Silver Line Extension Alternatives Analysis

FINAL REPORT

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massDOT
Massachusetts Department of Transportation

Massachusetts Bay Transportation Authority

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Executive Summary

The purpose of the Silver Line Extension Alternatives Analysis (SLXAA) project has been to explore the feasibility and utility of various corridor and service options to extend the Silver Line 3 from its current terminus in Chelsea through Everett and on to Somerville, Cambridge and/or Boston.

The primary recommendation from this study is to extend the Silver Line to the Sullivan Square MBTA station, providing a connection to the Orange Line and a dozen MBTA bus routes. This project is projected to increase daily ridership on the SL3 by over 15,000 riders, with a full daily ridership of over 27,800 riders, which is higher than many of the BRT projects in receipt of federal funding and in project development around the country. Furthermore, this extension will benefit transit-dependent riders by increasing frequencies outside of traditional peak commute hours and expanding access to an average of 345,000 jobs via a 45-minute transit commute.

The recommended alignment has the potential to provide transit service with exclusive bus transit right of way along 80% of the 6 1/3-mile extension and could be operated with the existing SL 3 bus fleet, with minimal impact to current service frequency. Other MBTA buses already in operation along portions of this alignment, including bus routes 104, 105, and 109, could avail themselves of dedicated transit right of way investment and as a result see a total of 2.9-minute reduction in travel time delay per trip on a daily basis. The recommended alignment traverses three municipalities, Chelsea, Everett, and Boston, which have been actively engaged in the SLXAA process, and endorse this recommendation. Due to their endorsement and the ability of the existing SL3 fleet to serve this extension, implementation is anticipated to be achievable in a relatively short timeframe.

This study also assessed the feasibility of extending Silver Line service beyond the Orange Line. The Alternatives Analysis showed a ridership benefit to providing service to either Kendall Square or downtown Boston. This service, referred to as the SL6 in this process to differentiate it from SL3 extension alternatives, assumed that the SL3 extension was in place to Everett Square and produced an additional 20,000-23,000 riders/day[1] for alignments to Kendall Square and 11,000-13,000 riders/day[2] for alignments to downtown Boston.

While extending Silver Line service beyond the Orange Line to either Kendall Square or downtown Boston provides potential ridership benefits, further study and the completion of ongoing planning efforts by others is required to determine the feasibility of implementing a Silver Line service to either location. Moreover, this study found that procuring additional Silver Line vehicles, and expanding vehicle maintenance and storage capacity would be required. A future study should consider the following:

- The ridership analysis should model the potential ridership using the Redesigned Bus Network that is currently being implemented by the MBTA;
- Further work be done on the Rutherford Ave. redesign effort and the Gilmore bridge project to better understand the potential for bus priority lanes within roadway infrastructure right of way; and
- More work be done to evaluate transit priority initiatives within Kendall square specifically.

In the near term, Bus Network Redesign will implement high frequency bus services from Chelsea to the Orange Line, and Sullivan Square to Kendall Square, creating the connections evaluated in this study to build market demand. Transitioning to Silver Line will be dependent on future operational resources, and fleet and on-street capital investments.

1 when compared to the no build.
2 Ibid.

Background

MassDOT and the MBTA began the SLXAA process in 2021. Since that time the agencies have analyzed dozens of potential operational and corridor alignment options against a discrete set of goals and objectives, developed in concert with a Working Group of municipal and advocacy partners and the general public.

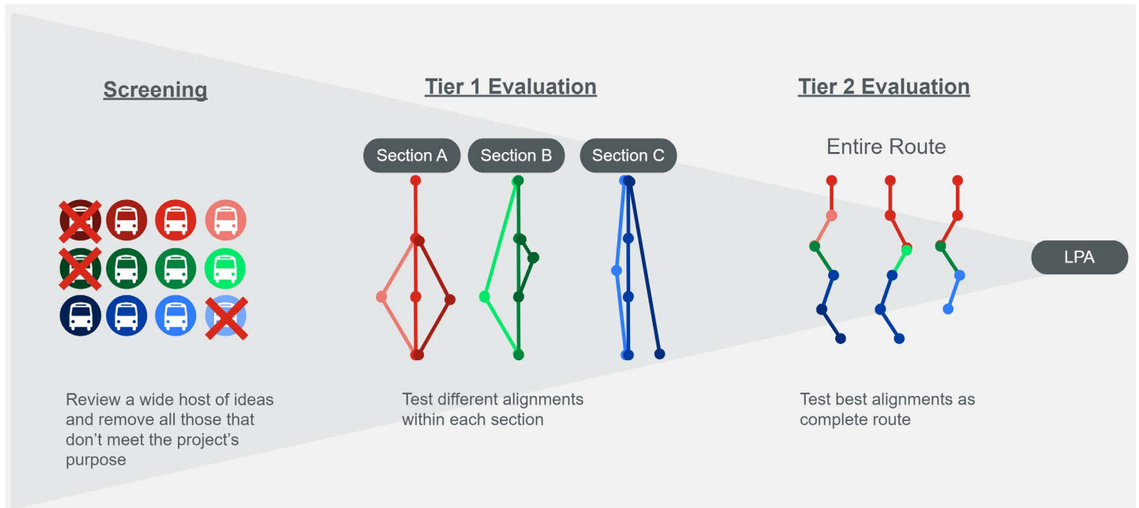
Following an analysis of needs, opportunities, and constraints, which featured Working Group discussions and a public meeting, MassDOT developed a universe of potential ideas. These were then narrowed over a course of three steps, illustrated below.

The first step broadly screened ideas against the project purpose, with ideas not meeting the purpose removed from further consideration. The second step evaluated concepts at a geographic scale – organized by logical breaking points. The most promising of these concepts were combined as end-to-end route alternatives for the third evaluation step. There were seven of these shortlisted route-level alternatives organized into two groups as follows:

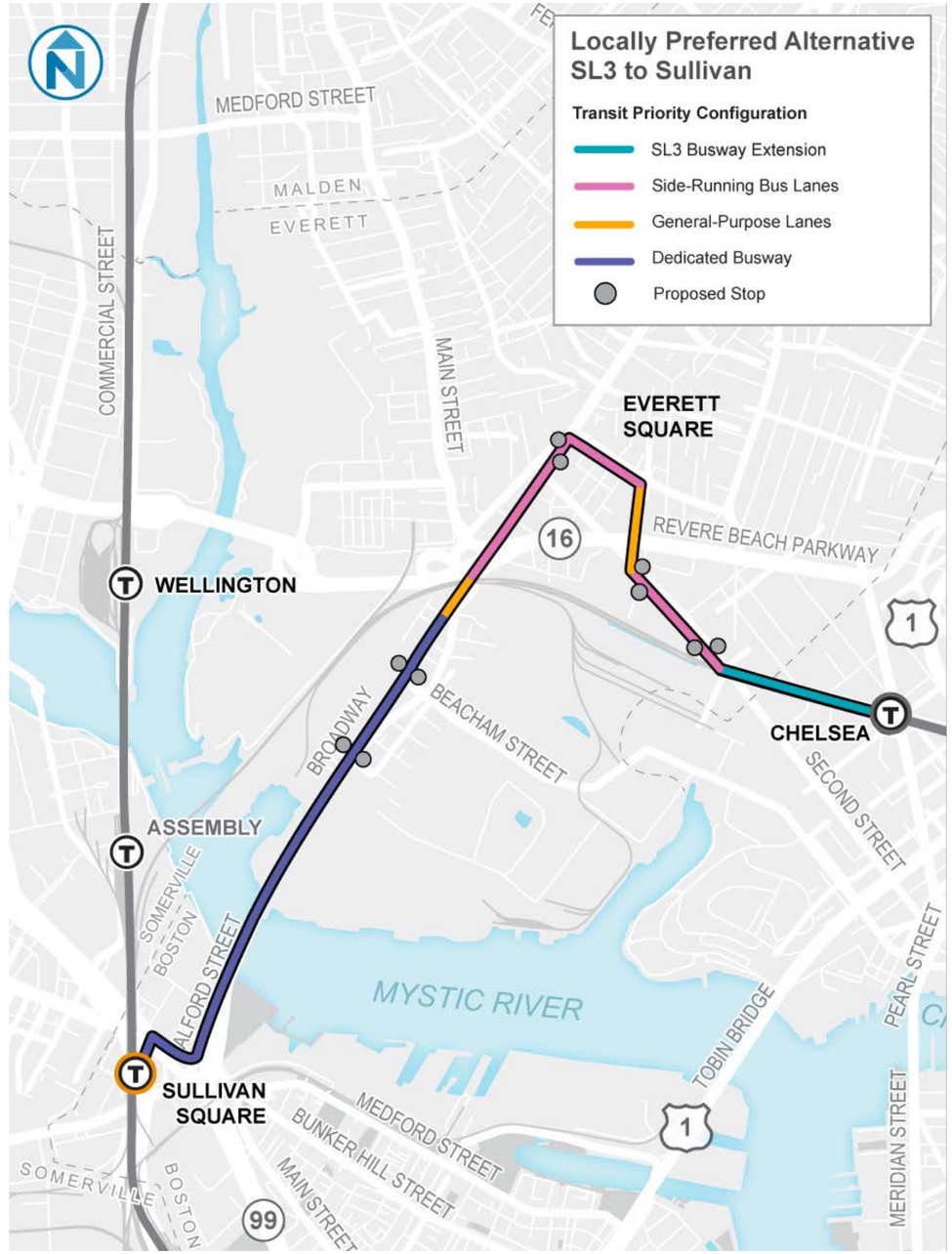
- A set of three alternatives extended the SL3 to the Orange Line (called SL3 extension alternatives, Alternative 1: SL3 to Malden Center, Alternative 2: SL3 to Wellington, Alternative 3: SL3 to Sullivan)
- A set of four alternatives that provide a new service (called the SL6 for evaluation purposes) extending from Everett into Kendall or downtown Boston (Alternative 4: SL6 to Kendall via McGrath, Alternative 5: SL6 to Kendall via Rutherford, Alternative 6: SL6 to Boston via Rutherford, and Alternative 7: SL6 to Kendall from Chelsea)

This final analysis step featured a robust evaluation including running the CTPS regional model. This work is now complete and results have been presented broadly to stakeholders and the public. MassDOT and the MBTA are now ready to move forward with a Locally Preferred Alternative (LPA) for SL3 Extension from its current terminus at Chelsea Station to the Sullivan Square Orange Line Station (Alternative 3), and recommend further modeling be done on the SL6 alternatives in the near future.

Silver Line Extension Alternatives Analysis Evaluation Process



Locally Preferred Alternative



Key Statistics

Length of the LPA: 6.36 Miles

Number of Stations: 8[1]

Assumed Span of Service:

4:20 AM-1:15 AM Weekday

4:55 AM-1:45 AM Saturday

5:50 AM-1:50 AM Sunday

Frequency: 10 minutes AM + PM Peak

Assumed Vehicle Load: 65 passengers[2]

Extent of Operation in Exclusive Transit Right-of-way: 80% (5.18 miles)

Time Spent at Each Station: 24 seconds[3]

Average Daily Ridership (2040): 27,800

Major Transfer Locations:

Chelsea Station

Everett Square

Sullivan Station

Additional Silver Line buses needed: 4 buses

Capital Costs: $95 M

Access to Jobs via 45-minute Transit Commute:

AM Peak: 347,000 jobs

Midday: 344,000 jobs

1 Chelsea Station, 2nd St. at commuter rail ROW, 2nd St. at Spring Street, Broadway/Everett Square, Broadway at Gladstone St., Lower Broadway at Beacham, Lower Broadway at Dexter St., Sullivan Square.
2 MBTA Service Delivery Policy, page 47: https://cdn.mbta.com/sites/default/files/2021-06/2021-service-delivery-policy.pdf
3 All-Door Boarding Pilot on the Silver Line (2017), OPMI Data Blog: https://massdottracker.com/datablog/?p=154. Assuming front-door boarding.

The SL3 LPA has been identified as an extension of the existing SL3 service from its current terminus at Chelsea Station to the Sullivan Square Orange Line Station. The primary attributes of this alternative are included in Table 1.

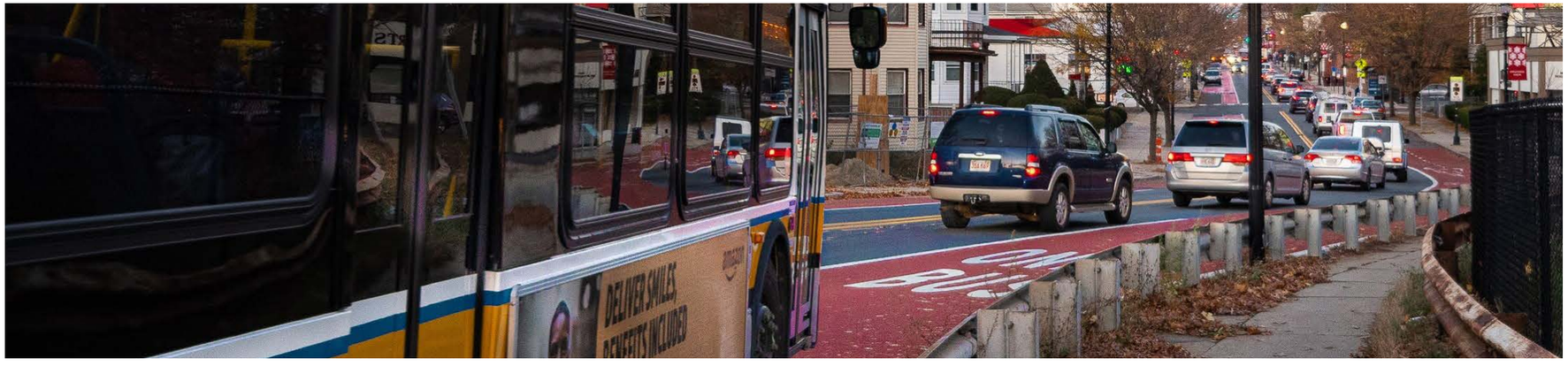
This service would operate primarily on dedicated bus-only lanes along an extended Chelsea busway, Second Street, Spring Street, Chelsea Street, Broadway, Lower Broadway, Alford Street and across the Alford Bridge to Sullivan Station. There were several key differentiators between the SL3 Extension to Sullivan and the other SL3 Extension alternatives, described in the paragraphs below.

- While the existing part-time, side-running bus lanes on Upper Broadway in Everett have helped eased some of the congestion during the peak commute hours along the Broadway corridor, transit users still face tremendous congestion, amounting to thousands of daily passenger minutes in delay between Chelsea Street and Sweetser Circle alone.[4]
- The SL3 LPA would provide full-time dedicated bus lanes along 80% of its alignment and transit signal priority at 14 intersections, providing travel times that are faster than drive alone times, and travel times that are more reliable because with dedicated transit lanes the Silver Line vehicles are not vulnerable to the traffic congestion experienced in the adjacent general-purpose lanes. The level of transit priority achieved under Alternative 3 is higher than the other SL3 Extension alternatives.
- In addition, other local bus routes that operate along the alignment can benefit from the bus lanes implemented as part of the SL3 extension. These include the MBTA Routes 97, 104, 105, 109, 110, and 112, several of which are among the MBTA's highest and most resilient ridership. On average, the proposed infrastructure could save its transit riders 3 daily minutes in delay. This is higher than any of the other SL3 Extension alternatives. The existing MBTA bus routes that operate along this alignment are more likely to serve people of color, people without access to a personal automobile, and persons of lower incomes.
- The CTPS Travel Demand Model estimated that extending the SL3 to Sullivan could see up to 27,800 daily boarding by year 2040. This is 15,000 more daily boardings than the SL3 would experience if it were to end at its current terminus at Chelsea Station – a 120% increase. While some of these riders would be people who would have otherwise used local bus routes, our analysis shows that extending the SL3 to Sullivan Station could add up to 11,000 net new daily boardings to the system.
- There is strong support for the recommended LPA among municipal leaders as well as from the community at large. In our third feedback survey, respondents ranked the LPA as the SL3 extension alternative they would be most likely to use, ahead of connections to the Orange Line via Malden Center or Wellington.
- The SL3 could be extended to Sullivan using the existing Silver Line fleet. The extended service is assumed to operate with 10-minute headways during most of the day[5] which results in a requirement for 12 Silver Line vehicles, four more than what is needed for the existing SL3 service.

While the technical analysis showed that a BRT capital investment connection between Chelsea and Sullivan aligned the best with the study goals and objectives, pursuing this LPA would not preclude transit service to Malden Station and to Wellington Station. In fact, the Bus Network Redesign shows a frequent service route T104 connecting Airport Station to Malden Center via Everett, and frequent service route T110 connecting Wonderland to Wellington vis Everett. As the SL3 extension moves into project development, additional refinements could be made to this and other MBTA bus route begin and end points to best serve ridership demand.

4 MBTA Winter 2020

5 Consistent with SL3 Winter 2020 schedule



The Alford Street Drawbridge provides an uninterrupted connection between Everett and Charlestown during most of the day. It is closed for the passage of vessel traffic during the morning peak hours and between 5 p.m. and 6 p.m. daily and would minimally impact Silver Line operations across the corridor.

Introduction

The Silver Line 3 (SL3) plays an important role in the MBTA service network, providing a transit connection between Downtown Boston, the Seaport, Logan Airport, East Boston, and Chelsea. Opened in 2018, the SL3 provides bus rapid transit service for much of its route– operating in exclusive right-of-way in South Boston and Chelsea. Since the opening of the SL3, multiple studies and plans have recommended extending the service west into Everett and adjacent municipalities. Everett, Chelsea, Somerville, and Cambridge are important growth centers in the greater Boston region, experiencing rapid population and employment changes. Strengthening the transit connections available in the Lower Mystic Region is critical to ensuring transportation challenges do not constrain growth in the region and that transit services provide sufficient access to job centers and resources across greater Boston.

The MBTA's Focus 40 Plan prioritized studying extending the Silver Line beyond Chelsea, and in 2021 the MassDOT Office of Transportation Planning launched the Silver Line Extension Alternatives Analysis.

This report summarizes the Silver Line Extension Alternatives Analysis process and outcomes and describes the Locally Preferred Alternative (LPA) that is recommended for moving into project development. This report describes which alternatives were studied, the major steps in the decision-making process, who was involved, and next steps to move the LPA towards implementation.

