



Northern New England Intercity Rail Initiative

BOSTON | SPRINGFIELD | NEW HAVEN | MONTREAL



BOSTON-TO-MONTREAL ROUTE SERVICE DEVELOPMENT PLAN

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EXECUTIVE SUMMARY

The Northern New England Intercity Rail Initiative (NNEIRI) is a feasibility and planning study to examine the opportunities and impacts of adding more frequent and higher speed intercity passenger rail service on the two routes that make up the NNEIRI Corridor: the Inland Route (Boston-Springfield-New Haven) and the Boston-to-Montreal Route (via Springfield, MA). Since these overlap between Boston, Massachusetts and Springfield, Massachusetts, planning was coordinated under a comprehensive NNEIRI Study. This Service Development Plan (SDP) is exclusively for the Boston-to-Montreal Route, but was prepared in coordination with a separate SDP for the Inland Route. The Massachusetts Department of Transportation (MassDOT) and the Vermont Agency of Transportation (VTRANS), in coordination with the Connecticut Department of Transportation (CTDOT) and the Federal Railroad Administration (FRA), developed both SDPs. FRA is providing grant funding for the study under its Next Generation High Speed Rail Program.

This SDP is a detailed plan for infrastructure investments needed to improve service along the Boston-to-Montreal Route. The SDP defines the purpose and need for service improvements, analyzes alternatives, defines the recommended improvements, and evaluates the operational, network, and financial impacts of the service changes and infrastructure investment.

Information presented in this SDP is based on work completed as part of the *NNEIRI Alternatives Analysis Report* (AA report) and the *NNEIRI Tier 1 Environmental Assessment* (EA). The AA report presents the process used to identify three different build alternatives and facilitated the selection of a single Build Alternative for further analysis. The EA summarizes the analysis conducted to compare the environmental impacts of the Build Alternative against a No-Build Alternative. Additionally, the NNEIRI analysis incorporated assessments completed for the CTDOT New Haven-Hartford-Springfield (NHHS) High-Speed Intercity Passenger Rail (HSIPR) Project which is considered as an existing condition within the SDP.

Figure E-1 shows the NNEIRI routes and rail stations on the NNEIRI Corridor.



Figure ES-1. NNEIRI Corridor Study Area

Based on the ridership and cost data developed through the AA processes, and input from regional stakeholders and members of the public, the build alternative was selected as the Recommended Alternative.

RECOMMENDED SERVICE & STATIONS

The current intercity passenger rail service that exists along the Boston-to-Montreal Route provides limited opportunity for traveling the entire length of the route. Planning for the Boston-to-Montreal Route, conducted in conjunction with the Inland Route, has identified potential improvements that would advance service and connect New England's largest cities with rural areas in Northern New England and Montreal, Quebec.

The Recommended Alternative consists of two daily round-trips on the Boston-to-Montreal Route, with one trip between Boston and Montreal via Springfield, and the other trip between New Haven and Montreal via Springfield. Each train would service all stations along the corridor segments. Service on the Inland Route is discussed separately in the Inland Route SDP.

The stations for the Boston-to-Montreal Service include:

- Boston, Massachusetts (South Station and Back Bay);
- Framingham, Massachusetts;
- Worcester (Union Station), Massachusetts;
- Palmer, Massachusetts;
- Springfield (Union Station), Massachusetts;
- Holyoke, Massachusetts;
- Northampton, Massachusetts;
- Greenfield, Massachusetts;
- Brattleboro, Vermont;
- Bellows Falls, Vermont;
- Claremont, New Hampshire;
- Windsor, Vermont;
- White River Junction, Vermont;
- Randolph, Vermont;
- Montpelier, Vermont;
- Waterbury, Vermont;
- Burlington (Essex Junction), Vermont;
- St. Albans, Vermont; and
- Montreal (Central Station), Quebec, Canada.

The stations for the New Haven-to-Montreal Service include:

- New Haven, Connecticut;
- Wallingford, Connecticut;
- Meriden, Connecticut;
- Berlin, Connecticut;
- Hartford, Connecticut;
- Windsor, Connecticut;
- Windsor Locks, Connecticut;
- Springfield, Massachusetts;

- Holyoke, Massachusetts;
- Northampton, Massachusetts;
- Greenfield, Massachusetts;
- Brattleboro, Vermont;
- Bellows Falls, Vermont;
- Claremont, New Hampshire;
- Windsor, Vermont;
- White River Junction, Vermont;
- Randolph, Vermont;
- Montpelier, Vermont;
- Waterbury, Vermont;
- Burlington (Essex Junction), Vermont;
- St. Albans, Vermont; and
- Montreal (Central Station), Quebec, Canada.

The level of proposed service was analyzed using a train network operations model. The Boston-to-Montreal Route was modeled utilizing the service plan in the Recommended Alternative to assess the impacts of the service on corridor capacity when operated with future freight and passenger rail services. Utilizing a modeling process identified by the FRA that isolates capacity needs for different corridor services, the results indicate that with the recommended infrastructure improvements, the NNEIRI Corridor would have sufficient capacity to meet the projected needs of the freight railroad, commuter rail operations, and the recommended intercity rail services.

RECOMMENDED CAPITAL INVESTMENTS

The recommended infrastructure improvements along the Boston-to-Montreal Route include:

- Track and signal improvements from Springfield to the U.S./Canadian Border;
- Constructing additional sidings in Vermont;
- Completing an additional passing siding between Worcester and Springfield;
- Building a station in Palmer, Massachusetts; and
- Making track and signal improvements throughout the NNEIRI Corridor.

The rolling stock required for the recommended two daily round-trips along the Boston-to-Montreal Route includes five train sets. Each train set would consist of five coaches and one locomotive. The estimated capital costs for the Boston-to-Montreal Route are \$591-634 million. This includes \$415-458 million for infrastructure improvements and \$176 million for the rolling stock.

RIDERSHIP, REVENUE & OPERATIONS AND MAINTENANCE COSTS

The Boston-to-Montreal Route SDP also includes ridership forecasts, revenue forecasts, and estimated operations and maintenance (O&M) costs. Total ridership estimates for the two services on the Boston-to-Montreal Route are 447,100 annual passengers. The strongest travel demand identified was between cities in eastern Massachusetts and Connecticut stations. The estimated annual fare revenue for service on the Boston-to-Montreal Route is \$12 million. The

total estimated O&M costs for the Boston-to-Montreal Route are approximately \$23 million, therefore the annual support for the service is estimated to be \$11 million.

All existing intercity rail stations along the corridor were analyzed for potential use as a part of service on the Boston-to-Montreal Route. Additionally, two new stations, one in the vicinity of Interstate 95 (Route 128) in Weston, Massachusetts and a second in Palmer, Massachusetts were studied through the Alternatives Analysis process. A new station the area of Route 128 was not included in the Recommended Alternative due to low ridership, high costs and constrained sites associated with any minimally practical locations. One new station in Palmer was identified as feasible and incorporated into the ridership, revenue, and costing analyses. Each station was examined based on the ability to accommodate additional passengers, the ability for passengers to access the station, and how each station will be integrated into the local transportation network. The analysis determined that each existing intercity station would serve as a stop on the Boston-to-Montreal Route, with each train stopping at all stations.

INVESTMENT OPTIONS

In an effort to examine how a portion of the services and related improvements could be implemented, seven investment options were developed for the Recommended Alternative services, including three phased options for the Boston-to-Montreal Route, three phased options for the Inland Route, and one full-build option.

The phased options were developed to assess partial or full implementation of the three proposed services. The investment options evaluate the annual operational and financial requirements over the implementation period, and how services along the two routes could be integrated. Specific infrastructure investments were determined to provide the capacity for the identified level of service related with each investment option. There are four investment options included in this SDP. The first two options are for partial implementation of service on the Boston-to-Montreal Route. Investment Option III includes all services recommended for the Boston-to-Montreal Route. Investment Option VII represents the full implementation of service on the NNEIRI Corridor, including all services on the Boston-to-Montreal Route and the Inland Route.

BENEFITS ASSESSMENT & IMPLEMENTATION

The Boston-to-Montreal Route SDP also includes an assessment of the public benefits of implementing the service, funding and governance options for the service, and identification of the next steps necessary to advance improvement of the corridor.



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1 INTRODUCTION

The Northern New England Intercity Rail Initiative (NNEIRI) is a feasibility and planning study to examine the opportunities and impacts of adding more frequent and higher speed intercity passenger rail service on two major rail routes that make up the NNEIRI Corridor (Corridor): the Inland Route and the Boston-to-Montreal Route. This Service Development Plan (SDP) is exclusively for the Boston-to-Montreal Route, but was prepared in coordination with the SDP for the Inland Route. The Massachusetts Department of Transportation (MassDOT) and the Vermont Agency of Transportation (VTRANS), in coordination with the Connecticut Department of Transportation (CTDOT) and the Federal Railroad Administration (FRA) developed both SDPs. FRA is providing funding for the study under its Next Generation High Speed Rail Program.

This SDP is a detailed plan for infrastructure investments needed for improved service along the Boston-to-Montreal Route. The SDP defines the purpose and need for service improvements, analyzes alternatives, defines the recommended improvements, and evaluates the operational, network and financial impacts of the changes. The Boston-to-Montreal Route SDP summarizes the feasibility and alternatives analysis work related to the Boston-to-Montreal Route that was completed and documented in reports conducted as part of the NNEIRI.

1.1 BACKGROUND

The Northern New England High-Speed Rail Corridor is one of ten federally designated high-speed rail corridors in the United States. The Boston-to-Montreal corridor was designated by U.S. Transportation Secretary Rodney E. Slater on October 11, 2000 as part of the “Northern New England Corridor,” which included a hub at Boston and two spokes: one to Montreal, Quebec, Canada, via Concord, New Hampshire, and the other to Portland/Lewiston-Auburn, Maine. The Inland Route (the rail line connecting Boston and Springfield, Massachusetts to New Haven, Connecticut) was added to the Northern New England High-Speed Rail Corridor designation along with the rail line between Springfield, Massachusetts, and Albany, New York in the Consolidated Appropriations Act, 2005 (PL 108-447) on December 8, 2004.

1.1.1 Corridor Definition

The original alignment federally designated for the Boston-to-Montreal corridor consisted of a route via Concord, New Hampshire and through to White River Junction, Vermont, continuing northwesterly across Vermont to the Canadian border, and then to Montreal. An initial study for this alignment was completed in April 2003. FRA approved a grant for a subsequent, more detailed study effort for this alignment on September 10, 2003. However, at the conclusion of the initial study the New Hampshire Department of Transportation (NHDOT) withdrew from continued planning efforts related to development of service between Boston and Montreal. NHDOT’s withdrawal halted further consideration of the Boston-to-Montreal corridor along the originally proposed route.

MassDOT and VTrans remained interested in considering other alternatives to provide intercity passenger train service between Boston and Montreal. Subsequently, when the federal Public

Law 108-447 of 2004 expanded the Northern New England High Speed Rail Corridor from Boston to Springfield, MassDOT and VTrans suggested to FRA that a logical route for Boston to Montreal passenger rail service could be made by using a connection from Springfield to White River Junction northward along existing rail lines. The existing rail lines consist of the Commonwealth of Massachusetts owned line from Springfield to East Northfield, Massachusetts, known as the Knowledge Corridor, and the connecting segment of the New England Central Railroad (NECR) from East Northfield to White River Junction. The remainder of the rail route to Montreal is as proposed in the previous *2003 Boston to Montreal* study.¹ Based on information presented by MassDOT and VTrans, FRA determined that the revised route is an acceptable alternative alignment for consideration of passenger rail options from Boston to Montreal.

With this revised alignment for recommended service between Boston and Montreal, the existing rail lines of the Northern New England High-Speed Rail Corridor between Boston and Springfield could be utilized by both the Inland Route service, as well as Boston-to-Montreal Route passenger rail service. The NNEIRI Study evaluated the options for passenger rail service along these routes, treating them as a consolidated corridor. The environmental analysis prepared as part of the NNEIRI Study does not include impacts that might occur in Canada. As NEPA is a United States law, any environmental impacts in Canada would be evaluated through applicable Canadian laws.

1.1.2 Regional Framework

In 2009, a framework was created for improving high speed and intercity rail in New England. This framework, known as the *New England Vision for High Speed and Intercity Passenger Rail*,² resulted from a collaborative effort of the New England states to improve the railroad network connectivity within the region. The vision seeks to develop a safe and efficient passenger rail system seamlessly linking every major city in New England with smaller cities and rural areas, as well as an international connection to Montreal to provide a foundation for economic competitiveness and promote livable communities. It includes faster and more frequent rail service that promotes energy efficiency and environmental quality by providing alternative transportation choices while also enhancing the movement of rail freight throughout the region.

Currently, significant infrastructure improvements on existing rail lines within the Corridor that are consistent with the *New England Vision for High Speed and Intercity Passenger Rail* are completed or underway. The total expenditures as of July 2015 are nearly a half billion dollars and are a combination of both public and private investments.

- In western Massachusetts, the Knowledge Corridor/Restore the Vermonter project has improved passenger service on Amtrak's Vermonter service by restoring the route to the Connecticut River line, which is shorter and more direct. The inaugural run of the Vermonter service on the Knowledge Corridor occurred on December 22, 2014.

¹ Boston to Montreal High-Speed Rail Planning and Feasibility Study Phase I. Final Report. April 2003.
<https://www.nh.gov/dot/org/aerorailtransit/railandtransit/documents/BostonMontrealHSR.pdf>

² Vision for the New England High-Speed and Intercity Rail Network. 2009.
https://www.massdot.state.ma.us/portals/20/docs/NewEngland_HSR_Vision.pdf

Additionally, construction is underway to improve station platforms at Springfield Union Station, as well as the passenger facilities and rail operations.

- In Connecticut, the New Haven-Hartford-Springfield (NHHS) High-Speed Intercity Passenger Rail (HSIPR) Project, headed by CTDOT with grant funding from FRA's HSIPR Program, began construction in July 2013. Construction is still ongoing on the project, which is now known as the CT Rail Hartford Line. Once completed, the proposed capacity, reliability, and safety improvements along the NHHS corridor will facilitate an increase in the maximum train speed to 110 miles per hour (mph), reduce scheduled travel times, reduce conflicts with freight trains that share the tracks, and increase frequencies on this segment.
- In eastern Massachusetts, the Boston South Station Expansion project would provide seven new tracks and four new platforms, as well as the reconfiguration of several existing tracks and platforms, interlockings, train layover facilities and passenger waiting space. The Draft Environmental Impact Report (DEIR) for the Boston South Station Expansion project was submitted on October 31, 2014. The Massachusetts Environmental Policy Act (MEPA) Certificate was issued on December 31, 2014. This project has not received additional sources of federal or State funding for final engineering or construction. MassDOT will select a Preferred Alternative prior to submission of the Final Environmental Impact Report.
- Additionally, the Massachusetts and Vermont segment of the NNEIRI Corridor between Springfield and the Canadian border, currently used for the Amtrak Vermonter service, was improved through a series of grants, funded by the HSIPR and Transportation Investment Generating Economic Recovery (TIGER) programs. The combination of rail investments made in Vermont and Massachusetts along with those being made as part of the CT Rail Hartford Line service (New Haven-Hartford- Springfield project) will enhance operation of the current Vermonter throughout its route from New Haven, Connecticut to St. Albans, Vermont, and reduce the trip time by approximately one hour.
- In Canada, plans are in progress to once again extend the Amtrak Vermonter service north to Montreal. Improvements to infrastructure would need to be completed between the U.S. border and Montreal, as identified in the Quebec Ministry of Transportation's *Study of CN and CP's Rail Networks between Montréal and the U.S. Border* released in 2014. Additionally, a new U.S. Customs and Immigration Services and Canada Border Services Agency station is planned for construction at Montreal Central Station Customs Checkpoint to allow faster travel in and out of Canada for passenger trains.

The NNEIRI Study evaluated options to advance the vision of improved regional connectivity by maximizing use of previous regional rail investments and utilizing existing rail infrastructure in the Corridor, much of which will have already been upgraded through a series of separate improvement projects.

1.1.3 NEC FUTURE

NEC FUTURE is a comprehensive planning study that examines investment and service options for the Northeast Corridor (NEC) rail network that connects Washington, D.C., to Boston, Massachusetts. The NEC is the most heavily utilized rail corridor in the country, and the study seeks to create a long-term vision for the corridor in the context of current and future transportation

demands. NNEIRI provides regional connectivity between smaller communities and larger, hub cities in the Northeast, and complements the NEC by providing improved connections from Montreal and Northern New England via Springfield, MA and Hartford, CT to the existing NEC at New Haven, CT, to and Boston, MA via the Inland Route. Through NEC FUTURE, FRA is examining the opportunities to provide new or improved service to markets in the NEC service area.

The NEC FUTURE program is ongoing and a Preferred Alternative has not been identified by FRA. However, each of the NEC FUTURE Action Alternatives improves service along the existing NEC between Washington, D.C. and Boston. More frequent, reliable and faster service via Boston and New Haven will complement the services proposed through NNEIRI.

The NNEIRI improvements, when combined with proposed improvements to the New Haven-Hartford-Springfield (NHHS) Corridor and any of the NEC FUTURE alternatives under consideration, will greatly improve intercity service connections to central Connecticut and Massachusetts, Northern New England, and Montreal. In this way, the NNEIRI service will provide new and important travel options across the region thereby expanding the regional rail network.

1.2 STUDY AREA

As shown in Figure 1-1, the 470-mile-long NNEIRI Corridor includes two overlapping rail routes: the Inland Route and the Boston-to-Montreal Route. The **Inland Route** runs between Boston, Massachusetts and New Haven, Connecticut via Springfield, Massachusetts. The **Boston-to-Montreal Route** runs between Boston and Montreal, Quebec, via Springfield. The corridors share the same rail segment between Boston and Springfield, Massachusetts.



Figure 1-1. NNEIRI Corridor Study Area

The Inland Route runs between South Station in Boston and western Massachusetts via Worcester and Springfield, where it turns southerly to New Haven and connects to Amtrak’s Northeast Corridor (NEC). The Boston-to-Montreal Route is the same as the Inland Route between Boston and Springfield. At Springfield, the rail corridor runs northerly through Holyoke, Northampton, and Greenfield, Massachusetts. In Vermont, the rail corridor runs on the east side of the state to White River Junction before heading northwesterly to Montpelier and Essex Junction before heading north through St. Albans, Vermont and to the Canadian border at Alburgh, Vermont. The route terminates at Central Station in Montreal, Quebec. This SDP addresses the Boston-to-Montreal Route portion of the NNEIRI Corridor.

The existing station locations that were evaluated as part of the NNEIRI Study are shown in Table 1-1. The table indicates if a station is located on the Inland Route, the Boston-to-Montreal Route, or both. One additional station in Palmer, Massachusetts was considered as part of the NNEIRI Study and would be a stop on both routes.

Table 1-1. NNEIRI Corridor Stations

Station	Route
Boston, Massachusetts (South Station)	Both
Boston, Massachusetts (Back Bay)	Both
Framingham, Massachusetts	Both
Worcester, Massachusetts	Both
Palmer, Massachusetts (new station)	Both
Springfield, Massachusetts	Both
Holyoke, Massachusetts	Boston-to-Montreal Route
Northampton, Massachusetts	Boston-to-Montreal Route
Greenfield, Massachusetts	Boston-to-Montreal Route
Brattleboro, Vermont	Boston-to-Montreal Route
Bellows Falls, Vermont	Boston-to-Montreal Route
Claremont, New Hampshire	Boston-to-Montreal Route
Windsor, Vermont	Boston-to-Montreal Route
White River Junction, Vermont	Boston-to-Montreal Route
Randolph, Vermont	Boston-to-Montreal Route
Montpelier, Vermont	Boston-to-Montreal Route
Waterbury, Vermont	Boston-to-Montreal Route
Burlington (Essex Junction), Vermont	Boston-to-Montreal Route
St. Albans, Vermont	Boston-to-Montreal Route
Montreal (Central Station), Quebec, Canada	Boston-to-Montreal Route
Windsor Locks, Connecticut	Inland Route
Windsor, Connecticut	Inland Route
Hartford, Connecticut	Inland Route
Berlin, Connecticut	Inland Route
Meriden, Connecticut	Inland Route
Wallingford, Connecticut	Inland Route
New Haven, Connecticut	Inland Route

1.3 OVERVIEW OF BOSTON-TO-MONTREAL ROUTE SDP

Given the unique services that will operate, the study team developed two separate SDPs for the two routes. The Boston-to-Montreal Route SDP includes the specific elements that are necessary for improving service on the Boston-to-Montreal Route. The SDP is based on conceptual engineering and service plans developed as part of the *NNEIRI Alternatives Analysis Report* (AA report) and the *NNEIRI Tier 1 Environmental Assessment* (EA). The AA report presents the process used to identify three different build alternatives and facilitated the selection of a single build alternative for further analysis. The EA summarizes the analysis conducted to compare the environmental impacts of the Build Alternative against a No-Build Alternative. Based on the ridership and cost data developed through the AA processes and on input from regional stakeholders and members of the public, the Build Alternative was selected as the Recommended Alternative. Information gained from the AA and EA processes was updated and used to define the SDP, including demand and revenue forecasts, operations modeling, station access analysis, conceptual engineering, public benefit analysis, and information from corresponding projects.

The first part of this SDP is closely aligned with the Inland Route SDP. The information in Chapters 2-5 provide a summary of work completed at the beginning of the NNEIRI Study. The later chapters, Chapters 6-9, provide service details, a review of the public benefits for the project, and outline of the funding, governance, investment considerations needed for implementation of service on the Boston-to-Montreal Route.

- **Chapter 2 (Purpose and Need)** provides the overall NNEIRI Study Purpose and Need Statement established at the onset of the study and a review of existing conditions.
- **Chapter 3 (Alternatives Analysis for NNEIRI)** reviews the AA process, the alternatives considered, the No Build Alternative, and the Recommended Alternative.
- **Chapter 4 (Demand and Revenue Forecasts)** reviews the methodology and ridership forecasts for the NNEIRI Corridor overall and for the Boston-to-Montreal Route.
- **Chapter 5 (Existing Conditions)** includes a summary of existing conditions assessment completed during the AA process.
- **Chapter 6 (Capital Improvements)** summarizes the capital investments required for service on the Boston-to-Montreal Route, including rail equipment and infrastructure improvements.
- **Chapter 7 (Service Operation Plan)** presents the recommended service schedule for the Boston-to-Montreal Route, equipment and train crew schedule, and operations and maintenance (O&M) costs for service.
- **Chapter 8 (Public Benefits Analysis)** presents the findings of a public benefits analysis of service on the Boston-to-Montreal Route including results of a benefit-cost analysis and a qualitative discussion of how the recommended project addresses the Project and Need.
- **Chapter 9 (Implementation Plan)** outlines the strategies and issues that need resolution prior to service implementation. The chapter discusses how service on the Boston-to-Montreal Route could be partially implemented, completed in phases, or completed in conjunction with the Inland Route Service. The chapter includes discussion of the governance issues that will need to be addressed prior to service implementation. Included is the identification of potential administrated models that could be used for



implementation and management of any additional services. The chapter contains the identified capital and operating funding requirements for the Boston-to-Montreal Route that will need to be considered in developing any of the services. Finally, the chapter concludes with a summary of the implementation considerations and next steps that would need to occur in advance of service.

2 PURPOSE AND NEED

This chapter includes the Purpose and Need statement developed at the onset of the NNEIRI Study. The Purpose and Need statement provides the justification for studying and implementing improved rail service in the New England region. One Purpose and Need statement was prepared for the Inland Route and Boston-to-Montreal Route due to the joint nature of the services on both routes.

2.1 PURPOSE

The purpose of the NNEIRI Study is to address the lack of intercity transportation choices in New England, particularly between major cities and the smaller cities and rural areas of the northern region. A potential increase in the use of passenger rail is not being considered as a replacement for other transportation alternatives such as automobile, bus, and air. Rather, enhancing passenger rail service is considered as a means to increase available choices for travelers in the identified travel markets, and to do so in a manner that is supportive of the environmental and economic development goals of the region. As noted in Section 1.1 above, the existing rail routes that comprise the NNEIRI Study area are the result of stipulations contained in Congressional legislation of Public Law 108-447 in Section 154³ and previous regional planning activities. Thus, the NNEIRI Study is focused on analyzing the passenger rail options for the pre-defined corridor in a manner that seeks to capitalize on the use of the considerable existing and pending public and private investments in the corridor. The alternatives developed within the Study will need to be capable of creating a competitive rail transportation alternative to existing automobile, bus, and air travel service through more frequent and higher speed intercity passenger rail service.

2.2 NEED

The need for the NNEIRI Study stems from recognizing benefits to the region's economy and livability from improved connections across and between the New England states. The Corridor has a wide variety of small and medium size cities and economic centers geographically dispersed across New England. Improved transportation connections between these centers would be of great benefit to its residents and employees, as well as visitors traveling within and through the region. Additionally, strong sustained increases in Amtrak New England ridership show that demand for intercity transportation in the Corridor is trending towards alternative modes, including intercity passenger rail. Many highways along the Corridor experience periodic congestion and capacity issues making rail travel a more attractive alternative. Improvements and expansion of intercity rail services would enhance options for the mobility and connectivity needed in the Corridor for the region to grow and prosper.

³ Public Law 108-447, Section 154 passed into law December 8, 2004 states in part that "The Northern New England High Speed Rail Corridor is expanded to include the train routes from Boston, Massachusetts, to Albany, New York, and from Springfield, Massachusetts, to New Haven Connecticut."

2.2.1 Economic Opportunity

In the global economy, regions across the country and the world are continually searching for ways to become or remain economically strong. The New England region has many attributes that support its strong economic position that include a rich social and cultural history, many prestigious academic and research institutions, a well-educated and diverse workforce and a mix of urban, suburban and rural population centers all located in fairly close proximity to the region's major economic centers. Ensuring ready connectivity between the region's population bases and its economic centers is a critical factor in maintaining its economic strength.

The following section identifies key attributes of the Corridor that would be enhanced by improved connectivity from expanded intercity rail service. These include the varied rate of employment and skill level of employees, the size and impact of the tourism sector, and the size and location of colleges and universities in the Corridor, a population that has shown a preference to travel by rail.

2.2.2 Job Access

Connectivity between job centers and specialized employment clusters is a key consideration of the NNEIRI Study. Through connectivity improvements provided by services envisioned for the NNEIRI Corridor, residents would have easy, convenient and affordable access to major job centers.

Access to wider employment markets is especially important in New England, where unemployment rates may vary considerably between metropolitan regions. Despite six-plus years of recovery after the 2007-2009 Recession, the unemployment rate remains high in several of the metropolitan areas along the Corridor. This is especially true in New Haven and Montreal.

In terms of educational attainment, Massachusetts, Connecticut, Vermont, and New Hampshire are all ranked within the top 10 states for percentage of population 25 years or older with a bachelor's degree or higher.⁴ All U.S. metropolitan areas and cities along the Corridor have higher percentage of people 25 years or older with a postsecondary degree. Boston and Burlington have the highest percent (approximately 50 percent) of people with a postsecondary degree while, Greenfield, Massachusetts has the lowest percent (only 38 percent) of people with a postsecondary degree.⁵ Montréal is even lower at 36 percent.⁶

Improved rail service would also expand the talent pool for potential employers. For example, Amtrak's successful Downeaster service (located along a separate branch of the Northern New England High Speed Rail Corridor) provides mobility options for residents throughout eastern New Hampshire and southern Maine to job centers in the metro-Boston area. The service is especially attractive for employment positions that do not require daily travel to an office.

⁴ U.S. Census Bureau, 2011.

⁵ American Community Survey (ACS), 2010-2012; American Community Survey 2007-2011; National Household Survey, 2011, Statistics Canada

⁶ National Household Survey, 2011, Statistics, Canada. Due to variances in educational standards, some Canadians listed as having a high school diploma or equivalent actually have more years of education than U.S. students who fall into the same category.

Additionally, the NNEIRI Corridor would provide connectivity to specialized employment clusters in New England, which include strong financial, academic, consulting, medical, and scientific communities, where collaboration and personal connections are instrumental. Boston, Worcester, Springfield, and New Haven all have large and diverse medical research and education centers. The recommended NNEIRI services would enable individuals from these institutions to physically connect at conferences, research, and employment events in a timely and cost-effective way, even during the challenging winter season when rail travel is typically less impacted by harsh weather compared to other modes. Similarly, it provides another avenue of access between those of similar professions from beyond the region to enhance productive collaboration.

2.2.3 Education

The NNEIRI Corridor is proximate to dozens of colleges and universities attended by almost one million students, as shown in Table 2-1. The majority of these students are based in the Boston, Montreal, and Hartford metropolitan areas, making travel by rail a viable, cost-efficient and timesaving option over driving or flying. Universities are also major destinations for performing arts, sporting events, conferences, research, and other events they host. Table 2-1 also shows the number of colleges and universities within each Metropolitan area along the Corridor. Over 190 schools exist in metropolitan areas along the Corridor. Improvements to the intercity rail service would increase faculty, staff, and students' ability to travel to/from campuses.

Table 2-1. Number of College Students and Colleges by Metropolitan Area

Metropolitan Area	Number of College Students	Number of Colleges
Boston, Massachusetts	432,706	78
Worcester, Massachusetts	61,425	15
Springfield, Massachusetts	74,174	20
Greenfield, Massachusetts*	819	2
Brattleboro, Vermont*	374	6
Lebanon, New Hampshire	14,965	4
Barre, Vermont	4,572	5
Burlington, Vermont	24,659	8
Montréal, Quebec**	>196,076	>7
Hartford, Connecticut	103,335	26
New Haven, Connecticut	68,669	19
Total	>981,774	190

Sources: 2010-2012 American Community Survey (ACS) 3-Year Estimates, 2007-2011 American Community Survey (ACS) 5-Year Estimates; National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education**

*Corridor cities not in metropolitan areas are identified separately.

**Sum of total students reported at seven major schools identified in the metropolitan area. No source on the number of colleges was found. A Google search was utilized to identify major college/universities.

2.2.4 Tourism

Tourism is an important driver of the regional economy within the NNEIRI study area. Tourists spend billions of dollars on tourism-related activities every year in Massachusetts, Vermont, New Hampshire, Québec, and Connecticut as shown in Table 2-2. Tourism also supports tens of thousands of jobs in each state and the province. The number of tourism-related jobs ranges from a high in Québec of 134,600 to 37,910 in Vermont.

With eight to eleven percent of all jobs in the region’s metropolitan areas directly or indirectly linked to this industry, encouraging more people to travel within the region is vital to maintaining and increasing these jobs. Improvements to the intercity rail service will make it easier for leisure travel within the region, particularly for senior or disabled travelers, and international tourists who are unfamiliar with American roadways but comfortable with passenger rail because it is a common travel alternative in their home countries.

