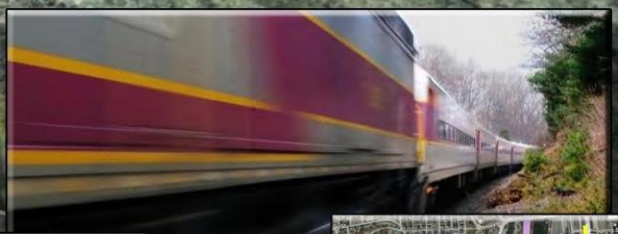
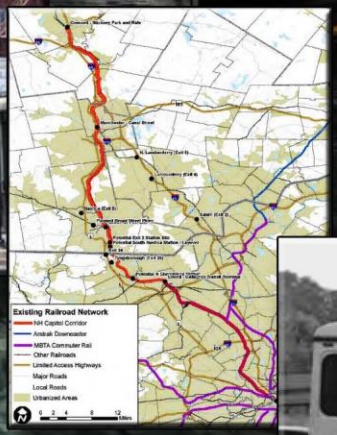
Appendix 7

TECHNICAL REPORT
Task 7: Detailed Evaluation of Alternatives

September 2014





New Hampshire
Capitol Corridor Rail & Transit Alternatives Analysis (Parts A & B)

State Project Numbers 16317 and 68067-A

New Hampshire DOT
Department of Transportation

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List of Acronyms

AA	Alternatives Analysis
AHWD	Automatic Highway Warning Devices
BX	Boston Express
CWR	Continuous Welded Rail
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
MassDOT	Massachusetts Department of Transportation
MBTA	Massachusetts Bay Transportation Authority
MP	Mile Post
mph	miles per hour
NHDOT	New Hampshire Department of Transportation
NHML	New Hampshire Main Line
NTD	National Transit Database
O&M	Operations and Maintenance
PAR	Pan Am Railways
TOD	Transit-Oriented Development
VOMS	Vehicles to Operate Minimum Service

Project Purpose and Need Summary

Increasing transportation demand and growing concerns about mobility, economic development, and quality-of-life have led New Hampshire and Massachusetts citizens and officials to explore transit and/or intercity passenger rail service options in the 73-mile corridor (Capitol Corridor) between Boston, Massachusetts and Concord, New Hampshire.[1] The purpose of this Capitol Corridor Rail and Transit Alternatives Analysis (AA) Study is to evaluate a diverse set of rail and bus options to improve connectivity by leveraging existing transportation infrastructure, including Pan Am Railways (PAR), Route 3, and I-93. Investment in an improved transportation strategy is needed for several reasons:

- Projected population growth will result in increased roadway congestion
- New Hampshire's existing transportation network does not effectively connect existing modes
- The regional economy is singularly dependent on roads for movement of goods and passengers
- Improved transportation options will attract employers to New Hampshire and improve employment options for New Hampshire residents
- Young New Hampshire professionals are leaving the area to be closer to employment and cultural/social opportunities associated with larger urban centers
- New Hampshire's growing senior population needs more "car-light" mobility options
- Residential development patterns resulting from population growth may negatively impact the region's existing quality-of-life
- The existing transportation network cannot accommodate increased levels of demand without negative environmental consequences

Task Objectives

In Task 7, the intermediate set of alternatives selected in Task 5 (Appendix 5 to the AA Final Report) – one intercity rail, two commuter rail, and three express bus – are evaluated using criteria developed in Task 6 (Appendix 6 to the AA Final Report).

- Section 1 of this report, "Definition of Intermediate Alternatives," describes the three bus, two commuter rail, and one intercity rail investment options that advanced through preliminary screening leading towards the selection of a recommended strategy.
- Section 2 of this report, "Application of Selection Criteria," discusses how the Study team evaluated each alternative according to five criteria: economic impacts, land use and economic development, equity impacts, financial considerations (including costs), and mobility impacts (including ridership forecasts).

[1] The report "Task 2: Project Purpose and Need" (Appendix 2 to the AA Final Report) provides an in-depth evaluation of the Capitol Corridor's historical, current, and future state, and how Massachusetts and New Hampshire citizens would benefit from a transit investment strategy responsive to transportation needs and the region's economic, social, and environmental climate

Overall analysis results were used, along with other important factors such as public and key stakeholder input, to select a transit investment strategy – the subject of Task 8 (Appendix 8 to the AA Final Report).

1 Definition of Intermediate Alternatives

Task 5 detailed analyses led to selection of seven (from 12) transit alternatives for further study. Table 1.1 summarizes these seven intermediate alternatives.

Table 1.1: Summary of Intermediate Alternatives

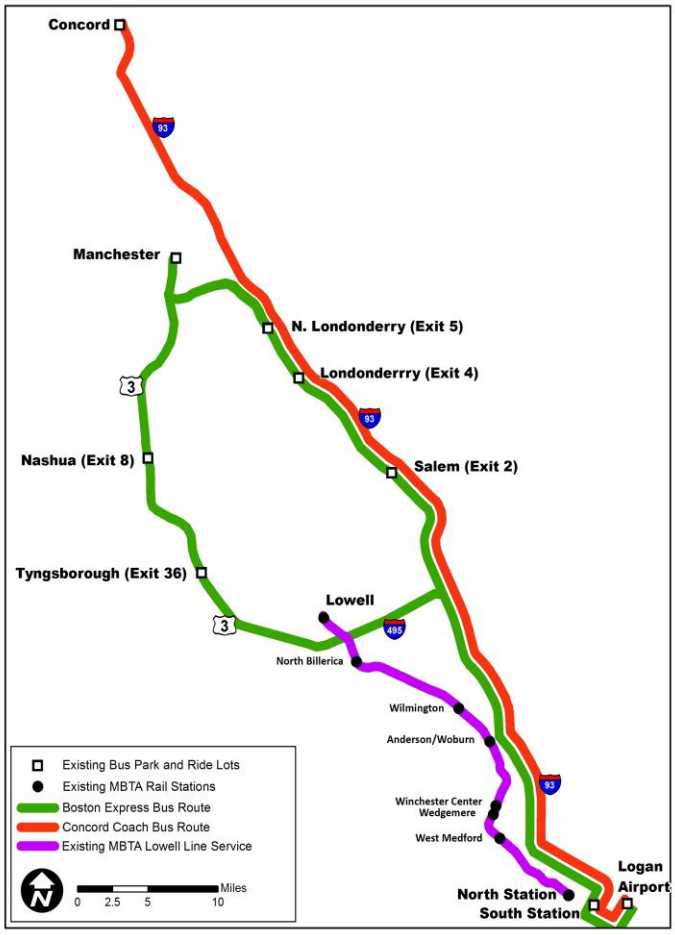
Base	▪ No investment; existing bus and rail services are continued, but not expanded
Expanded Base	▪ New Hampshire's Boston Express (BX) bus service is increased from current 80 buses per day to 120 buses per day ▪ All peak buses run direct and non-stop between each NH park-and-ride lot and Boston South Station with service every 30 minutes ▪ Each park-and-ride lot sees hourly off-peak service making intermediate stops at each NH park-and-ride lot ▪ No changes to existing passenger rail services
Bus on Shoulder	▪ BX bus service of 80 daily trips is permitted to operate within the I-93 shoulder south of I-495 to bypass congestion in general travel lanes ▪ Savings of eight to 12 minutes predicted during the morning peak period ▪ No significant travel time savings predicted during the afternoon peak period
Expanded Bus on Shoulder	▪ 120 daily trips permitted to operate within the I-93 shoulder south of I-495 to bypass congestion in general travel lanes ▪ Savings of eight to 12 minutes predicted during the morning peak period ▪ No significant travel time savings predicted during the afternoon peak period
Manchester Regional Commuter Rail	▪ Extends Massachusetts Bay Transportation Authority (MBTA) commuter rail service north from Lowell, MA to Manchester, NH with intermediate stops at South Nashua, Nashua Crown St., and Bedford/Manchester-Boston Regional Airport (Manchester Airport or MHT) ▪ BX I-93 service to Manchester, North Londonderry, Londonderry, and Salem is retained ▪ BX Route 3 service to Manchester, Nashua, and Tyngsborough is retained
Nashua Minimum Commuter Rail	▪ Extends MBTA commuter service north from Lowell, MA to South Nashua, NH ▪ BX I-93 service to Manchester, North Londonderry, Londonderry, and Salem is retained ▪ BX Route 3 service to Manchester, Nashua, and Tyngsborough is retained
Intercity 8	▪ Four daily intercity passenger rail round trips between Concord, NH and Boston, MA making intermediate stops at Manchester, Bedford/Manchester Airport, Nashua Crown St., and Lowell and Woburn, MA ▪ Base BX service is retained

1.1 Expanded Base

- New Hampshire's BX bus service is increased from current 80 buses per day to 120 buses per day
- All peak buses run direct and non-stop between each New Hampshire park-and-ride lot and Boston South Station with service every 30 minutes
- Each park-and-ride lot sees hourly off-peak (but not direct) service
- No changes to existing passenger rail services

The Expanded Base option (Figure 1.1) increases transit service frequency and directness within the Study Corridor by providing peak-period, point-to-point, non-stop trips from each of the New Hampshire park-and-ride lots to points within downtown Boston (southbound trips only), South Station, and Logan Airport. The service would add approximately 40 trips to the schedule and would require approximately 16 additional vehicles. There are no transit priority measures proposed in this option that would result in increased service velocities or decreased travel times.

Figure 1.1: Existing Corridor Bus and Existing Rail Services



Peak-period, point-to-point service would be provided at 30-minute headways, except for the Manchester service, which operates at 60-minute headways throughout the day. Hourly off-peak service would provide non-point-to-point service between each park-and-ride lot within the I-93 or Route 3 corridors and Boston South Station and Logan Airport without circulating through downtown Boston. A timetable for the proposed service is included in Index A at the end of this Section 1.

Anticipated ridership response to this service initiative would include increased ridership at all BX park-and-ride lots and some possible reduction of ridership on MBTA commuter rail service from Lowell and, perhaps, North Billerica, Massachusetts.

1.2 Bus on Shoulder

- Existing BX bus service of 80 daily trips is permitted to operate within the I-93 shoulder south of I-495 to bypass congestion in general travel lanes
- Savings of eight to 12 minutes predicted during the morning peak period
- Savings of up to five minutes predicted during the afternoon peak period

The Bus on Shoulder option provides faster peak-period service by permitting buses to operate within the I-93 shoulder south of I-495 to bypass peak congestion in Massachusetts. Typical southbound morning peak-period savings would be eight to 12 minutes depending upon arrival time. Typical northbound afternoon peak-period savings would be approximately five minutes. The option would not add any additional trips or operate in a point-to-point manner, but would provide faster, more reliable

peak travel times. The proposed schedules maintain the existing arrival and departure times at South Station and modify the departure and arrival times at New Hampshire park-and-ride lots based on the estimated travel time savings resulting from Bus on Shoulder operation. The service would not require any additional vehicles to operate the proposed schedule. The timetable (see Index A at the end of this Section 1) prepared for this analysis reflects time savings estimated using a variety of sources. Ridership response to the service initiative is anticipated to include increased ridership at all BX park-and-ride lots and some possible reduction of ridership on MBTA commuter rail service from Lowell and, perhaps, North Billerica.

1.3 Expanded Bus on Shoulder

- 120 daily trips permitted to operate within the I-93 shoulder south of I-495 to bypass congestion in general travel lanes
- Savings of eight to 12 minutes predicted during the morning peak period
- Savings of up to five minutes predicted during the afternoon peak period

The Expanded Bus on Shoulder option merges the increased frequency and directness of the Expanded Base option with the peak-period congestion bypass feature of the Bus on Shoulder option. It would offer faster and more direct peak service with more frequent off-peak service to all New Hampshire park-and-ride lots. The timetable prepared for this analysis merges the Bus on Shoulder and Expanded Base service concepts and can be found in Index A at the end of this Section 1. Ridership response to this service initiative is anticipated to include increased ridership at all park-and-ride lots and some possible reduction of ridership on MBTA commuter rail service from Lowell and, perhaps, North Billerica.

1.4 Manchester Regional Commuter Rail

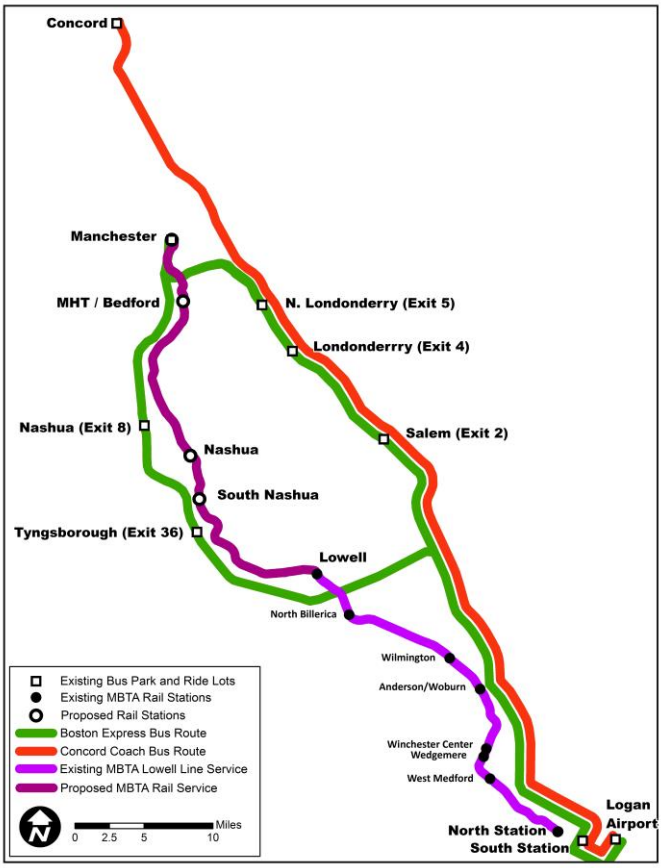
- Extends MBTA commuter rail service north from Lowell, Massachusetts to Manchester, New Hampshire with intermediate stops at South Nashua, Nashua Crown Street, and Bedford/Manchester Airport
- BX I-93 service to Manchester, North Londonderry, Londonderry, and Salem is retained
- BX Route 3 service to Manchester, Nashua, and Tyngsborough is retained

The Manchester Regional Commuter Rail option would extend MBTA service 30 miles north from Lowell to downtown Manchester. The service initiative would provide all day commuter rail service between Boston and Nashua with a lower frequency regional service provided north to Manchester (see Figure 1.2). The service adds four new stations to the line with 16 weekday trains for Manchester and 34 weekday trains for Nashua. All existing MBTA deadhead trains on the Lowell Line would be eliminated.

Eight optional connecting bus trips could be added between South Nashua and Manchester to supplement the schedule of rail services with additional midday and evening mobility options. The existing BX I-93 service to Manchester, North Londonderry, Londonderry, and Salem would be retained, as would BX Route 3 service to Nashua and Tyngsborough.

A layover facility for four train sets would be constructed in the vicinity of Manchester. Up to six coaches and one locomotive would be added to the MBTA's weekday equipment line-up. The number of weekday MBTA train miles operated on the line would increase 42 percent to 2,068. Six MBTA trains would be marginally adjusted with most changes required on light ridership reverse peak trains. The number of affected passengers would be 520 (3.9 percent) of 13,382 weekday riders. The total effect would be 10,202 passenger minutes of change (2.4 percent) out of 430,954 total daily passenger minutes of travel.

Figure 1.2: Proposed Manchester Regional Commuter Rail and Bus Service Configuration



Ridership response to this service initiative is anticipated to include new riders attracted to rail service provided to the proposed New Hampshire stations. It is assumed that some current MBTA rail passengers living in New Hampshire would shift to these new stations from the existing MBTA Lowell and North Billerica Stations. Ridership impacts on the BX I-93 main line services to Londonderry, North Londonderry, and Salem would be likely negligible.

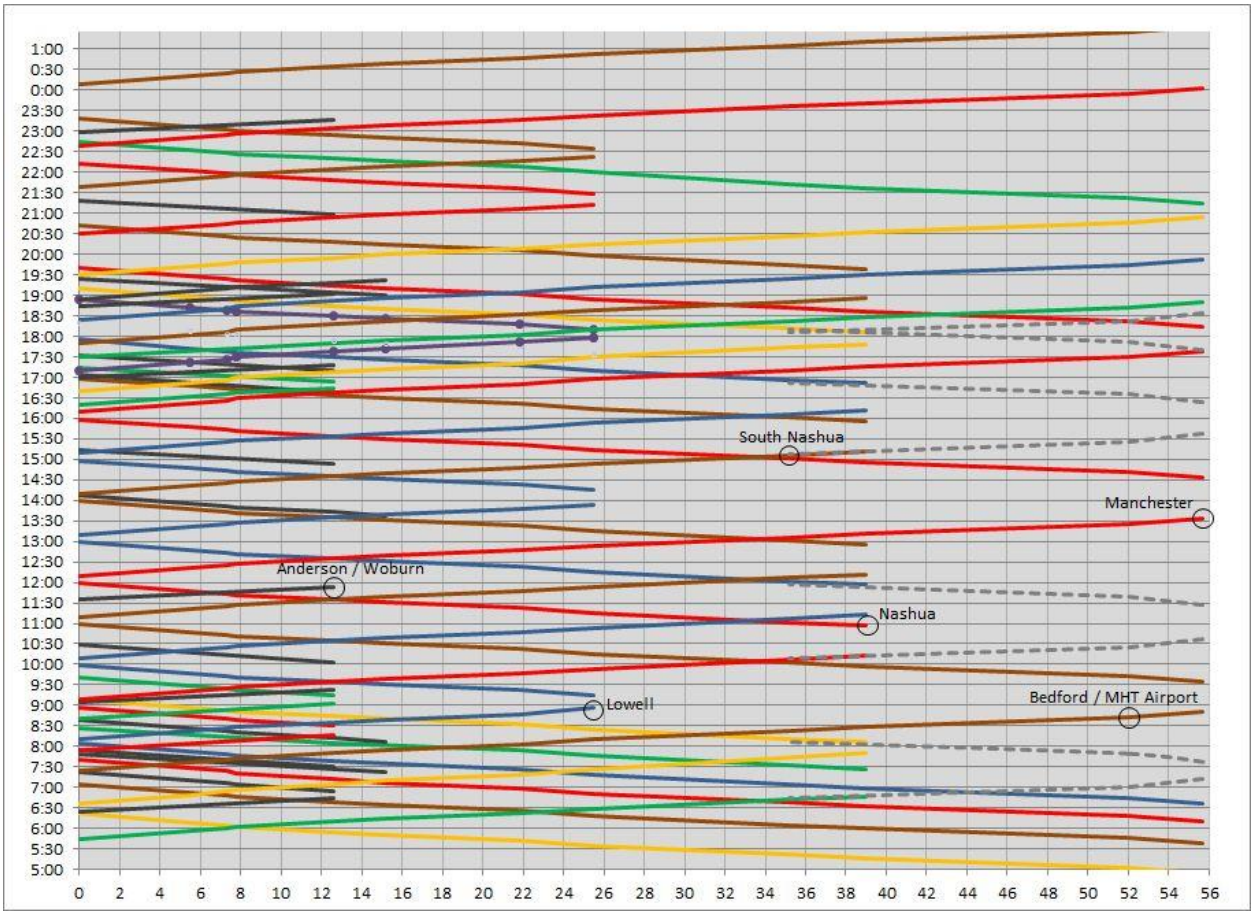
A timetable for the proposed service is included in Index B to this Section 1 and a stringline diagram is found in Figure 1.3. The stringline diagram graphically depicts the proposed schedule of passenger services. The vertical Y-axis represents time while the horizontal X-axis represents distance from Boston's North Station. The earliest portion of the day is at the bottom of the diagram. Boston is on the left of the chart while Manchester is on the right. Each train is graphed as a line indicating its movement through time and space. The colors represent unique train sets assigned to the service.

For example, the yellow line represents trainset "N." It departs Manchester at 4:54 as train 302 and returns north from North Station at 6:37 as train 305. It arrives in Nashua at 7:51 and returns south at 8:06 as train 312. Trainset "N" then operates along other lines during the midday until it departs North Station at 16:40 as train 329 and arrives in Nashua at 17:49. It returns south at 18:07 as train 338 arriving in North Station at 19:06. The final trip of the day departs North Station at 19:30 as train 339 and arrives in Manchester at 20:55. Trainset "N" then lays over in New Hampshire and completes the same schedule on the following day.

Optional midday and early evening feeder bus service would provide connecting service to fill out a complete schedule of services. Three midday and one early evening bus round trips linking South

Nashua, Bedford/Manchester Airport, and Manchester could supplement the peak-only rail service. The feeder bus service is represented in the stringline diagram by the dashed lines running between South Nashua and Manchester.

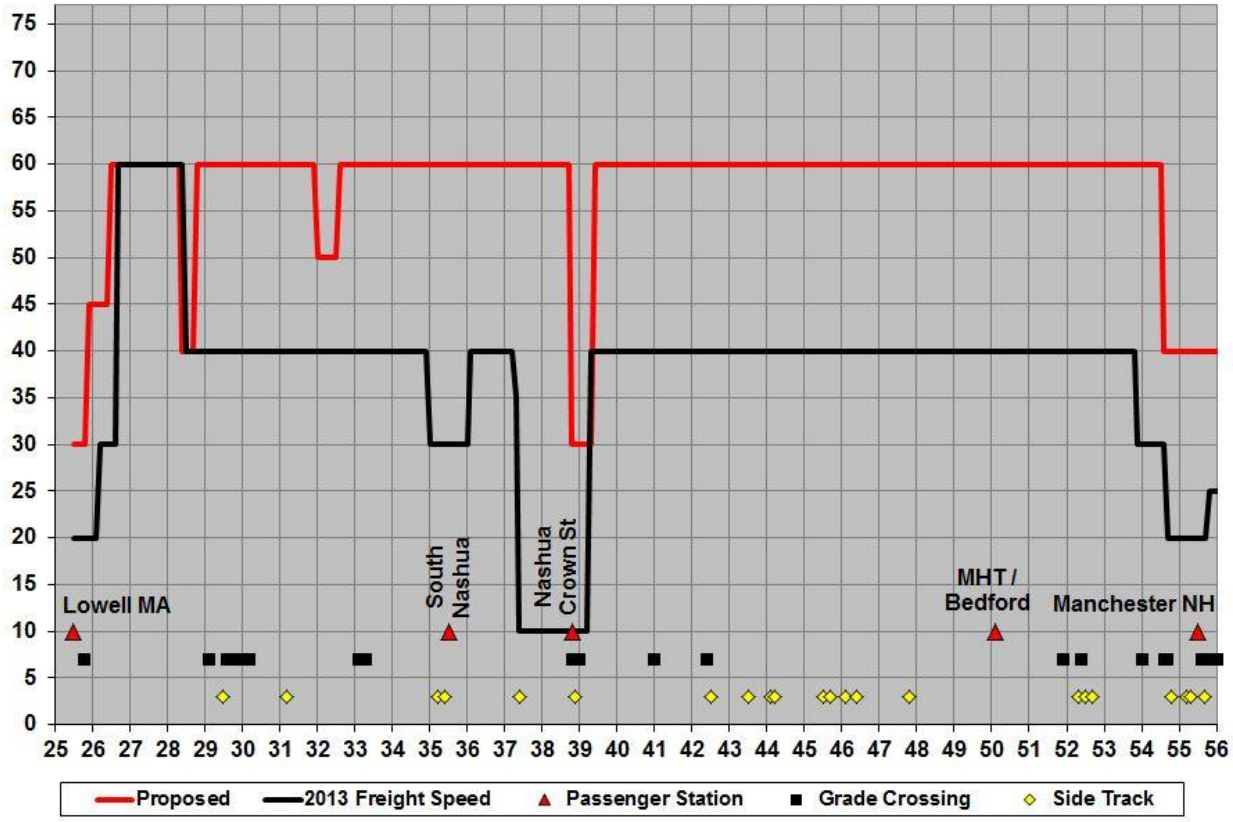
Figure 1.3: Time-Distance Stringline Diagram for Manchester Regional Commuter Rail Service



Infrastructure Requirements

No improvements would be required south of Lowell's Gallagher MBTA Terminal. North of Lowell the railroad would be upgraded to permit safe, reliable operation of 34 daily passenger trains making 16 round trips at speeds of up to 60 miles per hour (mph) (see Figure 1.4). Recommended upgrades to track, bridges, crossings, and signals are summarized below.

Figure 1.4: Current and Proposed Maximum Train Speeds for Manchester Regional Commuter Rail



Track – Study team engineers recommend that this option be supported by replacing nearly all the existing 70-plus-year-old main line rail between Lowell and Manchester with new continuous welded rail (CWR) of a similar weight. CWR is more expensive than jointed rail, but it is preferred because it is stronger, gives a smoother ride, allows for higher operating speeds, and has lower maintenance costs. Along segments where the rail is renewed with CWR, approximately one-quarter of the existing ties would be replaced to provide an additional margin of structural integrity in the track.

To facilitate meets between southbound and northbound passenger trains, a second track would be added between North Chelmsford (Mile Post [MP] 28.5) and the southern end of the Tyngsborough Curve (MP 32.0). Double track would also be extended through the Nashua and Manchester freight yards.

Industrial sidings would be created at three key areas of freight activity in Nashua and Merrimack to harmonize local freight deliveries with through passenger trains. At these locations the existing main line track would be retained as an industrial siding with an entirely new parallel main line track constructed in the same alignment for use by through trains. Adding a second track would be a straightforward undertaking, as the railway was once entirely double-tracked with the double-track bed still largely intact.

Bridges – The service expansion would use 16 existing bridges over watercourses or roadways (see Table 1.2). Most of the bridges are rated as having sufficient strength to accommodate the proposed additional traffic. One bridge in Tyngsborough (MP 32.5) is a candidate for complete replacement. The large steel (circa 1930) structure spanning the Merrimack River (MP 51.8) between Manchester and Bedford is subject to more detailed inspection. The other 14 bridges should receive a renewal of worn and weakened components when the rails crossing them are replaced.

Table 1.2: Manchester Regional Commuter Rail Bridge Inventory

MP	Length (Ft.)	PAR Rating (000's of lbs.)	Municipality	Overall Assessment
25.7	155	Not Available	Lowell	Fair
26.2	163	Not Available	Lowell	Fair
28.8	104	334	Chelmsford	Fair
28.8	44	350	Chelmsford	Good/Fair
29.1	13	350	Chelmsford	Fair
32.5	46	263	Tyngsborough	Fair/Poor
32.6	12	320	Tyngsborough	Good
37.9	17	350	Nashua	Good
39.2	113	350	Nashua	Fair
39.4	35	286	Nashua	Fair
41.8	48	350	Nashua	Good/Fair
44.8	16	289	Merrimack	Fair
44.9	108	350	Merrimack	Fair/Good
46.2	112	350	Merrimack	Good/Fair
47.8	10	350	Merrimack	Good/Fair
51.8	655	Not Rated	Manchester	Fair

Grade Crossings – With double tracking and increased frequency of faster trains, most of the roadway grade crossings between Granite Street in Manchester and Wotton Street in Chelmsford (listed in Table 1.3) would require upgrades to their Automatic Highway Warning Devices (AHWD). If requested by the communities, New Hampshire Department of Transportation (NHDOT) and the MBTA can work with the municipalities, PAR, and the Federal Railroad Administration (FRA) to establish "quiet zones" where desired.

Table 1.3: Manchester Regional Commuter Rail Grade Crossings

Municipality	MP	Street	Type	AHWD	Recommended Upgrades
Chelmsford	29.1	Wotton St.	Private	FGBX	Add provisions for second main line track
Chelmsford	29.6	Wellman Rd.	Private	CFGB	Add provisions for second main line track
Chelmsford	30.0	Cross St.	Private	None	Install FGBX for double-track main line
Tyngsborough	30.5	New England Marine	Private	None	Install FGBX for double-track main line
Tyngsborough	33.5	Helena Dr./River Rd.	Private	X	Install FGBX for single track main
Nashua	36.2	"Dustbowl"	Informal	None	Work with community to close or protect this informal crossing
Nashua	36.9	East Glenwood St.	Private	None	Install FGBX for single track main
Nashua	38.8	Crown St.	Public	FGBX	Renew crossing surface as new rail and ties are installed
Nashua	38.9	East Hollis St.	Public	FGBX	Renew crossing surface as new rail and ties are installed
Nashua	39.0	Bridge St.	Public	FGBX	Renew crossing surface as new rail and ties are installed
Nashua	40.8	Hills Ferry Rd.	Public	X	Install FGBX for single track main
Merrimack	42.4	Mast Rd.	Private	X	Install FGBX for single track main
Merrimack	43.7	Busch	Private	None	Work with Anheuser Busch to upgrade AHWD
Merrimack	44.1	Star Dr.	Private	None	Work with National Grid to upgrade AHWD
Merrimack	45.7	New England Pole	Private	X	Install FGBX for double-track main line
Manchester	52.1	Pine Island Rd.	Public	FGBX	Renew crossing surface as new rail and ties are installed
Manchester	52.6	Winston Rd.	Public	FGBX	Renew crossing surface as new rail and ties are installed; provide for a three track crossing if this becomes the commuter railroad's overnight layover facility
Manchester	54.0	West Mitchell St.	Public	FGBX	Renew crossing surface as new rail and ties are installed
Manchester	54.6	Sundial Ave. (Dunbar St.)	Public	FGBX	Renew crossing surface as new rail and ties are installed
Manchester	54.7	Bryon St.	Public	FGBX	Renew crossing surface as new rail and ties are installed
Manchester	55.6	Depot St.	Public	FGBX	CLOSE
The column marked "AHWD" reports the types of "Automatic Highway Warning Devices" installed at each crossing. F=Flashers, G=Gates, B=Bell, X=Cross buck Sign, C=Cantilever over roadway with flashing lights, None=No AHWD					

Stations – Five new passenger stations would be constructed for the Manchester Regional Commuter Rail option (see Table 1.4). They would be a mix of high-level platforms and low-level platforms with MBTA "mini-high" platforms for handicapped accessibility. High-level platforms would be preferred at all locations. A low-level with mini-high platform approach would be employed where no path was available for PAR freight trains to avoid using the platform track to ensure a clear route for wide freight loads. A mini-high platform is a short, elevated platform that allows for wheelchair accessibility for one or two cars. Mini-high platforms are usually located at the end of the station away from Boston, allowing them to be served by the car nearest the locomotive.

Table 1.4: Manchester Regional Commuter Rail Passenger Station Development Plan

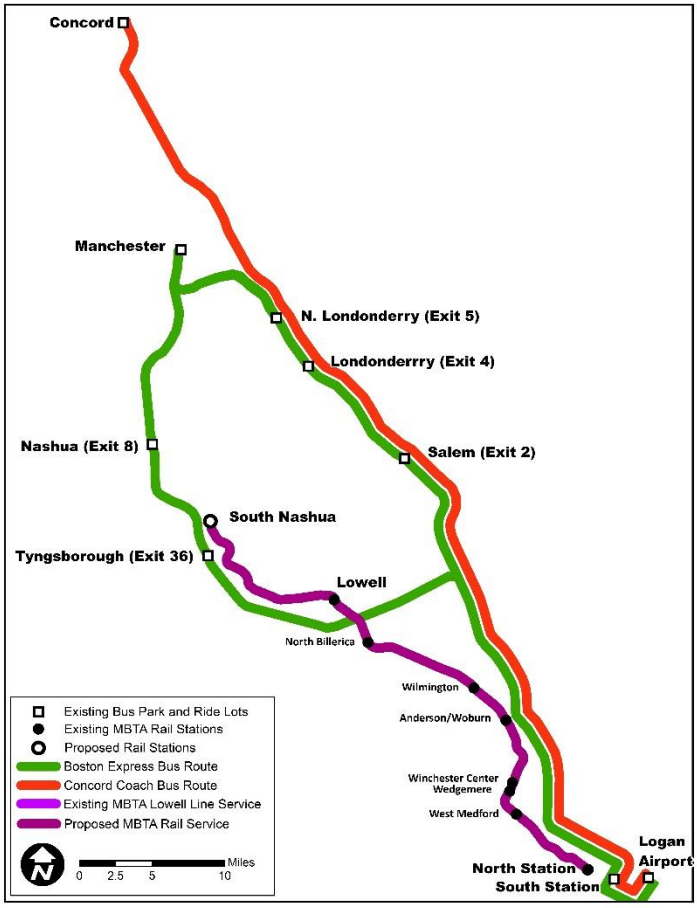
Station	MP	Type	Comments
Manchester	55.5	High-Level	Single high-level platform to the east of the eastern main line track
Bedford/MHT	50.1	Low-Level	Single low-level platform with mini-high to the west of the single main line track
Nashua	38.8	High-Level	Single island high-level platform between two main line tracks; oversize freight would run around platform using yard tracks
South Nashua	35.5	Low-Level	Single low-level platform with mini-high to the west of the single main line track

Other – Upgrades to the train control and signal systems would also be required as well as a number of new switches and interlockings. These details are described in detail in Appendix D, Capital Cost Methodology Report, to this report.

1.5 Nashua Minimum Commuter Rail

- Extends MBTA commuter service north from Lowell, Massachusetts to South Nashua, New Hampshire
- BX Route 3 service to Nashua and Tyngsborough is retained
- BX I-93 service to Manchester, North Londonderry, Londonderry, and Salem is retained

Figure 1.5: Proposed Nashua Minimum Commuter Rail and Bus Service Configuration



The Nashua Minimum Commuter Rail service option provides a minimal peak-period-only commuter rail service to and from South Nashua with no rail service further north to Manchester or Concord (Figure 1.5). It is specifically designed to minimize the MBTA operating cost of extending service to Nashua. It could be developed and operated as an interim service coordinated with bus service while markets and finances for further New Hampshire service were given time to develop.

MBTA service would be extended 13.5 miles north from Lowell to the South Nashua Station. The service adds one new station to the line with 20 weekday trains for South Nashua. A layover facility for four train sets would be constructed in the

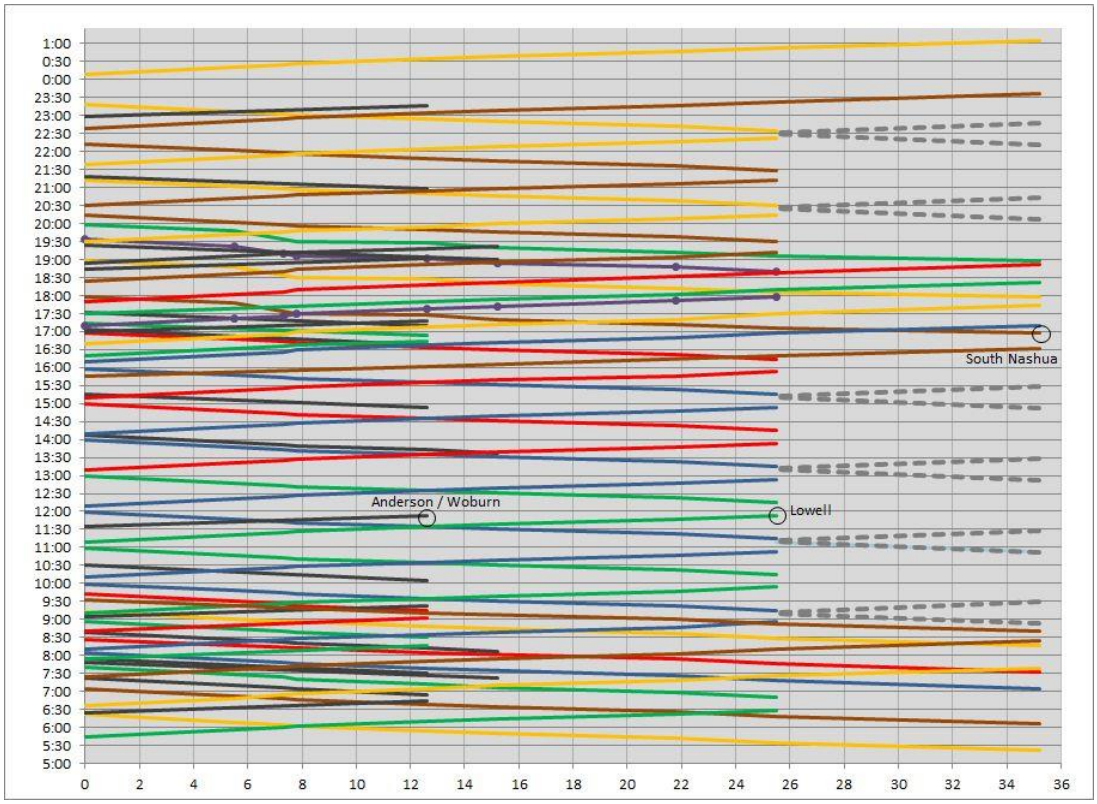
vicinity of South Nashua. No additional coaches or locomotives would need to be added to the MBTA's weekday line-up of equipment.

The number of weekday MBTA train miles operated on the line would increase only three percent to 1,496. Schedules for several MBTA trains would be marginally adjusted with most changes required on light ridership reverse peak trains. The number of affected passengers would be 876 (6.5 percent) of 13,382 weekday riders. The total effect would be 9,846 passenger minutes of change (2.3 percent) out of 430,954 total daily passenger minutes of travel.

A timetable for the proposed service is included in Index B to this Section 1 and a time-distance stringline diagram that graphically depicts the proposed schedule of passenger services is found in Figure 1.6.

Optional midday and early evening feeder bus service would provide connecting service to fill out a complete schedule of services. Three midday and two early evening bus round trips linking South Nashua with the Lowell MBTA train station could supplement the peak-only rail service. The feeder bus service is represented in the stringline diagram by the dashed lines running between Lowell and South Nashua. BX I-93 service to Manchester, North Londonderry, Londonderry, and Salem would be retained, as would Route 3 service to Nashua and Tyngsborough.

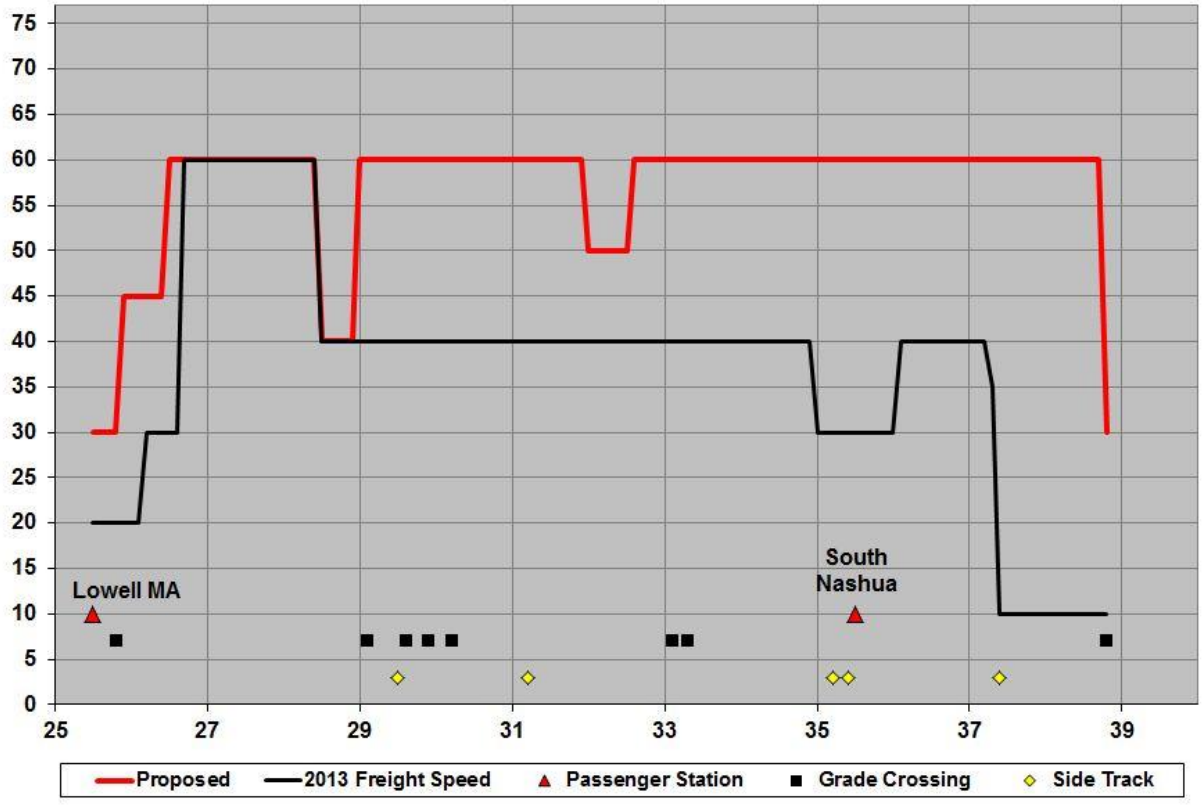
Figure 1.6: Time-Distance Stringline Diagram for Nashua Minimum Commuter Rail



Infrastructure Requirements

The Nashua Minimum Commuter Rail was specifically crafted to facilitate subsequent upgrades to the service, including a potential future extension to Manchester and more off-peak service to Nashua. Consequently, the infrastructure requirements for Nashua Minimum Commuter Rail are a subset of the proposed Manchester Regional Commuter Rail service needs. Like Manchester Regional, no improvements south of Lowell's Gallagher Terminal would be required. North of Lowell the railroad would be upgraded to permit safe, reliable operation of 20 weekday passenger trains at speeds of up to 60 mph (see Figure 1.7). Recommended upgrades to track, bridges, crossings, and signals are summarized below.