Project Purpose

The purpose of the Silver Line Extension Alternatives Analysis was to assess the feasibility, utility, and cost of various alignment and service frequency options of an extension of the Silver Line, providing high quality transit from Chelsea through Everett and on to Somerville, Cambridge, and/or Boston.

Project Need

This project's principal objective is to add transit service capacity and connectivity to knit together Chelsea and Everett with nearby communities that are not currently well connected with high-quality transit. Additional needs to be addressed through the Silver Line Extension are:

- Existing transit service is not competitive with driving for many types of trips being made to and from Chelsea and Everett.
- Despite the lack of competitiveness, bus ridership in Chelsea and Everett during the pandemic has been more durable than in other MBTA-served communities.
- Chelsea, Everett, Somerville, and Cambridge are experiencing rapid growth in housing and employment in areas that are not currently well served by transit.
- There are existing transit connections in Chelsea, Everett, and nearby communities that could be leveraged and improved into a high-quality cohesive network.

Goals and Objectives

The following five goals and related objectives stem from the project's Purpose and Need. These were used to develop evaluation metrics for comparing the alternative transit investment options for the study area.

Table 1 | Project Goals and Objectives

Expand Mobility and Access	• Optimize potential ridership • Connect residents directly with jobs, services, and other daily activities • Provide reliable transit service at or near rapid-transit levels to communities not currently served by rapid transit • Provide transit service that takes a similar amount of time or is faster than driving • Maximize new connections with other transit services • Provide transit connections to existing and planned affordable housing • Provide transit service to areas with current or future growth in housing and jobs • Use investments to improve existing transit services in the study area • Serve High Demand Areas identified by the Bus Network Redesign effort currently underway
Advance Equity	• Optimize potential ridership for transit critical populations • Provide new transit service for people who already rely on transit to get around • Make sure people who are likely to rely on transit have a route that matches how much service they need and when • Make improvements to existing transit service used by people who are likely to rely on transit
Improve Safety	• Provide safe, comfortable, and accessible bike/pedestrian access to and from stations • Address identified transportation safety issues at intersections along the project corridors
Support Climate Change Resilience and Sustainability	• Increase transit mode share and reduce dependence on cars for transportation within study area • Reduce greenhouse gas emissions from single occupancy vehicles within the study area • Address climate change vulnerabilities of transit infrastructure
Advance Feasible and Implementable Solutions	• Ability to phase alternative over time • Extent to which alternative provides standalone value of transit service, within this section alone • Ability for alternative to fit within existing roadway footprint • Ability to offer highly reliable bus service • Extent to which investment could be included without other efforts upcoming or currently underway • Extent of known municipal support for alternative alignment and service assumptions • Minimize the number of major cost items within alternative alignment while maintaining benefit

Relevant Previous Planning Efforts

Extending Silver Line service beyond Chelsea to Everett and the surrounding communities has been studied in the past. Many previous efforts, including the Urban Ring, the Everett Transit Action Plan, and the Lower Mystic Regional Working Group, have developed recommendations that are relevant to this study. Below, in alphabetical order by authoring agency, is a summary of these relevant previous and ongoing planning efforts.

The City of Boston released *Imagine Boston 2030* in 2017, outlining initiatives to support the City's future growth such as encouraging a mixed-use core in the urban center and expanding transit access for residents and workers. The City of Boston is also conducting the *Rutherford Avenue/Sullivan Square Design Project* which aims to improve the 1.4-mile corridor with measures such as a road diet, transit priority, a two-way bike path and walking trail, and new pedestrian crossings. These infrastructure improvements will be key to unlocking development parcels around the transit station and improving bus transit reliability along nearby corridors.

The City of Cambridge completed *Envision Cambridge* in 2019, the City's plan for inclusive and sustainable growth through 2030, with topics covering climate and environment, community wellbeing, economy, housing, mobility, and urban form, and advocates for improved multimodal connections between Kendall Square and Sullivan Square. Also in 2019, the Kendall Square Association released *Transport Kendall*, a plan that seeks to maintain and enhance the transit-oriented development model in Cambridge, and to promote future investment in the transit system, focusing on the Grand Junction Corridor, the Red Line, and bus connections.

The City of Everett put forth the 2016 *Everett Transit Action Plan*, which suggested using service/route improvements, major transit investments, and adding pedestrian/bike access to provide more transit access and connection to Boston. Priority corridors for transit improvements discussed in this plan include Broadway to Sweetser Circle, Main Street, Chelsea Street, and Ferry Street.

Metropolitan Area Planning Council (MAPC) published the *Lower Mystic Regional Working Group: Planning for Improved Transportation and Mobility in the Sullivan Square Area* in 2019, proposing solutions to traffic congestion by expanding public transit services. The Lower Mystic Regional Working Group is a group of 11 public agencies that was established by the Massachusetts Secretary of Transportation to assess the impact that new projected growth in the Sullivan Square area may have on travel conditions and to identify potential solutions. The Working Group consists of the Massachusetts Department of Transportation, the cities of Boston, Everett, and Somerville, the Metropolitan Area Planning Council (MAPC), the Executive Office of Housing and Economic Development, the Massachusetts Gaming Commission, the Office of the Attorney General, Massport, the Office of Congressman Michael Capuano, and Encore Boston Harbor.

In 2017, the *Working Group* started a two-year planning process to improve transportation in the Sullivan Square area. The process used quantitative modeling to test eight different scenarios of infrastructure and policies under future conditions and resulted in a set of recommendations that had transit service improvements at its core. The *Working Group* report identified BRT as a promising option to reduce vehicle trips and increase connectivity in Sullivan Square. The report recommended the construction of two BRT routes that would run on a combination of exclusive and priority lanes. The first recommended route, Route 1, would build off the SL3's Chelsea Station terminus and connect to North Station via Sullivan Square, using a combination of dedicated bus lanes and the commuter rail right-of-way. The route would travel along Second Street to Route 16, and then take Route 16 to Broadway. The service would then travel along Broadway to Sullivan Square and down Rutherford Avenue to North Station. In the final scenario analysis, this route was projected to see daily ridership of 27,600 trips.

Route 2 would connect Glendale Square with Kendall Square; via Broadway, Sullivan Square, the new Inner Belt Bridge and Inner Belt, and then along proposed bus lanes south from Lechmere on First Street, Binney Street, and

Third Street. The construction of a new bridge connecting Inner Belt Road and Lechmere station, and passing over the railroad tracks, was a key component of this alternative. In the final scenario analysis, this route was projected to see daily ridership of 13,400 trips.

The City of Somerville in 2021 released SomerVision 2040: Comprehensive Plan Update 2010-2040 to support the conservation of residential neighborhoods, enhance the City's squares and commercial corridors, and transform opportunity areas. The plan, an update to the previous SomerVision 2030, featured implementation priorities include equity, infrastructure investments, reducing vehicle miles traveled, and sustainability.

Public Outreach

Several comprehensive public outreach activities were initiated to engage and inform stakeholders and community members about this project. Due to the pandemic, many outreach activities were virtual, with some in person activities held outdoors where possible. A wide range of in-person and virtual events were organized with different formats including four virtual public meetings, six virtual working group meetings, and four pop-up events throughout the duration of the project.

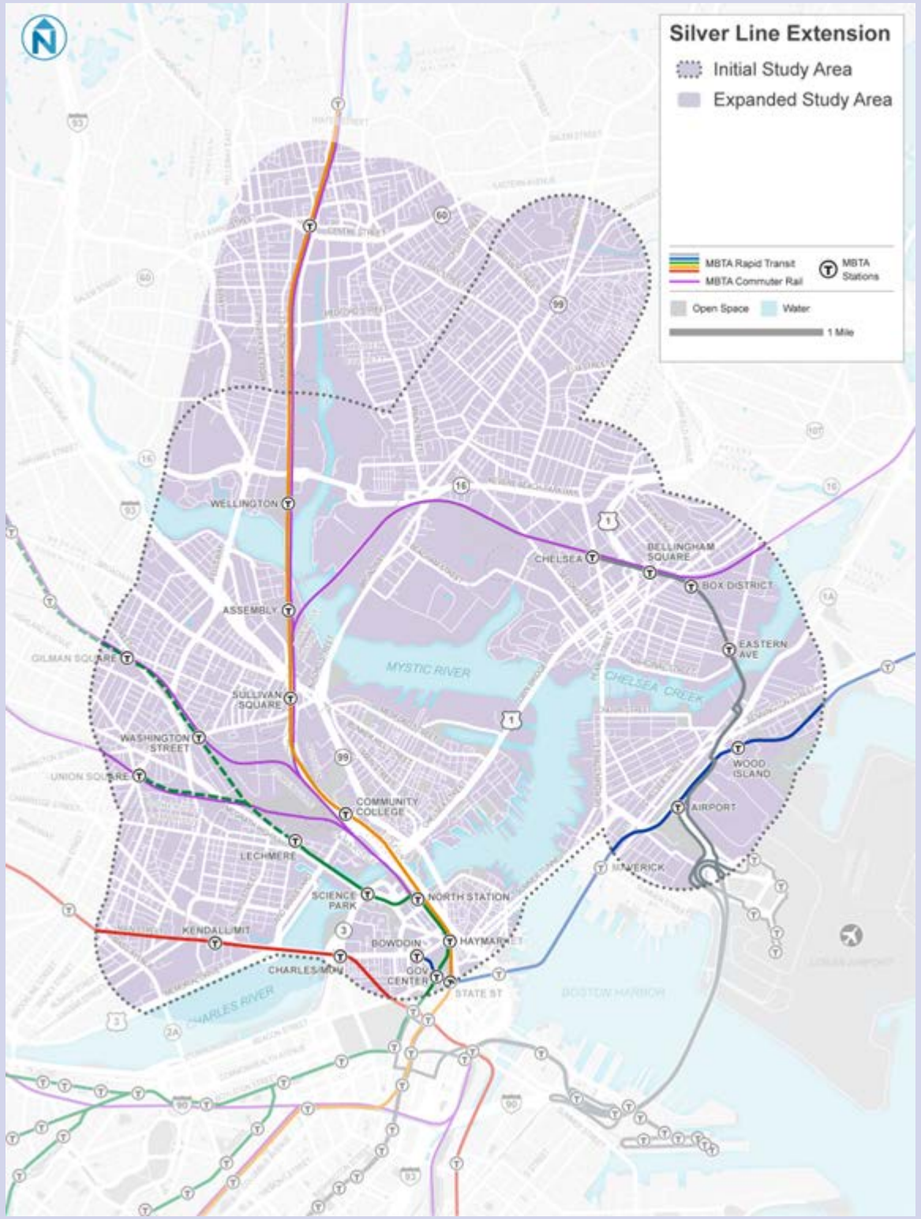
The External Working Group, which included representatives from the cities in the study area, MAPC, and the State Legislature, met five times throughout the planning process, provided input and collaborated with the project team to identify and evaluate alternatives.

Strategies used consistently throughout the project included regular updates to the Silver Line Extension (MBTA.com/SLX) webpage, promotion through social media platforms, management of the SLX@MBTA.com project inbox to receive and respond to comments and questions, and email delivery to notify subscribers about events and project updates. In addition to hosting both in-person and virtual events, opportunities for feedback were available via three feedback forms released throughout the different project phases. Please refer to Appendix A: Public Outreach Summary for a full overview of all public outreach activities conducted during this project.

Study Area

The study area for the project is shown in Figure 1. It includes sections of Boston, Cambridge, Chelsea, Everett, Somerville, and Medford. It was developed to include previous alignments considered in earlier planning efforts, with a buffer to reflect uncertainty and to be open to new ideas that could arise through public outreach. The original study area was slightly expanded to capture a section of Malden, including the Malden Center Orange Line Station, during the development of alternatives phase of the project.

Figure 1 | Silver Line Extension Alternatives Analysis Study Area



Existing Conditions

The existing and future conditions analysis provides an overview of the current transportation infrastructure and service conditions that affect the movement of people, goods, and services within, to, from and through the study area. This chapter summarizes the key findings from a full Existing Conditions Analysis conducted for the study. The full Analysis can be found as Appendix B: Existing Conditions.

Demographic Characteristics

In 2018[1], the study area was home to approximately 195,000 residents. As shown in Table 2, Everett and Chelsea have a combined population of approximately 75,000 and the remaining areas of the study area have a population of approximately 120,000. The communities in the study area have the population and employment density to support frequent, all-day transit service. A high potential for transit ridership in the study area is illustrated through the composite density (composed of both population and employment densities) map in Figure 2.

A crucial component of this analysis was to understand where the highest concentrations of transit-critical populations are located and the specific transportation challenges they face. Transit-critical populations are those that are traditionally more reliant on transit, which is defined by the MBTA as low-income people, people of color, and people from low-vehicle households.[2] Everett and Chelsea are made up of 66% minority residents and have a higher proportion of “transit-critical” residents, as compared to 47% minority residents in the rest of the study area and 44% in the Inner Core. One half of Chelsea and Everett residents are considered low-income compared to 42% in the rest of the study area. Everett and Chelsea have 43% foreign-born residents, compared to 36% in the rest of the study area. However, vehicle ownership is higher and transit use rates are lower in Everett and Chelsea than in the rest of the study area. This is likely because neither community is served directly by the rapid transit rail network, unlike neighboring communities like East Boston and Malden, which in turn increases the need to rely on a vehicle for mobility in Everett and Chelsea. This also in turn increases the transportation cost burden on residents of Chelsea and Everett.

Employment

Communities with high rates of shift workers and workers without a college degree tend to have different travel patterns, with more workers commuting outside of the traditional morning and afternoon peak rush hours. This can make it difficult to rely on public transit as the primary form of transportation, as the current MBTA bus system is focused on providing the most service during weekday peak-periods, with lower service during off-peak hours and on weekends. This means that commuters who work non-traditional hours or in areas without convenient transit routes, like in Everett and Chelsea, often have difficulty finding a transit option that meets their needs. Even when transit options are available, they may not run frequently enough to be reliable, or they may require multiple transfers. This can be especially problematic for workers who need to arrive at work at a specific time (jobs with a punch-in and punch-out system), as the consequences of not arriving on time could mean losing wages or their job.

Only 18% of residents in Everett and Chelsea age 25 and older have a bachelor’s degree or higher. In contrast, about 50% of residents in Cambridge, Somerville, and Charlestown have a bachelor’s degree or higher, with rates above 75% in East Cambridge and much of Charlestown. Everett and Chelsea also have a lower proportion (37%) of workers who leave for work between 7 a.m. and 9 a.m. than the Inner Core (52%) and the remainder of the study area (53%). This indicates that more Everett and Chelsea residents work jobs with

1 The existing population and socioeconomic variables are from the 2018 American Community Survey 5-year Estimates, and the existing employment and 2040 population and employment data are outputs from Central Transportation Planning Staff’s (CTPS) travel demand model, the Boston Region Metropolitan Planning Organization (MPO).

2 This study defines low-income as below 60% of area median income; people of color/minorities as all race categories except White alone (not Hispanic); and low-vehicle households as households with zero vehicles available and households with fewer vehicles than workers.

varying shifts and schedules, which are not well served by the existing peak-oriented transit system. It is therefore crucial to provide high-quality transit service all day for workers who do not work in traditional "9-to-5" positions.

While the MBTA is working to redesign the Bus Network to provide more frequent, all-day service, population and employment demographics in Everett and Chelsea indicate that rapid-transit service would be heavily utilized.

Table 2 | Study Area Demographic Comparisons

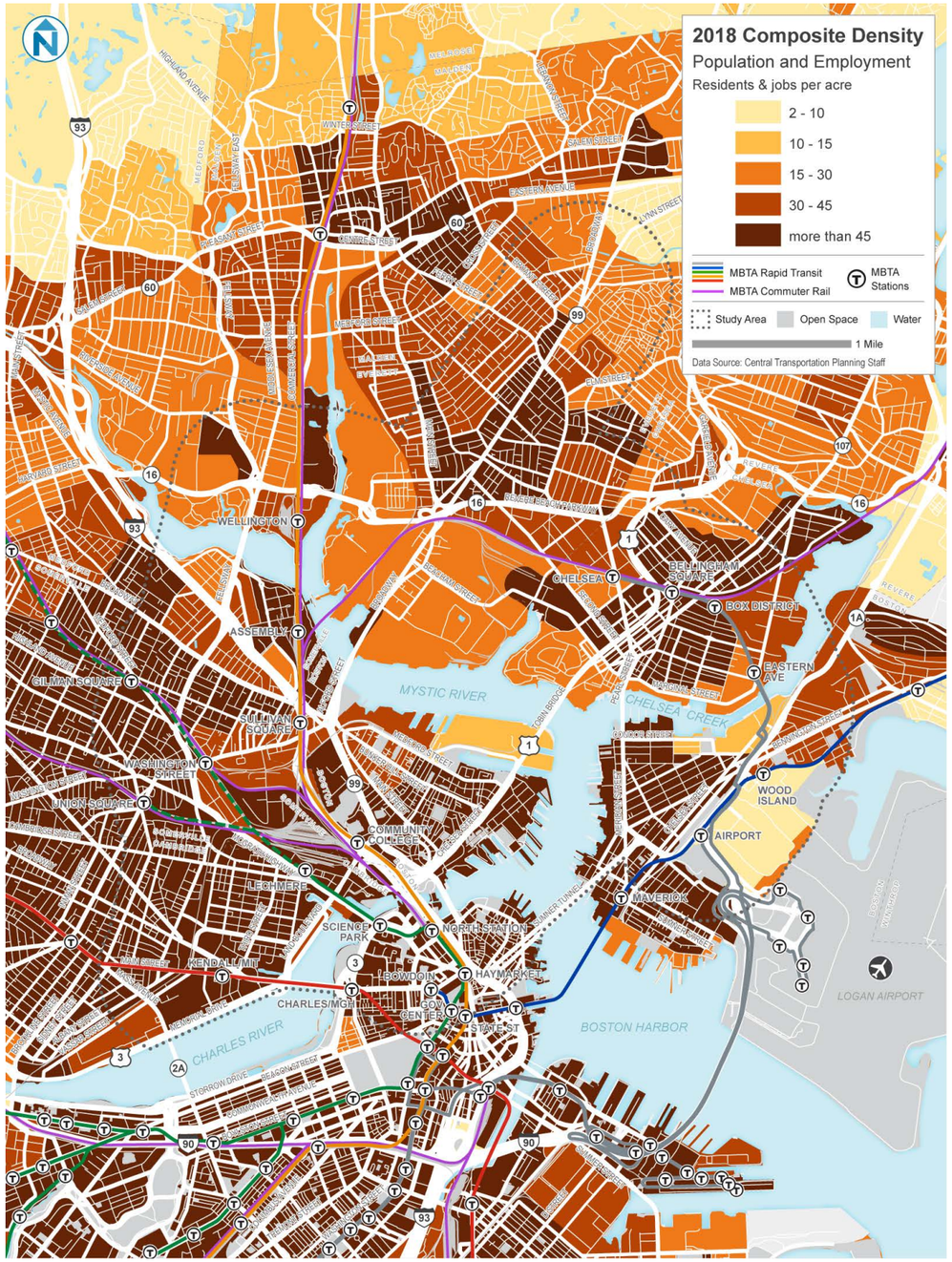
	Total Pop	Pop Density (per acre)	Minority Pop (%)	Below 60% AMI (%)	Zero and low-vehicle HH (%)	Foreign Born Population (%)	Population Age 25 and Over with a Bachelor's Degree	Workers who Leave during A.M. Peak (%)	Transit Commuters (%)
Study Area	195,416	25	54%	35%	46%	39%	37%	47%	33%
Everett and Chelsea	75,361	23	66%	40%	42%	43%	19%	37%	27%
East Boston[1]	29,470	42	71%	41%	63%	53%	23%	40%	56%
Cambridge, Somerville, Charlestown (Study Area Sections)	90,585	24	40%	31%	44%	31%	56%	57%	30%
Inner Core Communities[2]	1,771,225	13	44%	32%	39%	28%	49%	52%	27%