Table 2-2. Expenditure and Jobs from Tourism in Each State*

State/ Province	Expenditure (billions)	Tourism Jobs
Massachusetts	15.5	121,700
Vermont	1.7	37,910
New Hampshire	4.2	61,821
Québec	6.6	134,600
Connecticut	8.0	110,000

Source: Connecticut Commission on Culture & Tourism; Massachusetts Office of Travel and Tourism 2011 Annual Report; Vermont Tourism Industry Fact Sheet – 2011; Economic Impact, Tourism, Portrait of Québec

* Connecticut data is from FY2008, Québec data is from CY2009, Massachusetts data is from CY2010 and New Hampshire and Vermont data are from FY2011.

2.2.5 Population and Demographics

In the 2000s, the population of the New England region increased at a rate significantly slower than the rest of the United States. Between 2000 and 2010, the regional population increased by 3.8 percent compared to a national growth of 9.7 percent. While overall population is not significantly increasing, intercity rail ridership did dramatically increase. During a similar timeframe, 1997 to 2012, ridership on Amtrak lines serving New England increased by 71 percent. Even higher ridership was seen in several metropolitan areas. For example, Metropolitan Boston saw a 211 percent increase in Amtrak ridership between 1997 and 2012. Amtrak’s robust growth in New England is largely the result of changing transportation preferences coupled with significant service improvements and expansion in the region.

2.2.6 Changing Transportation Preferences

Nationally, Amtrak ridership increased from 20.5 million in Fiscal Year (FY) 2000 to 31.6 million in FY 2013, a growth rate of 50 percent and a faster rate than any other travel mode

during the same period.⁷ In New England, rail ridership outpaced national averages. For example, ridership on the Downeaster service between Boston and Portland, Maine, ridership grew 123 percent between 2005 and 2013.⁸ Despite relatively slow population growth, New Englanders have increasingly utilized intercity rail transportation. Table 2-3 details the change in Amtrak ridership between 1997 and 2012 in New England’s largest metropolitan areas.

Table 2-3. Change in Amtrak Ridership in New England Metropolitan Areas*

Census Defined Metropolitan Area	1997 Ridership	2012 Ridership	Percent Change
Bridgeport-Stamford-Norwalk, Connecticut	232,447	478,149	+106%
Boston-Cambridge-Quincy, Massachusetts-New Hampshire	1,018,297	3,167,716	+211%
Hartford-West Hartford-East Hartford, Connecticut	236,047	299,163	+27%
New Haven-Milford, Connecticut	276,021	808,300	+193%
Providence-New Bedford-Fall River, Rhode Island-Massachusetts	368,117	874,436	+138%
Springfield, Massachusetts	134,766	156,550	+16%
Worcester, Massachusetts**	15,667	8,900	- 43%
Total Ridership	2,281,362	5,793,214	+154%

Source: Brookings Institution, 2013

*Data for Ridership in other New England Metro Areas not available

**Worcester ridership decline is likely due to the introduction and improvement of the MBTA Commuter Rail Service between Worcester and Boston

2.2.7 Accommodate Populations with High Reliance on Non-Auto/Public Transit

Communities on or in close proximity to the NNEIRI Corridor have significant populations that do not own personal vehicles. In the two largest cities along the corridor, Boston and Montreal, the percentages of households that do not own a car are approximately 37%⁹ and 21%¹⁰, respectively. Households without personal vehicles are likely to be reliant on transit, intercity rail and bus, walking, and biking for transportation. Thus, in communities with high-percentages of households without personal vehicles, improved rail is imperative for mobility and economic competitiveness.

⁷ Szabo, Joseph. “Amtrak ridership breaks 10th record in 11 years.” United States Department of Transportation, October 22, 2013, <http://www.dot.gov/fastlane/amtrak-ridership-breaks-10th-record-11-years>

⁸ Ibid.

⁹ Sivak, Michael. “Has Motorization in the U.S. Peaked?” University of Michigan, Transportation Research Institute, January 2014, <https://deepblue.lib.umich.edu/handle/2027.42/102535>

¹⁰ Anowar, Sabreena and Miranda-Morena, Luis. “Analysis of Vehicle Ownership Evolution in Montreal, Canada Using Pseudo Panel Analysis.” McGill University, February 2015, <http://www.people.cecs.ucf.edu/neluru/Papers/VehicleOwnershipEvolution.pdf>

2.2.8 Accommodate Population and Demographics Changes

Despite being a slow growing region generally, New England has certain areas and demographic segments that are changing quickly. The region's urban and elderly populations have experienced significant growth. Both of these population groups are more likely to need alternatives to cars.

As the preference for urban living increases, key cities and urban centers in the Corridor are rapidly growing. For example, the City of Boston grew by an estimated three percent between 2010 and 2012, or a fifteen percent ten-year growth rate.¹¹ Similarly, Cambridge, Newton, Worcester, Springfield, Hartford, and New Haven saw positive growth rates during this period. With housing and employment location preferences changing to favor cities and urban living, growth in areas with existing public transit, walkable streets, and density is likely to continue. This reliance on public transit will also necessitate better intercity rail connections between cities.

By 2030, the Census Bureau projects that the New England states will see a dramatic change in the general age of its population with the percent of residents over 65 rising significantly. While population aging is occurring across the country and around the world, New England's average population is older and aging more rapidly than the U.S. average. An older population will experience a decrease in mobility and have a higher reliance on alternative means of transportation.

Between 2000 and 2030, the population of individuals aged 65 years and over in Massachusetts, Vermont, New Hampshire, and Connecticut is projected to increase by 79 percent during the 30-year period,¹² and by 2030, 1 in 50 Massachusetts residents are expected to be over the age of 65¹³.

2.2.9 Travel Demand

The New England region has a diverse intercity transportation network, with intercity passenger rail, expressway, bus, and air connections between major cities. However, most modes are already at or near capacity at critical points, with congestion projected to steadily increase.¹⁴

Historically, robust passenger rail options existed throughout New England. Today, with the exception of the Springfield to New Haven segment, only one train per day provides intercity service on the NNEIRI Corridor. The decline in passenger rail began in the 1920s with the arrival of the automobile and was exacerbated by the construction of the Interstate Highway System in the mid-20th Century. In the early 21st Century, intercity rail ridership is seeing resurgence, as changing travel preferences among large segments of the population redefine

¹¹ U.S. Census 2012 Estimate.

¹² Population Pyramids and Demographic Summary Indicators for States, retrieved on Nov. 11, 2013. <http://www.census.gov/population/projections/data/statepyramid.html>

¹³ O'Sullivan, Jim. "State Population Growth is Forecast to Slow." Boston Globe, December 4, 2013, <http://www.bostonglobe.com/metro/2013/12/04/state-population-growth-slow-age/oweUVZZaGhvKam36tozgOP/story.html>

¹⁴ New England Futures: New Century, New Game. Road, Rail, Air, Water: Separate Worlds or One System? <http://newenglandfutures.org/issues/connections/article/>. Originally published in February 2006.

travel in the United States. Amtrak, in partnership with various states, is expanding and improving regional passenger rail services.

Introducing additional intercity passenger rail services that connect major urban centers with smaller cities and towns in the region would provide a competitive modal option for travel in the Corridor. The traveling public selects travel modes based on a combination of trip time, cost, and convenience, and travelers are opting for rail where reliable and frequent rail service is available, as opposed to facing the increased congestion and delays of New England highways and airports.

Travel modes available to the public along the Corridor include automobile, air, bus, commuter rail, and relatively low-speed, low frequency, long-distance passenger rail. The predominant mode of travel in the region remains the automobile. Intercity highway access in the region is provided through Interstates 84, 89, 90, 91, 93, 95, and Canadian AutoRoute 35, as well as a number of state highways. Interstate 90 in Massachusetts and portions of Interstate 93 in New Hampshire are toll roads.

In addition to the costs and travel time of automobiles, Interstates in metropolitan Boston, Hartford, New Haven, and Montreal have peak-period congestion and capacity issues. In Boston, commuters spend an average of 64 hours a year sitting in traffic¹⁵, and in Montreal traffic congestion costs the city approximately \$1.7 billion annually¹⁶. The remainder of the Corridor experiences intermittent traffic congestion. Due to environmental concerns, cost, and community resistance, it is highly unlikely that significant roadway capacity will be added in the New England region in the near future.

Air service is currently available between certain major city pairs in the NNEIRI study area. Extensive commercial air service is provided in Boston (Logan International Airport), Hartford (Bradley International), Burlington, and Montreal (Dorval International). Air Canada provides direct flights between Boston and Montreal and Hartford and Montreal. The scheduled flight times range from 72-82 minutes; however, most airlines require passengers to arrive two hours early for international flights. Tickets purchased with two weeks advanced notice typically cost over \$600 for direct flights. While indirect flights are cheaper, costing \$361 if purchased in advance, the layover time also increases the travel time by up to four hours. Major airports in the region are experiencing ground transportation related congestion, with anticipated passenger demand expected to further strain capacity. Logan International Airport, for example, is anticipated to grow from 29 million passengers per year in 2012 to 40 million passengers in 2030 which will strain existing terminal and ground transportation facilities.¹⁷

A number of public and private bus companies provide intercity bus service between a majority of the region's mid-to-large sized cities, with intermittent service in smaller towns along the NNEIRI Corridor. Greyhound provides service throughout much of the corridor between Boston and Montreal. Service is as frequent as four trips per day between White River Junction,

¹⁵ "Report: Boston Ranks Among Top 10 Worst Cities For Traffic." CBS Boston, March 16, 2016, <http://boston.cbslocal.com/2016/03/16/boston-traffic-congestion-worst-inrix/>

¹⁶ "Montreal Traffic Woes by the Numbers." CBC News, November 2, 2015, <http://www.cbc.ca/news/canada/montreal/montreal-tolls-traffic-congestion-1.3299936>

¹⁷ "Boston-Logan International Airport 2011 Environmental Status and Planning Report, Massachusetts Port Authority, April 2013

Vermont and Montreal. Megabus.com, a subsidiary of Coach USA, is a low-fare express bus service with stops in Boston, Burlington, Montpelier, Hartford, and New Haven. In addition, Peter Pan Bus Lines, Concord Coach, Dartmouth Coach and others provide intercity bus service to and between cities on the Corridor. Megabus.com provides one round trip per day between Boston and Hartford. The 110 minute trip costs \$10-20 if purchased in advance. In addition to low fares, Megabus.com offers competitive amenities including Wi-Fi service, power ports at each seat, and on-board restrooms. However, Megabus and similar companies such as Bolt Bus and Greyhound are subject to the same delays as automobiles on New England's congested interstates that can make bus service less reliable..

Unlike the NEC to the south, passenger rail service along the NNEIRI Corridor is limited. Amtrak currently operates the following service along segments of the NNEIRI Corridor:

- The Lake Shore Limited provides one daily round-trip service between Boston and Chicago, Illinois via Springfield;
- The Vermonter runs once daily between Washington, D.C. and St. Albans, via New Haven and Springfield;
- The Northeast Regional Shuttle operates four roundtrip trains between Springfield and New Haven. An additional Northeast Regional train runs a daily roundtrip between Springfield, New Haven, New York City, and points south.

Travel time from Boston to Springfield on the current Amtrak service is approximately two hours and 15 minutes. Travel time from New Haven to Springfield is approximately 1 hour and 30 minutes. The typical ticket price for travel from Boston to Springfield is \$21 and from New Haven to Springfield is \$22.

3 ALTERNATIVE ANALYSIS FOR NNEIRI

This chapter summarizes the alternatives development and analysis process and describes the Recommended Alternative that was developed as a result of *NNEIRI Alternatives Analysis Report* (AA report)¹⁸ and *NNEIRI Tier 1 Environmental Assessment* (EA).¹⁹ The NNEIRI study team, which included MassDOT, VTrans, and a consultant team, developed three build alternatives from a range of preliminary options. The team conducted an analysis of these alternatives and compared a single selected Build Alternative against a No-Build Alternative. A single Recommended Alternative that best addresses the Project Purpose and Need while balancing feasibility and cost effectiveness was also defined. The Recommended Alternative described in this chapter includes services on both the Inland Route and Boston-to-Montreal Route.

3.1 ALTERNATIVES ANALYSIS OVERVIEW

At the beginning of the alternatives development process, the study team defined 18 initial alternatives with ranges of speed, frequency, and equipment. The study team analyzed these alternatives to assess impacts on ridership and train performance. This data was used to determine the three preliminary build alternatives analyzed in the AA report. Based on the results of the alternatives analysis, stakeholder input, public meetings, and technical review by public agencies, a Recommended Alternative was selected for comparison against a No-Build Alternative. These two alternatives were further developed and analyzed as part of the EA. This chapter summarizes the AA and EA processes, including the screening method to develop the three preliminary build alternatives, the screening process of those three alternatives, and the evaluation and selection process to identify the Recommended Alternative. This Recommended Alternative includes the service on the Inland Route that is described as part of this SDP. A more detailed description of the preliminary alternatives screening and evaluation process is included in the AA report. The EA includes more detailed analysis of affected environment and environmental considerations associated with the Recommended Alternative. The EA also outlined potential mitigation measures and anticipated future Tier 2 project level analysis for several environmental resources.

3.2 INITIAL SERVICE OPTIONS

The study team developed 18 initial alternatives for consideration and analysis by identifying train operating characteristics potentially feasible along the NNEIRI Corridor. Service between Springfield and New Haven utilizes CTDOT's plan for the CT Rail Hartford Line service and therefore was not modeled by the Study Team to determine speed, equipment, and engineering parameters. The Study team developed the initial alternatives based on consideration of the following criteria:

¹⁸ Northern New England Intercity Rail Initiative. Alternatives Analysis Report. January 2015.

¹⁹ Northern New England Intercity Rail Initiative. Tier 1 Environmental Assessment. August 2015.

- **Speed:** Top speeds of 60, 79, 90, 110, 125 mph.
- **Equipment:** Tilt and non-tilt train equipment.
- **Engineering Specifications:** Track engineering specification modifications that include:
 - Super-elevation, and
 - Unbalance.
- **Number of Locomotives:** Use of more than one locomotive for each trainset.
- **Station Stops:** Local service (fourteen intermediate stations) and express service (five intermediate stations).

3.2.1 Performance Results

The study team estimated travel time for the 18 initial alternatives using the Train Performance Calculator (TPC) simulation model within the Berkeley Simulation Software, LLC's Rail Traffic Controller (RTC) software package. The TPC model calculates the best possible train running time over a given route using specific route characteristics. The study team drew the following conclusions from the analysis:

- Eliminate use of more than one locomotive from further evaluation due to limited travel time savings;
- Eliminate top speeds of 110 or 125 mph due to the limited areas of feasibility and significantly higher capital and operating costs; and
- Use of tilt equipment in conjunction with a 90 mph maximum allowable speed provides largest estimated time savings.

3.2.2 Preliminary Service Plans

Based on the results of the TPC developed travel time estimates, a number of service plans were advanced into the preliminary ridership-estimating phase to develop the three build alternatives. The information required to develop preliminary ridership estimates included:

- Train service times;
- Daily frequencies; and
- Station stops.

The study team developed a set of daily train frequencies options for preliminary ridership analysis. For the Boston-Springfield Segment, alternatives with eight, twelve, and sixteen daily round-trip trains were tested. For the Springfield-Montreal Segment, options of four, seven, and twelve trips per day were analyzed by the study team. The study team utilized the schedule developed for the CT Rail Hartford Line service to develop a schedule for NNEIRI Corridor services operating between Springfield and New Haven. The preliminary service plans include a mixture of local and express service.

3.2.3 Preliminary Ridership Results

The initial ridership analysis evaluated speed, number of station stops, frequency of service, and other factors that affect ridership for the Corridor. The study team reached the following conclusions based on the preliminary ridership results:

- Ridership on the Boston-Springfield Segment is primarily influenced by travel time; and
- The Springfield-Montreal Segment is primarily influenced by access, or the number station stops.

The conclusions of the analysis were factored into development of the three build alternatives.

3.3 PRELIMINARY ALTERNATIVES

Based on analysis of the 18 initial alternatives and the input provided by stakeholders and the public, the initial options were screened down to three build alternatives. The three build alternatives represent the range of potential service and speed options that appeared to be the most feasible and efficient based on the analysis of the initial options. They are intended to meet the Project Purpose and Need in a cost-effective manner.

3.3.1 Alternative 1 Corridor Service

Alternative 1 provided improved passenger rail service on the Corridor with infrastructure upgrades to improve speeds to 60 mph where possible and accommodate the Alternative 1 service plan. Infrastructure upgrades included additional sidings, and track and bridge improvements. The Alternative 1 service plan provided local service between Boston, Montreal, and New Haven.

Service Program

As shown in Figure 3-1, Alternative 1 included two daily round-trips between Boston and Montreal and four daily round-trips between New Haven and Boston. These additional round-trips would provide six daily round-trips between Boston and Springfield. Four of the six additional trains would be extensions of existing services that currently operate between New Haven and Springfield. Under Alternative 1, these existing services will be extended to operate to Boston. Two of the six additional round-trip trains recommended to operate between Boston and Springfield would be through trains that continue north from Springfield to Montreal.

Additionally, Alternative 1 included one additional round-trip train operating between New Haven to Montreal via Springfield. It was not determined if this round-trip train should continue on the NEC as an additional train, be an extension of an existing train, or have a terminus at New Haven. All Alternative 1 round-trip trains would stop at all existing or proposed rail stations on the Corridor.

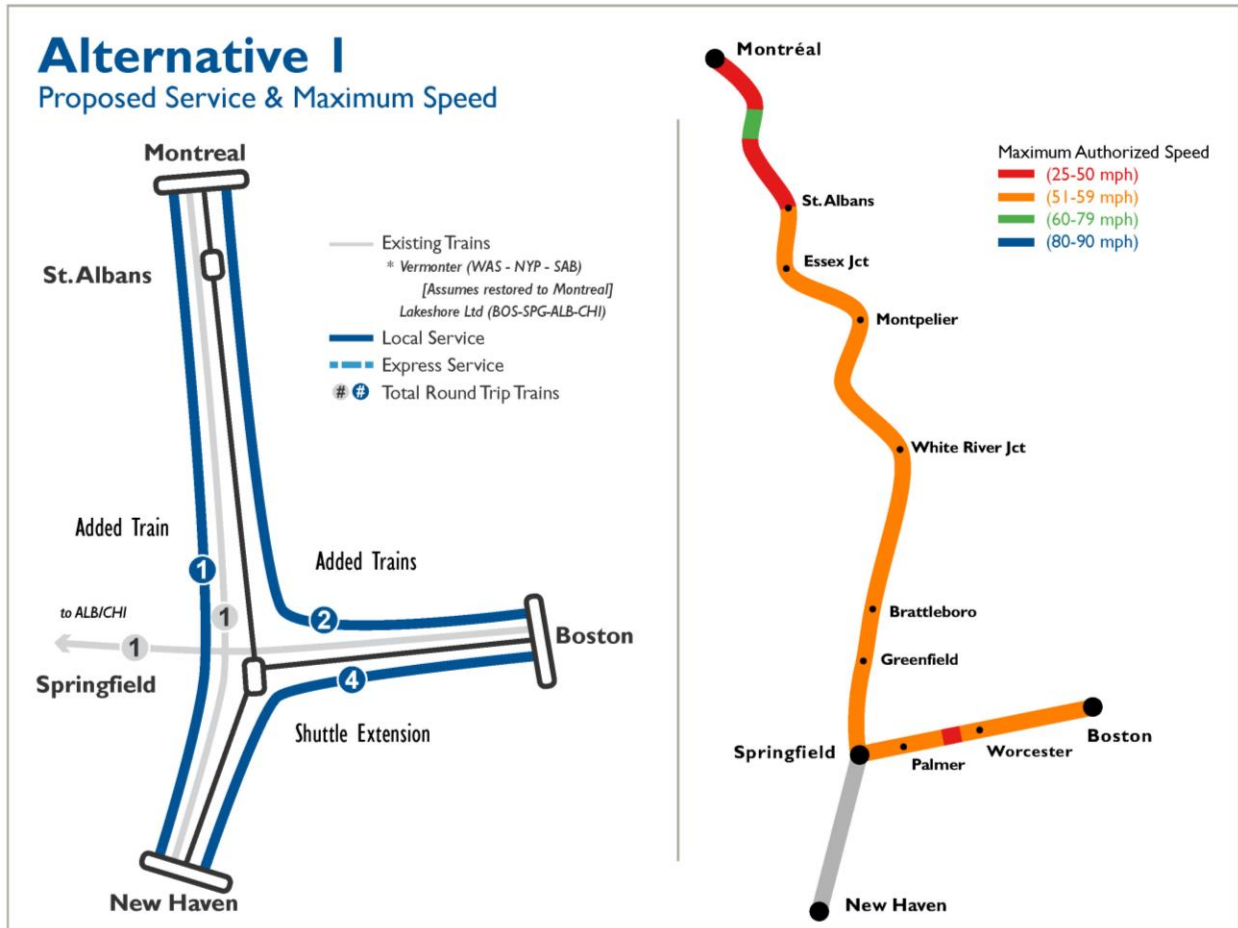


Figure 3-1. Alternative 1 Frequency and Speed Charts

Infrastructure Program

Alternative 1 would require infrastructure upgrades at some locations on the Corridor to accommodate the additional passenger rail service. Speeds would increase to at least 60 mph where possible and infrastructure upgraded to serve proposed train operations. Maximum operating speeds would be 79 mph where it currently exists.

- **Layover Facilities.** Train sets on the Corridor will access existing layover facilities near terminal stations.
- **Right-of-Way.** Alternative 1 would include track capacity improvements which would be constructed within the existing right-of-way. In multiple segments of the Corridor, only a single track exists or is currently in operation. Single-track segments constrain the number of trains that can operate on a segment for both freight and passenger railroads. Alternative 1 included adding a second track for switching between Spencer and Brimfield, Massachusetts on CSX and additional sidings between East Northfield and St. Albans on NECR to enable freight and passenger rail to operate more efficiently.
- **Signal Systems.** The Corridor currently has train control signal systems between Boston and Springfield, between Springfield and New Haven, between Springfield and East Northfield, along rail segments in Vermont, near Montreal, and other select locations on

the right-of-way. Due to the additional trains proposed in Alternative 1, an extensive train control signal system and positive train control (PTC) systems would be added in certain parts of the Corridor to provide additional safety measures for the increased frequencies. Signal systems would include improvements to warning devices at highway-rail grade crossings. The extent and location of additional signal improvements is based on planned freight and passenger train frequencies and changes in operating speed.

- **Station Infrastructure.** No major improvements to existing stations on the Corridor were planned as part of this alternative. However, minor station improvements are necessary to provide key passenger amenities and meet operational requirements. Worcester station requires additional platform and track capacity to accommodate any additional intercity services. The construction of a center island platform within the existing ROW would accommodate Alternative 1 service levels. Service to Palmer would require construction of a new station since the configuration of the historic station precludes the installation of the Massachusetts Architectural Access Board required high level platforms and double main tracks that are included in the Recommended Alternative.

3.3.2 Alternative 2 – Corridor Service with Speed Improvements

Alternative 2 provided eight round-trips from Boston to New Haven (four express and four local), three round-trips from Boston to Montreal (two local and one express), and two round-trips from New Haven to Montreal (one express and one local). Speeds would increase to 79 mph (except in areas where track is currently rated for higher speed operations) and standard train equipment would be used. Infrastructure upgrades included a second track in multiple single-track locations, several additional sidings, and bridge improvements. The Alternative 2 service plan provided local and express service between Boston, Montreal, and New Haven.

Service Program

As shown in Figure 3-2, Alternative 2 provided eight round-trips from Boston to New Haven (four express and four local), three trains from Boston to Montreal (two local and one express), and two trains from New Haven to Montreal (one express and one local).

All Alternative 2 round-trip local trains would stop at all existing or proposed rail stations on the corridor. Alternative 2 included the addition of express service for certain routes. Ridership data was utilized to determine the stations with the highest ridership potential for express service. Generally, express trains would stop at larger metropolitan centers and other strategic station locations. Express station stops modeled were Boston (South Station and Back Bay), Worcester (Union Station), Springfield (Union Station), White River Junction, Essex Junction, and Montreal (Central Station).

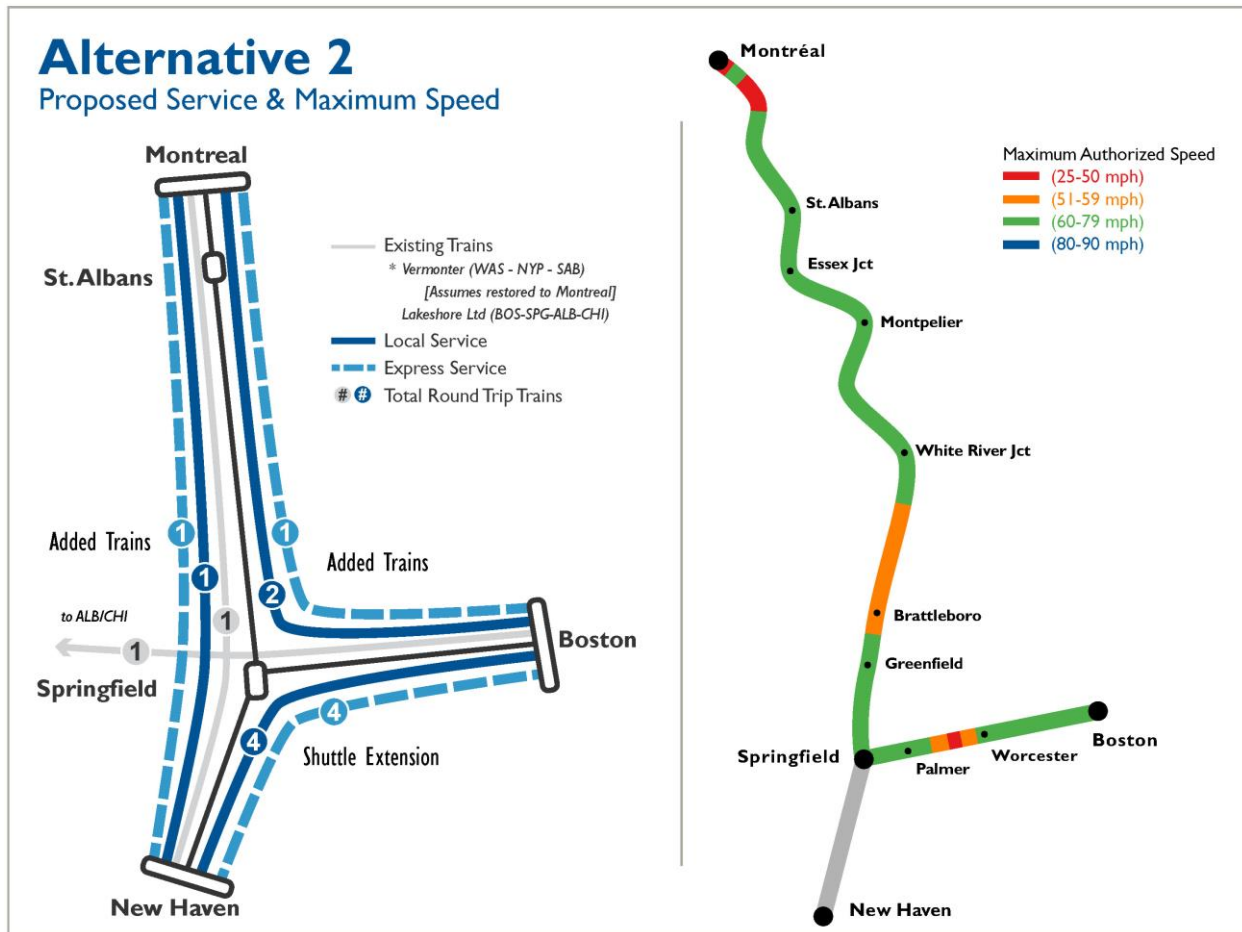


Figure 3-2. Alternative 2 Frequency and Speed Charts

Infrastructure Program

Alternative 2 would utilize existing infrastructure and include improved infrastructure that increases capacity and speeds to meet demands of the service program. Speeds would be improved to 79 mph where possible.

- **Layover Facilities.** Train sets on the Corridor would be accommodated at existing layover facilities near terminal stations.
- **Right-of-Way.** Alternative 2 would include track capacity improvements constructed within the existing right-of-way, including additional sidings between East Northfield and St. Albans on NECR, a second main track for all single-track segments between Worcester and Springfield, and an additional track for switching to between Spencer and Brimfield, Massachusetts to enable freight and passenger rail to operate more efficiently.
- **Signal Systems.** The Corridor currently has train control signal systems between Boston and Springfield, between Springfield and New Haven, along several segments in Vermont, near Montreal, and other select locations on the right-of-way. Due to the additional level of service, a full train control signal system would be added in Alternative 2 on the full length of the right-of-way to provide additional safety measures for the increased frequencies. Signal systems improvements would include upgrades to

warning devices at highway-rail grade crossings. Specific improvements at individual crossings would be based on increased train frequency, higher operating speeds, or both.

- **Station Infrastructure.** No major improvements to existing stations on the Corridor were planned as part of this alternative. However, minor station improvements are necessary to provide key passenger amenities and meet operational requirements. Worcester station requires additional platform and track capacity to accommodate any additional intercity services. At Worcester station, the construction of a center island platform within the existing ROW would accommodate Alternative 2 service levels. The construction of a center island platform within the existing ROW would accommodate Alternative 1 service levels. Service to Palmer would require construction of a new station since the configuration of the historic station precludes the installation of the Massachusetts Architectural Access Board required high level platforms and double main tracks that are included in the Recommended Alternative.

3.3.3 Alternative 3 – Corridor Service with Speed and Equipment Improvements

Alternative 3 considered service with a maximum operating speed of 90 mph and the use of tilt train equipment. A preliminary review of infrastructure needs associated with tilt equipment did not identify any improvements necessary specifically for tilt equipment. Similar to Alternative 2, this alternative provided eight round-trips between Boston and New Haven (four express and four local), three round-trips between Boston and Montreal (two local and one express), and two round-trips from New Haven to Montreal (one express and one local). Infrastructure upgrades included track rehabilitation, grade crossing improvements, full train signalization, and additional sidings/double tracking.

Service Program

As shown in Figure 3-3, the Alternative 3 service plan provided the following service: eight round-trip trains from Boston to New Haven (four express and four local), three round-trip trains from Boston to Montreal (two local and one express), five shuttle local service round-trip trains from Boston to Springfield, and two round-trip trains from New Haven to Montreal (one express and one local).

All Alternative 3 round-trip trains would stop at all existing or proposed rail stations on the corridor. Alternative 3 included the addition of express service for certain routes. Ridership data was utilized to determine the stations with the highest ridership potential for express service. Generally, express trains would stop at larger metropolitan centers and other strategic station locations. Express station stops modeled were Boston (South Station and Back Bay), Worcester (Union Station), Springfield (Union Station), White River Junction, Essex Junction, and Montreal (Central Station).