Figure 1.7: Proposed Maximum Allowable Passenger Speeds for Nashua Minimum Commuter Rail



Track – As proposed for the Manchester Regional Commuter Rail option, Study team engineers recommend that this option also be supported by replacing nearly all the existing 70-plus-year-old main line rail between Lowell and Nashua with new CWR of a similar weight. To facilitate meets between southbound and northbound passenger trains, a second track would be added between North Chelmsford (MP 28.5) and the southern end of the Tyngsborough Curve (MP 32.0). Unlike the Manchester Regional Commuter Rail option, no industrial sidings would be required because the service would not extend across the segments with the most intense freight activity.

Bridges – The service expansion would use eight existing bridges over watercourses or roadways (see Table 1.5). Most of the bridges are rated as having sufficient strength to accommodate the proposed additional traffic. One bridge in Tyngsborough (MP 32.5) is a candidate for complete replacement. The other seven bridges should receive a renewal of worn and weakened components when the rails crossing them are replaced.

Table 1.5: Nashua Minimum Commuter Rail Bridge Inventory

MP	Length (Ft.)	PAR Rating (000's of lbs.)	Municipality	Overall Assessment
25.7	155	Not Available	Lowell	Fair
26.2	163	Not Available	Lowell	Fair
28.8	104	334	Chelmsford	Fair
28.8	44	350	Chelmsford	Good/Fair
29.1	13	350	Chelmsford	Fair
32.5	46	263	Tyngsborough	Fair/Poor
32.6	12	320	Tyngsborough	Good
37.8	17	350	Nashua	Good

Crossings – With double tracking and increased frequency of faster trains, most of the roadway grade crossings between "Dustbowl" in Nashua and Wotton Street in Chelmsford listed in Table 1.6 would require upgrades in their AHWD. If requested by the communities, NHDOT and the MBTA can work with the municipalities, PAR, and the FRA to establish "quiet zones" where desired.

Table 1.6: Nashua Minimum Commuter Rail Grade Crossings

Municipality	MP	Street	Type	AHWD	Recommended Upgrades
Chelmsford	29.1	Wotton St.	Private	FGBX	Add provisions for second main line track
Chelmsford	29.6	Wellman Rd.	Private	CFGB	Add provisions for second main line track
Chelmsford	30.0	Cross St.	Private	None	Install FGBX for double-track main line
Tyngsborough	30.5	New England Marine	Private	None	Install FGBX for double-track main line
Tyngsborough	33.5	Helena Dr./River Rd.	Private	X	Install FGBX for single track main
Nashua	36.2	"Dustbowl"	Informal	None	Work with community to close or protect this informal crossing
Nashua	36.9	East Glenwood St.	Private	None	Install FGBX for single track main
The column marked "AHWD" reports the types of "Automatic Highway Warning Devices" installed at each crossing. F=Flashers, G=Gates, B=Bell, X=Cross buck Sign, C=Cantilever over roadway with flashing lights, None=No AHWD					

Stations – One new passenger station with a low-level platform would be constructed for the Nashua Minimum Commuter Rail option (see Table 1.7). An MBTA mini-high platform would be located at the north end of the station for handicapped accessibility.

Table 1.7: Nashua Minimum Commuter Rail Passenger Station Development Plan

Station	MP	Type	Comments
South Nashua	35.5	Low-Level	Single low-level platform with mini-high platform to the west of the single main line track

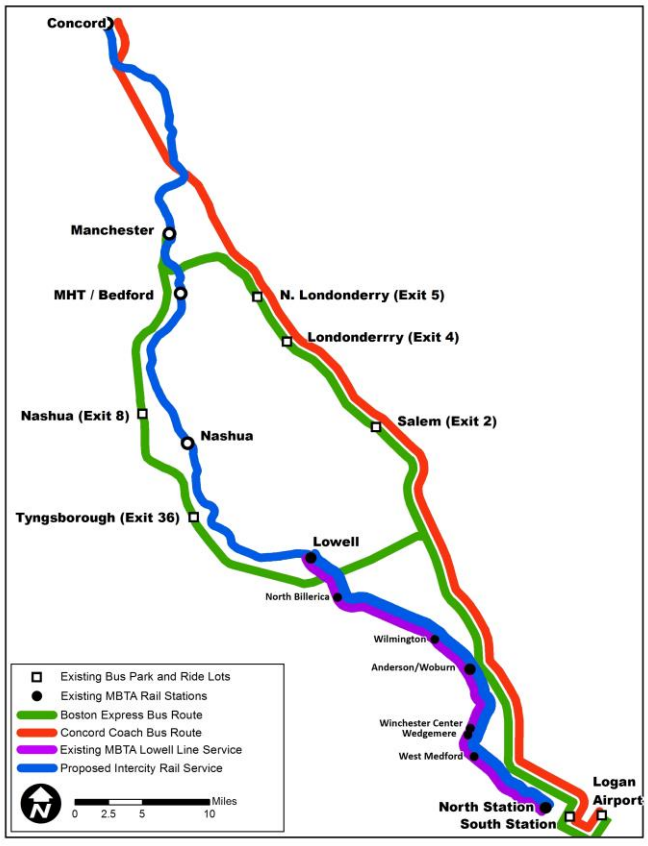
Other – Upgrades to the train control and signal systems would also be required as well as some new switches and interlockings. These details are covered in the Appendix D, Capital Cost Methodology Report, to this report.

1.6 Intercity 8

- Four daily intercity passenger rail round trips between Concord, New Hampshire and Boston, Massachusetts making intermediate stops at Manchester, Bedford/Manchester Airport, Nashua Crown Street, and Lowell and Woburn, Massachusetts
- BX Route 3 service to Nashua and Tyngsborough and BX I-93 service to Manchester, North Londonderry, Londonderry, and Salem is retained

The eight-train-per-day Intercity 8 rail option would provide four daily round trips over the 73-mile route stopping at five intermediate stations (see Figure 1.8). Intercity rail service would operate much like Amtrak's *Downeaster* service between Boston and Brunswick, Maine. The Intercity 8 option could be operated by Amtrak or the MBTA or contracted to a third-party service provider.

Figure 1.8: Proposed Intercity 8 Rail Service and Bus Service Configuration



The end-to-end trip time would be approximately 96 minutes and the service would operate 586 daily train miles. A timetable for the proposed service is shown in Table 1.8 and a full New Hampshire Main Line (NHML) schedule showing how the intercity trains would fit in with the existing Lowell line commuter rail service is found in Index C to this Section 1. A time-distance diagram showing the proposed service is found in Figure 1.9. Presuming an average cost of $36 per train mile, the Intercity 8 option would cost approximately $7.7 million per year to operate.

The service would provide connections in Concord to private bus services for North Country destinations. No changes are proposed to express bus service for commuting to Boston

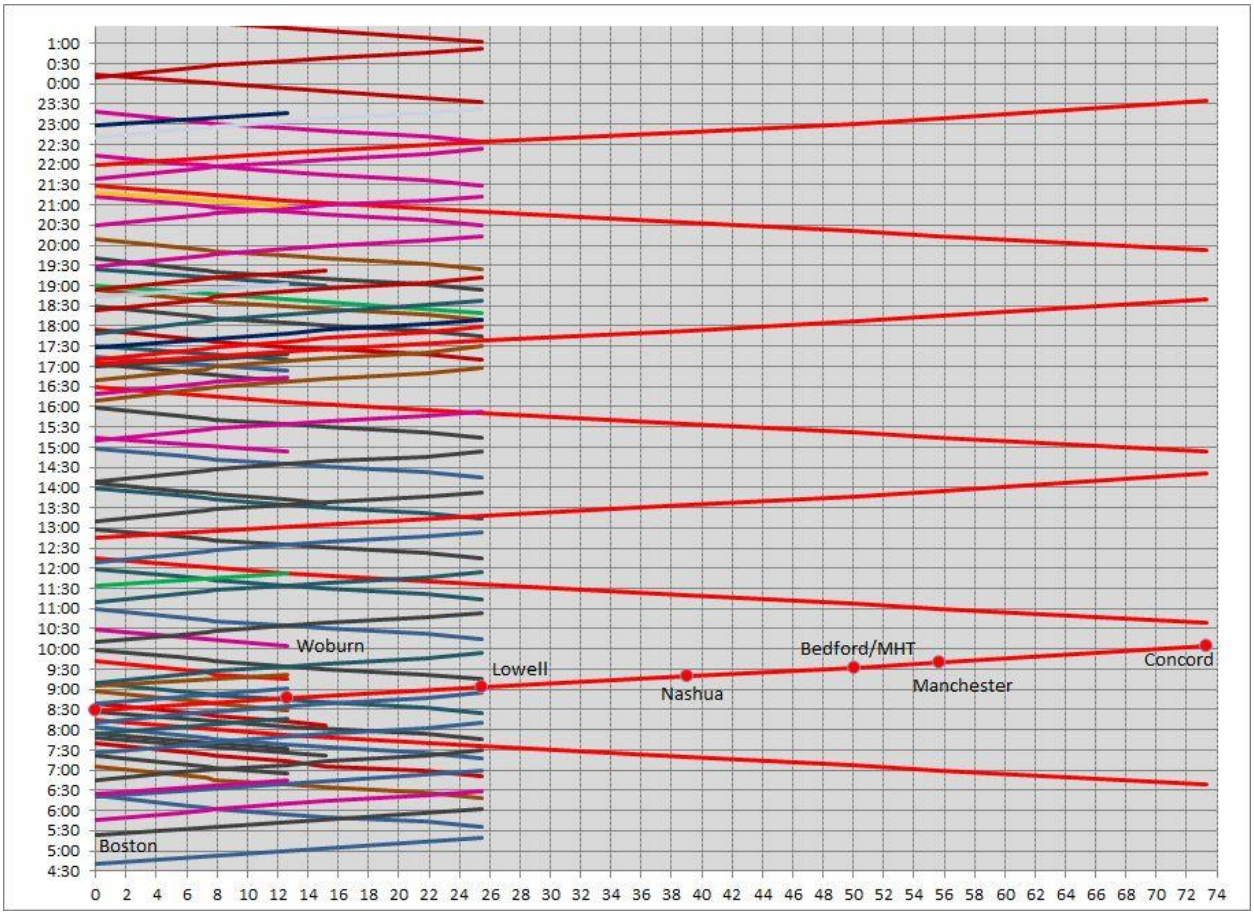
via I-93 or Route 3. Local bus service to the intercity rail stations could be offered, but would not be integral to the service design. A BX/Concord Coach/intercity rail fare integration scheme similar to that used by the *Downeaster* at Portland, Maine could be employed at the Concord and Manchester stations that would be shared by both intercity rail and coach bus services.

Anticipated ridership responses to the service initiative would include new riders attracted to the intercity rail service. It is anticipated that few current MBTA passengers living in New Hampshire would shift from using MBTA Lowell and North Billerica Stations to the new intercity rail service. Some BX and Concord Coach customers may shift to intercity rail service from Nashua, Manchester, and Concord. The overall increase in the quality and frequency of transit options to Manchester and Concord may stimulate bus ridership, as has been observed at the shared terminal in Portland, Maine.

Table 1.8: Intercity 8 Timetable

380	382	384	386		Station	MP		381	383	385	387
6:41	10:41	14:56	19:56	Read Down	**Concord, NH**	73.3	Read Up	10:05	14:20	18:55	23:35
6:54	10:54	15:09	20:09		**Manchester, NH**	55.7		9:39	13:54	18:29	23:09
7:07	11:07	15:22	20:22		**Bedford/MHT**	50.1		9:31	13:46	18:21	23:01
7:20	11:20	15:35	20:35		**Nashua**	39.0		9:18	13:33	18:08	22:48
7:36	11:36	15:51	20:51		**Lowell**	25.5		9:02	13:17	17:52	22:32
7:52	11:52	16:07	21:07		**Anderson/Woburn**	12.6		8:46	13:01	17:36	22:16
8:15	12:15	16:30	21:30		**North Station**	0.0		8:30	12:45	17:20	22:00

Figure 1.9: Time-Distance Stringline Diagram for Intercity 8 Rail Service

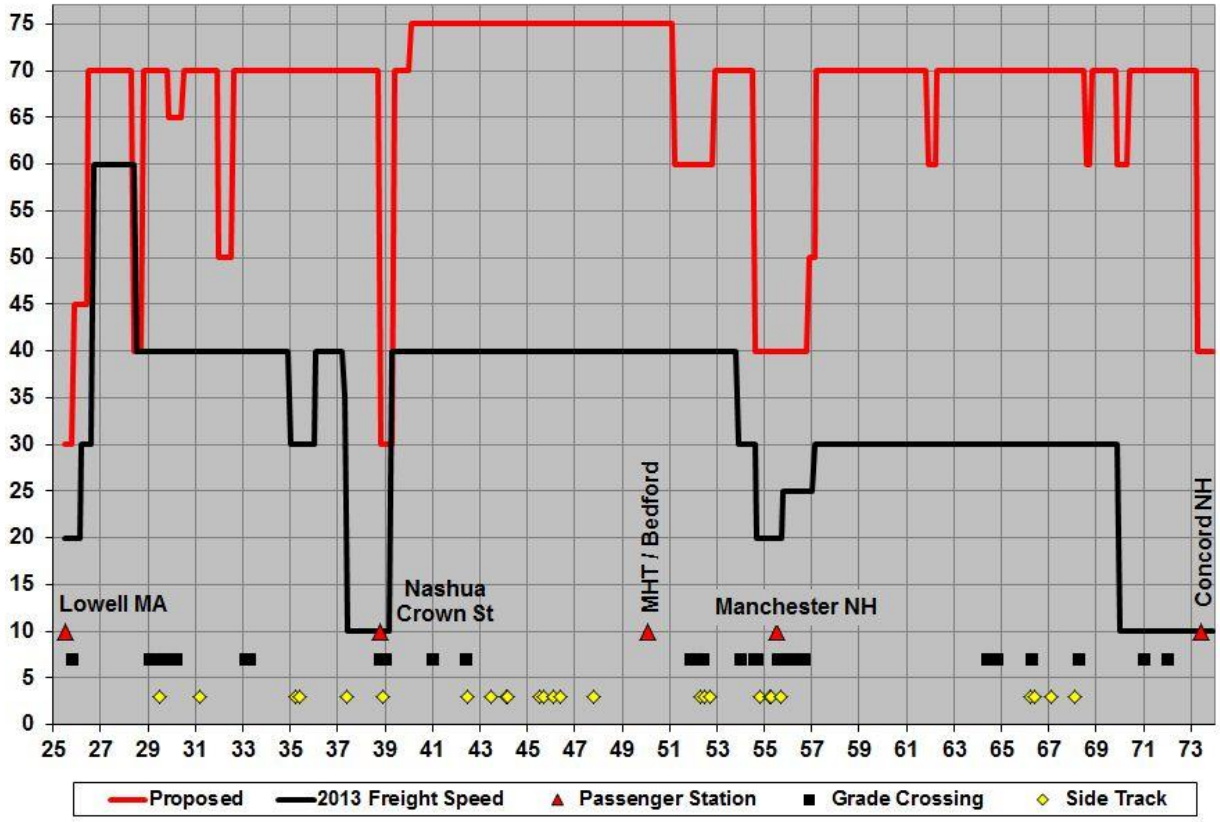


Infrastructure Requirements

No improvements would be required south of MBTA's Lowell Gallagher Terminal. North of Lowell the railroad would be upgraded to permit safe, reliable operation of eight daily passenger trains at speeds of up to 75 mph. Intercity 8 would require more extensive infrastructure upgrades than the commuter rail options as it is approximately 18 miles longer than the Manchester Regional Commuter Rail service. The service would also operate at higher maximum speeds: up to 75 mph between Manchester Airport and Nashua and 70 mph at many other locations (see Figure 1.10). Recommended upgrades to track, bridges, crossings, and signals are summarized below.

Track – Study team engineers recommend that this option be supported by replacing all of the existing 70-plus-year-old main line rail between Lowell and Concord with new CWR of a similar weight. Along segments where the rail is renewed with CWR approximately one-third of the existing ties would be replaced. This would provide an additional margin of structural integrity in the track over the one-quarter of existing ties that would be replaced for 60 mph maximum speeds.

Figure 1.10: Proposed Maximum Passenger Speeds for Intercity 8 Rail Service



Unlike the Manchester Regional and Nashua Minimum Commuter Rail options, no double track would be required between North Chelmsford (MP 28.5) and the southern end of the Tyngsborough Curve (MP 32.0). Industrial sidings would be created at three key areas of freight activity in Nashua and Merrimack to eliminate conflicts between local freight deliveries and through passenger trains. At these locations the existing main line track would be retained as an industrial siding with an entirely new parallel main line track constructed in the same alignment for use by through trains. Adding a second track would be straightforward as the railway was once entirely double tracked with the double-track bed still largely intact.

Bridges – The service expansion would use 25 existing bridges over watercourses or roadways (see Table 1.9). Most of the bridges are rated as having sufficient strength to accommodate the proposed additional traffic. One bridge in Tyngsborough (MP 32.5) is a candidate for complete replacement. The large steel (circa 1930) structure spanning the Merrimack River (MP 51.8) between Manchester and Bedford is subject to more detailed inspection. In Hooksett, the 488-foot steel bridge also spanning the Merrimack is similarly subject to more detailed inspection. The other 22 bridges should receive a renewal of worn and weakened components when the rails crossing them are replaced.

Table 1.9: Intercity 8 Bridge Inventory

MP	Length (Ft.)	PAR Rating* (000's of lbs.)	Town	Overall Assessment
25.7	155	Not Available	Lowell	Fair
26.2	163	Not Available	Lowell	Fair
28.8	104	334	Chelmsford	Fair
28.8	44	350	Chelmsford	Good/Fair
29.1	13	350	Chelmsford	Fair
32.5	46	263	Tyngsborough	Fair/Poor
32.6	12	320	Tyngsborough	Good
37.8	17	350	Nashua	Good
39.2	113	350	Nashua	Fair
39.4	35	286	Nashua	Fair
41.8	48	350	Nashua	Good/Fair
44.8	16	289	Merrimack	Fair
44.9	108	350	Merrimack	Fair/Good
46.2	112	350	Merrimack	Good/Fair
47.8	10	350	Merrimack	Good/Fair
51.8	655	Not Rated	Manchester	Fair
60.5	12	328	Hooksett	Fair
61.2	15	314	Hooksett	Good/Fair
64.3	488	Not Rated	Hooksett	Fair
67.6	15	286	Bow	Good/Fair
70.8	17	286	Bow	Good/Fair
71.1	11	350	Bow	Good/Fair
71.5	16	Not Rated	Concord	Good
71.5	10	Not Rated	Concord	Fair
73.3	Short	Not Rated	Concord	Fair

Crossings – With double tracking and increased frequency of faster trains, most of the 35 roadway grade crossings between Concord and downtown Lowell listed in Table 1.10 would need upgrades to their AHWD. The density of crossings just north of the proposed Granite Street Station in Manchester is very high. If requested by the communities, NHDOT and the MBTA can work with the municipalities, PAR, and FRA to establish "quiet zones" where desired.

Table 1.10: Intercity 8 Grade Crossings

Municipality	MP	Street	Type	AHWD	Recommended Upgrades
Chelmsford	29.1	Wotton St.	Private	FGBX	Add provisions for second main line track
Chelmsford	29.6	Wellman Rd.	Private	CFGB	Add provisions for second main line track
Chelmsford	30.0	Cross St.	Private	None	Install FGBX for double-track main line
Tyngsborough	30.5	New England Marine	Private	None	Install FGBX for double-track main line
Tyngsborough	33.5	Helena Dr./River Rd.	Private	X	Install FGBX for single track main
Nashua	36.2	"Dustbowl"	Informal	None	Work with community to close or protect this informal crossing
Nashua	36.9	East Glenwood St.	Private	None	Install FGBX for single track main
Nashua	38.8	Crown St.	Public	FGBX	Renew crossing surface as new rail and ties are installed.
Nashua	38.9	East Hollis St.	Public	FGBX	Renew crossing surface as new rail and ties are installed.
Nashua	39.0	Bridge St.	Public	FGBX	Renew crossing surface as new rail and ties are installed.
Nashua	40.8	Hills Ferry Rd.	Public	X	Install FGBX for single track main
Merrimack	42.4	Mast Rd.	Private	X	Install FGBX for single track main
Merrimack	43.7	Busch	Private	None	Work with Anheuser Busch to upgrade AHWD
Merrimack	44.1	Star Dr.	Private	None	Work with National Grid to upgrade AHWD
Merrimack	45.7	New England Pole	Private	X	Install FGBX for double-track main line
Manchester	52.1	Pine Island Rd.	Public	FGBX	Renew crossing surface as new rail and ties are installed
Manchester	52.6	Winston Rd.	Public	FGBX	Renew crossing surface as new rail and ties are installed; provide for a three track crossing if this becomes the commuter railroad's overnight layover facility
Manchester	54.0	West Mitchell St.	Public	FGBX	Renew crossing surface as new rail and ties are installed
Manchester	54.6	Sundial Ave. (Dunbar St.)	Public	FGBX	Renew crossing surface as new rail and ties are installed
Manchester	54.7	Bryon St.	Public	FGBX	Renew crossing surface as new rail and ties are installed
Manchester	55.6	Depot St.	Public	FGBX	CLOSE
Manchester	55.7	Granite St.	Public	CFGBX	Renew crossing surface as new rail and ties are installed
Manchester	55.9	Pleasant St.	Public	FGBX	Renew crossing surface as new rail and ties are installed
Manchester	56.0	Ped Xing #1	Public	FBX	Renew crossing surface as new rail and ties are installed
Manchester	56.2	Spring St.	Public	FGBX	Renew crossing surface as new rail and ties are installed
Manchester	56.3	Kidder St.	Public	FGBX	Renew crossing surface as new rail and ties are installed
Manchester	56.5	Ped Xing #2	Public	FBX	Renew crossing surface as new rail and ties are installed
Manchester	56.6	Commercial St.	Public	FGBX	Renew crossing surface as new rail and ties are installed
Manchester	58.7	Eve St. (Chauncey Ave.)	Private	X	Install FGBX for single track main
Hooksett	64.3	Old Londonderry Turnpike	Public	FGBX	Renew crossing surface as new rail and ties are installed
Hooksett	64.8	Edgewater Dr.	Public	FBX	Renew crossing surface as new rail and ties are installed
Bow	66.3	Johnson Rd.	Public	FBX	Renew crossing surface as new rail and ties are installed
Bow	68.3	Robinson Ferry	Private	X	Install FGBX for single track main
Bow	69.8	Gavins Falls Rd.	Private	None	Install FGBX for single track main
Bow	71.0	Hall St.	Public	FGBX	Renew crossing surface as new rail and ties are installed

The column marked "AHWD" reports the types of "Automatic Highway Warning Devices" installed at each crossing.
F=Flashers, G=Gates, B=Bell, X=Cross buck Sign, C=Cantilever over roadway with flashing lights, None=No AHWD

Stations – Four new passenger stations would be constructed (see Table 1.11). They would be a mix of high-level and low-level platforms with mini-high platforms for handicapped accessibility. The platforms at Nashua and Manchester would be less complex than for the commuter rail options because no intercity trains would turn from northbound to southbound at these stations.

Table 1.11: Intercity 8 Passenger Station Development Plan

Station	MP	Comments
Concord	73.3	Single high-level platform on the stub end terminal track east of the main line
Manchester	55.5	Single low-level platform with mini-high to the east of the single main line track
Bedford/MHT	50.1	Single low-level platform with mini-high to the west of the single main line track
Nashua	38.8	Single low-level platform with mini-high to the west of the single main line track

Other – Upgrades to the train control and signal systems would also be required as well as some new switches and interlockings. These details are covered in Appendix D, Capital Cost Methodology Report, to this report.

Index A: Proposed Bus Service Option Timetables

Table A.1: Proposed Expanded Base Timetable

Proposed Southbound Expanded Base							
	I-93			Route 3			
Manchester	N. Londonderry (Exit 5)	Londonderry (Exit 4)	Salem (Exit 2)	Nashua (Exit 8)	Tyngsborough (Exit 35)	South Station	Logan Airport
-	4:00	-	4:20	-	-	5:20	5:35
-	-	-	-	-	5:00	5:50	6:05
-	-	-	5:00	-	-	5:55	6:10
-	-	-	-	5:00	-	6:00	6:15
-	-	5:00	-	-	-	6:00	6:15
-	5:00	-	-	-	-	6:05	6:20
4:30	-	-	-	-	-	6:10	6:25
-	-	-	-	-	5:30	6:20	6:35
-	-	-	5:30	-	-	6:25	6:40
-	-	5:30	-	-	-	6:30	6:45
-	-	-	-	5:30		6:30	6:45
-	5:30	-	-	-	-	6:35	6:50
-	-	-	-	-	6:00	7:05	7:20
-	-	-	6:00	-	-	7:05	7:20
5:30	-	-	-	-	-	7:10	7:25
-	-	-	-	6:00	-	7:10	7:25
-	-	6:00	-	-	-	7:10	7:25
-	6:00	-	-	-	-	7:15	7:30
-	-	-	6:30	-	-	7:35	7:50
-	6:30	-	-	-	-	7:50	8:05
-	-	6:30	-	-	-	7:50	8:05
-	-	-	-	-	6:30	8:05	8:20
-	-	-	-	6:30	-	8:10	8:25
6:30	-	-	-	-	-	8:10	8:25
-	7:00	-	-	-	-	8:25	8:40
-	-	-	7:00	-	-	8:25	8:40
-	-	7:00	-	-	-	8:35	8:50
-	-	-	-	-	7:00	8:35	8:50
-	-	-	-	7:00	-	8:40	8:55
-	-	-	7:30	-	-	8:55	9:10
-	7:30	-	-	-	-	9:00	9:15
-	-	-	-	-	7:30	9:00	9:20
-	-	-	-	7:30	-	9:05	9:05
-	-	7:30	-	-	-	9:15	9:30
-	8:05	8:20	8:35	-	-	9:35	9:50
7:30	-	-	-	-	-	9:50	10:05
8:30	-	-	-	8:50	9:05	10:05	10:20
-	-	-	-	9:30	9:45	10:35	10:50
9:00	9:20	9:35	9:50	-	-	10:35	10:50
-	10:20	10:35	10:50	-	-	11:35	11:50
10:00	-	-	-	10:30	10:45	11:35	11:50
-	-	-	-	11:30	11:45	12:35	12:50
11:00	11:20	11:35	11:50	-	-	12:35	12:50
-	12:20	12:35	12:50	-	-	13:35	13:50
12:00	-	-	-	12:30	12:45	13:35	13:50
	-	-	-	13:30	13:45	14:35	14:50
13:00	13:20	13:35	13:50	-	-	14:35	14:50
-	14:20	12:35	14:50	-	-	15:35	15:50
14:00	-	-	-	14:30	14:45	15:35	15:50
-	-	-	-	15:30	15:45	16:35	16:50
15:00	15:20	15:35	15:50	-	-	16:35	16:50
-	16:20	16:35	16:50	-	-	17:35	17:50
16:00	-	-	-	16:30	16:45	17:50	18:05
17:00	17:20	17:35	17:50	-	-	18:35	18:50
-	-	-	-	17:30	17:45	18:50	18:50
-	18:20	18:35	18:50	-	-	19:35	19:50
18:00	-	-	-	18:30	18:45	19:35	19:50
19:00	19:20	19:35	19:50	-	-	20:35	20:50
-	-	-	-	19:30	19:45	20:35	20:50
-	20:20	20:35	20:50	-	-	21:35	21:50

Proposed Northbound Expanded Base							
		I-93			Route 3		
Logan Airport	South Station	Salem (Exit 2)	Londonderry (Exit 4)	N. Londonderry (Exit 5)	Tyngsborough (Exit 35)	Nashua (Exit 8)	Manchester
07:45	8:00	8:35	8:50	9:00	-	-	9:20
07:45	8:00	-	-	-	8:45	9:00	-
08:45	9:00	9:35	9:50	10:00	-	-	-
08:45	9:00	-	-	-	9:45	10:00	10:30
09:45	10:00	10:35	10:50	11:00	-	-	11:20
09:45	10:00	-	-	-	10:45	11:00	-
10:45	11:00	11:35	11:50	12:00	-	-	-
10:45	11:00	-	-	-	11:45	12:00	12:30
11:45	12:00	12:35	12:50	13:00	-	-	13:20
11:45	12:00	-	-	-	12:45	13:00	-
12:45	13:00	13:35	13:50	14:00	-	-	-
12:45	13:00	-	-	-	13:45	14:00	14:30
13:45	14:00	14:35	14:50	15:00	-	-	15:20
13:45	14:00	-	-	-	14:45	15:00	-
14:45	15:00	15:35	15:50	16:00	-	-	-
14:45	15:00	-	-	-	15:45	16:00	16:30
15:45	16:00	16:35	16:50	17:00	-	-	17:20
15:45	16:00	-	-	-	16:45	17:00	-
16:00	16:15	-	-	17:20	-	-	-
16:05	16:20	-	17:20	-	-	-	-
16:05	16:20	-	-	-	-	17:45	-
16:10	16:25	17:10	-	-	-	-	-
16:10	16:25	-	-	-	17:35	-	-
16:30	16:45	-	-	17:50	-	-	-
16:35	16:50	-	17:50	-	-	-	-
16:35	16:50	-	-	-	-	18:15	-
16:40	16:55	17:40	-	-	-	-	-
16:40	16:55	-	-	-	18:05	-	-
16:45	17:00	-	-	-	-	-	18:20
17:00	17:15	-	-	18:20	-	-	-
17:05	17:20	-	18:20	-	-	-	-
17:05	17:20	-	-	-	-	18:45	-
17:10	17:25	18:20	-	-	-	-	-
17:10	17:25	-	-	-	18:40	-	-
17:30	17:45	-	-	18:50	-	-	-
17:35	17:50	-	18:50	-	-	-	-
17:35	17:50	-	-	-	-	19:05	-
17:40	17:55	18:40	-	-	-	-	-
17:40	17:55	-	-	-	19:05	-	-
17:45	18:00	-	-	-	-	-	19:20
18:00	18:15	-	-	19:20	-	-	-
18:05	18:20	-	19:20	-	-	-	-
18:05	18:20	-	-	-	-	19:30	-
18:10	18:25	19:00	-	-	-	-	-
18:10	18:25	-	-	-	19:25	-	-
18:30	18:45	-	-	19:50	-	-	-
18:35	18:50	-	19:50	-	-		-
18:35	18:50	-	-	-	-	20:00	-
18:40	18:55	19:40	-	-	-	-	-
18:40	18:55	-	-	-	19:55	-	-
19:10	19:25	20:00	20:15	20:25	-	-	-
19:10	19:25	-	-	-	20:10	20:25	20:55
20:10	20:25	21:00	21:15	21:25	-	-	-
20:10	20:25	-	-	-	21:10	21:25	21:55
21:10	21:25	22:00	22:15	22:25	-	-	-
21:10	21:25	-	-	-	22:10	22:25	22:55
22:10	22:25	23:00	23:15	23:25	-	-	-
22:10	22:25	-	-	-	23:10	23:25	23:55
23:10	23:25	0:00	0:15	0:25	-	-	-

Table A.2: Proposed Bus on Shoulder Timetable

Proposed Southbound Bus on Shoulder							
	I-93			Route 3			
Manchester	N. Londonderry (Exit 5)	Londonderry (Exit 4)	Salem (Exit 2)	Nashua (Exit 8)	Tyngsborough ugh (Exit 35)	South Station	Logan Airport
-	4:00	-	4:20	-	-	05:20	05:35
-	5:08	-	5:28	-	-	06:15	-
-	5:38	-	-	-	-	06:35	06:50
-	-	5:38	-	-	-	06:30	-
-	5:38	-	5:58	-	-	06:50	07:05
-	-	-	-	6:09	-	07:00	07:15
-	6:09	-	-	-	-	07:20	-
5:39	-	6:09	-	-	-	07:20	-
-	-	-	6:29	-	-	07:25	-
-	-	-	-	6:09	6:24	07:20	07:35
-	-	6:29	-	-	-	07:40	-
-	6:39	-	6:59	-	-	08:10	08:25
-	-	6:50	-	-	-	08:15	-
6:10	-	-	-	6:40	6:55	08:20	08:35
-	7:10	-	-	-	-	08:30	-
-	-	7:10	7:30	-	-	08:45	-
-	-	-	-	7:10	7:25	08:50	09:05
-	7:43	-	8:03	-	-	09:10	09:25
7:13	-	-	-	7:43	7:58	09:15	09:30
-	-	7:43	-	-	-	09:20	-
8:37	-	-	-	-	-	09:30	09:45
-	8:42	-	9:02	-	-	09:50	10:05
-	-	8:59	-	-	-	10:00	-
-	-	-	-	9:09	9:24	10:15	10:30
9:25	9:45	-	10:05	-	-	10:50	11:05
-	10:30	-	10:50	-	-	11:35	11:50
-	-	-	-	10:30	10:45	11:35	11:50
-	11:30	-	11:50	-	-	12:35	12:50
11:30	-	-	-	12:01	12:15	13:05	13:20
-	12:30	-	12:50	-	-	13:35	13:50
-	-	-	-	13:30	13:45	14:35	14:50
-	13:30	-	13:50	-	-	14:35	14:50
-	14:30	-	14:50	-	-	15:35	15:50
14:30	-	-	-	15:00	15:15	16:05	16:20
-	15:30	-	15:50	-	-	16:35	16:50
-	16:30	-	16:50	-	-	17:35	17:50
-	-	-	-	16:30	16:45	17:50	18:05
17:10	17:30	-	17:50	-	-	18:35	18:50
-	18:30	-	18:50	-	-	19:35	19:50
-	-	-	-	19:15	19:30	20:20	20:35
-	19:30	-	19:50	-	-	20:35	20:50
-	20:30	-	20:50	-	-	21:35	21:50

Proposed Northbound Bus on Shoulder							
	I-93			Route 3			
Logan Airport	South Station	Salem (Exit 2)	Londonderry (Exit 4)	N. Londonderry (Exit 5)	Tyngsborough (Exit 35)	Nashua (Exit 8)	Manchester
7:15	8:00	8:35	-	9:00	-	-	9:20
8:10	8:45	-	-	-	9:30	9:45	-
8:25	9:00	9:35	-	9:55	-	-	-
9:25	10:00	10:35	-	10:55	-	-	-
9:40	10:15	-	-	-	11:00	11:15	11:45
10:25	11:00	11:35	-	11:55	-	-	-
11:10	11:45	-	-	-	12:30	12:45	-
11:25	12:00	12:35	-	12:55	-	-	-
12:25	13:00	13:35	13:50	14:00	-	-	-
12:40	13:15	-	-	-	14:00	14:15	14:45
13:25	14:00	14:35	-	14:55	-	-	-
14:10	14:45	-	-	-	15:35	15:50	-
14:25	15:00	15:35	-	15:55	-	-	16:15
-	15:30	16:05	-	16:25	-	-	-
-	15:45	-	16:45	-	-	-	-
15:25	16:00	16:35	-	16:55	-	-	17:15
15:25	16:00	-	-	-	17:10	17:25	-
-	16:15	-	17:20	17:30	-	-	-
-	16:30	17:10	-	17:35	-	-	17:55
16:05	16:40	-	-	-	17:45	18:00	-
-	16:45	-	17:45	17:55	-	-	-
16:25	17:00	17:40	-	18:00	-	-	-
-	17:15	-	18:25	18:40	-	-	-
-	17:20	-	-	-	18:30	18:45	-
-	17:30	18:20	-	18:40	-	-	-
-	17:45	-	18:40	18:50	-	-	-
17:15	17:50	-	-	-	18:45	19:00	19:30
17:25	18:00	18:30	-	18:50	-	-	-
-	18:15	-	19:05	19:15	-	-	-
17:45	18:20	-	-	-	19:15	19:30	20:00
-	18:45	-	19:35	19:45	-	-	-
18:25	19:00	19:35	-	19:55	-	-	-
18:40	19:15	-	-	-	20:00	20:15	20:45
19:25	20:00	20:35	20:50	21:00	-	-	-
20:25	21:00	21:35	21:50	22:00	-	-	-
20:55	21:30	-	-	-	22:15	22:30	23:00
21:25	22:00	22:35	-	22:55	-	-	-
22:25	23:00	23:35	-	23:55	-	-	-

Typical Day Time Savings (minutes)							
6:30	7:00	7:30	8:00	8:30	9:00	9:30	10:00
8	9	9	10	10	13	12	9

Typical Day Time Savings (minutes)							
6:30	7:00	7:30	8:00	8:30	9:00	9:30	10:00
8	9	9	10	10	13	12	9

Table A.3: Proposed Expanded Bus on Shoulder Timetable

Proposed Southbound Expanded Bus on Shoulder							
	I-93			Route 3			
Manchester	N. Londonderry (Exit 5)	Londonderry (Exit 4)	Salem (Exit 2)	Nashua (Exit 8)	Tyngsborough (Exit 35)	South Station	Logan Airport
-	4:00	-	4:20	-	-	5:20	5:35
-	-	-	-	-	5:08	5:50	6:05
-	-	-	5:08	-	-	5:55	6:10
-	-	-	-	5:08	-	6:00	6:15
-	-	5:08	-	-	-	6:00	6:15
-	5:08	-	-	-	-	6:05	6:20
4:38	-	-	-	-	-	6:10	6:25
-	-	-	-	-	5:38	6:20	6:35
-	-	-	5:38	-	-	6:25	6:40
-	-	5:38	-	-	-	6:30	6:45
-	-	-	-	5:38	0:08	6:30	6:45
-	5:38	-	-	-	-	6:35	6:50
-	-	-	-	-	6:08	7:05	7:20
-	-	-	6:09	-	-	7:05	7:20
5:39	-	-	-	-	-	7:10	7:25
-	-	-	-	6:09	-	7:10	7:25
-	-	6:09	-	-	-	7:10	7:25
-	6:09	-	-	-	-	7:15	7:30
-	-	-	6:39	-	-	7:35	7:50
-	6:39	-	-	-	-	7:50	8:05
-	-	6:39	-	-	-	7:50	8:05
-	-	-	-	-	6:39	8:05	8:20
-	-	-	-	6:39	-	8:10	8:25
6:40	-	-	-	-	-	8:10	8:25
-	7:10	-	-	-	-	8:25	8:40
-	-	-	7:10	-	-	8:25	8:40
-	-	7:10	-	-	-	8:35	8:50
-	-	-	-	-	7:10	8:35	8:50
-	-	-	-	7:10	-	8:40	8:55
-	-	-	7:40	-	-	8:55	9:10
-	7:43	-	-	-	-	9:00	9:15
-	-	-	-	-	7:43	9:05	9:20
-	-	-	-	7:40	-	9:05	9:05
-	-	7:42	-	-	-	9:15	9:30
-	8:17	8:32	8:47	-	-	9:35	9:50
7:42	-	-	-	-	-	9:50	10:05
8:39	-	-	-	8:59	9:14	10:05	10:20
-	-	-	-	9:30	9:45	10:35	10:50
9:00	9:20	9:35	9:50	-	-	10:35	10:50
-	10:20	10:35	10:50	-	-	11:35	11:50
10:00	-	-	-	10:30	10:45	11:35	11:50
-	-	-	-	11:30	11:45	12:35	12:50
11:00	11:20	11:35	11:50	-	-	12:35	12:50
-	12:20	12:35	12:50	-	-	13:35	13:50
12:00	-	-	-	12:30	12:45	13:35	13:50
0:00	-	-	-	13:30	13:45	14:35	14:50
13:00	13:20	13:35	13:50	-	-	14:35	14:50
-	14:20	12:35	14:50	-	-	15:35	15:50
14:00	-	-	-	14:30	14:45	15:35	15:50
-	-	-	-	15:30	15:45	16:35	16:50
15:00	15:20	15:35	15:50	-	-	16:35	16:50
-	16:20	16:35	16:50	-	-	17:35	17:50
16:00	-	-	-	16:30	16:45	17:50	17:50
17:00	17:20	17:35	17:50	-	-	18:35	18:50
-	-	-	-	17:30	17:45	18:50	18:50
-	18:20	18:35	18:50	-	-	19:35	19:50
18:00	-	-	-	18:30	18:45	19:35	19:50
19:00	19:20	19:35	19:50	-	-	20:35	20:50
-	-	-	-	19:30	19:45	20:35	20:50
-	20:20	20:35	20:50	-	-	21:35	21:50