Pop = population
HH = household

AMI = Annual Median Income
Data Source: 2018 American Community Survey 5-year Estimates

1 Sections inside study area, excludes Logan Airport
2 Boston Area Inner Core Communities include Arlington, Belmont, Boston, Cambridge, Chelsea, Everett, Lynn, Malden, Medford, Melrose, Milton, Needham, Newton, Quincy, Revere, Saugus, Somerville, Waltham, Watertown, and Winthrop

Figure 2 | 2018 Employment and Population Composite Density



Zoning

Zoning provides an indication both of how land is used and how municipalities wish land to be used. Both of these are important for identifying transit-supportive land uses. The current zoning in the study area[1] is diverse, with a significant share of residential, industrial, and mixed-use classifications within each city. Approximately 40.5% of the entire study area is zoned as residential, followed by industrial (20.8%), mixed-use (16.8%), and commercial (11.3%) districts. Almost 5% of the study area is zoned as open space (see Figure 3). Approximately half of the land area in Cambridge, Chelsea, Everett, and Somerville is zoned as residential, whereas this classification makes up only 27.9% of Boston and 19.8% of Medford's land within the study area. Mixed-use land is fairly standard across the study area, accounting for 15 to 20% of land area for each municipality. Everett (24.9%) and Medford (30%) have the largest share of industrial zoned land, though parts of the Second Street corridor in Everett have already been planning for transitions to mixed-use neighborhoods.

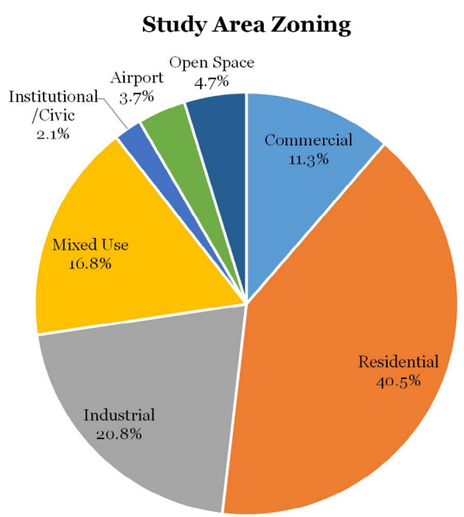
Anticipated Future Growth

The 2040 regional model was updated with anticipated development to estimate future population, household, and employment growth more accurately within the study area. This was done by starting with the 2040 regional model and comparing its forecasted growth with what was known in the 2019 Lower Mystic Regional Working Group study and what developments are currently included in the study area municipalities development pipelines. To be conservative, only development projects listed as completed, in construction, or permitted and approved were included in future forecasts. Based on the housing unit counts and commercial square footages of 88 development projects not included in the 2018 projection, the projected number of employees, residents, and housing units were calculated and added to the 2040 projection.[2]

A review of the development adjustments by municipality indicates that Cambridge is projected to contribute the highest share of additional employment at 47.7%, while Boston accounts for over half of the additional housing units (59.2%) and population (57.7%) that new developments have or are anticipated to generate within the study area.

In total, 31,905 jobs, 8,825 housing units, and 20,550 residents have been or are anticipated to be generated by new development projects within the study area TAZs. Adding these to the existing 2040 projections, the study area could have approximately 321,510 residents (11.0% increase), 150,230 housing units (6.2% increase), and 320,700 jobs (6.8% increase) by the year 2040. These figures are based on projection trends by MAPC/CTPS continuing through 2040 and the identified development pipeline coming to fruition.

Figure 3 | Study Area Zoning



1 It is important to note that zoning percentages reflected here are not for the full municipalities of Boston, Cambridge, Chelsea, Everett, Medford, and Somerville – just for the proportion of those municipalities that are within the SLXAA study area.

2 New development projects have either come online or have been proposed since the regional projections were completed 2018. To capture their potential impact, the latest real estate development project inventory from MassBuilds (December 2020) were collected, in addition to requesting updated development pipeline information from each city in the study area and reviewing city websites. An analysis was then conducted to compare the latest development database with the inputs that MAPC used in 2018 to produce their projections. The adjustments to the development database included 88 projects within the study area's TAZs.

Transit Service and Access Conditions

Transit Availability and Ridership

Chelsea and Everett are both served by MBTA Bus Routes 110, 111, and 112, with an additional six routes serving Everett only (Routes 97, 99, 104, 105, 106, and 109) and four routes serving Chelsea only (Routes 114, 116, 117, and the SL3). The Newburyport/Rockport Line provides commuter rail service to Chelsea Station. Important transit hubs in the two communities include Bellingham Square in Chelsea and Everett Square in Everett. In Winter 2020, 23% of weekday bus boardings within the study area occurred in Chelsea and 12% occurred in Everett. Combined, this is higher than Cambridge and Somerville, where 26% of boardings took place.

In Winter 2020, Route 111 was the second-highest ridership route in the MBTA bus system, with nearly 65,000 average weekday boardings. Routes 104, 105, 109, and 111 are also all within the top 10 most crowded routes in the network[1], indicating that demand exceeds current service levels.

Chelsea and Everett have very high ratios of off-peak boardings compared to the study area, meaning that transit demand remains high throughout the day rather than only during traditional commute times. On average, stops in Chelsea and Everett, see 36% and 6% more off-peak boardings, respectively, than the average stop in the study area. In turn, Cambridge has the lowest off-peak to peak boarding ratio in the study area, indicating that boardings in the city tend to skew toward peak times. This ratio of off-peak to peak bus boardings is illustrated in Figure 4.

The highest ridership locations include Bellingham Square, with 3,600 weekday bus boardings, which is comparable to Wellington Station. Stops between Bellingham Square and Chelsea Square have some of the highest consecutive boardings in the study area. The 2,640 boardings at 18 stops along the Broadway corridor in Everett are comparable to Broadway and Highland Avenue in Somerville and Cambridge Street in Cambridge. Ridership is highly distributed across stops in Everett, which lacks a rapid transit station to act as a central boarding hub.

Ridership across all MBTA bus routes dropped dramatically with the onset of the COVID-19 pandemic. Systemwide ridership saw a modest increase at the end of 2020, hovering between 39% and 42% of pre-pandemic ridership levels, while routes in the study area, Routes 104, 109, 111, 116, and 117, recovered between 56% and 60% of bus riders. This difference is even more apparent when excluding Key Route ridership from systemwide totals – on average, routes serving the study area have recovered almost 20% more riders than routes that serve other communities in the region. These stark differences in ridership patterns can be attributed to a high concentration of transit-dependent populations, and particularly bus-dependent individuals, due to poor rail transit access in Everett and Chelsea, as well as a high concentration of workers who work jobs that cannot be done from home and require them to continue commuting.

Travel Flows

Within the Inner Core[2], most trips from Everett and Chelsea are local. Approximately 44% of trips, including both auto and transit, begin and end in Chelsea or Everett; 27% of trips from Everett and Chelsea end in Revere, East Boston, or Malden; and the remaining trips end in regional activity hubs like downtown Boston (4%), Logan Airport (2%), and Back Bay (1.5%).

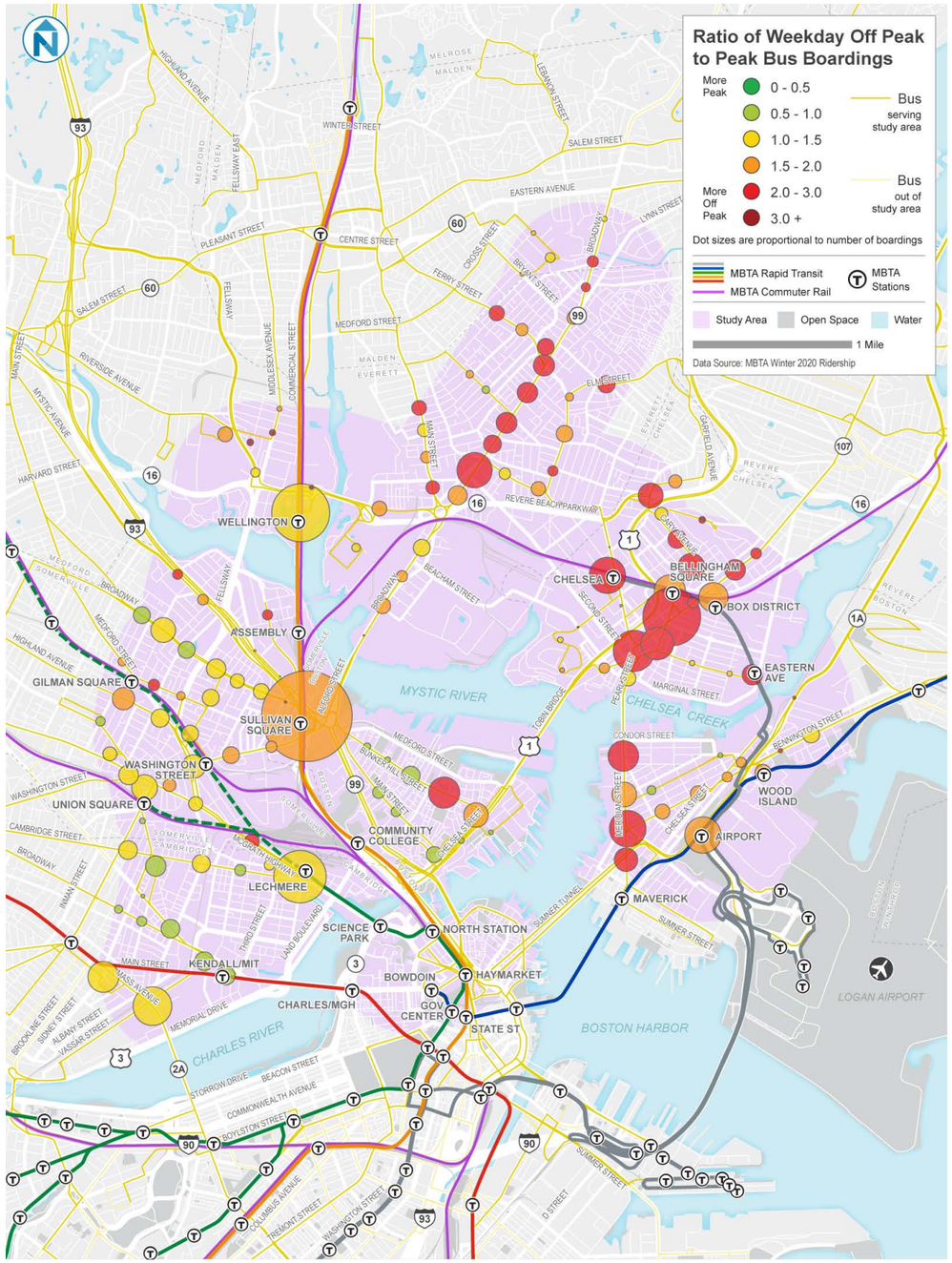
When looking only at transit trips from Everett and Chelsea, downtown Boston emerges as the top destination for riders. 24% of transit trips from Everett and Chelsea end in downtown Boston and 23% begin and end in Everett and Chelsea. Other top transit destinations are Back Bay (5%) and the Longwood Medical Area (LMA) (4%).

Notably, Kendall Square is not shown as a top current destination for Everett and Chelsea transit riders. This is likely to be less of an issue of demand and more of an issue of access. It is currently difficult to access the many job opportunities in Kendall Square via transit (or by driving). It takes over an hour and two transfers to travel between most locations in Chelsea and Everett and Kendall Square. The Silver Line Extension process therefore looked more at latent demand for this connection rather than historical demand.

1 MBTA Daily Bus Ridership, Passenger-weighted crowding by route and hour for the week of September 7, 2020.

2 The Boston Area Inner Core Communities include Arlington, Belmont, Boston, Cambridge, Chelsea, Everett, Lynn, Malden, Medford, Melrose, Milton, Needham, Newton, Quincy, Revere, Saugus, Somerville, Waltham, Watertown, and Winthrop.

Figure 4 | Ratio of Weekday Off-Peak to Peak Bus Boardings



Transit Access, Travel Time, and Job Access

Traveling within and between communities in the study area by transit is challenging. Transit trips between major study area locations can take 30, 45, or 60 minutes or longer and often require one or more transfers. As shown in Figure 5, buses are delayed by congestion on most primary corridors in the study area. Everett residents access the lowest number of jobs within a "typical" commute time (45 minutes) relative to neighboring municipalities, in part due to the city's lack of access to high quality, high-capacity transit. Transit travel time access is illustrated for the following transit centers in Figure 6 through Figure 9.

Figure 5 | Daily Passenger Minutes in Delay

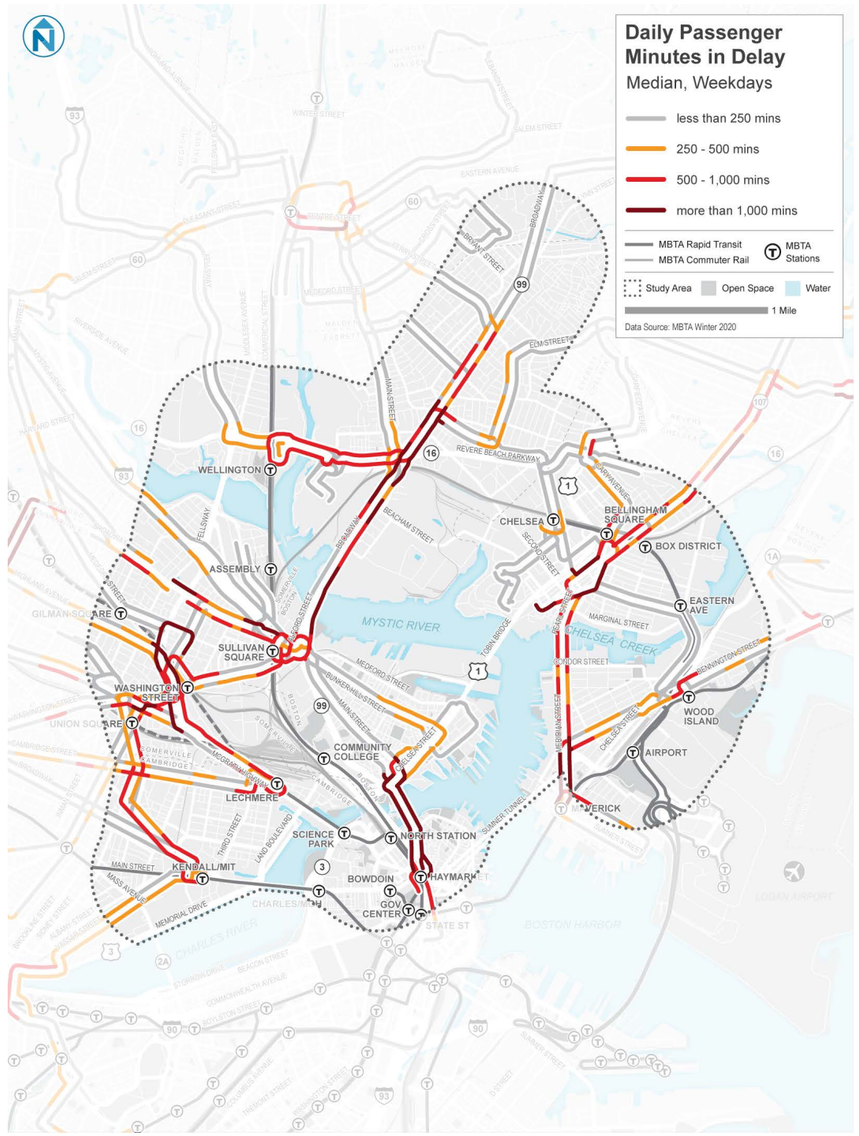
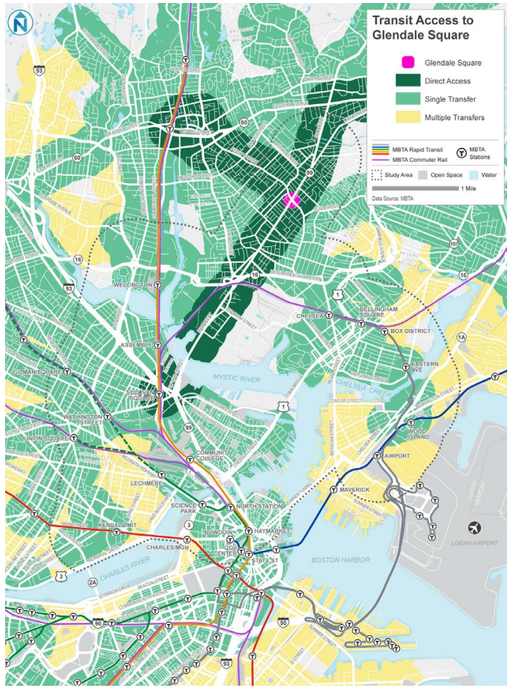
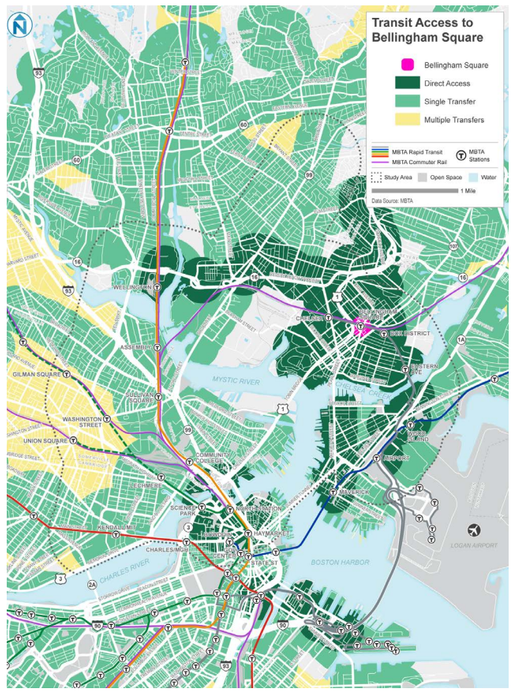