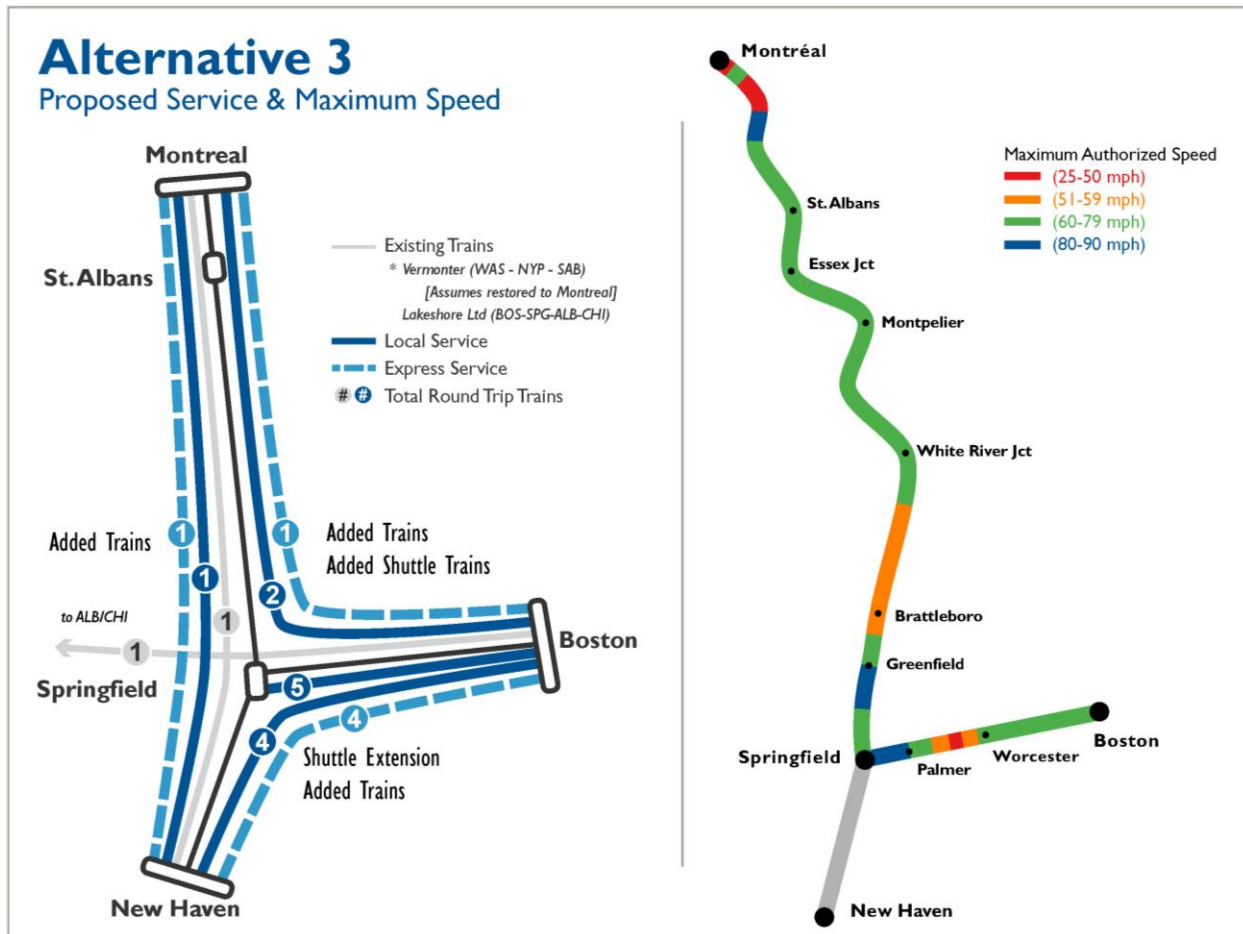


Figure 3-3. Alternative 3 Frequency and Speed Charts

Infrastructure Program

- **Layover Facilities.** Train sets on the Corridor would be accommodated at existing layover facilities near terminal stations.
- **Right-of-Way.** Alternative 3 did not propose any track re-alignment changes. Several proposed track capacity improvements would be made. These improvements would be constructed within the existing right-of-way and included, additional sidings between East Northfield and St. Albans on NECR, a second main track for all single-track segments between Worcester and Springfield and adding an additional track for switching to between Spencer and Brimfield, Massachusetts on CSX to enable freight and passenger rail to operate more efficiently.
- **Signal Systems.** The Corridor currently has train control signal systems between Boston and Springfield, between Springfield and New Haven, along several segments in Vermont, near Montreal, and other select locations on the right-of-way. Due to the additional level of service, a full train control signal system would be added in Alternative 3 on the full length of the right-of-way to provide additional safety measures for the increase frequencies. Signal systems improvements would include upgrades to

warning devices at highway-rail grade crossings. Specific improvements at individual crossings would be based on increased train frequency, higher operating speeds, or both.

- **Stations.** No major improvements to existing stations on the Corridor were planned as part of this alternative. However, minor station improvements are necessary to provide key passenger amenities and meet operational requirements. Worcester station requires additional platform and track capacity to accommodate any additional intercity services. At Worcester station, the construction of a center island platform within the existing ROW would accommodate service levels for Alternative 3. The construction of a center island platform within the existing ROW would accommodate Alternative 1 service levels. Service to Palmer would require construction of a new station since the configuration of the historic station precludes the installation of the Massachusetts Architectural Access Board required high level platforms and double main tracks that are included in the Recommended Alternative.

3.3.4 Alternatives Comparison

The AA report provided a detailed comparison of the three build alternatives based on preliminary service plans, ridership forecasts, capital costs, and operations and maintenance costs (O&M). Table 3-1 summarizes these criteria for each of the alternatives.

Table 3-1. Alternatives Comparison

Alternative	Capital Costs	Annual Operating Support	Annual Riders (2035)
Alternative 1	\$615-785 million	\$24 million	681,500 riders
Alternative 2	\$1,065-1,350 million	\$39 million	1,201,200 riders
Alternative 3	\$1,255-1,590 million	\$48 million	1,334,800 riders

A high-level, corridor-wide environmental screening was completed during the AA to identify any known significant impacts that would result from the proposed alternatives. The analysis found that impacts along the Corridor would be generally minor and moderate with some minor impacts in specific locations due to operations and infrastructure needs. No significant impacts are anticipated.

- **Alternative 1 - Corridor Service:** Provides local service (stopping at all stations) on the Corridor, including four round-trip trains between Boston and New Haven, two round-trip trains from Boston to Montreal, and one additional round-trip train between New Haven and Montreal. Speeds on the Corridor will be improved to at least 60 mph and use standard train equipment. Alternative 1 is the least expensive alternative, estimated between \$615-785 million. This alternative has the lowest ridership with an estimated 681,500 passengers annually.
- **Alternative 2 - Corridor Service with Speed Improvements:** Builds on Alternative 1 with the addition of four express round-trip trains between Boston and New Haven, one round-trip train from Boston to Montreal, and one round-trip train from New Haven to Montreal. Additionally, speeds will be improved to at least 79 mph and operations and standard train equipment will be used. Initial capital costs are expected to be \$1.065-

1.350 billion. Estimated ridership increases by 76 percent over Alternative 1 to 1,201,200 annually.

- **Alternative 3 - Corridor Service with Speed and Equipment Improvements:** In addition to providing the same services as Alternatives 1 and 2, Alternative 3 also adds five local round-trips between Boston and Springfield. Additionally, speeds are improved to at least 90 mph and tilting train sets are utilized. Capital costs for Alternative 3 are estimated to be between \$1.255-1.590 billion and ridership is expected to be 1,334,800 annual riders, approximately 11 percent more annual riders than Alternative 2.

Due to track geometry, the NNEIRI Corridor has limited locations where trains could operate at 90 mph. Consequently, the travel time savings for Alternative 3 are not significantly greater than Alternative 2 and would not justify the higher costs associated with this alternative. Ridership was significantly less for the Alternative 1 with a maximum speed of 60 mph as compared to Alternative 2 with a maximum speed of 79 mph. Therefore, Alternative 2 proved the most promising of these alternatives due to a combination of infrastructure constraints, ridership, and costs. With some modifications described later in this chapter, Alternative 2 was carried forward as the single build alternative for analysis in the EA.

3.4 NO-BUILD ALTERNATIVE

To better evaluate the Build Alternative that was analyzed as part of the EA, a No-Build Alternative was developed to provide a benchmark to compare the impacts. This No-Build Alternative included all recently completed, ongoing, and planned improvements to the Corridor through future year 2035. The Study Team chose an analysis year of 2035 to assess the full impacts of NNEIRI service implementation. Additionally, the 20-year time horizon is a standard FRA requirement for long-range rail planning.²⁰

3.4.1 Existing and Proposed Passenger Service

The No-Build Alternative assumes the continuation of the passenger rail services that currently operate on the Corridor, including:

- MBTA Southside Commuter Rail Services between Boston South Station and Boston Back Bay Station;
- MBTA Worcester Line Service between Boston and Worcester;
- Amtrak Lake Shore Limited service between Boston and Chicago, via Springfield and Albany;
- Amtrak Northeast Regional Shuttle between New Haven and Springfield;
- Amtrak Northeast Regional between Springfield and Washington, D.C.; and
- Amtrak Vermonter service between Washington, D.C. and St. Albans, via New Haven, Springfield, and White River Junction.

²⁰ “State Rail Plan Guidance,” Federal Register, September 2013, <https://www.federalregister.gov/articles/2013/09/18/2013-22679/state-rail-plan-guidance>

In addition, new and improved passenger rail operations are anticipated for the following corridors:

- MassDOT Knowledge Corridor/Restore Vermonter Project service changes between Springfield and East Northfield, Massachusetts;
- Amtrak Vermonter extension from St. Albans to Montreal on the NECR and Canadian National (CN) Lines; and
- CTDOT CT Rail Hartford Line service between New Haven, Hartford, and Springfield.

3.4.2 Current and Planned Infrastructure Upgrades

The No-Build Alternative assumes several known capacity and speed upgrades to the right-of-way and station projects that are currently in progress or planned to occur. These completed or underway improvements include:

- As part of the Knowledge Corridor/Restore Vermonter project, Amtrak Vermonter service has been reestablished along the Connecticut River Line between Springfield and East Northfield, Massachusetts. The service on this track segment began in December 2014 and all related project work will be completed by fall 2016.
- CTDOT infrastructure improvements on the NHHS rail line are underway, including double tracking and station improvements between New Haven, Hartford, and Springfield.
- Construction is underway for the Springfield Redevelopment Authority's restoration of Springfield Union Station.
- In a project associated with restoration of Springfield Union Station, MassDOT is currently making improvements to the train platforms at the station.

Planned services include:

- The planned expansion of Boston South Station to accommodate additional track capacity, train storage space, and provide additional station platforms.
- Extension of the Amtrak Vermonter service north to Montreal and improvements to infrastructure that would need to be completed between the U.S. border and Montreal, as identified in the Quebec Ministry of Transportation's *Study of CN and CP's Rail Networks between Montréal and the U.S. Border* released in 2014.
- A new U.S. Customs and Immigration Services and Canada Border Services Agency station is planned for construction at Montreal Central Station Customs Checkpoint to allow faster travel in and out of Canada for passenger trains.

3.4.3 Layover Facilities

A significant element of infrastructure needed to support railroad operations is the layover facilities for trains. Train sets on the Corridor would be accommodated at layover facilities near terminal stations, which either exist today or are planned as part of other projects previously described in Section 3.4.3. Layover facilities would primarily serve as points to store, restock, and perform light maintenance on rail equipment. Additionally, layover facilities would provide crew quarters, including briefing rooms, locker rooms, and break rooms.

Locations of existing or proposed layover facilities include:

- Southampton Street Yard in Boston (Amtrak) and other MBTA layover facilities in the Boston area;
- A proposed Springfield Union Station Layover and Maintenance Facility in Springfield;
- Springfield Station Sweeny Yard in Springfield (Amtrak);
- New Haven Yard in New Haven (Amtrak);
- St. Albans Yard in St. Albans (NECR); and
- Montreal Area – Assumed to be included in improvements to infrastructure between the U.S. border and Montreal that were identified in the Quebec Ministry of Transportation study released in 2014. Existing VIA Rail Canada Montreal Maintenance Center (MMC) facility will be used.

3.5 RECOMMENDED ALTERNATIVE

Based on the results of the AA, stakeholder input, public meetings, and technical review by public agencies, the study team developed a single Build Alternative that was further developed and analyzed against the No-Build Alternative as part of the Tier 1 EA. The three primary factors used to determine the build alternative were infrastructure constraints, ridership, and cost. Subsequent to development of the EA, the build alternative was accepted as the Recommended Alternative. The Recommended Alternative included speeds up to 79 mph and new passenger services along the entire NNEIRI Corridor between Boston, Montreal, and New Haven. An overview of the services, speeds, and infrastructure are provided in the following sections. More details on ridership, costs, and the service operation plan for the Boston-to-Montreal Service are provided in later chapters of this SDP.

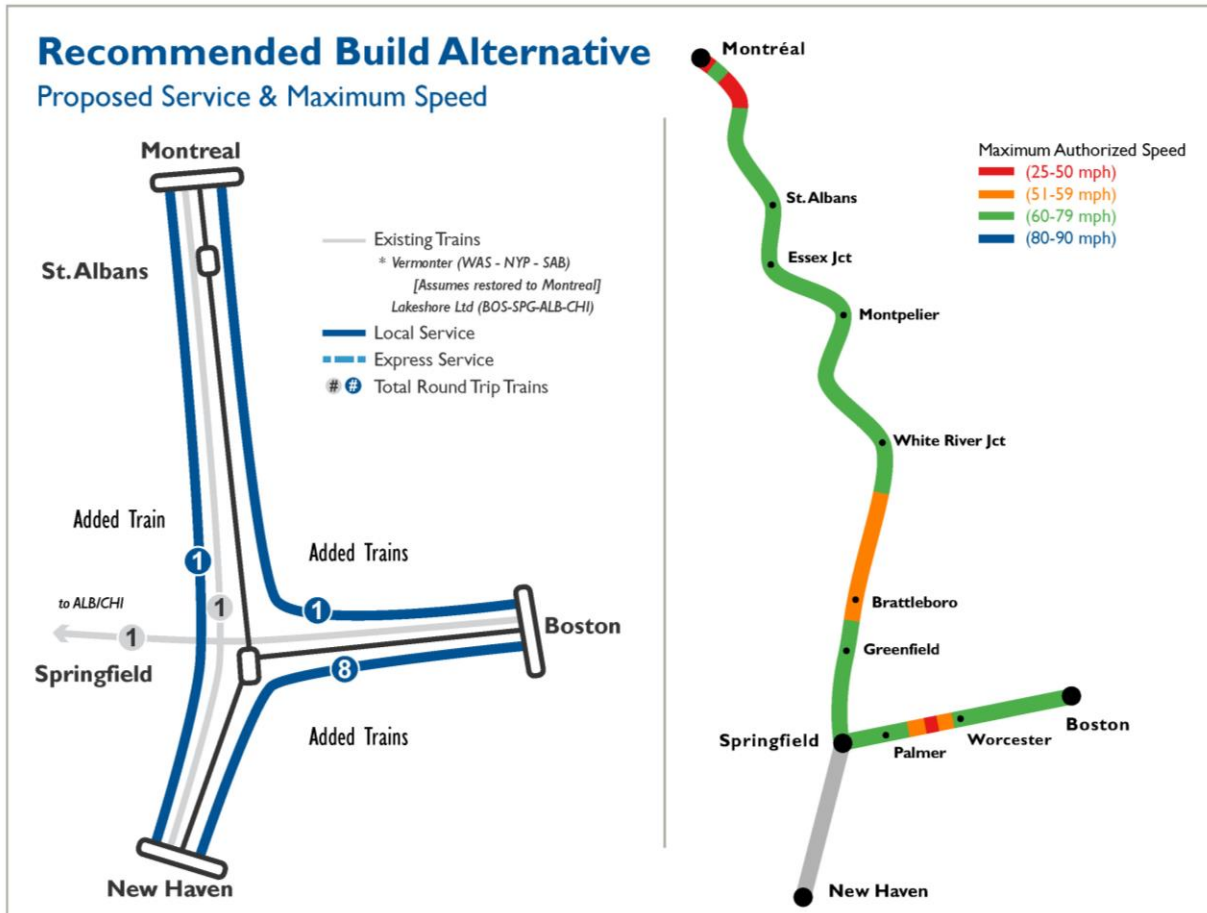


Figure 3-4. Recommended Build Alternative Frequency and Speed Charts

3.5.1 Service Plan

The Recommended Alternative included three new services (see Figure 3-5). The three new services include: Boston-to-Montreal Service, New Haven-to-Montreal Service, and Boston-to-New Haven Service, all via Springfield, MA. Services would be provided to all existing intercity rail stations between Boston and Springfield, and Springfield and Montreal. Trains operating between New Haven and Springfield would operate based on existing shuttle stopping patterns, with select trains skipping stops.

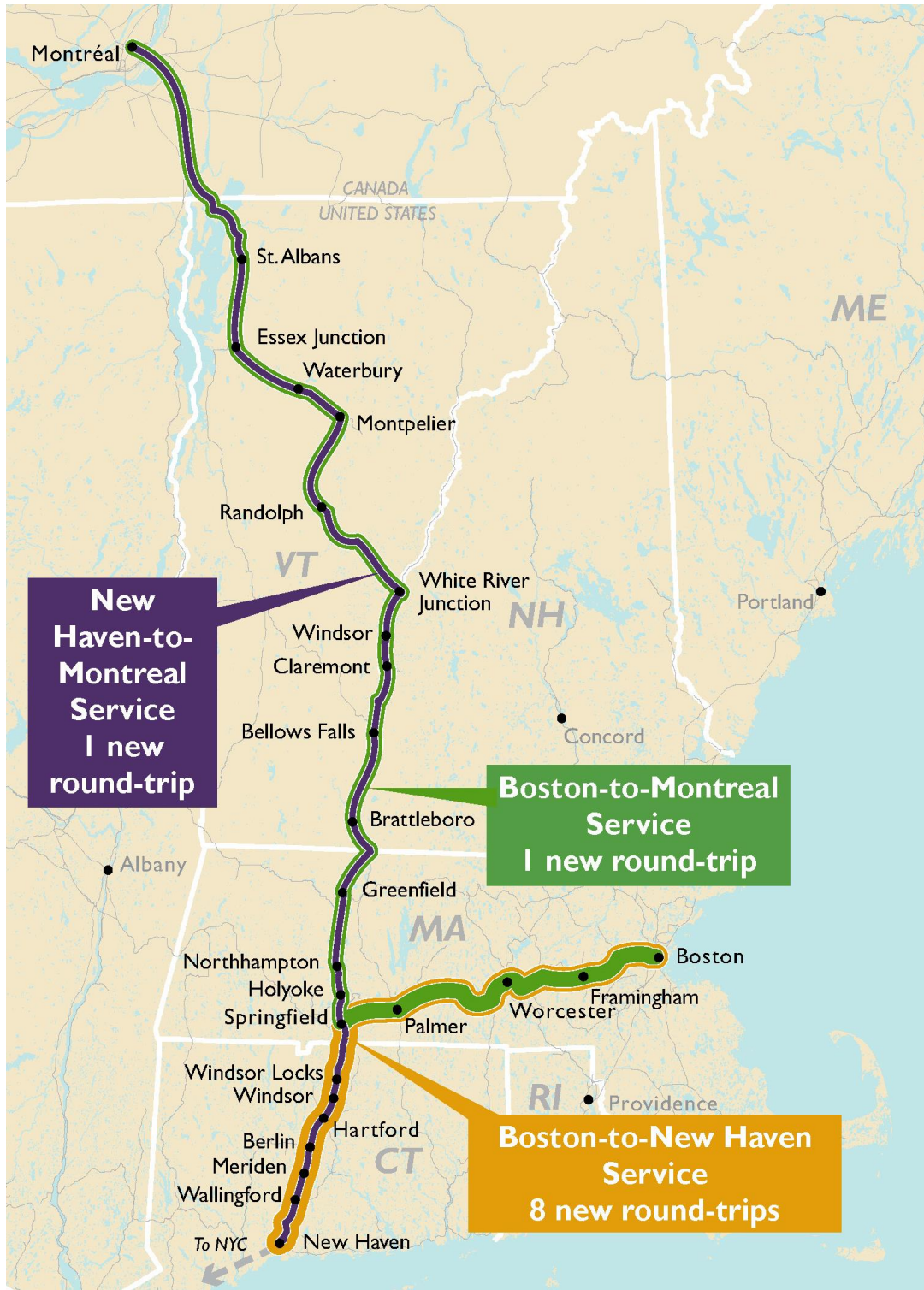


Figure 3-5. Recommended Build Alternative Service and Stations

Boston-to-Montreal Service

Along the Boston-to-Montreal Route, one round-trip would operate daily between Boston to Montreal, with trains serving all stations. The frequency of service is considered optimal due to the level of demand anticipated in ridership forecasting. Station stops would include:

- Boston, Massachusetts (South Station and Back Bay);
- Framingham, Massachusetts;
- Worcester, Massachusetts;
- Palmer, Massachusetts (new station);
- Springfield, Massachusetts;
- Holyoke, Massachusetts;
- Northampton, Massachusetts;
- Greenfield, Massachusetts;
- Brattleboro, Vermont;
- Bellows Falls, Vermont;
- Claremont, New Hampshire;
- Windsor, Vermont;
- White River Junction, Vermont;
- Randolph, Vermont;
- Montpelier, Vermont;
- Waterbury, Vermont;
- Burlington (Essex Junction), Vermont;
- St. Albans, Vermont; and
- Montreal (Central Station), Quebec, Canada.

New Haven-to-Montreal Service

The second service on the Boston-to-Montreal Route provides an additional local round-trip between New Haven and Montreal, with similar characteristics to Amtrak's Vermonter service. The additional service would complement the Vermonter and provide additional services to meet demand anticipated by ridership studies. Station stops would include:

- New Haven, Connecticut;
- Wallingford, Connecticut;
- Meriden, Connecticut;
- Berlin, Connecticut;
- Hartford, Connecticut;
- Windsor, Connecticut;
- Windsor Locks, Connecticut;
- Springfield, Massachusetts;
- Holyoke, Massachusetts;
- Northampton, Massachusetts;
- Greenfield, Massachusetts;
- Brattleboro, Vermont;
- Bellows Falls, Vermont;

- Claremont, New Hampshire;
- Windsor, Vermont;
- White River Junction, Vermont;
- Randolph, Vermont;
- Montpelier, Vermont;
- Waterbury, Vermont;
- Burlington (Essex Junction), Vermont;
- St. Albans, Vermont; and
- Montreal (Central Station), Quebec, Canada.

Boston-to-New Haven Service

Eight round trips would operate daily between Boston and New Haven on the Inland Route. These services would be extensions of existing services operating on the Corridor between New Haven and Springfield. The ultimate destination of each train (i.e., New Haven, New York City, or Washington, D.C.) would be determined through discussions with Amtrak and coordination with other services operating along the NEC at the time of service implementation. The service would stop at the following stations:

- Boston, Massachusetts (South Station and Back Bay);
- Framingham, Massachusetts;
- Worcester, Massachusetts;
- Palmer, Massachusetts (new station);
- Springfield, Massachusetts;
- Windsor Locks, Connecticut;
- Windsor, Connecticut;
- Hartford, Connecticut;
- Berlin, Connecticut;
- Meriden, Connecticut;
- Wallingford, Connecticut; and
- New Haven, Connecticut.

3.5.2 Infrastructure Program

The Recommended Alternative would require infrastructure upgrades at some locations on the Corridor to provide additional capacity and support increased speed. Tracks would be upgraded to support a maximum speed of 79 mph where possible. A second track or passing siding would be added in certain locations to support increased passenger and freight service. Full signalization would be installed in locations it does not currently exist.

- **Layover Facilities.** No additional layover facilities are proposed as part of the Recommended Alternative. Train sets on the Corridor would access layover facilities near terminal stations. Layover facilities would primarily serve as points to store, restock, and perform light maintenance on rail equipment. Additionally, layover facilities would provide crew quarters, including briefing rooms, locker rooms, and break rooms.
Right-of-Way. Several proposed track capacity improvements would be made in the Recommended Alternative within the existing ROW and include additional sidings

between East Northfield and St. Albans on NECR, a second main track for all single-track segments between Worcester and Springfield and adding an additional track for switching to between Spencer and Brimfield, Massachusetts on CSX to enable freight and passenger rail to operate more efficiently. CTDOT is upgrading the NNEIRI Corridor in Connecticut as part of NHHS Project. No additional improvements on the NHHS line are required for NNEIRI-related operations.

In Canada, from the Canadian border to Central Station in Montreal, improvements to the rail line have been identified in a Canadian study completed by the Quebec Ministry of Transportation that would support increased speeds and train capacity²¹. This SDP assumes that these improvements would be made, but due to federal laws that prohibit spending U.S. DOT funds in other nations, it is assumed that no federal dollars will be utilized to progress the improvements.

The following describes these improvements by segment.

- ***Boston-Springfield Segment.*** No significant changes are required on the line between Boston and Worcester. Between Worcester and Springfield, tracks would be upgraded to allow for FRA Class 4 train operations and allow passenger trains to operate up to 79 mph where track geometry allows. The Recommended Alternative proposed two miles of new track, three new turnouts, and one railroad crossing upgrade along this segment. The restoration of the second track in single-track locations and an additional siding are also recommended. Some bridge improvements are proposed, including approximately 2,135 feet of bridge rehabilitation and 1,805 feet of bridge re-decking. The bridge work would apply to three different bridges in this segment, which are located between Mileposts 48.3 and 57.7, Mileposts 64.0 and 79.4, and Mileposts 83.6 and 92.0. This bridgework is necessary for the restoration of the second track between Boston and Springfield and would take place on the CSX track sections.
- ***Springfield to the Canadian Border.*** The Recommended Alternative proposed track upgrades to allow for FRA Class 4 train operations and allow passenger trains to operate up to 79 mph where track geometry allows. A total of 40 miles of new track, 45 new turnouts, and 18 railroad crossing upgrades are proposed. The new track and turnouts are proposed to allow for the addition of a second track or a passing siding in six new locations along this segment. A second track or a passing siding is proposed to be added along the corridor in Brattleboro, Putney, Walpole, Claremont, St. Albans, and East Alburgh. Some bridge improvements are recommended, including approximately 350 feet of bridge replacement in Walpole, New Hampshire and East Alburgh, Vermont.
- ***Signal Systems.*** The Corridor currently has train control signal systems between Boston and Springfield, between Springfield and New Haven, along several segments in Vermont, near Montreal, and other select locations on the right-of-way. Due to the additional level of service, a full train control signal system is proposed along the full length of the right-of-way. Passenger rail compatible signal and grade crossing updates in

²¹ “High-Speed Rail Pre-Feasibility Study.” Quebec Ministry of Transportation, <https://www.dot.ny.gov/programs/i-87-multimodal-corridor-study/repository/draftfinal-highspeedrailsummary-may04.pdf>

this segment would be provided as part of the Recommended Alternative. Centralized Traffic Control (CTC) would be added over several sections of the NECR-owned that are currently under Track Warrant Control (TWC). This includes the section from East Northfield, Massachusetts to West River (located in Brattleboro, Vermont), and from White River Junction, Vermont to the Canadian border at Alburgh, Vermont.

Intermediate signals would be installed approximately every two miles along the line and interlocking signals would be added at both ends of key existing passing sidings intended for use in this area.

- Stations.** No major improvements to existing stations on the Corridor were planned as part of the Recommended Alternative. However, minor station improvements may be necessary to provide key passenger amenities and meet operational requirements upon further review, including at Worcester Union Station and the construction of a station in Palmer, Massachusetts. Worcester Union Station requires additional platform track capacity to accommodate any additional intercity services because the existing single track and platform configuration will not accommodate additional service, particularly during peak periods when the facility is at maximum capacity. A center island platform could be constructed to accommodate the additional service. Service to Palmer would require construction of a new station since the configuration of the historic station precludes the installation of the Massachusetts Architectural Access Board required high level platforms and double main tracks that are included in the Recommended Alternative.

3.6 ENVIRONMENTAL ANALYSIS OVERVIEW

As part of the Tier 1 EA, an inventory and identification of the locations of each environmental resource from readily available federal and state GIS data was completed to assess the potential for impacts based on conceptual plans for the Recommended Alternative. A summary of the affected resources and the environmental consequences associated with the Recommended Alternative, potential mitigation measures, and anticipated future Tier 2 project level analysis for each of the environmental resources are summarized in Table 3-2.

Table 3-2. Summary of Potential Environmental Consequences and Next Steps

Environmental Resources	Build Alternative Consequences	Next Steps	
		Potential Mitigation Measures	Tier 2 Analysis
Air Quality	A shift to passenger rail expected to reduce VMT and improve regional air quality.	Mitigation measures not anticipated at this time. Final determination will be made during Tier 2.	General Conformity analysis will be conducted by FRA or other lead federal agency during Tier 2.

Environmental Resources	Build Alternative Consequences	Next Steps	
		Potential Mitigation Measures	Tier 2 Analysis
Noise and Vibration	Potential for a total of 435 severe noise impacts, 11,827 moderate noise impacts, and 2,234 vibration annoyance impacts.* <i>*Impacts based on worst-case scenario, estimates will likely decrease when a more detailed analysis is performed.</i>	Potential mitigation measures may include noise barriers, operational changes, stationary wayside horns at grade crossings, horn shrouds on locomotives, and resilient rail fasteners and ties.	Tier 2 Project Level analysis by FRA or another lead federal agency will more precisely determine the number of potential noise and vibration impacts that may require mitigation.
Flood Hazards and Floodplain Management	Minor impacts possible. Additional track construction will take place within or adjacent to mapped floodplain for approximately 28 miles. Impacts expected to be minor due to restoration of historically double tracked corridor.	If impacts are unavoidable, compensatory mitigation can be provided by constructing a detention/retention basin to handle runoff from the site and any lost flood storage capacity.	Tier 2 project proponent(s) will attempt to avoid and minimize loss of flood storage capacity. Potential impacts to floodplains will require further assessment and agency coordination to determine whether mitigation measures are necessary.
Coastal Zone Management	No impacts anticipated.	Mitigation measures not anticipated.	Further analysis not required.
Water Quality	Minor impacts possible. Additional track construction will take place within or adjacent to water resources in MA and VT. Impacts expected to be minor due to restoration of historically double tracked corridor.	All construction activities will comply with the applicable stormwater quality manual. Best Management Practices (BMPs) for erosion and sedimentation control will be followed.	During Tier 2, design details will be developed to avoid or reduce potential water quality impacts associated with the Build Alternative. The Tier 2 project proponent(s) will coordinate with VTDEP and MassDEP for final designs and permits.
Wetlands	Minor impacts possible. Additional track construction will take place within respective state's mapped wetland buffer area for approximately 13 miles. Impacts expected to be minor due to restoration of historically double tracked corridor.	If wetland impacts cannot be avoided, compensatory mitigation measures include restoration, creation, enhancement, and preservation of impacted wetlands.	Tier 2 project proponent(s) will attempt to avoid and minimize wetland impacts. Potential impacts to wetlands would require further assessment, and any compensatory mitigation measures would be subject to state and federal permitting requirements.
Ecological Systems, Threatened and Endangered Species, and Wildlife	Minor impacts possible. Additional track construction will take place within or adjacent to mapped endangered species habitat for approximately 16 miles. Impacts expected to be minor due to utilization of historically double tracked corridor.	If impacts cannot be avoided mitigation measures include but are not limited to pre- and/or post-construction monitoring of populations, and restoration, enhancement, and conservation of impacted habitats.	During Tier 2 project level analysis the project proponent(s) would confirm records of federal- or state-listed species with the appropriate resource agencies and seek to avoid and minimize impacts.