Proposed Northbound Expanded Bus on Shoulder							
		I-93			Route 3		
Logan Airport	South Station	Salem (Exit 2)	Londonderry (Exit 4)	N. Londonderry (Exit 5)	Tyngsborough (Exit 35)	Nashua (Exit 8)	Manchester
07:45	8:00	8:35	8:50	9:00	-	-	9:20
07:45	8:00	-	-	-	8:45	9:00	-
08:45	9:00	9:35	9:50	10:00	-	-	-
08:45	9:00	-	-	-	9:45	10:00	10:30
09:45	10:00	10:35	10:50	11:00	-	-	11:20
09:45	10:00	-	-	-	10:45	11:00	-
10:45	11:00	11:35	11:50	12:00	-	-	-
10:45	11:00	-	-	-	11:45	12:00	12:30
11:45	12:00	12:35	12:50	13:00	-	-	13:20
11:45	12:00	-	-	-	12:45	13:00	-
12:45	13:00	13:35	13:50	14:00	-	-	-
12:45	13:00	-	-	-	13:45	14:00	14:30
13:45	14:00	14:35	14:50	15:00	-	-	15:20
13:45	14:00	-	-	-	14:45	15:00	-
14:45	15:00	15:35	15:50	16:00	-	-	-
14:45	15:00	-	-	-	15:45	16:00	16:30
15:45	16:00	-	-	-	-	-	17:20
15:45	16:00	-	-	-	16:45	17:00	-
16:00	16:15	-	-	17:20	-	-	-
16:05	16:20	-	17:20	-	-	-	-
16:05	16:20	-	-	-	-	17:45	-
16:10	16:25	17:10	-	-	-	-	-
16:10	16:25	-	-	-	17:35	-	-
16:30	16:45	-	-	17:45	-	-	-
16:35	16:50	-	17:45	-	-	-	-
16:35	16:50	-	-	-	-	18:10	-
16:40	16:55	17:35	-	-	-	-	-
16:40	16:55	-	-	-	18:00	-	-
16:45	17:00	-	-	-	-	-	18:15
17:00	17:15	-	-	18:15	-	-	-
17:05	17:20	-	18:15	-	-	-	-
17:05	17:20	-	-	-	-	18:40	-
17:10	17:25	18:15	-	-	-	-	-
17:10	17:25	-	-	-	18:35	-	-
17:30	17:45	-	-	18:45	-	-	-
17:35	17:50	-	18:45	-	-	-	-
17:35	17:50	-	-	-	-	19:00	-
17:40	17:55	18:35	-	-	-	-	-
17:40	17:55	-	-	-	19:00	-	-
17:45	18:00	-	-	-	-	-	19:15
18:00	18:15	-	-	19:15	-	-	-
18:05	18:20	-	19:15	-	-	-	-
18:05	18:20	-	-	-	-	19:25	-
18:10	18:25	18:55	-	-	-	-	-
18:10	18:25	-	-	-	19:20	-	-
18:30	18:45	-	-	19:45	-	-	-
18:35	18:50	-	19:45	-	-	-	-
18:35	18:50	-	-	-	-	19:55	-
18:40	18:55	19:35	-	-	-	-	-
18:40	18:55	-	-	-	19:50	-	-
19:10	19:25	20:00	20:15	20:25	-	-	-
19:10	19:25	-	-	-	20:10	20:25	20:55
20:10	20:25	21:00	21:15	21:25	-	-	-
20:10	20:25	-	-	-	21:10	21:25	21:55
21:10	21:25	22:00	22:15	22:25	-	-	-
21:10	21:25	-	-	-	22:10	22:25	22:55
22:10	22:25	23:00	23:15	23:25	-	-	-
22:10	22:25	-	-	-	23:10	23:25	23:55
23:10	23:25	0:00	0:15	0:25	-	-	-

Index B: Proposed Commuter Rail Service Option Timetables

Table B 1: Conceptual Manchester Regional Commuter Rail Timetable

New Hampshire Main Line Service Extension: Conceptual Option 3 (Manchester Regional Service)

READ DOWN		302E	304E	352	306E	208	680	308E	310E	212	356	312 Old	B312	312M	358	314	682	316	318E	B320	320	322	222	324	684	326	328E	686	686	232	B330	330E	334D	336	236	B338	338M	340M	342M	688	344	344X	346
Concord NH	73.3																																										
Manchester NH	55.7	**4:54**	**5:37**		**6:10**			**6:37**					**7:37**					9:34		**11:28**						14:34					**16:23**					**17:40**		**18:14**				**21:15**	
Bedford / MHT Airport	52.0	5:02	5:45		6:18			6:45					7:49					9:42		11:40						14:42					16:35					17:52		18:22				21:23	
Nashua Downtown	39.0	**5:16**	**5:59**		**6:32**			**6:59**	**7:27**				#N/A	**8:06**				**9:56**	**10:56**	#N/A	**11:56**	**12:56**					**14:56**	**15:56**				#N/A	**16:51**				#N/A	**18:07**	**18:36**	**19:39**			**21:37**	
Nashua South	35.2	5:22	6:05		6:38			7:05	7:33				8:06	8:11				10:02	11:02	11:57	12:02	13:02				15:02	16:02				16:52	16:57				18:09	18:12	18:42	19:45			21:42	
Lowell	25.5	**5:35**	**6:18**		**6:51**			**7:18**	**7:46**			*8:25*		8:24		**9:15**		**10:15**	**11:15**		**12:15**	**13:15**		**14:15**		**15:15**	**16:15**					**17:10**	17:35	**18:10**			**18:25**	**18:55**	**19:58**		**21:30**	**22:00**	**22:35**
North Billerica	21.8	5:43	6:26		6:59			7:26	7:54			*8:33*		8:32		9:23		10:23	11:23		12:23	13:23		14:23		15:23	16:23					17:18	17:43	18:18			18:33	19:03	20:06		21:38	22:08	22:43
Wilmington	15.2	5:51	6:34		7:06	**7:22**		#N/A	#N/A	**8:07**		*8:41*		8:40		9:31		10:31	11:31		12:31	13:31	**13:37**	14:31		15:31	16:31					17:26	17:51	18:26	**19:00**		18:41	19:11	20:14		21:46	22:16	22:51
Anderson/ Woburn	12.6	5:55	6:38	6:55	7:13	#N/A	***7:31***	7:38	8:05	8:12	8:30	*8:45*		8:44	9:15	9:35	***10:04***	10:35	11:35		12:35	13:35	13:43	14:35	***14:54***	15:35	16:35	***16:39***	16:55	17:11		17:30	17:55	18:30	19:04		18:45	19:15	20:18	***20:59***	21:50	22:20	22:55
Winchester Center	7.8	6:02	6:46	7:04	7:21	#N/A	*#N/A*	7:46	#N/A	8:20	8:39	*8:52*		8:51	9:23	9:42	*#N/A*	10:42	11:42		12:42	13:42	13:50	14:42	*#N/A*	15:42	16:42	*#N/A*	#N/A	#N/A		17:37	18:02	18:37	#N/A		18:52	19:22	20:25	*#N/A*	21:57	22:27	23:02
Wedgemere	7.3	6:04	6:49	7:06	7:24	#N/A	*#N/A*	7:49	#N/A	8:23	8:41	*8:54*		8:53	9:26	9:44	*#N/A*	10:44	11:44		12:44	13:44	13:52	14:44	*#N/A*	15:44	16:44	*#N/A*	#N/A	#N/A		17:39	18:04	18:39	#N/A		18:54	19:24	20:27	*#N/A*	21:59	22:29	23:04
West Medford	5.5	6:08	6:53	7:10	7:28	#N/A	*#N/A*	7:53	#N/A	8:27	8:45	*8:58*		8:57	9:30	9:48	*#N/A*	10:48	11:48		12:48	13:48	13:56	14:48	*#N/A*	15:48	16:48	*#N/A*	#N/A	#N/A		17:43	18:08	18:43	#N/A		18:58	19:28	20:31	*#N/A*	22:03	22:33	23:08
North Station	0.0	6:22	7:05	7:22	7:40	7:48	*7:55*	8:05	8:26	8:39	8:57	*9:10*		9:09	9:42	9:59	*10:30*	10:59	11:59		12:59	13:59	14:07	14:59	*15:15*	15:59	16:59	*17:05*	17:15	17:32		17:56	18:21	18:54	19:25		19:11	19:41	20:44	*21:20*	22:14	22:44	23:20
														Moved to arrive Boston 1 minute earlier than today																			Annulled					Moved to depart Lowell 48 minutes earlier than today	Moved to depart Lowell 30 minues earlier than today	Moved to arrive Boston 32 minutes earlier than today				

READ UP		301E	B301	351	305M	307E	355	309	357	681	311	B311	315E	317E	683	319E	321	323	B323	325E	327E	359	329E	B329	685	331	333E	335	337E	687	237	339E	341	343	345E	689	347E
Concord NH	73.3																																				
Manchester NH	55.7		**7:12**			**8:51**						**10:37**				**13:34**			**15:37**		**17:38**			**18:34**			**18:50**		**19:52**			**20:55**			0:04		**1:34**
Bedford / MHT Airport	52.0		7:00			8:43						10:25				13:26			15:25		17:30			18:22			18:42		19:44			20:47			23:56		1:26
Nashua Downtown	39.0	**6:47**	#N/A		**7:51**	**8:29**					**10:12**	#N/A	**11:12**	**12:12**		**13:12**		**15:12**	#N/A	**16:12**	**17:16**		**17:49**	#N/A			**18:28**	**18:57**	**19:30**			**20:33**			**23:42**		**1:12**
Nashua South	35.2	6:41	6:43		#N/A	8:23					10:06	10:08	11:06	12:06		13:06		15:06	15:08	16:06	17:10		17:43	18:05			18:22	18:51	19:24			20:27			23:36		1:06
Lowell	25.5	**6:29**			**7:26**	**8:11**		**8:56**			**9:54**		**10:54**	**11:54**		**12:54**	**13:54**	**14:54**		**15:54**	**16:58**		**17:31**			**17:59**	**18:10**	**18:39**	**19:12**			**20:15**	**21:14**	**22:24**	**23:24**		**0:54**
North Billerica	21.8	6:22			7:18	8:02		8:47			9:47		10:47	11:47		12:47	13:47	14:47		15:47	16:51		17:21			17:52	18:03	18:32	19:05			20:08	21:07	22:17	23:17		0:47
Wilmington	15.2	6:14			7:11	7:54		8:39			9:39		10:39	11:39		12:39	13:39	14:39		15:39	16:43		17:13			17:43	17:55	18:23	18:57		**19:23**	20:00	21:00	22:09	23:09		0:39
Anderson/ Woburn	12.6	6:10		6:45	7:04	7:50	8:17	8:35	9:02	***9:23***	9:35		10:35	11:35	***11:53***	12:35	13:35	14:35		15:35	16:38	16:45	17:08		***17:18***	17:38	17:50	18:18	18:52	***19:03***	19:19	19:55	20:55	22:05	23:05	***23:18***	0:35
Winchester Center	7.8	6:03		#N/A	6:56	7:43	#N/A	8:28	#N/A	*#N/A*	9:28		10:28	11:28	*#N/A*	12:28	13:28	14:28		15:28	16:30	16:38	17:00		*#N/A*	17:30	#N/A	18:10	18:44	#N/A	19:12	19:48	20:48	21:58	22:58	*#N/A*	0:28
Wedgemere	7.3	6:01		#N/A	#N/A	7:41	#N/A	8:26	#N/A	*#N/A*	9:26		10:26	11:26	*#N/A*	12:26	13:26	14:26		15:26	16:27	16:36	16:57		*#N/A*	17:27	#N/A	18:07	18:41	#N/A	19:10	19:46	20:46	21:56	22:56	*#N/A*	0:26
West Medford	5.5	5:57		#N/A	6:49	7:37	#N/A	8:22	#N/A	*#N/A*	9:22		10:22	11:22	*#N/A*	12:22	13:22	14:22		15:22	16:23	16:32	16:53		*#N/A*	17:23	#N/A	18:03	18:37	#N/A	19:06	19:42	20:42	21:52	22:52	*#N/A*	0:22
North Station	0.0	5:45		6:25	6:37	7:25	7:55	8:10	8:40	*9:05*	9:10		10:10	11:10	*11:35*	12:10	13:10	14:10		15:10	16:10	16:20	16:40		*17:00*	17:10	17:30	17:50	18:25	*18:45*	18:55	19:30	20:30	21:40	22:40	*23:00*	0:10
					Departs Boston 8 minutes earlier than today																																	

Note: Yellow cells represent optional feeder buses

Table B.2: Conceptual Nashua Minimum Commuter Rail Timetable

New Hampshire Main Line Service Extension: Conceptual Option 6 (Nashua Minimum Service)

READ DOWN		302E	304E	352	306	208	680	308E	310E	212	356	312 Old	312M	358	B314	314	682	316	B318	318	320	B322	322	222	324	684	B326	326	328	686	360	232	330E	334D	336E	236	336X	338E	340	B342	342	688	344	B346	346
Concord NH	73.3																																												
Manchester NH	55.7																																												
Bedford / MHT Airport	52.0																																											
Nashua Downtown	39.0																																											
Nashua South	35.2	**5:22**	**6:05**					**7:05**	**7:33**				8:16		**8:53**				**10:53**			**12:53**					**14:53**						**16:58**		**17:58**			**18:58**		**20:08**				**22:13**	
Lowell	25.5	5:35	6:18		**6:51**			7:18	7:46			*8:25*	8:28		9:10	**9:15**		**10:15**	11:10	**11:15**	**12:15**	13:10	**13:15**		**14:15**		15:10	**15:15**	**16:15**				17:06	17:45	18:06		**18:41**	19:06	**19:30**	20:25	**20:30**		**21:30**	22:30	**22:35**
North Billerica	21.8	5:43	6:26		6:59			7:26	7:54			*8:33*	8:36			9:23		10:23		11:23	12:23		13:23		14:23			15:23	16:23				17:13	17:53	18:13		18:48	19:13	19:38		20:38		21:38		22:43
Wilmington	15.2	5:51	6:34		7:06	**7:22**		#N/A	#N/A	**8:07**		*8:41*	8:44			9:31		10:31		11:31	12:31		13:31	**13:37**	14:31			15:31	16:31				17:20	18:01	18:20	**19:00**	18:55	19:20	19:46		20:46		21:46		22:51
Anderson/ Woburn	12.6	5:55	6:38	**6:55**	7:13	#N/A	***7:31***	7:38	8:05	8:12	**8:30**	*8:45*	8:48	9:15		9:35	***10:04***	10:35		11:35	12:35		13:35	13:43	14:35	***14:54***		15:35	16:35	***16:39***	**16:55**	**17:11**	17:28	18:05	18:28	19:04	19:03	19:28	19:50		20:50	**20:59**	21:50		22:55
Winchester Center	7.8	6:02	6:46	7:04	7:21	#N/A	*#N/A*	7:46	#N/A	8:20	8:39	*8:52*	8:55	9:23		9:42	*#N/A*	10:42		11:42	12:42		13:42	13:50	14:42	*#N/A*		15:42	16:42	*#N/A*	#N/A	#N/A	17:31	18:12	18:31	#N/A	19:06	19:31	19:57		20:57	*#N/A*	21:57		23:02
Wedgemere	7.3	6:04	6:49	7:06	7:24	#N/A	*#N/A*	7:49	#N/A	8:23	8:41	*8:54*	8:57	9:26		9:44	*#N/A*	10:44		11:44	12:44		13:44	13:52	14:44	*#N/A*		15:44	16:44	*#N/A*	#N/A	#N/A	17:35	18:14	18:35	#N/A	19:10	19:35	19:59		20:59	*#N/A*	21:59		23:04
West Medford	5.5	6:08	6:53	7:10	7:28	#N/A	*#N/A*	7:53	#N/A	8:27	8:45	*8:58*	9:01	9:30		9:48	*#N/A*	10:48		11:48	12:48		13:48	13:56	14:48	*#N/A*		15:48	16:48	*#N/A*	#N/A	#N/A	17:48	18:18	18:48	#N/A	19:23	19:48	20:03		21:03	*#N/A*	22:03		23:08
North Station	0.0	6:22	7:05	7:22	7:40	7:48	*7:55*	8:05	8:26	8:39	8:57	*9:10*	9:13	9:42		9:59	*10:30*	10:59		11:59	12:59		13:59	14:07	14:59	*15:15*		15:59	16:59	*17:05*	17:15	17:32	17:59	18:31	18:59	19:25	19:34	19:59	20:14		21:14	*21:20*	22:14		23:20
													Moved to arrive BOS 3 minutes later than today		Feeder Bus				Feeder Bus			Feeder Bus					Feeder Bus						Moved to arrive Boston 10 minutes later to get clockface with other trains	Annulled	Moved to arrive Boston 10 minutes later to get clockface with other trains		New train inserted into schedule	Moved to arrive 18 minutes later to achieve clockface schedule		Feeder Bus				Feeder Bus	

READ UP		301	351	305M	307E	355	309	B309	357	681	311	315	B315	317	683	319	B319	321	323	B323	325	327E	359	329E	685	331	333E	335	337	687	237	339	B339	341	343	B343	345E	689	347E
Concord NH	73.3																																						
Manchester NH	55.7																																						
Bedford / MHT Airport	52.0																																						
Nashua Downtown	39.0																																						
Nashua South	35.2			7:38	**8:23**			**9:29**					**11:29**				**13:29**			**15:29**		**17:10**		**17:43**			**18:22**	**18:51**				**20:44**			**22:49**	**23:36**		**1:06**	
Lowell	25.5	**6:29**		**7:26**	8:11		**8:56**	9:12			**9:54**	**10:54**	11:12	**11:54**		**12:54**	13:12	**13:54**	**14:54**	15:12	**15:54**	16:58		17:31		**17:59**	18:10	18:39	**19:12**			**20:15**	20:27	**21:14**	**22:24**	22:32	23:24		0:54	
North Billerica	21.8	6:22		7:18	8:02		8:47				9:47	10:47		11:47		12:47		13:47	14:47		15:47	16:51		17:21		17:52	18:03	18:32	19:05			20:08		21:07	22:17		23:17		0:47	
Wilmington	15.2	6:14		7:11	7:54		8:39				9:39	10:39		11:39		12:39		13:39	14:39		15:39	16:43		17:13		17:43	17:55	18:23	18:57		**19:23**	20:00		21:00	22:09		23:09		0:39	
Anderson/ Woburn	12.6	6:10	**6:45**	7:04	7:50	**8:17**	8:35		**9:02**	***9:23***	9:35	10:35		11:35	***11:53***	12:35		13:35	14:35		15:35	16:38	16:45	17:08	***17:18***	17:38	17:50	18:18	18:52	***19:03***	19:19	19:55		20:55	22:05		23:05	***23:18***	0:35	
Winchester Center	7.8	6:03	#N/A	6:56	7:43	#N/A	8:28		#N/A	*#N/A*	9:28	10:28		11:28	*#N/A*	12:28		13:28	14:28		15:28	16:30	16:38	17:00	*#N/A*	17:30	#N/A	18:10	18:44	*#N/A*	19:12	19:48		20:48	21:58		22:58	*#N/A*	0:28	
Wedgemere	7.3	6:01	#N/A	#N/A	7:41	#N/A	8:26		#N/A	*#N/A*	9:26	10:26		11:26	*#N/A*	12:26		13:26	14:26		15:26	16:27	16:36	16:57	*#N/A*	17:27	#N/A	18:07	18:41	*#N/A*	19:10	19:46		20:46	21:56		22:56	*#N/A*	0:26	
West Medford	5.5	5:57	#N/A	6:49	7:37	#N/A	8:22		#N/A	*#N/A*	9:22	10:22		11:22	*#N/A*	12:22		13:22	14:22		15:22	16:23	16:32	16:53	*#N/A*	17:23	#N/A	18:03	18:37	*#N/A*	19:06	19:42		20:42	21:52		22:52	*#N/A*	0:22	
North Station	0.0	5:45	6:25	6:37	7:25	7:55	8:10		8:40	*9:05*	9:10	10:10		11:10	*11:35*	12:10		13:10	14:10		15:10	16:10	16:20	16:40	*17:00*	17:10	17:30	17:50	18:25	*18:45*	18:55	19:30		20:30	21:40		22:40	*23:00*	0:10	
				Departs No Sta 7 minutes earlier than today				Feeder Bus					Feeder Bus				Feeder Bus				Feeder Bus													Feeder Bus							

Note: Yellow cells represent optional feeder buses

Index C: Proposed Intercity Rail Service Option Timetable

Table C.1: Conceptual Intercity 8 Timetable

New Hampshire Main Line: Proposed Intercity 8 Service Schedule Class III

READ DOWN		302	304	352	306	208	680	308	380	310	212	356	312	358	314	682	316	318	382	320	322	222	324	#REF!	326	384	686	360	232	330	334	336	DH333	236	338	340	342	#REF!	386	344	346	DH345	DH347
Concord NH	73.3								6:41										10:41							14:56													19:56				
Manchester NH	55.7								6:54										10:54							15:09													20:09				
MHT Airport (Goff's Falls)	52.0								7:07										11:07							15:22													20:22				
Nashua Downtown	39.0								7:20										11:20							15:35													20:35				
Nashua South	35.2								#N/A										#N/A							#N/A													#N/A				
Lowell	25.5	5:35	6:18		6:51			7:18	7:36	7:46			8:25		9:15		10:15	11:15	11:36	12:15	13:15		14:15		15:15	15:51				17:10	17:45	18:20	18:10		18:55	19:25	20:30		20:51	21:30	22:35	23:34	1:04
North Billerica	21.8	5:43	6:26		6:59			7:26	#N/A	7:54			8:33		9:23		10:23	11:23	#N/A	12:23	13:23		14:23		15:23	#N/A				17:18	17:53	#N/A	18:18		19:03	19:33	20:38		#N/A	21:38	22:43	#N/A	#N/A
Wilmington	15.2	5:51	6:34		7:06	**7:22**		#N/A	#N/A	#N/A	**8:07**		8:41		9:31		10:31	11:31	#N/A	12:31	13:31	**13:37**	14:31		15:31	#N/A				17:26	18:01	#N/A	18:26	**19:00**	19:11	19:41	20:46		#N/A	21:46	22:51	#N/A	#N/A
Anderson/ Woburn	12.6	5:55	6:38	6:55	7:13	#N/A	***7:31***	7:38	7:52	8:05	8:12	8:30	8:45	9:15	9:35	***10:04***	10:35	11:35	11:52	12:35	13:35	13:43	14:35	***14:54***	15:35	16:07	***16:39***	16:55	17:11	17:30	18:05	#N/A	18:30	19:04	19:15	19:45	20:50	***20:59***	21:07	21:50	22:55	#N/A	#N/A
Winchester Center	7.8	6:02	6:46	7:04	7:21	#N/A	*#N/A*	7:46	#N/A	#N/A	8:20	8:39	8:52	9:23	9:42	*#N/A*	10:42	11:42	#N/A	12:42	13:42	13:50	14:42	*#N/A*	15:42	#N/A	*#N/A*	#N/A	#N/A	17:37	18:12	#N/A	18:37	#N/A	19:22	19:52	20:57	*#N/A*	#N/A	21:57	23:02	#N/A	#N/A
Wedgemere	7.3	6:04	6:49	7:06	7:24	#N/A	*#N/A*	7:49	#N/A	#N/A	8:23	8:41	8:54	9:26	9:44	*#N/A*	10:44	11:44	#N/A	12:44	13:44	13:52	14:44	*#N/A*	15:44	#N/A	*#N/A*	#N/A	#N/A	17:39	18:14	#N/A	18:39	#N/A	19:24	19:54	20:59	*#N/A*	#N/A	21:59	23:04	#N/A	#N/A
West Medford	5.5	6:08	6:53	7:10	7:28	#N/A	*#N/A*	7:53	#N/A	#N/A	8:27	8:45	8:58	9:30	9:48	*#N/A*	10:48	11:48	#N/A	12:48	13:48	13:56	14:48	*#N/A*	15:48	#N/A	*#N/A*	#N/A	#N/A	17:43	18:18	#N/A	18:43	#N/A	19:28	19:58	21:03	*#N/A*	#N/A	22:03	23:08	#N/A	#N/A
North Station	0.0	6:22	7:05	7:22	7:40	7:48	*7:55*	8:05	8:15	8:26	8:39	8:57	9:10	9:42	9:59	*10:30*	10:59	11:59	12:15	12:59	13:59	14:07	14:59	*15:15*	15:59	16:30	*17:05*	17:15	17:32	17:56	18:31	19:00	18:54	19:25	19:41	20:09	21:14	*21:20*	21:30	22:14	23:20	0:14	1:44

READ UP		3801	3803	301	3805	351	305	307	355	309	381	357	681	311	315	317	683	383	319	321	323	325	327	359	359	685	331	385	333	335	337	687	237	339	341	343	387	345	689	347
Concord NH	73.3										10:05							14:20										18:55									23:35			
Manchester NH	55.7										9:39							13:54										18:29									23:09			
MHT Airport (Goff's Falls)	52.0										9:31							13:46										18:21									23:01			
Nashua Downtown	39.0										9:18							13:33										18:08									22:48			
Nashua South	35.2										#N/A							#N/A										#N/A									#N/A			
Lowell	25.5	5:20	6:03	6:29	7:00		7:30	8:11		8:56	9:02			9:54	10:54	11:54		13:17	12:54	13:54	14:54	15:54	16:58		17:31		17:59	17:52	18:10	18:39	19:12			20:15	21:14	22:24	22:32	23:24		0:54		
North Billerica	21.8	#N/A	#N/A	6:22	#N/A		7:21	8:02		8:47	#N/A			9:47	10:47	11:47		#N/A	12:47	13:47	14:47	15:47	16:51		17:21		17:52	#N/A	18:03	18:32	19:05			20:08	21:07	22:17	#N/A	23:17		0:47		
Wilmington	15.2	#N/A	#N/A	6:14	#N/A		7:13	7:54		8:39	#N/A			9:39	10:39	11:39		#N/A	12:39	13:39	14:39	15:39	16:43		17:13		17:43	#N/A	17:55	18:23	18:57		**19:23**	20:00	21:00	22:09	#N/A	23:09		0:39		
Anderson/ Woburn	12.6	#N/A	#N/A	6:10	#N/A	6:45	7:08	7:50	*8:17*	8:35	8:46	9:02	9:23	9:35	10:35	11:35	*11:53*	13:01	12:35	13:35	14:35	15:35	16:38	16:45	17:08	*17:18*	17:38	17:36	17:50	18:18	18:52	*19:03*	19:19	19:55	20:55	22:05	22:16	23:05	*23:18*	0:35		
Winchester Center	7.8	#N/A	#N/A	6:03	#N/A	#N/A	7:01	7:43	*#N/A*	8:28	#N/A	#N/A	#N/A	9:28	10:28	11:28	*#N/A*	#N/A	12:28	13:28	14:28	15:28	16:30	16:38	17:00	*#N/A*	17:30	#N/A	#N/A	18:10	18:44	*#N/A*	19:12	19:48	20:48	21:58	#N/A	22:58	*#N/A*	0:28		
Wedgemere	7.3	#N/A	#N/A	6:01	#N/A	#N/A	#N/A	7:41	#N/A	8:26	#N/A	#N/A	#N/A	9:26	10:26	11:26	#N/A	#N/A	12:26	13:26	14:26	15:26	16:27	16:36	16:57	#N/A	17:27	#N/A	#N/A	18:07	18:41	#N/A	19:10	19:46	20:46	21:56	#N/A	22:56	#N/A	0:26		
West Medford	5.5	#N/A	#N/A	5:57	#N/A	#N/A	6:57	7:37	#N/A	8:22	#N/A	#N/A	#N/A	9:22	10:22	11:22	#N/A	#N/A	12:22	13:22	14:22	15:22	16:23	16:32	16:53	#N/A	17:23	#N/A	#N/A	18:03	18:37	#N/A	19:06	19:42	20:42	21:52	#N/A	22:52	#N/A	0:22		
North Station	0.0	4:40	5:23	5:45	6:20	6:25	6:45	7:25	*7:55*	8:10	8:30	8:40	9:05	9:10	10:10	11:10	*11:35*	12:45	12:10	13:10	14:10	15:10	16:10	16:20	16:40	*17:00*	17:10	17:20	17:30	17:50	18:25	*18:45*	18:55	19:30	20:30	21:40	22:00	22:40	*23:00*	0:10		

2 Application of Selection Criteria

The application of five selection criterion is discussed in the following sections of this document:

- Economic impacts
- Land use and economic development
- Equity impacts
- Financial considerations, including costs
- Mobility impacts, including ridership forecasts

In addition, technical memoranda that detail the analysis supporting criteria application are appended to this report:

- Economic development (Appendix A)
- Sustainable land use (Appendix B)
- Corridor and regional equity analysis (Appendix C)
- Capital costs (Appendix D)
- Operations and maintenance (O&M) costs (Appendix E)
- Ridership forecasting (Appendix F)

2.1 Economic Impacts

An economic development assessment aimed at estimating the potential benefits associated with the set of final build alternatives in the corridor was conducted to examine two types of economic benefit:

1. The amount of new development that might occur locally around new station areas
2. The impact of this new development, plus the investment in new or upgraded transit infrastructure measured in terms of employment and economic output in the Capitol Corridor region

This assessment estimates benefits associated with the three rail alternatives, all of which provide new permanent infrastructure such as stations. In contrast, none of the bus alternatives involve new stations, and are, therefore, not expected to generate the development-based economic benefits.

Numerous studies done by transportation research organizations have identified a net positive benefit of fixed-guideway transit investment to the regional economy. This economic benefit is a result of travel time savings and congestion reduction, expanded access to jobs and workforce, and new development attracted to station areas. Studies have also found a positive impact of transit on property values in station areas. There are very few studies of the economic impacts of bus enhancement projects, and, of those, none suggest that the kinds of enhancements contemplated in the Capitol Corridor would help catalyze new, more intense development.

The Study team assembled data on land use and zoning to evaluate the potential impact of the Capitol Corridor project alternatives on development and redevelopment. This potential was measured in terms

of commercial square footage (office and retail) and housing units for the different alternatives. The Study team estimated the following illustrative impacts, as summarized in Table 2.1.

Table 2.1: Total Station Area Development Potential by Alternative

Alternative	Commercial (Sq. Ft.)	Residential (Units)	Jobs
Manchester Regional Commuter Rail	1,898,000	3,600	5,600
Nashua Minimum Commuter Rail	930,000	1,100	2,500
Intercity 8	819,000	1,600	2,500
Intercity Bus	0	0	0
No Build (Base)	0	0	0

Note: residential units and jobs rounded to the nearest hundred

- **Manchester Regional Commuter Rail** – This alternative, serving four stations in Nashua and Manchester at a moderate-to-high frequency, would have the greatest benefit. It has the potential to generate more than 3,600 new residential units and nearly two million square feet of commercial space supporting 5,600+ new jobs by the year 2030.
- **Nashua Minimum Commuter Rail** – This alternative, serving one station in Nashua at moderate-to-high frequency, could potentially generate about 1,100 new residential units and 930,000 square feet of commercial space supporting 2,500 new jobs by the year 2030.
- **Intercity 8** – With four trains per day serving Nashua, Manchester, and Concord, this alternative could potentially generate about 1,600 new residential units and 819,000 square feet of commercial space supporting 2,500 new jobs by the year 2030. While the same number of stations would be served for Manchester Regional Commuter Rail, impacts per station would be somewhat lower due to the lower service frequency.
- **Bus Alternatives** – Capital improvements associated with the bus alternatives range from additional buses to operate increased levels of service, to roadway improvements that would help buses bypass congestion by operating on the shoulder along I-93 south of I-495. These alternatives differ from the three rail alternatives above in that they will not include new stations around which Transit-Oriented Development (TOD) might occur. For this reason, and notwithstanding other benefits associated with bus improvements such as reductions in travel times, the kinds of economic development benefits documented in this assessment are not expected to occur for the bus alternatives. This is supported by the literature and was the consensus opinion of the stakeholders interviewed.

The Study team used this data to measure development potential at the individual stations. The analysis shows that the commuter rail alternatives consistently perform better from both a jobs and development perspective. The Concord location could potentially generate the highest square feet of commercial space in either scenario; the downtown Manchester location could potentially generate the greatest number of residential units; and the Nashua Spit Brook Road location has the potential to support the greatest number of jobs. See the summary in Tables 2.2 and 2.3.

Table 2.2: Commuter Rail Development Potential in Each Station Area

Alternative	Commercial (Sq. Ft.)	Residential (Units)	Jobs
Manchester – Bridge St.	587,000	1,410	2,040
Manchester – Granite St.*	567,000	1,360	1,970
Bedford – MHT*	245,000	0	720
Nashua – Crown St.*	155,000	1,110	410
Nashua – Spit Brook Rd.*	930,000	1,120	2,480
Nashua – Pheasant Lane Mall	116,000	0	280

**Included in summary totals for Manchester Regional Commuter Rail*

Table 2.3: Intercity Rail Development Potential in Each Station Area

Alternative	Commercial (Sq. Ft.)	Residential (Units)	Jobs
Concord – Stickney Ave.*	335,000	400	890
Manchester – Bridge St.	294,000	710	1,020
Manchester – Granite St.*	284,000	680	980
Bedford – MHT*	123,000	0	360
Nashua – Crown St.*	77,000	560	210
Nashua – Spit Brook Rd.	465,000	560	1,240
Nashua – Pheasant Lane Mall	58,000	0	140

**Included in summary totals for Intercity 8*

The economic modeling tool IMPLAN was used to estimate the broader economic benefits to the southern New Hampshire region of each Capitol Corridor project rail alternative and its associated station area development. For this assessment, the following regional economic benefits were evaluated:

- Short-term benefits as a result of spending on construction of rail improvements in New Hampshire
- Long-term benefits as a result of the attraction of more residents and jobs to southern New Hampshire; these include benefits related to the construction of new real estate in station areas, as well as ongoing benefits from new worker earnings reinvested in the local economy

Benefits of time savings to travelers cannot be directly monetized in this type of economic analysis. However, they are capitalized into land values and, therefore, are indirectly considered through the real estate effects. Benefits of the bus alternatives were not estimated, as these alternatives would involve minimal capital investment and the literature, stakeholder interviews, and the Study team's professional experience suggest that associated development impacts would also be minimal.

The economic modeling provides the following illustrative regional impacts, as summarized in Tables 2.4 and 2.5:

- **Manchester Regional Commuter Rail** – This alternative has moderate construction impacts and the highest development-related impacts. It has the potential to generate 230 new jobs over the construction period (2019-2022), about 3,390 jobs related to new real estate development between 2021 and 2030,[2] and about 1,730 new jobs annually in 2030 and beyond (with benefits beginning to accrue after 2021) due to reinvested worker earnings. Real estate development would add $1.2 billion to the state's output between 2021 and 2030, with reinvested earnings adding $220 million per year beyond 2030.
- **Nashua Minimum Commuter Rail** – This alternative generates the lowest construction and development impacts since only one new station is located in New Hampshire. It has the potential to generate 80 new jobs over the construction period (2019-2022), more than 850 jobs related to new real estate development between 2021 and 2030, and nearly 380 new jobs annually in 2030 and beyond due to reinvested worker earnings. Real estate development would add $260 million to the state's output between 2021 and 2030, with reinvested earnings adding $50 million per year beyond 2030.
- **Intercity 8** – This alternative generates the greatest construction impacts, but lesser development-related impacts compared to the Manchester Regional Commuter Rail alternative because of its lower-service frequency. It has the potential to generate 350 new jobs over the construction period (2019-2022), 2,460 jobs related to new real estate development between 2021 and 2030, and 1,140 new jobs annually in 2030 and beyond (with benefits beginning to accrue after 2021) due to reinvested worker earnings. Real estate development would add $750 million to the state's output between 2021 and 2030, with reinvested earnings adding $140 million per year beyond 2030.

Table 2.4: Impacts on Employment (Jobs) by Alternative

Alternative	Project Construction (2019-2022)	Real Estate Development (2021-2030)	Reinvested New Resident Earnings (Annual, 2030+)
Manchester Regional Commuter Rail	230	3,390	1,730
Nashua Minimum Commuter Rail	80	850	380
Intercity 8	350	2,460	1,140
Bus on Shoulder	0	0	0
No Build	0	0	0

These impacts are in addition to the new jobs located in station areas as shown in Tables 2.2 and 2.3

[2] A new "job" over a multi-year period is really a "job-year," i.e., 3,400 jobs over a 10-year period is equivalent to 340 jobs that each continue for the entire 10-year period

Table 2.5: Impacts on Output (Gross Regional Product) by Alternative (In Millions, 2014$)

Alternative	Project Construction (2019-2022)	Real Estate Development (2021-2030)	Reinvested New Resident Earnings (Annual, 2030+)
Manchester Regional Commuter Rail	$70	$1,200	$220
Nashua Minimum Commuter Rail	$20	$260	$50
Intercity 8	$100	$750	$140
Bus on Shoulder	0	0	0
No Build	0	0	0

2.2 Land Use and Economic Development

Each of the alternatives was also evaluated for its ability to support local land use goals and to catalyze and support economic development activity within station areas.

Generally, the cities of Concord, Manchester, and Nashua have transit-supportive plans and policies. Specifically, three of the potential station locations (downtown Concord, Manchester [both Bridge and Granite Street sites], and Nashua Crown Street) have transit-supportive existing zoning and land use. These policies support further transit growth and TOD around the potential stations. The other three potential stations (Bedford/Manchester Airport/South Suburban Manchester, Nashua South at Spit Brook, and Nashua South at Pheasant Lane Mall) have less transit-supportive existing zoning and land use around each of the potential stations. These areas would more likely be developed as a park-and-ride station and less focused on integrating residential and mixed-use types of developments.

When evaluated at the individual station level, the number of jobs within a half-mile of each potential station is categorized as “low” per the Federal Transit Administration (FTA) breakpoints. However, the FTA evaluates this criterion by looking at the total number of jobs within a half-mile of all the stations on the line (not by individual station); this includes North Station in Boston and all stations on the existing MBTA Lowell Line commuter rail in Massachusetts. When including this data in the project calculation, the total number of jobs served by the Lowell Line and the proposed Capitol Corridor extension results in a “medium” FTA rating for employment served.

Some of the potential station locations are better suited for TOD and supporting growth in transit than others. The four sites in the urban centers (Concord, Manchester [Bridge or Granite Streets], and Nashua Crown Street) are all primed for future transit growth and TOD. Potential stations on the municipalities’ outskirts (Bedford/Manchester Airport/South Suburban Manchester, Nashua South at Spit Brook, and Nashua South at Pheasant Lane Mall) all lack strong existing zoning and plans/policies that support their future growth as transit hubs. However, they would be good locations for park-and-ride stations, which are intended as their primary function.

2.2.1 *Sustainable Land Use*

A sustainable transportation system is one that meets and balances the existing environmental, social, and economic needs of a community without compromising resources for future generations. Each alternative was evaluated for its ability to meet land use goals in these three categories.

- Environmental goals:
  - Catalyze more compact, infill transit-supportive land use and development patterns, thereby reducing the need for additional infrastructure (sewer, water, power) to support new development and supporting maintenance of existing open/rural space
  - Reduce reliance on cars for trips/errands
- Social goals:
  - Expand mobility and transportation choice for all age cohorts
  - Support low-income households through increased access to jobs
- Economic goals: Alternatives that create more opportunities for people to move efficiently from place-to-place and open up more connections to transportation serve to increase access and mobility. Access and mobility also affect the economies of the places served by transportation at local and regional levels:
  - Attract employers to New Hampshire
  - Attract and retain regional employers to New Hampshire and Boston
  - Provide improved residency location choice in New Hampshire for commuters to Boston or regional jobs

Table 2.6 presents the composite assessments for each of the three categories of sustainable land use goals by alternative.

Table 2.6: Summary of Goals by Alternative

	Alternative						
	Base	**Expanded Base**	**Bus on Shoulder**	**Expanded Bus on Shoulder**	**Manchester Regional Commuter Rail**	**Nashua Minimum Commuter Rail**	**Intercity 8**
Environmental Goals	no change	low	low	low	medium	low	low/ medium
Social Goals	no change	low	low	low	low/medium	low	low/ medium
Economic Goals	no change	medium	low	medium	medium	low	medium
Summary Assessment	**no change**	**low**	**low**	**low/medium**	**medium**	**low**	**medium**

2.3 Equity Impacts

Equitable access to transit investments – and the mobility benefits that these investments confer on riders – is an important consideration when assessing the alternatives. Public transit investment supports broad improvements in mobility, but is a particularly critical tool in increasing the mobility of transit-reliant or -dependent populations, including households below the poverty line, minorities, and households in affordable housing units.

U.S. Census data was used to calculate statistics related to income, race, and housing for households and individuals in Census Tracts within a half-mile of the Capitol Corridor alternatives (PAR right-of-way between the state lines of New Hampshire and Massachusetts and the potential rail station location in Concord, New Hampshire; BX bus route between the state lines of New Hampshire and Massachusetts and the existing Manchester, New Hampshire BX station; the Concord Coach bus route between the state lines of New Hampshire and Massachusetts; and the existing Concord, New Hampshire Concord Coach station). This data was also collected for New Hampshire and Massachusetts, and the U.S. comparison between the alternatives within the larger geographic context will support the analysis of which alternatives minimize potential adverse impacts on concentrations of households below the poverty line, minority populations, and households in affordable housing units, while supporting equitable transit access by these populations.

The three populations considered as part of this equity analysis – population below the poverty line, minority populations, and households living in affordable housing units – tend to be concentrated in the central areas of Concord, Manchester, and Nashua. When compared to the base and bus alternatives, the rail alternatives offer comparatively higher levels of service and transit access to these populations with minimal adverse impacts anticipated. The equity of and access to the rail alternatives improve as transit service extends north from Nashua (to Manchester and/or Concord) because those alternatives (Manchester Regional Commuter Rail and Intercity 8) reach more individuals and households living below the poverty line, minority households, and households living in affordable housing units. The base and all bus alternatives would not adversely impact these populations either, but also would not offer expanded access to these populations through new station locations.

Table 2.7 provides a summary of the equity metrics for each existing bus station and proposed rail station.

Table 2.7: Summary of Alternatives

Station Area (Half-Mile Buffer)	Proposed Rail Station	Existing Bus Station	Equity Metrics				Stations Served by Alternative(s)			
			Average Median Income	Population Below Poverty	Minority Population	Affordable Housing Units	Base and All Bus Alternatives	Intercity 8	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail
Concord, NH	X	X	$39,000	18.0%	9.7%	398	X	X		
Manchester, NH	X	X	$30,300	29.5%	26.1%	675	X	X	X	
Bedford/MHT	X		$65,500	4.5%	5.2%	0		X	X	
N. Londonderry, NH		X	$82,900	1.7%	4.7%	minimal	X			
Londonderry, NH		X	$84,700	3.9%	5.2%	minimal	X			
Nashua, NH		X	$80,500	4.4%	12.9%	minimal	X			
Nashua, NH: Crown St.	X		$52,500	14.9%	12.2%	28		X	X	
South Nashua, NH: Spit Brook Rd. or Pheasant Lane Mall	X		$76,900	4.8%	11.3%	0			X	X
Salem, NH		X	$75,300	3.7%	5.9%	minimal	X			

Sources: U.S. Census, American Community Survey 2008-2012; various local New Hampshire Housing Authorities

2.4 Capital and O&M Costs

2.4.1 Capital Costs

Summary of Estimated Rail Costs

Estimated capital costs for each final rail service option are summarized below and in Table 2.8.