Figure 6 | Transit Access to Glendale Square



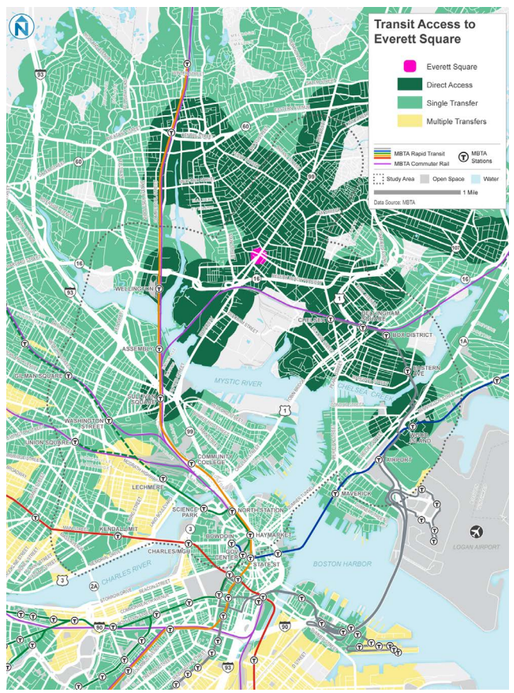
Glendale Square has limited direct transit access, with direct travel only available to the Orange Line at Malden Center and Sullivan. From the Square, riders can travel along Broadway in Everett and Ferry Street in Malden without a need to transfer. A single transfer is required to access the rest of Everett as well as much of Chelsea. Almost all of Somerville, as well as job centers in downtown Boston and Kendall and Central Squares, are one transfer from Everett Square. Downtown Boston and much of Somerville are accessible within 45 minutes, while the rest of the city and all of Cambridge take up to 60 minutes to reach. Travel to the eastern part of Chelsea, along with most of East Boston and Cambridge, requires multiple transfers.

Figure 7 | Transit Access to Bellingham Square



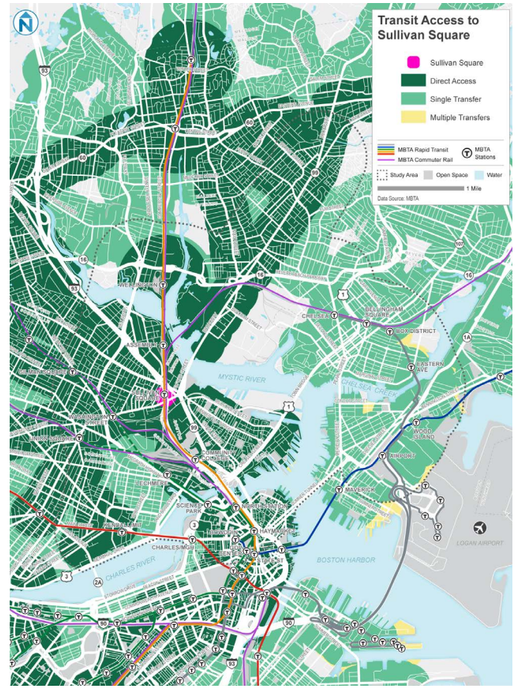
Bellingham Square has direct (one-seat ride) travel available to the Orange and Blue Lines, as well as to Everett Square, East Boston, and downtown Boston. Transit riders beginning their trip at Bellingham Square have modest access to the surrounding area. From Bellingham Square, riders can travel across Chelsea without the need to transfer. With a single transfer, almost all of Everett, Malden, and Revere can be accessed. Job centers in Cambridge's Kendall Square and Central Square are also one transfer away (although requiring a trip through downtown Boston), along with downtown Boston and the Seaport. Travel to Cambridge and Somerville, such as the Union Square area, requires multiple transfers from Bellingham Square. Central Square, Kendall Square, and most of Boston typically take 45 minutes to reach, creating challenges with job access to those employment hubs. Transit rides of 60 minutes or longer are required to reach some destinations in Medford, Cambridge, and Somerville.

Figure 8 | Transit Access to Everett Square



Everett Square has direct travel available to the Orange and Blue Lines, as well as much of Chelsea and East Boston's Day Square. Transit riders beginning their trip at Everett Square have modest access to the surrounding area. From Everett Square, riders can travel across most of Everett without a need to transfer. One-seat rides to Malden Center, south Revere, and Day Square are also available. A single transfer grants access to most of Somerville, as well as job centers in downtown Boston, and Cambridge's Kendall and Central Squares (albeit requiring a trip through downtown Boston). Travel to South Boston and much of Cambridge requires multiple transfers from Everett Square. Travel times from Everett Square increase dramatically outside the peak hours. Trips across the study area are moderate to long and, compared to the AM peak, transit riders from Everett Square headed to Boston need 15 extra minutes to reach East Boston and downtown Boston during midday, outside of Orange Line stops.

Figure 9 | Transit Access to Sullivan Square



Sullivan Square has short travel times to various destinations, with direct travel possible throughout Somerville, Boston, Cambridge, Everett, Malden, and Medford thanks to the Orange Line station and bus hub. From the station, riders can directly travel across all of east Somerville and to much of Everett, Cambridge, and Boston within one transfer. Multiple transfers are required only to reach the edges of Chelsea, East Boston, and the South Boston Seaport. Travel times from Sullivan Square to major destinations in the study area vary by location and by time of day, but access to high quality, high-capacity transit dramatically increases access within 30 minutes when compared to the other centers in the study area.

Silver Line 3

The SL3 offers critical connections to residents of the study area, particularly for people traveling from Chelsea to downtown Boston and to Boston Logan International Airport, one of the region's largest employers and major transportation activity centers, sitting in the top 10 busiest airports on the East Coast.[1]

The SL3 provides service between 5:00 AM and 12:55 AM on weekdays, between 5:30 AM and 12:55 AM on Saturdays, and between 6:30 AM and 12:55 AM on Sundays. Service frequency ranges between every 10 minutes during weekday peak hours and every 12 minutes the rest of the weekday and on weekends. A one-way, end-to-end trip between Chelsea Station and South Station takes about 30 minutes on average.

In Winter 2020, the SL3 had an average daily weekday ridership of 7,173, placing it alongside the top highest ridership bus routes in the MBTA system. During the height of the pandemic, the SL3 fared better than the MBTA bus system as a whole, with 46% ridership recovery as of Fall of 2021. The South Station, Courthouse, Bellingham Square, and Airport stations have the highest boardings of the SL3 on average.

The MBTA currently operates all Silver Line routes with a dedicated fleet of diesel-electric and battery-electric, articulated buses (BEBs) for use on the Silver Line routes. The MBTA is procuring enhanced electric hybrid (EEHs) buses to replace aging Silver Line buses. The new, 45-vehicle fleet is anticipated to be fully operating in 2024.

There are a few infrastructure and operational constraints within the existing SL3 alignment. These are organized by the extremity of the constraint. NOTE: None of these constraints are addressed by the current SLXAA effort, as other efforts are underway or have been completed to help these constraints and their impacts on SL3 service.

Chelsea Street Bridge Openings: The bridge, which is regulated by the United States Coast Guard, opens and closes as requested by any maritime users, and as such opens as many as ten times per day to allow passage of ships carrying petroleum products to upstream tank farms. Federal regulations give priority to marine traffic at all times of day, and therefore require the bridge to be opened on demand, making transit time over the bridge less predictable. The Chelsea Street Bridge rises to the full extent at 175' designed to accommodate high tides and larger vessels in the future. As a result, the Bridge lifts last between 12 to 30 minutes on average, meaning that a typical 30 minute trip between South Station and Chelsea could be doubled in travel time to 60 minutes due to a bridge lift event, which may be longer if there are multiple lifts back-to-back causing significant backups on all approaches for all vehicles.

In 2019 MassDOT submitted a request to the United States Coast Guard to allow the bridge to open to 139 feet above mean high water instead of the full open position of 175 feet unless a full bridge opening is requested. In March 2020 the United States Coast Guard granted this request by publishing a final rule in the Federal Register. By reducing the height of the bridge lift, the total time the bridge is lifted is reduced, therefore reducing travel time impacts on SL3 service. MassDOT also implemented both an advanced notification system to alert users of future lifts and will soon operate new equipment to better inform users real time when a bridge lift is underway (variable message boards and beacon lights at the top of the bridge). Finally, MassDOT has made significant operational enhancements to improve the reliability of the bridge and the communications to stakeholders.

MassDOT has also maintained a Twitter account @LogantoChelsea since 2016 that provides advanced and real time information on bridge lifts to the public, so that travelers can plan accordingly.

The City of Boston has proposed routing SL3 service through Day Square in East Boston and implementing bus lanes on Chelsea Street from Day Square to the Chelsea Creek bridge. If implemented, these bus lanes would potentially reduce delays on the SL3 due to bridge lifts by allowing SL3 buses to bypass queuing traffic on Chelsea Street.[2]

Alford Street Bridge Openings: The Alford Street Drawbridge provides an uninterrupted connection between Everett and Charlestown during most of the day. It is closed for the passage of vessel traffic during the morning peak hours and between 5 p.m. and 6 p.m. daily and would minimally impact Silver Line operations across the corridor.

Ted Williams Tunnel Congestion: When traveling between Silver Line Way and the Airport, SL3 buses use the regular travel lanes through the Ted Williams Tunnel. Congestion in the tunnel can cause substantial travel time delays, and although they are largely correlated to the morning and afternoon rush hours they can happen at any time when there is a backup in traffic in the tunnel.

Seaport Circulation: When traveling from the Ted Williams Tunnel to Silver Line Way, SL3 buses currently make a "loop" in the Seaport using Haul Road, in the outbound direction, or Congress Street, in the inbound direction. Both routes are circuitous, add to travel times, and increase the potential for delays because buses are in general purpose travel lanes when making these loops. SL3 buses also experience delays at the D Street signal where buses are coming from the Silver Line Transit Tunnel, crossing traffic at D Street, and need to wait for a green light signal to proceed. The Bus Network Redesign project has proposed a modification to the SL1 and SL3 routes in the Seaport to reduce travel time and delay. Under the proposal, Silver Line buses would turn onto D Street at the intersection of Silver Line Way and D Street.

Pedestrian and Bicycle Conditions

The study area has a burgeoning but disparate local and regional bicycle network, with approximately 40 miles of on-street bike facilities. Protected bike lanes account for 14% of the on-street bike network and bike lanes account for 60%. In addition to on-street infrastructure, there are more than 30 miles of off-street multi-use trails within the study area.

There remains significant room to improve conditions for people biking in the study area. While most neighborhoods have dense street grids, which often indicate good walkability and bikeability, some lack the dedicated infrastructure needed to enable people to feel safe while biking amidst other vehicular traffic. In some of these neighborhoods, expanding the bike network may only require filling in small network gaps around transit stations, while in others, more substantial efforts may be needed to safely connect people biking from surrounding neighborhoods.

In general, sidewalk and pedestrian infrastructure is safe and accessible across residential neighborhoods and business districts in the study area, where there is a higher density of existing and potential riders within walking distance to transit. Pedestrian mobility is significantly more challenging in the industrial portions of the study area, such as Lower Broadway in Everett and Brickbottom in Somerville. Besides being physically isolated by railroads, arterial roads, and high truck and train volumes, the urban fabric or these areas is not at this time conducive of pedestrian activity.

1 https://www.worldatlas.com/places/the-10-busiest-airports-in-the-united-states.html#h_936655818865167639204606 8 (last accessed February 28, 2023).

2 https://www.bostonplans.org/planning/planning-initiatives/plan-east-boston

While neighborhoods themselves are very walkable, traveling between them can be hindered by the presence of busy arterials and highways. The Newburyport/Rockport line and Route 16 in Chelsea and Everett, McGrath Highway and the many rail lines in East Somerville and East Cambridge, and Rutherford Avenue in Boston make it difficult (and at times impossible) for pedestrians to travel comfortably between neighborhoods.

Traffic Conditions

The study area is comprised of some of the largest and busiest communities in the Commonwealth. Major roadways included in the study network include Route 16 and Route 28/McGrath Highway, Rutherford Avenue, Broadway, and the dense street network of East Cambridge between Lechmere and Kendall. Some of the region's most complex traffic circles are part of the network: Sweetser Circle, Santilli Circle, and Sullivan Square. Major bridge structures that serve as points of constraint include the Alford Street Bridge, the Gilmore Bridge, and the Charles River Dam Bridge. Due to the vast nature of the study area the Silver Line Extension focused on identifying capacity constrained roadway corridors with narrow rights-of-way where converting a travel or parking lane to a dedicated transit lane could have implications on overall traffic; major intersections with critical congestion levels that could delay transit vehicles; and locations or corridors with documented safety concerns. Some of these roadways and intersections are highlighted below.

Select Roadway Corridors and Traffic Circles:

- **Second Street (Everett)** is generally one lane in each direction with single lane widths of 12 feet. The total roadway is 32 feet wide. The Revere Beach Parkway intersection is a High Crash Location, and the Second Street corridor from Revere Street to Broadway is a High Pedestrian Crash Cluster.
- **Broadway (Route 99) (Everett)** is generally one 10-foot travel lane in each direction separated by a double yellow center line. The bike and parking lanes operate as peak-direction bus/bike lanes along a portion of the corridor. The Broadway corridor from Second Street to High Street is a High Pedestrian Crash Cluster.
- **Revere Beach Parkway (Route 16) (MassDOT)** is generally three 12-foot travel lanes in each direction separated by a raised median. Parking is prohibited, and no shoulders are present. As noted above, the Second Street intersection is a High Crash Location.
- **Sweetser Circle (MassDOT)** is an approximately 450-foot outside diameter rotary connecting Revere Beach Parkway with Broadway and Main Street. Revere Beach Parkway passes beneath Sweetser Circle and is connected via ramps. Sweetser Circle was recently restriped to function as a modern roundabout and provides two circulating lanes and a bus lane.
- **Broadway (Route 99) (Everett)** south of Sweetser Circle, Broadway generally provides two 12-foot travel lanes and a bike lane in each direction, with a raised median. Parking is prohibited. The Beacham Street intersection is a High Crash Location. Broadway continues south into Boston as Alford Street, crossing the Mystic River via a drawbridge. South of the drawbridge, Alford Street is connected to the Sullivan Square rotary via diamond interchange type ramps.
- **McGrath Highway (Route 28) (MassDOT)** in Somerville is generally three 12-foot-wide travel lanes in each direction, with turn lanes at signalized intersections. Parking is prohibited. McGrath Highway continues into Cambridge as Monsignor O'Brien Highway where travel lanes are 11-foot wide. This section is located within a High Pedestrian Crash Cluster. McGrath Highway is currently under design for a major reconstruction of the corridor.
- **Cambridge Street (Boston) and Washington Street (Somerville)** is generally one 11-foot-wide travel lane and a buffered bicycle lane in each direction. Parking is generally permitted.

Washington Street from Franklin Street to McGrath Highway is a High Bicycle and Pedestrian Crash Cluster.

- **Rutherford Avenue (Route 99) (Boston)** is generally two 11-foot-wide travel lanes in each direction, separated by a raised median and with turn lanes at key intersections Parking is prohibited. Rutherford Avenue is currently under design for a major reconstruction of the corridor.
- South of Chelsea Street, Rutherford Avenue continues as **North Washington Street (Boston)**. Between Causeway Street and New Chardon Street, North Washington Street provides two 10-foot to 11-foot travel lanes in each direction. A northbound on-street bicycle lane and southbound bus/bike lane are also provided in this segment. Parking is generally permitted on the northbound side of the roadway. This corridor from Causeway Street to New Chardon Street is a High Bicycle Crash Cluster.
- **Charles River Dam Road (Route 28) (DCR)** is generally two 10-foot travel lanes and an on-street bicycle lane in each direction. Flexposts provide separation between travel and bicycle lanes and parking is prohibited. The Edwin H. Land Boulevard intersection is a High Crash Location, the corridor is a High Bicycle Crash Cluster from the Museum of Science to Edward H. Land Boulevard, and a High Pedestrian Crash Cluster in the vicinity of Lechmere Square.
- **First Street (Cambridge)** is generally one 12-foot-wide travel lane and one 5 foot wide on-street bicycle lane in each direction. Parking is generally permitted on the southbound side of the roadway. Between Rogers Street and Binney Street, parking is prohibited to accommodate a turn lane. The First Street corridor from Cambridge Street to Otis Street is within a High Pedestrian Crash Cluster.
- **Third Street (Cambridge)** is generally one 11- to 12-foot-wide travel lane in each direction, although lanes narrow to 10 feet at some intersections to provide an additional turn lane. Parking is permitted along one or both sides along portions of the roadway. 5-foot wide on-street bicycle lanes are provided on Third Street south of Binney Street. The Spring Street intersection is a High Crash Location, and the Third Street corridor from Monsignor O'Brien Highway to Otis Street is a High Pedestrian Crash Cluster.

The full description of roadway corridors is included in Appendix B.