Environmental Resources	Build Alternative Consequences	Next Steps	
		Potential Mitigation Measures	Tier 2 Analysis
Land Use, Existing and Planned	No impacts anticipated due to use of existing rail corridor. Palmer Station likely to have beneficial impact on economic development.	Mitigation measures not anticipated at this time.	During Tier 2, more details relating to the location and design of a new Palmer Station will be determined. Project proponent(s) will coordinate with the affected municipalities to ensure compatibility with present and future land uses.
Socioeconomic and Environmental Justice (EJ)	Potential beneficial impact on economic development and EJ populations near existing and proposed stations is anticipated.	Any potential mitigation measures, if required, will be determined during the Tier 2 project level analysis.	Upon completion of engineering plans, additional EJ analysis will be conducted by the project proponent(s).
Possible Barriers to the Elderly and Handicapped	No impacts anticipated.	Mitigation measures not anticipated.	Further analysis not required.
Public Health and Safety	No impacts anticipated.	Mitigation measures not anticipated.	Further analysis not required.
Hazardous Materials	No impacts anticipated. No active hazardous waste sites were identified in locations where construction will take place.	If required, mitigation measures may include soil samples to determine the nature of contaminated soil, storage techniques that contain run-off, use of material within right-of-way, and requirements for transporting and disposing of unused contaminated materials.	If hazardous materials are encountered during construction, the project proponent(s) will coordinate with the MassDEP and the VTDEP to comply with all regulations.
Solid Waste Disposal	No impacts anticipated.	Mitigation measures not anticipated.	Further analysis not required.
Aesthetic and Design Quality Impacts	No impacts anticipated at this time. There may be potential visual impacts at Palmer due to construction of a new station. Palmer Station design to be determined.	If impacts are identified the FRA or other lead federal agency will determine mitigation strategies such as landscaping to screen views of adverse impacts or use of building materials consistent with the surrounding area.	During Tier 2, more details relating to the design of a new Palmer Station and a platform at Worcester Union Station will be developed. At that time, further analysis will be conducted to determine any adverse visual impacts.
Cultural Resources and Historic Properties	Improvements would be restricted to the railroad right-of-way (ROW) and therefore are not anticipated to adversely affect adjacent National Register-listed historic buildings, sites and districts.	If adverse effects to National Register of Historic Places (NRHP) eligible properties are determined, measures to avoid, minimize or mitigate the effects would be developed in consultation with the MA, NH and VT State Historic Preservation Office (SHPO) and other consulting parties.	Further identification and review of historic properties will proceed to determine the potential effects. Bridges will be evaluated for NRHP eligibility.

Environmental Resources	Build Alternative Consequences	Next Steps	
		Potential Mitigation Measures	Tier 2 Analysis
Use of Section 4(f) Protected Properties	Improvements would be restricted to the ROW and therefore are not anticipated to diminish significant features or the use of adjacent 4(f) properties.	If there is both the use of a 4(f) property and FRA determines that there is no prudent and feasible alternative, the project will include all possible planning to minimize harm.	Full Section 4(f) analysis would occur during Tier 2 project level analysis to determine impacts to publicly owned parks, recreation areas, wildlife and waterfowl refuges, and public or private historic sites.
Use of Section 6(f) Lands	Improvements would be restricted to the ROW and therefore impacts to 6(f) properties are unlikely.	If a conversion of 6(f) property is required a request must be submitted to the NPS including proposal to substitute the property with another of equal or better usefulness and value.	During Tier 2, once the design has advanced, additional data may be collected regarding 6(f) properties to determine impacts.
Recreational Opportunities	No impacts anticipated.	Mitigation measures not anticipated.	Further analysis not required.
Transportation	Given the low numbers of traffic movements anticipated at each station, significant impacts are unlikely.	Mitigation measures not anticipated.	As the design develops and more data can be collected, further traffic impact analysis will be conducted during Tier 2 project level analysis.
Use of Energy Resources	No impacts anticipated.	Mitigation measures not anticipated.	Construction impact analysis will be conducted during Tier 2 project level analysis.
Use of Other Natural Resources, such as Water, Minerals, or Timber	No impacts anticipated.	Mitigation measures not anticipated.	Further analysis not required.
Construction Period Impacts	Construction-related impacts would be temporary at any given location along the Corridor. Track work would largely be sited within the existing rail ROW using rail-mounted equipment, and should not involve large quantities of earthwork.	Construction-phasing plans that avoid, minimize or mitigate temporary impacts will be developed in coordination with appropriate agencies. Temporarily impacted natural resources would be restored to their natural conditions.	During Tier 2, the duration of construction would be better defined and appropriate mitigation measures will be identified. The sequence and extent of construction will be determined and staging plans developed.
Indirect and Cumulative Impacts	Indirect and cumulative impacts generally beneficial due to induced development and additional transportation mode choice.	Mitigation measures not anticipated.	During Tier 2, once the design has advanced further evaluation of indirect and cumulative impacts will be conducted.



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4 DEMAND AND REVENUE FORECASTS

This chapter presents the methodology and ridership forecasts for all services on the NNEIRI Corridor, as well as individual forecasts for the Boston-to-Montreal Route. The chapter includes a review of the methodology including key input data and assumptions. The ridership and revenue estimates are based on the Boston-to-Montreal Route's schedule for a 2035 baseline year (described in Chapter 7).

4.1 RIDERSHIP METHODOLOGY AND DATA SOURCES

As part of the NNEIRI AA process, an intercity passenger rail ridership-forecasting model for NNEIRI Corridor and two overlapping routes was developed to provide ridership estimates for the three proposed services. The model consists of available travel market data for Massachusetts, Connecticut, and Vermont, including historic rail ridership data, trends, and demographic data. Other models prepared for Amtrak's NEC, Southeast Corridor, California Corridor, Florida, and the Midwest States provided a foundation for NNEIRI's ridership model. Inputs required to complete the analysis include:

- Rail schedules for the Inland Route and Boston-to-Montreal Route services (Boston-to-Montreal Service, Boston-to-New Haven Service, and New Haven-to-Montreal Service);
- Geographic zone system covering the entire study area;
- Highway network connecting all the zones, all the rail stations and all the airports in the study area;
- Socio-economic data for the zone system;
- Ridership information for the Massachusetts, Connecticut, and Vermont passenger rail services;
- Travel characteristics for auto, air, and rail.

Ridership forecasts were prepared for two forecast years, 2020 and 2035. As part of the AA, eight different ridership scenarios were developed using the three build alternatives, the No-Build Alternative, and the two forecast years. All scenarios assume full implementation of the CT Rail Hartford Line service at 10 round-trips between Springfield and New Haven and extension of the five existing Amtrak services along the corridor to either Boston or Montreal. The complete travel market study report prepared during the AA is provided in Appendix A.

4.2 RIDERSHIP RESULTS

4.2.1 NNEIRI Corridor Ridership

For the three services included in the Recommended Alternative, the projected annual ridership forecast is 875,700. This includes ridership on the Boston-to-Montreal Service, Boston-to-New Haven Service, and New Haven-to-Montreal Service. Additionally, the forecasts include anticipated ridership on the existing Amtrak Lake Shore Limited and Vermonter services. The annual forecast results for diverted vehicle miles traveled on the NNEIRI Corridor are summarized in Table 4-1.

Table 4-1. 2035 NNEIRI Corridor Annual Diverted Vehicle Miles Traveled

	Annual VMT
Total Diverted Automobile Vehicle Miles Traveled (VMT)	113,847,700
Total Annual Diverted VMT by Segment	
Within Springfield-Montreal Segment	18,634,543
Between Springfield-Montreal Segment and Boston-Springfield Segment (thru, not including Springfield)	2,376,380
Between Springfield-Montreal Segment and Springfield-New Haven/NEC Segment (thru, not including Springfield)	47,391,902
Within Boston-Springfield Segment	2,543,477
Between Boston-Springfield Segment and Springfield-New Haven/NEC Segment (thru, not including SPG)	42,901,399

4.2.2 Boston/New Haven-to-Montreal Route Ridership

The projected ridership for the Boston-to-Montreal Route is 447,100, including riders on the New Haven-to-Montreal Service, the Boston-to-Montreal Service, and the existing Vermonter service. Most ridership would occur between stations within the Montreal-Springfield Segment or from stations within this segment to New York City or Connecticut. Annual ridership within the Springfield-New Haven Segment has not been included since ridership would be a result of the existing Amtrak service or the future CT Rail Hartford Line commuter rail service. Table 4-2 provides details on the projected ridership distribution between or within the three segments of the Boston-to-Montreal Route.

Table 4-2. Boston-to-Montreal Route 2035 Annual Ridership between Segments

Segment I	Segment II	Annual Ridership
Stations along Montreal-Springfield Segment	Stations in Connecticut or points south	268,600
Stations along Montreal-Springfield Segment	Stations along the Boston-Springfield Segment	23,800
Stations along Boston-Springfield Segment	Stations along Boston-Springfield Segment	5,600
Stations along Montreal -Springfield Segment*	Stations along Montreal -Springfield Segment*	149,100
Total Boston-to-Montreal Route Ridership		447,100

**Includes ridership on Boston-to-Montreal Route trains only*

The annual boardings for each station along the three segments of the Boston-to-Montreal Route is provided in Table 4-3. Individual station boardings presented in the tables represent all three services on the NNEIRI Corridor. The combined ridership study did not differentiate between the three services at individual station stops.

Table 4-3. NNEIRI Annual Boardings by Station on Boston-to-Montreal Route, 2035

Station	Annual Ridership*
Boston, Massachusetts (South Station)	9,100
Boston, Massachusetts (Back Bay)	500
Suburban Boston (Framingham, Massachusetts)	50
Worcester, Massachusetts	1,900
Palmer, Massachusetts	400
Springfield, Massachusetts	17,000
Windsor Locks, Connecticut	2,00
Windsor, Connecticut	1,500
Hartford, Connecticut	9,200
Berlin, Connecticut	1,300
Meriden, Connecticut	2,200
Wallingford, Connecticut	800
New Haven, Connecticut	16,300
Holyoke, Massachusetts	16,300
Northampton, Massachusetts	12,500
Greenfield, Massachusetts	5,500
Brattleboro, Vermont	17,200
Bellows Falls, Vermont	3,600
Claremont, Vermont	1,100
Windsor, Vermont	1,300
White River Junction, Vermont	9,800
Randolph, Vermont	1,900
Montpelier, Vermont	2,700
Waterbury, Vermont	3,000
Burlington (Essex Junction), Vermont	11,300
St. Albans, Vermont	1,900
Montreal, Quebec	36,900

The ridership analysis revealed significant demand for passenger rail service on the NNEIRI Corridor. The addition of services on the NNEIRI Corridor would restore passenger rail services to many regions that historically hosted robust rail service. Service along the NNEIRI Corridor would utilize an existing infrastructure network and reestablish travel patterns that were reduced or eliminated in the mid-20th Century.

4.3 REVENUE METHODOLOGY AND DATA SOURCES

The fare revenue estimates are based on the three service plans and the estimate of ridership at the station level for origin-destination pairs. The revenue estimation was completed by creating an average fare between origin-destinations pairs that reflects current average fare values for intercity rail service in the Northeast. These fares were extrapolated for new markets based on mileage. An average fare for each origin-destination pair was developed. Alternative fare structures were not evaluated as part of the ridership forecasts or revenue estimates. Some examples of the average fares between key markets along the Boston-to-Montreal Route include:

- Montreal-Springfield: \$49
- Montreal-Worcester: \$58
- Montreal-Boston: \$64
- Montreal-New Haven: \$58
- White River Junction-Springfield: \$32
- White River Junction-Worcester: \$41
- White River Junction-Boston: \$47
- White River Junction-New Haven: \$44
- Boston-Springfield: \$25
- Boston-New Haven: \$45
- Worcester-Springfield: \$17
- Worcester-New Haven: \$35
- Springfield-New Haven: \$20

Implementation of the Recommended Alternative, including the Boston-to-Montreal and New Haven-to-Montreal services, assumes implementation of the CT Rail Hartford Line service's ten new round-trips. The revenue estimates assume that some of these new trips would be extend north and east of Springfield as part of the Boston-to-Montreal Service.

4.4 FARE REVENUE RESULTS

The estimated annual fare revenue for the Boston-to-Montreal Route, based on ridership and average fares, is \$12 million, inclusive of trains traveling from Boston to Montreal and New Haven to Montreal. Revenue analysis was conducted for passenger trips beginning and/or ending within the NNEIRI Corridor. For passenger trips continuing to points beyond the NNEIRI Corridor, only the revenue generated as a result of the travel within the NNEIRI Corridor is included in revenue forecast for the Boston-to-Montreal Route. The estimated annual fare revenue for all recommended service on the NNEIRI Corridor is \$30 million.

5 EXISTING CONDITIONS

This chapter includes a summary of the identification and analysis of existing infrastructure conditions, passenger services, freight services, and complementary passenger modes on the NNEIRI Corridor. Analyzing existing conditions and services was an important part of the AA process, as it provided a known baseline used to compare and evaluate alternatives and service plans. The NNEIRI Existing Conditions Report was prepared in January 2015 and updated in November 2015. The report includes detailed infrastructure conditions, environmental issues, and demographic information. Since conditions along the Inland Route and the Boston-to-Montreal Route were studied together collectively, this chapter provides an overview of the entire corridor.

5.1 OWNERSHIP

Ownership of the 470-mile-long NNEIRI Corridor varies by segment. The following public entities and private railroads own the following segments of the corridor:

- **Commonwealth of Massachusetts:** 44 miles between Boston and Worcester;
- **CSX Transportation Company (CSX):** 55 miles between Worcester and Springfield;
- **Commonwealth of Massachusetts:** 49 miles between Springfield and East Northfield, Massachusetts;
- **New England Central Railroad (NECR):** 206 miles from East Northfield, Massachusetts to three miles south of the U.S./Canada border;
- **Canadian National (CN) Railroad:** 53 miles from three miles south of the U.S./Canada border to Montreal; and
- **Amtrak:** 62 miles from Springfield to New Haven.

The Boston-to-Montreal Route includes the Boston-Springfield Segment owned by the Commonwealth of Massachusetts and CSX, the Springfield-New Haven Segment owned by Amtrak, and the Springfield-Montreal Segment owned by CN, NECR, and the Commonwealth of Massachusetts.

5.2 INFRASTRUCTURE CONDITIONS

The existing conditions of the infrastructure along the NNEIRI Corridor greatly affect the potential level of service moderate investment could spur. The study team completed an infrastructure assessment along the entire Corridor to analyze the condition of the tracks, track configuration, rail age and type, vertical profiles and grades, bridges and tunnels, operating class, at-grade crossings, and signaling. A summary of the findings is provided in this section. Additional detail is included in the Existing Conditions Report and related Appendix.

5.2.1 Number of Tracks

Existing track conditions along the Corridor vary by segment. The segment between Boston and Springfield is primarily a two-track right-of-way with some sections configured as a single-track

operation. Historically, these sections were completely double tracked, but the second track was removed in some sections in the mid-20th century as freight and passenger volumes declined.

The segment between Springfield and New Haven is primarily a two-track right-of-way with some sections of single-track operation. Historically, the Springfield-New Haven Segment was a double track railroad. A significant portion of the double track was removed or abandoned in the 1990s. Currently, this segment has approximately 25 miles of double track and 37 miles of single track. CTDOT is currently undertaking a program to double track the segment to accommodate the CT Rail Hartford Line commuter rail service. A detailed analysis of track conditions is in the appendix to the Existing Conditions Report.

The segment between Springfield and Montreal has portions which currently have two tracks, historically had two tracks, or have always been single tracked with sidings. The Recommended Alternative proposes to add sidings as necessary to accommodate both increased passenger and freight amounts.

5.2.2 Rail Age and Type

The age of the rail along the Corridor varies by location and owner/operator. While the oldest rail dates from 1927, the majority of the rail is less than 20 years old with some sections having rail that was just installed over the past few years. Locations of new rail funded in part by the Federal Railroad Administration include the 49 miles of mainline on the Knowledge Corridor from Springfield to East Northfield, Massachusetts and 175 miles of new mainline on the section in Vermont between Vernon and the Canadian border at East Alburgh. Additionally, rail type and weight varies across the corridor. The lightest weight of track used is 85 lb, currently on a siding segment, and the heaviest weight of track used is 140 lb.

5.2.3 Vertical Profiles/Grades

Rail sections with vertical profiles or grades of one percent or greater affect the speed of rail operations. Due to the tonnage of freight trains, freight operations are more sensitive to grades changes than passenger services. An analysis of Corridor track charts noted few grades one percent or higher.

5.2.4 Bridges and Tunnels

The Corridor has numerous bridges and tunnels along its length. Major bridges on the Corridor span waterways, such as Lake Champlain and the Connecticut, Richelieu, and St. Lawrence rivers. Smaller bridges span local roadways, streams, and brooks. The condition of these bridges varies greatly. Some bridges currently only accommodate a single track, but an additional track could be added. Two tunnels are located along the Corridor: the Back Bay Tunnel in Boston and the Bellows Falls Tunnel in Rockingham, Vermont.

5.2.5 Operating Class

FRA operating classes specify the maximum speeds at which passenger and freight trains may operate. These operating classes are based on track geometry, condition, and maintenance standards. The Boston to Springfield and Springfield to Montreal segments are primarily Class 3, but some sections are maintained and operated at higher levels. The segment from New Haven to

Springfield is currently maintained to Class 4 standards, but is anticipated to have segments upgraded to Class 6 as part of the NHHS project that is underway. A complete inventory of NNEIRI Corridor operating classes is found in the appendix to the Existing Conditions Report.

5.2.6 At-Grade Crossings

The locations of at-grade crossings are important considerations in the evaluation as they may affect the safety and efficiency of service. At-grade crossings are numerous along the Corridor, particularly outside major urban areas. The at-grade crossings occur at all levels of roadways, ranging from major roads to farm crossings. At-grade crossings, particularly for trains operating at higher speeds, require specialized crossing gates and warning devices. Passive type warning devices include railroad cross-buck signs, stop signs, and other warning devices that alert a driver or pedestrian that a grade crossing is present. These passive devices do not provide a warning that a train is approaching. Active warning devices indicate the approach of a train and include flashing lights, bells, and gates that close as a train approaches the grade crossing.

The Corridor has 256 public at-grade crossings, including 201 with active warning devices and 55 without any active warning protection. Additionally, there are 231 private crossings along the corridor. Most of these have passive warning devices or no signage of any type.

5.2.7 Signaling

The NNEIRI Corridor contains approximately 480 miles of track. Approximately 290 miles are under Centralized Traffic Control (CTC). This means that train movements are automatically regulated through wayside signaling (and/or cab signaling in some segments) by train dispatchers. Passing sidings and interlockings in CTC territory use power-operated switches, promoting efficient operations.

There are some segments of the route that the signal system is in place and in a condition that would support operation of the Recommended Alternative. These locations include the MBTA operated Boston to Worcester segment; the completed signal improvements on the Pan Am operated Springfield to Northfield segment; and Amtrak's New Haven to Springfield segment. To facilitate track improvements included in the Recommended Alternative, additional project specific signal improvements will be required.²²

In remaining sections of the Corridor, there are 31 interlocking control points and 13 intermediate (non-interlocked) signals. Based on an on-site condition assessment of a portion of the corridor, it was assumed that approximately 19 control points and six intermediates would require modernization upgrades for the reliability needed for a passenger service, including 5 locations on the CSX Worcester to Springfield segment and 14 along the New England Central Railroad segment between Northfield and Alburgh.

The estimated signal improvements were calculated based on the condition of select locations and not a complete evaluation of the entire corridor signal systems. On the NECR segment, seven of the nine control points visited during the inspection would require replacement to ensure long-term reliability. Along the CSX-owned Worcester to Springfield segment, two out of

²² See NNEIRI Existing Conditions Report for additional information related to existing signal systems.

the five visited control points appear to require upgrading. Additional observations revealed that approximately half of the NECR's intermediate signals would require replacement to ensure long-term reliability.

The remaining 190 miles of the NNEIRI Corridor, from White River Junction to Montreal (including the Canadian segment), are controlled by track warrant, where dispatchers issue movement authorities via radio to specific trains for specific sections of track. Passing sidings and switches exist in this territory too, but switches are generally hand-thrown and limited local signal interlockings exist at critical junctions such as Northfield and the Burlington Branch connection in Essex Junction, Vermont.

5.2.8 New and Recommended Infrastructure Projects

As described in Section 3.4.2, several new infrastructure projects are recently completed, underway, or planned. These infrastructure projects are separate from improvements recommended to support NNEIRI-related service and are considered to be part of the No-Build future condition. These completed or underway improvements include:

- As part of the Knowledge Corridor/Restoration of the Vermonter project, Amtrak Vermonter service has been re-established along the Connecticut River Line between Springfield and East Northfield, Massachusetts. The service on this track segment begun in December 2014 and all related project work will be completed in fall 2016.
- CTDOT infrastructure improvements on the NHHS rail line are underway, including double tracking and station improvements between New Haven, Hartford, and Springfield.
- Construction is underway for the Springfield Redevelopment Authority's restoration of Springfield Union Station.

In a project associated with restoration of Springfield Union Station, MassDOT is currently making improvements to the train platforms at the station

Planned services include:

- The planned expansion of Boston South Station to accommodate additional track capacity, train storage space, and provide additional station platforms.
- Extension of the Amtrak Vermonter service north to Montreal and improvements to infrastructure that would need to be completed between the U.S. border and Montreal, as identified in the Quebec Ministry of Transportation's *Study of CN and CP's Rail Networks between Montréal and the U.S. Border* released in 2014.
- A new U.S. Customs and Immigration Services and Canada Border Services Agency station is planned for construction at Montreal Central Station Customs Checkpoint to allow faster travel in and out of Canada for passenger trains.

5.3 EXISTING RAIL TRAFFIC

5.3.1 Passenger Services

As described previously in Section 3.4.1, the Corridor has existing passenger rail operations. Service along the Corridor varies significantly by segment, ranging from twenty-four daily

round-trips between Boston and Worcester, one round-trip between Springfield and St. Albans, and one round-trip between Springfield and Worcester. A comparison of the existing weekday passenger rail service and planned service that is committed for implementation through other initiatives is summarized by segment in Table 5-1.

Table 5-1. Summary of Weekday Revenue Passenger Service

Segment	Operator(s)	Service	Existing Revenue Daily Round-trips	Planned 2035 Revenue Daily Round-trips
Boston to Worcester	MBTA, Amtrak	<ul style="list-style-type: none"> • MBTA Southside Commuter Rail (Boston South Station to Back Bay Station) • MBTA Worcester Line Service (Boston South Station to Worcester and Framingham) • Amtrak Lake Shore Limited 	24	24 ²³
Worcester to Springfield	Amtrak	<ul style="list-style-type: none"> • Amtrak Lake Shore Limited 	1	1
Springfield to New Haven ²⁴	Amtrak	<ul style="list-style-type: none"> • Amtrak Northeast Regional Shuttle (Springfield to New Haven) • Amtrak Northeast Regional (Springfield to Washington, D.C.) • Amtrak Vermonter (St. Albans to Washington, D.C.) 	6-8	25

Note: Table reflects Existing and Planned services as of Fall 2015

Complementary passenger modes also exist along most of the corridor. Air travel is available in most major cities proposed to be served, and intercity bus service currently exists along all major cities along the corridor and most small to mid-sized areas in between. Intermodal connections also are available at most existing stations to help connect passengers to the surrounding area.

Also described in Section 3.4.1 are the Corridor’s new and improved passenger rail operations that are anticipated to be completed independently of the NNEIRI service. This includes realignment of Amtrak’s Vermonter along the Knowledge Corridor between Springfield and East Northfield, Massachusetts, the proposed extension of the Amtrak’s Vermonter from St. Albans to

²³ Since completion of the NNEIRI study modeling, the MBTA undertook a system wide commuter rail rescheduling process that included adding trains along the line. The MBTA operates 27 daily revenue round trips on the segment between Boston and Framingham as of May 23, 2016. With the Amtrak Lake Shore limited service, the total daily revenue round trip passenger trains along the segment is 28.

²⁴ Rail system assessments conducted for the CT Rail New Haven Line project identified the capacity of that segment to have the ability to accommodate 25 daily round-trip passenger trains. These were envisioned to include 10 CT Rail Hartford Line round-trips, four Amtrak Northeast Regional round-trips, one Amtrak Vermonter round-trip and 10 NNEIRI round-trips. CTDOT is in the process of implementing the 10 CT-Rail Hartford Line round-trips. The seven additional daily round-trips will depend, in-part, on the implementation of the NNEIRI program.

Montreal, and the new CT Rail Hartford Line commuter rail service between New Haven and Springfield.

5.3.2 Freight Services

A variety of freight railroads currently operate along the NNEIRI Corridor. The number of trains and operators vary based on corridor segment.

- **Boston-Springfield Segment.** CSX is the rail operator between Boston and Springfield. CSX operates a limited number of trains between Boston and Framingham and recently constructed a large intermodal facility located in Worcester.
- **Springfield-St. Albans Segment.** NECR and Pan Am Southern (PAS) operate regular freight service along this segment. Several other railroads have operating rights in along this segment, including CN, Vermont Railway, Washington County Rail Corporation (Vermont Rail Systems), and Claremont Concord Railroad Corporation. Most northbound NECR freight is switched to CN operations at St. Albans.
- **St. Albans-Montreal Segment.** CN freight service operates along the entire St. Albans to Montreal segment, with the exception of a short stretch leading to Central Station in Montreal. Most southbound freight operated by CN is switched to NECR operations at St. Albans.
- **Springfield-New Haven Segment.** Freight railroads including the Connecticut Southern Railroad (CSO), PAS, Providence & Worcester (P&W), NECR, and CSX operate on the Springfield to New Haven segment of the Corridor.

Table 5-2 summarizes the existing weekday freight operations and the anticipated freight service growth along the Boston-to-Montreal Route. Anticipated 2035 services were calculated using anticipated freight growth rates provided by freight operators.

Table 5-2. Boston-to-Montreal Route Summary of Weekday Freight Operations

Segment	Primary Operator(s)	Regular Weekday Round-trips	Anticipated 2035 Weekday Round-trips
Boston to Worcester	CSX	2-3	2-3
Worcester to Springfield	CSX	25	26-28
Springfield to New Haven	CSO, PAS, P&W, and CSX	9	9
Springfield to East Northfield	PAS	1 and local services	1 and local services
East Northfield to St. Albans	NECR	1 and local services	1 and local services
St. Albans to Montreal	CN	1-30	1-30

6 CAPITAL IMPROVEMENTS

This chapter considers the rail equipment and corridor infrastructure improvements required for implementation of the Boston-to-Montreal Service and New Haven-to-Montreal Service along the Boston-to-Montreal Route. The chapter includes estimated capital costs for projects and groups of projects. The assumptions and methods used are documented. The engineering detail included in this chapter is conceptual, based on aerial photography and a general understanding of site conditions. The designs will be further refined during later phases once onsite visits and Corridor-wide inspections are conducted. Cost estimates included in this chapter are presented in 2014 dollars.

6.1 OVERVIEW OF CAPITAL INVESTMENTS

The implementation of service along the NNEIRI Corridor would require several infrastructure improvements and acquisition of rail equipment. The total estimated capital costs to implement the Recommended Alternative are \$1,104 to \$1,247 million. Implementation of just the Boston-to-New Haven Service along the Inland Route is estimated to cost \$554 to \$660 million. Capital costs for the two services along the Boston-to-Montreal Route are estimated at \$591 to \$634 million. Since the Boston-to-Montreal Route and Inland Route both utilize the Boston-Springfield Segment, the total capital costs to implement all three services are less than the costs of the two Routes added together.

Table 6-1 summarizes the costs associated with the Boston-to-Montreal Route portion of the program. This includes all capital costs associated with the Boston-to-Montreal Service and New Haven-to-Montreal Service. It does not include the capital costs to complete improvements for the CT Rail Hartford Line project on the Connecticut portion of the Corridor or capital costs associated with Inland Route Service. The detailed costs are provided in the following sections.

Table 6-1. Summary of Boston/New Haven-to-Montreal Route Costs (2014 dollars)

Item	Cost (Millions)
Rolling Stock Cost	\$176
Corridor Infrastructure Improvements	\$415-458
Total	\$591-634

6.2 ROLLING STOCK

The two Boston-to-Montreal Route services would operate with five train sets, this includes one set that will rotate in as a spare. It was assumed that 5 coach trains, similar in size to the existing Vermonter service would be appropriate. Rolling stock refers to the quantity of coaches and locomotives and types of locomotives used in each train (train set). Each train set included one locomotive and five coach cars. The five car coach consist provides sufficient ability to

accommodate passenger demand during peak travel periods. The estimated cost per train set is approximately \$27 million.

The anticipated rolling stock capital cost is based on the recent purchase price for Passenger Rail Investment and Improvement Act (PRIIA) Fleet design train sets. The cost includes a 30 percent contingency instead of the range of 30 to 50 percent used with infrastructure costs because there is more certainty with rolling stock costs compared to infrastructure costs. The estimated cost of each train set with contingency is \$35 million. The total cost for five train sets is \$135 million before contingency. With the \$41 million contingency, the total estimated rolling stock capital cost for five train sets is \$176 million.

This does not include costs for Inland Route rolling stock. The additional eight to ten train sets for the Inland Route Service are estimated at \$281 to \$351 million. The total equipment cost for all NNEIRI services, with need of between thirteen and fifteen total train sets is \$456-527 million.

Rolling stock cost estimates were developed assuming purchase of new train sets. If at the time of implementation, refurbished or surplus equipment is available, equipment costs could be significantly reduced. As there is great variability in availability and condition of non-new equipment, planning on the cost of new equipment at this stage in the evaluation process is a prudent estimating assumption.