Table 2.8: Summary of Project Capital Costs (In Millions, 2014$)

	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail	Intercity 8
Main Line Tracks	$29.7	$15.3	$42.1
Track Switches	$6.4	$2.8	$7.8
Interlockings	$10.6	$5.1	$12.0
Block Signals	$1.0	$0.4	$1.2
Grade Crossing Signals	$5.0	$1.4	$8.3
Grade Crossing Track Renewals	$3.3	$0.8	$5.6
Bridges	$10.7	$2.1	$15.4
Stations	$20.8	$6.3	$18.7
Layovers	$12.4	$13.4	$4.8
Right-of-Way Improvements	$6.2	$2.9	$8.8
Positive Train Control	$6.5	$2.9	$9.5
Railroad Appliances	$0.5	$0.1	$1.0
Direct Construction Expense Subtotal	**$113.3**	**$53.7**	**$135.2**
Multipliers for Allowances	$20.4	$9.7	$24.3
Railroad Services	$4.5	$2.1	$5.7
Land for Stations	$1.2	$0.3	$0.9
Land for Layovers	$0.6	$2.1	$1.4
Assemblage Allowance (220%)	$4.0	$5.3	$5.2
Subtotal Land	**$5.9**	**$7.8**	**$7.5**
Contingency	$50.0	$25.6	$60.5
Grand Total (infrastructure)	**$194.5**	**$98.9**	**$233.2**
Coaches	$27.8	$15.2	$12.7
Locomotives	$5.3	$5.3	$10.6
Grand Total (rolling stock)	**$33.2**	**$20.5**	**$23.3**
Trackage Rights	**$18.0**	**$0.9**	**$0.0**
Total Project Value	**$245.6**	**$120.3**	**$256.5**

- **Manchester Regional Commuter Rail** is projected to cost $143 million for infrastructure and land plus $50 million contingency allowance. This option cost also includes $33 million in rolling stock and $18 million in trackage rights that would be contributed by the Commonwealth of Massachusetts.
- **Nashua Minimum Commuter Rail** is projected to cost $73 million for infrastructure and land plus $26 million contingency allowance. This option cost also includes $20 million in rolling stock that would be contributed by the Commonwealth of Massachusetts. The value of the Massachusetts trackage rights for this option is $0.95 million as it would use roughly one mile of PAR right-of-way in New Hampshire to access a station and/or a layover facility at the Spit Brook Road site.
- **Intercity 8** is projected to cost $172 million for infrastructure and land plus a $60 million contingency allowance. This option cost also includes $23 million in rolling stock that would be the responsibility of NHDOT. This option would be operated by Amtrak (although no decision on an operator has been made); therefore, the value of Massachusetts acquired trackage rights would be zero since Amtrak has statutory authority to operate without acquiring trackage rights from PAR.

2.4.2 Summary of Estimated Bus Costs

Final estimates of capital costs for the bus options revolved around the same two factors applied to derive preliminary estimates: additional buses required to operate more frequent service and roadway upgrades required to allow for Bus on Shoulder operations providing faster peak service for some options.

As noted for the preliminary options, some bus service improvement options entailed increasing the frequency of bus service. These services would require additional rolling stock to operate. The Study team estimated the required number of additional buses by consulting with NHDOT and BX to determine the size and utilization of the current BX fleet. Study team analysis indicated that amending the current schedule of peak service to operate direct, non-stop, half-hourly peak service from all six park-and-ride lots currently served by BX would require an addition of 16 buses to BX's current fleet of 22 vehicles as shown in Table 2.9.

Table 2.9: BX Vehicle Requirements by Service Option

	Base	Expanded Base	Bus on Shoulder	Expanded Bus on Shoulder
Vehicles to Operate Minimum Service (VOMS)	16	30	16	30
Fleet	22	38	22	38
Spares	6	8	6	8
% Spare	27%	21%	27%	21%

A preliminary estimate of $400,000 was included for new vehicles, but NHDOT informed the Study team that new vehicles would be expected to cost $600,000 each. Study team work on existing highway conditions found sufficient shoulder width for the 22 affected route miles between I-495 and Somerville, Massachusetts along I-93 to allow Bus on Shoulder operations without substantial investment in new right-of-way. A preliminary estimate of $100,000 per route mile[3] had been used based on early experience in Minnesota. For the final estimate, a more recent figure of $250,000 per route mile[4] was employed. Consistent with FTA guidance, a 35 percent contingency was applied to projected infrastructure costs (see Table 2.10).

Table 2.10: Final Capital Cost Estimates for Bus Options (In Millions, 2014$)

	Base	Expanded Base	Bus on Shoulder	Expanded Bus on Shoulder
Vehicles Cost *	$0.0	$9.6	$0.0	$9.6
Infrastructure Cost **	$0.0	$0.0	$7.4	$7.4
Total Capital Cost	**$0.0**	**$9.6**	**$7.4**	**$17.0**

** New coaches at $600,000 each*
*** Infrastructure cost of $250,000 per route mile plus a 35% contingency allowance*

2.4.3 Final Estimates of Capital Costs

In summary, the final estimates of capital cost for each of the final rail and bus service options are found in Table 2.11.

Table 2.11: Final Estimates of Capital Cost (In Millions, 2014$)

Service Option	Infrastructure, Land and Contingency	Rolling Stock	Massachusetts Department of Transportation (MassDOT) Trackage Rights	Total
Commuter Rail Options				
Manchester Regional	$194.5	$33.2	$18.0	$245.6
Nashua Minimum	$98.9	$20.5	$0.0	$120.3
Intercity Rail Option				
Intercity 8	$233.2	$23.3	$0.0	$256.5
Bus Service Options				
Base	$0.0	$0.0	$0.0	$0.0
Expanded Base	$0.0	$9.6	$0.0	$9.6
Bus on Shoulder	$7.4	$0.0	$0.0	$7.4
Expanded Bus on Shoulder	$7.4	$9.6	$0.0	$17.0

[3] *TCRP Synthesis 64 Bus Use of Shoulders,* Peter C. Martin, Wilbur Smith Associates, San Francisco, CA, 2006, pg 20
[4] *TCRP Report 151 A Guide for Implementing Bus On Shoulder Systems*, Peter Martin and Herbert S. Levinson, Texas Transportation Institute, 2012, pg 2-5

2.4.4 O&M Costs

Refined O&M cost estimates were prepared for more detailed final analysis of the two commuter rail, one intercity rail, and three bus options that advanced through preliminary screening: Manchester Regional Commuter Rail, Nashua Minimum Commuter Rail, Intercity 8, Expanded Base, Bus on Shoulder, and Expanded Bus on Shoulder.

2.4.5 Commuter Rail – Manchester Regional and Nashua Minimum

The Study team revisited the operating conditions for each of the three remaining rail options in meetings with PAR, MassDOT, MBTA, and NHDOT and was able to refine the service characteristics based on their feedback. The O&M costs evolved over the course of the Study's preliminary stages, but did not change significantly. The total number of weekday vehicle miles and weekday revenue miles changed slightly as options were refined. Two additional elements where changes were applied are in the calculation of unit costs and fare revenue. The operating cost data for the commuter rail options were updated to 2012 National Transit Database (NTD) figures from the 2009 NTD values. These values were used to describe each service option to estimate O&M cost drivers for each commuter rail option: train miles, rolling stock fleet size (locomotives and coaches), and track miles.

2.4.6 Intercity Rail

The Intercity 8 service option that advanced through preliminary screening was developed to the same level of detail as the commuter rail service options, including estimates of daily train miles, rolling stock requirements, track miles required, number and location of stations, and schedules of service.

The most recent data on the *Downeaster* service indicated that it costs roughly $36 per train mile to operate. This metric is roughly equivalent to the costs applied for Midwestern and New York/Vermont services reviewed in the studies recommended by Amtrak. Using the simple cost of $36 per train mile, the preliminary estimates of operating cost were derived for the three intercity service options.

2.4.7 Commuter Bus

Weekday service schedules developed for each of the three commuter bus options did not change after the preliminary screening. The estimates of vehicle requirements and revenue miles, however, did change slightly as the options were refined.

2.4.8 Summary of Final Estimates of Annual O&M Costs

In summary, the preliminary estimates of annual O&M costs for the rail and bus service options are found in Table 2.12.

Table 2.12: Final Estimates of Annual O&M Costs (In Millions, 2012$)

Service Option	Total
Commuter Rail Options	
Manchester Regional	$11
Nashua Minimum	$4
Intercity Rail Options	
Intercity 8	$8
Bus Service Options	
Expanded Base	$3
Bus on Shoulder	$0
Expanded Bus on Shoulder	$3

2.5 Ridership

Opening day forecasts on the Manchester Regional and Nashua Minimum Commuter Rail alternatives are presented below in Tables 2.13 and 2.14. The model results are presented with a forecast value and an upper and lower bound that are the 95 percent confidence interval around the forecast value. It is important to note that, as with all forecasts, the predictions are not a single value but are a range of possible values.

Table 2.13: Manchester Regional Daily Boarding Estimates

Station	Forecast	Lower Bound	Upper Bound
Manchester	270	180	390
Bedford/MHT	280	230	350
Nashua	420	330	540
South Nashua	590	440	800
TOTAL	**1,560**	**1,180**	**2,090**

Table 2.14: Nashua Minimum Daily Boarding Estimates

Feeder Bus Weight	Forecast	Lower Bound	Upper Bound
South Nashua	590	450	770

The estimated model predicts the daily boards (Table 2.15) for each proposed station. These boards represent one-half of a daily round trip. To convert these boarding data to daily ridership a factor of two is applied to account for the second half of the round trip.

Table 2.15: Daily Ridership Estimates

Alternative	Ridership	Lower Bound	Upper Bound
Manchester Regional Commuter Rail	3,130	2,350	4,170
Nashua Minimum Commuter Rail	1,170	890	1,540

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Appendix A
Economic Development Assessment

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Executive Summary

Building upon the land use and economic development analyses prepared for the New Hampshire Capitol Corridor Alternatives Analysis (AA) Transit Study, Cambridge Systematics has conducted an economic development assessment aimed at estimating the potential benefits associated with the set of final build alternatives in the corridor. The assessment examines two types of economic benefit. First is the amount of new development that might occur around new station areas. Second is the impact of this new development plus the investment in new or upgraded transit infrastructure measured in terms of employment and economic output in the Capitol Corridor region. This assessment does not attempt to capture every type of economic benefit that might be realized from implementation of the alternatives; rather it focuses on these two key benefits measures to help identify differences among the alternatives. As a consequence, this assessment estimates benefits associated with the three rail alternatives, all of which provide new permanent infrastructure such as stations. In contrast, none of the bus alternatives involve new stations, and are therefore not expected to generate the development-based economic benefits measured in this assessment.

1.1 Economic Benefits of Transit Investment

The Study team examined the literature and findings from recent studies of similar regional transit enhancement projects. Numerous studies have identified a net positive benefit of fixed-guideway transit investment to the regional economy, as a result of travel time savings and congestion reduction, expanded access to jobs and workforce, and new development attracted to station areas. Studies have also found a positive impact of transit on property values in station areas. While only a few studies have specifically examined commuter rail, evidence from other rail system expansions in the greater Boston region similarly suggests that transit investment will have a positive effect on the communities it serves. There are very few studies of the economic impacts of bus enhancement projects, and none which suggest that the kinds of enhancements contemplated in the Capitol Corridor would help catalyze new, more intense development.

1.2 Station Area Economic Development

The Study team conducted interviews with local stakeholders to gather information on the impact the different transit alternatives could have in bringing about new development over the next 20 years. Based on the expressed opinions of the set of stakeholders interviewed, there was general consensus that commuter rail service to Boston is important for the future development of southern New Hampshire. While some high tech, residential and institutional development is currently occurring near several of the stations, respondents felt that this development would be difficult to maintain or boost (particularly in the case of high tech) without rail enhancements to attract the type of workers necessary to facilitate growth, namely a younger demographic looking for urban to semi-urban living with walkable amenities.

The Study team also assembled data on land use and zoning to evaluate the potential impact of the project alternatives on development and redevelopment. This potential was measured in terms of commercial square footage (office and retail) and housing units for the different alternatives. The Study team estimated the following illustrative impacts, as summarized in Table ES-1:

- **Manchester Regional Commuter Rail** – This alternative, serving four stations in Nashua and Manchester at a moderate to high frequency, would have the greatest benefit. It has the potential to generate over 3,600 new residential units and nearly 2 million square feet of commercial space supporting over 5,600 new jobs by the year 2030.
- **Nashua Minimum Commuter Rail** – This alternative, serving one station in Nashua at moderate to high frequency, could potentially generate about 1,100 new residential units and 930,000 square feet of commercial space supporting 2,500 new jobs by the year 2030.
- **Intercity 8** – This alternative, with four trains per day serving Nashua, Manchester, and Concord, could potentially generate about 1,600 new residential units and over 800,000 square feet of commercial space supporting 2,500 new jobs by the year 2030. While the same number of stations would be served as for the Manchester Regional Commuter Rail, impacts per station would be somewhat lower due to the lower service frequency.
- **Bus Alternatives** – Capital improvements associated with the bus alternatives range from additional buses to operate increased levels of service, to roadway improvements that would help buses bypass congestion by operating on the shoulder along I-93 south of I-495. These alternatives differ from the three rail alternatives above, in that they will not include new stations around which transit oriented development might occur. For this reason, and notwithstanding other benefits associated with bus improvements such as reductions in travel times, the kinds of economic development benefits documented in this assessment are not expected to occur for the bus alternatives. This is supported both by the literature and was the consensus opinion of the stakeholders interviewed.

Table ES.1: Total Station Area Development Potential by Alternative

Alternative	Commercial (Square Feet)	Residential (Units)	Jobs
Manchester Regional Commuter Rail	1,898,000	3,600	5,600
Nashua Minimum Commuter Rail	930,000	1,100	2,500
Intercity 8	819,000	1,600	2,500
Intercity Bus	0	0	0
No Build	0	0	0

Note: residential units and jobs rounded to the nearest hundred

The Study team used these data to measure potential at the individual stations. The analysis shows that the commuter rail alternatives consistently perform better from both a jobs and development perspective. The Concord location could potentially generate the highest square feet of commercial space in either scenario, either downtown Manchester location could potentially generate the greatest

number of residential units in either scenario, and the Nashua Spit Brook Road location had the potential to support the greatest number of jobs. See summary in Tables ES.2 and ES.3.

Table ES.2: Summary – Commuter Rail Development Potential in Each Station Area

Alternative	Commercial (Square Feet)	Residential (Units)	Jobs
Manchester – Bridge Street	587,000	1,410	2,040
Manchester – Granite Street*	567,000	1,360	1,970
Bedford – Manchester-Boston Regional Airport (Bedford – MHT)*	245,000	0	720
Nashua – Crown Street*	155,000	1,110	410
Nashua – Spit Brook Road*	930,000	1,120	2,480
Nashua – Pheasant Lane Mall	116,000	0	280

**Included in summary totals for Manchester Regional Commuter Rail alternative*

Table ES.3: Summary – Intercity 8 Development Potential in Each Station Area

Alternative	Commercial (Square Feet)	Residential (Units)	Jobs
Concord – Stickney Avenue*	335,000	400	890
Manchester – Bridge Street	294,000	710	1,020
Manchester – Granite Street*	284,000	680	980
Bedford – MHT*	123,000	0	360
Nashua – Crown Street*	77,000	560	210
Nashua – Spit Brook Road	465,000	560	1,240
Nashua – Pheasant Lane Mall	58,000	0	140

**Included in summary totals for Intercity 8 alternative*

1.3 Regional Economic Benefits

The economic modeling tool IMPLAN was used to estimate the broader economic benefits to the southern New Hampshire region of each Capitol Corridor project rail alternative and its associated station area development. IMPLAN is a widely accepted and utilized model that shows how an investment made in particular sectors of the economy – in this case public transportation and station area development – then flow through and benefit other sectors, for a total estimate of economic activity generated by that original investment. For this assessment, the following regional economic benefits were evaluated:

- Short-term benefits as a result of spending on construction of rail improvements in New Hampshire
- Long-term benefits as a result of the attraction of more residents and jobs to southern New Hampshire; these include benefits related to the construction of new real estate in station areas, as well as ongoing benefits from new worker earnings reinvested in the local economy

Benefits of time savings to travelers cannot be directly monetized in this type of economic analysis. However, they are capitalized into land values, and therefore are indirectly considered through the real estate effects. Benefits of the bus alternatives were not estimated, as these alternatives would involve minimal capital investment, and the literature, stakeholder interviews, and the Study team's professional experience suggest that associated development impacts would also be minimal.

The economic modeling provides the following illustrative regional impacts, as summarized in Tables ES.4 and ES.5:

- **Manchester Regional Commuter Rail** – This alternative has moderate construction impacts and the highest development-related impacts. It has the potential to generate 230 new jobs over the construction period (2019-2022), about 3,390 jobs related to new real estate development between 2021 and 2030;[1] and about 1,730 new jobs annually in 2030 and beyond (with benefits beginning to accrue after 2021) due to reinvested worker earnings. Real estate development would add $1.2 billion to the state's output between 2021 and 2030, with reinvested earnings adding $220 million per year beyond 2030.
- **Nashua Minimum Commuter Rail** – This alternative generates the lowest construction and development impacts since only one new station is located in New Hampshire. It has the potential to generate 80 new jobs over the construction period (2019-2022), over 850 jobs related to new real estate development between 2021 and 2030; and nearly 380 new jobs annually in 2030 and beyond due to reinvested worker earnings. Real estate development would add $260 million to the state's output between 2021 and 2030, with reinvested earnings adding $50 million per year beyond 2030.
- **Intercity 8** – This alternative generates the greatest construction impacts but lesser development-related impacts compared to the Manchester Regional Commuter Rail alternative, because of its lower service frequency. It has the potential to generate 350 new jobs over the construction period (2019-2022), 2,460 jobs related to new real estate development between 2021 and 2030; and 1,140 new jobs annually in 2030 and beyond (with benefits beginning to accrue after 2021) due to reinvested worker earnings. Real estate development would add $750 million to the state's output between 2021 and 2030, with reinvested earnings adding $140 million per year beyond 2030.

Table ES.6 shows the impacts on state and local tax revenues by alternative. Project construction would add up to $2.1 million, real estate development up to $43 million over the 2021-2030 timeframe, and reinvested worker earnings up to $13 million annually in 2030 and beyond.

[1] A new "job" over a multi-year period is really a "job-year", i.e., 3,400 jobs over a 10-year period is equivalent to 340 jobs that each continue for the entire 10-year period

Table ES.4: Impacts on Employment (Jobs) by Alternative*

Alternative	Project Construction (2019-2022)	Real Estate Development (2021-2030)	Reinvested New Resident Earnings (Annual, 2030+)
Manchester Regional Commuter Rail	230	3,390	1,730
Nashua Minimum Commuter Rail	80	850	380
Intercity 8	350	2,460	1,140
Intercity Bus	0	0	0
No Build	0	0	0

**These impacts are in addition to the new jobs located in station areas as shown in Table ES-1.*

Table ES.5: Impacts on Output (Gross Regional Product) by Alternative (In Millions, 2014$)

Alternative	Project Construction (2019-2022)	Real Estate Development (2021-2030)	Reinvested New Resident Earnings (Annual, 2030+)
Manchester Regional Commuter Rail	$70	$1,200	$220
Nashua Minimum Commuter Rail	$20	$260	$50
Intercity 8	$100	$750	$140
Intercity Bus	0	0	0
No Build	0	0	0

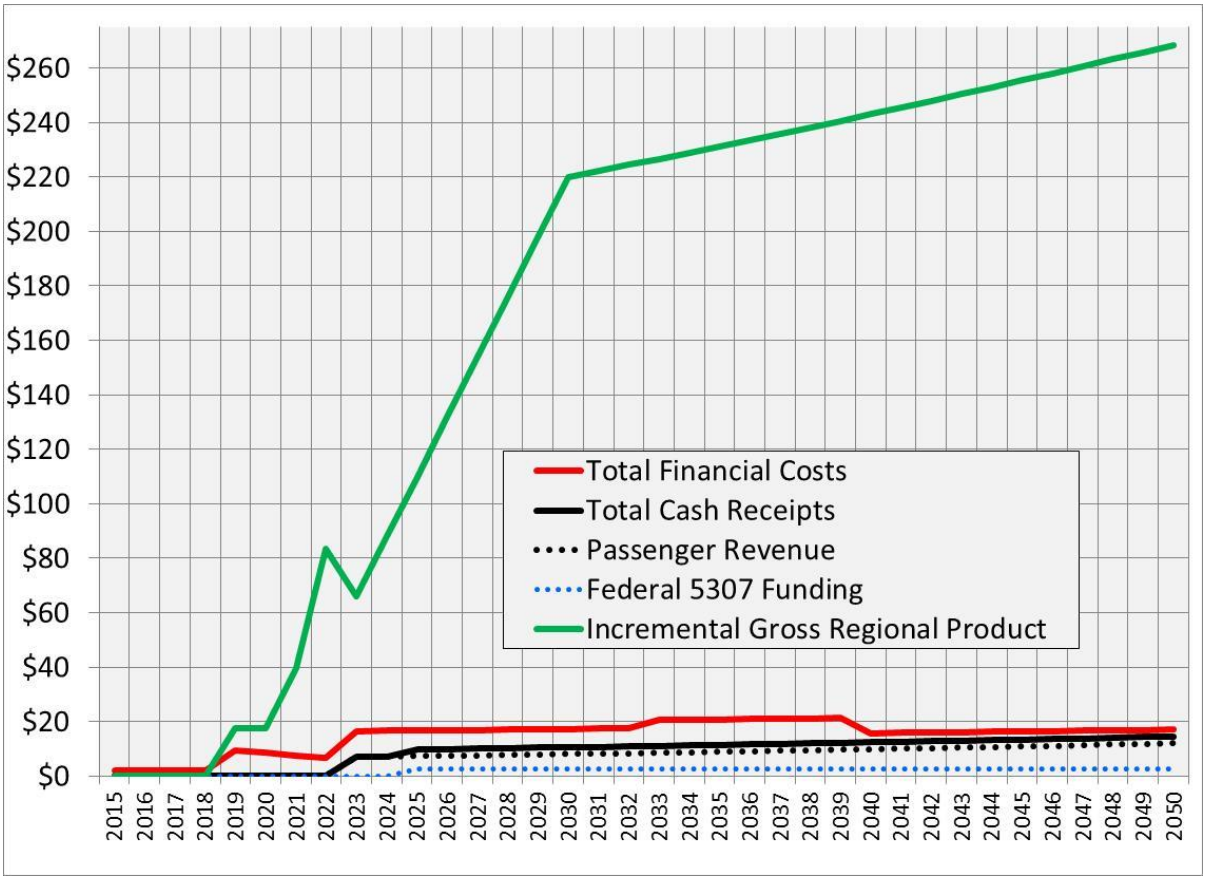
Table ES.6: Impacts on State and Local Tax Receipts by Alternative (In Millions, 2014$)

Alternative	Project Construction (2019-2022)	Real Estate Development (2021-2030)	Reinvested New Resident Earnings (Annual, 2030+)
Manchester Regional Commuter Rail	$1.3	$43.3	$13.1
Nashua Minimum Commuter Rail	$0.5	$9.3	$2.9
Intercity 8	$2.1	$27.1	$8.7
Intercity Bus	0	0	0
No Build	0	0	0

1.4 Time Line of Costs, Revenues, and Economic Benefits

The Study team integrated the forecast stream of economic benefits with the forecast streams of costs and revenues to derive a timeline of costs, revenues, and economic benefits forecast to result from a state investment in the Manchester Regional Commuter Rail alternative. Figure ES.1 shows a 35-year time horizon with forecast annual costs, cash receipts, and economic benefits for each future year**. All costs, revenues, and benefits are shown in 2014 dollars.**

Figure ES.1: Forecast Annual Costs, Revenues, and Economic Benefits



With an allowance for capital renewal, the forecast cash receipts (fare revenue and federal formula funds) over the next 35 years approach, but do not fully cover, the annual financial costs for engineering, debt retirement, operating costs, and asset renewal. However, forecast economic benefits in terms of employee wages, business earnings, and tax receipts clearly exceed the annual financial costs of the service. While the forecast economic benefits are estimates, if only half that forecast growth in regional economic activity is achieved, the benefits would still outweigh the net financial liabilities by a large margin.

It is notable that the forecast regional economic activity grows to include $13 million in annual tax revenue by 2030. If New Hampshire officials can fashion a mechanism to capture a fraction of this new tax revenue to support the rail service, a self-sustaining financial path forward could be achievable.

2 Economic Benefits of Transit Investment

The objective of this task was to document the potential benefits of the New Hampshire Capitol Corridor alternatives. The assessment included both quantitative and qualitative findings of economic benefits resulting from improved transit services. Two types of benefit were evaluated:

- Station area economic development benefits, measured through new development and increased population and employment, which supports community development/ revitalization and the local tax base
- Net regional benefits, including jobs, income, and regional product, resulting from increased population and workforce in southern New Hampshire, traveler benefits, and the short-term benefits from constructing the project

Given that this assessment was focused primarily on new development that could be spurred by construction of new transit facilities such as stations, the kinds of economic benefits estimated will not be expected to occur for the three bus alternatives. Capital improvements associated with those alternatives range from additional buses to operate increased levels of service, to roadway improvements that would help buses bypass congestion by operating on the shoulder along I-93 south of I-495. In other words, the bus alternatives differ from the three rail alternatives, in that they will not include new stations around which Transit-Oriented Development (TOD) might occur. For this reason, and notwithstanding other benefits associated with bus improvements such as reductions in travel times, the kinds of economic development benefits documented in this assessment are not expected to occur for the bus alternatives. This is supported by the literature and was the consensus opinion of the stakeholders interviewed.

Furthermore, while the focus of this assessment was on new benefits directly related to transit enhancements, it is worth noting that the relocation of economic activity can also lead to net benefits. For instance, the relocation of businesses and jobs into more compact, TOD patterns may increase transportation efficiencies while decreasing the social and environmental costs of sprawling development patterns. These types of indirect benefits are more difficult to quantify and beyond the scope of this assessment, but are nonetheless important to consider.

The remainder of this section provides a qualitative overview of the various ways in which a transit investment in the Capitol Corridor is expected to benefit the local and regional economy. Section 2.0 describes a quantitative estimate of local (station area) development impacts. Section 4.0 describes a quantitative estimate of the net regional benefits developed using the IMPLAN economic model.

2.1 Regional Economic Benefits

Transit investments can add regional value in the following ways:

- By reducing time and cost for roadway and transit travelers, as well as freight traffic through reduced traffic congestion; these time and cost savings may result in business cost savings and productivity improvements
- By attracting new businesses or residents to the region, or encouraging existing businesses to expand, because of improved transportation infrastructure

These benefits can lead to increases in jobs, regional product, and personal income. According to a recent Transit Cooperative Research Program (TCRP) publication, nearly 15,900 jobs are supported for a year for each billion dollars of spending on public transportation *capital,* and over 24,200 jobs are supported for a year for each billion dollars of annual spending on public transportation *operations*.[2]

The benefits of transportation improvements can also be reflected in higher property values, which add to the local tax base.

Several research efforts have estimated the benefits of transit investment in different cities. For example, a 2012 study developed by Cambridge Systematics for the Itasca Project in the Twin Cities region[3] found that build-out of a regional transit network through year 2030 would yield the following:

- A 25 percent increase in access to workforce within a 30-minute travel time
- Direct benefits of $6.6 to $13.9 billion accruing over the 2030-2045 period (including travel time savings, vehicle operating cost savings, and other benefits)
- Over 30,000 full-time equivalent jobs and $4.3 billion in gross regional product (GRP) from construction
- Indirect benefits of an additional 3,500 to 8,495 jobs by 2045 and expansion of the regional economy up to $1.4 billion

A 2005 study for Envision Utah[4] of transit improvements in the Salt Lake City region estimated annual direct benefits to users of $220 million, an increase in employment of 1,400 jobs, an increase in net personal income of $105 million, and an increase in GRP of $140 million from efficiency gains for business travel.

[2] Economic Impact of Public Transportation Investment, EDRG, Inc., 2014. Includes all modes of public transportation, including bus and rail, but does not differentiate benefits among them. Benefits are estimated in terms of direct spending (i.e., capital and operations and maintenance [O&M] costs), but also in terms of travel time and access improvements and economic impacts, such as increases in property values.

[3] *Regional Transit System Return on Investment Assessment*. Itasca Project, 2012

[4] Economic Impacts of Expanding Public Transportation in the Wasatch Front Region. Envision Utah Project, 2005

A 1995 light rail study conducted by the Greater Hartford Transit District[5] found that transit investment could create as many as 2,246 jobs and $34.3 million change in real GRP by 2030.

A 1998 study of light trail transit investment in Rochester, New York[6] estimated that the project would add nearly $54 million to GRP during construction, up to $7 million annually to GRP over life of the project, and create 111 permanent jobs by 2025 with an annual personal income of $9.9 million, not including O&M jobs required by light rail transit.

2.2 Station Area Development Benefits

2.2.1 Property Values

A considerable amount of research and literature across the U.S. has examined the impacts of transit systems on property values for both residential and commercial development. Numerous studies have found a positive link between rail transit and property values. The evidence for commuter rail systems is more limited, but also positive. While U.S. bus rapid transit (BRT) systems, which share characteristics with fixed guideway systems such as dedicated rights-of-way, stations with passenger amenities, level boarding, and frequent service, are showing impacts to development and property values, there are no studies providing similar evidence for standard bus service.

Studies quantifying property value increases in the Boston area found the following conclusions:

- Armstrong (1994) found an increase in single-family residential property values of approximately 6.7 percent by virtue of being located within a community having a commuter rail station. At the regional level there appears to be a significant impact on single-family residential property values resulting from the accessibility provided by commuter rail service.[7]
- Where commuter rail service was restored since 1994 in Brockton, Newburyport, and Worcester, real estate values climbed faster than state and county averages by most measures, in some cases much faster.[8]

Studies in other areas have found similar benefits. Here are some examples:

- In the New York region, Cambridge Systematics performed an analysis of the overall property value benefit of a commuter rail system to the counties served by the system. The analysis found that between seven and 15 percent of the value of a home may be due to proximity to rail stations.

[5] *Griffin Line Major Investment Study Economic Impact Analysis*, 1995
[6] *Rochester LRT Economic Development Feasibility Study*, Wilbur Smith Associates with BRW, Erdman Anthony, and Fisher Associates, 1998
[7] Armstrong, Robert J., "Impacts of Commuter Rail Service as Reflected in Single-Family Residential Property Values," Transportation Research Record, 1466 (1994): 88-97
[8] Howe, Peter J. "New rail service to Hub called economic boon: Three cities point to rise in real estate values." *Boston Globe*, February 17, 2008

- A study of the Coaster commuter rail line in San Diego found a residential premium of 17 percent for properties within one-half mile of stations.[9]
- A 1997 study by Gruen Gruen + Associates found that proximity to Chicago Transit Authority heavy rail and Metra commuter rail stations positively affects the value of single family homes, with the price of a single-family house located 1,000 feet from a station averaging 20 percent higher than a comparable house located a mile away.

2.2.2 New Development

Several studies have demonstrated that under the right circumstances, rail transit stations can serve as a catalyst or focal point for growth. Here are some examples:

- A 2006 study by the Kennedy School of Government at Harvard University on the impacts of commuter rail in Massachusetts concluded that commuter rail is most likely to impact land use patterns when it is explicitly and clearly linked to local and regional policies for land use and development.
- Opening of the Massachusetts Bay Transportation Agency's (MBTA's) Greenbush line has supported new residential and mixed-use developments in Kingston, Scituate, and Weymouth.[10]
- The California Intercity High Speed Rail Commission projected land value increases between 0 and 20 percent, and between $1.7 and $2.0 billion of development attributable to high speed rail (HSR). The study also found that land within 1,000 feet of HSR alignment, but outside of station radius would remain stable or decrease slightly depending on future conditions.[11]
- Transit-oriented planning and rezoning, in conjunction with related development activities and anticipation of new LRT service, has helped spur 46 new development projects in Charlotte's South Corridor LRT station areas.
- In Washington, D.C., the Metrorail system generated more than $15 billion in development through the year 2000. At least 52 joint development projects with a market value of $4 billion were constructed around Metrorail stations, generating an estimated 50,000 new transit riders and over 25,000 jobs.

2.2.3 Transit Supportive Factors

Numerous studies have concluded that these types of successful development outcomes in transit station areas, with associated gains in ridership and economic benefits, require the presence of other supportive factors. These factors are summarized in a report for the TCRP (Cervero et al, 2004):

[9] Cervero, R., and M. Duncan. "Effects of Light and Commuter Rail Transit on Land Prices Experiences in San Diego." National Association of Realtors and Urban Land Institute, 2002

[10] Robert Preer, "Now arriving: Development spurred by Greenbush line South Shore towns rezone land to concentrate building near new stations," Boston Globe, April 16, 2006; and "Family-Friendly Housing." Editorial, *Boston Globe*, April 25, 2007

[11] Economic Impact and Benefit/Cost of High Speed Rail for California, Economic Research Associates, 1996

- Local comprehensive plans and zoning ordinances must promote development with transit-supportive characteristics, including higher-density, mixed-use, and pedestrian-oriented development.
- Public assistance with land assembly, contaminated site cleanup, infrastructure finance, or other factors may sometimes be needed to leverage private investment.
- Timely processing of development permits, and certainty on the types of allowable development, are extremely important.
- Station area planning is another critical activity to address neighborhood concerns about development and create greater certainty for developers.

Many of these type of transit supportive development policies, including higher-density mixed-use zoning, flexible parking requirements, development agreements for expedited permitting, and pedestrian-oriented development are in place for the Concord and downtown Manchester sites, while TOD supportive zoning enhancements are recommended for the Crown Street and Spit Brook Road station sites in Nashua.[12] Combined with a favorable regional economic climate, these factors suggest that the New Hampshire Capitol Corridor could act as an organizing force for new development.

3 Station Area Development Potential

To assess the potential economic benefits of the alternatives, an illustrative analysis was conducted of the station area development potential for the seven proposed station areas. This analysis did not identify quantifiable development or other economic benefits associated with any of the three bus alternatives – Expanded Base, Bus on Shoulder, or Expanded Bus on Shoulder. As explained above, this is because there are no new permanent infrastructure improvements, such as stations, that would be constructed in New Hampshire. While there are other benefits that would be expected as a result of these bus improvement alternatives, such as increased mobility options, improved bus travel time and related increases in ridership, and lowered carbon footprints per passenger mile, neither the literature nor interviews with corridor stakeholders support meaningful increases in economic activity for the final set of bus alternatives as compared to the fixed guideway commuter rail and intercity rail alternatives.

Literature examining benefits of intercity bus and motor coach services generally cites tourism as the primary industry served. For a predominantly intercity commuter service, such as the services that are contemplated in the Capitol Corridor, benefits would be expected to include increased mobility options and out-of-pocket savings for riders, decreased travel times, and lower emissions. However, no studies have specifically addressed economic development benefits of this type of bus service.[13,14,15,16,17] Rather,

[12] Land Use & Economic Development Analysis, Capitol Corridor Rail & Transit Alternatives Analysis (Parts A & B), URS, 2014

[13] However, as noted above, direct bus capital spending will generate economic benefits, commensurate with the level of spending. The majority of those benefits, for example related to bus manufacturing, will accrue to the locations where the manufacturing activities take place.

[14] *The Economic Impacts and Social Benefits of the U.S. Motorcoach Industry*, Nathan and Associates, Inc., December 2008

[15] *Economic and Community Benefits of Local Bus Transit Service*, Michigan Department of Transportation, July 2010

economic benefit studies have been focused on fixed guideway infrastructure that provides permanent stations and other facilities around which TOD can occur. This type of development impact, which is not comparable for bus, can generate direct capital and indirect consumer spending, which, in turn, results in economic benefits to local and regional economies.

Finally, the extensive national experience of Study team members – and other transit industry experts – on both bus and rail projects indicates that well-designed rail projects can lead to the kinds of desirable economic impacts estimated in this assessment, while bus service of the type envisioned in the Capitol Corridor would not.

3.1 Approach

The Study team assembled land use, parcel and zoning data, where available, for the potential station area sites in Nashua, Manchester, and Concord. A quantitative and qualitative approach was used to assess the amount of additional development potential that might be reasonably expected for the proposed station areas included in each of the corridor transit alternatives. Underdeveloped and/or vacant parcels within a one-half mile radius of each station area were considered most likely for new development. Development potential was calculated using floor area ratios (FAR) permitted under existing zoning, combined with assumptions about the likely mix of uses for each station area. This potential was measured in terms of commercial square footage (office and retail) and housing units for the different alternatives. For residential development, conversion factors of 1,250 square feet per residential unit and two persons per unit were applied as being typical for TOD style multi-family development. For commercial development, 250 square feet per office job and 750 square feet per retail job were assumed.

This analysis assumed that the development potential for each alternative would be fully realized by 2030. A No Build scenario was also considered.

3.2 Interviews

The Study team conducted stakeholder interviews with local and regional planners (4), developers (1), chamber of commerce members (2), and local planning board members (1) to help inform the necessary assumptions, such as existing development conditions and trends and the degree of impact the different transit alternatives could have in bringing about new development for each of the potential station area sites over the next 20 years. Participants, who were selected based on their knowledge of the development climate in the Southern New Hampshire, were asked 11 questions beginning with their level of involvement with the Capitol Corridor Alternatives Analysis (AA) Study and their detailed knowledge of economic development conditions in specific station areas. Participants were asked for their professional opinions as to the development impact that might occur under the different

[16] Kansas Statewide Intercity Bus Study, Kansas Department of Transportation, December 2012
[17] The American Bus Association Economic Impact Study, ABA, January 2013

alternatives, including commuter rail service of 16-34 trains per day, intercity rail service with four trains per day, and the intercity bus alternatives as "enhanced" bus service. Participants were also asked for their professional opinions of what development might look like over the next 20 years *without* the project. Based on participant responses, the Study team assumed *full* development potential would be achieved with the commuter rail alternative, but only *half* that potential would be realized under an intercity rail alternative. There was general consensus that the intercity bus alternative would do little to boost economic development, as buses are subject to existing roadway congestion issues. Similarly, while there currently is some high tech, residential, and institutional development occurring near several of the station area sites, there was general consensus among interview participants that this economic development would be difficult to maintain or boost (particularly in the case of high tech) without rail enhancements to attract the type of workers necessary to facilitate growth, namely a younger demographic looking for urban to semi-urban living with walkable amenities. One respondent also indicated rail was just as important to retain existing workers in New Hampshire that may be otherwise attracted to the transit amenities and walkable lifestyle found farther south in the Boston area.

3.3 Station-by-Station Assessment

3.3.1 Concord – Stickney Avenue

The Stickney Avenue station area site was identified as suitable for TOD, primarily due to the mixed use and high-density residential allowances and flexible parking requirements under zoning. Parcels considered most likely to develop or redevelop due to transit alternatives were primarily located within the Opportunity Corridor Performance (OCP) District, the Gateway Performance District (GWP), and the Central Business Performance (CBP) District, all with a FAR of 2. The potential development/ redevelopment area is large (1.7 million square feet), so the analysis conservatively assumes a FAR of 1.0 as an average across the sites. The analysis also assumed a 60/40 residential/commercial mix of uses (built square footage) with commercial split evenly between office and retail. See Table 3.1.

Table 3.1: Development Potential in Concord Stickney Avenue Station Area

Alternative	Commercial (Square Feet)	Residential (Units)	Jobs
Commuter Rail	n/a	n/a	n/a
Intercity Rail	335,000	400	890
Intercity Bus	0	0	0
No Build	0	0	0

3.3.2 Manchester – Bridge Street

Similar to the Granite Street site, there is little vacant land within this station area. Parcels considered likely to redevelop are predominantly located within the Central Business (CBD, FAR 5) and residential (R-3, FAR 0.75) districts. The Study team assumed a majority of floor area (75 percent) would be developed with residential use, with most of the remaining being office. See Table 3.2.

Table 3.2: Development Potential in Manchester Bridge Street Station Area

Alternative	Commercial (Square Feet)	Residential (Units)	Jobs
Commuter Rail	587,000	1,410	2,040
Intercity Rail	294,000	710	1,020
Intercity Bus	0	0	0
No Build	0	0	0

3.3.3 Manchester – Granite Street

There is little vacant land within the Granite Street station area. Due to the transit supportive zoning, however, there are many underutilized parcels that could potentially redevelop in conjunction with the proposed rail service enhancements. Parcels considered likely to redevelop are predominantly located within the Central Business District (CBD, FAR 5) with some intensification possible in the residential (R-3, FAR 0.75) district. This area is also considered suitable for TOD due to its high-density residential and commercial allowances under zoning. The Study team assumed a majority of floor area (75 percent) would be developed with residential use, with most of the remaining being office. See Table 3.3.

Table 3.3: Development Potential in Manchester Granite Street Station Area

Alternative	Commercial (Square Feet)	Residential (Units)	Jobs
Commuter Rail	567,000	1,360	1,970
Intercity Rail	284,000	680	980
Intercity Bus	0	0	0
No Build	0	0	0

3.3.4 Manchester Airport (Bedford/MHT)

Given the relatively low residential and commercial densities proximate to the proposed station area, this site has the least amount of development potential; however, there was a general consensus among interview participants that rail connectivity to the airport was critical for regional economic development. The analysis focused on land presently zoned industrial and an assumed FAR of 0.15 to 1.0 developed with office and retail uses. This analysis did not consider parcels likely to redevelop but not vacant in this station area. See Table 3.4.