Key intersections included locations where potential lane reconfigurations would have the greatest impact on traffic operations based on existing traffic operations, constraints on available width or right-of-way, or unusual complexity due to adjacent land uses, interactions of multiple modes of travel, crash experience, planned projects, or other factors. Key Intersections in the study area include:

- Revere Beach Parkway (Route 16) at Second Street (Everett)
- Broadway (Route 99) at Beacham Street (Everett)
- Revere Beach Parkway (Route 16) at Santilli Circle (Everett)
- Fellsway/McGrath Highway (Route 28) at Mystic Avenue (Route 38) (Somerville)
- Monsignor O'Brien Highway (Route 28) at Third Street (Cambridge)

A full description of these key intersections is included in Appendix B.

The analysis showed that even with the proposed Silver Line service in place, with signal and infrastructure upgrades traffic flow would operate at generally acceptable conditions, in relation to volume-to-capacity and/or level of service, at these critical locations. This also suggests that other, less challenging locations along the corridors would also be able to accommodate the project.

Environmental and Public Health Conditions

Overall, the study area is primarily urbanized with scattered areas of open space. None of the environmental conditions within the study area constrain the development of alternative route alignments.

Throughout the study area, road traffic, aviation activity, and nearby rail lines contribute to higher noise levels than much of Boston's Inner Core. Traffic noise is a concern for residences adjacent to highways or busy state routes. Another major source of noise in the study area is created from the aviation traffic traveling in and out of Boston Logan International Airport. The areas with highest rail noise levels in the study area appear to be where the MBTA's Green Line, Orange Line, and multiple Commuter Rail lines converge in the East Somerville/Inner Belt area heading towards North Station.

In Chelsea, one of the top five environmental concerns identified included outdoor air quality. In Boston, the top environmental health concerns include outdoor noise and air pollution from vehicles and dangerous traffic. Also worth noting is that transportation access, including Route 111 and the Silver Line, was noted as a community strength.

Across all communities in the study area, access to health care and services was identified as a primary concern. Most communities in the study area, including Chelsea, Everett, and Malden, noted access to healthy and affordable food was a public health concern.

Alternatives Analysis

The LPA was identified through a three-step evaluation process, starting with a high-level assessment of several ideas, and with each subsequent step applying a more robust and quantitative analysis:

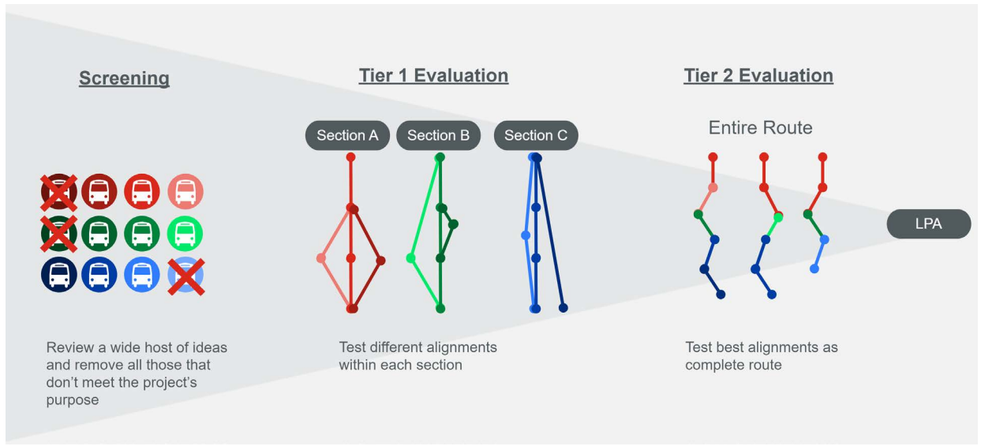
Step 1. Screening against Project Purpose

Step 2. Tier 1 Evaluation (performed at a geographic level)

Step 3. Tier 2 Evaluation (performed at an end-to-end route level)

This three-step evaluation process is illustrated in Figure 10 below.

Figure 10 | Silver Line Extension Alternatives Analysis Evaluation Process



The study area was organized into four sections, which are listed below:

- Section 1: Chelsea Station or Glendale Square to Sweetser Circle in Everett
- Section 2: Sweetser Circle to the Orange Line
- Section 3: Orange Line to Kendall Square
- Section 4: Orange Line to Downtown Boston

Municipal stakeholders and the public were engaged for each step of the evaluation process. The first round of public engagement helped to create the universe of 22 potential concepts that were ultimately considered. This universe of ideas is shown in Table 3.

Table 3 | Preliminary Concepts

Section	Concept Code	Concept Name	Description
1	1A*	Rail Right-of-way to 2nd to Route 16	Chelsea Station – Rail Right-of-way – 2nd Street – Route 16 – Sweetser Circle
1	1B	Spruce Street / 2nd Street	Chelsea Station – Everett Avenue – Spruce Street
1	1C	Rail Right-of-way	Rail Right-of-way – Sweetser Circle
1	1D	2nd Street / Spring Street	Spring Street – Chelsea Street – Broadway – Sweetser Circle
1	1E	Everett Avenue / Route 16	Chelsea Station – Everett Avenue – Route 16 – Sweetser Circle
1	1F	Continue on 2nd Option	Chelsea Station – Rail Right-of-way – 2nd Street – Broadway – Sweetser Circle
1	1G	Upper Broadway	Glendale Square – Broadway – Sweetser Circle
2	2A*	Lower Broadway	Sweetser Circle – Lower Broadway – Sullivan Square
2	2B	Rail Right-of-way to Lower Broadway	Sweetser Circle – Rail Right-of-way – Lower Broadway – Sullivan Square
2	2C	Route 16	Sweetser Circle – Revere Beach Parkway – Wellington
2	2D	Rail Right-of-way to Rail Bridge	Rail Right-of-way – New Bridge – New Alignment – Sullivan Square
3	3A*	Inner Belt	Sullivan Square – Washington – Inner Belt Road – McGrath – Lechmere – First Street – Binney Street – Third Street – Kendall Square
3	3B	Fellsway / McGrath	Wellington – Fellsway – McGrath – Lechmere – First Street – Binney Street – Third Street – Kendall Square
3	3C	Washington / McGrath	Sullivan Square – Washington – East Somerville – McGrath – Lechmere – First Street – Binney Street – Third Street – Kendall Square
3	3D	Rutherford / Gilmore	Sullivan Square – Rutherford Avenue – Gilmore Bridge – Charles River Dam Road – Lechmere – First Street – Binney Street – Third Street – Kendall Square
3	3E	Grand Junction Option	(From McGrath) – Grand Junction Line – Binney Street – Kendall Square
3	3F	Land Blvd Option	(From Lechmere) – Charles River Dam Road – Land Boulevard – Binney Street – Third Street – Kendall Square
3	3G	Assembly Option	Wellington – Grand Union – Sullivan – Washington (continues alignment of 3A)
4	4A*	Rutherford to North Station	Sullivan Square – Rutherford Avenue – Washington Street – North Station
4	4B	Lechmere to North Station	Lechmere – Charles River Dam Road – Marth Street – North Station – Nashua Street
4	4C	Connection to Haymarket Option (from the east)	(From Washington Street Bridge) – Washington Street – Haymarket
4		Connection to Haymarket (from the west)	(From Washington Street or North Station) – Merrimac Street – Haymarket

* Preferred Alignment from LMRWG Study

Screening Against Project Purpose

The screening phase of the evaluation considered each of the preliminary concepts against the minimum requirements of the project's purpose. Screening criteria represent this set of minimum requirements and were based on existing or readily available data and may reflect regulatory or policy imperatives. These screening criteria, listed below, align specifically with the project purpose.

1. Does the concept either create new or improve existing transit connections between Chelsea and Everett or improve transit services within Chelsea or Everett?
2. Does the concept continue on from Everett to the Orange Line, Somerville, Cambridge, and/or Boston?
3. Does the concept serve the identified needs of transit-critical populations?
4. Does the concept avoid displacing the dwellings of any transit-critical populations?
5. Does the concept provide a relatively direct line of travel[1]?
6. Is this concept compatible with local plans and/or priorities?
7. Is this concept feasible from an engineering perspective?
8. Can the concept be permitted from an environmental perspective?

Preliminary concepts that met these screening criteria were considered generally feasible and relevant and were developed into project concepts to be advanced into the Tier 1 Evaluation process. Any concept receiving a "no" response was considered infeasible and/or nonresponsive to the project purpose, and was dropped from further consideration, without any design or evaluation.

The Internal and External Stakeholder Working Groups reviewed the screening results that were then made available for public comment during and after the April 2021 Public Meeting. In total, three concepts were removed during the screening phase: concepts 2D, 3E, and 3G. The remaining 19 concepts were advanced for Tier 1 Evaluation. The results of the screening process are further documented in Appendix B: Silver Line Extension Alternatives Analysis Screening.

1 Defined as no more than double the length of a straight-line roadway path of travel.

Tier 1 Evaluation

The Tier 1 Evaluation identified the best performing alignments within specific communities. For example, Tier 1 explored many ways to connect Chelsea Station and Everett Square, different ways to connect Everett Square with the Orange Line, etc. It was structured to identify which concepts best achieve the project goals and objectives by section. The following descriptions and maps describe the concepts considered in the Tier 1 Evaluation.

Figure 11 | Section 1: Chelsea Station or Glendale Square to Sweetser Circle in Everett

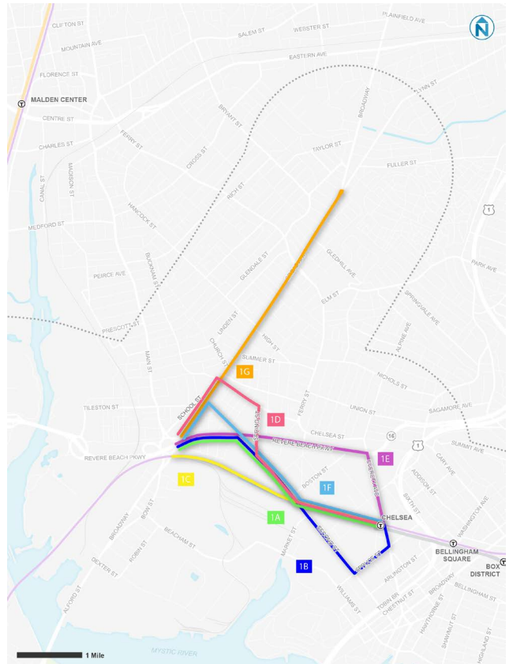
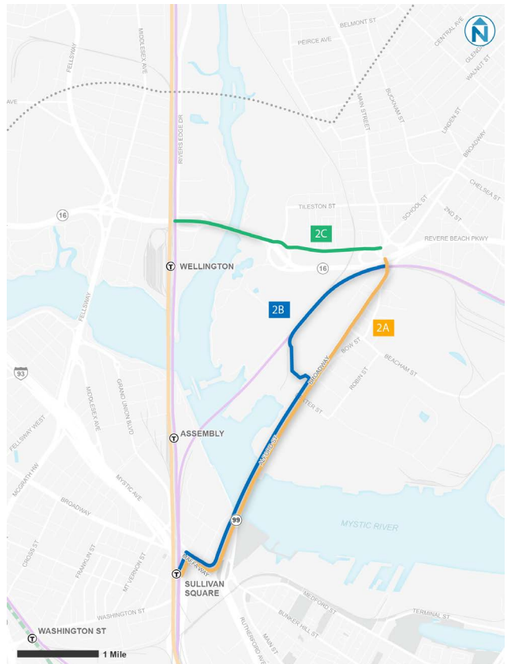


Figure 12 | Section 2: Sweetser Circle to the Orange Line



Section 1: Chelsea Station or Glendale Square to Sweetser Circle in Everett

There were seven concepts in Section 1:

- Concept 1A began at Chelsea Station and operated along the commuter rail right-of-way, Second Street, and Revere Beach Parkway, until Sweetser Circle.
- Concept 1B began at Chelsea Station and operated along Everett Avenue, Spruce Street, Second Street, and Revere Beach to reach Sweetser Circle.
- Concept 1C began at Chelsea Station and then operated entirely along the commuter rail right-of-way to Sweetser Circle.
- Concept 1D began at Chelsea Station and operated along the commuter rail right-of-way, Second Street, and Spring Street. It then continued on Chelsea Street to Everett Square and ran on Broadway to reach Sweetser Circle.
- Concept 1E began at Chelsea Station, continued along Everett Avenue to Revere Beach Parkway, and then continued on Revere Beach Parkway to reach Sweetser Circle.
- Concept 1F began at Chelsea Station, continued along the commuter rail right-of-way to Second Street, continued along Second Street to Broadway, and then continued on Broadway to reach Sweetser Circle.
- Concept 1G began near Glendale Square in Everett and continued entirely on Broadway to reach Sweetser Circle.

Section 2: Sweetser Circle to the Orange Line

Section 2 had four concepts:

- Concept 2A began at Sweetser Circle and operated entirely along Broadway in Everett and Alford Street in Boston to reach Sullivan Square Station.
- Concept 2B began at Sweetser Circle, operated along the commuter rail right-of-way to Horizon Way, and then used Horizon Way to reach Broadway. It then continued on Broadway in Everett and Alford Street in Boston to reach Sullivan Square Station.
- Concept 2C began at Sweetser Circle and operated on the Santilli Connector to Santilli Circle, then the Route 16 Bridge. After crossing the Malden River, the alignment used the Rivers Edge Drive ramps and station access roads to reach the Wellington Station busway.
- Concept 2D began at Everett Square and operated along Broadway, Ferry Street, and Centre Street to reach Malden Center Station. (Not Pictured.)[1]

1 A connection to the Orange Line at Malden Center was introduced into the analysis during the second round of public outreach (Fall 2021), as the preliminary Tier 1 results were being presented to internal and external stakeholders. Support for a Malden Center connection was also voiced through the second public survey and at the second online public meeting.

Figure 13 | Section 3: Orange Line to Kendall Square

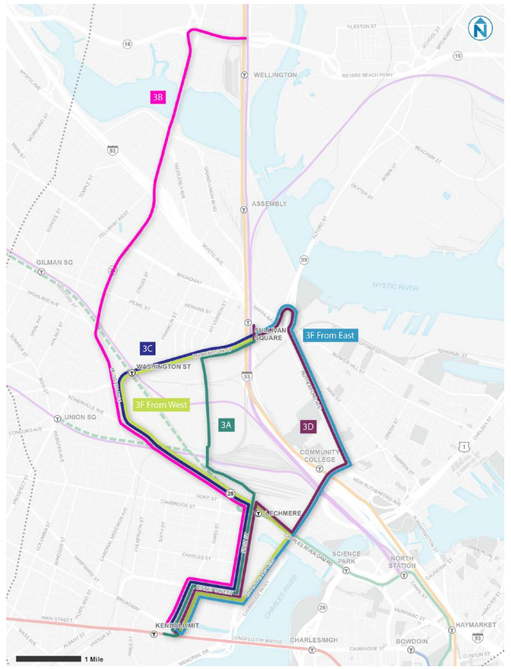
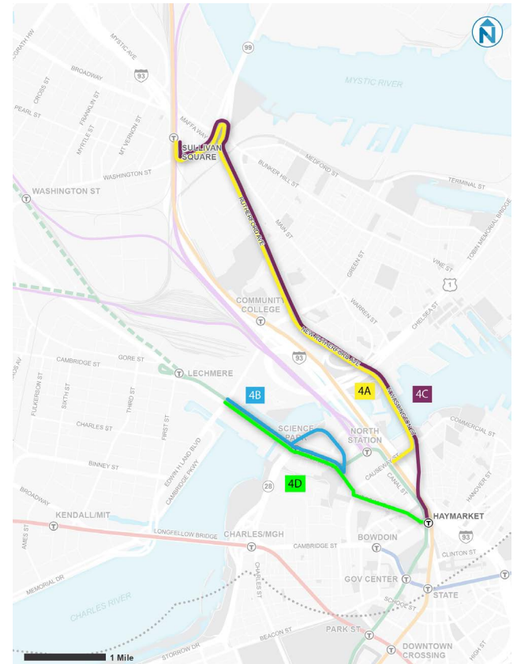


Figure 14 | Section 4: Orange Line to Downtown Boston



Section 3: Orange Line to Kendall Square

Six concepts in Section 3 advanced to the Tier 1 Evaluation. Concepts 3A to 3D share an alignment from First Street, at Lechmere Station, to Kendall Station, along First Street, Binney Street and Third Street.

- Concept 3A began at Sullivan Square Station and operated on Washington Street and Inner Belt Road. It then entered a new structure across the commuter rail and Green Line Extension right-of-way to reach Morgan Avenue. It then continued on First Street to Lechmere Station.
- Concept 3B began at Wellington Station, used the station access roads and the Rivers Edge Drive ramps to reach Revere Beach Parkway, and operated through Wellington Circle to Route 28. It then continued on Route 28 until First Street, near Lechmere Station.
- Concept 3C began at Sullivan Square Station and operates on Washington Street to Route 28. It then followed the same route to Kendall as Concept 3B.
- Concept 3D began at Sullivan Square Station and operated on Rutherford Avenue to Austin Street/Gilmore Bridge. After crossing the Gilmore Bridge, it then continued on Route 28 to First Street until Lechmere Station.
- Concept 3F – From East followed the same alignment as Concept 3D, but used Land Boulevard, instead of First Street, to run between Route 28 and Binney Street.
- Concept 3F – From West followed the same alignment as Concept 3C, but used Land Boulevard, instead of First Street, to run between Route 28 and Binney Street.

Section 4: Orange Line to Downtown Boston

Section 4 concepts include:

- Concept 4A began at Sullivan Square Station, operated on Rutherford Avenue, and then continued across the North Washington Street Bridge into Downtown Boston. It then turned onto Causeway Street and terminated near North Station.
- Concept 4B began near Lechmere Station, operated on Route 28 across the Charles River, and then terminated near North Station via a loop on Martha Road and Nashua Street.
- Concept 4C began at Sullivan Square Station, operated on Rutherford Avenue, and then continued across the North Washington Street Bridge into Downtown Boston. It then continued on North Washington Street and terminated near Haymarket Station.
- Concept 4D began near Lechmere Station, operated on Route 28 across the Charles River, passed North Station, and then used Merrimac Street to reach Haymarket Station.

