire Office of Energy and Planning's report, Achieving Smart Growth in New Hampshire (2003), and the New Hampshire Long Range Transportation Plan, Final Report of the Community Advisory Committee to the Commissioner (2006).

This study considered in detail only the full Exit 5-Lawrence-Boston alignment to consider the maximum range of benefits from the M&L. However, a phased implementation would be possible, with a service initially terminating at Salem. This phasing approach could be developed as part of an Alternatives Analysis/Draft Environmental Impact Statement (AA/DEIS), the probable next phase of the planning process to progress I-93 corridor transit services. Some of the high costs associated with the project are based on the need to provide double tracking on portions of the MBTA route south of Lawrence. The Commonwealth is considering moving forward with some of these key project elements under the American Recovery & Reinvestment

[8] See discussion of Transportation System User Benefits at section XIII D.3 of this final report.

Act of 2009. Should these costs be eliminated from the M&L project, the cost/benefit rating may improve.

New Hampshire Main Line: Manchester-Nashua-Boston

The New Hampshire state legislature has established the New Hampshire Rail Transit Authority, with the responsibility of prioritizing and implementing passenger rail service in the southern part of the state. The Authority and the NHDOT have identified the New Hampshire Capitol Corridor as the state's top passenger rail priority. This privately-owned line, also known as the New Hampshire Main Line, runs from Concord, through downtown Manchester and Nashua, to Lowell where in connects with an MBTA line to Boston[9]. The I-93 study team recommended, and the study's Technical Advisory Committee (TAC) approved, a decision to eliminate the New Hampshire Main Line from the list of alternatives because of its comparatively limited impact on the I-93 corridor itself, compared with the options located closer to I-93, a major study objective. This is not to suggest that it would have no impact, only less. Nor is it to suggest that the Capitol Corridor would not successfully satisfy other, equally compelling, transportation, environmental and development objectives. In fact, the Capitol Corridor, along with either BOS or the M&L, would constitute a vibrant transit system for the region.

Reasons for early implementation of that corridor include:

- Relative ease of implementation,
- Lower capital and operating costs,
- Greater potential for federal funding,
- Access to downtown Manchester, and
- Existing community support.

Implementation Steps: Bus on Shoulder

In order to deploy effective, as well as cost-effective, transit service in the corridor, when required, it is recommended that both New Hampshire and Massachusetts begin a phased implementation of BOS between Manchester and downtown Boston. While bus acquisition and station/park and ride construction could begin relatively quickly, shoulder and interchange modifications could logically be phased in, with projects and segments providing the greatest benefits coming first.

Priority segments would be those toward the southern end of the corridor, where current congestion is most severe – and where the number of buses (and passengers) is greatest. This is supportive of the fact that existing services in addition to the greatly enhanced New Hampshire routes would also benefit. Specifically, MBTA, Massport and Merrimack Valley Regional Transit Authority (MVRTA) routes would gain significant travel-time benefits, emphasizing the bi-state nature of project benefits. Constructing the improvements necessary for BOS along I-93 south of I-95/Route 128 in Massachusetts may be difficult due to the right-of-way constraints through both heavily developed areas in Medford and Somerville as well as in the environmentally significant Middlesex Fells area. The study team did accomplish an informed yet cursory review of the engineering feasibility for implementing BOS service, indicating the need for more detailed analysis of each segment.

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[9] MBTA ownership begins at the state line in Tyngsborough. Pan Am has freight operating rights over the line in Massachusetts.

From an infrastructure standpoint, a logical phasing would be**:**

- Phase 1: Incorporate BOS into design of projects:
    - Route 110/113 rotary
    - Lowell Junction Interchange
    - I-93/I-95 interchange
- Phase 2: Construct Medford to I-95 improvements
    - Widen shoulder
    - Drainage
    - Bridge modifications
- Phase 3: Construction of Phase 1 projects
- Phase 4: I-95 to state line
- Phase 5: New Hampshire improvements
    - Construct pull out segments
    - Widen shoulders

Next steps toward implementation of BOS should include:

- Develop agreement among New Hampshire Department of Transportation (NHDOT), Massachusetts Executive Office of Transportation (MAEOT), Massachusetts Highway Department (MHD) to pursue BOS strategy in concept.
- Establish bi-state implementation task force, consisting of NHDOT, MAEOT, MHD, transit agencies and operators, FTA, Federal Highway Administration (FHWA), regional planning commissions (RPCs) to continue coordination and technical analyses.
- Perform detailed engineering analysis of improvements along I-93 from I-95/Route 128 to Medford for BOS operations.
- Develop design for infrastructure requirements, equipment requirements, operating plans, phasing strategy(ies).
- Develop analysis of project benefits, distribution of those benefits, and alternative bi-state financial strategies.
- Initiate an environmental assessment (EA), the likely environmental clearance document for the project.
- Develop implementation agreements of program to share projects costs between two states.