6.3 BOSTON-TO-MONTREAL ROUTE INFRASTRUCTURE IMPROVEMENTS

A number of improvements are recommended on the Boston-to-Montreal Route to support the Boston-to-Montreal Service and New Haven-to-Montreal Service, including upgrades to the tracks owned by MBTA and CSX. As described in this section, projects along this route include individual sections of additional or upgraded track, locomotive and rolling stock purchases, signal improvements, bridgework, and station improvements.

The cost calculations for infrastructure improvements on this route were developed using two contingencies. The low-end estimate uses a 30 percent contingency and the high end of the estimate uses a 50 percent contingency to account for the level of certainty associated with project cost estimates. Project cost estimates were developed using industry standards, inspection by aerial images, and select field visits. Detailed engineering would be required for project-level cost estimates.

The total costs for infrastructure improvements for the Boston-to-Montreal Route are \$415 to \$458 million. This includes siding restorations or extensions, track and bridge improvements, station improvements, and signal upgrades. Table 6-3 provides a summary of all infrastructure-related capital costs, which are all located in Massachusetts. Details are provided in the following sections.

Table 6-3. Summary of Boston-to-Montreal Route Infrastructure Improvement Costs*

Improvement	Cost (Millions)
Worcester to Springfield: 4 Mile Siding Restoration & 2 New Interlockings	\$16-18
Improvements to Existing Track	\$133-155
Improvements to Existing Bridges	\$7-8
Station Infrastructure Improvements at Worcester and Palmer	\$12-14
Extensions to 6 Existing Sidings in Vermont Segment	\$101-117
Signal Improvements	\$146
Total	\$415-458

*All costs are developed in 2014 dollars. Estimated costs include a 30-50 percent range to represent different contingency factors. Details for infrastructure improvement components are located in the Appendix B.

6.3.1 Siding Restoration between Worcester to Springfield

On the CSX owned rail line between Worcester and Springfield, the construction of one section of new passing siding is recommended. Historically, the rail segment between Worcester and Springfield had at one time consisted of two main tracks with a third track in locations that was used as a switching track or a passing siding. Restoration of a passing siding between Worcester and Springfield was identified in the RTC analysis as necessary to accommodate passenger and freight operations in the segment.

Therefore, the NNEIRI program recommends restoring a 4 mile passing siding on the CSX line located approximately in the area of East Brookfield, Massachusetts. The passing siding is in location where a passing siding was historically located. The total anticipated cost for the passing siding restoration is \$13 to \$15 million. Included in the capital cost is the restoration of undergrade bridges (bridges where a track passes over a roadway, river, or other structure) that historically hosted a second track, and realignment of the existing track in certain segments to accommodate the restoration of the passing track. An additional \$3 to \$4 million is also required to install two siding interlockings for the new passing siding.

6.3.2 Springfield to the Canadian Border

New track and associated turnouts are proposed to allow for the addition of a second track or a passing siding in six new locations along this segment, located on the Pan Am Southern and NECR-owned right of ways. A second track or a passing siding is proposed to be added along the corridor in Brattleboro, Putney, Walpole, Claremont, St. Albans, and East Alburgh. Table 6-4 defines the Springfield-to-Montreal second track and passing siding segments.

Table 6-4. Summary of New Track/Siding Costs - Springfield-to-Montreal

Rail Segment	Total Length of New Track	Existing Grade Crossings	Estimated Capital Cost
MP 111-112.3 (East Northfield)	1.3	0	\$3.7-4.3 million
MP 123.5-144 (Brattleboro, Dummerston, Putney, Bellows Falls):	20.5	19	\$71.5-82.5 million
MP 121-122.5 (Brattleboro Downtown)	1.5	1	\$4.0-4.7 million
MP 1-8 (St. Albans, Swanton) *	7	7	\$18.0-20.7 million
MP 44.5-45.5 (Randolph)	1	1	\$2.8-3.2 million
MP 61.19-61.59 (Roxbury)	0.5	1	\$1.5-1.7 million
Total	29.5	28	\$101.5-117.0 million

* The bridge at MP 5, Pennell Road, Swanton, VT will remain single tracked

6.3.3 Track Improvements

In addition to the new passing tracks noted in the previous sections, the existing infrastructure would be improved to accommodate FRA Class 4 operations, or maximum 79 mph operations, along the Boston-to-Montreal Route. At several locations between Springfield and Worcester, recommended track improvements would be made to accommodate Class 4 operations, including installation of new rail, crossies, turnouts, and crossing upgrades. The anticipated cost for track improvements is \$133 to \$155 million. (Refer to Appendix B, Table B-5 for more detailed analysis.)

6.3.4 Bridge Work

Existing railroad bridges will be utilized, but several bridges would need improvements to accommodate the service along the Boston-to-Montreal Route. The most significant bridge improvement is on a bridge located in Walpole, New Hampshire where a second track segment is proposed. The total anticipated cost for bridge improvements is \$7 to \$8 million. (Refer to Appendix B, Table B.6 for a detailed breakdown of recommended bridgework and costs.)

6.3.5 Station Infrastructure Improvements

All of the existing intercity rail stations along the Boston-to-Montreal Route are included as stops on the Boston-to-Montreal Service and New Haven-to-Montreal Service. It is anticipated that prior to implementation of the full NNEIRI services the following station related projects

that are either currently planned or underway will be completed: South Station Expansion, Boston Landing Station, the Springfield Union Station building improvements, and the track and platform improvements at Springfield Union Station. A new station was considered in the area of Interstate 95/Route 128 in Weston, Massachusetts. This station was not included in the Recommended Alternative due to low ridership and high cost and constrained sites associated with any minimally practical locations.

The Boston-to-Montreal Route includes one station infrastructure project at Palmer. While there is an existing historic head house and low-level station platforms, service to Palmer would require construction of a new station since the configuration of the historic station precludes the installation of the Massachusetts Architectural Access Board required high level platforms and double main tracks that are included in the Recommended Alternative. The total cost for a new station in Palmer, including all platform, station, track, and contingency costs, is \$12 to \$14 million. (Refer to Appendix A, Table A-8 for more details.) The exact location of the new station has not been identified and would need to be determined by local and state officials. A new station in Palmer is not required to implement NNEIRI service, however the addition of a station would improve access to the service that without the station is limited in the area between Worcester and Springfield.

Descriptions of the existing and proposed stations are provided in Appendix D.

6.3.6 Signal Improvements

Currently, the rail segments between Boston and Springfield, Springfield and Northfield, Springfield and New Haven, and select island sections in Vermont have train control signal systems. Due to the additional level of service recommended on the NNEIRI Corridor, the expansion of the train control signal system is recommended along the full length of the right-of-way to accommodate the additional service, and provide for efficient movements between passing sidings.

Warning devices as well as Centralized Traffic Control (CTC) would be added over the segments of the NECR that are currently under Track Warrant Control (TWC), which total 140 miles of the corridor. This includes the section from East Northfield, Massachusetts to West River, Vermont and from White River Junction, Vermont to the Canadian border at Alburgh, Vermont. A full assessment of existing signal conditions was not conducted for this study, however a sampling of locations was examined to identify the level of rehabilitation that would likely be needed. Evaluation of the signal system along the entire corridor will be required in future phases of project development.

Based on previous site visits, 20 signals along the NECR would need to be replaced. Fifty-seven intermediate signals would be installed approximately every two miles along the line and interlocking signals will be added at both ends of key existing passing sidings intended for use in this area. These sidings are located at St. Albans, Oakland (Georgia), Berlin, Roxbury, Bethel, S. Royalton, and Hartland.

All grade crossings along the Corridor will be brought into a state of good repair. This includes replacing grade crossing warning devices that have reached the end of their useful life as well as upgrading unequipped public crossings with active warning devices at an estimated 83 locations

along the NECR (upgrade of 55 locations that currently have not active protection and rehabilitate an estimated 23 locations to accommodate higher speed passenger rail services). Also, passive signage will be installed at 161 private crossings along the NECR section. To accommodate increased passenger service, five additional sidings along the NECR were included for signaling upgrades. These sidings are located at: Swanton, Fonda Junction (Swanton), Bolton Valley, Randolph, and Brattleboro.

Signal work in Vermont is expected to cost \$140 million. An additional \$5 million would be required to make signal improvements along the Knowledge Corridor where a second track is proposed in East Northfield, Massachusetts at the junction with the NECR line. For a more detailed breakdown of costs refer to the Appendix B.

6.4 CONCEPTUAL ENGINEERING DESIGN DOCUMENTATION

As a part of the conceptual engineering process, schematics and drawings were prepared. These conceptual designs are included in Appendix C. The graphics are on 11"x17" sheets and at two scales (i.e., 1 inch equals 500 feet and 1 inch equals 250 feet). The schematics include existing and proposed railroad mileposts, stations, main tracks, controlled sidings, yard entrances and exits, grade crossings and grade separations, bridges, horizontal and vertical alignment, and freight and passenger train track speeds.

7 SERVICE OPERATION PLAN

This chapter provides an overview of the Boston-to-Montreal Service and New Haven-to-Montreal Service on the Boston-to-Montreal Route. The chapter includes the preliminary conceptual service schedule that was developed as part of the AA process and refined for this SDP based on anticipated ridership, revenue, and annual operating costs. The equipment and train crew schedule and the annual O&M costs for service on the Boston-to-Montreal Route are also provided.

7.1 OVERVIEW

Operations modeling was performed for the three recommended NNEIRI Corridor services to evaluate the capacity of the corridors, and determine needed infrastructure improvements to support greater train frequencies. On the Boston-to-Montreal Route, one daily round-trip between Boston and Montreal (Boston-to-Montreal Service) and one round-trip between New Haven and Montreal (New Haven-to-Montreal Service) are recommended. A service schedule and equipment and train crew schedule were developed as part of this modeling. The annual costs to operate and maintain service along the Boston-to-Montreal Route were also estimated. More information on the operations modeling, including methodology is provided in Appendix E.

7.2 SERVICE SCHEDULE

The one-way travel time for the Boston-to-Montreal Service is approximately 9 hours 3 minutes heading south and 9 hours 13 minutes heading north. The service makes station stops in Boston, Framingham, Worcester, Palmer, Springfield, Holyoke, Northampton, Greenfield, Brattleboro, Bellows Falls, Claremont, Windsor (Vermont), White River Junction, Randolph, Montpelier, Waterbury, Essex Junction, St. Albans, and Montreal. One daily round-trip would be provided between Montreal and Boston.

The one-way travel time for the New Haven-to-Montreal Service is approximately 8 hours 10 minutes. The service makes station stops in New Haven, Wallingford, Meriden, Berlin, Windsor (Connecticut), Windsor Locks, Springfield, Holyoke, Northampton, Greenfield, Brattleboro, Bellows Falls, Claremont, Windsor (Vermont), White River Junction, Randolph, Montpelier, Waterbury, Essex Junction, St. Albans, and Montreal. In addition to the extension of the existing Vermonter service, one additional daily round-trip would be provided between New Haven and Montreal.

The conceptual Boston-to-Montreal Route schedules are shown in Tables 7-1 and 7-2 and demonstrate the travel times, span of service and service headways being contemplated. Schedules were coordinated with other intercity rail stations to provide adequate spacing and coordination with service. The schedules include the recommended one round-trip between Boston and Montreal and the one new round-trip between New Haven and Montreal. A proposed schedule with the extension of the Vermonter north from St. Albans to Montreal is also included in the schedule. Trains would make all station stops between Boston and Springfield and Springfield and Montreal. However, certain trains operating in the Springfield to New Haven

segment could skip station stops in accordance to existing Amtrak schedules. To account for operational and service changes to other commuter, intercity, and freight rail operations on the NNEIRI Corridor, a final schedule has not been developed as part of this SDP.

Table 7-1. Southbound Boston-to-Montreal Service & New Haven-to-Montreal Service Schedule 2035

Stations	Vermont Train 55	New Haven-to- Montreal Service Train 57	Boston-to-Montreal Service Train 59
Montreal (Depart)	750A	1122A	222P
St. Albans	925A	1257P	357P
Burlington	949A	121P	421P
Waterbury	1014A	145P	446P
Montpelier	1028A	159P	500P
Randolph	1101A	232P	533P
White River Junction	1137A	308P	609P
Windsor, Vermont	1157A	328P	629P
Claremont	1207P	338P	639P
Bellows Falls	1227P	358P	659P
Brattleboro	100P	431P	732P
Greenfield	129P	500P	801P
North Hampton	142P	523P	824P
Holyoke	158P	539P	840P
Springfield (Arrive)	225P	607P	857P
Springfield (Depart)	240P	622P	9229
Palmer	-	-	939P
Worcester	-	-	1026P
Framingham	-	-	1054P
Boston (Arrive)	-	-	1125P
Windsor Locks	300P	642P	-
Windsor, Connecticut	305P	647P	-
Hartford	320P	702P	-
Berlin	334P	716P	-
Meriden	344P	726P	-
Wallingford	352P	734P	-
New Haven (Arrive)	410P	752P	-

Table 7-2. Northbound Boston-to-Montreal Service & New Haven-to-Montreal Service Schedule 2035

Stations	New Haven-to-Montreal Service Train 52	Boston-to-Montreal Service Train 54	Vermont Train 56
New Haven (Depart)	900A	-	125P
Wallingford	918A	-	143P
Meriden	923A	-	148P
Berlin	938A	-	203P
Hartford	952A	-	217P
Windsor, Connecticut	1002A	-	227P
Windsor Locks	1010A	-	235P
Boston (Depart)	-	1050A	-
Framingham	-	1121A	-
Worcester	-	1149A	-
Palmer	-	1236P	-
Springfield (Arrive)	1030A	1253P	255P
Springfield (Depart)	1045A	108P	310P
Holyoke	1102A	125P	327P
North Hampton	1128A	141P	343P
Greenfield	1151A	204P	406P
Brattleboro	1220P	233P	435P
Bellows Falls	1253P	306P	508P
Claremont	113P	326P	528P
Windsor, Vermont	123P	336P	538P
White River Junction	143P	356P	558P
Randolph	219P	432P	634P
Montpelier	252P	505P	707P
Waterbury	306P	519P	721P
Burlington	331P	544P	746P
St. Albans	355P	608P	810P
Montreal (Arrive)	540P	803P	1005P

7.3 EQUIPMENT AND TRAIN CREW SCHEDULING

Train crew schedule modeling was completed for the Boston-to-Montreal Service and the New Haven-to-Montreal Service. The outputs from these models determined the necessary total equipment and train crew resources required to meet each operating timetable. The train crew schedule modeling was completed based on the assumption of one daily round-trip train operating between Boston and Montreal and one daily round-trip between New Haven and Montreal. The model also assumes reasonable connection with the Amtrak Vermonter service at Springfield. It was also assumed that 5 coach trains, similar in size to the existing Vermonter service would be appropriate. Equipment and crew scheduling also assumes that crews from the state-supported New Haven-Springfield Shuttle train operated by Amtrak would be incorporated into NNEIRI services. Additionally, the model provides for five crews to operate the Boston to Montreal Route, including one spare crew. Each crew was assumed to include four people.

The model produced a system using five trainsets with schedules that incorporate train number, days of operation, times of departure, and assigned crew runs. Trains and sets are lettered and numbered based on a continuation of the train set names and numbers established for the Inland Route Service (ten trainsets).

Five trainsets would be required to allow one daily round-trip for each of the Boston-to-Montreal Route services. Due to trip lengths, trains and crews layover in Boston, Montreal, or New Haven during the night and return to their origin the following day. The train sets that were developed for the Boston-to-Montreal Route services are as followed:

- Train Set 11 – Departs Boston at 10:50am and arrives in Montreal at 8:03pm. The train layovers in Montreal at night. Departs Montreal at 2:02pm and arrives in Boston at 11:25pm.
 - Set K (Boston Engine and Coaches, BM-1) – Trains 54 (Sat, Mon, Wed)
 - Set K (Boston Engine and Coaches, BM-1) – Trains 59 (Sun, Tues, Thurs)
 - Set K (Boston Engine and Coaches, Boston Extra Board) – Trains 54 (Fri)
 - Set K (Boston Engine and Coaches, Boston Extra Board) – Trains 59 (Sat)
- Train Set 12 – Departs Montreal at 2:02pm and arrives in Boston at 11:25pm. The train layovers in Boston at night. Departs Boston at 10:50am and arrives in Montreal at 8:03pm.
 - Set L (Montreal Engine and Coaches, MB-2) – Trains 59 (Mon, Wed, Fri)
 - Set L (Montreal Engine and Coaches, MB-2) – Trains 54 (Sun, Tues, Thurs)
- Train Set 13 – Departs New Haven at 9:00am and arrives in Montreal at 5:40pm. The train layovers in Montreal at night. Departs Montreal at 11:02am and arrives in New Haven at 7:52pm.
 - Set M (New Haven Engine and Coaches, NHM-1) – Train 52 (Sat, Mon, Wed)
 - Set M (New Haven Engine and Coaches, NHM-1) – Train 57 (Sun, Tues, Thurs)
 - Set M (New Haven Engine and Coaches, New Haven Extra Board) – Trains 54 (Fri)
 - Set M (New Haven Engine and Coaches, New Haven Extra Board) – Trains 59 (Fri)

- Train Set 14 – Departs Montreal at 7:30am and arrives in New Haven at 4:10 pm. Train layovers in New Haven at night. Departs New Haven at 9:00am and arrives in Montreal at 5:40 pm.
 - Set N (Montreal Engine and Coaches, MB-2) – Train 59 (Mon, Wed, Fri)
 - Set N (Montreal Engine and Coaches, MB-2) – Train 54 (Sun, Tues, Thurs)
- Train Set 15 at Boston Facility, used for Scheduled Maintenance and Emergencies
 - Set O (Boston Engine and Coaches) - Spare Set, used as needed.

Train set utilization assumes a minimum turn time of two hours, provides significant recovery time, and would provide operators with a wide range of options regarding set utilization and maintenance schedules. This configuration would provide for four active sets and one spare set.

7.4 OPERATIONS AND MAINTENANCE COSTS

The operations and maintenance (O&M) costs, inputs, and methodology described in this section include the annual costs associated with implementation of the Boston-to-Montreal Service and New Haven-to-Montreal Service on the Boston-to-Montreal Route. O&M costs help to determine the total cost of operating new rail services based on standard passenger rail costs from the Northeast.

7.4.1 Methodology

To generate operations costs for the Boston-to-Montreal Route services, a flexible O&M cost model was developed. The model considers the following operating characteristics:

- Level of service;
- Peak fleet requirements;
- Operating speed;
- Revenue operating hours; and
- Route length.

Project Alternatives

The O&M cost estimates for the Boston-to-Montreal Route services were based on travel times, number of stops served, and type of equipment used that were identified as part of the Recommended Alternative. The cost estimates assume a maximum speed of 79 mph, the use of standard equipment, and local station stops.

Passenger Rail O&M Cost Elements

Typically, O&M costs for intercity passenger rail services are divided into six primary cost categories. The cost model includes train and engine crew, rolling stock maintenance, rolling stock capital depreciation, maintenance of way, maintenance of facilities, and administrative costs. For the purposes of the Boston-to-Montreal Route O&M model, relevant cost categories have been combined into train, engine and onboard crew costs, maintenance and administrative costs, and rolling stock capitalization costs.

The O&M cost models are structured to predict operating costs based on a combination of the standard cost drivers, including price per passenger, per mile, per train hour, per trip, per train set, or lump sum based on contract or allocation methodology. This model uses train sets, train hours, and train miles as the three variables to predict costs. Other elements incorporated into the O&M cost model include:

- Wages and fringe benefits for locomotive engineers, conductors, assistant conductors, and on-board service crew are represented in train hours and include labor associated with terminal yard operations. Train hours were used to estimate labor costs for crew hours.
- Host railroad charges, rolling stock preventive maintenance, running repairs and inspections, terminal maintenance of way, station maintenance, fuel, on-board provisions, insurance and administrative costs are reflected in train miles. Administrative costs (unless otherwise accounted for) include marketing, customer service, security, rents and leases and payments for host freight railroad track sharing rights. Fuel, maintenance, and administrative costs are affected more by number and distance of trips, rather than train hours. Therefore, these unit elements were incorporated into the O&M cost model's train miles variable.
- The cost per train set includes the annual depreciation of the rolling stock required for the service, and is defined as an annual cost for each train set required to operate the service.

Unit Costs

Peer services operated by Amtrak on similar corridors in the Northeast, using similar rolling stock, and under similar operating conditions were identified and used to establish unit costs for service on the Boston-to-Montreal Route. The peer services used to create the unit costs for this SDP are based on Amtrak's Vermonter, Adirondack, and Empire Corridor O&M costs. The operating costs of the peer services were then broken down into cost per train set, cost per train hour, and cost per train mile. The rates of the peer system are represented in Table 7-3.

Once the per train mile, train hour, train set, and track mile rates were identified, the O&M cost model was developed to establish a cost for the Boston-to-Montreal Route's proposed operating characteristics and draft revenue service schedule. The model incorporated annualized costs based on the number of train sets required to operate the service each day, the total number of train hours are operated (which is derived from the schedule) and the number of train miles, which is calculated by multiplying the number of daily trips time the route length.

Table 7-3. Unit Costs (2014 Dollars)

Cost Category	Cost
Train Set ²⁵	\$827,000.00
Train Hour ²⁶	\$793.69
Train Mile ²⁷	\$22.97

Cost Methodology

The costs identified in Table 7-3 were calculated in the O&M model utilizing the following operating characteristics:

- Train Sets/Rolling Stock.** The quantity of coaches and locomotives and type of locomotive, collectively known as rolling stock, used in each train (train set) was incorporated into the model. The number of coaches and locomotives dictates the amount of rolling stock maintenance. Both locomotives and coaches must be inspected and preventative maintenance performed on components, in addition to routine running repairs. The O&M rates established in the model assume one diesel locomotive pulling five coaches, one of which includes food and beverage service facilities. To establish the equipment requirements, a minimum two-hour layover was assumed at each terminal station. The turn time includes passenger alighting, schedule recovery, cleaning, commissary restocking, and passenger boarding. In addition, during this time, brake tests and cab signal/PTC tests would occur. Vehicles were assigned routes based on the proposed operating schedule to minimize excess layover time to the extent possible. Once the peak vehicle requirements were established, an industry standard 20 percent spare ratio was assigned so that “ready-spares” were available. As noted turn time minimums of two hours were utilized for this plan, however, as individual services plans are refined, turn time minimums be reduced and range between 30 minutes and two hours depending on terminal conditions and requirements of the service operator.
- Length of Route.** The length of the route typically defines the hours of operation for each train and the miles over which it must be operated. This in turn determines some maintenance requirements for both the vehicle, station and the track.
- Trip Frequency.** The number and frequency of trips operated impact both train hours and train miles. The number of daily trips helps to define cost of the service, since crew labor (and fringe benefit) costs are assessed based on hours of operation (as crews are paid hourly) and frequency of operation drives the cost of rolling stock maintenance. The more the rolling stock is used, the more maintenance required.
- Schedule Characteristics.** The speed of operation, number of stops, and operational schedule or revenue hours, and the length and frequency of the runs define the paid time

²⁵ Annual cost to operate a train set

²⁶ Cost to operate one train for one hour

²⁷ Cost to operate one train for one mile

of service for train crews. The paid time for train crews took into account all current operating rules related limitations on train crew hours of service.

The Boston-to-Montreal Service and the New Haven-to-Montreal Service both have an operating speed of 79 mph using traditional push, pull diesel locomotive equipment for all speeds.

Limitations

The O&M model has some limitations that must be considered in evaluating its outputs. The model reflects a train consist with a standardized diesel locomotive and five coaches. Additional O&M costs would be expected if longer consists are operated. At this time, it is expected that none of the train consists would exceed five coaches.

7.4.2 Boston-to-Montreal Route O&M Costs

The Boston-to-Montreal Route services requires four train sets and one spare train set for contingency. The unit costs used to prepare the O&M costs for the Boston-to-Montreal Route are outlined in Table 7-4. These unit quantities are used, along with the unit costs identified in Table 7-3, to calculate the annual operating costs identified in Table 7-5.

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Table 7-4. Annual Boston-to-Montreal Route O&M Cost Units in 2014 Dollars

Units	Quantity
Operating Train Sets	4
Daily Revenue Hours	35
Annual Operating Days	365
Annual Revenue Hours	12,623
Daily Train Miles	1535.60
Annual Train Miles	560,494

The total O&M costs for the Boston-to-Montreal Route include the costs for operating service between Springfield and New Haven that are currently part of Amtrak's New Haven-Springfield Shuttle service. Assuming these shuttle services are incorporated into NNEIRI, the Connecticut operating costs would be deducted from the total costs to operate NNEIRI trains. Connecticut currently pays Amtrak \$17 million per year for these services. It is assumed that \$14 million would be dedicated to Inland Route services and the remaining \$3 million could be used for the New Haven-to-Montreal Service. Therefore, as shown in Table 7-5, total Boston-to-Montreal Route O&M costs would be reduced from \$26 to \$23 million.

Table 7-5. Annual Boston-to-Montreal Route O&M Costs in 2014 Dollars

Operating Cost/ Category Unit	Total
Train Set	\$3,308,000
Train Hour	\$10,018,700
Train Mile	\$12,876,700
Total	\$26,203,400
Amtrak New-Haven Springfield Shuttle O&M costs	-\$3,436,600
Total (Excluding Shuttle O&M Costs)	\$22,766,800



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8 PUBLIC BENEFIT ANALYSIS

As part of this SDP, a public benefit analysis was conducted to estimate the benefits to society derived from the recommended NNEIRI service. The analysis compares the No-Build Alternative and the Recommended Alternative (outlined in Chapter 3), and a Full-build service scenario that includes both the Boston-to-Montreal Route and Inland Route services. The first part of this analysis uses a Benefit-Cost Analysis (BCA) framework to compare, in monetary terms, the public benefits and costs of these added rail services. Information used in this public benefits analysis was gathered from the NNEIRI Alternatives Analysis, Existing Conditions Report, and information developed for this SDP.

The second part of this chapter includes a qualitative discussion of the public benefits of the Recommended Alternative, focusing on how the proposed service addresses the NNEIRI Purpose and Need identified at the onset of the study (see Chapter 2). Additional technical details can be found in Appendix G.

8.1 BENEFIT-COST ANALYSIS METHODOLOGY

For this study, benefits for rail users were estimated on an incremental basis. This means that the gains that users, and more generally, society achieve from access to the additional passenger rail service are compared to the existing level of service and alternate transportation options. As with most transportation projects, the benefits that result from infrastructure projects are derived from the reduction in costs associated with changes or improvements to transportation options.

In general, benefits are measured as the creation of economic value that result from the added service and the quality (time spent, comfort, reliability, among other factors) of this service provided to users. Benefits may come in the form of average time saved by users, reduction of pollution or highway congestion, or more generally, a combination of these or other similar effects.

The following principles were used to guide the estimation of benefits and costs as part of this analysis:

- Only incremental benefits and costs were measured.
 - The incremental benefits of the project include the transportation cost savings for the users of the service that would not otherwise be available without the improvement.
 - The incremental costs of project implementation include both initial and recurring costs over and above currently anticipated costs. Initial costs refer to the capital costs required for design and construction of the infrastructure and the purchase of necessary rolling stock. Recurring costs include incremental operating costs, administration costs, and marketing expenses.
- Benefits and costs are valued at their opportunity costs.
 - The benefits of a transportation improvement include all benefits that can be obtained above and beyond the benefits from the next-best transportation alternative. For instance,

transportation cost savings for users is measured against the best existing alternative, in this case, the highway.

- The cost of the project reflects investments that cannot be made elsewhere. These expenditures are considered foregone opportunities to invest in other uses.

8.1.1 Valuation

As part of this analysis, all benefits were estimated using end-of-2014 dollars.²⁸ A number of assumptions were used to generate monetized values for non-monetary benefits. For example, several different components of time were monetized using a “value of time.” The “value of time” is assumed equivalent to a user’s willingness to pay for time savings in transit. The “value of time” varies depending on the trip purpose (i.e., business or personal trips) as well as time spent waiting as opposed to actually traveling. Other examples of estimations used to monetize benefits include the costs of operating a vehicle and the cost per metric ton of various pollutants.

Annual costs and benefits are computed over a long-run planning horizon and summarized by a life-cycle cost analysis that examines the whole time period. The planning horizon used for this analysis is 33 years, including three years of construction and 30 years of operation. Construction costs are assumed to occur within the first three years of implementation, while operating costs are incurred annually throughout the 30 years after service initiation. Similarly, benefits accrue during the full operation of the project.

8.1.2 Opportunity Cost of Capital and Discounting

Spending capital now to create benefits in the future requires not investing those funds elsewhere. The loss of potential gains from other uses to support one alternative is referred to as an opportunity cost of capital. By undertaking the capital investment, the funds cannot be spent on anything else or invested for capital gain. In general, people attach less value to outcomes that occur in the future than they do to outcomes that occur in the present. In other words, even with no inflation, the value attached to \$1 received one year from now is less than the value attached to \$1 received today. Because the analysis occurs over multiple years, with benefits and costs accruing at different and various times, it is necessary to somehow reflect these preferences.

The opportunity cost of foregoing alternatives is measured using a discount rate. Discounting expresses future outcomes in their present value, and it permits a level-playing-field comparison of options whose costs occur at different periods over time. All benefits and costs are discounted to reflect what was given up to commit resources to a specific project. Calculated real discount rates are applied to all future costs and benefits as a representation of how the public sector evaluates investments with a preference toward consumption sooner than later. The discount rate is measured as the compounded annual percentage change in the present value of a future dollar. Consistent with USDOT and FRA recommendations and information presented in Office of Management and Budget (OMB) Circulars A-4 and A-94, two discount rates were used in this analysis. In accordance with this guidance, a seven percent real discount rate was used as the primary value. Per the OMB Circulars, this represents the estimated before-tax rate of return of

²⁸ All monetary values were inflated from their original source value to 2014 dollars using the appropriate price index and data series. Additional detail on the valuations can be found in Appendix I.

private capital in the U.S. economy. In addition to the seven percent discount rate, most guidance indicates that analyses should also provide estimates of net benefits at a three percent discount rate. The three percent discount rate reflects the rate at which “society” discounts future consumption flows.

8.1.3 Alternatives Considered

The No-Build Alternative, or the Base Case for this analysis, is a continuation of existing service. As outlined in Section 3.4, the Base Case also includes several improvements along the Corridor that will be completed independently of NNEIRI. This includes the South Station expansion in Boston, the Montreal Central Station U.S. Customs checkpoint, and improvements made as part of the New Haven-Hartford-Springfield passenger rail service.