Tier 1 Evaluation Findings

Each of the concepts were evaluated against the goals, objectives, and metrics shown in Table 4. Appendix C: Tier 1 Evaluation Methodology Memo details the methodology and findings from the Tier 1 Evaluation process.

Because the units of data varied by metric, and each goal area contained several metrics, results were aggregated into a five-point scale from Low to High as outlined below.

The Tier 1 scoring was done on a section-by-section basis, comparing the different concepts with one another within each section. Scoring did not compare a concept in one section against a concept in a different section.

Figure 15 | Tier 1 Five-Point Scale

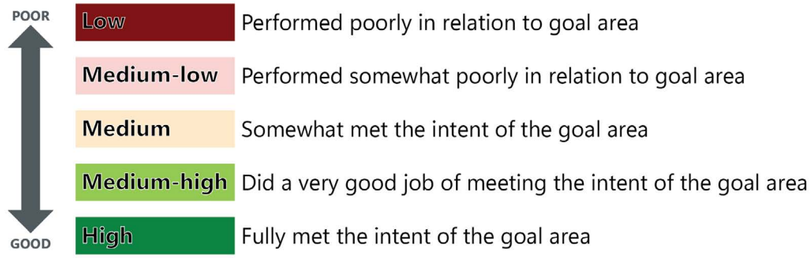


Table 4 | Goals and Tier 1 Metrics

Goal Area	Tier 1 Metrics
Expand Mobility and Access	• Total employment (existing or projected) within ½ mile of the concept • Total trips beginning, ending, or passing through area served by concept • Number and quality of transfer opportunities • Provides service within one or more of the Bus Network Redesign's identified High Priority Corridors • Number of affordable housing units within ½ mile of the concept
Advance Equity	• Proportion of transit critical population (people of color, low-income households, zero vehicle households)
Improve Safety	• Existing or potential for accessible pedestrian path • Existing or potential bicycle connections • Ability to address known safety issues
Support Climate Change Resilience and Sustainability	• Ability to remain outside known areas of climate change vulnerability OR ability to construct alignment so that it would withstand climate change vulnerability
Advance Feasible and Implementable Solutions	• Proportion of alignment that could support dedicated transit facilities (sketch analysis) – on entire alignment and alignment segments with MBTA bus service • Extent of active planning efforts on identified corridors • Extent of known community support • Number and extent of known major cost items • Number and extent of new connections between major activity centers

Mobility and Access

There was a wide range of performance for mobility and access, ranging from very high to moderate and poor ratings. Overall, concepts in Section 1 that served Chelsea and Everett provided both mobility and access benefits, with those connecting Chelsea with Everett Square performing the highest. Those in Section 2 serving Lower Broadway provided better access benefits than the other concepts. Service along Washington Street to Kendall in Section 3, and concepts serving both Charlestown and Haymarket in Section 4, provided the most access and mobility benefits.

Equity

Almost all concepts performed well in relation to equity, which is unsurprising because many of the areas served by them are communities with high concentrations of transit-critical populations. There was variety between sections: alignments in Chelsea and Everett have higher proportions of transit-critical populations served than alignments in other parts of the study area, and so overall, the Section 1 concepts performed better in relation to equity benefits. Of the sections, Section 3 showed the largest variation between concepts. In particular, the percentage of the population who are people of color within walking distance of the alignment varied greatly between concepts, with the alignments routing through Charlestown performing worse than the other concepts.

Safety

The safety goal area also had wide variation between concepts in each of the four sections. One difference was in terms of connections to the bicycle network. Alignments that serve activity centers such as Everett Center, concepts that serve Lower Broadway, and concepts along Washington Street in Somerville all interact and intersect with existing bicycle facilities, and they generally performed well in this metric.

In addition, there was some differentiation between concepts in relation to addressing known safety concerns. Most concepts interface with locations with one or more safety concerns, but design adjustments associated with the Silver Line Extension investment are anticipated to address them as part of the project scope. Other concepts, like Concept 3B, which approached Wellington Station from the west, faced more challenging safety concerns that would need to be addressed as part of a larger effort.

Climate Resiliency

Climate change resiliency in the Tier 1 Evaluation was limited to looking at alignments that interacted with locations that are vulnerable to flooding and a 21-inch sea level rise.[13] All Section 1 concepts were outside areas of projected sea level rise. In Section 2, the two concepts that crossed the Alford Street bridge, which has approaches vulnerable to flooding and sea level rise, scored worse than the concept extending to Wellington.

Within Sections 3 and 4 there was little differentiation between concepts, and all of them showed some level of vulnerability to flooding and sea level rise. Those concepts that interfaced with Inner Belt and Brickbottom areas – 3A, 3D, and 3F-From East – scored worse than the others, and Concept 3C Washington to McGrath performed better. The entirety of Section 4 is highly vulnerable to flooding and sea level rise, and thus all concepts received Low scores.

Feasibility and Implementation

This goal area relied on preceding work done by municipal partners to identify feasible corridors that could serve current and future markets. Within Section 1, concepts that served Everett Center via the Second Street corridor were most compatible with previous and ongoing plans. From a cost and ease of implementation perspective, Concept 1C, which operated entirely along the commuter rail right-of-way, was more challenging than the alignments on Second Street between the commuter rail right-of-way and north of Route 16. The commuter rail right-of-way also presented a challenge in Section 2, specifically tying into Lower Broadway south of the Encore Casino. Within Section 3, the major cost elements required to construct a bridge over the commuter rail and GLX tracks between Inner Belt Road and First Street in Cambridge,

in the context of current construction plans, caused that concept to perform poorly. In Section 4, the turning radii and roadway right-of-way constraints in the vicinity of North Station caused those alignments to perform worse than the options that connected with the Green and Orange Lines at Haymarket.

Tier 1 Evaluation Results

Table 5 | Tier 1 Concepts advanced to Tier 2 Evaluation

Section No.	Concepts to Move into Tier 2		
Section 1	1D	1G	
Section 2	2A	2C	2D
Section 3	3C	3F-West	
Section 4	4C		

In Section 1, **Concepts 1D** and **1G** were advanced into the Tier 2 Evaluation. Concepts 1D and 1G scored high across the Safety, Climate Resilience, and Feasibility and Implementation goal areas. All their potential station areas are accessible by pedestrians and they both overlap with dedicated bike facilities. Furthermore, both are compatible with previous efforts that explored transit connecting Chelsea and Everett and within Everett. Both align with the Everett Transit Action Plan, and Concept 1G is also compatible with the Lower Mystic Working Group study.

Concept 1D has the added benefit of providing direct access to Everett Square and the many jobs in its vicinity. While job access is lower for Concept 1G, since its surrounding neighborhood is mostly residential, dedicated transit facilities along Broadway could benefit several local MBTA routes that also operate on the corridor.

In Section 2, **Concepts 2A, 2C, and 2D** were forwarded into the Tier 2 Evaluation. Concept 2A, which connects to Sullivan Station, serves the Lower Broadway corridor, which includes major employers such as the Encore Casino and the MBTA Everett Maintenance Facility. Concept 2C serves retail plazas and offices along Route 16 and at Wellington, which have far fewer total jobs accessible within walking distance of the alignment than the Lower Broadway concepts.

Concepts 2A and 2C perform well in the Equity goal area. Concept 2A serves a high proportion of zero-vehicle households, and Concept 2C serves a high proportion of people of color and low-income households. In terms of Climate Resiliency, however, Concept 2A received a Low score due to its alignment across the Alford Street Bridge, which has approaches that are highly vulnerable to flooding and sea level rise.

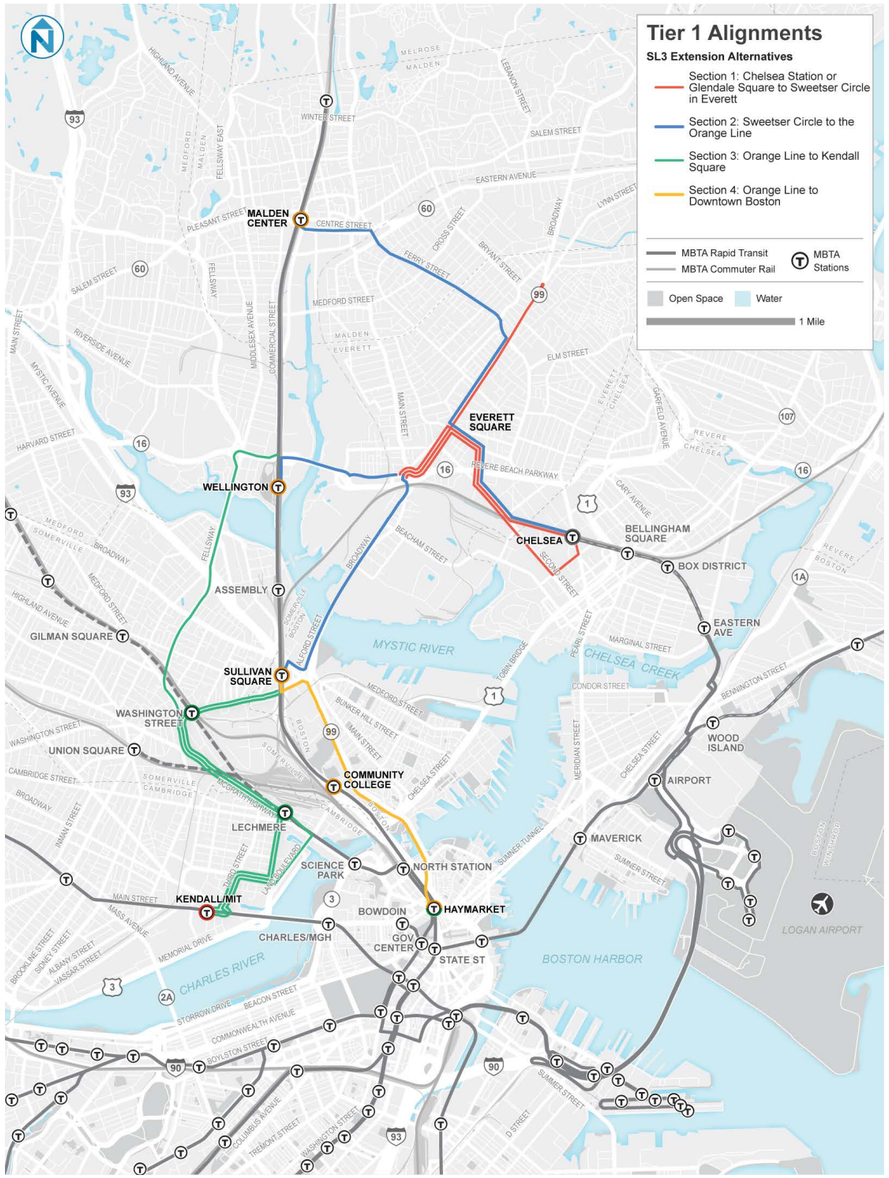
With substantial reconfiguration, the roadways serving most of Concept 2A could accommodate dedicated bus lanes in both directions. Feasibility and Implementation for Concept 2C, which connects to Wellington, could be more challenging because most of the roads on the alignment likely cannot accommodate dedicated bus lanes or platform-style stations. Both concepts are also relatively consistent and compatible with other planning efforts, including the Lower Mystic Regional Working Group, Wellington Circle Study, and Wellington Station Redesign.

Concept 2D performed well at connecting existing and potential riders with desirable destinations. The concept performs well in relation to equity and climate change resiliency. There are some concerns over the ability to create transit priority along the Ferry Street corridor sufficient to provide travel time benefits or reliability benefits.

In Section 3, **Concepts 3C and 3F-From West** were advanced into the Tier 2 Evaluation. These two concepts performed better than their counterparts across several metrics. They both serve a higher proportion of transit critical populations and operate mostly on roads that could accommodate dedicated bus lanes in both directions and do not appear to cross any critical pinch-points (short segments or intersections that could not be feasibly modified as part of this project). They also provide a new transit connection with high utility, including improved connections between the Orange Line and Kendall Square and a potential new connection from the northern Orange Line and the First Street corridor in Cambridge. Concept 3C provides access to a high concentration of jobs near Union Square and Boynton Yards. It also provides multiple transfer opportunities to rapid transit and high-frequency bus routes.

Only one Section 4 concept was advanced into the Tier 2 Evaluation, **Concept 4C**. This concept operates mostly on roads that could accommodate dedicated bus lanes in both directions and do not appear to cross any critical pinch-points. It outperformed the other concepts in this section in Mobility and Access and Safety. As it extends into downtown Boston to serve Haymarket, Concept 4C provides access to more jobs than Concepts 4A and 4B. It also provides more transfer opportunities for riders looking to travel farther. Concept 4C also serves Sullivan Square and Haymarket, which have far more transfer opportunities than Lechmere alone, in the case of Concept 4A.

Figure 16 | All Tier 1 Concepts



Tier 2 Evaluation

The Tier 2 Evaluation connected the best performing concepts from Tier 1 (see Table 5 above) into end-to-end alternatives and analyzed them for performance and effectiveness on a capital and service basis. There were seven Tier 2 alternatives in total. Appendix E: Tier 2 Evaluation Methodology Memo describes the assumptions that guided the conceptual design and service planning work that was done to define the Tier 2 alternatives.

The alternatives were organized into two groups: a set of three alternatives that extend the SL3 to the Orange Line, and a set of three alternatives that provide a new service (called the SL6 for evaluation purposes) extending from Everett into Kendall Square in Cambridge or into downtown Boston, as well as one additional alternative that provides a new service (also called the SL6 for evaluation purposes) extending from Chelsea into Kendall Square.

SL3 Extension Alternatives: From Chelsea to Everett and continuing on to the Orange Line

The three SL3 Extension Alternatives are illustrated in Figure 17 below.

Figure 17 | SL3 Extension Alternatives

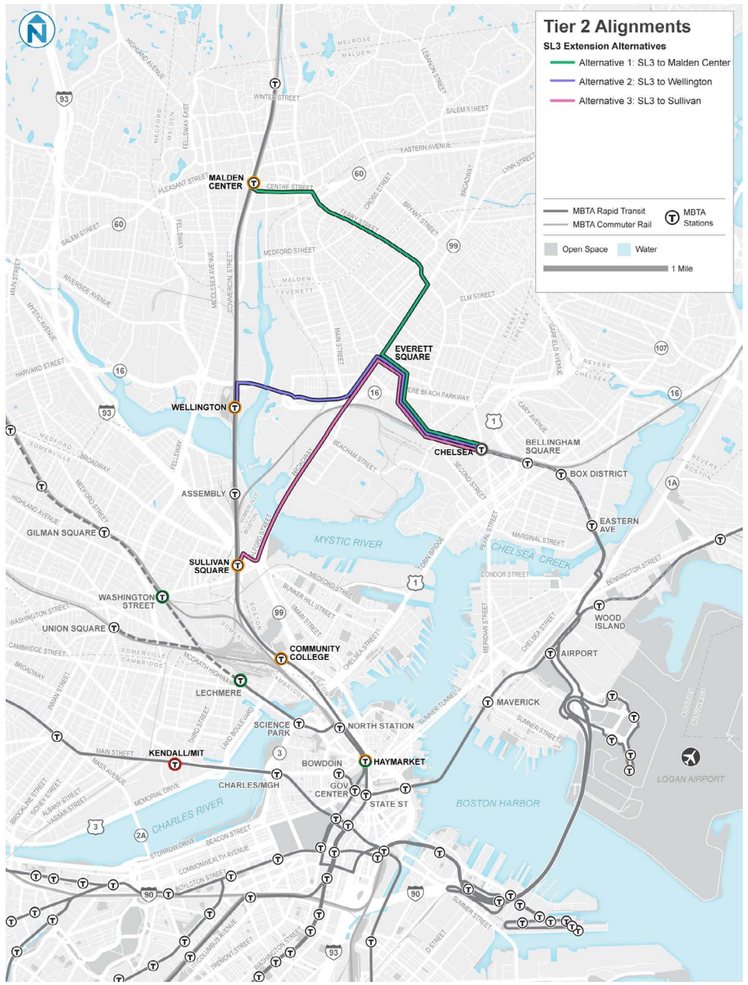


Figure 18 | Alternative 1: SL3 to Malden Center

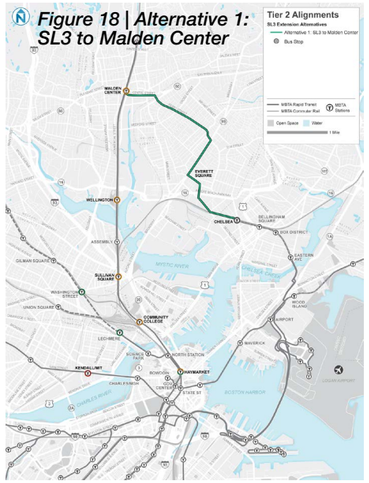
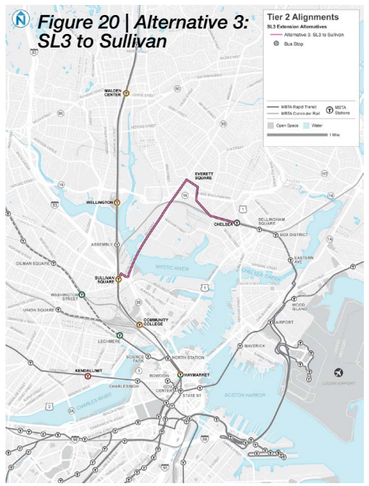


Figure 19 | Alternative 2: SL3 to Wellington

Figure 20 | Alternative 3: SL3 to Sullivan



Each of the three SL3 Extension Alternatives connect Chelsea to the Orange Line via Everett Square. All three alternatives follow the same path between the existing Chelsea busway and Everett Square. The following describes what the three SL3 extension alternatives have in common:

- Extend the Chelsea busway within and along the southern edge of the commuter rail right-of-way (bi-directional transitway) between the existing Chelsea station terminus and the Second Street intersection.
- Cross the Newburyport/Rockport commuter rail line tracks at grade, and travel along Second Street to Spring Street via side-running dedicated bus lanes (both directions).
- Travel along Spring Street to Chelsea Street. There are two pieces to this section:
  - Between 2nd Street and Revere Beach Parkway, the street is assumed to be closed to general-purpose traffic, with dedicated bus lanes only. This condition would transition over time -- in the short-term, buses would operate in general-purpose traffic.
  - Between Revere Beach Parkway and Chelsea Street, the Silver Line operates in general-purpose traffic.
- Travel along Chelsea Street from Spring Street to Broadway. SL3 buses would utilize a westbound bus lane and operate in mixed traffic eastbound.