Implementation Steps: M&L/MBTA

As noted above, based on existing and anticipated population trends and on potential development patterns in the I-93 corridor, it may be feasible and desirable to implement passenger service on the M&L alignment at some point in the future. That point could be well beyond the 2030 planning horizon or could be sooner, depending on shifting population, development and political patterns. It is important to recognize that if a decision is made to move forward on implementing commuter rail on the M&L the first step would be to begin the formal environmental planning process.

In the meantime, the right-of way needs to be protected. Essential steps in the short and intermediate terms should focus on preserving the right-of-way for potential transit use. As was mentioned, despite several authorized encroachments (e.g., for recreation trails), NHDOT does retain the right to use most of the right-of-way for transit purposes. It would be useful, therefore, for the Department to ensure that towns and other entities with which the department has agreements are reminded of these rights. A logical way to accomplish this would be to send a letter highlighting the I-93 Transit Investment Study recommendations. Furthermore, when unauthorized encroachments are identified, the Department should notify the encroaching property owner of NHDOT's position.

One factor that could impact the timing of the start of service on the M&L would be phased implementation, i.e., initial service to a New Hampshire terminus south of Exit 5. While consideration of Boston-Salem or Boston-Derry service was not considered in this study, such alternatives should be part of the required environmental review and alternatives analysis focused on the rail line. In such a process there would be a determination of incremental costs and benefits (ridership-focused) of each additional segment north of Salem. Since some riders who board trains north of Salem in the study's ridership forecasts would drive to Salem, if that were the northern terminus, the shorter line could have an improved cost-benefit ratio, due to its lower capital cost. This could enhance prospects for federal funding. In addition, such a starter line would presumably encounter fewer community concerns. And finally, the possibility of major new transit-supportive development near a potential station, such as Salem, could also enhance ridership and the line's performance against FTA's land-use evaluation criteria, which emphasize existing transit-supportive development and policies that promote such development.

Potential Funding Sources

It is assumed that the goal is to have approximately 50 percent of the capital cost of the project federally funded, primarily through the FTA. The evaluation criteria that will determine the project's likelihood of receiving those funds include cost-effectiveness and land use factors. In addition, another major FTA criterion is financial feasibility, i.e., have sources of non-federal funds to cover the remaining half of the capital cost and all of the annual operating and maintenance costs been identified and, preferably, committed.

For the two I-93 preferred investment strategies, BOS obviously presents a smaller financial challenge, with lower capital requirements and annual operating costs of $6 million. Using the study's ridership forecasts and assuming current MBTA and commercial carriers fare policies, the study concluded that fares could cover a substantial portion of annual non-federal capital and operating requirements. Should fares fail to fully cover those costs, the two states would work together to identify an equitable funding arrangement to cover BOS operations.

With the M&L strategy, however, the financial requirements are more substantial: $246 million for capital improvements to Exit 5 and equipment, plus $9 million annually for operations and maintenance. While the study team has made no recommendation for sources of those funds it could be instructive to consider financial strategies for other recent or planned commuter rail projects. (The MBTA is funded with a statewide sales tax.) The following rail projects are, or would be, all above $200 million in capital costs:

- Minneapolis: federal grant, state grant, local grants
- Albuquerque: federal grant, local sales tax
- Salt Lake City: federal grant, local sales tax
- Madison, WI (planned): federal grant, local sales tax

In the United States, with a few exceptions, such as Portland, Oregon (local payroll tax) and Baltimore (transit is state-provided), the source of non-federal financial funds is a local or regional sales tax.

Summary

- Proceed now with planning to implement Manchester-Boston BOS, beginning with bi-state agreements on phasing details, facility requirements, environmental and engineering review and funding plan.
- Preserve the option of implementing M&L rail service to Boston from some terminus in New Hampshire, with an early emphasis on maintaining state control of the right-of-way in New Hampshire.
- Continue with plans to provide rail service in the NH Capitol Corridor as the probable first route of a regional system.
- Begin formal process of determining financial strategy for any bi-state major transit project.