For this public benefits analysis three Build Case scenarios were developed: the Boston-to-Montreal Route service scenario, the Inland Route service scenario, and a Full-build service scenario that includes services along both routes. The Inland Route service scenario assumes the addition of eight new daily round-trips between Boston and New Haven, connecting through Springfield as an extension of existing Amtrak service. The Boston-to-Montreal Route service scenario assumes the addition of one daily round-trip train from Boston to Montreal via Springfield and one daily round-trip train from New Haven to Montreal via Springfield. The Full-build service scenario includes all three services. In this SDP, analysis of two scenarios are included: the Boston-to-Montreal Route service scenario and the Full-build service scenario. The Inland Route analysis can be found in the Inland Route SDP.

8.1.4 Project Costs

Only the incremental costs associated with the investments required to increase service are included in this evaluation. Thus, any costs that accrued in the Base Case are assumed to be incurred and the capital cost estimates solely reflect costs required to allow for the improvements discussed specifically for the Build Case scenarios.

Capital Costs

The anticipated capital improvements costs for the Inland Route service scenario are \$554 to \$660 million, including infrastructure improvements and rolling stock acquisition. The estimated capital investment associated with the Boston-to-Montreal Route service scenario is \$591 to \$634 million, including infrastructure improvements and acquisition of rolling stock. The capital improvement costs associated with the Full-build service scenario, including all infrastructure investments and equipment acquisition, are \$1,104 to \$1,247 million. The costs for the Full-build service scenario are less than the sum of the two individual service scenarios since some costs, including double-tracking from Worcester to Springfield, are shared between the two services.

For purposes of this analysis the higher-end, conservative cost estimates are included in the total project costs. This will reflect the lowest anticipated return on investment. The lower-end cost estimates were used as a sensitivity analysis and do not drastically affect the results.

Operating and Maintenance (O&M) Costs

To maintain the expected level of service during the analysis period, regular annual operating and maintenance expenditures are required. These O&M costs include the cost to operate the additional service and regular maintenance of the rail infrastructure and rolling stock. The following outlines the annual operating and maintenance costs for each of the three Build Case scenarios:

- Inland Route service scenario \$33 million
- Boston-to-Montreal service scenario \$23 million
- Full-build service scenario \$56 million

8.1.5 Ridership Estimates

As part of the NNEIRI Study, ridership estimates were generated assuming that the existing and anticipated transportation improvements in the NNEIRI study area including the New Haven-Hartford-Springfield rail service, Springfield Union Station improvements, Boston South Station expansion, extension of Vermonter rail service to Montreal, and Montreal Central Station improvements were completed. The ridership estimates presented in this public benefits analysis rely upon the completion of these coordinating improvements as well as the improvements associated with the two build scenarios.

Full details of the NNEIRI Corridor ridership estimates are presented in Chapter 4. These estimates were prepared using origin-destination pairs for two years, the first year of service and fifteen years later. The NNEIRI Corridor ridership estimates were prepared using the Full-build Service scenario. Consequently, some assumptions were required to analyze ridership for the Boston-to-Montreal Route Service scenario. The Boston-to-Montreal Route service scenario accounts for one-ninths of the roundtrips originating in Boston and New Haven as well as all trips from Springfield and extending north to Montreal.

The NNEIRI Corridor ridership estimate was used as the basis for this analysis. Like these other estimates, it is assumed that the opening year ridership estimates reflect ridership in the first year of service. Future year ridership estimates were prepared for fifteen years after the start of service. Because this analysis uses a 30-year benefit horizon, the growth rate from the ridership model was used to further project demand for fifteen additional years after the modeled estimate. The analysis also considered a scenario where ridership levels remained constant after 15 years which had negligible impacts on the overall benefits and benefit-cost ratios.

Though bus and air service transportation alternatives are available, the ridership model assumed that all new passenger rail riders were diverted from auto. For consistency with the overall NNEIRI Corridor ridership estimates, the public benefits analysis uses the same assumption as other modal diversion information is unavailable for use in this analysis.

8.1.6 Benefits

This section contains a description of the benefit categories, including the specific inputs and assumptions, that were used to develop the BCA results described later in the chapter. The following sections describe how the calculations were developed for the following five

categories of benefits, while the results are included in the following section. The benefit categories estimated as part of the analysis are:

- User Benefits;
- Emissions Reduction;
- Safety Benefits;
- Pavement Maintenance Benefits; and
- Congestion Benefits.

User Benefits

The first benefit category, User Benefits, considers both “value of time” and out-of-pocket costs for rail users.

The value of travel time per passenger includes both time spent in transit and wait times.²⁹ The dollar value of travel time varies depending on trip purpose (i.e., personal or business related trips). Time spent waiting, or dwell time, is valued differently than time spent in-vehicle. For modeling purposes, travel time and dwell time are considered, but travel time to and from stations was not included as this is variable at each station and for each traveler.³⁰ Each mode was measured on the distance from its respective station, excluding any time that would be required for a user to access the station. For comparison purposes, the travel time for auto trips was calculated using distances from rail stations. Per USDOT guidance on the valuation of travel time³¹ for intercity trips, the following values of time were used in the analysis:

- Personal Trips \$17.78
- Business Trips \$24.80
- Dwell Time \$25.37

These values increase at a rate of 1.2 percent per year to reflect real growth in productivity. An average pre-board dwell time of 10 minutes for rail users was assumed. Consistent with the ridership estimates, it was assumed that 15.2 percent of trips were for business purposes.

The out-of-pocket costs include vehicle operating and parking costs for private vehicle users and train fares for rail users. Vehicle operating costs are assumed to be \$0.55 per mile per the 2012 federal estimate for fully allocated auto operating costs. Rail fares are assumed to be \$0.30 per mile based on average projected costs between destinations. Parking costs for auto trips are calculated using a weighted average of ridership and the average daily parking cost for each city serviced by the new service, assuming a single-day trip. These values are as follows:

- Inland Route Service scenario \$24.54
- Boston-to-Montreal Service scenario \$15.88
- Full-build Service scenario \$20.66

²⁹ For additional information on value of travel time, see section 8.1.1.

³⁰ This is consistent with the ridership model methodology.

³¹ *Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis (Revision 2 – corrected)*; <http://www.dot.gov/office-policy/transportation-policy/guidance-value-time>

The time and out-of-pocket costs of each trip taken by private vehicle or rail were calculated using the weighted average of trip length (miles) and ridership based on the origin-destination pairs from the ridership estimates. In general, the average rail trip length was slightly shorter than the average auto trip length while the total travel time, including rail dwell time, was less than one minute longer for auto trips.³² To generate the total savings, the difference between the rail cost and the auto cost (the incremental benefit) was multiplied by the total number of riders for the Boston-to-Montreal Route service and Full-build service scenarios. This incremental value reflects the net benefit to users of the service.

It should be noted that while the proposed service alignments impact grade-crossings, the potential time and safety impacts to roadway users were not estimated as part of this effort. Most of the grade crossings in the corridor are located in the rural Vermont segment with very little vehicular traffic. A study of traffic delay at grade crossings was not conducted, though it is expected that the added time delay would be minimal and would not significantly impact the results of this analysis due to the limited number of daily trains, the short time the trains would occupy the crossings, and the limited volume of traffic..

Emissions

Air pollution levels can increase or decrease as a result of a transportation infrastructure project. A reduction in private vehicle travel decreases pollutants while an increase in rail miles adds pollutants. Pollution levels vary based on the number of miles traveled for each mode. Automobile vehicle miles traveled (VMT) are calculated based on the average trip length for each scenario and the number of riders, assuming an average rate of 1.5 persons per vehicle.³³ This analysis considers the total amount of various pollutants associated with the change in automobile vehicle miles traveled and train miles. The pollutants measured are volatile organic compounds, nitrogen oxides, fine particulate matter, sulfur dioxide, and carbon dioxide.

Emission rates for automobiles, which vary by year, are generated by the EPA’s MOVES model. Rail emission rates are calculated based on information in EPA’s “Regulatory Impact Analysis: Control of Emissions of Air Pollution from Locomotive Engines and Marine Compression Ignition Engines Less than 30 Liters per Cylinder.”³⁴ Per-unit emission costs are then applied to the change in emission volumes associated with the modal shift from automobiles to passenger rail. Following guidance from USDOT,³⁵ the following costs per metric ton are assumed for the various pollutants:

- Volatile Organic Compounds \$2,031
- Nitrogen Oxides \$8,005

³² Additional information regarding trip characteristics can be found in Appendix G.

³³ The vehicle occupancy rate is consistent with the ridership estimate.

³⁴ Auto emission rates vary by time and speed and rail emission rates vary by time. A table of emissions rates can be found in Appendix G.

³⁵ *Corporate Average Fuel Economy for MY2017-MY2025 Passenger Cars and Light Trucks* (August 2012), page 922, Table VIII-16, “Economic Values Used for Benefits Computations (2010 dollars)”;
http://www.nhtsa.gov/staticfiles/rulemaking/pdf/cafe/FRIA_2017-2025.pdf; Values have been updated to 2015 dollars.

- Fine Particulate Matter \$366,229
- Sulfur Dioxide \$47,316
- Carbon Dioxide \$69³⁶

Safety

Safety benefits are based on changes in crash occurrences that, like other variable costs, are dependent on changes in VMT. The rates of fatality and injury crashes vary by mode and are calculated per 100 million auto vehicle miles and 100 million passenger train-miles. Ideally, crash data for the specific corridors would be available to generate area-specific crash rates and crash savings. Since this information is not available, the crash rates used in this analysis are based on ten-year national averages from the U.S. Bureau of Transportation Statistics.³⁷ Some analyses also consider property damage only crashes, but these rates tend to be very small. Due to their small value and a lack of property damage only crash data for rail, these crashes were not included in this analysis. To generate the benefit, the crash rates for automobiles are applied to the reduction in VMT and the crash rates for rail are applied to the increase in passenger train miles.³⁸ The crash rates used in this analysis are:

- Auto (per 100 million VMT)
 - 1.29 fatalities
 - 83.58 injuries
- Rail (per 100 million passenger train-miles)
 - 7.24 fatalities
 - 1,185.96 injuries

The value of safety benefits was monetized using USDOT's guidance on the value of life and injuries.³⁹ According to this data, the value of a fatality is \$9.55 million at the end of 2014. The average cost per injury crash is \$110,826. Consistent with the guidance, the values used in the analysis model are increased by 1.18 percent per year to reflect the growth in real income.

Pavement Maintenance

Vehicles traveling over roadways cause wear and tear, which requires ongoing roadway maintenance and repairs. Reducing the usage of roadways decreases the frequency of this maintenance. Pavement maintenance cost reduction is another benefit of reduced vehicle traffic due to diversion to rail. Based on the 1997 FHWA Cost Allocation Study with valuations

³⁶ It should be noted that the cost of carbon varies on an annual basis. Per the Federal interagency Social Cost of Carbon (SCC) guidance, the value of carbon dioxide emissions should be always discounted at the lower discount rate of 3 percent. Due to this differentiation, emissions benefits are separated into non-carbon and carbon emissions in the BCA results.

³⁷ U.S. Bureau of Transportation Statistics, Table 2-42 for Rail and Table 2-17 for auto; Average of 2003-2012 values for auto and rail

³⁸ Information on avoided auto vehicle miles traveled and increased rail passenger train-miles can be found in Appendix G.

³⁹ *Guidance on Treatment of the Economic Value of a Statistical Life in U.S. Department of Transportation Analyses (2015)*; <http://www.dot.gov/office-policy/transportation-policy/guidance-treatment-economic-value-statistical-life>

updated to end-of-2014 dollars, the average pavement maintenance cost per mile is \$0.0014. Costs associated with the additional wear and tear on rail infrastructure are included in the annual operating and maintenance costs.

Highway Congestion Reduction

Diverting users from automobiles on the highway to a rail transit option will remove vehicles from the road, leading to an associated reduction in congestion and a small travel time savings for remaining roadway users. Ideally, it would be possible to estimate the actual number of vehicles on the corridor to fully evaluate the change in traffic associated with the additional rail service. In the absence of this information, a calculation for the marginal external benefit of avoided highway congestion due to additional vehicles was based on the 1997 FHWA Cost Allocation Study methodology. The average trip length along each corridor was multiplied by the total change in private vehicle trips between the Base Case scenario and the Build Case scenarios. The congestion reduction benefit is valued at \$0.06 per vehicle mile.

8.2 RESULTS OF BENEFITS-COST ANALYSIS

Using the BCA framework and the assumptions described in the previous sections, two different BCA models were prepared for the two Build Case scenarios included in this SDP: the Boston-to-Montreal Route service scenario and the Full-build service scenario. As noted previously, BCA is an industry-accepted approach to determining whether a project should proceed based on the societal benefits it is likely to generate. In this case, the BCA framework is essentially a comparison of values: the cost to build and operate the passenger rail service compared to the lost opportunity to invest elsewhere. The costs are offset by a number of benefits that have been estimated for current and future users. These benefits represent the improvement in social welfare that the project delivers.

Using the BCA framework, a Benefit-Cost Ratio (BCR) is calculated to reflect the amount of societal benefit generated by \$1 of investment. As previously mentioned, since benefits of transportation projects accrue years after completion, annual costs and benefits were computed over the life cycle of the project (33 years). For purposes of this analysis, a three-year construction period was assumed. The life cycle also includes 30 years of operations that begin after construction is complete. Per USDOT guidance and standard accepted practice, two different discount rates were used to account for the change in perceived value of money over time. A primary discount rate of seven percent and an alternative rate of three percent were applied to the constant-dollar values to account for the opportunity cost of capital and benefits over time (see Section 8.1.2). The following section summarizes the results of the BCA.

8.2.1 Boston-to-Montreal Scenario Benefit-Cost Analysis

The BCA results and specific costs and benefits for the Boston-to-Montreal Route service scenario are included in Table 8-1. As shown, this scenario results in a benefit-cost ratio (BCR) of 0.8 at a seven percent discount rate and 1.2 at a three percent discount rate. These ratios indicate that the quantifiable and monetized benefits of the Boston-to-Montreal Route service scenario exceed the costs and provide a positive net value to society at a discount rate of

approximately five percent. Using the “societal” discount rate of three percent, every dollar invested will result in societal gains of \$1.20 in value.

Table 8-1. Boston-to-Montreal Route Service Scenario BCA Results

BOSTON-TO-MONTREAL ROUTE SERVICE			
7% Discount Rate		3% Discount Rate	
Discounted Benefits	Millions (2014\$)	Discounted Benefits	Millions (2014\$)
User Benefits	\$363.2	User Benefits	\$684.3
Non-Carbon Emission Benefits	\$4.1	Non-Carbon Emission Benefits	\$7.6
Carbon Emission Benefits	\$24.0	Carbon Emission Benefits	\$24.0
Safety Benefits	\$180.9	Safety Benefits	\$352.3
Pavement Maintenance Benefits	\$1.0	Pavement Maintenance Benefits	\$1.9
Congestion Benefits	\$44.4	Congestion Benefits	\$83.8
PV TOTAL BENEFITS	\$617.6	PV TOTAL BENEFITS	\$1,153.9
Discounted Costs		Discounted Costs	
Capital Costs	\$518.2	Capital Costs	\$580.2
Operating & Maintenance Costs	\$215.5	Operating & Maintenance Costs	\$396.5
PV TOTAL COSTS	\$733.7	PV TOTAL COSTS	\$976.7
Net Present Value (NPV)	-\$116.1	Net Present Value (NPV)	\$177.2
Benefit-Cost Ratio (BCR)	0.8	Benefit-Cost Ratio (BCR)	1.2

User benefits are the largest category of benefits, accounting for \$363.2 million of the \$617.6 million total benefits. This benefit category accounts for the generalized travel cost savings between the alternate travel modes in the Base Case and Boston-to-Montreal Route service scenario. The large value for user benefits indicates that the perceived cost of traveling by rail is less than the perceived cost of traveling by auto. These costs are measured by the difference in out-of-pocket costs (vehicle operation and parking for automobiles and fares for rail) as well as the “value of time” spent traveling or waiting to travel.

Emissions savings accounted for \$28.1 million in benefits. This indicates that at the modeled ridership levels, the reduction in pollutants emitted into the atmosphere from the removal of automobile trips exceeds the increase in pollutants added due to the additional train-miles. The positive valuation indicates that society is better off due to less vehicle related pollution along this corridor.

Safety benefits accounted for \$180.9 million over the project life. The shift from auto trips to rail trips reduces the anticipated number of highway crashes while the additional service increases the likelihood of a rail crash occurring. Crash rates for rail are lower than those for highway travel, and the projected decrease in vehicle trips due to rail diversion greatly offsets the impacts of additional rail passenger miles.

Pavement maintenance and congestion reduction accounted for \$1.0 and \$44.4 million in savings, respectively. These two categories highlight the benefits associated with a reduction in total vehicles traveling on the already congested highways. Respectively, these benefits are an approximation of the avoided cost of repairing highway infrastructure and the time-savings for users who continue to make trips in the impacted corridors.

As mentioned in Section 8.1.4, the analysis was conducted using the conservative, high-end of the expected capital cost range. Since a range of capital costs was presented, a sensitivity test was conducted on the low-end of the range of project costs. Assuming a capital cost of \$590.5 million instead of \$633.8 million results in BCRs of 0.9 and 1.2 at seven and three percent, respectively.

8.2.2 Full-build Service Scenario Benefit-Cost Analysis

The previous section outlined the benefits of only investing in the infrastructure required for the Inland Route Service scenario. A BCA was also completed for the Full-build service scenario that includes the Boston-to-Montreal Route and Inland Route services. As shown in Table 8-2, the Full-build service requires a \$1.247 billion investment and produces \$1.04 billion in benefits at a seven percent discount rate. The BCR for this scenario is 0.7. At a three percent discount rate, the BCR is 0.9. These results indicate that investing in the Full-build service scenario generates a lower societal return on investment than only investing in the Boston-to-Montreal Route service scenario. Assuming a capital cost of \$1.104 billion instead of \$1.227 billion results in BCRs of 0.7 and 1.0 at seven and three percent, respectively.

Table 8-2. Full-build Service Scenario (All Services) BCA Results

FULL-BUILD SCENARIO			
7% Discount Rate		3% Discount Rate	
Discounted Benefits	Millions (2014\$)	Discounted Benefits	Millions (2014\$)
User Benefits	\$634.7	User Benefits	\$1,195.8
Non-Carbon Emission Benefits	\$6.5	Non-Carbon Emission Benefits	\$12.3
Carbon Emission Benefits	\$38.9	Carbon Emission Benefits	\$38.9
Safety Benefits	\$285.8	Safety Benefits	\$557.1
Pavement Maintenance Benefits	\$1.6	Pavement Maintenance Benefits	\$3.0
Congestion Benefits	\$72.1	Congestion Benefits	\$135.9
PV TOTAL BENEFITS	\$1,039.7	PV TOTAL BENEFITS	\$1,943.1
Discounted Costs		Discounted Costs	
Capital Costs	\$1,1019.7	Capital Costs	\$1,141.8
Operating & Maintenance Costs	\$525.6	Operating & Maintenance Costs	\$966.8
PV TOTAL COSTS	\$1,545.3	PV TOTAL COSTS	\$2,108.6
Net Present Value (NPV)	-\$505.6	Net Present Value (NPV)	-165.5
Benefit-Cost Ratio (BCR)	0.7	Benefit-Cost Ratio (BCR)	0.9

8.3 ADDITIONAL BENEFITS

In addition to the BCA quantitative analysis, each of the two Build Case scenarios were also analyzed qualitatively in regards to how they address the NNEIRI Purpose and Need Statement that was established at the beginning of the NNEIRI Study. As described in Chapter 2, the Purpose of the NNEIRI Study is to address the lack of intercity transportation choices in New England, particularly between major cities and the smaller cities and urban areas. The Need for the service stems from the recognition of benefits that could accrue to the region's economy and livability from improved regional connections. The following sections outline how the Boston-to-Montreal Route service scenario and the Full-build service scenario address the identified NNEIRI Purpose and Need.

8.3.1 Boston-to-Montreal Route Service Scenario

Currently, only one daily round-trip is provided between Boston and Springfield (Lake Shore Limited Service) and one daily round-trip is provided between New Haven and St. Albans, Vermont (Vermont Line). In the future, the Vermonter service will extend north all the way to Montreal.

For the Boston-to-Montreal Route Service, the number of daily round-trips will double along the corridor. Each day, one additional train will depart New Haven for Montreal. One additional train will also depart Boston for Montreal, passing through Springfield. Currently, direct service between Boston and Montreal is not provided.

Based on the commuters, students, and other anticipated users, the projected ridership for the Boston-to-Montreal services fifteen years after the initiation of service is 447,058 annual riders.

By providing increased passenger rail service, connectivity between the major cities and the smaller cities and rural areas will be enhanced. The Boston-to-Montreal Route has a number of important local and regional destinations, including several key employment centers. The Boston-to-Montreal Route services would provide residents, visitors, students, and employees along the corridor with additional transportation options for daily commuting, non-daily commuting, or other travel needs.

The estimated population who reside within three miles of one of the stations along the Boston-to-Montreal Route is 2.25 million. The total employed population who reside near any of the stations is estimated at 1.35 million (or 60 percent of the total corridor population). The majority of the employed population lives within two hours by train from one or more of the five major cities along the corridor: Montreal, Boston, New Haven, Hartford, and Springfield. The estimated employed population within two hours of each major city is shown in Table 8-3. Given the proximity of some of these cities, some employees can live within two hours of more than one city.

Table 8-3. Boston-to-Montreal Route Service Scenario Estimated Working Age Population

Major City	Estimated Working Age Population Within 2 Hours
Montreal	7,000
Boston	224,000
New Haven	355,000
Hartford	375,000
Springfield	1,066,000

Source: U.S. Census Bureau, American Community Survey, 2011

Additionally, the Boston-to-Montreal services would also provide alternative modes of transportation for almost one million college students who attend one of the 190 higher education institutions located in the major and smaller cities along the corridor.

8.3.2 Full-build NNEIRI Service

With the Full-build NNEIRI service, trips along all segments of the NNEIRI corridor will significantly increase. As previously described, today, only two daily round-trips operate along the NNEIRI Corridor. For NNEIRI service, nine additional daily trains will depart Boston for either Montreal or New Haven, nine additional trains will depart each day from New Haven for Boston or Montreal, and two additional trains will depart Montreal for Boston or New Haven.

Service between Boston, Springfield, Hartford, and New Haven along the Inland Route is dramatically increased.⁴⁰

The increased level of service provides considerable access and connectivity improvements for commuters along the corridor. Since the Full-Build NNEIRI service provides higher level of service and includes trips along the Inland Route, it provides a meaningful transportation option for students, tourists, and transit-dependent riders.

The estimated population who reside within three miles of one of the stations along the NNEIRI Corridor is 2.25 million. The employed population who reside near any of the stations is estimated at 1.35 million. The employed population that can reach one of the five major cities along the corridor is higher than for the Boston-to-Montreal service alone, since service is provided between Boston and New Haven. The estimated employed population within two hours of each major city is shown in Table 8-4. The employed population that can reach Hartford and New Haven by train in less than two hours in the Full-Build NNEIRI service increases by almost 100,000 and 6,000, respectively.

Table 8-4. Full-build Service Scenario Estimated Employed Population

Major City	Estimated Employed Population Within 2 Hours
Montreal	7,000
Boston	224,000
New Haven	362,000
Hartford	473,000
Springfield	1,066,000

Source: U.S. Census Bureau, American Community Survey, 2011

Given the increased service levels, the ridership is also boosted. The ridership projected for the Full-build Service is 875,700 annual passengers in 2035. In comparison, the long-running Empire Service runs between New York City and Niagara Falls, New York via Albany. In FY2014, 1,119,959 passengers traveled between New York City and Albany (approximately 141 miles), and 410,344 annual riders traveled between Albany and Niagara Falls (319 miles).

The Cascade Service is another successful regional Amtrak service. Running between Vancouver, British Columbia and Eugene, Oregon, the service connects 18 different cities include Portland, Oregon and Seattle, Washington. The ridership on this 467-mile-long service was 782,519 in FY2014.

⁴⁰ Although additional service are planned to be operating the corridor by 2035, only the NNEIRI services are included in the description and the Benefit Cost Analysis to isolate the costs and benefits associated specifically with the NNEIRI services.



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9 IMPLEMENTATION PLAN

This chapter outlines the strategies and plan for service implementation. The chapter discusses how the proposed NNEIRI Corridor service could be partially implemented, or implemented in stages, the governance issues that would need to be addressed prior to service implementation and offers a range of potential models. The capital and operating funding requirements, opportunities, and strategies for the Boston-to-Montreal Route are also detailed. Finally, the chapter concludes with a summary of the implementation considerations and next steps that would need to be taken in advance of service.

9.1 INVESTMENT OPTIONS ANALYSIS

A set of seven investment options were developed to allow partial or full implementation of the services of the Recommended Alternative on the NNEIRI Corridor over time. These investment options were prepared to outline how service could be partially implemented, implemented over time, or fully implemented through a series of infrastructure and service investments. Other options are possible depending upon interim goals, such as adding service along the Knowledge Corridor portion only to improve connections to Boston or New York. Three different Boston-to-Montreal Route investment options were developed in tandem with three separate Inland Route options to properly understand the impact on the Corridor as a whole. One complete Full Build option was also developed, which includes all services proposed as part of the Recommended Alternative outlined in Chapter 3. The first part of this section presents the three Boston-to-Montreal Route investment options and the Full Build investment option (complete implementation of all recommended Inland Route and Boston-to-Montreal Route services). The Inland Route investment options are presented in the Inland Route SDP. The later parts of this section analyze the capital costs, ridership, and O&M costs for these four options.

9.1.1 Boston-to-Montreal Route Investment Options

Due to the large investment required to support the complete implementation of the Recommended Alternative, an analysis was done to evaluate the potential for partial investments and service development. This analysis is important to understand the benefits that minimal investments could provide. The investment options were developed based on an understanding of maximizing ridership, providing rational service levels, and minimizing infrastructure investments.

This section outlines the three different investment options that were prepared for the Boston-to-Montreal Route (Investment Options I, II, and III) and, for comparison purposes, the full-build implementation of NNEIRI Corridor services (Investment Option VII). The scope of improvements required in each corridor segment and associated capital costs are provided in greater detail in Chapters 6 and 7 of this SDP. In addition, the service operation plan described in Chapters 6 and 7 of this SDP outline in more detail the full implementation of Boston-to-Montreal Route service (Investment Option III). The three additional Boston-to-Montreal Route investment options (Investment Options IV, V, and VI) are discussed separately in the Inland Route SDP.

Investment Option I (Boston-to-Montreal Service Only)

Investment Option I includes one round-trip between Boston and Montreal primarily during off-peak hours; peak hours include AM arrivals at South Station between 6 AM and 9AM and PM departures from South Station between 3:30 and 6:30. Figure 9-1 shows schematically the Boston-to-Montreal Service included in Investment Option I.

Investment Option I includes construction of a 4-mile passing siding on the CSX-owned segment between Springfield and Worcester to improve the reliability of both passenger and freight services in East Brookfield, Massachusetts. This option also requires completion of passing sidings along the Springfield-Montreal Segment at the several locations within Vermont identified as part of the Recommended Alternative. However, if implemented in the near future, the mainline improvements made during recent FRA grant-funded projects within Vermont were designed and constructed to support the additional round trip train operation in Vermont without further infrastructure investment. This capacity was included as part of the FRA grant's Service Outcome Agreement between the Vermont Agency of Transportation, Amtrak and the New England Central Railroad.

Improvements planned and underway at Springfield Union Station are assumed to be completed prior to implementation of this option so the terminal can accommodate the additional service. The improvements at Union Station will create sufficient capacity for the level of service required for this option and open the potential for even more future service. The completion of the U.S. Customs and immigration checkpoint in Montreal Central would also be necessary for this service to commence. Three new trainsets would be required for the Boston-to-Montreal Service to provide one daily service trips and the inclusion of one spare trainset. As discussed in section 6.2, if at the time of implementation of additional service refurbished or surplus equipment is available, equipment costs could be significantly reduced.

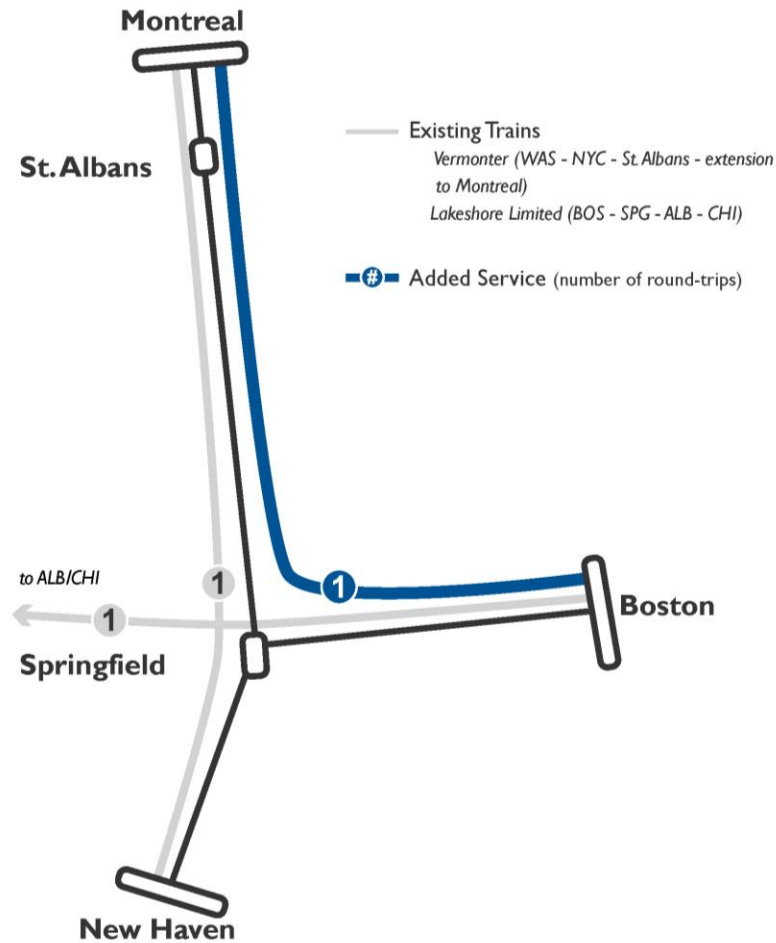


Figure 9-1: Investment Option I Service

Investment Option II (New Haven-to-Montreal Service Only)

Investment Option II includes one round-trip between New Haven to Montreal. Figure 9-2 shows schematically the New Haven-to-Montreal Service included in Investment Option II.

Investment Option II includes the completion of the passing sidings along the Springfield-Montreal Segment at several locations within Vermont as included in Investment Option I. If implemented in the near future, mainline improvements made during recent FRA grant funded projects within Vermont would support the additional round trip train operation in Vermont without further infrastructure investment. Thus, this investment option assumes that no additional infrastructure investment is required. However, the completion of the U.S. Customs and immigration Checkpoint in Montreal Central would be necessary for this service to commence. Three additional train sets would be required for the New Haven-to-Montreal Service, including two train sets to operate the service and one spare set. As discussed in section 6.2, if at the time of implementation, refurbished or surplus equipment is available, equipment costs could be significantly reduced.