Table 3.4: Development Potential in Manchester Airport (Bedford/MHT) Station Area

Alternative	Commercial (Square Feet)	Residential (Units)	Jobs
Commuter Rail	245,000	0	720
Intercity Rail	123,000	0	360
Intercity Bus	0	0	0
No Build	0	0	0

3.3.5 Nashua – Crown Street

The predominant zoning for this station area is multi-family residential (R-B, FAR 0.5) and General Industrial (GI, FAR 2). This analysis utilized FAR for these districts and an assumed development would be predominantly residential with a small amount of commercial use. A mixed-use or TOD supportive overlay in this area would boost development potential, given the amount of vacant land suitable for development. This analysis did not consider parcels likely to redevelop but not vacant in this station area, as in the near-term at least such redevelopment is expected to be modest. See Table 3.5.

Table 3.5: Development Potential in Nashua Crown Street Station Area

Alternative	Commercial (Square Feet)	Residential (Units)	Jobs
Commuter Rail	155,000	1,110	410
Intercity Rail	77,000	560	210
Intercity Bus	0	0	0
No Build	0	0	0

3.3.6 Nashua – Spit Brook Road

The predominant zoning for vacant parcels within this station area are Highway Business (HB, FAR 0.75) and General Business (GB, FAR 1.25). This analysis assumes a 60/40 residential to commercial mix with an even split between retail and office uses. A mixed use or TOD overlay for this station area, including higher allowable densities for the large undeveloped parcel adjacent to the station site, could boost the development potential of this station area significantly. See Table 3.6.

Table 3.6: Development Potential in Nashua Spit Brook Road Station Area

Alternative	Commercial (Square Feet)	Residential (Units)	Jobs
Commuter Rail	930,000	1,120	2,480
Intercity Rail	465,000	560	1,240
Intercity Bus	0	0	0
No Build	0	0	0

3.3.7 Nashua – Pheasant Lane Mall

The limited vacant land near this station area is zoned Highway Business (HB, FAR 0.75). This analysis assumed the land is developed for commercial uses with a greater emphasis on retail. The current low density zoning and development configuration of this site remain limited for economic development through rail and transit enhancements. See Table 3.7.

Table 3.7: Development Potential in Nashua Pheasant Lane Mall Station Area

Alternative	Commercial (Square Feet)	Residential (Units)	Jobs
Commuter Rail	116,000	0	280
Intercity Rail	58,000	0	140
Intercity Bus	0	0	0
No Build	0	0	0

3.3.8 Station Area Summary

Tables 3.8 and 3.9 provide a summary of the economic benefits at each station.

Table 3.8: Summary – Commuter Rail Development Potential at Each Station Area

Alternative	Commercial (Square Feet)	Residential (Units)	Jobs
Concord – Stickney Avenue	n/a	n/a	n/a
Manchester – Bridge Street	587,000	1,410	2,040
Manchester – Granite Street	567,000	1,360	1,970
Bedford – MHT	245,000	0	720
Nashua – Crown Street	155,000	1,110	410
Nashua – Spit Brook Road	930,000	1,120	2,480
Nashua – Pheasant Lane Mall	116,000	0	280

Table 3.9: Summary – Intercity 8 Development Potential at Each Station

Alternative	Commercial (Square Feet)	Residential (Units)	Jobs
Concord – Stickney Avenue	335,000	400	890
Manchester – Bridge Street	294,000	710	1,020
Manchester – Granite Street	284,000	680	980
Bedford – MHT	123,000	0	360
Nashua – Crown Street	77,000	560	210
Nashua – Spit Brook Road	465,000	560	1,240
Nashua – Pheasant Lane Mall	58,000	0	140

3.4 Combined Economic Benefits of Alternatives

Based on the analysis of the individual station areas, the Study team estimated the following illustrative, cumulative economic development potential for the various project alternatives:

- **Manchester Regional Commuter Rail** – Commuter rail benefits for the Manchester Granite Street, Manchester Airport (Bedford/MHT), Nashua Crown Street, and Spit Brook Road station locations
- **Nashua Minimum Commuter Rail** – Commuter rail benefits for the Spit Brook Road station only
- **Intercity 8** – Intercity rail benefits for the Concord, Manchester Granite Street, Manchester Airport (Bedford/MHT), and Nashua Crown Street station locations

The greatest benefit, as expected, is for the Manchester Regional Commuter Rail alternative serving four stations at a moderate to high frequency. Manchester Regional Commuter Rail has the potential to generate over 3,600 new residential units and nearly two million square feet of commercial space supporting over 5,600 new jobs. The second greatest benefit is for the Intercity 8 alternative, which serves the most stations, but with more limited impact due to its low frequency of service. The Nashua Minimum Commuter Rail alternative provides frequent service, but only to one station in New Hampshire. See Table 3.10.

Table 3.10: Total Development Potential by Alternative

Alternative	Commercial (Square Feet)	Residential (Units)	Jobs
Manchester Regional Commuter Rail	1,898,000	3,600	5,600
Nashua Minimum Commuter Rail	930,000	1,100	2,500
Intercity 8	819,000	1,600	2,400
Intercity Bus	0	0	0
No Build	0	0	0

Note: residential units and jobs rounded to the nearest hundred

3.5 Limitations of the Analysis

This analysis was intended to expand upon the Land Use & Economic Development Analysis (January, 2014) of the Capitol Corridor AA Study,[18] which detailed the transit supportive conditions of each of the seven proposed station areas. It provides illustrative estimates of the potential station area economic development that could be leveraged by the proposed transit alternatives. Parcel level data and existing development conditions in a GIS format are critical in determining new development potential. This information was not readily accessible for each of the station areas. Absent this information, assumptions were rooted in local knowledge about the likelihood of development and/or redevelopment of certain parcels informed the analysis. In addition, assumptions about the likely mix of uses for each station area were highly malleable resulting in slightly variable development projections.

[18] Not included as an appendix to the AA Final Reports; available under separate cover

Jobs and residents per square foot of development may also vary. Development potential projections were based only on FAR under existing zoning. Other dimensional requirements that may influence development potential (such as building height, open space, or parking) were not considered in the analysis, and zoning could be changed in the future. Long-term development potential could be greater than estimated here, if lower-value properties were redeveloped at higher intensities. Finally, as explained in this section, the types of economic impacts examined would not be expected for any of the bus alternatives; however, other benefits could be expected as a result of the improvements in bus travel time, but were not captured in this assessment.

4 Regional Economic Benefits

4.1 IMPLAN Analysis

The economic modeling tool IMPLAN was used to estimate the broader economic benefits to the Southern New Hampshire region of each Capitol Corridor project alternative. These benefits are in addition to the direct attraction of new station area jobs and residents. IMPLAN is a widely accepted and utilized model that shows how an investment made in one sector of the economy – in this case transportation – then flows through and generates benefits in other sectors for a total estimate of economic activity in a region.

4.1.1 Scope of the Analysis

The following regional economic benefits were evaluated:

- Short-term benefits as a result of spending on construction of rail improvements and new station area development in New Hampshire
- Long-term benefits as a result of the attraction of more residents and jobs to Southern New Hampshire, through worker earnings that are reinvested in the state's economy

Direct benefits to travelers (time and cost savings) were not explicitly included in the analysis. Economic modeling tools such as IMPLAN are designed to track monetary flows through the economy. Time savings can only be monetized if they lead to direct cost savings, such as in the case of "on-the-clock" business or freight travel. Personal time savings benefits (for commuting or other personal travel) cannot be directly monetized in this way. However, they may be capitalized into land values, and therefore were indirectly considered through the real estate effects included in this analysis. While commuting time savings benefits were also sometimes assumed to benefit businesses by increasing productivity or reducing costs, in this case, most of the transit riders will be commuters to Boston, and, therefore, the businesses benefiting will not be within the southern New Hampshire Study area.

Cost savings to travelers using the commuter rail also were not included. While travelers would save out-of-pocket expenses on gasoline, vehicle maintenance, and parking, they would also incur expenses in the form of transit fares. With a marginal vehicle operating cost of about $0.20 per mile and a round trip of 80 miles, the vehicle cost savings would be $16, which compares with expected fares of around

$20 to $24 round-trip (based on current MBTA Zone 8-10 fares). Parking cost savings would be accrued by some, not all, commuters, as some employers provide free parking. Cost savings for other highway travelers also could not be estimated since the impacts of the project on highway congestion have not been modeled.

Benefits of the bus alternatives were not estimated, as these alternatives would involve minimal capital investment, and the Study team's professional experience, the literature, and stakeholder interviews suggested that associated development impacts would also be minimal.

4.1.2 Methodology

IMPLAN is a regional input-output model used to measure how changes in economic activity lead to direct, indirect, and induced changes in output, final payments, employment, and final demand. This analysis used the IMPLAN model version 3.1.1001.12, released in 2013. The study area for this analysis included the State of New Hampshire.

Construction Costs

This analysis was based on the projected external (primarily federal) capital spending in New Hampshire for the three rail alternatives: Commuter Rail with terminals in Nashua and Manchester and Intercity 8 rail with a terminal in Concord. Internal spending (i.e., funding from New Hampshire sources) is not included, as there will be an impact of reduced consumer spending that will offset the construction spending benefit.

The source for this spending is the list of line items produced by Jacobs Engineering Inc. for NHDOT in September, 2014. The approach was as follows:

- Isolate the line items that are located within the State of New Hampshire
- Identify the alternatives for which each line item is relevant
- Assign the line items IMPLAN industry codes
- Compute total spending by alternative and industry
- Factor the spending to compute the projected external share
- Divide the external share among the construction years 2019-2022

The Capitol Corridor project includes approximately 10 miles of track improvements and stations in Massachusetts; the Nashua alternative does not include any revenue track or stations in New Hampshire (though it does include service track and a layover yard there). Project costs were divided by state based on information provided by Jacobs on the locations of the costs incurred.

IMPLAN uses a unique system of industry codes that differs from other classification systems. When modeling the economic impact of a project, the inputs to IMPLAN consist of the projected productivity of each industry, equivalent in this case to the income earned by each sector from out-of-state sources. Capital spending was assigned to the four IMPLAN industries in Table 4.1.

Table 4.1: IMPLAN Industries Associated with Capital Spending

IMPLAN Number	IMPLAN Name	Description
36	Construction of other new non-residential structures	Proxy for all new construction spending on track and facilities
39	Maintenance and repair construction of non-residential structures	Proxy for "maintenance and protection" spending on track and facilities
360	Real estate establishments	Proxy for land acquisition
369	Architectural, engineering, and related services	Includes "final design and construction phase services" for each alternative

A formal financing plan has not yet been finalized and the project has not yet been submitted for federal funding. Consequently, professional judgment was used to estimate that less than half the project costs will be covered by NHDOT, with the remainder coming from external sources, including the Federal Transportation Administration (FTA). To reflect these projections, the cost of each of the alternatives was factored to account for those external sources of capital funding. Project construction is projected to occur between 2019 and 2022.

Residential Relocation and Business Expansion

The development estimates provided in Section 2.0 were used as a basis for estimating the long-term change in jobs and output related to residential and business growth. It is assumed that the new growth identified in Section 2.0 will all occur by the year 2030. Benefits will also accrue in earlier years in proportion to the amount of development realized by that year. It is further assumed that this is new development in the Southern New Hampshire region, rather than a relocation of activity that would have occurred anyway within the region.

The following impacts related to new development were included:

- Real estate construction and sales – Commercial valued at $95.49 per square foot[19] and residential valued at $167,000 to $181,000 per unit.[20] These benefits are assumed to accrue over a 10-year period (2021–2030).
- Earnings of new resident workers (based on the average income for New Hampshire), which are reinvested in the New Hampshire economy. These will be ongoing, annual benefits reaching their full extent in 2030 and beyond.

[19] http://www.loopnet.com/Nashua_New-Hampshire_Market-Trends
[20] Derived from Trulia listings, adjusted for an eight percent premium for proximity to commuter rail

4.1.3 Results

Table 4.2 shows the estimated impact on jobs for each alternative by year. These results include direct jobs in project construction and real estate development, as well as indirect and induced jobs related to spending flowing through the economy. Over the four-year construction period, the various alternatives are projected to generate between 80 and 350 new jobs.[21] Impacts are largest for the Intercity 8 alternative to Concord, since this alternative would include the longest track improvements and most stations. Real estate development between 2021 and 2030 is projected to generate between 850 and 3,390 new jobs. The reinvested earnings of new residents are expected to generate between 380 and 1,730 new jobs per year in 2030 and beyond, with proportionally smaller benefits increasing from 2021 to 2029 as development scales up. The greatest real estate and earnings impacts are for the Manchester Regional Commuter Rail alternative since this alternative is expected to have the largest development impacts.

Table 4.2: Impacts on Employment (Jobs) by Alternative

Alternative	Project Construction (2019-2022)	Real Estate Development (2021-2030)	Reinvested New Resident Earnings (Annual, 2030+)
Manchester Regional Commuter Rail	230	3,390	1,730
Nashua Minimum Commuter Rail	80	850	380
Intercity 8	350	2,460	1,140

Table 4.3 shows the estimated impact on output (gross regional product, or GRP) for each alternative by year. Over the four-year construction period, the various alternatives are projected to generate between $20 and $100 million in new state output. Real estate development between 2021 and 2030 is projected to generate between $260 million and $1.2 billion in new state output, cumulatively over this period. The reinvested earnings of new residents are expected to generate between $50 million and $220 million in new state output, in 2030 and beyond, with proportionally smaller benefits increasing from 2021 to 2029 as development scales up. The impacts by alternative are similar to the job impacts, with the Intercity 8 to Concord generating the largest construction impacts and the Manchester Regional Commuter Rail generating the largest real estate and earnings benefits.

Table 4.3: Impacts on Output (Gross Regional Product) by Alternative (In Millions, 2014$)

Alternative	Project Construction (2019-2022)	Real Estate Development (2021-2030)	Reinvested New Resident Earnings (Annual, 2030+)
Manchester Regional Commuter Rail	$70	$1,200	$220
Nashua Minimum Commuter Rail	$20	$260	$50
Intercity 8	$100	$750	$140

[21] A new "job" is really a "job-year", i.e., 353 jobs over a four-year period is equivalent to 88 jobs that each continue for the entire four-year period

IMPLAN also reports changes in federal, state, and local tax receipts. These include revenue from taxes on employee compensation (social insurance), production and imports (sales, property, motor vehicle, and other taxes), households (income, property, and licenses, fines and fees), and corporations (profits and dividends). The net changes are shown in Table 4.4. The vast majority of new tax receipts are from taxes on production and imports and corporations.

Table 4.4: Impacts on State and Local Tax Receipts by Alternative (In Millions, 2014$)

Alternative	Project Construction (2019-2022)	Real Estate Development (2021-2030)	Reinvested New Resident Earnings (Annual, 2030+)
Manchester Regional Commuter Rail	$1.3	$43.3	$13.1
Nashua Minimum Commuter Rail	$0.5	$9.3	$2.9
Intercity 8	$2.1	$27.1	$8.7
Intercity Bus	0	0	0
No Build	0	0	0

4.2 Comparison of Economic Benefits, Costs, and Revenues

The Study team integrated the forecast stream of economic benefits with the forecast streams of costs and revenues to derive a timeline of costs, revenues, and economic benefits forecast to result from a state investment in the Manchester Regional Commuter Rail alternative. Table 4.5 shows a 35-year time horizon with forecast annual costs, cash receipts, and public benefits for each future year. **All costs, revenues, and benefits are shown in 2014 dollars.**

Table 4.5: Forecast Annual Costs, Revenues, and Economic Benefits (In Millions, 2014$)

Year	Total Financial Costs	Total Cash Receipts	Passenger Revenue	Federal 5307 Funding	Incremental Gross Regional Product
Present Value	$537	$326	$261	$64	$6,176
2015	$2.0	$0.0	$0.0	$0.0	$0.0
2016	$2.0	$0.0	$0.0	$0.0	$0.0
2017	$2.0	$0.0	$0.0	$0.0	$0.0
2018	$2.0	$0.0	$0.0	$0.0	$0.0
2019	$9.4	$0.0	$0.0	$0.0	$17.5
2020	$8.5	$0.0	$0.0	$0.0	$17.5
2021	$7.6	$0.0	$0.0	$0.0	$39.5
2022	$6.7	$0.0	$0.0	$0.0	$83.5
2023	$16.5	$7.1	$7.1	$0.0	$66.0
2024	$16.6	$7.2	$7.2	$0.0	$88.0
2025	$16.8	$9.8	$7.4	$2.5	$110.0
2026	$16.9	$10.0	$7.5	$2.5	$132.0
2027	$17.0	$10.1	$7.7	$2.5	$154.0
2028	$17.1	$10.3	$7.8	$2.5	$176.0
2029	$17.2	$10.5	$8.0	$2.5	$198.0
2030	$17.3	$10.6	$8.1	$2.5	$220.0
2031	$17.4	$10.8	$8.3	$2.5	$222.2
2032	$17.5	$10.9	$8.5	$2.5	$224.4
2033	$20.6	$11.1	$8.6	$2.5	$226.7
2034	$20.8	$11.3	$8.8	$2.5	$228.9
2035	$20.9	$11.5	$9.0	$2.5	$231.2
2036	$21.0	$11.6	$9.2	$2.5	$233.5
2037	$21.1	$11.8	$9.3	$2.5	$235.9
2038	$21.3	$12.0	$9.5	$2.5	$238.2
2039	$21.4	$12.2	$9.7	$2.5	$240.6
2040	$15.8	$12.4	$9.9	$2.5	$243.0
2041	$15.9	$12.6	$10.1	$2.5	$245.4
2042	$16.0	$12.8	$10.3	$2.5	$247.9
2043	$16.2	$13.0	$10.5	$2.5	$250.4
2044	$16.3	$13.2	$10.7	$2.5	$252.9
2045	$16.4	$13.4	$10.9	$2.5	$255.4
2046	$16.6	$13.6	$11.2	$2.5	$258.0
2047	$16.7	$13.9	$11.4	$2.5	$260.5
2048	$16.8	$14.1	$11.6	$2.5	$263.2
2049	$17.0	$14.3	$11.8	$2.5	$265.8
2050	$17.1	$14.6	$12.1	$2.5	$268.4

Total Financial Costs:

- Engineering and design at $2 million per year over four years
- Debt service on long-term bonds for 20 years, plus the interest on Grant Anticipation Notes during the four-year construction period
- O&M costs starting once construction is complete and escalating at one percent per year as ridership grows
- Capital renewal allowance for periodic rail and tie renewal as well as other periodic asset refurbishment costs

Total Cash Receipts:

- Passenger revenue once service starts
- Federal formula funding based on route miles and vehicle miles of operation

Future passenger revenue grows at a conservative long-term rate of two percent per year as development occurs to stimulate ridership growth.

Incremental Gross Regional Product includes benefits of employee wages, business earnings, and state and local tax receipts associated with project construction, real estate development, and ongoing increased economic activity in the state. Projecting beyond 2030, this is assumed to grow at two percent per year as ridership grows.

With an allowance for capital renewal, the forecast cash receipts (fare revenue and federal formula funds) over the next 35 years approach, but do not fully cover, the annual financial costs for engineering, debt retirement, operating costs, and asset renewal. However, forecast economic benefits in terms of employee wages, business earnings, and tax receipts clearly exceed the annual financial costs of the service.

While the forecast economic benefits are estimates, if only half that forecast growth in regional economic activity is achieved, the benefits would still outweigh the net financial liabilities by a large margin.

Appendix B
Sustainable Land Use

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List of Tables

1 Introduction

1.1 Purpose of Report

This Sustainable Land Use Technical Report was prepared in support of Task 7 of the New Hampshire Capitol Corridor Rail & Transit Alternative Analysis (AA) Study. The objective of this report is to evaluate the sustainability of the potential land use impacts of the project in the Study corridor.

1.2 Methodology

The approach for preparing this report included the following tasks:

- Defining the scope of analysis
- Reviewing station locations for the seven intermediate alternatives
- Reviewing station area land use and economic development characteristics
- Evaluating final alternatives against the defined goals

2 Sustainable Land Use Goals

As stated in the Purpose and Need document (Appendix 2 to the Capitol Corridor AA Final Report), a sustainable transportation system is one that meets and balances the existing environmental, social, and economic needs of a community without compromising resources for future generations. Each transit investment alternative was evaluated for its ability to meet land use goals in these three categories.

- Environmental Goals:
    - Catalyze more compact, infill transit-supportive land use and development patterns, thereby reducing the need for additional infrastructure (sewer, water, power) to support new development, and supporting maintenance of existing open/rural space
    - Reduce reliance on cars for trips/errands
- Social Goals:
    - Expand mobility and transportation choice for all ages
    - Support low-income households through increased access to jobs
- Economic Goals:
    - Attract employers to New Hampshire
    - Attract and retain regional employers to New Hampshire and Boston
    - Provide improved residency location choice in New Hampshire for commuters to Boston or regional jobs

2.1 Environmental Goals

The following situations describe the degree to which the transit investment may meet the defined environmental goals.

Sub goal 1: Catalyze more compact, infill transit-supportive land use and development patterns, thereby reducing the need for additional infrastructure (sewer, water, power) to support new development, and supporting maintenance of existing open/rural space.

Transit investments have shown ability to catalyze or influence a Transit-Supportive Development (TSD) or Transit-Oriented Development (TOD) around station areas. Four pre-conditions are necessary for this to occur:

- Favorable real estate market conditions
- Available land for development
- Transit-supportive land use policies and plans (comprehensive plans, neighborhood plans, zoning ordinances, parking policy, etc.)
- Urban design that supports efficient and pleasant station access

These four conditions are generally mode/service-neutral. Variations in the ability to support this sub goal come from the differing degrees to which various modes and service schedules influence TSD/TOD. Fixed guideway modes (heavy rail, light rail, commuter rail, and streetcar) historically have tended to have more significant impact on development than flexible modes (express bus, standard bus, vanpool, bikeshare, etc.). Service that is more frequent and faster also tends to have a more significant impact than service that is infrequent (e.g., peak hour only, or long head-ways) or offers slower trips (e.g., all-stops vs. express or skip-stop).

By concentrating more development in existing areas (infill) around stations, not in outlying greenfield areas, transit service can reduce the need for additional infrastructure investments at the urban edge.

Likewise, as increased choice in places to live, work, and visit become available through the development of TSD/TOD, demand for development at the urban fringe that can consume agricultural land and place pressure on previously undeveloped open spaces may be reduced. The conveniences of locating closer to transit stations may come to outweigh the benefits of edge/semi-rural living for some households or businesses, increasing demand for space in existing urban areas or new infill development.

Therefore, the following can be concluded:

- Rail alternatives will meet this goal better than bus alternatives
- Alternatives with more runs/trips will meet this goal better than alternatives with fewer trips

Sub goal 2: Reduce reliance on cars for trips/errands.

Increased transit service indicates increased choice in how people travel for work, shopping, entertainment/recreation, and other purposes. Some households may choose to use transit for their trips instead of cars, which may reduce Vehicle Miles Travelled (VMT) by single-occupancy vehicles. Overall reductions in VMT reduce roadway congestion and emissions produced by passenger automobiles. The degree to which overall mode share shifts between single-occupancy passenger automobile based trips and transit, and changes in the absolute numbers of vehicle-based trips is complex and depends upon a number of circumstances:

- Travel patterns for various types of trips: local vs. regional, single-destination vs. chained trips, work vs. non-work
- Service frequency
- Station location and proximity to desired destinations
- Population and employment growth in station areas and across the service area
- Other exogenous factors, such as fuel costs

Mode-shift and VMT changes and related emissions reductions were not modeled for this Study. However, the following can be concluded:

- Alternatives that offer additional runs or trips will support this goal, with alternatives offering more frequent service coverage meeting the goal comparatively better
- Alternatives that introduce new station locations or transit access points will also meet this goal comparatively better than alternatives that use the same alignment and station locations as existing conditions

2.2 Social Goals

The following situations describe the degree to which the transit investment may meet the defined social goals.

Sub goal 1: Expand mobility and transportation choice for all ages.

Compared to the existing transit service, alternatives that introduce more opportunities for people to move efficiently from place-to-place increase mobility. This can result from increased options for routes, increased windows for travel time, and new modes or means for travel (transportation choice). Therefore, the following can be concluded:

- Alternatives that offer additional runs or trips will support this goal, with alternatives offering more frequent service coverage meeting the goal comparatively better
- Alternatives that introduce new station locations or transit access points (as destinations and as intermediate stops) will also meet this goal comparatively better than alternatives that use the same alignment and station locations as the baseline

Sub goal 2: Support low-income households through increased access to jobs.

Alternatives that introduce new connections – origins and/or destinations – or make it easier to get from place-to-place increase access. Connections to employment centers will result in increased access to jobs. Therefore, the following can be concluded:

- Alternatives that introduce new station locations or transit access points (as destinations and as intermediate stops) will meet the "increased access to jobs" component of this goal comparatively better than alternatives that use the existing alignments/routes and station locations as the baseline (assuming that one or more of the station locations [new or existing] feature employment uses within walking or connecting distance of the station)
- New station/stop locations that are located within areas that have a presence of low-income households, or that have connections (via feeder bus, pedestrian or non-motorized paths, or roadways) to areas with a presence of low-income households will meet the "supports low-income households" component of this goal comparatively better than alternatives that feature station locations in areas where household incomes meet or exceed area median incomes

2.3 Economic Goals

The following situations describe the degree to which the transit investment may meet the defined economic goals. As discussed in the *Social Goals* section above, alternatives that create more opportunities for people to move efficiently from place-to-place and open up more connections to transportation serve to increase access and mobility. Access and mobility also affect the economies of the places served by transportation, at local and regional levels.

Sub goal 1: Attract employers locally to New Hampshire, and attract and retain regional employers from New Hampshire to Boston.

Employers in most industry sectors consider a variety of labor force characteristics when choosing locations for their business concerns. These may include typical levels of educational attainment and availability of specialized skills required by their business processes, but also consider to some degree how easy it will be for employees to get to work or to conduct any intra-workday travel that may be required. Good access and high degrees of resident mobility correspond to workforce stability, on-time performance, and lower levels of turnover related directly to employees' ability to get to work consistently and on time.

From the perspective of current or prospective employees, the transportation infrastructure that provides access to a job site also affects the decision to take a job with that company, whether the employer contributes financially to its construction and operation or not. Other factors being equal, employees may choose a job that is easier to get to, or for which they have multiple choices in how to get to, over another similar job that is less accessible. In this way, employers may also present transportation access as a job benefit and way to attract and retain quality employees.

Therefore, the following can be concluded:

- Alternatives that offer increased access and mobility will support this goal, with alternatives offering more frequent service and/or new station locations or transit access points meeting this goal comparatively better than alternatives that use the same alignment and station locations as the baseline
- Alternatives that provide more reliable service (i.e., rail-based or in dedicated right-of-way) will meet this goal comparatively better than alternatives that simply provide more service

Sub goal 2: Provide improved residency location choice in New Hampshire for commuters to Boston or regional jobs.

For many households, the decision on where to live may include preferences for a certain style or price-point of housing stock, neighborhood, or community, and proximity to shopping, healthcare, and open and space/recreation (among other types of destinations). Other factors may include proximity to extended family, or ties to an area where household members grew up or previously lived. For many, access to employment is also important: choice and convenience in ways to get to work, travel time length and consistency, and impacts of the commute on quality-of-life. Transportation investments that increase access across a region and increase the number of potential connections between residential centers and employment centers provide more choice to employees as to where they can live according to their preferences (e.g., a rural New Hampshire hamlet with a short drive to a transit station) and still work in the region (e.g., Boston's financial district).

Multiple choices will help retain skilled employees and productive citizens in the region, because they are not obligated to move away from their preferred residence location to access jobs. Communities may have an additional desire to maintain the balanced age distribution necessary for healthy communities, and retaining workers in all age groups accomplishes that policy goal. (For example, young professional workers from New Hampshire who work in Boston are less likely to move to Massachusetts to work in their industry of choice.)

Therefore, the following can be concluded:

- Alternatives that offer increased access will support this goal, with alternatives offering more new station locations or transit access points meeting this goal comparatively better than alternatives that use the same alignment and station locations as the baseline

3 Review of Station Characteristics

3.1 Summary of Final Alternatives

This section describes the baseline, three bus, two commuter rail, and one intercity rail investment options that advanced through preliminary screening leading towards the selection of recommended strategies (see Tables 3.1 and 3.2). Details concerning each final investment option are listed below with more detail available in the Task 7 Technical Report, Detailed Evaluation of Alternatives (Appendix 7 to the AA Final Report).

Table 3.1: Summary of Alternatives

Base	▪ No investment; existing bus and rail services are continued, but not expanded
Expanded Base	▪ New Hampshire's Boston Express (BX) bus service is increased from current 80 buses per day to 120 buses per day ▪ All peak buses run direct and non-stop between each NH park-and-ride lot and Boston South Station with service every 30 minutes ▪ Each park-and-ride lot sees hourly off-peak service making intermediate stops at each NH park-and-ride lot ▪ No changes to existing passenger rail services
Bus on Shoulder	▪ BX bus service of 80 daily trips is permitted to operate within the I-93 shoulder south of I-495 to bypass congestion in general travel lanes ▪ Savings of eight to 12 minutes predicted during the morning peak period ▪ No significant travel time savings predicted during the afternoon peak period
Expanded Bus on Shoulder	▪ 120 daily trips permitted to operate within the I-93 shoulder south of I-495 to bypass congestion in general travel lanes ▪ Savings of eight to 12 minutes predicted during the morning peak period ▪ No significant travel time savings predicted during the afternoon peak period
Manchester Regional Commuter Rail	▪ Extends Massachusetts Bay Transportation Authority (MBTA) commuter rail service north from Lowell, MA to Manchester, NH with intermediate stops at South Nashua, Nashua Crown St., and Bedford/Manchester-Boston Regional Airport (Bedford/MHT) ▪ BX I-93 service to Manchester, North Londonderry, Londonderry, and Salem is retained ▪ BX Route 3 service to Manchester, Nashua, and Tyngsborough is retained
Nashua Minimum Commuter Rail	▪ Extends MBTA commuter service north from Lowell, MA to South Nashua, NH ▪ BX I-93 service to Manchester, North Londonderry, Londonderry, and Salem is retained ▪ BX Route 3 service to Manchester, Nashua, and Tyngsborough is retained
Intercity 8	▪ Four daily intercity passenger rail round trips between Concord, NH and Boston, MA making intermediate stops at Manchester, Bedford/MHT, Nashua Crown St., and Lowell and Woburn, MA ▪ Base BX service is retained

Table 3.2: Stations Served by Alternatives

Location	Rail Station (Proposed)	Bus Station (Existing)	Stations Served by Alternative						
			Base	Expanded Base	Bus on Shoulder	Expanded Bus on Shoulder	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail	Intercity 8
Number of Stations (excluding existing MA + Boston terminal)			7 Bus	7 Bus	7 Bus	7 Bus	4 Rail 5 Bus	1 Rail 4 Bus	4 Rail 8 Bus
Concord, NH	X	X	B	B	B	B	B	-	R, B
Manchester, NH: Granite Street	X	X	B	B	B	B	R, B	B	R, B
Bedford/MHT	X		-	-	-	-	R	-	R
N. Londonderry, NH: Exit 5		X	B	B	B	B	B	B	B
Londonderry, NH: Exit 4		X	B	B	B	B	B	B	B
Nashua, NH: Exit 8		X	B	B	B	B	-	-	B
Nashua, NH: Crown Street	X		-	-	-	-	R	-	R
South Nashua, NH: Spit Brook Road or Pheasant Lane Mall	X		-	-	-	-	R	R	B
Tyngsborough, MA: Exit 36		X	B	B	B	B	-	-	B
Salem, NH: Exit 2		X	B	B	B	B	B	B	B

3.2 Summary of Land Use and Economic Development Conditions

A detailed analysis of the land use and economic development characteristics of proposed transit stations is contained in the technical memorandum *Land Use & Economic Development Analysis* dated January 2014 and in the draft supporting working memorandum *Land Use Evaluation of Alternatives for Preliminary Screening* dated September 2013. The findings from those memoranda are not repeated here, but are incorporated by reference.

4 Analysis Presented by Goal

This section of the report contains a qualitative assessment of each alternative's anticipated potential to meet the three sustainable land use goals. This qualitative assessment is based upon an understanding of service levels and route characteristics of the alternatives, as well as the varied land use and socio-economic characteristics of each of the station areas served by the alternative.

A station-level assessment is provided for each station area served by an alternative, with footnotes explaining the rationale for assessment. Assessments were absolute, not relative rankings among alternatives. Ratings are provided on the following scale:

- N/A: For the alternative, there is no service to this station
- No Change: This alternative is not anticipated to have any effect on this aspect of sustainable land use
- Negative: This alternative could potentially reduce sustainability
- Low: This alternative is anticipated to have some positive effect on this aspect of sustainable land use
- Medium: This alternative is anticipated to have a solidly positive effect on this aspect of sustainable land use
- High: This alternative is anticipated to have a very positive effect on this aspect of sustainable land use

These very localized assessments were then rolled-up as a composite assessment for the overall alternative. A summary of the composite goals is presented in Section 5.0.

4.1 Environmental Goals

Environmental Goals:

1. Catalyze more compact, infill transit-supportive land use and development patterns, thereby reducing the need for additional infrastructure (sewer, water, power) to support new development, and supporting maintenance of existing open/rural space
2. Reduce reliance on cars for trips/errands

Assessments for the Environmental Goals are presented in Tables 4.1 and 4.2. Each sub-goal was assessed separately due to different influencing factors.

Table 4.1: Evaluation of Environmental Goals by Alternative and Station

Location	Rail Station (Proposed)	Bus Station (Existing)	Alternative						
			Base	Expanded Base	Bus on Shoulder	Expanded Bus on Shoulder	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail	Intercity 8
Number of Stations (excluding existing MA + Boston terminal)			7 Bus	7 Bus	7 Bus	7 Bus	4 Rail 5 Bus	1 Rail 4 Bus	4 Rail 8 Bus
Composite/Environmental Goals			**no change**	**low**	**low**	**low**	**medium**	**low**	**low/ medium**
Composite/Environmental Sub-Goal 1: catalyze more compact, infill transit supportive land use and development patterns			**no change**	**low/no change**	**low/no change**	**low/no change**	**low/ medium**	**low**	**low**
Concord, NH	X	X	no change	n/a	n/a	n/a	n/a	n/a	low [3]
Manchester, NH: Granite Street	X	X	no change	low/no change	low/no change [2]	low/no change [2]	medium [4]	low/no change [1,2]	medium [4]
Bedford/MHT	X		n/a	n/a	n/a	n/a	low/no change [6]	n/a	low/no change [6]
N. Londonderry, NH: Exit 5		X	no change	low/no change [1]	low/no change [2]	low/no change [2]	low/no change	low/no change [1,2]	no change [1,2]
Londonderry, NH: Exit 4		X	no change	low/no change [1]	low/no change [2]	low/no change [2]	low/no change	low/no change [1,2]	no change [1,2]
Nashua, NH: Exit 8		X	no change	low/no change [1]	low/no change [2]	low/no change [2]	no change/ negative [5]	no change/ negative [5]	no change [1,2]
Nashua, NH: Crown Street	X		n/a	n/a	n/a	n/a	low/medium [3,4]	n/a	low/ medium [3,4]
South Nashua, NH: Spit Brook Road or Pheasant Lane Mall	X		n/a	n/a	n/a	n/a	low [3]	low [3]	n/a
Tyngsborough, MA: Exit 36		X	no change	low/no change [1]	low/no change [2]	low/no change [2]	n/a	n/a	n/a
Salem, NH: Exit 2		X	no change	low/no change [1]	low/no change [2]	low/no change [2]	low/no change [1]	low/no change [1]	no change [1,2]

[1] Traditional bus service was not correlated to changing or encouraging more transit-oriented land use and development patterns, particularly in systems with highway service and park-and-ride commuter stations
[2] Bus on shoulder was not correlated to changing or encouraging more transit-oriented land use and development patterns, particularly in systems with highway service and park-and-ride commuter stations
[3] Proposed station location, local real estate conditions, accessibility and urban design, and service schedule suggest some positive potential for transit-oriented development
[4] Proposed station location, local real estate conditions, accessibility and urban design, and service schedule suggest positive potential for TOD
[5] Elimination of bus service may reduce or eliminate the marginal correlations of bus service to TOD patterns
[6] Proposed station location, local real estate conditions, accessibility and urban design, function as a park-and-ride, and service schedule suggest little potential for TOD

Table 4.2: Evaluation of Environmental Goals by Alternative and Station

Location	Rail Station (Proposed)	Bus Station (Existing)	Alternative						
			Base	Expanded Base	Bus on Shoulder	Expanded Bus on Shoulder	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail	Intercity 8
Number of Stations (excluding existing MA + Boston terminal)			7 Bus	7 Bus	7 Bus	7 Bus	4 Rail 5 Bus	1 Rail 4 Bus	4 Rail 8 Bus
Composite/Environmental Sub-Goal 2: reduce reliance on cars for trips/errands			**no change**	**medium**	**low**	**medium**	**medium**	**low/ medium**	**medium**
Concord, NH	X	X	no change	n/a	n/a	n/a	n/a	n/a	medium [7]
Manchester, NH: Granite Street	X	X	no change	medium [7]	low [8]	medium [8]	high [7,8]	low/no change [7,8]	medium [7]
Bedford/MHT	X		n/a	n/a	n/a	n/a	low [7]	n/a	medium [7]
N. Londonderry, NH: Exit 5		X	no change	medium [7]	low [8]	medium [8]	low/no change [7]	low/no change [7,8]	no change [7,8]
Londonderry, NH: Exit 4		X	no change	medium [7]	low [8]	medium [8]	low/no change [7]	low/no change [7,8]	no change [7,8]
Nashua, NH: Exit 8		X	no change	medium [7]	low [8]	medium [8]	no change/ negative [9]	no change/ negative [9]	no change [7,8]
Nashua, NH: Crown Street	X		n/a	n/a	n/a	n/a	high [7,8]	n/a	medium [7]
South Nashua, NH: Spit Brook Road or Pheasant Lane Mall	X		n/a	n/a	n/a	n/a	high [7,8]	high [7]	n/a
Tyngsborough, MA: Exit 36		X	no change	medium [7]	low [8]	medium [8]	n/a	n/a	n/a
Salem, NH: Exit 2		X	no change	medium [7]	low [8]	medium [8]	low/no change [7]	low/no change [7]	no change [7,8]

[7] Increased service may provide more choice for use in some trips, but only between stations, as this is commuter service, not local service
[8] Increased travel speed may provide more choice for use in some trips, but only between stations, as this is commuter service, not local service
[9] Elimination of bus service may reduce or eliminate choice for some trips

4.2 Social Goals

Social Goals:

- Expand mobility and transportation choice for all ages
- Support low-income households through increased access to jobs

Assessments for the Social Goals are presented in Tables 4.3. The two sub-goals have been assessed together due to the same influencing factors.

Table 4.3: Evaluation of Social Goals by Alternative and Station

Location	Rail Station (Proposed)	Bus Station (Existing)	Stations Served by Alternative						
			Base	Expanded Base	Bus on Shoulder	Expanded Bus on Shoulder	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail	Intercity 8
Number of Stations (excluding existing MA + Boston terminal)			7 Bus	7 Bus	7 Bus	7 Bus	4 Rail 5 Bus	1 Rail 4 Bus	4 Rail 8 Bus
Composite Assessment/Social Goals			**no change**	**low**	**low**	**low**	**low/medium**	**low**	**low/ medium**
Concord, NH	X	X	no change	n/a	n/a	n/a	n/a	n/a	medium [10]
Manchester, NH: Granite Street	X	X	no change	low [10]	low [10]	low [10]	medium [10]	low/no change [10]	medium [10]
Bedford/MHT	X		n/a	n/a	n/a	n/a	medium [10]	n/a	medium [10]
N. Londonderry, NH: Exit 5		X	no change	low [10]	low [10]	low [10]	low/no change [10]	low/no change [10]	low/no change [10]
Londonderry, NH: Exit 4		X	no change	low [10]	low [10]	low [10]	low/no change [10]	low/no change [10]	low/no change [10]
Nashua, NH: Exit 8		X	no change	low [10]	low [10]	low [10]	no change/ negative [11]	no change/ negative [11]	no change [10]
Nashua, NH: Crown Street	X		n/a	n/a	n/a	n/a	medium [10]	n/a	medium [10]
South Nashua, NH: Spit Brook Road or Pheasant Lane Mall	X		n/a	n/a	n/a	n/a	medium [10]	medium [10]	n/a
Tyngsborough, MA: Exit 36		X	no change	low [10]	low [10]	low [10]	n/a	n/a	n/a
Salem, NH: Exit 2		X	no change	low [10]	low [10]	low [10]	low/no change [10]	low/no change [10]	no change [10]

[10] *Increased service or new station will provide more choice for use in some trips, increasing access and mobility*
[11] *Elimination of bus service may reduce or eliminate choice for some trips, reducing access and mobility*

4.3 Economic Goals

Economic Goals:

- Attract employers locally to New Hampshire
- Attract and retains regional employers from New Hampshire to Boston
- Provide improved residency location choice in New Hampshire for commuters to Boston or regional jobs

Assessments for the Economic Goals are presented in Tables 4.4. The three sub-goals have been assessed together due to the same influencing factors.