At Broadway in Everett Square, the three SL3 Extension alternatives differ as follows:

Alternative 1: SL3 to Malden Center connects with the Malden Center Orange Line station. After reaching Everett Square, it would operate on dedicated bus lanes along Upper Broadway and then in mixed traffic on Ferry Street until reaching the Centre Street Busway and Malden Center Station.

Alternative 2: SL3 to Wellington would travel south along Broadway, primarily in dedicated bus lanes until the approach to Sweetser Circle. It would then continue in general-purpose lanes around Sweetser Circle, the Santilli Connector, and Santilli Circle, and stay in mixed traffic on Route 16 to Rivers Edge Drive, the approach to Wellington Station.

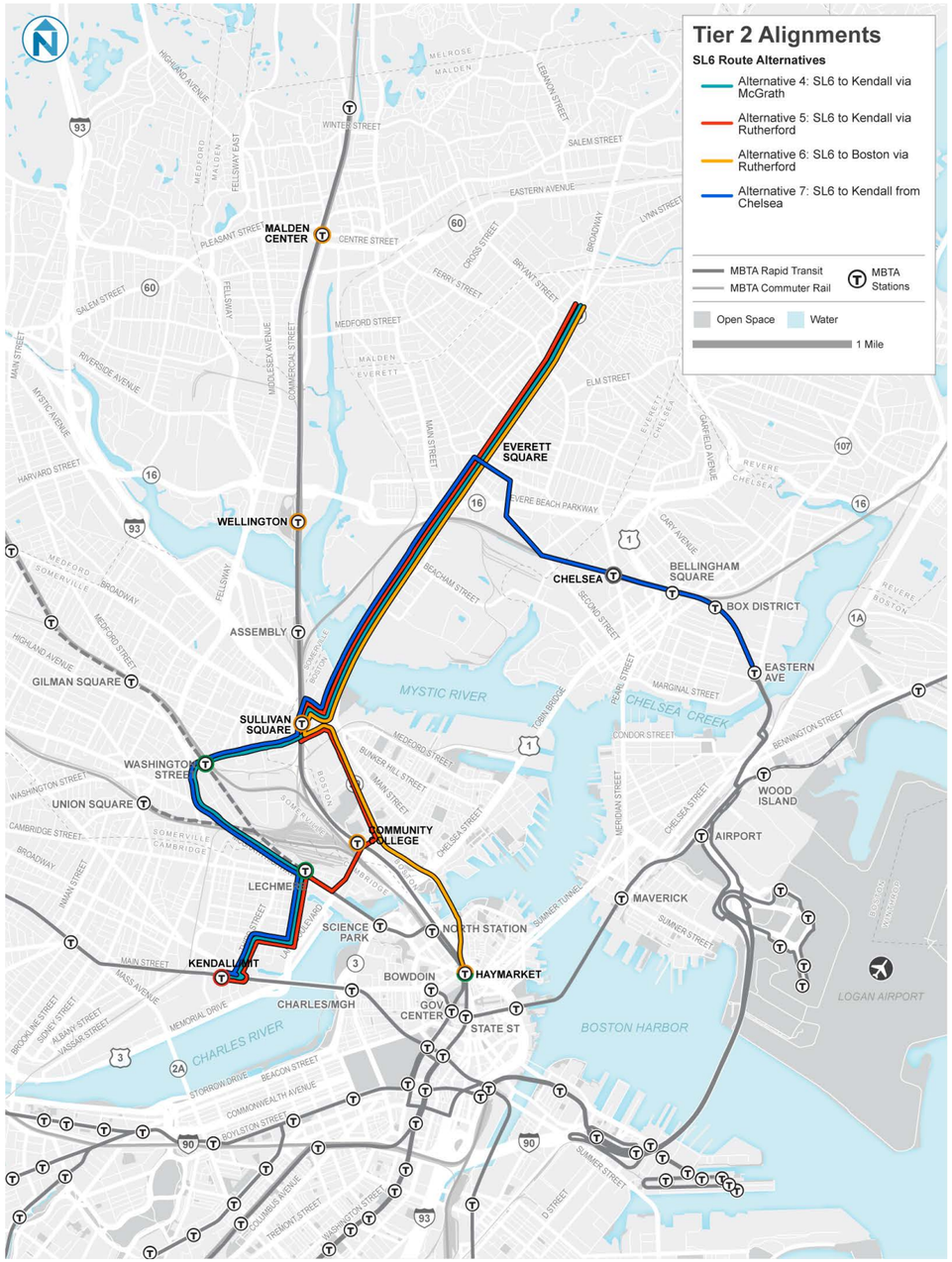
Alternative 3: SL3 to Sullivan continues south on Broadway using dedicated bus lanes. Silver Line vehicles would travel in the outer lanes of Sweetser Circle using bus-only lanes in both directions to reach Lower Broadway. Along Lower Broadway and Alford Street, buses would also largely operate in dedicated bus lanes. These bus lanes continue over the Alford Street Bridge until just before Sullivan Square Station.

For modeling purposes, the SL3 Extension frequencies we assumed to be every 10 minutes on weekdays, except for night and late night periods where frequencies would match the weekend frequency of every 12 minutes.

New Silver Line Service (SL6) Extension Alternatives: From Chelsea and Everett to Sullivan, continuing on to Kendall and/or Boston

The four SL6 Alternatives are illustrated in Figure 21 below.

Figure 21 | SL6 Alternatives



Three of the SL6 alternatives connect Everett with Kendall and one (Alternative 6) connects Everett with downtown Boston.

All the alternatives that serve Kendall assumed a specific circulation between Kendall and Lechmere. The SL6 would circulate westbound on Main Street, turn north onto Ames Street and east on Broadway until the intersection with Third Street. Then the SL6 would follow the same route it traveled in the southbound direction. Upon further discussion, the City of Cambridge suggested a different routing that uses Galileo Galilei Way, as opposed to Ames Steet. Further study on Kendall Square circulation may be necessary before a preferred alignment is selected.

Figure 22 | Alternative 4: SL6 to Kendall via McGrath

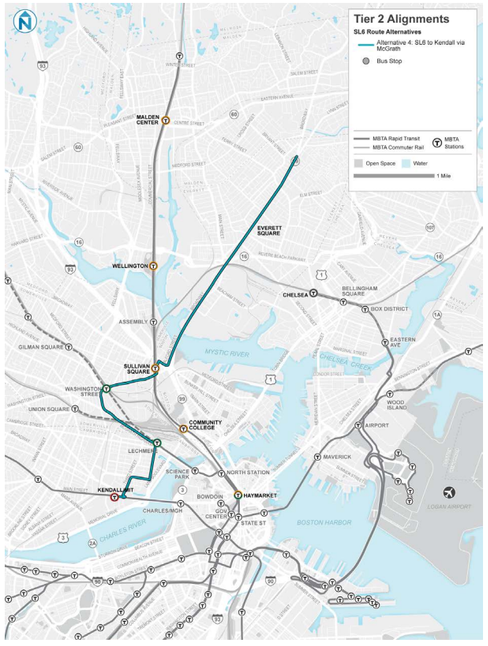


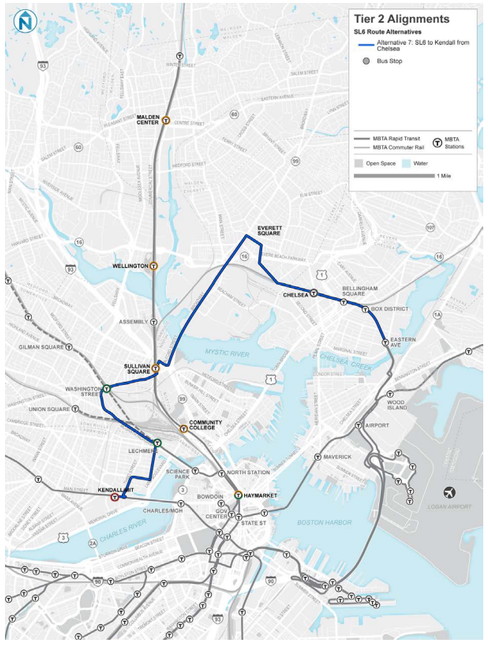
Figure 23 | Alternative 5: SL6 to Kendall via Rutherford

Alternative 4: SL6 to Kendall via McGrath begins in Glendale Square in Everett and operates in side-running bus lanes along Upper Broadway until it connects with the SL3 Extension LPA in Everett Square and follows that alignment until Sullivan Station. Silver Line vehicles would exit Sullivan Station by turning onto Cambridge Street and continue along Washington Steet until McGrath Boulevard, where the alignment would turn south and travel along McGrath Boulevard until Lechmere Station for passengers to connect to the Green Line. It was assumed that redesign of McGrath Boulevard would include dedicated bus lanes. After stopping at Lechmere, buses head south on First Street, then turn west onto Binney Street, and then back south along Third Street until Main Street and the Kendall Red Line station.

Alternative 5: SL6 to Kendall via Rutherford follows the same alignment as Alternative 4 from Glendale Square to Sullivan Station. After stopping at Sullivan, Silver Line vehicles would travel down a redesigned Rutherford Avenue, which was assumed to have dedicated bus lanes, in Charlestown. Buses would then turn west to cross the Gilmore Bridge and travel along McGrath Boulevard until Lechmere Station. From Lechmere to Kendall, and back, Alternative 5 would follow the same alignment as Alternative 4.

Figure 24 | Alternative 6: SL6 to Boston via Rutherford

Figure 25 | Alternative 7: SL6 to Kendall from Chelsea



Alternative 6: SL6 to Boston via Rutherford is the only SL6 alternative connecting to downtown Boston. This alternative also began in Glendale Square and follows the same alignment as Alternative 5 up until Rutherford Avenue, where instead of turning on the Gilmore Bridge, it continues down Rutherford and New Rutherford Avenues, crosses the North Washington Street bridge, and travels along Washington Street until reaching its southern terminus at Haymarket Station.

Alternative 7: SL6 to Kendall from Chelsea provides a one-seat ride from Chelsea through Everett to Kendall Square. Instead of beginning at Glendale Square, this SL6 alternative begins at Eastern Avenue Station and travels along the Chelsea busway to Chelsea Station, following the same route as the existing SL3. Once the SL6 reaches Chelsea Station, it would continue along the same alignment as Alternative 3 to Sullivan Station. Between Sullivan Station and Kendall Station, Alternative 7 would operate along an identical alignment as Alternative 4, along Washington Street and McGrath Boulevard and connecting with the Green Line at Lechmere and the Red Line at Kendall.

SL6 Alternatives were modeled at higher frequencies than the SL3 Extension alternatives and match the level of service proposed for the MBTA's Bus Network Redesign (BNRD) proposed high-frequency network – every 5 minutes during weekday peak hours, every 8 minutes weekdays midday, and every 10 minutes on weekends and weekday early mornings and nights.

The Tier 2 Evaluation process differed from the Tier 1 Evaluation in multiple respects. First, the analysis used the CTPS Travel Demand Model to assess ridership, changes in VMT, mode split, and greenhouse gas reductions for each alternative. The CTPS model used 2040 as the analysis year, the Winter 2020 bus network as its base, and a set of transportation and land use investments as assumptions. The land use assumptions started with those used for the Lower Mystic River Working Group Study and added projects in the development pipeline as discussed in the Existing Conditions chapter. For a full list of the transportation investments included in the model, please see Appendix F: Additional Transit Projects for Inclusion in the CTPS No Build 2040 Model.

The entirety of the Silver Line Extension Alternatives Analyses overlapped with the MBTA's BNRD project. Given that the changes to the MBTA bus network were still preliminary at the time the Tier 2 Evaluation and all CTPS modeling were being conducted, this study used the Winter 2020 bus network for most of the evaluation metrics. The Revised BNRD was incorporated into metrics as much as possible after it was released to the public. Coordination occurred with the BNRD team throughout the Tier 2 Evaluation process to ensure the assumptions and analyses were consistent.

As shown in Table 6, the Tier 2 metrics had a strong focus on equity, feasibility, and reliability of the proposed service.

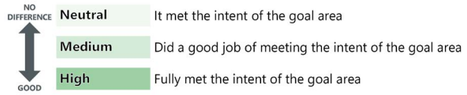
Table 6 | Goals and Tier 2 Metrics

Goal Area	Tier 2 Metrics
Expand Mobility and Access	Total Ridership (Daily) Number of jobs accessible via 45-minute transit commute (Average by stop during AM peak, midday) Ratio of transit time to drive time (AM peak, midday) Number of affordable housing units within ½ mile of a stop or station TOD Propensity Score
Advance Equity	Percentage of commuters to jobs accessible by a 45-minute transit commute who rely on transit Average reduction in daily passenger minutes of delay on bus routes that overlap with the alternative Number of travel flows with more than 5,000 daily trips (weighted by low-income and minority trips) served by the alternative
Improve Safety	Ability for alternative to provide a connection to an existing pedestrian and bicycle facility or to retain width for a new facility that is continuous, comfortable, and safe
Support Climate Change Resilience and Sustainability	Change in transit mode split Change in greenhouse gas emissions and VMT
Advance Feasible and Implementable Solutions	Number of Silver Line buses needed to operate the alternative (Estimated fleet surplus or deficit) Extent to which investment could be included within other efforts upcoming or currently underway Extent that could operate within exclusive transit right-of-way Planning-level cost estimate

Tier 2 Evaluation Results

Quantification of performance is possible at this level of conceptual planning, but it is important to note that Tier 2 Evaluation results are only for relative comparison purposes between the alternatives. At this high level, values such as travel times and costs lack precision that can only be generated as more detailed planning and engineering is performed.

Because the units of data varied by metric, and each goal area contained several metrics, results were summarized into a three-point scale from "neutral" to "high" as follows:



All the proposed alternatives performed positively across metrics, so it was decided not to include low-performing categories in the Tier 2 Evaluation scale. The use of a "high," "medium," and "neutral" rating system thus allows for a comparative analysis of the tradeoffs between each alternative's ability to best meet the project purpose and need. Of note is that this scoring was done on a category basis, comparing the different SL3 and SL6 alternatives with one another within each category. Scoring did not compare SL3 Extension alternatives against SL6 alternatives.

Results for SL3 Extension Alternatives

Table 7 | Performance of SL3 Extension Alternatives

Goal Area	Alternative 1: SL3 to Malden Center	Alternative 2: SL3 to Wellington	Alternative 3: SL3 to Sullivan
Expand Mobility and Access	High	Medium	High
Advance Equity	Medium	Medium	High
Improve Safety	Neutral	Neutral	Neutral
Support Climate Change Resilience and Sustainability	Neutral	Neutral	Neutral
Advance Feasible and Implementable Solutions	Medium	Medium	High

All three SL3 Extension alternatives have comparable performances across several evaluation metrics. All SL3 Extension alternatives show that extending the SL3 to an Orange Line station will significantly increase the route's ridership. The build alternatives show ridership increases between 90% and 150% when compared to the 2040 no-build condition. Alternative 1 shows the highest potential ridership, followed by Alternative 3.

All SL3 Extension alternatives also provide tremendous access to jobs. Overall, people riding the alternatives will have greater access to jobs in the morning, which corresponds to the bus network's peak frequency period. Despite connecting to a major bus transfer hub like Malden Center, Alternative 1 connects riders to the lowest number of jobs. The other two alternatives travel through and connect to areas of higher job density and intersect with more transit routes, increasing the opportunities for transfers.

The SL3 could be extended to any of the three proposed Orange Line termini with the anticipated Silver Line fleet. Alternative 1, being the longest alignment and having slightly lower travel speeds than the other two alternatives, would require one additional vehicle to operate

beyond the number of vehicles required for Alternatives 2 and 3. Another metric with consistent results across alternatives was transit mode share, which did not vary greatly across alternatives.

However, other metrics highlighted key differences between the alternatives. By design, all the SL3 Extension alternatives also increase the extent of bus transit priority along their respective corridors, especially between Chelsea Station and Everett Square. This increase results in improved travel time reliability. Travel time reliability is highest for Alternative 3, as it has the highest level of transit priority, which improves travel times, especially during peak congestion periods. In turn, despite featuring dedicated bus lanes between Chelsea Station and Sweetser Circle, Alternative 2's transit travel time is quite comparable to the drive time. This is because most of the traffic congestion for this alternative is concentrated on Santilli Circle and Route 16, segments where transit priority treatments were not proposed due to operational and right-of-way limitations.

Travel time savings from dedicated bus lanes and transit signal priority also extend to local bus routes, which were assumed to be able to use all proposed infrastructure improvements, except for the Chelsea busway extension. Because we know that the local bus routes in our study area carry more people of color and people with low incomes, this has an equity benefit.

Each alternative presents a set of tradeoffs. Alternative 1 to Malden Center performs well in terms of ridership overall, and travel flows serving transit-critical populations. Alternative 1 stands out among the others for its transit-oriented development (TOD) readiness. Its score is reflective of high housing density and high percentage of transit-critical residents along the corridor. Furthermore, it ranks highly in pedestrian and bicycle access, due to a dense street network with primarily residential uses adjacent to the corridor. However, Alternative 1 does not perform well when it comes to transit priority along Ferry Street. Our preliminary analysis showed that Ferry Street is not wide enough to accommodate both bus lanes and general-purpose lanes. The ongoing Ferry Street Reconstruction project will improve pedestrian safety by installing curb extensions at intersections. Alternative 1 would carry the cost of removing the new curb extensions and replacing them with queue jumps. Despite the assumed transit signal priority and queue jumps, the lack of dedicated transit facilities has a detrimental effect on travel times and travel time reliability.

Despite being the shortest route to an Orange Line station and major bus transfer hub, Alternative 2 to Wellington has lower ridership demand than the other two SL3 Extension alternatives. Almost half of Alternative 2 operates in mixed traffic. This alternative faces right-of-way challenges along Sweetser Circle, the Santilli Connector, and Santilli Circle. West of Santilli Circle, the short operating distance on Route 16 makes it unfeasible to install dedicated lanes in that segment. Finally, the ramps connecting to Wellington Station are not assumed to be widened to accommodate additional bus lanes. This results in transit trip times similar to driving times: when this stretch of roadway is congested, buses are caught in the congestion too. However, because it would not require construction beyond Broadway, Alternative 2 is relatively cost effective.