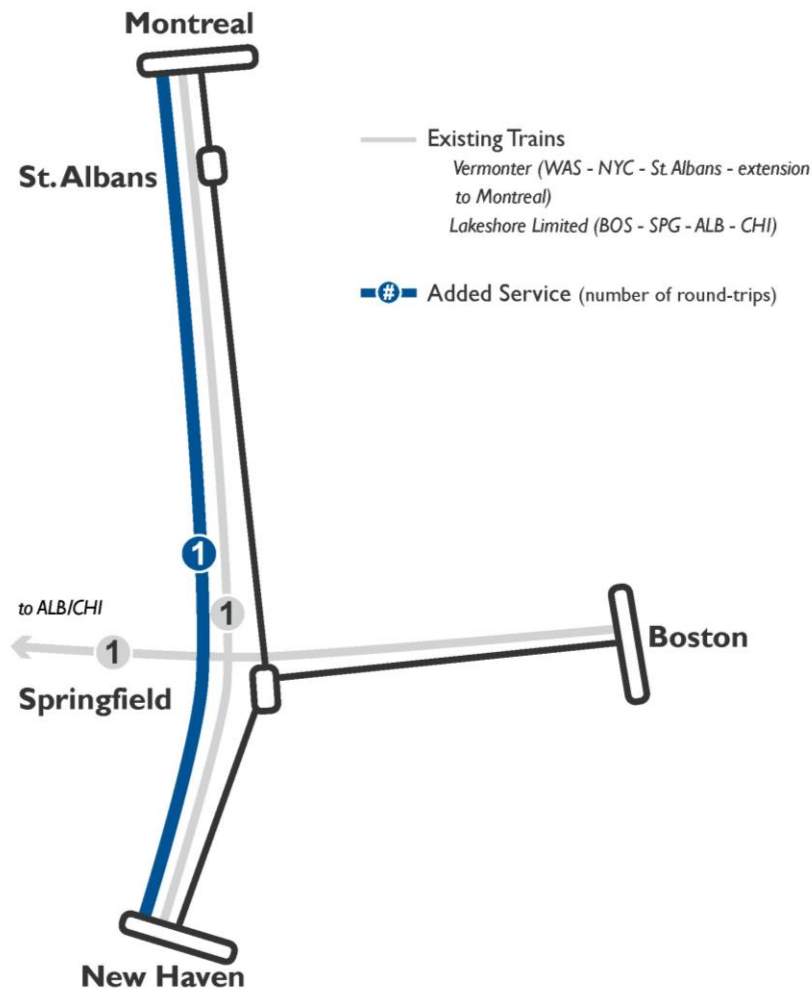


Figure 9-2. Investment Option II Service

Investment Option III (Boston-to-Montreal Route Full Service)

Investment Option III includes all recommended services on the Boston-to-Montreal Route, including one round-trip between Boston and New Haven and one round-trip between Boston and Montreal. Figure 9-3 shows schematically the Boston-to-Montreal Service and New Haven-to-Montreal Service included in Investment Option III.

Investment Option III includes construction of a 4-mile passing sidings on the CSX-owned segment between Springfield and Worcester to improve the reliability of both passenger and freight services in East Brookfield, Massachusetts. This option also requires completion of passing sidings and signalization along the Springfield-Montreal Segment at several locations within Vermont as included in the Recommended Alternative. The Springfield Union Station improvements must also be completed as part of this option to accommodate the additional

service. These improvements at Union Station would create sufficient capacity for the level of service required for this option and open the potential for even more future service. The completion of the U.S. Customs and immigration Checkpoint in Montreal Central would also be necessary for this service to commence. Five new trainsets would be required to provide one daily round-trip each on the Boston-to-Montreal Service, one daily round-trip on the New Haven-to-Montreal Service, and the inclusion of one spare trainset.

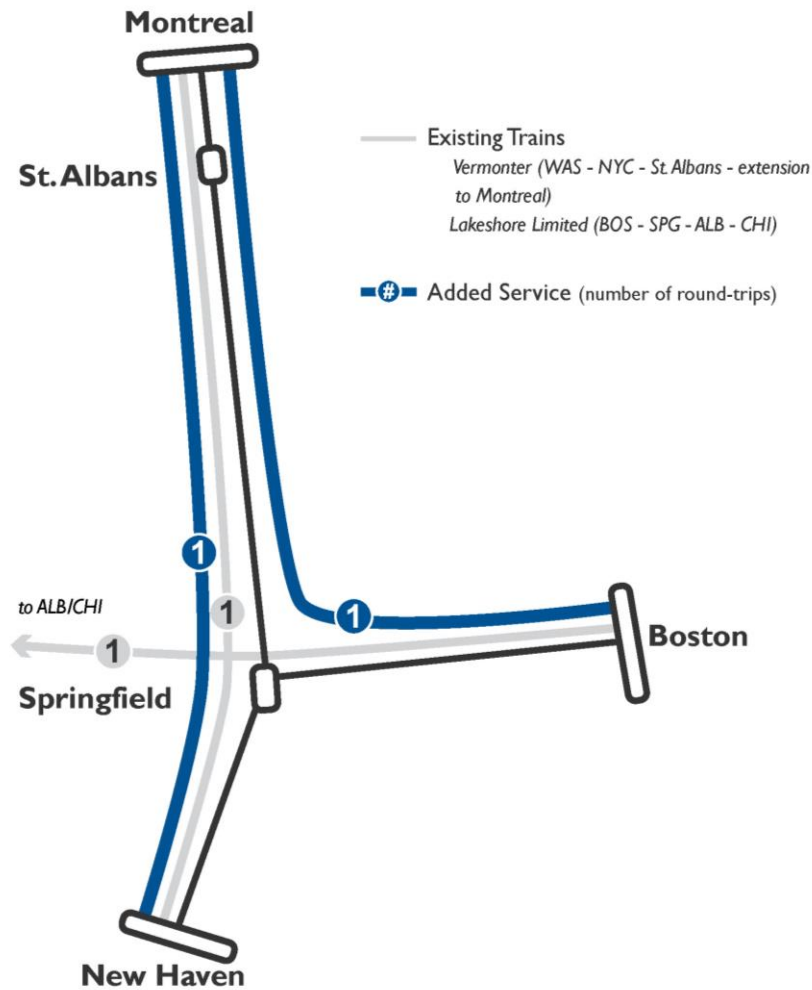


Figure 9-3: Investment Option III Service

Investment Option VII (Full Service NNEIRI Corridor: Inland Route and Boston-to-Montreal Route)

Investment Option VII provides for the full implementation of the NNEIRI Recommended Alternative. This includes eight daily round-trips between Boston and New Haven on the Inland Route and one daily round-trip between Boston and Montreal and one daily round-trip between New Haven and Montreal on the Boston-to-Montreal Route. Figure 9-4 shows schematically the new passenger rail service in Investment Option VII.

Investment Option VII is the full build-out of the recommended service on the NNEIRI Corridor, with all proposed infrastructure constructed on the Boston-to-Montreal Route and the Inland Route as included in the Recommended Alternative. This includes the completion of a second platform at Worcester Union Station, track and platform improvements at Springfield Union Station, and full or partial completion of Boston South Station expansion would be required to be completed as part of separate projects as part of this option. The completion of the U.S. Customs and immigration Checkpoint in Montreal Central would also be necessary for this service to commence.

Investment Option VII requires the acquisition of 13 to 15 trainsets, depending on required spare equipment needs and train layover turn-time requirements. The required train sets include five for use on the Boston-to-Montreal Route services and eight to ten for the Inland Route Service. This includes two spare trainsets for the Inland Route Service and one spare trainset for the Boston-to-Montreal Service and New Haven-to-Montreal Service. As discussed in section 6.2, if at the time of implementation, refurbished or surplus equipment is available, equipment costs could be significantly reduced

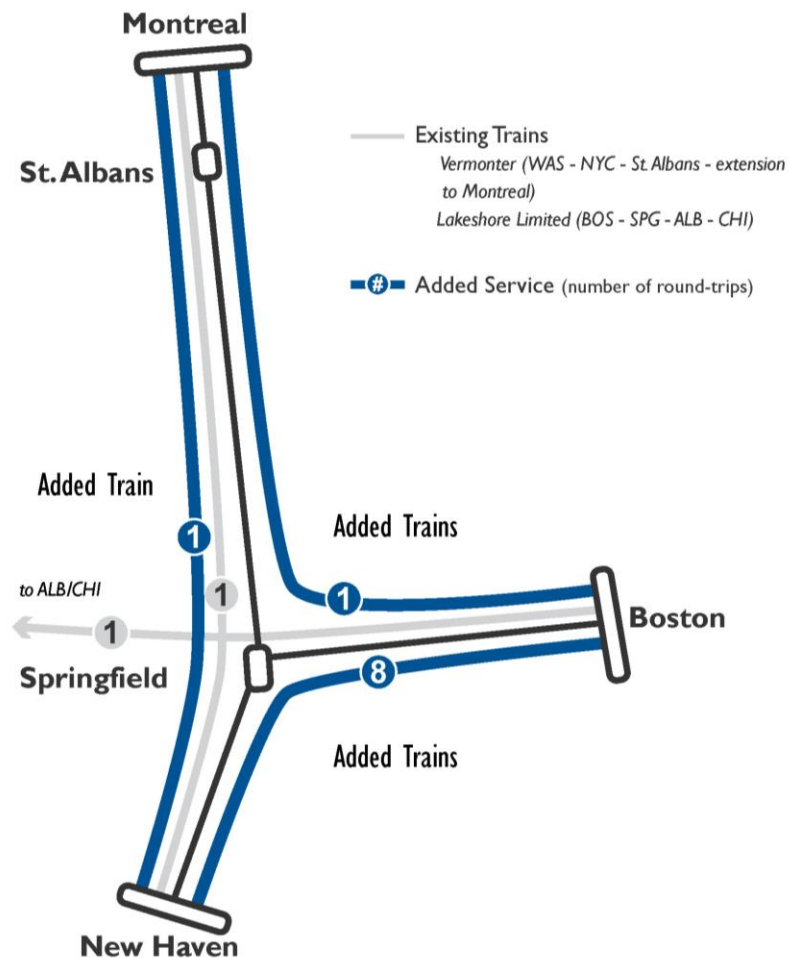


Figure 9-4: Investment Option VII Service

9.1.2 Capital Costs

Capital costs for service on the Inland Route, the Boston-to-Montreal Route, and the entire NNEIRI Corridor were estimated using conceptual engineering. For each of the seven investment options, including the three Inland Route options, three Boston-to-Montreal Route options, and the full-build NNEIRI Corridor option, estimated capital costs, operating costs, and revenues were prepared. The estimated capital costs represent the minimal costs needed to complete services included in each option. Table 9-1 provides a brief description and cost summary for each of the Boston-to-Montreal Route options, as well as the NNEIRI Corridor full service option. The complete capital costs for the all Boston-to-Montreal Route Service (Investment Option VI) is \$591 to \$634 million. As described in the Inland Route SDP, the complete capital costs for service on that route is \$554 to \$660 million. The total cost for implementation of all services on both routes (Investment Option VII) is \$1,104 to \$1,247 million. Since some infrastructure costs overlap between the Inland Route and Boston-to-Montreal Route, the implementation of all recommended services is not cumulative of services on both routes.

Table 9-1. Summary of Boston-to-Montreal Route Capital Costs by Investment Option

Investment Option	Capital Improvements Included	Capital Costs – Infrastructure (Millions)	Capital Costs – Vehicles (Millions)
Investment Option I (Boston-to-Montreal Service Only)	<ul style="list-style-type: none"> Siding extension between Worcester and Springfield Springfield-Montreal Segment track and signal improvements (U.S. only), inclusive of additional sidings and CTC. Requires completion of independent Springfield Union Station track and platform improvement projects (costs not included in total calculation for Investment Option) Requires completion of the independent Montreal Central Station U.S. Customs and Immigration Checkpoint project (costs not included in total calculation for Investment Option) Three trainsets (includes one spare) 	\$160-175	\$105
Investment Option II (New Haven-to-Montreal Service Only)	<ul style="list-style-type: none"> Springfield-Montreal Segment track and signal improvements (U.S. only), inclusive of additional sidings and CTC. Requires completion of the Montreal Central Station U.S. Customs and Immigration Checkpoint (costs not included in total calculation for Investment Option) Three trainsets (includes one spare) 	\$135-155	\$105
Investment Option III (Boston-to-Montreal Route Full Service)	<ul style="list-style-type: none"> Siding extension between Worcester and Springfield Springfield-Montreal Segment track and signal 	\$415-458	\$176

Investment Option	Capital Improvements Included	Capital Costs – Infrastructure (Millions)	Capital Costs – Vehicles (Millions)
	<p>improvements (U.S. only) inclusive of additional sidings and CTC.</p> <ul style="list-style-type: none"> • Requires completion of Springfield Union Station track and platform improvements • Requires completion of the Montreal Central Station U.S. Customs and Immigration Checkpoint (costs not included in total calculation for Investment Option) • Five trainsets (includes one spare) 		
Investment Option VII (Full Service NNEIRI Corridor: Inland Route and Boston-to-Montreal Route)	<ul style="list-style-type: none"> • Double track between Worcester and Springfield and passing siding • Springfield-Montreal Segment track and signal improvements (U.S. only) inclusive of additional sidings and CTC. • Requires Worcester Union Station Second Platform • Requires completion of independent Boston South Station expansion project (full or partial) (costs not included in total calculation for Investment Option) • Requires completion of independent Springfield Union Station track and platform improvement project (costs not included in total calculation for Investment Option) • Requires completion of the independent Montreal Central Station U.S. Customs and Immigration Checkpoint project (costs not included in total calculation for Investment Option) • 13-15 trainsets (5 for Boston-to-Montreal Route and 8 to 10 for Inland Route, includes spares) 	\$648-721	\$456-527

9.1.3 Annual Ridership

Annual ridership on the Boston-to-Montreal Route was calculated for each Investment Option. The results are profiled in Table 9-2. The total annual ridership represents the number of passengers expected to use Boston-to-Montreal Route services after the implementation of each investment option.

Table 9-2. Annual Ridership by Investment Option 2035

Investment Option	Annual Ridership
Investment Option I (Boston-to-Montreal Service Only)	55,300
Investment Option II (New Haven-to-Montreal Service Only)	268,000
Investment Option III (Boston-to-Montreal Route Full Service)	447,100
Investment Option VII (Full Service NNEIRI Corridor: Inland Route and Boston-to-Montreal Route)	875,700

**Includes Boston-to-Montreal Route, Inland Route, and existing Vermonter services.*

9.1.4 Operations and Maintenance Costs

The O&M costs for each of the four Investment Options considered as part of this SDP are profiled in Table 9-3. The total O&M costs to provide all the recommended service on the Boston-to-Montreal Route described under investment Option III is \$23 million. The total O&M costs for all recommended services on the NNEIRI Corridor is \$56 million.

The O&M costs for each of the four investment option considered as part of this SDP were compared with the projected revenue. Table 9-3 also profiles the costs, revenues, and operating support required to provide service for the three Boston-to-Montreal Route options and the NNEIRI Corridor full service option. The estimated operating support indicates the difference between O&M costs and annual ticket revenue.

Table 9-3. Boston-to-Montreal Route O&M Costs Compared to Revenue 2035

Investment Option	O&M Costs (Millions)	Ticket Revenue (Millions)	Operating Support (Millions)
Investment Option I (Boston-to-Montreal Service Only)	\$13	\$3	\$10
Investment Option II (New Haven-to-Montreal Service Only)	\$10	\$9	\$1
Investment Option III (Boston-to-Montreal Route Full Service)	\$23	\$12	\$11
Investment Option VII (Full Service NNEIRI Corridor: Inland Route and Boston-to-Montreal Route)	\$56	\$30	\$26

9.2 FUNDING AND FINANCING

This section discusses the landscape of potential capital funding and financing sources for NNEIRI under implementation of the Boston-to-Montreal Route Full Service (Investment Option III) and the full NNEIRI Full Service (Investment Option VII) defined in Section 9.1. This section also addresses the potential sources of revenue to operate the proposed services.

At this early stage of NNEIRI projects definition, this chapter discusses only the program-level capital funding required for the implementation of the Full Service Investment Options. The capital and operating costs are preliminary and are subject to further refinement as the program moves further through the planning process. Discussions will be required with the potential funding partners and cooperating agencies regarding the preferred funding and financing strategy.

9.2.1 Need for the Funding and Financing Strategy

Given the complexity of the project in terms of size of capital required, the multitude of potential public and private partners (i.e., railroads and private developers) to be involved, and the time it takes to secure funding and financing sources, the NNEIRI Funding and Financing Strategy could be developed to parallel the sequence of improvements proposed in the SDP plans.

NNEIRI investments will need to compete with other transportation projects for finite transportation funding resources at federal, state and local levels. This underscores the importance of Funding and Financing Strategy to be considered early on in project implementation so as to allow time for NNEIRI investments to be integrated with the participating states, MPOs and localities transportation improvement plans. It is also important to recognize the need to identify a mix of funding and financing sources as a project of the scale envisioned is unlikely to be able to rely only on one or a few funding sources.

A time-bound strategic funding and financing plan could be developed as a program of annual capital funding investments as part of NNEIRI implementation strategy. The allocation of costs and funding commitments among project stakeholders could be established through a continued dialogue and cooperation of participating states and localities, the Federal government, as well as the railroads and commuter rails operators that may benefit from NNEIRI infrastructure investment. The Funding and Financing Strategy could consider an alignment of interests between freight, passenger and commuter rail needs.

The Funding and Financing Strategy would further address the questions relative to the difficulty of securing the funding discussed in this Chapter, and the degree to which specific project elements would qualify (and compete well) for funding.

9.2.2 Capital Plan

The capital plan provides a summary of the total costs estimates for the full service investment options and describes the potential funding and financing options to meet capital needs.

Capital Costs

The capital costs associated with each full service investment option were broken out by investment in infrastructure and vehicles. The cost estimates in 2014\$ are presented in Table 9-4. Capital improvements and estimated costs are those identified as required for reliable passenger rail service.

Table 9-4. Capital Cost Estimate for Full Service on Boston-Montreal and NNEIRI Corridors

Investment Option	Capital Improvements Included	Capital Costs – Infrastructure (Millions)	Capital Costs – Vehicles (Millions)
Investment Option III (Boston-to-Montreal Route Full Service)	<ul style="list-style-type: none"> Siding extension between Worcester and Springfield Springfield-Montreal Segment track and signal improvements (U.S. only) Requires completion of Springfield Union Station track and platform improvements Requires completion of the Montreal Central Station U.S. Customs and Immigration Checkpoint Five trainsets (includes one spare) 	\$415-458	\$176
Investment Option VII (Full Service NNEIRI Corridor: Inland Route and Boston-to-Montreal Route)	<ul style="list-style-type: none"> Double track between Worcester and Springfield and passing siding Springfield-Montreal Segment track and signal improvements (U.S. only) Requires Boston South Station expansion (full or partial) Requires Worcester Union Station Second Platform Requires Springfield Union Station track and platform improvements Requires completion of the Montreal Central Station U.S. Customs and Immigration Checkpoint 13-15 trainsets (5 for Boston-to-Montreal Route and 8 to 10 for Inland Route, includes spares) 	\$648-721	\$456-527

Capital Funding and Financing Sources

This section describes a range of potential sources of the capital funds to build the project. Capital funding and/or financing for implementation of each of the investment options will need to be derived from a mix of multiple sources that may be secured by the participating states over time. The sources may include a combination of:

- Federal formula and discretionary grants
- State sources of transportation funding, including taxes, fees, and state bond proceeds dedicated to transportation
- Contributions from cities and counties along the corridors which would benefit from the improved rail service.

If NNEIRI project sponsors decide to seek federal and/or state credit and loan programs for the project capital costs, they would need to identify one or more dedicated funding sources for repayment of the borrowed funds.

Federal Capital Funding Sources

The following Federal funding sources could be considered by project sponsors as part of the NNEIRI Funding and Financing Strategy:

- **Federal Rail Administration (FRA):** Previous Federal grant programs that were focused specifically on supporting high speed rail and intercity passenger rail have superseded with the passage of the Fixing America's Surface Transportation (FAST) Act in December 2015. The following summarizes the Federal funding programs established through the new authorization act.
 - **Consolidated Rail Infrastructure & Safety Improvements Program** - To improve the safety, efficiency, and reliability of passenger and freight rail systems,
 - **Federal-State Partnership for State of Good Repair Program** - To reduce the state of good repair backlog on publically-owned or Amtrak-owned infrastructure, equipment, and facilities, and
 - **Restoration & Enhancements Program** - For operating assistance to initiate, restore, or enhance intercity passenger rail transportation.
 - **Railroad Safety Technology Grant Program:** Grant funding for deployment of positive train control (PTC) and complementary advanced technologies. Currently not accepting applications.
- **Railroad Safety Grants:** \$10 million in total discretionary funding to states for public & private railroad grade crossing enhancement & track improvement that improve safety on rail routes that transport flammable energy products. This is a new program announced by FRA in September 2015.
- **Amtrak Capital Grants:** FRA is responsible for administering federal grants to Amtrak.
- **Federal Highway Administration (FHWA):** FHWA is mainly in charge of the construction, maintenance and preservation of the Nation's highways, bridges and tunnels. It offers the following programs which intersect with the rail projects.
 - **Railway-Highway (Section 130) Crossing Program:** This program provides annual funding of about \$220 million to fund the elimination of hazards at railway-highway crossings to reduce the number of fatalities, injuries, and crashes.⁴¹ Funding is distributed to the states based on a formula which accounts for the number of public railway-highway crossings in the state. Fifty percent of a State's apportionment is dedicated for the installation of protective devices at crossings. The remainder of the funds apportionment can be used for any hazard elimination project, including protective devices. A state's apportionment of Section 130 funds may be a used to improve safety at grade crossings along the corridors.
 - **Transportation Enhancements Program:** This program supports nontraditional transportation-related improvements. For rail, program funds can be used to support the rehabilitation and operation of historic transportation buildings and other structures, as

⁴¹ <http://www.fhwa.dot.gov/map21/factsheets/rhc.cfm>

well as the acquisition of abandoned railroad corridors. The federal share of project costs for this program is up to 80 percent.

- **Federal Transit Administration (FTA):** FTA provides financial and technical assistance to local public transit systems (e.g., buses, subways, light rail, commuter rail, monorail, passenger ferry boats, trolleys, inclined railways, and people movers). FTA offers the following grant programs which funding can be accessed by state and local transit services providers such as commuter rail operators active in NNERI corridor:
 - **Capital Investment Program (New Starts, Small Starts, Core Capacity and Program of Interrelated Projects):** FTA Section 5309 provides approximately \$2 billion per year in discretionary grant funding to local public transit systems nationwide on a competitive basis. While transit is not a prime element of the NNEIRI program, specific elements of the NNEIRI program could benefit from discretionary transit grants that share asset(s) with NNEIRI; for example, a station serving both intercity and commuter rail or tracks owned by a commuter rail. However, the primary purpose of the transit grant would be for the transit and/or commuter rail project.
 - **FTA Formula Capital Grants:** Commuter rail operators active in the corridor, (i.e. MBTA), are eligible for the following FTA capital grants:
 - *Urbanized Area Formula Program (Section 5307):* These are formula-based grants urbanized areas and to states for transit capital and operating assistance in urbanized areas and for transportation-related planning. An urbanized area is an incorporated area with a population of 50,000 or more that is designated as such by the U.S. Department of Commerce, Bureau of the Census.
 - *State of Good Repair Grants (Section 5337):* These are formula-based grants for projects for replacement and rehabilitation of rolling stock, track, line equipment and structures, signals and communications, power equipment, passenger stations and terminals, security equipment, maintenance facilities to maintain rail transit systems in the state of good repair.
- **Combined/Multimodal Programs.**
 - **USDOT Multimodal Discretionary Program - Transportation Investment Generating Economic Recovery (TIGER):** TIGER is a discretionary multimodal program administered by USDOT that provides competitive grants to fund investments in road, rail, transit, and port projects that promise to have a significant impact on the nation, a region or a metropolitan area. The 2015 budget authorization included \$500 million in funding for projects nationwide, with a special set-aside of \$100 million for rural projects⁴². While the average TIGER grant has been around \$14.5 million, TIGER could help fund selected elements if the corridor investments were prioritized by the states and local governments in their choice of TIGER projects. There are examples in state of Vermont where TIGER grants were used in combination with state funds and

⁴² <http://www.dot.gov/tiger>

contributions from railroads to fund installation of new welded rail, in addition to new ties, ballast and bridge upgrades.⁴³

- **Congestion Mitigation and Air Quality Improvement (CMAQ) Program:** Jointly administered by FHWA and FTA, this program provides a flexible funding source for transportation projects and programs that help improve air quality and reduce congestion. Funds are distributed by the formula for areas that do not meet the National Ambient Air Quality Standards (nonattainment areas). The distribution formula is based on an area's population by county and the severity of its ozone and carbon monoxide problems within the nonattainment area. Eligible uses are projects that reduce emissions or improve air quality, including capital costs of transit and highway projects; intermodal freight facilities and operations; and three years of operating and maintenance costs for new service, such as transit service or traffic management operations centers. CMAQ funding may be used for freight and passenger rail projects that accomplish CMAQ goals. CMAQ funds have been used by Maine to fund operations of the Downeaster rail service. CMAQ funds have also been transferred to FRA by State DOTs to fund intercity passenger rail projects that accomplish CMAQ goals.
- **Other Federal Programs:** USDOT and its modal administrations periodically offer discretionary programs aimed at particular topics, which may be used to further specific investment options. Such programs have included: livability (offered in conjunction with the Environmental Protection Agency (EPA) and Department of Housing and Urban Development (HUD)), rail safety, and climate resiliency. The corridor states may be in a position to pursue future funding opportunities as categories of funding become available.

Federal Loan Programs

Limited discretionary Federal funding for major transportation projects has led to increased reliance on Federal loans – notably through the following and programs:

- **Federal Rail Administration Railroad Rehabilitation and Improvement Financing (RRIF) Loans:** RRIF was created in 1998 to help railroad operators finance improvements to infrastructure and equipment. Eligible borrowers include railroad operators, state and local governments, government-sponsored authorities and joint ventures that include at least one railroad. With \$35 billion in authorized funding (33 loans executed for \$1.7 billion as of June 2014)⁴⁴ the program provides direct loans for up to 100% of project costs for up to 35-year loan term from the date of loan execution, priced at U.S. Treasury rates with principal deferral for up to 6 years from loan execution. The program was designed to operate at no cost to the government and therefore it charges the Credit Risk Premium (CRP) to the borrower based on the borrower's financial health. The CRP is equal the net present value of expected losses due to default and generally ranges between 0 and 5% of the loan amount. The borrower pays CRP upfront and is not allowed to fund CRP through loan proceeds. FRA returns the CRP to

⁴³ Vermont State Rail Plan, June 2015 Draft:

<http://vtrans.vermont.gov/sites/aot/files/VT%20State%20Rail%20Plan%20Draft%20June%202015.pdf>

⁴⁴ <https://www.oig.dot.gov/sites/default/files/RRIF%20final.pdf>

the borrower after the loan is repaid. The borrower may choose to reduce the credit risk with collateral pledge. Average RRIF loans assistance was \$80 million.

RRIF loan example projects: 2012 \$54.6 million 25-year loan to Kansas City Southern Railway Company (KCSR) to reimburse its purchase 30 new locomotives. The loan was priced at 2.96 percent per annum. The obligations under the financial agreement were secured by a first priority security interest in the locomotives and certain related rights.⁴⁵ In 2011 Amtrak secured a 25-year \$562.9 million RRIF loan to finance the purchase of 70 new electric locomotives, related spare parts, and improvements to existing maintenance facilities to serve the new locomotives. Amtrak repays the loan out of farebox receipts. The loan has an interest rate of 4.04 percent per annum. In addition, Amtrak pays a 4.424 percent CRP on the loan advances.⁴⁶

- **Federal Highway Administration Transportation Infrastructure Finance and Innovation Act (TIFIA) program:** Created in 1998, TIFIA provides loans and loan guarantees for highway, transit, railroad, intermodal freight, and port access projects. According to 2009 TIFIA program guide rail projects “involving the design and construction of intercity passenger rail facilities or the procurement of intercity passenger rail vehicles” are eligible for TIFIA assistance. However, no TIFIA loans have been approved for pure rail projects.⁴⁷ TIFIA did finance intermodal projects and stations improvement projects which benefited rail systems (Miami Intermodal Center and Denver Union Station). TIFIA had authorized funding of \$1.75 billion for FY2013-2014 to cover the cost of program administration and Credit Risk Premium (CRP). Since DOT assumes a CRP of 10 percent, the \$1.6 billion available after administrative costs provided TIFIA with the capacity to extend \$16 billion in loans in FY2013-2014 or about \$8 billion annually. The program provides direct loans and loan guarantees for up to 33-49 percent of project costs (33 percent has been practice so far), 35-yr loan term from substantial project completion. The loans are priced at U.S. Treasury rates plus one basis point (the credit spread). The program average loan has been about \$379 million.⁴⁸

TIFIA loan example: Denver Union Station \$145M TIFIA loan, repayment pledge included 30-year Tax Incremental Financing (TIF) District revenue, property taxes after TIF expiration, lodger’s tax generated within project area, Denver area Regional Transportation District Authority (RTD) sale tax revenue bond.⁴⁹

⁴⁵ Kansas City Southern 2013 Form 10-K filed with the SEC:

<http://www.sec.gov/Archives/edgar/data/54480/000005448014000014/kcs1231201310k.htm>

⁴⁶ Amtrak 2013 Annual Report, Note 7: <http://www.amtrak.com/ccurl/1000/237/Amtrak-Annual-Report-2013.pdf>

⁴⁷ TIFIA database of projects: <http://www.transportation.gov/tifia/projects-financed>

⁴⁸ The Railroad Rehabilitation and Improvement Financing (RRIF) Program, David Randall Peterman, Congressional Research Service, May 2015: <http://pennyhill.com/jmsfileseller/docs/R44028.pdf>

⁴⁹ Financing of the Denver Union Station, Ballard Spahr LLP:

<http://www.law.du.edu/documents/rmlui/conference/powerpoints/2013/KhokhryakovaADUSCaseStudyFinancing-of-The-Denver-Union-Station-DMWEST-9630502-1.pdf>

Public Private Partnerships

Public private partnerships are another option for financing and/or delivering public transportation projects and may be considered as a way to expand the financial resources of the state sponsors. The transaction may be limited to financing or project delivery or may be as broad as maintaining and operating selected assets. In some cases (i.e., CREATE, Crescent Gateway), private carriers have collaborated with states to secure funding for selected projects. The Patriot Corridor Double-Stack Clearance Initiative is also an example of CSX and MassDOT collaboration to jointly invest in improvements to a rail corridor. The project was an element of a larger transaction, MassDOT and CSX provided full double-stack access to Massachusetts by improving the clearance on 30 bridges along the CSX line. This full double stack access provides efficiencies and cost savings in the movement of goods to and from Massachusetts that will be shared with businesses and consumers. In addition, CSX made a significant investment in intermodal facilities in Worcester, West Springfield, and Westborough which in turn was a supportive action in allowing the MBTA to increase its service between Boston and Worcester.⁵⁰

Although it is not clear whether the private railroads that own/operate over segments of the NNEIRI corridors would be inclined to enter into such partnerships, or if such cooperation would secure meaningful funding, financing or project delivery advantages, the NNEIRI Funding and Financing Strategy should involve discussions with CSX and other track owners to address the potential options for such an approach.