Table 4.4: Evaluation of Economic Goals by Alternative and Station

Location	Rail Station (Proposed)	Bus Station (Existing)	Stations served by Alternative						
			Base	Expanded Base	Bus on Shoulder	Expanded Bus on Shoulder	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail	Intercity 8
Number of Stations (excluding existing MA + Boston terminal)			7 Bus	7 Bus	7 Bus	7 Bus	4 Rail 5 Bus	1 Rail 4 Bus	4 Rail 8 Bus
Composite Assessment/Economic Goals			**no change**	**medium**	**low**	**medium**	**medium**	**low**	**medium**
Concord, NH	X	X	no change	n/a	n/a	n/a	n/a	n/a	medium [12, 13]
Manchester, NH: Granite Street	X	X	no change	medium [13]	low [13]	medium [13]	medium [12, 13]	medium [12, 13]	medium [12, 13]
Bedford/MHT	X		n/a	n/a	n/a	n/a	medium [12]	n/a	medium [12]
N. Londonderry, NH: Exit 5		X	no change	medium [13]	low [13]	medium [13]	low/no change [13]	low/no change [13]	low/no change [13]
Londonderry, NH: Exit 4		X	no change	medium [133]	low [13]	medium [13]	low/no change [13]	low/no change [13]	low/no change [13]
Nashua, NH: Exit 8		X	no change	medium [13]	low [13]	medium [13]	no change/ negative [13,14]	no change/ negative [13,14]	low/no change [13]
Nashua, NH: Crown Street	X		n/a	n/a	n/a	n/a	medium [12]	n/a	medium [12]
South Nashua, NH: Spit Brook Road or Pheasant Lane Mall	X		n/a	n/a	n/a	n/a	medium [12]	medium [12]	n/a
Tyngsborough, MA: Exit 36		X	no change	medium [13]	low [13]	medium [13]	n/a	n/a	n/a
Salem, NH: Exit 2		X	no change	medium [13]	low [13]	medium [13]	low/no change [13]	low/no change [13]	low/no change [13]

[12] New stations provide more options for local residents to commute within alignment or to Massachusetts/Boston destinations, expanding worker market
[13] Increased service or more reliable service can be perceived as employment market asset
[14] Elimination of some bus service may reduce or eliminate access for some workers to commuting options

5 Summary of Analysis

5.1 Summary Assessment of Goals by Alternative

Table 5.1 presents the composite assessments for each of the three categories of sustainable land use goals by alternative. The summary assessment is a roll-up of the composite assessments.

Table 5.1: Summary of Goals by Alternative

	Alternative						
	Base	**Expanded Base**	**Bus on Shoulder**	**Expanded Bus on Shoulder**	**Manchester Regional Commuter Rail**	**Nashua Regional Commuter Rail**	**Intercity 8**
Environmental Goals	no change	low	low	low	medium	low	low/ medium
Social Goals	no change	low	low	low	low/ medium	low	low/ medium
Economic Goals	no change	medium	low	medium	medium	low	medium
Summary Assessment	**no change**	**low**	**low**	**low/ medium**	**medium**	**low**	**medium**

In summary, the three rail alternatives have higher qualitative assessments of contributing to sustainable land use than the bus alternatives or base scenario. As described in Section 2.0, rail investments have typically been perceived by the public (riders and community stakeholders) as more permanent and as providing greater levels-of-service and benefit than bus enhancements.

Appendix C
Equity Analysis

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1 Introduction

Equitable access to transit investments – and the mobility benefits that these investments confer on riders – is an important consideration when assessing the alternatives developed through the Capitol Corridor Alternative Analysis (AA). Public transit investment supports broad improvements in mobility, but is a particularly critical tool in increasing the mobility of transit-reliant or -dependent populations, including households below the poverty line, minorities, and households in affordable housing units.

U.S. Census data was used to calculate statistics related to income, race, and housing for households and individuals in Census tracts within a half-mile of the Capitol Corridor alternatives (Pan Am Railways [PAR] right-of-way between the state lines of New Hampshire and Massachusetts and the potential rail station location in Concord, New Hampshire; Boston Express (BX) bus route between the state lines of New Hampshire and Massachusetts and the existing Manchester, New Hampshire BX station; and the Concord Coach bus route between the state lines of New Hampshire and Massachusetts and the existing Concord, New Hampshire Concord Coach station).

This data was also collected for the States of New Hampshire and Massachusetts, and the U.S. comparison between the alternatives within the larger geographic context will support the analysis of which alternatives minimize potential adverse impacts on concentrations of households below the poverty line, minority populations, and households in affordable housing units, while supporting equitable transit access by these populations.

2 Income and Poverty

Income is an important element of the equity analysis because the costs associated with car ownership are relatively fixed, and can consume a comparatively larger percentage of lower-income household budgets. Access to transit allows households to maintain mobility and access while reducing the household expenditures on transportation, which then increases the amount of discretionary budget available to the household.

Table 2.1 shows the median income of households in Census tracts within a half-mile of the Capitol Corridor alternatives, the States of New Hampshire and Massachusetts, and the U.S., as well as the percent of the population within a half-mile of the Capitol Corridor alternatives whose household income falls below the federal poverty line.

Table 2.1: Median Households Income and Percent of Population below the Poverty Line

	Median Household Income				% Below Poverty Line		
	2000	2000$ Adjusted for 2011	2011	% Change Adjusted for 2011 $	2000	2011	% Change
Capitol Corridor	--	--	$64,754	--	--	9.0%	--
New Hampshire	$49,467	$64,617	$64,664	0%	6.5%	8.0%	23%
Massachusetts	$50,502	$65,969	$65,981	0%	9.3%	10.7%	15%
U.S.	$41,994	$54,855	$52,762	-4%	12.4%	14.3%	15%

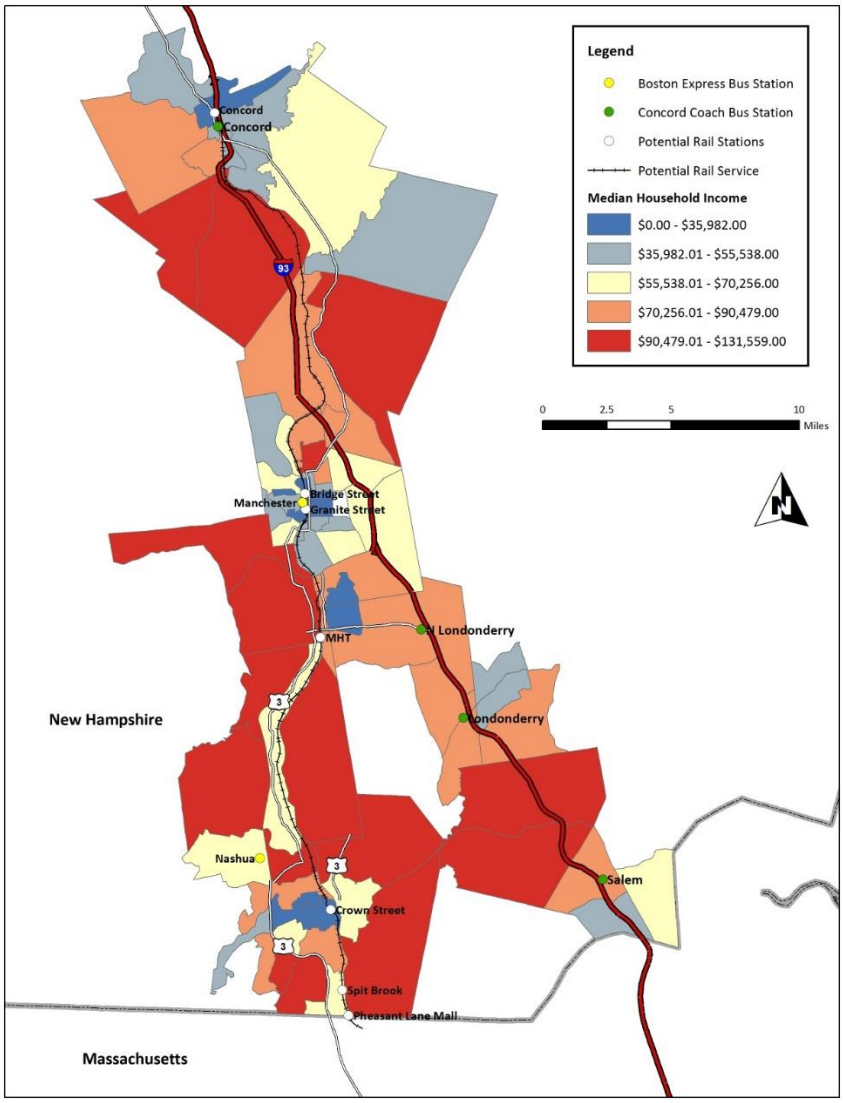
Source: U.S. Census 2000, ACS 2007-2011

The 2011 median household income of the Census tracts within a half-mile of the Capitol Corridor alternatives is approximately the same as the median household income for the State of New Hampshire. The 2011 percentage of the population below the poverty line is also lower in the Capitol Corridor than in Massachusetts or the U.S.

2.1 Median Household Income

While median household income within the Capitol Corridor is comparatively high, median household income declines in the urban areas, closer to where the potential rail stations would be located. Figure 2.1 shows Census tracts within a half-mile of all Capitol Corridor alternatives.

Figure 2.1: Median Income in Capitol Corridor by Census Tract



The median income in the cities of Concord, Manchester, and Nashua are all lower than the areas immediately surrounding each of these cities. Alternatives that have central-city station locations would expand the mobility options of the comparatively lower-income households that are concentrated in the urban areas. Service and operational improvements made to the BX service as part of the bus-based Capitol Corridor alternatives are unlikely to adversely impact comparatively lower-income households within the corridor; however, these alternatives are also unlikely to improve access to transit by this population because they will not result in the construction of new stations (and improved transit access) in areas with comparatively lower-income households.

2.2 Poverty

The percent of Capitol Corridor population living below the poverty line is consistent with or lower than state or national rates (Table 2.2).

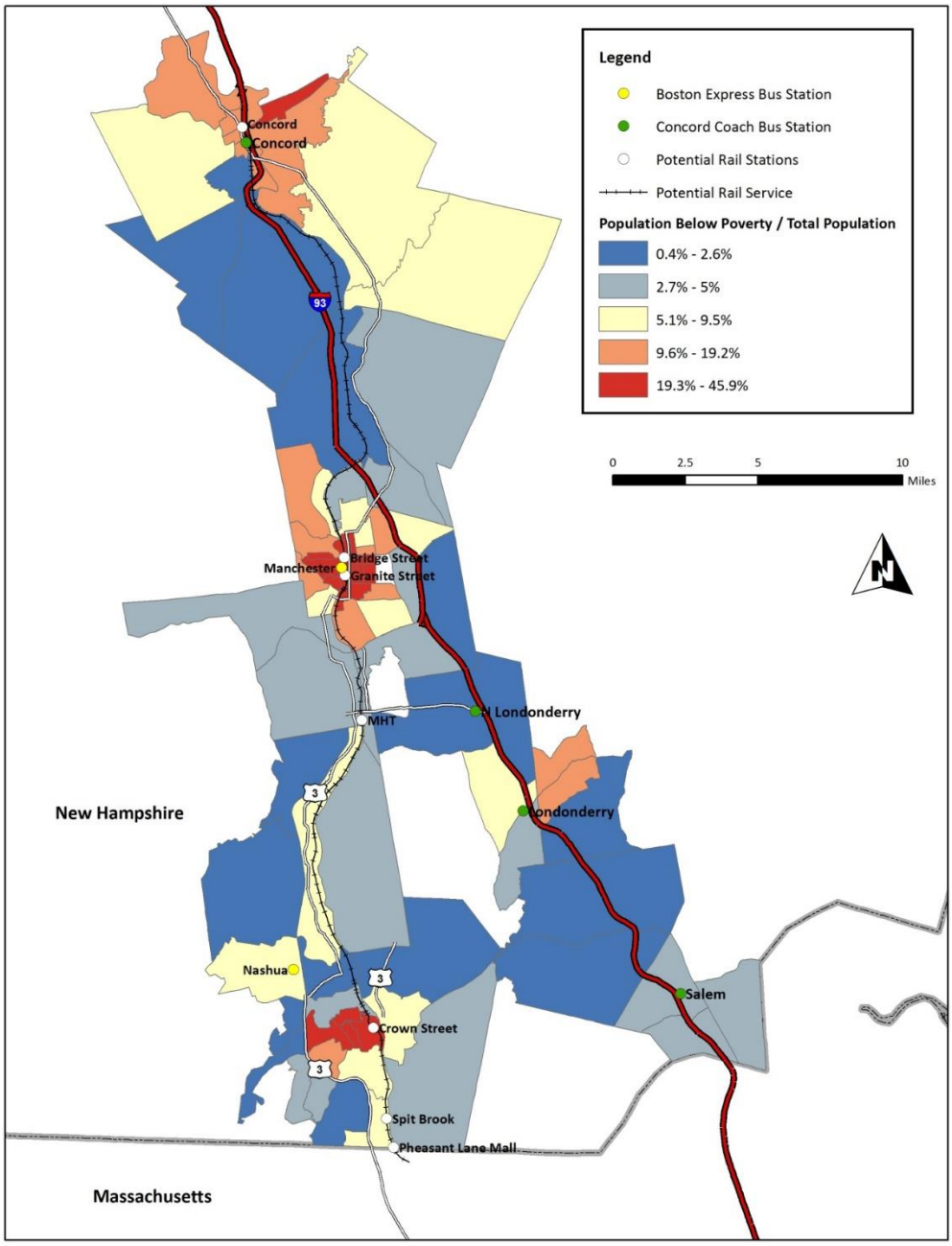
Table 2.2: Percent of Population Living below the Poverty Line

Geography	% Below Poverty Line
Capitol Corridor	9%
New Hampshire	8%
Massachusetts	11%
U.S.	14%

Source: U.S. Census, ACS 2008-2012

However, the poverty levels are comparatively higher in the central areas of Concord, Manchester, and Nashua. As Figure 2.2 shows, the poverty level in those downtowns ranges from 19 to 46 percent. Transit investments that directly serve these urban households living below the poverty line would promote equity through increased access to comparatively lower-cost transportation options. Service and operational improvements made to the BX service as part of the bus-based Capitol Corridor alternatives are unlikely to adversely impact people living below the poverty line within the corridor; however, these alternatives are also unlikely to improve access to transit by this population because they will not result in the construction of new stations (and improved transit access) in areas with comparatively large shares of the population living below the poverty line.

Figure 2.2: Percent of Population Living Below the Poverty Line



3 Minority Population

Approximately 10 percent of the population in Census tracts within a half-mile of the Capitol Corridor alternatives is non-white. Though this is higher than the minority population found within the State of New Hampshire (six percent), it is substantially lower than the percent of minority population found in the State of Massachusetts (19 percent) and the U.S. (26 percent), as shown in Table 3.1.

Table 3.1: Minority Population

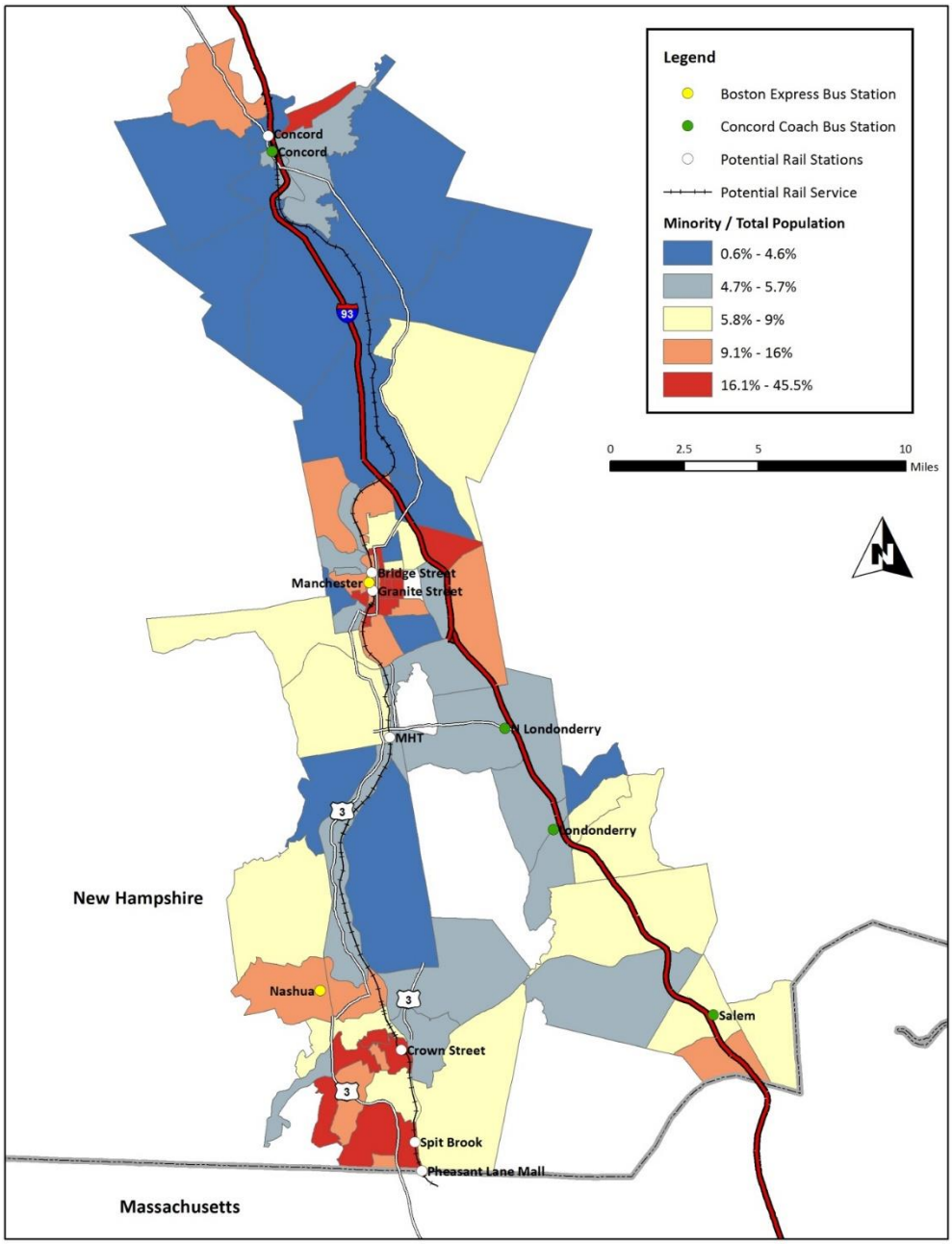
Geography	% Minority
Capitol Corridor	10%
New Hampshire	6%
Massachusetts	19%
U.S.	26%

Source: U.S. Census, ACS 2008-2012.

While the data shows that the share of minority population within the Capitol Corridor is comparatively lower than is found throughout Massachusetts and across the U.S., minority share of the population is comparatively higher in the central areas of Concord, Manchester, and Nashua. The minority population share in some parts of these cities reaches 45 percent. Figure 3.1 illustrates shares of minority population within the Capitol Corridor.

Alternatives that serve the downtown core of Concord, Manchester, and Nashua will serve the greatest shares of minority populations within the Capitol Corridor. Service and operational improvements made to the BX service as part of the bus-based Capitol Corridor alternatives are unlikely to adversely impact minority populations within the corridor; however, these alternatives are also unlikely to improve access to transit by this population because they will not result in the construction of new stations (and improved transit access) in areas with comparatively large shares of minority populations.

Figure 3.1: Minority Share of the Population



4 Affordable Housing

Many cities and states choose to develop voluntary or mandatory affordable housing statutes as a means to maintain an economically-diverse population and support diversity of housing choice.

New Hampshire has a Workforce Housing Law that went into effect on January 1, 2010. This law codifies and clarifies the 1991 New Hampshire Supreme Court decision in *Britton v. Town of Chester*, and requires all municipalities to provide reasonable and realistic opportunities for the development of workforce housing. It does not require that municipalities set aside a set percentage of its housing stock as affordable.

Here are some highlights of New Hampshire's Workforce Housing law:

- In every municipality that exercises the power to adopt land use ordinances and regulations, such ordinances and regulations must provide reasonable and realistic opportunities for the development of workforce housing, including rental multi-family housing. To provide such opportunities, lot size and overall density requirements for workforce housing must be reasonable. A municipality that adopts land use ordinances and regulations must allow workforce housing to be located in a majority, but not necessarily all, of the land area that is zoned to permit residential uses within the municipality.
- "Workforce housing" means housing that is intended for sale and that is affordable to a household with an income of no more than 100 percent of the median income for a four-person household for the metropolitan area or county in which the housing is located.
- "Workforce housing" also means rental housing that is affordable to a household with an income of no more than 60 percent of the median income for a three-person household for the metropolitan area or county in which the housing is located.
- Housing developments that exclude minor children from more than 20 percent of the units or in which more than 50 percent of the dwelling units have fewer than two bedrooms must not constitute workforce housing.

Concord, Manchester, and Nashua each have several affordable housing developments within a half-mile radius of the potential rail station locations. While the income of the households targeted for residence in these affordable housing units may not fall below the federal poverty line (as discussed in Section 2.0), additional comparatively lower-cost alternatives to car ownership (such as access to transit) can help to reduce the share of household income spent on transportation costs. Service and operational improvements made to the BX service as part of the bus-based Capitol Corridor alternatives are unlikely to adversely impact existing or planned affordable housing units; however, these alternatives are also unlikely to improve access to transit by this population because they will not result in the construction of new stations (and improved transit access) in areas with concentrations of affordable housing.

4.1 Concord

There are 11 affordable housing sites within a half-mile of the potential Concord rail station. Within the 11 sites, there are 398 affordable housing units (Figure 4.1 and Table 4.1).

Figure 4.1: Affordable Housing Sites in Concord

Table 4.1: Concord Affordable Housing Developments

Development Name	# of Units	Development Name	# of Units
Bicentennial Square	16	Pitman Place	105
Fellowship House	10	Pleasant Street	9
Firehouse Block	15	Union Street	4
Firehouse Block – Elderly	68	The Endicott Hotel	36
John F Kennedy	86	1820 House	4
		Mennino Place	45
		Total Units	**398**

4.2 Manchester

There are 17 affordable housing sites within a half-mile radius of the proposed Granite Street Manchester rail stations. There are a total of 675 affordable housing units within these 17 sites (Figure 4.2 and Table 4.2).

Figure 4.2: Affordable Housing Sites in Manchester

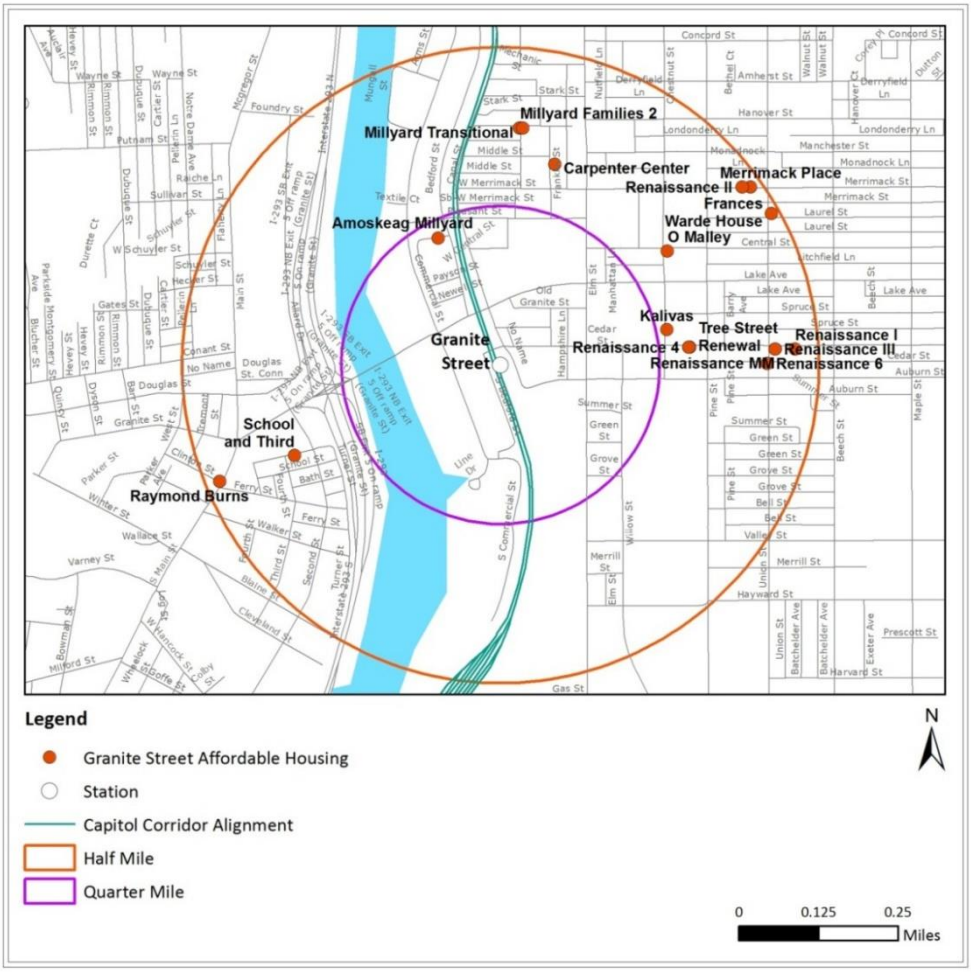


Table 4.2: Manchester Affordable Housing Developments

Development Name	# of Units	Development Name	# of Units
Amoskeag Millyard	48	Raymond Burns	121
Carpenter center	96	School and Third	16
Frances Warde House	26	Tree Street Renewal	23
Kalivas	100	Renaissance 2	10
Merrimack Place	16	Renaissance 6	14
Millyard Families 2	20	Renaissance 1	8
Millyard Transitional	12	Renaissance 3	14
O Malley	100	Renaissance MM	28
Renaissance 4	23	**Total Units**	**675**

4.3 Nashua

There is one affordable housing site within a half-mile of the potential Crown Street rail station; this site has 28 affordable housing units (Figure 4.3 and Table 4.3).

Figure 4.3: Affordable Housing Site in Nashua

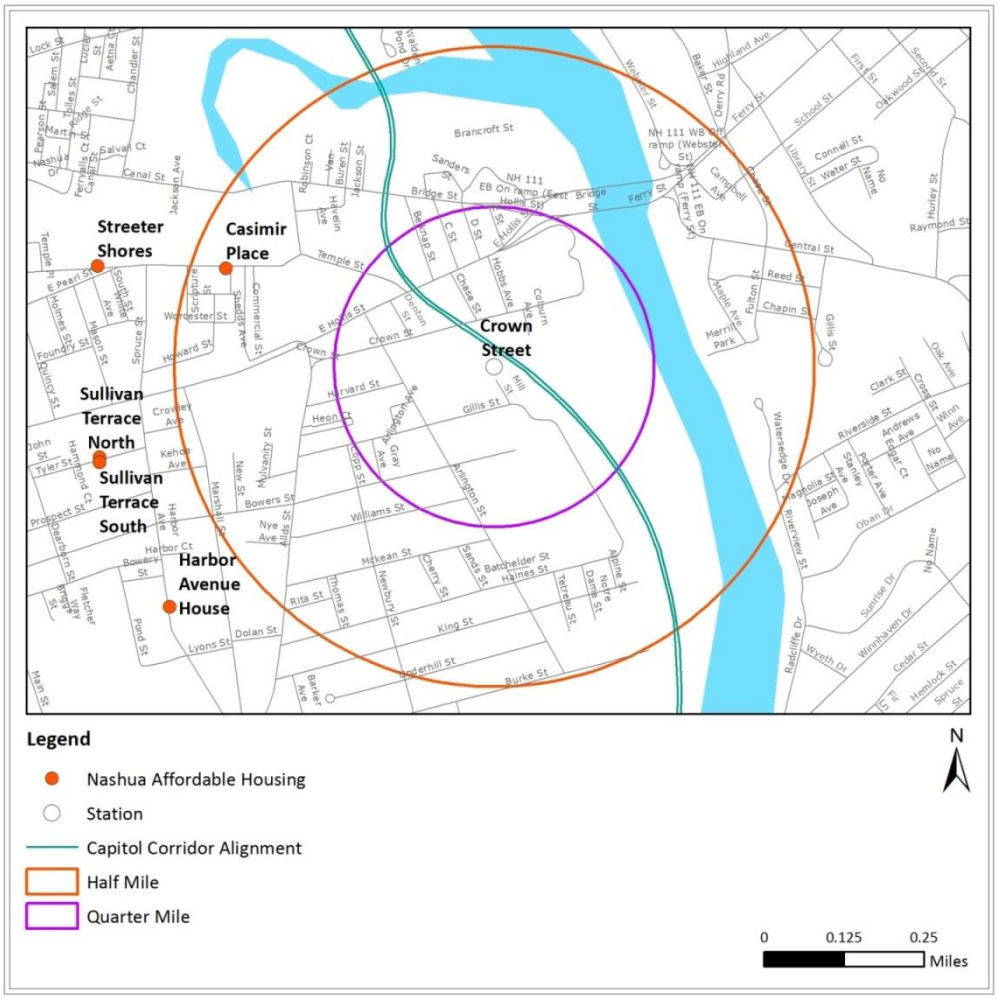


Table 4.3: Nashua Affordable Housing Development

Development Name	# of Units
Casimir Place	28
Total Units	**28**

5 Conclusion

The three populations considered as part of this equity analysis – population below the poverty line, minority populations, and households living in affordable housing units – tend to be concentrated in the central areas of Concord, Manchester, and Nashua. When compared to the base and bus alternatives, the rail alternatives offer comparatively higher levels of service and transit access to these populations with minimal adverse impacts anticipated. The equity of and access to the rail alternatives improves as transit service extends north from Nashua (to Manchester and/or Concord) because those alternatives (Manchester Regional Commuter Rail and Intercity 8), reach more individuals and households living below the poverty line, minority households, and households living in affordable housing units. The base and all bus alternatives would not adversely impact these populations either, but also would not offer expanded access to these populations through new station locations. Table 5.1 provides a summary of the equity metrics for each of the existing bus stations and proposed rail stations.

Table 5.1: Summary of Alternatives

Station Area (Half-Mile Buffer)	Proposed Rail Station	Existing Bus Station	Equity Metrics				Stations Served by Alternative(s)			
			Average Median Income	Population Below Poverty	Minority Population	Affordable Housing Units	Base and all Bus Alternatives	Intercity 8	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail
Concord, NH	X	X	$39,000	18.0%	9.7%	398	X	X		
Manchester, NH	X	X	$30,300	29.5%	26.1%	675	X	X	X	
Bedford/ Manchester-Boston Regional Airport	X		$65,500	4.5%	5.2%	0		X	X	
N. Londonderry, NH		X	$82,900	1.7%	4.7%	minimal	X			
Londonderry, NH		X	$84,700	3.9%	5.2%	minimal	X			
Nashua, NH		X	$80,500	4.4%	12.9%	minimal	X			
Nashua, NH: Crown Street	X		$52,500	14.9%	12.2%	28		X	X	
South Nashua, NH: Spit Brook Road or Pheasant Lane Mall	X		$76,900	4.8%	11.3%	0			X	X
Salem, NH		X	$75,300	3.7%	5.9%	minimal	X			

Sources: U.S. Census, American Community Survey 2008-2012; various local New Hampshire Housing Authorities

Appendix D
Final Capital Costs Methodology and Results

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1 Final Estimates of Capital Cost

Refined capital cost estimates were prepared for more detailed final analysis of the two commuter rail, one intercity rail, and three bus options that advanced through preliminary screening. These are the Manchester Regional Commuter Rail, Nashua Minimum Commuter Rail, Intercity 8, Bus on Shoulder, Expanded Base, and Expanded Bus on Shoulder.

Rail Costs – The Study team revisited the infrastructure requirements for each of the three remaining rail options in meetings with Pan Am Railways (PAR), Massachusetts Department of Transportation (MassDOT), Massachusetts Bay Transportation Authority (MBTA), and New Hampshire Department of Transportation (NHDOT). The Study team was able to refine the preliminary infrastructure requirements based on their feedback and with the aid of two Hi-Rail trips along the corridor with railroad officials. The principal adjustments in the rail infrastructure upgrades necessary for the service include the following:

- Reappraisal and adjustment of passenger train schedules to restrict all meets between passenger trains to three locations:
    - Between Lowell (B25.4) and Tyngsborough Curve (B32.2)
    - Nashua Station (B37.4 to B38.7)
    - Manchester Station (B54.7 to B55.8)
- Reconsidered needs and limits of industrial freight sidings designed to avoid conflicts with passenger trains. Sidings required:
    - Nashua Corporation (B41.8 to B42.5)
    - Anheuser-Busch (B43.8 to B44.8)
    - Merrimack Running Track/Jones Chemical (B45.6 to B47.9)
    - Public Service of New Hampshire Receiving Track (B66.4 to B 68.5)
- Reappraisal of existing track conditions to reduce required track upgrades:
    - Replace only one-third of all ties due to better than anticipated tie conditions (50 percent had been assumed earlier)
    - Reduced rail weight standard from 132# to 112/115# rail due to recent PAR/Amtrak experiences
    - Retaining or relaying existing rail on tangent track and industrial sidings instead of replacing all rails to utilize all life left in existing rail and minimize initial required capital outlays. Relay and retained rail would need to be replaced in a multiyear program that would begin approximately 10 years after start of service.

PAR began supplying data on bridge conditions, track conditions, crossings, and other infrastructure in late March of 2014. Using this information together with field inspections of track, crossings, and

selected bridges, the Study team engineers were able to assemble more detailed evaluations of the conditions of existing assets. Study team engineers were able to estimate the costs of the various necessary upgrades using information from current and recent passenger rail development projects elsewhere in eastern Massachusetts together with inventory prices from the MBTA's commuter rail department. These cost categories are summarized below.

New and Rebuilt Track – Costs for labor and materials for new and rebuilt track were developed using track construction metrics, costs experienced on the MBTA's recent and current work improving its line to Fitchburg, and using current prices for materials in the MBTA/Massachusetts Bay Commuter Railroad (MBCR) inventory system. The length in miles of new and rebuilt track required for each service option is summarized in Table 1.1. Details showing where track would be replaced, rebuilt, and renewed are found in the conceptual track plans for commuter rail at the end of this report in Appendix A-1 and intercity rail in Appendix B-1. Cost parameters for new and rebuilt track are summarized in Table 1.2.

Table 1.1: Estimated Miles of New and Rebuilt Track by Type of Rail

	Replace Rail with Continuous Welded Rail (CWR)	Replace Rail with Relay Rail	New Track with CWR	New Track with Relay Rail
Manchester Regional Commuter Rail	17.0	18.2	4.6	4.6
Nashua Minimum Commuter Rail	13.2	1.4	4.2	1.2
Intercity 8	26.1	27.0	4.6	6.8

Table 1.2: Cost Parameters and Unit Costs (2014$) for New Track

Cost Element	Quantity	Unit Cost	Subtotal	Source
Cost of New Track (New 115# CWR)			**$1,155,088/mile**	$218.77/foot
Materials			**$616,894**	
Wood Ties	3,249	$47.21	$153,396	MBCR Inventory Value
Ballast (tons)	1,500	$33.64	$50,460	Fitchburg Main Line (ML) Improvement Project
Subballast (tons)	1,000	$36.13	$36,130	Fitchburg ML Improvement Project
Plates	6,498	$15.00	$97,477	MBCR Inventory Value
Spikes	19,495	$0.50	$9,748	MBCR Inventory Value
Anchors	6,498	$1.50	$9,748	MBCR Inventory Value
Thermite Welds	6.6	$512.23	$3,381	Fitchburg ML Improvement Project
CWR Rail (LF)	10,560	$24.30	$256,555	Fitchburg ML Improvement Project
Labor	5,280	$101.93	**$538,193**	Fitchburg ML Improvement Project
New Track (Jointed Relay Rail)			**$970,381/mile**	$183.78/foot
Materials			**$432,188**	
Wood Ties	3,249	$47.21	$153,396	MBCR Inventory Value

Cost Element	Quantity	Unit Cost	Subtotal	Source
Ballast (tons)	1,500	$33.64	$50,460	Fitchburg ML Improvement Project
Subballast (tons)	1,000	$36.13	$36,130	Fitchburg ML Improvement Project
Plates	6,498	$15.00	$97,477	MBCR Inventory Value
Spikes	19,495	$0.50	$9,748	MBCR Inventory Value
Anchors	6,498	$1.50	$9,748	MBCR Inventory Value
Joint Bars (pr)	271	$65.00	$17,600	Fitchburg ML Improvement Project
Bolts	1,625	$2.50	$4,062	Fitchburg ML Improvement Project
Bond Wires	135	$5.67	$768	MBCR Inventory Value
Relay Rail (LF)	10,560	$5.00	$52,800	Jacobs Engineering Estimate
Labor	5,280	$101.93	**$538,193**	Fitchburg ML Improvement Project
Cost of New 115# CWR Replacement Rail			**$662,678/mile**	$125.51/foot
Materials			**$353,914**	
CWR Rail (LF)	10,560	$24.30	$256,555	Fitchburg ML Improvement Project
Ties (33% of ties)	1,083	$47.21	$51,132	MBCR Inventory Value
Anchors	6,498	$1.50	$9,748	MBCR Inventory Value
Plates (10%)	650	$15.00	$9,748	MBCR Inventory Value
Thermite Welds	6.6	$512.23	$3,381	Fitchburg ML Improvement Project
Spikes (67%)	13,062	$0.50	$6,531	MBCR Inventory Value
Ballast (tons)	500	$33.64	$16,820	Fitchburg ML Improvement Project
Labor	3,029	$101.93	**$308,763**	Adjusted Down for Reduced Material
Cost of Used (Relay) Replacement Rail			**$477,971/mile**	$90.52/foot
Materials			**$169,208**	
Relay Rail (LF)	10,560	$5.00	$52,800	Jacobs Engineering Estimate
Ties (33% of ties)	1,083	$47.21	$51,132	MBCR Inventory Value
Anchors	6,498	$1.50	$9,748	MBCR Inventory Value
Plates (10%)	650	$15.00	$9,748	MBCR Inventory Value
Joint Bars	271	$65.00	$17,600	Fitchburg ML Improvement Project
Bolts	1,625	$2.50	$4,062	Fitchburg ML Improvement Project
Bond Wires	135	$5.67	$768	MBCR Inventory Value
Spikes (67%)	13,062	$0.50	$6,531	MBCR Inventory Value
Ballast (tons)	500	$33.64	$16,820	Fitchburg ML Improvement Project
Labor	3,029	$101.93	**$308,763**	Adjusted Down for Reduced Material

Track Switches – Needs for new and renewed switches in the track structure were identified as the track configuration was finalized for each option. Costs for new switches were derived using reported costs for installed switches on the MBTA's ongoing Fitchburg Line Improvement Project. Switch renewals were estimated at two-thirds of the installed cost for an entirely new switch. New and renewed switches for each of the three rail options are listed in Table 1.3.

Table 1.3: New and Renewed Switches by Service Option

Switch Location and Type	Installed Cost (2014$)	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail	Intercity 8
New #15 Crossover (B25.8)	$632,475	1	1	1
Renew #15 Crossover (B25.9)	$421,650	1	1	1
New #15 Turnout (CPF-NC)	$316,238	1	1	1
Renew #15 Turnout (CPF-NC)	$210,825	1	1	1
New #15 Crossover (B29)	$632,475	1	1	1
New #10 Turnout (B29.7) Courier Corp	$184,000	1	1	1
New #20 Turnout (B32.1) Tyngsborough Curve	$434,526	1	1	1
New #15 Turnout (B34.2) to Layover Facility	$316,238		1	
Renew #15 Turnout (CPN9)	$210,825	1		1
Renew #15 Crossover (B37.9) Robies	$421,650	1		1
Renew #15 Turnouts Nashua Yard/Station (B38.7)	$210,825	1		1
New #10 Hand Throw (B42.3) Nashua Corp Siding	$184,000	2		2
Renew #10 Turnout to Nashua Corp	$122,667	1		2
New #10 Hand Throw (B43.5) Anheuser Busch	$184,000	2		2
Renew #10 Turnout (B43.6) Anheuser Busch	$122,667	1		1
New #15 Turnout (B45.4) Merrimack Running Track	$316,238	1		1
New #10 Hand Throw (B45.6) to NE Pole Siding	$184,000	1		1
Renew #10 Hand Throw (B46.1) Jones Chemical	$122,667	1		1
Renew #15 Turnout (B47.8) CPN 20	$210,825	1		1
Renew #10 Turnouts to Manchester Customers	$122,667	3		1
Renew #15 Turnout (B55.3) Manchester Yard	$210,825	1		1
New #15 Turnout (B55.6) to Layover Facility	$316,238	1		1
New #15 Turnout (B55.7) CPN 28 to Concord	$210,825			1
Renew #10 Hand Throw (B66.1) Cement Quebec	$122,667			1
Renew #15 Turnout (B66.4) Perini Siding	$210,825			1
Renew #10 Hand Throw (B67) Coastal Wood	$122,667			1
New #10 Hand Throw (B68) PSNH Siding	$122,667			1
Renew #15 Turnout (B72.7) Concord Yard	$210,825			1
Renew #10 Hand Throw (B73) Scrap Yard	$122,667			1
New #15 Turnout (B73.6) Loudon Road/Concord Station	$316,238			1

Interlockings and Block Signals – The New Hampshire Main Line has a fully functioning Centralized Traffic Control (CTC) signal system in place between Lowell and CPN28 in Manchester that would be renewed and upgraded for the new passenger service. Existing block signals were identified by reference to PAR documentation. New and renewed interlockings were identified in the track configuration planning process. Estimated signal costs for new interlockings were based on average value for six new interlockings constructed on the nearby MBTA Fitchburg ML. Estimated costs to renew block signals were derived from the same source. Costs for interlocking renewal were estimated at two-thirds the cost of a new interlocking. See Table 1.4.

Table 1.4: New and Renewed Interlockings and Block Signals

Interlocking Location and Treatment	Installed Cost (2014$)	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail	Intercity 8
Renew CPF-LO	$683,295	1	1	1
Renew Western Avenue	$683,295	1	1	1
New CPF-NC	$1,024,942	1	1	1
New CPN2 Crossover (B29)	$1,024,942	1	1	1
New CPN4	$1,024,942	1	1	1
Renew CPN6 So Nashua Station	$1,024,942	1	1	1
Renew CPN9	$683,295	1		1
Renew Nashua	$683,295	1		1
Renew CPN13 (12.86) Hills Ferry	$683,295	1		1
New CPN 18	$1,024,942	1		1
Renew CPN20	$683,295	1		1
New Manchester	$1,024,942	1		1
Renew CPN28 (Granite Street)	$1,024,942	1		1
New Concord	$1,024,942			1
Block Signals				
Renew 27/27.1	$147,872	1	1	1
Renew 30.6/30.7	$147,872	1	1	1
Renew 352/353 (So Nashua) MP7	$147,872	1	1	1
Renew 14.4/14.5 Mast Road	$147,872	1		1
Renew 16.0/16.1 Anheuser-Busch	$147,872	1		1
Renew 500/499 (MP22)	$147,872	1		1
Renew 540/539 (West Mitchell Street)	$147,872	1		1
Renew 28.6 (Commercial Street)	$147,872			1

Automatic Highway Warning Devices (AHWD) – The rail line has 35 highway and pedestrian crossings between Lowell and Concord. The Study team inspected each crossing with an accompanying PAR signalman to determine its condition and identify necessary signal and warning system upgrades for each crossing. The site survey ran south to north to view the conditions at each of the 35 crossings from Wotton Street in Chelmsford, Massachusetts to Commercial Street in Manchester, New Hampshire. The specific cities and towns visited and the number of active crossings include Chelmsford (3), Tyngsborough (2), Nashua (6), Merrimack (4), Manchester (14), Hooksett (2), and Bow (4).

The Study team's estimate includes all material and labor to purchase and install new equipment and remove and dispose of old equipment including a five percent design contingency. The estimate includes costs for crossing houses complete with racks, crossing controllers, relays and wiring necessary for the control of the wayside equipment. Constant warning time control equipment was included in the estimate due to the variation in speeds between passenger trains and freight trains that will coexist on the line. Wayside equipment has been determined for each location to be either a two- or four-quadrant gate system or flasher-only system with foundations, cable, lights, and bells. A cost for a power service up-grade at each location was included. **All estimated backup details are based on 2014 dollars**. This estimate does not include any costs for the operating contractor (force account), future escalation, contractor's general conditions, overhead, profit, bond, or any other allowances. Other general information and assumptions used in developing this cost estimate include the following:

1. Review of Information contained in the U.S. Department of Transportation (USDOT) Crossing Inventory.
2. Material and labor costs for contractor work are based on various sources, including estimating publications, historical contractor rates from similar projects bids, and experience of the estimators. A material list estimate from Safetran Systems dated 2004 was also used as reference. Material costs from that estimate (where used) were escalated to be consistent with recent cost information.
3. The cost estimate includes assumption of manpower and assumes all work will be done on straight time.
4. The overall cost does not include any credit for salvageable equipment.
5. The cost estimate does not include any cost for upgrades to the wayside signal system.
6. Costs are included for interface at locations where electric switch locks may be required.
7. Cost was added at Crown Street and E. Hollis Street in Nashua between the main line and the branch line specifically for a crossing control interface between the two locations.
8. From the site survey it was observed that the Manchester traffic signals along Canal Street provide signage and a steady flashing yellow light in advance of the crossing for warning of the motorist. Cost for an upgrade to this traffic system is not included.
9. From the site survey it was observed that several locations have traffic signals within 200 feet of the Highway Rail Grade Crossing Warning System and will need to be interconnected to pre-empt the traffic signals in accordance with the Manual on Uniform Traffic Control Devices (MUTCD).

The resulting signal cost estimates for each crossing are shown in Table 1.5.

Table 1.5: Estimated Signal Costs for AHWD Upgrades (2014$)

City	State	Grade Crossing	MP	Cost
Chelmsford	MA	Wotton Street	29.1	$241,750
Chelmsford	MA	Wellman Road	29.6	$260,650
Chelmsford	MA	Cross Street	30.0	$298,576
Tyngsborough	MA	New England Marine	30.5	$298,576
Tyngsborough	MA	Helena Drive/River Road	33.5	$258,203
Segment Total				**$1,357,755**
Nashua	NH	East Glenwood	36.9	$258,203
Nashua	NH	Crown Street	38.8	$324,364
Nashua	NH	East Hollis Street	38.9	$297,767
Nashua	NH	Bridge Street	39.0	$266,267
Nashua	NH	Hills Ferry Road	40.8	$258,203
Merrimack	NH	Mast Road	42.4	$258,203
Merrimack	NH	Anheuser-Busch	43.7	$258,203
Merrimack	NH	Star Drive	44.1	$258,203
Merrimack	NH	New England Pole	45.7	$258,203
Manchester	NH	Pine Island Road	52.1	$220,403
Manchester	NH	Winston Road	52.6	$225,653
Manchester	NH	West Mitchell Street	54.0	$291,635
Manchester	NH	Sundial Avenue (Dunbar Street)	54.6	$225,653
Manchester	NH	Bryon Street	54.7	$238,757
Manchester	NH	Depot Street	55.6	$13,304
Segment Total				**$3,653,026**
Manchester	NH	Granite Street	55.7	$26,174
Manchester	NH	Pleasant Street	55.9	$288,485
Manchester	NH	Pedestrian Crossing #1	56.0	$132,190
Manchester	NH	Spring Street	56.2	$288,485
Manchester	NH	Kidder Street	56.3	$288,485
Manchester	NH	Pedestrian Crossing #2	56.5	$132,190
Manchester	NH	Commercial Street	56.6	$288,485
Manchester	NH	Eve Street (Chauncey Avenue)	58.7	$263,453
Hooksett	NH	Old Londonderry Turnpike	64.3	$263,453
Hooksett	NH	Edgewater Drive	64.8	$263,453
Bow	NH	Johnson Road	66.3	$263,453
Bow	NH	Robinson Ferry	68.3	$263,453
Bow	NH	Gavins Falls Road	69.8	$263,453
Bow	NH	Hall Street	71.0	$284,453
Segment Total				**$3,309,669**

Grade Crossing Track Renewals – Each of the highway grade crossings would also be renewed with new track and paving material. The estimated cost for upgrading each of highway grade crossings was based on the average value to upgrade the track and crossing material for six substantial crossings on the MBTA's ongoing Fitchburg Line Improvement Project at $165,950 per crossing.

Bridges – There are 25 railroad bridges along the route between Lowell and Concord spanning an aggregate 2,100 feet over waterways and roadways. The Study team obtained inspection reports, plans, and documentation for each bridge from PAR and the MBTA. The Study team combined this information with selected field inspections to estimate costs to rehabilitate each of the railroad bridges along the route. The assessment of the bridge structures was limited to review and evaluation of this available information only. The scope of this Study does not include bridge inspection and/or development of an independent load capacity rating for any of the bridges. Available information used in the assessment and evaluation of the 25 bridges within the Study limits includes the following:

1. Bridge Inspection Reports obtained from MBCR
2. Bridge Inspection Reports obtained from PAR
3. Bridge Rating Reports obtained from PAR
4. Bridge Plans obtained from PAR
5. Video and photos from a Hi-Rail trip along the rail corridor
6. Photographs of some bridges where access was possible
7. GIS mapping and online aerial photos of the bridges

A Bridge Summary Sheet was developed for each bridge to summarize the basic information and condition of each bridge as identified in available bridge inspection reports. Based on condition ratings, inspector notes and available photographs, a recommended scope of repairs is presented, with concept-level cost item quantities identified. The recommended repairs were also given a weighted rating of "Minor," "Moderate," or "Extensive" based on a subjective evaluation of the available information. Unit costs for various repair/rehabilitation work items were utilized for each of the three weighted ratings, and the appropriate unit cost was then applied to the specific cost item quantity for the given bridge.

The condition of each bridge is summarized in Table 1.6. Bridge repair cost information was developed for the purpose of establishing order-of-magnitude capital investment levels and considered as representative of preliminary conceptual repair/rehabilitation requirements. As project design development advances, more accurate requirements and development of associated costs at each bridge will be required based on further engineering assessment, including hands-on inspections and load capacity ratings for two bridges that have not recently been rated.

Table 1.6: Estimated Bridge Rehabilitation Costs (2014$)

Location		Length (Feet)	Bridge Structure	Deck Type	Spans	Rehabilitation Costs
City/Town	Bridge No.					
Lowell, MA	25.62	30' +/-	Deck Plate Girder	Open	1	$41,000
	25.69	154'-6"	Deck Plate Girder	Open	4	$99,000
	26.20	163'-0"	Thru Truss	Open	1	$183,000
Chelmsford, MA	28.65	43'-8"	Stone Arch	Ballast	2	$29,000
	29.10	13'-0"	I-Beam	Open	1	$58,000
Tyngsborough, MA	32.46	45'-9"	Frame Trestle	Open	6	$1,647,000
	32.56	12'-3"	Reinforced Concrete	Ballast	1	$50,000
Nashua, NH	37.87	17'-3"	Stone Arch	Ballast	1	$5,000
	39.22	113'-2"	Thru Truss	Open	1	$72,000
	39.39	35'-0"	Reinforced Concrete	Ballast	2	$75,000
	41.77	47'6"	Deck Plate Girder	Ballast	1	$422,000
Merrimack, NH	44.76	16'-0"	Reinforced Concrete	Reinforced Concrete Slab (RCS)	1	$95,000
	44.92	108'-8"	Deck Plate Girder	Ballast	3	$1,011,000
	46.22	111'-6"	Deck Plate Girder	Ballast	2	$980,000
	47.80	10'-0"	Reinforced Concrete	RCS	1	$8,000
Bedford, NH	51.84	655'-3"	Thru Truss	Ballast	4	$5,956,000
Hooksett, NH	60.53	12'-0"	Reinforced Concrete	RCS	1	$50,000
	61.21	15'-0"	Reinforced Concrete	RCS	1	$21,000
	64.32	487'-6"	Thru Truss	Ballast	3	$4,478,000
Bow, NH	67.63	15'-0"	Reinforced Concrete	RCS	1	$21,000
	70.82	17'-0"	Reinforced Concrete	RCS	1	$21,000
	71.12	11'-0"	Reinforced Concrete	RCS	1	$21,000
Concord, NH	71.47	16'-0"	Reinforced Concrete	RCS	1	$23,000
	71.54	10'-0"	Reinforced Concrete	RCS	1	$21,000
	73.33	Unknown	I-Beam	Timber	1	$16,000

Stations – Costs for station development were estimated for a number of alternative sites. Estimates relied on unit costs recently generated for a directly applicable peer site. The MBTA Fitchburg Commuter Rail-Wachusett Extension Project is currently under construction. The estimated Wachusett Station construction cost with escalations and contingencies came to $13,303,000 for a station facility with a single-track siding station with one 800-foot high-level side platform and 360 parking spaces.

Detailed costs for Wachusett were used to inform cost estimates for each of the proposed station sites through the use of allocation factors. These include variables such as the number of parking spaces, number of platforms, number of side tracks, square feet of existing wetlands, and whether there was the possibility of contaminated soil disposal. This allowed for the application of the Wachusett station

unit costs even where the characteristics of the sites were different. The costs for a station at the Pheasant Lane Mall site include a parking garage that was estimated at 10 times the cost per space of a surface parking space. This figure is consistent with Jacobs' estimates for other parking garages.

Layover Facilities – Costs to develop layover yards for overnight storage and light maintenance of the service rolling stock were estimated for a number of alternative sites. Estimates relied on unit costs recently generated for a directly applicable peer site. As noted above, the MBTA Fitchburg Commuter Rail-Wachusett Extension Project is currently underway and moving in to construction. The estimated Wachusett layover construction cost with escalations and contingencies came to $13,303,000 for a layover facility with six tracks, including 9,655 track-feet available for the storage of trains.

These detailed costs were used to develop cost estimates for each of the proposed layover facilities through the use of allocation factors. These allocation factors included variables such as the number of storage positions, total track length (feet), and whether there was the possibility of contaminated soil disposal. This allowed for the application of the Wachusett layover facility unit costs even where the characteristics of the sites were different.

Right-of-Way Improvements – Restoration of passenger service on the New Hampshire Main Line will require some right-of-way improvements including relocation of fiber optic lines where new tracks are being restored to the right-of-way, vegetation removal, reestablishing ditches, and cleaning shoulder ballast. The right-of-way hosts three separate private fiber optic installations north from Lowell to Nashua, two between Nashua and Manchester, and one from Manchester north to Concord. Based on the experience of Jacobs' telecommunications engineers, an allowance of $290,400 per route mile was used to estimate the costs of installing replacement fiber optic lines where new tracks were being laid. Allowances for other improvements were derived from earlier studies of the same right-of-way updated to 2014 costs and are listed in Table 1.7.

Table 1.7: Allowances for Right-of-Way Improvements

Right-of-Way Improvement	Unit	Unit Cost (2014$)
Relocate Fiber Optic Lines	Route Mile	$290,400
Vegetation Management	Route Mile	$20,925
Reestablish Ditches	Route Mile	$39,600
Shoulder Ballast Cleaning	Track Mile	$39,930

Positive Train Control – The Rail Safety Improvement Act of 2008 (RSIA) created a new infrastructure requirement for all U.S. commuter railroads. This new requirement should reduce the likelihood of the following:

- Train-to-train collisions
- Injuries to rail roadway workers
- Over-speed derailments
- Accidents due to misaligned switches to sidings

Under the RSIA, all conventional passenger railroads must operate with Positive Train Control (PTC) as soon as possible after December 2015. The MBTA installation of PTC is lagging the 2015 deadline like most of its peers and its ultimate costs are unknown. The Study team employed a 2009 economic analysis prepared by the Federal Railroad Administration (FRA)[1] to account for the cost of PTC, and then escalated the estimates to 2014 at four percent per annum.

At the most basic level, all PTC systems require three equipment elements:

- **Wayside Devices** – Equipment to detect, monitor, and communicate the status of track and switches installed in the field
- **Locomotive/Cab Car Devices** – Equipment to monitor and control train status relative to information on field conditions communicated from central control and wayside equipment
- **Central Office Equipment** – To integrate and communicate information concerning the status of trains, track maintenance crews, switches, signals, and tracks

The relevant work to install onboard locomotive and cab car devices should be completed for the MBTA, PAR, and Amtrak fleets well before the proposed passenger rail service north of Lowell could be implemented. Similarly the PAR and MBTA dispatching offices should have the relevant Central Office Equipment. Any new passenger railway mileage will require the installation of wayside devices.

Using information from the above referenced FRA Study, the Study team conservatively estimated that the more expensive Advanced Civil Speed Enforcement System (ACSES) wayside equipment would be deployed on the route with an average cost of $147,215 per track mile. If Enhanced Traffic Management System (ETMS) is installed, the PTC costs may be lower than estimated here.

Railroad Appliances – Various appliances such as train defect detectors, rail lubricators, and electric locks for hand-thrown turnouts would be required on the refurbished line. Installed unit costs for these appliances and estimated numbers required for each option are listed in Table 1.8.

[1] Roskind, Frank D, Senior Industry Economist, Federal Railroad Administration, Office of Safety Analysis POSITIVE TRAIN CONTROL SYSTEMS: ECONOMIC ANALYSIS. DEPARTMENT OF TRANSPORTATION, FEDERAL RAILROAD ADMINISTRATION, 49 CFR PARTS 229, 234, 235, AND 236 [DOCKET NO. FRA-2006-0132, NOTICE NO. 1] RIN 2130-AC03 July 10, 2009 202 302 9704 pp 112-119 (Retrieved from http://www.fra.dot.gov/downloads/PTC_%20RIA_%20Final.pdf on July 21, 2009)

Table 1.8: Unit Costs and Quantities of Railroad Appliances

Railroad Appliance	Installed Cost (2014$)	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail	Intercity 8
Train Defect Detector	$45,000	1	1	1
Rail Lubricator Unit	$8,000	4	2	6
Electric Locks for Industrial Sidings	$75,000	4	1	5
Electric Locks for Customer Turnouts	$75,000	6	0	12

Multipliers for Allowances – As per typical practice, costs for various professional services and incidental non-itemized expenditures are estimated on the basis of total costs for all rail infrastructure improvements. These multipliers for professional services and incidental work are listed in Table 1.9.

Table 1.9: Professional Services and Incidental Items

Culverts and Retaining Walls	3% of Infrastructure Cost
Environmental (soil disposal, noise abatement, LEED)	3% of Infrastructure Cost
Final Engineering Design	8% of Infrastructure Cost
Construction Phase Engineering Services	4% of Infrastructure Cost

Railroad Services – Mechanisms for estimating the costs for railroad project management, inspections, and protective flagging are reviewed in Table 1.10.

Table 1.10: Railroad Services and Estimated Days of Inspections and Flagging

	Unit Cost	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail	Intercity 8
Railroad Project Management	3% of Infrastructure Cost	N/A	N/A	N/A
Maintenance and Protection of Railroad (Inspections)	$2.00/day	180	90	270
Flagging	$2.00/day	360	180	540

Land – Beyond the railroad right-of-way that will be shared with PAR freight trains, land will be required for stations, parking, and overnight train storage yards. The cost for this land was estimated by consulting local public assessor records in Tyngsborough, Nashua, Bedford, Manchester, and Concord to determine the current assessed value of each parcel that had been identified as necessary for a station or layover yard. Where only a portion of the parcel would be required for the rail facility, Geographic Information System (GIS) tools were used to determine what fraction of the overall parcel would be necessary and to prorate the cost accordingly.

Acquisition of private land for transportation improvements can be a litigious process. An allowance of 220 percent was added to all raw land costs to allow for negotiations, takings, eminent domain, and legal costs. The 220 percent was derived from the Study team's experience working on similar projects in other jurisdictions. New Hampshire's experience may be different. See Table 1.11.

Table 1.11: Assessed Land Value and Estimated Cost (2014$) for Selected Station and Layover Sites

Facility Type	Parcel Size (Acres)	Required Portion	Assessed Value per Acre	Estimated Value	Estimated Cost with 220% Assemblage Factor
Stations					
Tyngsborough	55.640	0.1183	$63,680	$342,380	$1,095,616
Spit Brook Road	40.930	0.2	$510,271	$4,177,080	$13,366,656
Crown Street	6.826	1	$45,224	$308,700	$987,840
Bedford/Manchester Airport or MHT	6.000	0.33	$29,416.67	$444,400	$1,422,080
Granite Street	0.5544	1	$279,132.58	$148,800	$476,160
Stickney Avenue	6.08	1	$237,990	$1,447,000	$4,630,400
Layover Yards					
Spit Brook Road	40.930	0.10	$510,271	$2,088,540	$6,683,328
Manchester	17.7266	0.21	$160,083.55	$592,673	$1,896,555
Stickney Avenue	6.08	1	$237,990	$1,447,000	$4,630,400

Infrastructure Contingency – In accordance with FTA recommendations, a 35 percent contingency was applied to the sum of all infrastructure, engineering, and land costs described above to allow for unforeseen and unusual circumstances that might have been unaccounted for in this engineering cost estimate.

Rolling Stock – Coach requirements were derived using the information concerning the MBTA's current Lowell line ridership and train consist assignments with the Study team's station-by-station weekday ridership estimates to determine which would need additional cars to carry the forecast increase in ridership. Analysis of the schedules also determined that both the Manchester Regional and Nashua Commuter Rail services would require an additional consist in the morning and evening lineups to account for the longer cycle times that service to Nashua or Manchester would entail. The extra train would need to have a locomotive and six coaches.

For the Intercity 8 service, the *Downeaster's* standard consist of four coaches with a locomotive was used as a model. It was further assumed that the Intercity 8 service would operate in the same equipment pool with the *Downeaster's* five train sets adding one more four-car train set, one spare coach, and one spare locomotive to Amtrak's North Station complement.

Equipment requirements for the three final rail service alternatives are summarized in Table 1.12.

Table 1.12: Unit Costs (2014$) and Quantities of Railroad Rolling Stock

Rolling Stock	Purchase Price	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail	Intercity 8
Coaches	$2,530,000	11	6	5
Locomotives	$5,320,000	1	1	2

Trackage Rights – The proposed rail services would be operated on a mix of tracks owned by the MBTA in Massachusetts and by the successors to the Boston and Maine Railroad (B&M) in New Hampshire. The MBTA recently transferred $35 million dollars to PAR in exchange for the right to offer passenger service on B&M/PAR tracks approximately 37 miles north from Tyngsborough, Massachusetts to Concord, New Hampshire. The value of these rights to the MBTA and PAR is approximately $946,000 per route mile. Without these trackage rights the MBTA and NHDOT would need to purchase trackage rights from PAR to operate into New Hampshire. Consequently one of the costs of the project is the $946,000 per route mile one-time trackage fee for every route mile operated into New Hampshire. The estimated value of the MBTA trackage fees for each of the three rail options is summarized in Table 1.13.

Intercity 8 routes operated by Amtrak, in contrast to the MBTA, have statutory rights to operate over every railroad in the nation without paying trackage fees. Consequently, the trackage rights and resulting fees would not be an issue or a cost for Amtrak if Amtrak is the operator of the Capital Corridor intercity rail service.

Table 1.13: MBTA Trackage Right Values by Service Option

	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail	Intercity 8
MBTA Route Miles in New Hampshire	19	1	0
$946,000/Mile	$18 million	$0.95 million	$0

1.1 Summary of Estimated Rail Costs

Estimated capital costs for each rail service option are summarized below and in Table 1.14.

The **Manchester Regional Commuter Rail Option** is projected to cost $143 million for infrastructure and land plus $50 million contingency allowance. The option cost also includes $33 million in rolling stock and $18 million in trackage rights that would be contributed by the Commonwealth of Massachusetts.

The **Nashua Minimum Commuter Rail Option** is projected to cost $73 million for infrastructure and land plus $26 million contingency allowance. The option cost also includes $20 million in rolling stock that would be contributed by the Commonwealth of Massachusetts. The value of the Massachusetts trackage rights for this option is $0.95 million as it would use roughly one mile of PAR right-of-way in New Hampshire to access a station and/or a layover facility at the Spit Brook Road site.

The **Intercity 8 Option** is projected to cost $172 million for infrastructure and land plus a $60 million contingency allowance. The option cost also includes $23 million in rolling stock that would be the responsibility of NHDOT. This option may be operated by Amtrak and, therefore, the value of Massachusetts acquired trackage rights would be zero since Amtrak has statutory authority to operate without acquiring trackage rights from PAR.

Table 1.14: Summary of Projected Capital Costs (2014$)

	Manchester Regional Commuter Rail	Nashua Minimum Commuter Rail	Intercity 8
Main Line Tracks	$29.7	$15.3	$42.1
Track Switches	$6.4	$2.8	$7.8
Interlockings	$10.6	$5.1	$12.0
Block Signals	$1.0	$0.4	$1.2
Grade Crossing Signals	$5.0	$1.4	$8.3
Grade Crossing Track Renewals	$3.3	$0.8	$5.6
Bridges	$10.7	$2.1	$15.4
Stations	$20.8	$6.3	$18.7
Layovers	$12.4	$13.4	$4.8
Right-of-Way Improvements	$6.2	$2.9	$8.8
Positive Train Control	$6.5	$2.9	$9.5
Railroad Appliances	$0.5	$0.1	$1.0
Direct Construction Expense Subtotal	**$113.3**	**$53.7**	**$135.2**
Multipliers for Allowances	$20.4	$9.7	$24.3
Railroad Services	$4.5	$2.1	$5.7
Land for Stations	$1.2	$0.3	$0.9
Land for Layovers	$0.6	$2.1	$1.4
Assemblage Allowance (220%)	$4.0	$5.3	$5.2
Subtotal Land	**$5.9**	**$7.8**	**$7.5**
Contingency	$50.0	$25.6	$60.5
Grand Total (infrastructure)	**$194.5**	**$98.9**	**$233.2**
Coaches	$27.8	$15.2	$12.7
Locomotives	$5.3	$5.3	$10.6
Grand Total (rolling stock)	**$33.2**	**$20.5**	**$23.3**
Trackage Rights	**$18.0**	**$0.9**	**$0.0**
Total Project Value	**$245.6**	**$120.3**	**$256.5**

Bus – Final estimates of capital costs for the bus options revolved around the same two factors applied to derive the preliminary estimates: additional buses required to operate more frequent service and the roadway upgrades required to allow for bus on shoulder operations providing faster peak service for some options.

As noted for the preliminary options, some bus service improvement options entailed increasing the frequency of bus service. These services would require additional rolling stock to operate. The Study team estimated the required number of additional buses by consulting with NHDOT and BX to

determine the size and utilization of the current BX fleet. Study team analysis indicated that amending the current schedule of peak service to operate direct non-stop half-hourly peak service from all six park-and-ride lots currently served by BX would require an addition of 16 buses to BX current fleet of 22 vehicles as shown in Table 1.15.

Table 1.15: BX Vehicle Requirements by Service Option

	Base	Expanded Base	Bus on Shoulder	Expanded Bus on Shoulder
Vehicles to Operate Minimum Service (VOMS)	16	30	16	30
Fleet	22	38	22	38
Spares	6	8	6	8
% Spare	27%	21%	27%	21%

A preliminary estimate of $400,000 was included for new vehicles, but NHDOT informed the Study team that new vehicles would be expected to cost $600,000 each. Study team work on existing highway conditions found sufficient shoulder width for the 22 affected route miles between I-495 and Somerville, Massachusetts along I-93 to allow Bus on Shoulder operations without substantial investment in new right-of-way. A preliminary estimate of $100,000 per route mile[2] had been used based on early experience in Minnesota. For the final estimate a more recent figure of $250,000 per route mile[3] (2007 dollars) was employed. Consistent with FTA guidance, a 35 percent contingency was applied to projected infrastructure costs (see Table 1.16).

Table 1.16: Final Capital Cost Estimates for Bus Options (In Millions, 2014$)

	Base	Expanded Base	Bus on Shoulder	Expanded Bus on Shoulder
Vehicles Cost (millions) *	$0.0	$9.6	$0.0	$9.6
Infrastructure Cost (millions) **	$0.0	$0.0	$7.4	$7.4
Total Capital Cost (millions)	$0.0	$9.6	$7.4	$17.0

** New coaches at $600,000 each*
*** Infrastructure cost of $250,000 per route mile plus a 35% contingency allowance*

[2] *TCRP Synthesis 64 Bus Use of Shoulders,* Peter C. Martin, Wilbur Smith Associates, San Francisco, CA, 2006, pg 20
[3] *TCRP Report 151 A Guide for Implementing Bus On Shoulder (BOS) Systems,* Peter Martin and Herbert S. Levinson, Texas Transportation Institute, 2012, pp 2-5

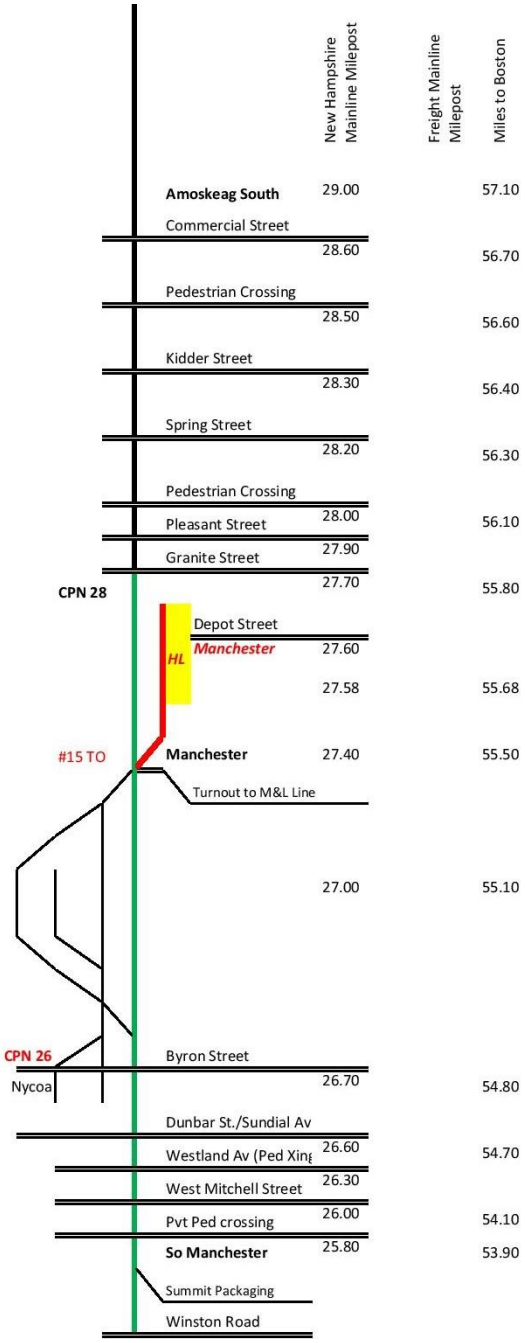
Estimates of Capital Costs – In summary, the final estimates of capital cost for each of the intermediate rail and bus service options are found in Table 1.17.

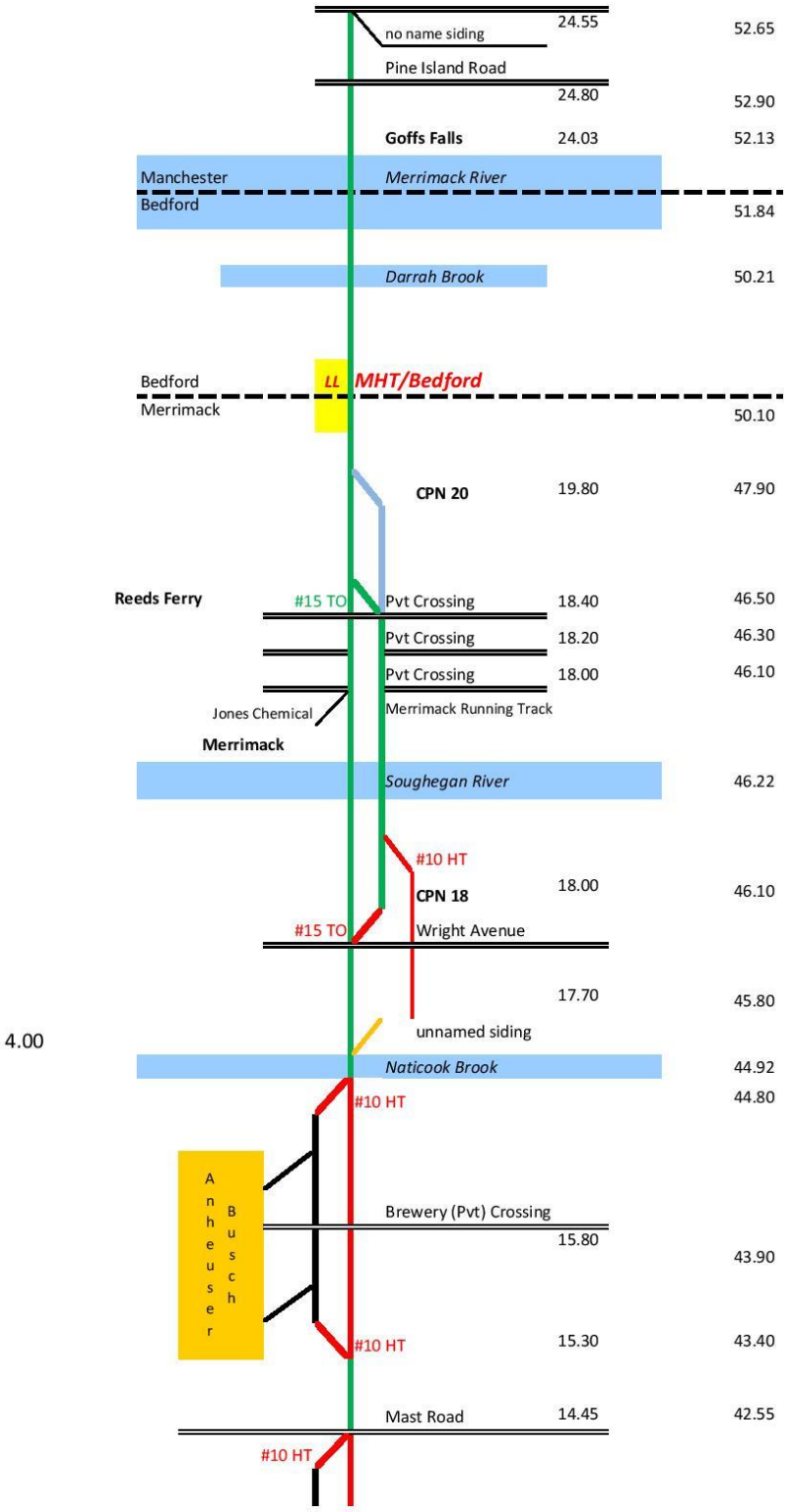
Table 1.17: Final Estimates of Capital Cost (In Millions, 2014)

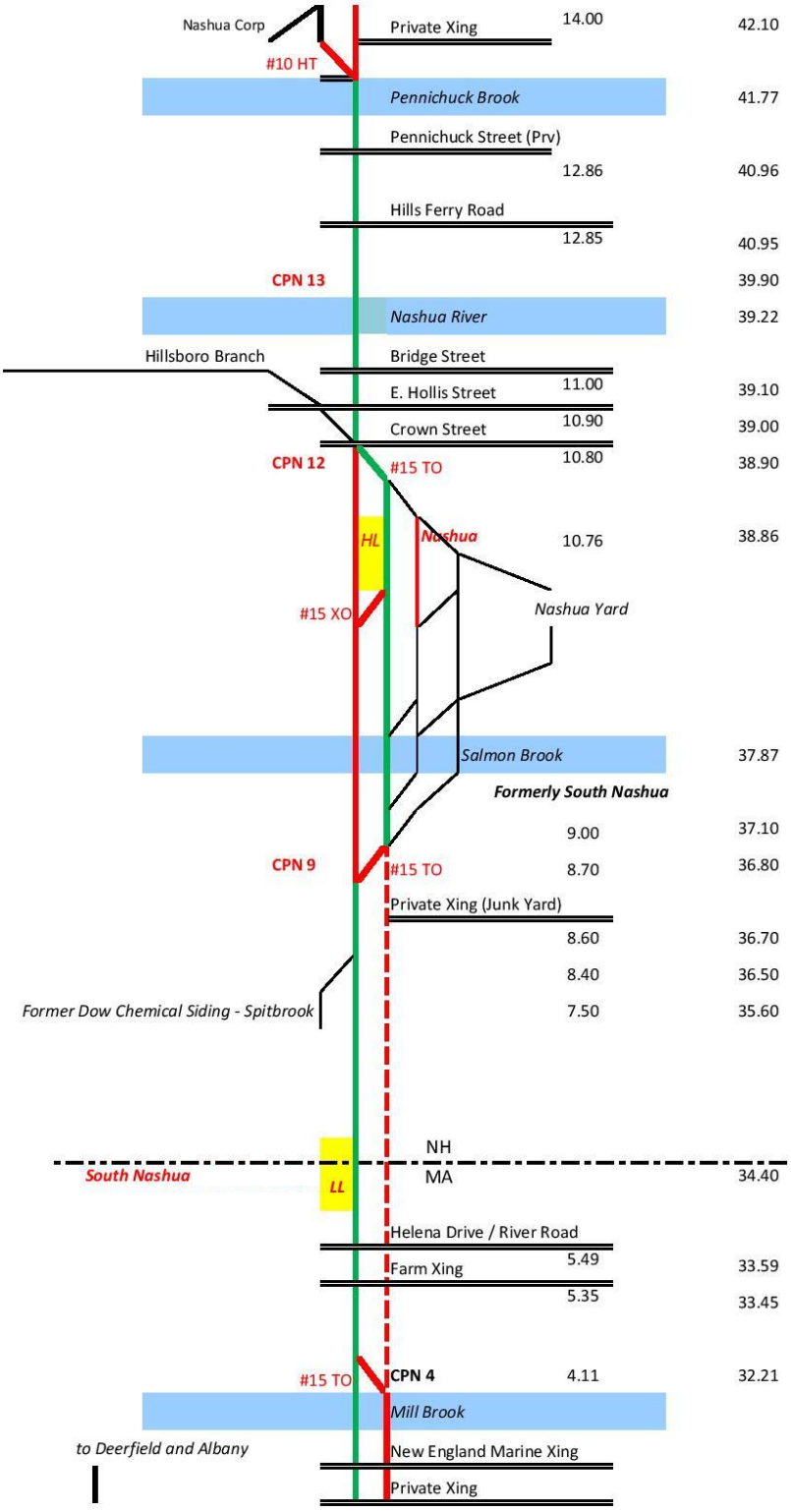
Service Option	Infrastructure, Land, and Contingency	Rolling Stock	MassDOT Trackage Rights	Total
Commuter Rail Options				
Manchester Regional	$194.5	$33.2	$18.0	$245.6
Nashua Minimum	$98.9	$20.5	$0.0	$120.3
Intercity Rail Option				
Intercity 8	$233.2	$23.3	$0.0	$256.5
Bus Service Options				
Base	$0.0	$0.0	$0.0	$0.0
Expanded Base	$0.0	$9.6	$0.0	$9.6
Bus on Shoulder	$7.4	$0.0	$0.0	$7.4
Expanded Bus on Shoulder	$7.4	$9.6	$0.0	$17.0

Appendix A-1: Proposed Commuter Rail Service Option Track Configuration

Figure A-1.1: Manchester Regional Commuter Rail Proposed Track Configuration




24.55
52.65
no name siding
Pine Island Road
24.80
52.90
Goffs Falls
24.03
52.13
Manchester
Bedford
Merrimack River
51.84
Darrah Brook
50.21
Bedford
Merrimack
LL
MHT/Bedford
50.10
CPN 20
19.80
47.90
Reeds Ferry
#15 TO
Pvt Crossing
18.40
46.50
Pvt Crossing
18.20
46.30
Pvt Crossing
18.00
46.10
Jones Chemical
Merrimack Running Track
Merrimack
Soughegan River
46.22
#10 HT
CPN 18
18.00
46.10
#15 TO
Wright Avenue
17.70
45.80
4.00
unnamed siding
Naticook Brook
44.92
#10 HT
44.80
Anheuser Busch
Brewery (Pvt) Crossing
15.80
43.90
#10 HT
15.30
43.40
Mast Road
14.45
42.55
#10 HT


Nashua Corp
Private Xing
14.00
42.10
#10 HT
Pennichuck Brook
41.77
Pennichuck Street (Prv)
12.86
40.96
Hills Ferry Road
12.85
40.95
CPN 13
39.90
Nashua River
39.22
Hillsboro Branch
Bridge Street
E. Hollis Street
11.00
39.10
Crown Street
10.90
39.00
CPN 12
#15 TO
10.80
38.90
HL
Nashua
10.76
38.86
#15 XO
Nashua Yard
Salmon Brook
37.87
Formerly South Nashua
9.00
37.10
CPN 9
#15 TO
8.70
36.80
Private Xing (Junk Yard)
8.60
36.70
8.40
36.50
Former Dow Chemical Siding - Spitbrook
7.50
35.60
NH
South Nashua
LL
MA
34.40
Helena Drive / River Road
5.49
Farm Xing
33.59
5.35
33.45
#15 TO
CPN 4
4.11
32.21
Mill Brook
to Deerfield and Albany
New England Marine Xing
Private Xing