State and Local Capital Funding Sources

Potential capital contributions from the participating states could be explored in the context of the states' existing capital program revenues and transportation improvement plans including specific freight and rail plans and priorities. The NNEIRI Funding and Financing Strategy needs to align with the participating states rail policies and priorities. The states increasingly apply specific prioritization criteria in their project funding allocation decisions.

This section explores existing capital improvement plans (latest publicly available plans sourced primarily from state DOTs' websites) of the states along the NNEIRI corridor. It provides a brief overview of the types of taxes and fees available (gas taxes, sales taxes, DMV related fees, toll revenues and other) and reliance on bond proceeds for capital projects.

Commonwealth of Massachusetts

The Commonwealth Transportation Fund (CTF) is the principal source of transportation related revenues and expenditures for the Commonwealth of Massachusetts. It accounts for road and highway use revenues, including the gas tax, registry fees, motor vehicle sales tax, underground storage tank fees and a general fund transfers. The fund revenues are used to pay debt service associated with highway maintenance and construction projects. In 2013, the state legislature authorized a transportation bond bill that allowed for the issuance of general special obligation bonds for certain improvements to transit. These bonds are to be repaid from the CTF.

⁵⁰ P 37: http://www.nh.gov/dot/org/aerorailtransit/railandtransit/documents/2015ne_pass_rail_summit.pdf

The total revenue available in the CTF was \$1.77 billion in 2014 and \$2.5 billion in 2015.⁵¹ The breakdown in spending for 2014 and 2015 included:

- **2014:** \$1.18 billion or 67 percent of the CTF fund revenue was spent for debt service, with the balance made available on pay-as-you go basis
- **2015:** \$1.6 billion or 76 percent of the CTF funds were allocated to fund debt service with the balance made available on pay-as-you go basis.

Sixteen percent of the state 6.25 percent sales tax receipts go to the MBTA, as a dedicated source of funding, to enable the authority to pay for its own capital improvement projects.⁵²

MassDOT 2016 capital plan provides for approximately \$2.59 billion in total revenue and \$2.59 billion in total costs.⁵³

The sources of funds include:

- 31.5 percent from bond proceeds (money borrowed by the Commonwealth);
- 25.4 percent from FHWA;
- 15.3 percent from Special Obligation Debt bond proceeds (issued to fund MBTA and transit projects);
- 15.7 percent from bond proceeds issued for the Accelerated Bridge Program (to fund bridge projects);
- 9.2 percent from toll revenues (tolls on highways, bridges and tunnels), the toll revenues are used to fund operations and maintenance of the Metropolitan Highway System and the Western Turnpike;
- 1.95 percent from FTA; and
- 1.0 percent from FAA/Other funding.

The uses of funds include:

- 65.5 percent for highway projects;
- 15.5 percent for MBTA;
- 7.7 percent for Chapter 90 (funding for municipalities for local road projects and others);
- 3.2 percent for Transit (funding for 15 Regional Transit Authorities);
- 2.3 percent for Commonwealth Funded projects;
- 1.2 percent for Rail (allocation from bond proceeds and FHWA funds); and
- 4.6 percent for Planning, Aeronautics and DMV.

\$30.5 million or 1.2 percent in rail funding (non-MBTA related) includes funding to improve the existing rails system:

⁵¹ http://www.mass.gov/bb/h1/fy15h1/bal_15/hfundbal4.htm

⁵² <http://www.mass.gov/osc/publications-and-reports/legislatively-mandated/mbta-certifications/march-2015-certifications-of-mbta.html>

⁵³ MassDOT Capital Investment Plan FY 2016:
https://www.massdot.state.ma.us/Portals/0/docs/infoCenter/docs_materials/FY16_FinalCapitalBudget.pdf

- **Knowledge Corridor and Vermonter Service (\$3.9 million):** Funding for the continued development of the Knowledge Corridor rail service between Springfield, Northampton, Greenfield, and Southern Vermont.
- **Grade Crossings (\$9.0 million):** Funding for activities to improve lights, approaches, physical barriers and other warning devices at locations where public and private rail lines cross state or municipal roads. The primary focus of these roads is safety, reducing the risk for a train collision.
- **Industrial Rail Access Program (\$2.5 million):** Funding for the rehabilitation and restoration of short spur lines that service underutilized industrial or commercial parks.

State of Vermont

State funds are appropriated from the State Transportation Fund (STF), which includes the Transportation Fund and the Transportation Infrastructure Bond Fund (TIB Fund). The TIB Fund revenue can only be expended on certain long life transportation assets (either directly or via payment of debt service on bonds issued for such purposes). Vermont STF had \$230 million in available funds in 2015 and TIB fund had about 20 million in funds.⁵⁴

The Transportation Fund (excluding the TIB Fund) has six sources of revenue:⁵⁵

- **Gasoline tax:** a fixed cent-per-gallon gasoline tax and a fixed cent-per-gallon diesel fuel tax, a gasoline percentage-of-price assessment with a minimum and maximum cent-per-gallon equivalent. *This tax contribution to Transportation Fund made up about 30.2 percent in 2014.*
- **Purchase and Use tax:** a motor vehicle purchase and use tax (6% split 4% to the Transportation Fund and 2% to the Education Fund). *This tax contribution to Transportation Fund made up about 24.2 percent in 2014.*
- **Motor vehicle fees:** *This revenue contribution to Transportation Fund made up about 31.2 percent in 2014.*
- **Other revenue (other small transportation related taxes and fees):** *This revenue contribution to Transportation Fund made up about 7.7 percent in 2014.*

The TIB fund is funded by revenue from a gasoline percentage of price assessment, and a fixed-cent-per-gallon diesel fuel assessment.

In June 2015, VTTrans unveiled a draft version of its 2015 state rail plan.⁵⁶ The plan places three passenger rail projects on high priority:

- Extending the Ethan Allen Express to Burlington,
- Extending the Vermonter to Montreal, and
- Adding new service between Albany, New York and Burlington, Vermont.

⁵⁴ <http://vtrans.vermont.gov/sites/aot/files/documents/aboutus/capprog/16/FY2016BudgetHighlights.pdf>

⁵⁵ <http://www.leg.state.vt.us/jfo/publications/2015%20Fiscal%20Facts.pdf>

⁵⁶ 2015 Vermont State Rail Plan, Draft June 19, 2015:

<http://vtrans.vermont.gov/sites/aot/files/VT%20State%20Rail%20Plan%20Draft%20June%202015.pdf>

The Plan identifies \$370.3 million in passenger rail needs and \$295.3 million in freight rail needs. The plan proposes that these investments be phased over 20 years. According to plan, the annual State funding available to cover capital needs is approximately \$4 million. Since 2002, Vermont has been able to secure on average slightly over \$15 million in federal capital funding per year.

State of New Hampshire

The main revenue sources for transportation funding in the state of New Hampshire are motor vehicle fees and surcharges, including licensing and vehicle registration, and tolling. The current Governor's capital budget proposal for fiscal years 2016 -2017 consists of \$82.5 million allocated for the Department of Transportation - with \$66.5 allocated for aeronautics, rail and transit and \$8 million for highway.⁵⁷

The New Hampshire Rail Transit Authority (NHRTA) is an administrative agency attached to the New Hampshire Department of Transportation (NHDOT), created in 2007 to oversee the development of commuter rail and other passenger rail service in New Hampshire. NHRTA Rail Plan outlines the following existing New Hampshire Programs for Funding Rail

- **Rail Line Revolving Loan Fund:** \$4 million revolving loan fund program providing long-term (up to 20 years) loans for capital improvements to short line railroads.
- **Special Railroad Fund:** The Special Railroad Fund provides that income from state-owned rail lines, as well as 25 percent of the revenue received from the state railroad tax, be deposited in a dedicated fund and used for maintenance and repair of state-owned rail lines. This fund is comprised of roughly \$160,000 in annual user fees, paid by the railroads, and lease and other payments of approximately \$90,000 per year paid by other entities using railroad property.
- **State Capital Budget:** As owner of railroad property, the state has included funding for repairs to the state-owned lines in the capital budget in past years.

State of Connecticut

The Department of Transportation committed approximately \$1.6 billion for all transportation modes – road and bridge, railroad and bus and other public transit - in the Capital Program in 2014. In Federal Fiscal Year 2015, CTDOT had approximately \$1.7 billion in the total Capital Program funding for all transportation modes. This amount includes approximately \$500 million for bus and rail assets and \$1.2 billion available for highway and bridge infrastructure. CTDOT's anticipates about \$39 million in Maritime funding. CTDOT's Capital Program is largely dependent on federal funding. Historically, federal monies accounted for 70 to 80 percent of the Program.⁵⁸

⁵⁷ <http://admin.state.nh.us/budget/>

⁵⁸ http://www.ct.gov/dot/lib/dot/documents/dcommunications/press_release/capital_plan/DOT_FY_2015_2019_Capital_Plan.pdf

The Special Transportation Fund (STF) is the funding source for transportation operating and capital expenditures. The Special Transportation Fund is supported by revenues from a variety of sources:

- State Motor Fuels Taxes, including the gasoline tax, the diesel oil tax (except diesel oil used for home heating purposes), and the Motor Carrier Road Tax paid by out-of-state truckers operating in Connecticut;
- A portion of the Petroleum Gross Receipts Tax, which is a tax levied on the first sale in Connecticut (generally from a wholesaler to a retailer) on a variety of petroleum products including gas and oil;
- Fees paid to the Department of Motor Vehicles for licenses, permits and fees;
- DMVL Sales tax paid on the private sale of motor vehicles (paid to the Department of Motor Vehicles);
- Interest income;
- Transfers from the general fund;
- Transit operating assistance funds received by the state from FTA; and
- Proceeds of Special Tax Obligation Bonds.

The STF pays the debt service cost for state bonds issued as a means of providing funds for the state's share of transportation projects; supports a small program of Pay-As-You-Go activities; and finances the capital projects, operations, and services of the Department, excluding support of Bradley International Airport.

Potential New State Revenue Streams

The four states along the NNEIR corridor are also members of Regional Greenhouse Gas Initiative (RGGI). RGGI is a cooperative effort among the states of Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont to cap and reduce CO₂ emissions from the power sector. The states earn revenues from auctioning carbon emission allowances. While most of the proceeds so far have been invested into energy efficiency and clean and renewable energy projects, the state of New York, one of RGGI members, invested some of the proceeds in development of multi-modal transportation hubs.⁵⁹ The State of California designated some of the cap-and-trade revenue proceeds for transit, commuter rail and high speed rail initiatives.

Local Capital Funding Sources

Local funding may include place-specific funding for stations improvements from localities that own or regulate the land around NNEIRI stations. The potential funding sources include:

- Local County and Cities general funds

⁵⁹ Investment of RGGI Proceeds Through 2013, RGGI, April 2015:
<http://www.rggi.org/docs/ProceedsReport/Investment-RGGI-Proceeds-Through-2013.pdf>

- Private developer contributions and joint development, where there is a joint interest in land re-development around the stations
- Station-specific tax increment financing, special assessment districts and/or joint development have been successfully applied to partially fund transit projects nationwide. Additional analysis will be required to assess whether these mechanisms could be considered for improvements to areas in and around the NNEIRI stations. The analysis would require a careful consideration of the projected daily ridership at individual stations, real estate market, land use productivity and enabling zoning, and whether such projections would warrant consideration of value capture mechanisms.

9.2.3 Operating Plan

This section summarizes the operating and maintenance costs, ticket revenue and operating subsidy forecast for full service investment options on Boston-Montreal and Full NNEIRI Service. Operating and maintenance (O&M) costs estimation methodology and different elements of the O&M costs are described in Chapter 7 of the report. Estimation of ridership and annual ticket revenues under each Investment Option is described in Chapter 9.1.

Operating Costs, Ticket Revenue and Operating Support Estimates

The program-level funding plan, as described in this section, did not consider the sources of funding for the ongoing operating needs above the ticket revenue at this stage of the project development. This chapter only estimates the magnitude of the potential operating support (i.e. a subsidy) required. Other potential sources of operating revenue could include parking and advertising revenues.

Tables 9-5 provides a summary of the estimated operating costs, ticket revenues and operating support (2014\$) required for the full service on Boston-Montreal Route and full service on NNEIRI.

Table 9-5. Operating Costs and Revenues for Boston-Montreal and NNEIRI Corridor Full Service

Investment Option	O&M Costs (Millions)	Ticket Revenue (Millions)	Operating Support (Millions)
Investment Option III (Boston-to-Montreal Route Full Service)	\$23	\$12	\$11
Investment Option VII (Full Service NNEIRI Corridor: Inland Route and Boston-to-Montreal Route)	\$56	\$30	\$26

Operating Subsidy Required

Under the current federal legislation the Federal Highway Trust Fund revenues funding FTA formula grants and FTA/FHWA jointly administered CMAQ funds cannot be applied to operate intercity passenger rail. Such funds are limited mostly to transit and commuter rail under the existing transportation legislation.

Depending on the choice of the operator for NNEIRI services, the annual operating support (or subsidy) is likely to be funded by the states (and possibly by railroads and communities) along the corridor. The operating support model could be similar to the one currently used by Amtrak. Amtrak receives funding from 18 states under 19 operating agreements for financial support on short-distance routes (less than 750 miles). Section 209 of the Passenger Rail Investment and Improvement Act (PRIIA) required Amtrak and its state partners to jointly develop a cost-sharing methodology that would equitably charge states for state-supported intercity passenger rail service. The PRIIA 209 cost allocation methodology has been effective since 2013.⁶⁰

Continued operation of these state-supported routes is subject to state legislative appropriations according to PRIIA Section 209. The states of Connecticut, Massachusetts and Vermont, along the NNEIRI Corridor, have existing operating agreements with Amtrak.

Another model for sharing operating expenses, which would be relevant to NNEIRI, is the Northern New England Passenger Rail Authority (NNEPRA). NNEPRA is a public transportation authority, which provides passenger rail service between Maine and Boston and points within Maine. NNEPRA holds a 20-year agreement with Amtrak to operate the Downeaster rail service between Portland and Boston and is party to agreements with host railroads, i.e., Pan Am Railways and the Massachusetts Bay Transportation Authority to ensure that freight, commuter, and Downeaster trains operated efficiently and that the corridor remains in good repair. Under contract to NNEPRA, Amtrak provides equipment and crews to operate the Downeaster rail service. NNEPRA staff works closely with Amtrak to develop revenue-management strategies, schedules, capital projects, and service improvement programs. NNEPRA also supports station communities in enhancing private development and quality of life around the stations.⁶¹

Additional concepts, information, and analysis regarding cost sharing and management strategies for the NNEIRI Corridor and services are included in Section 9.3.

9.3 GOVERNANCE

This section analyzes the possible issues that would need to be addressed to establish a governance model for implementation of service on the Boston-to-Montreal Route. An examination of potential structures that could be relevant to Boston-to-Montreal Route operations is also provided.

9.3.1 Issues to be Addressed

The expansion of passenger service on the Boston-to-Montreal Route as recommended by the NNEIRI Study raises important issues of governance and program management. The resolution of these issues will help determine how the various pieces of the expanded rail program, including federal, state, and private interests would come together to achieve the states' goals for the NNEIRI Corridor and maximize the benefits of increased service.

⁶⁰ <http://www.amtrak.com/servlet/ContentServer?c=Page&pagename=am%2FLayout&cid=1246041980246>

⁶¹ http://www.amtrakdowneaster.com/sites/default/files/content/images/Partnerships_NNEPRA_Brochure_2013.pdf

An integrated strategy for corridor management is needed for several reasons. This approach would include the following benefits:

- An ongoing corridor management plan would be created to provide a coherent and consistent approach to implementation, including budgeting. It would also help the host states prioritize needs and coordinate right-of-way actions and operational decisions.
- Unified negotiations with Amtrak and host railroads would build on the transparency intended by PRIIA.
- Shared information that may help the states assess freight rail patterns and anticipate freight rail growth that could require special accommodations and benefit from passenger-related improvements.
- An incremental approach would help assure that the NNEIRI Corridor will always have a “ready to go” project that will be eligible for funding authorized under the FAST Act.
- Documenting the integrated corridor management strategy through periodic updates to the service development plan could identify the benefits and relationships of incremental investments (i.e., “early wins”) and thereby build stakeholder support for more service on the Corridor.

The host states could benefit from continuing joint efforts that were established during the NNEIRI Study if the implementation of the recommended services proceeds. Massachusetts, Vermont, and other participating states could move forward from the coordinated NNEIRI planning efforts to fund, construct, and operate the proposed services.

A number of issues emerged during the NNEIRI Study would need to be addressed as a governance strategy is developed moving forward, including a need to:

- Coordinate with other rail services (commuter and freight);
- Determine station capacity;
- Identify final scheduling;
- Create appropriate fare structures;
- Establish Amtrak contract requirements; and
- Identify funding sources.

Other specific elements that would need to be addressed as the recommended plan is implemented include:

- Liability;
- Insurance requirements;
- Cost allocation (including under section 209 of PRIIA);
- Dispute resolution;
- Schedule changes;
- Revenue sources and uses, including fare box targets;
- Budgeting;
- Audits and financial reporting;
- Safety requirements and reviews;
- Station management; and
- Local stakeholders.

9.3.2 Governance Models

Table 9-6 provides a review of several governance models used for rail service and capital management in the United States. The multi-state and international nature of the service on the Boston-to-Montreal Route means that a governance model will require input from the states, federal agencies, and Canadian partners. These models serve as examples of governance agreements could be adapted for use in the implementation of new service on the Boston-to-Montreal Route.

Table 9-6. Governance Model Examples

Type	Details	Example
Memorandum of Agreement	States have successfully created non-binding, informal, planning organizations through a Memorandum of Understanding (MOU). The MOU is fundamentally an agreement to agree, but it has provided a basis for states to invest in equipment, prompted the states to establish a system of cost sharing, encouraged them to coordinate their negotiations with vendors, and provided the framework for development of a Corridor Management Workplan. The Workplan is one of a series of steps by which they are moving from coordinated decisions toward integrated commitments. Each step provides near-term actions that will advance the states' longer-term vision, notwithstanding their financial insecurities.	I-95 Corridor Coalition, Amtrak Cascades Service
Federally Chartered Corridor Organization	Originating in Section 212 of PRIIA, a Federally Chartered Corridor Organization model provides a basis for a governance approach for the NNEIRI. In this scenario, states would deliberate on issues ranging from capital funding to maintenance plans to service schedules, bring the stakeholder railroads to the table, and identify topics on which the states are ready to act jointly. This model's federal authorization might provide superior access to federal funds. Federal authorization would seem appropriate for the international operations contemplated by NNEIRI.	Northeast Corridor (NEC) Infrastructure and Operations Advisory Commission
State Chartered Rail Authority	State Chartered Rail Authorities (SCRA) are chartered and usually subsidized by a single state. SCRA's can incorporate governance and funding mechanisms from additional states in the form of Memoranda of Agreement (MOA) or other governance agreements. Nationally, SCRA's have different governing and financing structures, but benefit from the ability to use federal funds to support capital and sometimes operating funds.	Northern New England Passenger Rail Authority (Downeaster), MTA Metro North
Interstate Compact	An Interstate Compact (IC) can provide a permanent basis for multi-state action. ICs can support significant transportation organizations, typically with access to federal and state funding. However, not all compacts are funded. These unfunded compacts can be of transitory effectiveness. Funding for interstate compacts is idiosyncratic, including self-supporting, annual state appropriations, or dependent on federal grants and member contributions. True ICs require Congressional approval, as well as adoption of identical provisions by the legislatures of all participating states.	Port of Authority of New York and New Jersey; Washington Metropolitan Area Transportation Authority
Public-Private Partnerships	A Public-Private Partnership (P3) can advance priorities that affect state and local governments, commuter rail providers, Amtrak, and freight railroads. This model has been successful in aligning and advancing a broad range of support for disparate projects and has helped provide a framework for comprehensive regional or corridor-wide plan. P3s can coordinate public and private investment in rail infrastructure and have been successful in obtaining discretionary federal funding.	Chicago Region Environmental and Transportation Efficiency (CREATE) Program

9.4 IMPLEMENTATION CONSIDERATIONS

Initiating service on the Boston-to-Montreal Route and the overall NNEIRI Corridor would require careful planning by several agencies and coordination with key stakeholders. Previous sections of this SDP have provided specific elements that would need to be taken into consideration to improve service on the Boston-to-Montreal Route. This section outlines the next steps that relevant public agencies would need to take to proceed with service implementation.

9.4.1 Coordination

Full implementation of the NNEIRI Corridor recommended service would require close coordination between a number of local, state, and federal agencies. Since the three proposed services cross state and international lines, several different organizations would need to be involved during the continued planning and implementation of the service.

Due to the complexity and scale of this project, implementation of service on the Boston-to-Montreal Route would require provincial and state governments in Massachusetts, Connecticut, Vermont, New Hampshire, and Quebec to develop a partnership or augment existing agreements. Customs agencies in the United States and Canada would also need to be involved. Coordination with numerous local jurisdictions along this section of the NNEIRI Corridor would also be expected.

Multiple entities will need to work together to define the future service under mutually agreeable terms. The state and local governments along the Inland Route would need to concur on the key aspects of governance, funding, and management of the proposed system and services. As the lead state agency and project champion, MassDOT would need to continue working with partner agencies to ensure implementation of Boston-to-Montreal Route service.

9.4.2 NEPA Tier 2 Analysis

As part of the NNEIRI Study, a *Tier 1 Service Level Environmental Analysis* (EA) was prepared in accordance with the NEPA process. The EA concluded that the potential for significant adverse impacts from the Recommended Alternative is low, in large part due to the use of operating rail lines within the existing right-of-way. Additionally, impacts would be minimal because the proposed infrastructure improvements would be located within the existing right-of-way that previously supported double or triple track alignments.

After discussions with the FRA, it is anticipated that the FRA will issue a Finding of No Significant Impact (FONSI) for the Tier 1 Service Level EA. However, as individual projects are identified and refined, such as restoration of the second mainline track between Worcester and Springfield, additional NEPA Project Level Tier 2 analysis will be necessary to identify these project-specific impacts. The potential project-specific impacts are possible in several key NEPA impact categories, including:

- **Air Quality** – During a Tier 2 assessment, additional analysis would be required to determine key air quality parameters. The analysis will include consideration of increased congestion close to stations, change in regional vehicle-miles-traveled, and the impact of railroad sidings near sensitive receptors. The data collected and analyzed would

determine the impacts on the quality of the air in the region and identify if mitigation is required and what those measures would be.

- **Water Quality** – As part of a Tier 2 assessment, coordination with resource agencies regarding permits and design details that could result in potential impacts would occur.
- **Noise and Vibration** – In the Tier 1 noise and vibration assessment, a general assessment and preliminary screening were completed. These impacts would be further explored in the Tier 2 analysis. For example, the Tier 2 analysis would include a review of the FTA Category 1 receptors and the number of potential noise and vibration impacts that would require the consideration of mitigation measures.
- **Ecological Systems** – In areas where the addition of a second track is proposed, the Tier 1 assessment included the Massachusetts Natural Heritage and Endangered Species Program (NHESP) examination of the potential for endangered species in the area. The study mapped out where the proposed track coincides with potential endangered species habitats. Project-related construction in these areas would have to be reviewed under the applicable state endangered species and habitat laws in future phases of work.
- **Wetlands** – The potential impacts to wetlands would require further assessment. Any compensatory mitigation measures, including wetlands restoration, creation, or enhancement, would be subject to state and federal permitting requirements. In particular, the location of the proposed station at Palmer was not determined and the location site would need to minimize possible impacts.
- **Endangered Species and Wildlife** – In areas where the addition of a second track is proposed, the NHESP mapped the potential endangered species habitats adjacent to the proposed track during the Tier 1 assessment. Project-related construction in these areas would have to be reviewed under the applicable state endangered species and habitat laws in future phases of work.
- **Flood Hazards** – Impacts to floodplains and flood hazard areas would require further assessment and agency coordination to identify possible avoidance or minimization measures during a Tier 2 assessment.
- **Aesthetics/Visual Impacts** - Potential visual impacts would be temporary and limited to the areas where construction will take place. To minimize construction-related visual impacts, mitigation measures may include staging of work activities and removing waste as soon as the work is completed. Visual impacts would be further analyzed in the project-specific Tier 2 assessment.
- **Environmental Justice** – Until more detailed engineering designs are completed, it would be difficult to determine if significant impacts would affect environmental justice populations. As part of the Tier 2 assessment, the impacts would be evaluated and potential mitigation measures, if necessary, will be considered.
- **Use of Section 6(f) Lands** – In the Tier 2 analysis, coordination with the U.S. Fish and Wildlife Service would occur to ensure impacts are minimized and potential mitigation measures are implemented as necessary.
- **Cultural Resources and Historic Properties** – Further identification and review of historic properties along the corridor would proceed during the Tier 2 assessment to determine the potential effects on historic and cultural resources. The lead federal agency

would consult with the applicable State Historic Preservation Offices (SHPO) to identify any impacts to historic resources and identify mitigation measures, if needed.

- **Use of Section 4(f) Protected Properties** – A complete Section 4(f) analysis would occur during a Tier 2 assessment to determine impacts to publicly owned parks, recreation areas, wildlife and waterfowl refuges, and public or private historic sites.
- **Socioeconomic** – The Tier 2 assessment would include a detailed evaluation of potential socioeconomic impacts where deemed necessary in the EA.
- **Construction Period** – During the Tier 2 assessment, the duration of construction would be further defined and appropriate mitigation measures will be identified. The sequence and extent of construction would be identified and staging plans developed during the final design phases.

The lead agency responsible for sponsoring specific projects would be required to conduct further Tier 2 environmental analysis as a part of the NEPA process. The timeline for the Tier 2 environmental process should be determined by the lead agency.

9.4.3 SDP Update

As sponsor agencies further refine timelines for specific projects and service implementation, updates to specific sections of this SDP would be required to account for changes to the existing conditions and rail operations on the corridor. The specific sections of this SDP that would likely require updating are outlined below.

Scheduling and Operations Modeling Analysis

As passenger service and freight schedules continue to change, a final service schedule will need to be developed prior to the implementation of service to ensure optimal travel demand times. It is anticipated that the final schedule of each service, including the Boston-to-Montreal Service and the New Haven-to-Montreal Service on the Boston-to-Montreal Route, would maintain the same number of round-trips as previously recommended. When the final schedule is adopted, the operations modeling analysis in this SDP (see Appendix E) would need to be updated to account for variations in the final schedule from the preliminary schedule found in Section 7.2, including operations for passenger and freight railroads with shared tracks.

Conceptual Engineering and Rolling Stock

To ensure that the NNEIRI Corridor has sufficient capacity to implement the proposed service, the recommended infrastructure improvements outlined in Chapter 6 would need to be permitted, designed, and completed. Detailed plans, project designs, and permits would be required before final funding and construction can commence. Additionally, sponsoring agencies would need to procure design and construction firms to facilitate the work. Infrastructure improvement construction may be staggered depending on the availability of funding.

To accommodate service on the Boston-to-Montreal Route, four train sets will need to be procured for full operations. If new equipment is required, it will be necessary for lead state agencies to order the train sets and monitor the construction of the train sets and the delivery of the train sets.

The proposed Boston-to-Montreal Service and New Haven-to-Montreal Service relies on other independent improvement projects that are underway or planned along the NNEIRI Corridor. While the recommended NNEIRI service depends on the completion of these projects, these projects have separate funding. These other projects include the South Station expansion, New Haven-Hartford-Springfield commuter rail service, restoration of Springfield's Union Station, and a new U.S. Customs station in Montreal's Central Station. The planning and staging of these improvements must be considered with the implementation of service on the Boston-to-Montreal Route.

Investment Options Finalization

The Investment Options outlined in Section 9.1 are conceptual in nature. Lead agencies should consider developing final investment option phases in order to coordinate construction timelines, service implementation timeframes, and other logistics.

Governance and Funding

As outlined in Section 9.2, a governance and funding agreement must be finalized prior to implementation of service on the Inland Route or Boston-to-Montreal Route. The states and provincial agencies should establish a governance agreement that identifies a service operator and grants operating authority for Boston-to-Montreal Route services. Funding and financing agreements for the project should identify state or federal funding sources to assist in initial capital requirements and operation of the service.

Funding streams will be necessary through out the life of the service. An initial funding source will be required for the capital infrastructure improvements, and purchase of the train sets, and an on-going funding source will be required to assist in the annual operations and maintenance of the service.

9.4.4 Host Railroad and Service Operator Agreements

Agreements with the freight railroad operations and track owners must be in place before any permitting, construction, or implementing service can begin on the NNEIRI Corridor. The Boston-to-Montreal Route includes several rail segments that are owned by a number of different host railroads, including CSX, Pan Am Southern, NECR, and CN. For implementation of the Boston-to-Montreal Route, agreements with each host railroad must be in place before additional passenger service can occur on the right-of-way. These agreements should consider how the proposed services would affect freight service and how the lead agencies plan to mitigate any disruptions that may occur for the host railroad. Previous agreements between host railroads and service operators could be used as a guideline for the service on the Boston-to-Montreal Route.

The state agencies must also enter into an agreement with a passenger service operator prior to implementation of service on the Boston-to-Montreal Route. The selected service operator should have sufficient knowledge of intercity rail operations and should be able to meet terms agreed upon between the states and host freight railroads. Once an operator is procured, the O&M costs in Section 7.4 would require updating to account for the service operator's standards and any changes to standard intercity passenger rail operations in the northeastern United States or eastern Canada.

APPENDICES

- A. RIDERSHIP FORECASTING METHODOLOGY
- B. PROJECT COST ESTIMATE METHODOLOGY AND ASSUMPTIONS
- C. CONCEPTUAL ENGINEERING SHEETS
- D. STATION ACCESS
- E. OPERATIONS MODELING
- F. PUBLIC MEETING NOTES