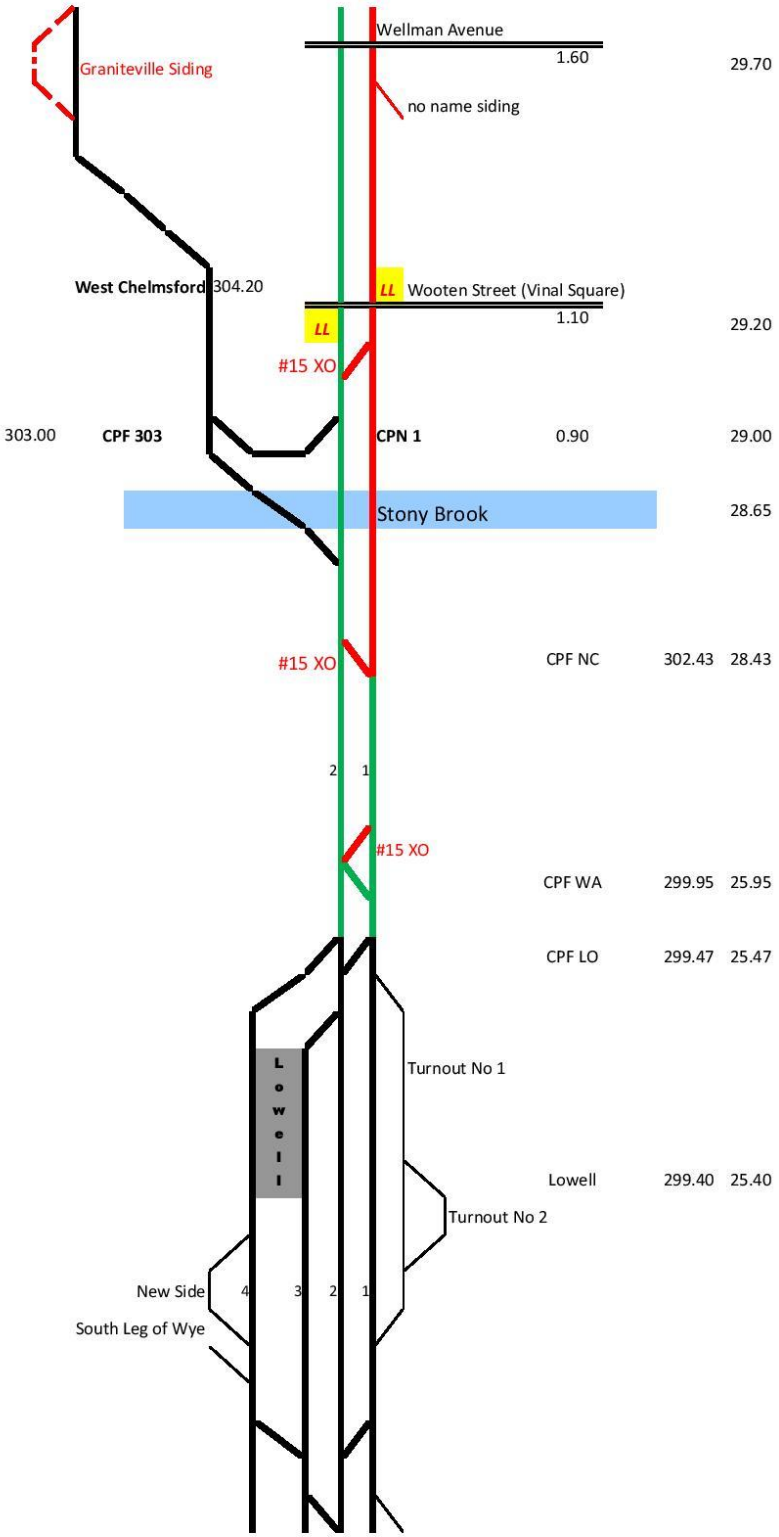
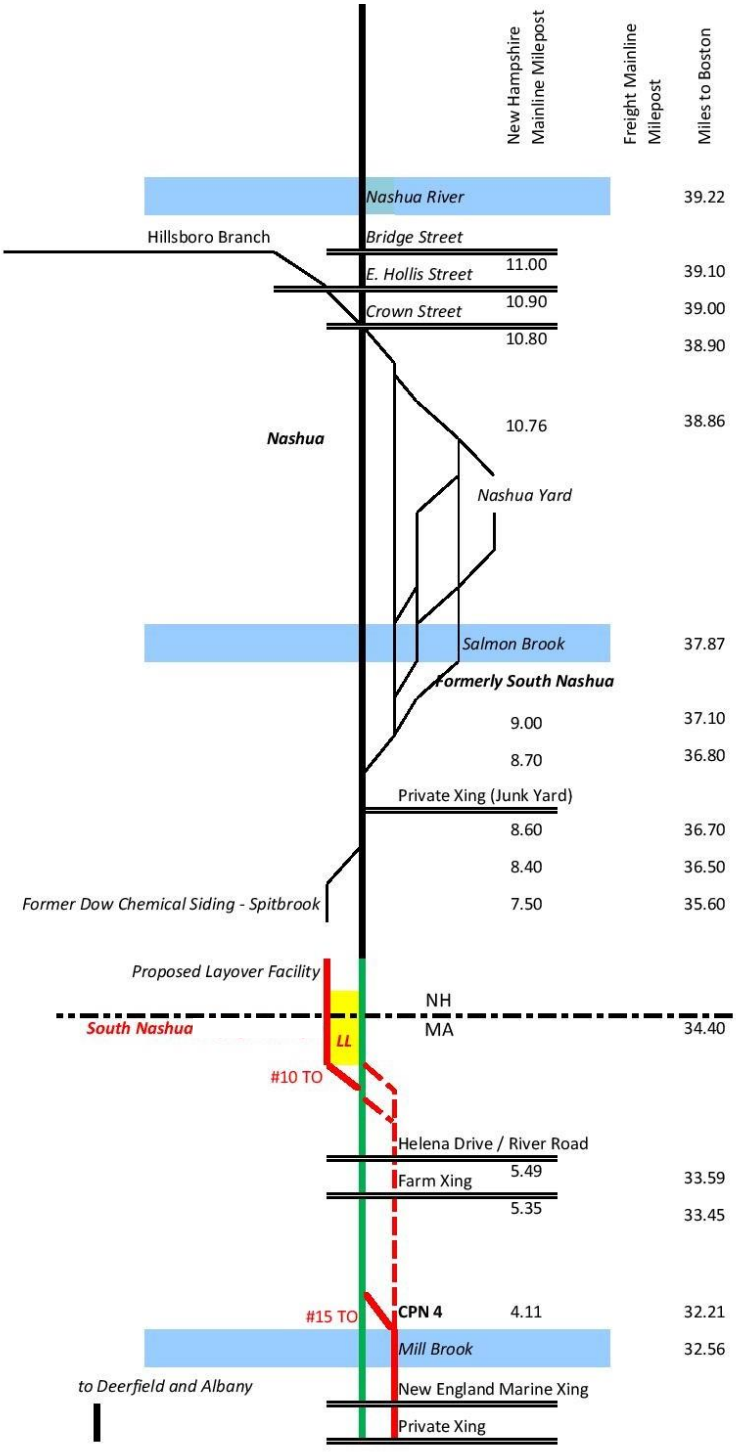
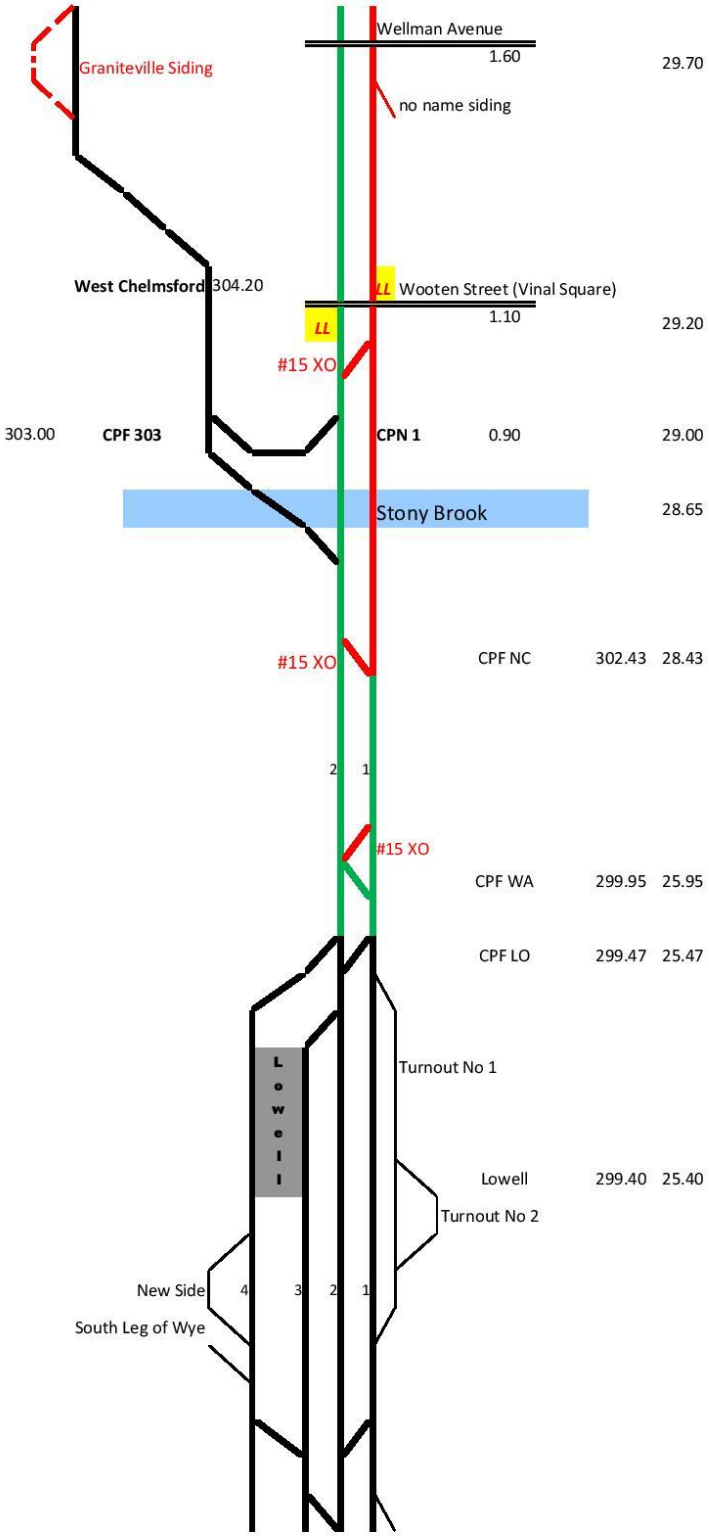

Wellman Avenue
1.60
29.70
Graniteville Siding
no name siding
West Chelmsford 304.20
LL
Wooten Street (Vinal Square)
1.10
29.20
LL
#15 XO
303.00
CPF 303
CPN 1
0.90
29.00
Stony Brook
28.65
#15 XO
CPF NC
302.43
28.43
2
1
#15 XO
CPF WA
299.95
25.95
CPF LO
299.47
25.47
Turnout No 1
Lowell
Lowell
299.40
25.40
Turnout No 2
New Side
4
3
2
1
South Leg of Wye

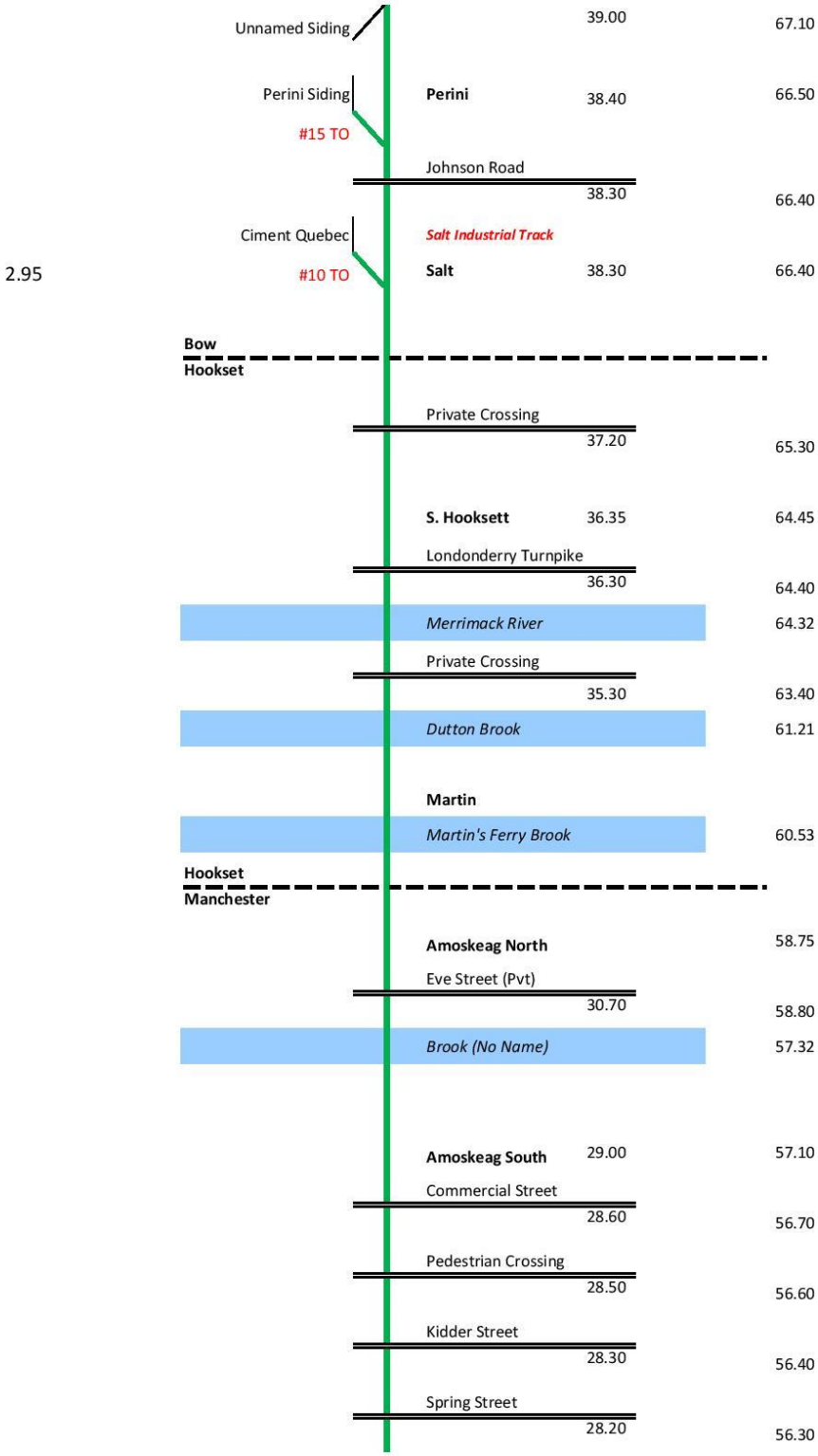
Figure A-1.2: Nashua Minimum Commuter Rail Proposed Track Configuration

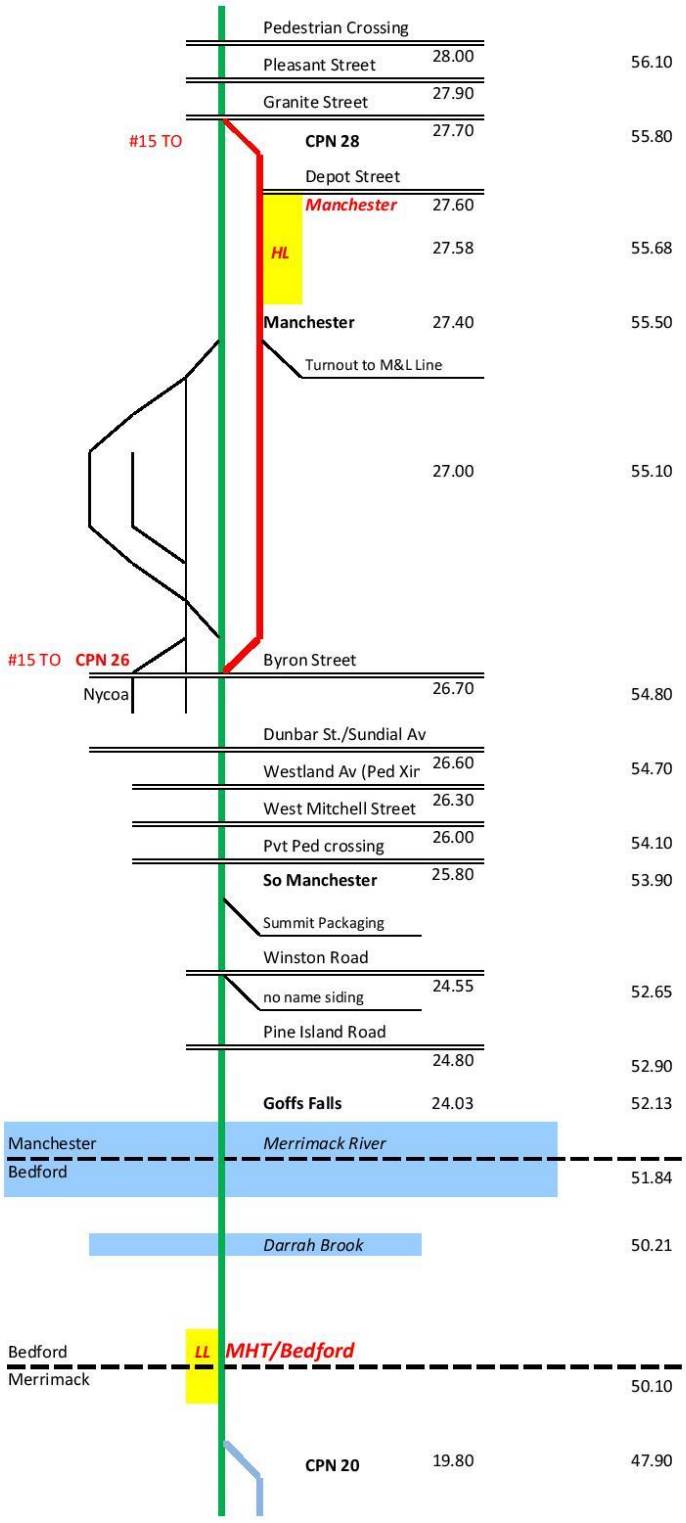


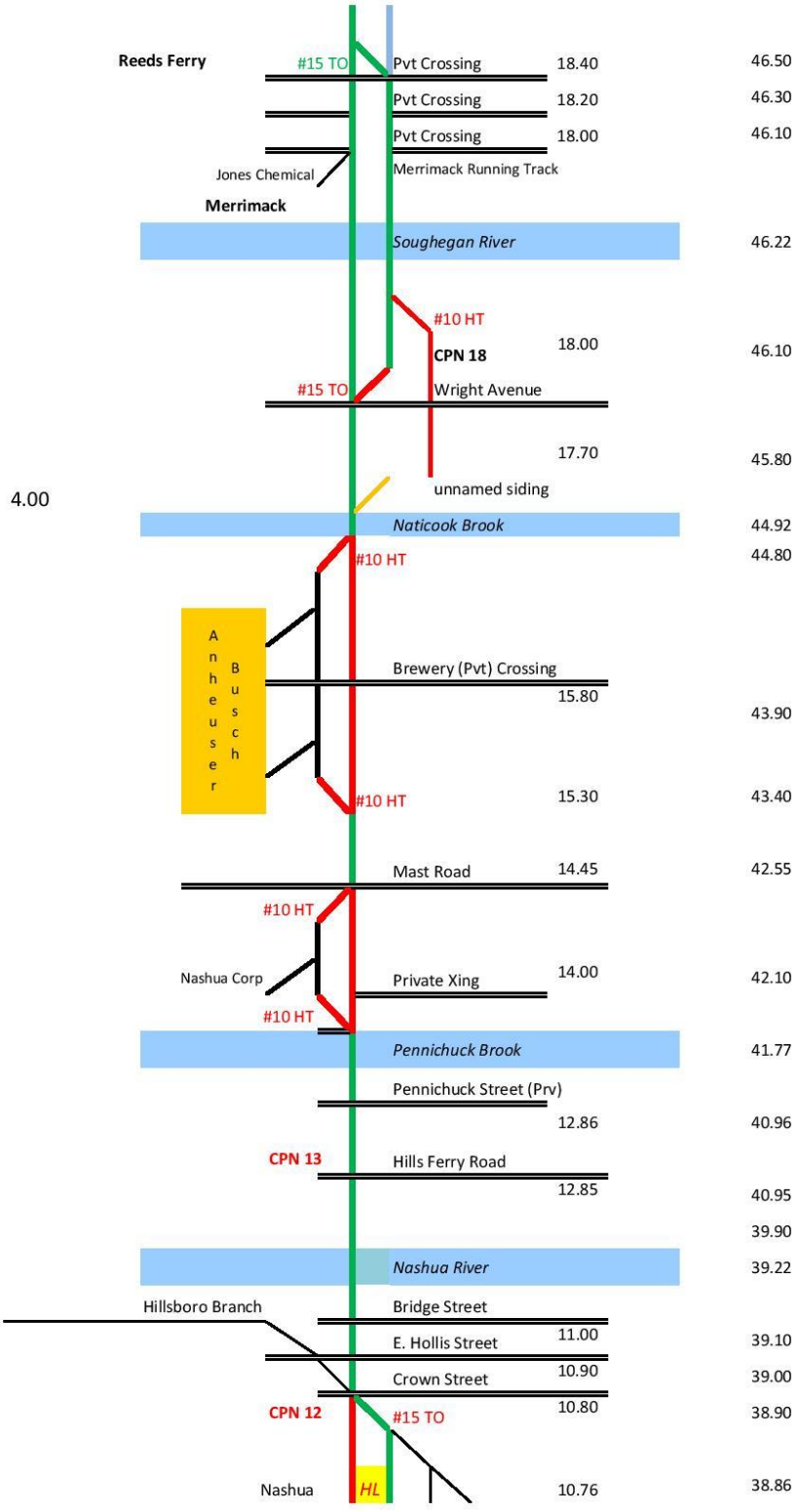

Wellman Avenue
1.60
29.70
Graniteville Siding
no name siding
West Chelmsford 304.20
LL
Wooten Street (Vinal Square)
1.10
29.20
LL
#15 XO
303.00
CPF 303
CPN 1
0.90
29.00
Stony Brook
28.65
#15 XO
CPF NC
302.43
28.43
2
1
#15 XO
CPF WA
299.95
25.95
CPF LO
299.47
25.47
Turnout No 1
Lowell
Lowell
299.40
25.40
Turnout No 2
New Side
4
3
2
1
South Leg of Wye

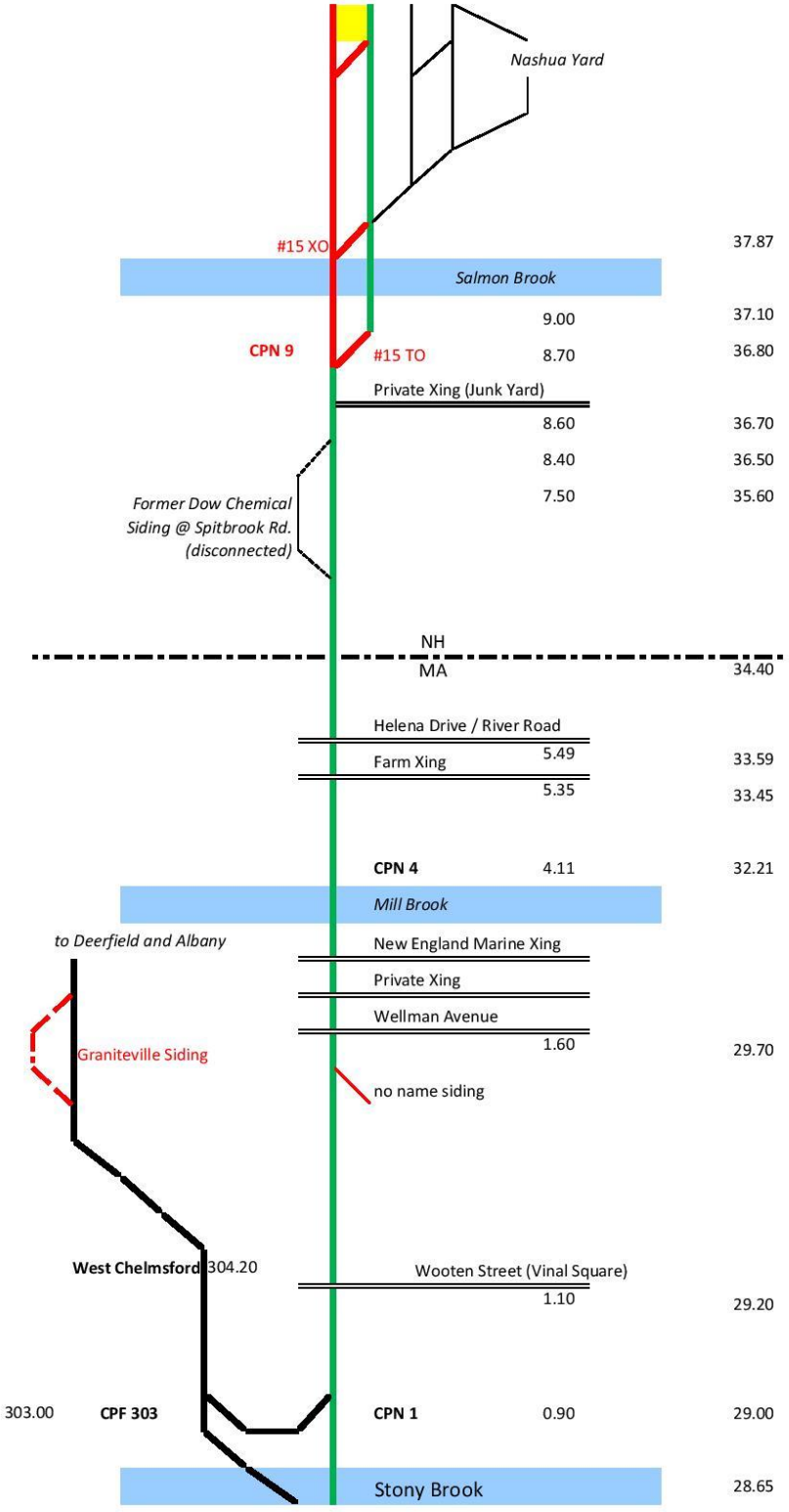
Appendix B-1: Proposed Intercity 8 Rail Service Option Track Configuration

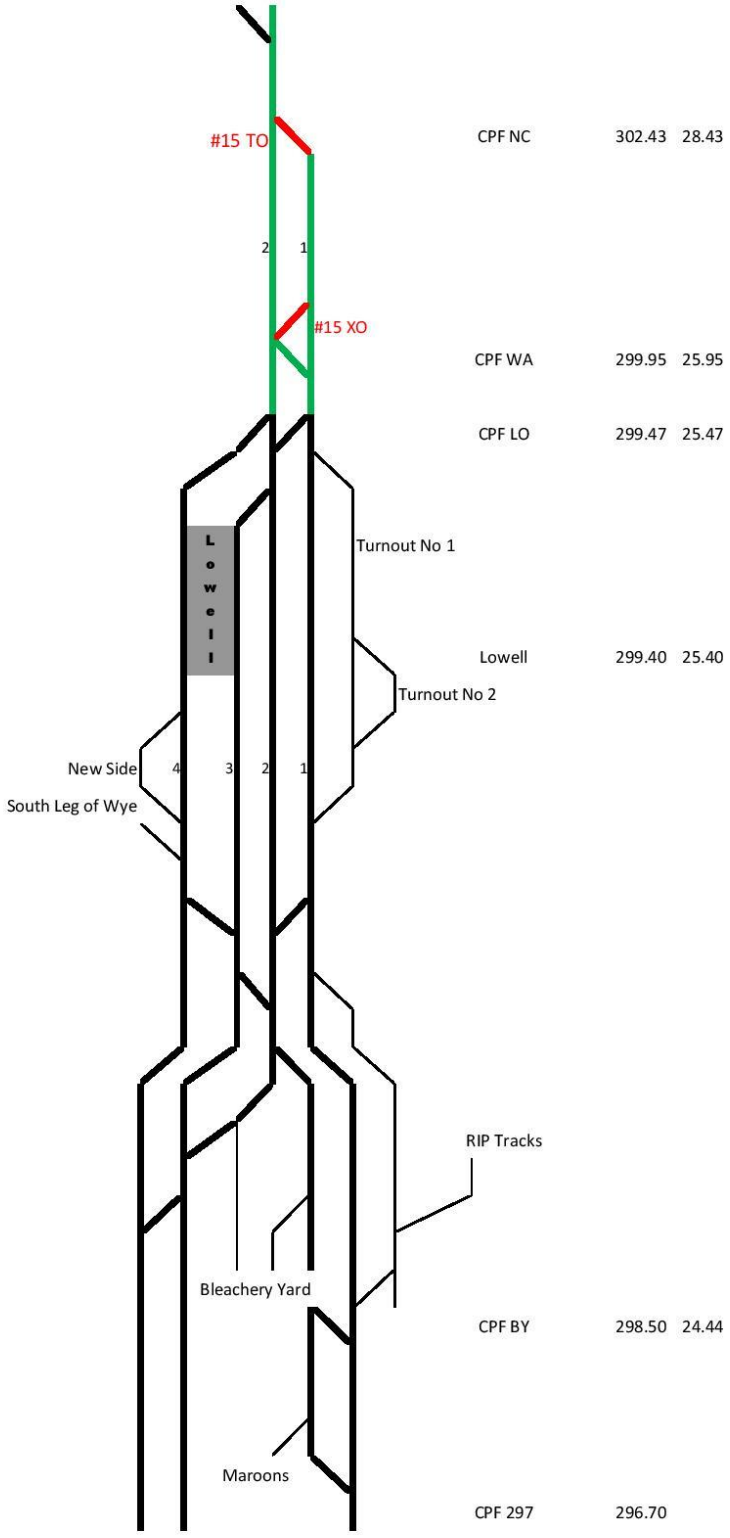
Figure B-1.1: Intercity 8 Proposed Track Configuration


Unnamed Siding
39.00
67.10
Perini Siding
Perini
38.40
66.50
#15 TO
Johnson Road
38.30
66.40
Ciment Quebec
Salt Industrial Track
2.95
#10 TO
Salt
38.30
66.40
Bow
Hookset
Private Crossing
37.20
65.30
S. Hooksett
36.35
64.45
Londonderry Turnpike
36.30
64.40
Merrimack River
64.32
Private Crossing
35.30
63.40
Dutton Brook
61.21
Martin
Martin's Ferry Brook
60.53
Hookset
Manchester
Amoskeag North
58.75
Eve Street (Pvt)
30.70
58.80
Brook (No Name)
57.32
Amoskeag South
29.00
57.10
Commercial Street
28.60
56.70
Pedestrian Crossing
28.50
56.60
Kidder Street
28.30
56.40
Spring Street
28.20
56.30


Pedestrian Crossing
Pleasant Street
28.00
56.10
Granite Street
27.90
#15 TO
CPN 28
27.70
55.80
Depot Street
Manchester
27.60
HL
27.58
55.68
Manchester
27.40
55.50
Turnout to M&L Line
27.00
55.10
#15 TO CPN 26
Byron Street
Nycoa
26.70
54.80
Dunbar St./Sundial Av
Westland Av (Ped Xir
26.60
54.70
West Mitchell Street
26.30
Pvt Ped crossing
26.00
54.10
So Manchester
25.80
53.90
Summit Packaging
Winston Road
no name siding
24.55
52.65
Pine Island Road
24.80
52.90
Goffs Falls
24.03
52.13
Manchester
Merrimack River
Bedford
51.84
Darrah Brook
50.21
Bedford
LL
MHT/Bedford
Merrimack
50.10
CPN 20
19.80
47.90


Reeds Ferry
#15 TO
Pvt Crossing
18.40
46.50
Pvt Crossing
18.20
46.30
Pvt Crossing
18.00
46.10
Jones Chemical
Merrimack Running Track
Merrimack
Soughegan River
46.22
#10 HT
CPN 18
18.00
46.10
#15 TO
Wright Avenue
17.70
45.80
unnamed siding
4.00
Naticook Brook
44.92
#10 HT
44.80
Anheuser Busch
Brewery (Pvt) Crossing
15.80
43.90
#10 HT
15.30
43.40
Mast Road
14.45
42.55
#10 HT
Nashua Corp
Private Xing
14.00
42.10
#10 HT
Pennichuck Brook
41.77
Pennichuck Street (Prv)
12.86
40.96
CPN 13
Hills Ferry Road
12.85
40.95
39.90
Nashua River
39.22
Hillsboro Branch
Bridge Street
E. Hollis Street
11.00
39.10
Crown Street
10.90
39.00
CPN 12
#15 TO
10.80
38.90
Nashua
HL
10.76
38.86


Nashua Yard
#15 XO
37.87
Salmon Brook
9.00
37.10
CPN 9
#15 TO
8.70
36.80
Private Xing (Junk Yard)
8.60
36.70
8.40
36.50
7.50
35.60
Former Dow Chemical Siding @ Spitbrook Rd. (disconnected)
NH
MA
34.40
Helena Drive / River Road
Farm Xing
5.49
33.59
5.35
33.45
CPN 4
4.11
32.21
Mill Brook
to Deerfield and Albany
New England Marine Xing
Private Xing
Wellman Avenue
1.60
29.70
Graniteville Siding
no name siding
West Chelmsford
304.20
Wooten Street (Vinal Square)
1.10
29.20
303.00
CPF 303
CPN 1
0.90
29.00
Stony Brook
28.65


#15 TO
CPF NC 302.43 28.43
2 1
#15 XO
CPF WA 299.95 25.95
CPF LO 299.47 25.47
Lowell
Turnout No 1
Lowell 299.40 25.40
Turnout No 2
New Side 4 3 2 1
South Leg of Wye
RIP Tracks
Bleachery Yard
CPF BY 298.50 24.44
Maroons
CPF 297 296.70

Appendix E
Final Operations and Maintenance (O&M) Costs Methodology and Results

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1 Final Estimates of O&M Cost

Refined O&M cost estimates were prepared for more detailed final analysis of the two commuter rail, one intercity rail, and three bus options that advanced through preliminary screening: Manchester Regional Commuter Rail, Nashua Minimum Commuter Rail, Intercity 8, Bus on Shoulder, Expanded Base, and Expanded Bus on Shoulder.

1.1 Commuter Rail

The Study team revisited the operating conditions for each of the three remaining rail options in meetings with Pan Am Railways (PAR), Massachusetts Department of Transportation (MassDOT), Massachusetts Bay Transportation Authority (MBTA), and New Hampshire Department of Transportation (NHDOT) and was able to refine the service characteristics based on their feedback. The O&M costs evolved over the course of preliminary stages of the Study, but did not change significantly. The total number of weekday vehicle miles and weekday revenue miles changed slightly as the options were refined. Two additional elements where changes were applied are in the calculation of unit costs and fare revenue. The operating cost data for the commuter rail options in Table 1.1 were updated to 2012 National Transit Database (NTD) figures from the 2009 NTD values used for the preliminary estimates.

Table 1.1: Derivation of Final Estimates of Commuter Rail Operating Costs

	Reported Annual Cost	Units	Reported Quantity	Ratio	% Variable	Variable Cost Ratio
Operations	$107,909,000	Train Miles	3,947,889	$27.33	85%	$23.23
Mechanical	$88,208,552	Peak Vehicles	416	$212,039.79	85%	$180,234
Locomotive Maint.	$32,045,720	Locomotives	60	$534,095	85%	$453,981
Coach Maintenance	$47,534,485	Coaches	356	$133,524	85%	$113,495
Infrastructure Maint.	$93,677,312	Track Miles	712	$131,661.72	85%	$111,912

Based on 2012 Financial Reports of MBTA to Federal Transit Administration

These values were used to describe each service option to estimate the O&M cost drivers for each commuter rail option. These cost drivers are train miles, rolling stock fleet size (locomotives and coaches), and track miles (see Table 1.2).

Table 1.2: Cost Drivers Used for Final Estimates of Commuter Rail Operating Costs

Commuter Rail Option	Weekday Train Miles	Morning Peak Locomotives	Morning Peak Coaches	Track Miles
Manchester Regional Commuter Rail	1,843	5	36	97.4
Nashua Minimum Commuter Rail	1,298	4	24	72.8
Increments Above Base Service				
Manchester Regional Commuter Rail	573	1	11	44.4
Nashua Minimum Commuter Rail	28	0	6	19.8

An annualization factor of 254.25 weekday equivalents per annum was used to convert weekday train miles into an estimate of annual train miles. No weekend or holiday service was included in the commuter rail operating cost, ridership, or revenue estimates. The product of the cost drivers multiplied by the cost factors for each service option yielded the two final operating cost forecasts shown in Table 1.3.

Table 1.3: Final Estimates of Commuter Rail Operating Costs (In Millions, 2012$)

Commuter Rail Option	Operations	Mechanical Maintenance	Infrastructure Maintenance	Total
Manchester Regional	$3.75	$2.07	$4.97	$10.78
Nashua Minimum	$1.04	$0.83	$2.22	$4.08

1.2 Intercity 8

The Intercity 8 service option that advanced through preliminary screening was developed to the same level-of-detail as the commuter rail service options, including estimates of daily train miles, rolling stock requirements, track miles required, number and location of stations, and schedules of service.

The most recent data (2012) on the *Downeaster* service indicated that it costs roughly $36 per train mile to operate. This metric is roughly equivalent to the costs applied for Midwestern and New York/Vermont services reviewed in the studies recommended by Amtrak. Using the simple cost of $36 per train mile, the estimates of operating cost in Table 1.4 were derived for the three intercity service options.

Table 1.4: Derivation of Final Estimates of Intercity Rail Operating Costs (2012$)

Intercity Service Option	Trips per Day	Train Miles per Day	Train Miles per Year	Annual Operating Cost (@ $36/train mile)
Intercity 8	8	586	214,036	$7,705,296

1.3 Commuter Bus

Weekday service schedules developed for each of the three commuter bus options did not change after the preliminary screening. The estimates of vehicle requirements and revenue miles, however, did change slightly as the options were refined. The variables used to estimate the annual operating costs for the three service options as summarized in Table 1.5.

Table 1.5: Derivation of Final Estimates of Commuter Bus Operating Costs (2012$)

Service Statistics and Costs	Base Service	Expanded Base	Bus on Shoulder	Expanded Bus on Shoulder
Peak Vehicles	16	30	16	30
Total Fleet including Spares	22	38	22	38
Revenue Vehicle Miles Travelled	1,286,685	1,914,368	1,286,685	1,914,368
Fuel, Crew and Supervision per RVMT	$4.17	$4.17	$4.17	$4.17
Maintenance Expense per Coach	$27,032	$27,032	$27,032	$27,032
Vehicle Maintenance Expense	$594,704	$1,027,216	$594,704	$1,027,216
Vehicle Operating Expense	$5,364,033	$7,980,768	$5,364,033	$7,980,768
Preliminary Estimate of Total Expense	**$5,958,737**	**$9,007,984**	**$5,958,737**	**$9,007,984**

Summary of Final Estimates of O&M Costs – The final estimates of *incremental* O&M cost for each rail and bus service option are found in Table 1.6.

Table 1.6: Final Estimates of Annual Incremental O&M Costs (In Millions, 2012$)

Service Option	Total
Commuter Rail	
Manchester Regional	$11
Nashua Minimum	$4
Intercity Rail	
Intercity 8	$7.7
Bus Service	
Expanded Base	$3
Bus on Shoulder	$0
Expanded Bus on Shoulder	$3

Appendix F
Rail Ridership Forecast Methodology and Results

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1 Rail Ridership Forecast Methodology and Results

This document describes the Capitol Corridor rail ridership forecasting model development and presents forecasts for the Manchester Regional Commuter Rail and Nashua Minimum Commuter Rail alternatives.

1.1 Model Development

The forecast models use the existing Massachusetts Bay Transportation Authority (MBTA) commuter rail system to estimate parameters for forecasting commuter rail boardings on the proposed New Hampshire extensions of the MBTA system.

Multiple models were estimated with parameter inputs, including rail operations data (service frequency, headway, travel time), station characteristics (parking, highway access, transit service, distance between stations, distance to Boston), socio-economic data (population, household income, vehicle ownership, employment), the Census Transportation Planning Package (CTPP) journey-to-work (JTW) data, and available MBTA system boarding data. A recommended model was selected from the estimated models based on the following:

- **Model Statistical Performance:** The model must be statistically valid.
- **Expected Relationships between Model Parameters:** The model must make sense. If an additional train is provided in the peak period, daily boards should increase more than if the additional train was provided in the off-peak period.
- **Expert Opinion:** A set of statistically valid models was developed and reviewed by the Study team. These models were presented to the FTA, which approved the preferred model.

The recommended model inputs and the reasons why each are used are discussed below.

- **Frequency of peak and off-peak trains** accounts for the impacts of differing levels of service on ridership. Trains in the peak direction during peak travel times are expected to attract more riders than trains during off-peak times and direction. A train is considered to be a peak train if it arrives in Boston between 6:00am and 9:30am or if it departs Boston between 4:00pm and 7:00pm. The inclusion of the peak and off-peak frequency in the model allows the model to be sensitive to the differing frequency of service in the commuter rail alternatives.
- **JTW data** provide information on the size of the work market to Boston around each station. JTW trips to downtown Boston are associated with the closest commuter rail station where riders would board if they were to use commuter rail to go to work. The inclusion of the JTW data provides a measure of the number of workers who could possibly use the proposed rail service.

- **Employment around the station** informs the potential for a station to attract trips other than those destined for Boston, such as reverse/intermediate commute trips and non-work related trips. The total employment within a half-mile of each station is calculated. A half-mile buffer is used to allow for walk access to the employment location.
- **Park-and-Ride (P&R) station designation** accounts for the impacts of parking availability. A P&R station is characterized as having a large parking lot that is not located in a densely developed area. MBTA P&R stations have a greater number of boardings than non-P&R stations. The inclusion of a P&R designation allows the model to be sensitive to the differences in the proposed stations, with the South Nashua and Bedford/Manchester-Boston Regional Airport (Manchester Airport or MHT) stations designated as P&R lots in the alternatives.

1.2 Model Forecasts

Opening day forecasts on the Manchester Regional Commuter Rail and Nashua Minimum Commuter Rail commuter alternatives are presented below in Tables 1.1 and 1.2. The model results are presented with a forecast value and an upper and lower bound that are the 95 percent confidence interval around the forecast value. It is important to note that, as with all forecasts, the predictions are not a single value, but rather a range of possible values.

Table 1.1: Manchester Regional Commuter Rail Daily Boarding Estimates

Station	Forecast	Lower Bound	Upper Bound
Manchester, NH	270	180	390
Bedford/MHT	280	230	350
Nashua	420	330	540
South Nashua	590	440	800
Total	**1,560**	**1,180**	**2,090**

Table 1.2: Nashua Minimum Commuter Rail Daily Boarding Estimates

Feeder Bus Weight	Forecast	Lower Bound	Upper Bound
South Nashua	590	450	770

The estimated model predicts the daily boards for each of the proposed stations. These boards represent one-half of a daily round trip. To convert these boarding data to daily ridership, a factor of two is applied to account for the second-half of the round trip.

Table 1.3: Daily Ridership Estimates

Alternative	Ridership	Lower Bound	Upper Bound
Manchester Regional Commuter Rail	3,130	2,350	4,170
Nashua Minimum Commuter Rail	1,170	890	1,540