Alternative 3 has a "high" performance in most goal areas. It performs well on key metrics like ridership, access to jobs, cost effectiveness, and, most importantly, transit travel time reliability. Alternative 3's alignment has more capacity to accommodate dedicated bus lanes than Alternatives 1 and 2, which result in a greater transit travel time advantage when compared to driving. Finally, Alternative 3 aligns well with upcoming efforts, or efforts currently underway. A Silver Line Extension along Lower Broadway connecting Everett to Sullivan Station was a recommendation from the Lower Mystic Regional Working Group report. Furthermore, this part of Everett is in transition; Lower Broadway is the location of the recently constructed Encore Casino, and other development applications are underway. Through this process, the City of Everett is exploring the potential to require setbacks to allow more space for dedicated transit along Lower Broadway, which would be beneficial for Alternative 3.

Results for SL6 Alternatives

Table 8 | Performance of SL6 Alternatives

Goal Area	Alternative 4: SL6 to Kendall via McGrath	Alternative 5: SL6 to Kendall via Rutherford	Alternative 6: SL6 to Boston via Rutherford	Alternative 7: SL6 to Kendall from Chelsea
Expand Mobility and Access	High	High	Medium	High
Advance Equity	High	Medium	High	High
Improve Safety	Neutral	Neutral	Neutral	Neutral
Support Climate Change Resilience and Sustainability	Neutral	Neutral	Neutral	Neutral
Advance Feasible and Implementable Solutions	High	Medium	Medium	High

Alternatives 4, 5, and 6 all connect Upper Broadway in Everett with either Kendall Square or downtown Boston in different ways. These alternatives assume that the existing SL3 alignment would be extended from Chelsea Station to Everett Square along the Commuter Rail right-of-way, Second Street, Spring Street and Chelsea Street (as described in Alternatives 1 through 3), allowing for a transfer between the SL3 and the SL6. Alternative 7 aims to connect Chelsea and Kendall via a one-seat ride.

As was the case for the SL3 Extension alternatives, the Tier 2 evaluation revealed that the SL6 alternatives have several things in common:

- All alternatives provide tremendous access to jobs via transit and with little difference between the peak hour and midday.
- All alternatives increase the extent of bus transit priority to between 75% and 90% of the alignment lengths. This lends itself to competitive transit travel times and reduced travel time delays, for all transit services that can use the bus lanes.
- All the SL6 alternatives result in a greater transit mode share than the SL3 Extension alternatives, close to 3% higher than the 2040 no-build scenario.
- To operate any of the SL6 alternatives, the MBTA would need to expand the size of the Silver Line fleet by acquiring new vehicles, which has downstream impacts on where vehicles are stored and maintained.
- Finally, the SL6 alternatives all rely on investments that are made by other parties. These investments in roadway and intersection redesign and reconstruction would happen outside of this process. The redesign of Sullivan Square, Rutherford Avenue, Gilmore Bridge, and McGrath Highway are necessary precursors to these alternatives operating at their assumed potential.

Among the key findings from the Tier 2 Evaluation is that ridership to Kendall is higher than to Downtown Boston. While the project team partially attributes this to an increase in future demand for this service as growth continues in the study area, the ridership model results show that the ridership discrepancy is partially due to Alternative 6 riders transferring to the Orange Line at Sullivan instead of staying on the Silver Line to reach Downtown.

Each SL6 alternative also presents a set of tradeoffs. Alternative 4 to Kendall via McGrath connects Everett residents with the Orange Line at Sullivan, the Green Line at Lechmere, and the Red Line at Kendall. It does very well with overall ridership. When combining the projected SL3 and SL6 ridership, Alternative 4 has the most riders among all SL6 alternatives. While it has the lowest extent of transit priority among SL6 alternatives (75%), it still shows great potential for travel time reductions for overlapping MBTA services. Alternative 4 runs through areas that are generally bike and pedestrian friendly and almost 90% of its stops are accessible by bike.

Alternative 5 to Kendall via Rutherford connects to an additional Orange Line station,

Community College, in addition to Sullivan, Lechmere, and Kendall. By nature of being shorter in length, this alternative has a slightly shorter travel time than Alternative 4, which is further enhanced by a higher percentage of transit priority along its length (80%). However, as is also the case with Alternative 4, Alternative 5 is likely to experience delays while circulating around Kendall, particularly in the outbound direction. A key distinction between Alternatives 4 and 5 is the approach to Kendall from Rutherford and the Gilmore Bridge. The Gilmore Bridge currently experiences high levels of traffic congestion. After consultation with several stakeholders, the policy assumption was made to model dedicated bus lanes in each direction on the Gilmore Bridge and a Silver Line station at Community College. Pavement reconstruction and painting for bus lanes are included in our cost estimates for this alternative.

Alternative 6, from Everett to Haymarket via Rutherford Avenue, is the only SL6 alternative that connects Everett directly to Downtown Boston. Alternative 6 performs well on a number of metrics, including extent of transit priority, access to jobs, access to affordable housing units. Where Alternative 6 falls short of its counterparts is ridership. Projected ridership for Alternative 6 is more than a third lower than that of other SL6 alternatives. This ridership shortfall could be attributed to the many competing services between Sullivan Station and Downtown Boston. The CTPS ridership model assumed the implementation of the Red Line and the Orange Line Transformation projects, which should result in 4-minute peak headways for the Orange Line. Transit riders along the Rutherford corridor may instead choose to ride the T101 bus route along a similar alignment once BNRD is implemented.

Alternative 7, the last of the SL6 alternatives, was added to the Tier 2 Evaluation as part of the stakeholder engagement process. The purpose of evaluating this alternative is to understand the impact and the demand for a more direct connection from Chelsea to Kendall. Despite being the longest and most expensive route evaluated, Alternative 7 performs well on several fronts. It shows the highest ridership among SL6 alternatives, although part of the estimate is riders diverted from the SL3, with which it overlaps for much of the Chelsea busway. This alternative also shows promising travel time savings compared to driving and it serves many of the travel flows with high demand among transit-critical populations. Like Alternative 4, it is estimated that operating Alternative 7 will require up to 13 new SL vehicles, the most for any alternative.

The Transition from Analysis to Recommendations

The analysis results summarized above were discussed with the External Working Group and with the community through an online survey and a public meeting. Overwhelming support for transit priority investments were received in general, and support favored extending the Silver Line to Sullivan as opposed to Wellington or Malden Center. Support was also voiced for extending the Silver Line beyond the Orange Line over time, and to both Kendall and Downtown Boston.

While extending Silver Line service beyond the Orange Line to either Kendall Square or Downtown Boston provides potential ridership benefits, MassDOT concluded that further study and the completion of ongoing planning efforts by others is required to determine the feasibility of implementing a Silver Line service to either location. Moreover, this study found that procuring additional Silver Line vehicles, and expanding vehicle maintenance and storage capacity would be required. Therefore, the primary recommendation from this study is to extend the Silver Line to the Orange Line, as is outlined in Chapter 5, the Locally Preferred Alternative.

Locally Preferred Alternative

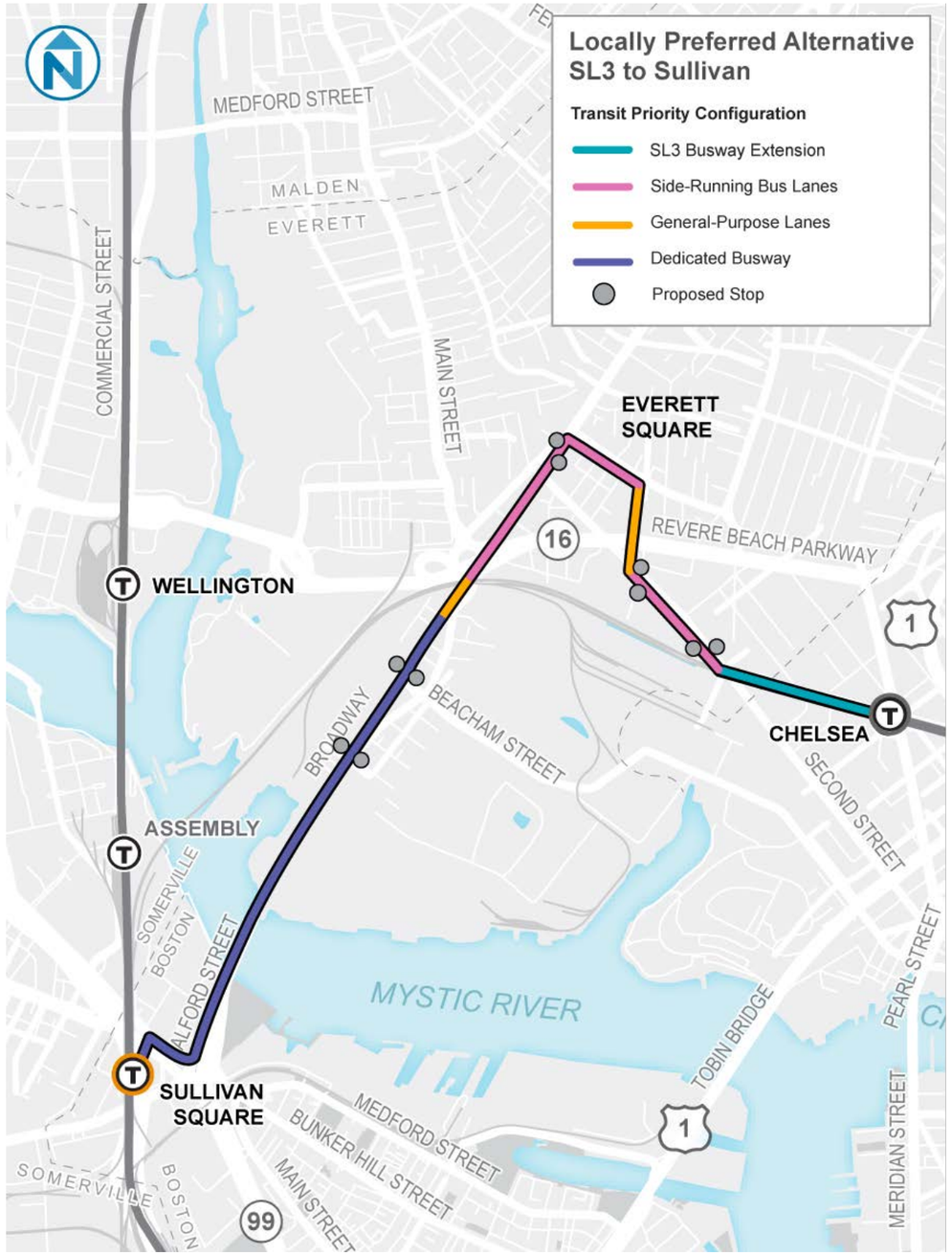
Alternative 3: SL3 to Sullivan is the Locally Preferred Alternative (LPA) identified from the evaluation process. This LPA extends the existing SL3 service from its current terminus at Chelsea Station to the Sullivan Square Orange Line Station. This section describes the transit vehicle, alignment, station locations, and service plan for the LPA. Design specifics and the definition of additional elements of the project, including details related to station locations, will be refined during subsequent engineering and planning efforts.

Table 9 | LPA Key Statistics

SL3 to Sullivan: Key Statistics	
Length: 6.36 Miles (roundtrip)	Assumed Average Dwell Time: 24 seconds[1]
Number of Stations: 7	Frequency: 10 minutes AM + PM Peak
Span of Service: 4:20 AM-1:15 AM Weekday 4:55 AM-1:45 AM Saturday 5:50 AM-1:50 AM Sunday	Major Transfer Locations: Everett Square Sullivan Station
Assumed Vehicle Load: 65 passengers[2]	Extent of Operation in Exclusive Transit Right-of-way: 80% (5.18 miles)

1 All-Door Boarding Pilot on the Silver Line (2017), OPMI Data Blog: https://massdottracker.com/datablog/?p=154. Assuming frontdoor boarding.
2 MBTA Service Delivery Policy, page 47: https://cdn.mbta.com/sites/default/files/2021-06/2021-service-delivery-policy.pdf

Figure 26 | LPA – Alternative 3: SL3 to Sullivan



LPA Alignment

The LPA would operate primarily on dedicated bus-only lanes along an extended Chelsea busway, Second Street, Broadway, Lower Broadway, Alford Street, and across the Alford Street Bridge to Sullivan Station. This alternative would extend the existing SL3, which operates between South Station and Chelsea. The end-to-end service plan for this LPA is from South Station to Sullivan Square.

From Chelsea Station to Everett Square

The LPA begins by extending the Chelsea Silver Line busway by approximately 0.4 miles, from its current terminus at Chelsea Station to Second Street in Everett. This new busway segment would run along the southern edge of the existing commuter rail tracks, mostly within existing MBTA commuter rail right-of-way. As shown in Appendix G: Busway Extension Concept Drawing, much of the existing commuter rail right-of- way appears sufficient to accommodate a 33-foot wide, bi-directional busway. Some evidence of encroachment of private business onto the commuter rail right-of-way has been identified, and some limited, partial right-of-way acquisitions are assumed. Future survey to be collected as part of the design process would confirm these details. At several points, the busway's shoulder would narrow for short segments, which is necessary to avoid conflicts and relocation of existing high-voltage electricity poles running parallel to the corridor. The maintenance building and comfort station that are currently adjacent to Chelsea Station would also require relocation.

At Second Street, Silver Line vehicles would turn northwest from the busway to Second Street. A traffic signal would be installed at this new intersection and connected to the adjacent railway crossing to allow four quadrant gates to lower and Silver Line vehicles to wait as trains travel through the intersection. In addition, a new signal will be required at Third Street to enable Silver Line vehicles to cross Third Street without conflict. These crossings were assumed to be similar to those at existing Chelsea busway intersections, such as the busway at Everett Avenue, and the busway at Spruce Street, where the railroad grade crossings and busway intersection signals are tied together to ensure safe and efficient operations for all modes.

Reviewing the current speed, frequency, and length of MBTA trains operating in this area, as well as looking towards the future vision for this railway line as identified in Rail Vision, it is anticipated that delays caused by railroad crossings to Silver Line service will be minimal. Railroad crossing gates would lower for a similar amount of time as a traffic signal or transit stop, or approximately 30 seconds two to six times per hour, and Silver Line vehicles are able to operate parallel to trains except at the Second Street grade crossing. Future improvements to the Newburyport/Rockport commuter rail line are anticipated to improve train frequency; however, the delays caused by additional commuter trains to Silver Line service still would not increase delays in a statistically meaningful way.

Today, Second Street has an approximate curb-to-curb width of 32 feet, which precludes the construction of dedicated bus lanes in both directions. In the near-term, Silver Line buses will operate in mixed traffic along this corridor. However, as redevelopment occurs along Second Street in the future, right-of-way widening to accommodate side-running bus lanes between the busway and Spring Street will greatly benefit Silver Line service.

Silver Line vehicles will then turn north onto Spring Street. In the near term, buses will operate in mixed traffic until Chelsea Street. Long-term improvements to this corridor could occur as part of the Revere Beach Parkway redesign.[1] This could lead to Spring Street operating in two sections:

1. Between Second Street and Revere Beach Parkway, the street could potentially be made one-way for non-bus traffic, or become a transitway, closed to mixed traffic. Property access would need to be addressed for the businesses

1 Route 16 in Chelsea and Everett was designated as a priority corridor for multimodal infrastructure and traffic improvements. Short-, medium-, and long-term strategies were identified to ameliorate safety, congestion, infrastructure, operations, and environmental challenges (Route 16 Priority Corridor Study, CTPS, 2019).

located along the northern edge of the block.

2. Between Revere Beach Parkway and Chelsea Street, buses would remain in mixed traffic.

To reach Everett Square, the Silver Line vehicles would turn west onto Chelsea Street, where there would be a westbound dedicated bus lane between Spring Street and Broadway. Implementing this side-running bus lane assumes removing the existing westbound parking and bike lane, though details would be confirmed during design. Buses in the eastbound direction would operate in mixed traffic.

All intersection signals in this section assume use of Transit Signal Priority (TSP) to improve the efficiency and reliability of Silver Line and local buses.

Three stops are assumed in this section:

- Chelsea Station
- CR right-of-way and Second Street
- Second Street and Spring Street

Diagrams showing the proposed transit configuration in this section are shown in Figures 27 and 28.

Figure 27 | Proposed Transit Configuration for the LPA -1

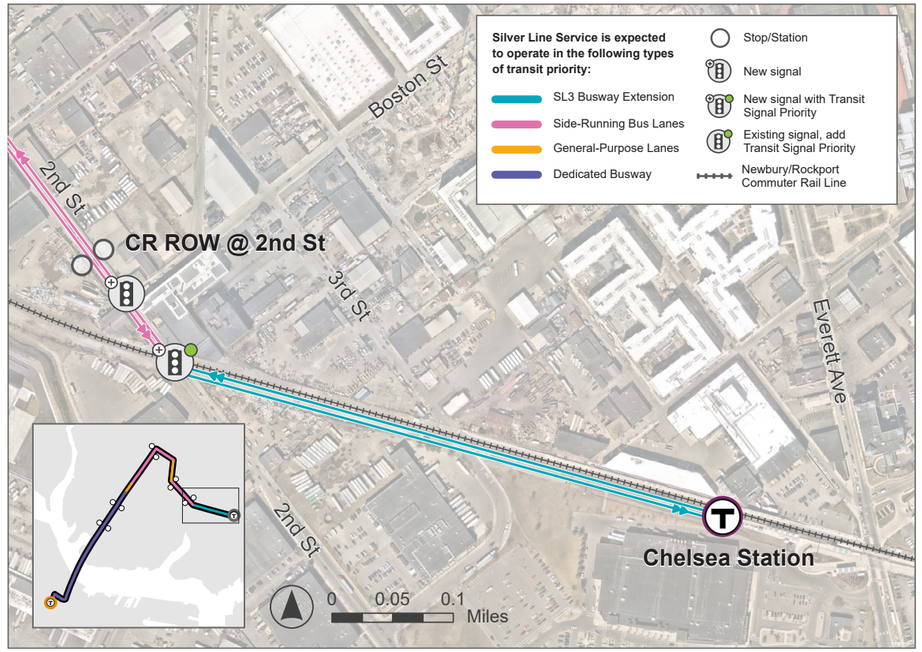
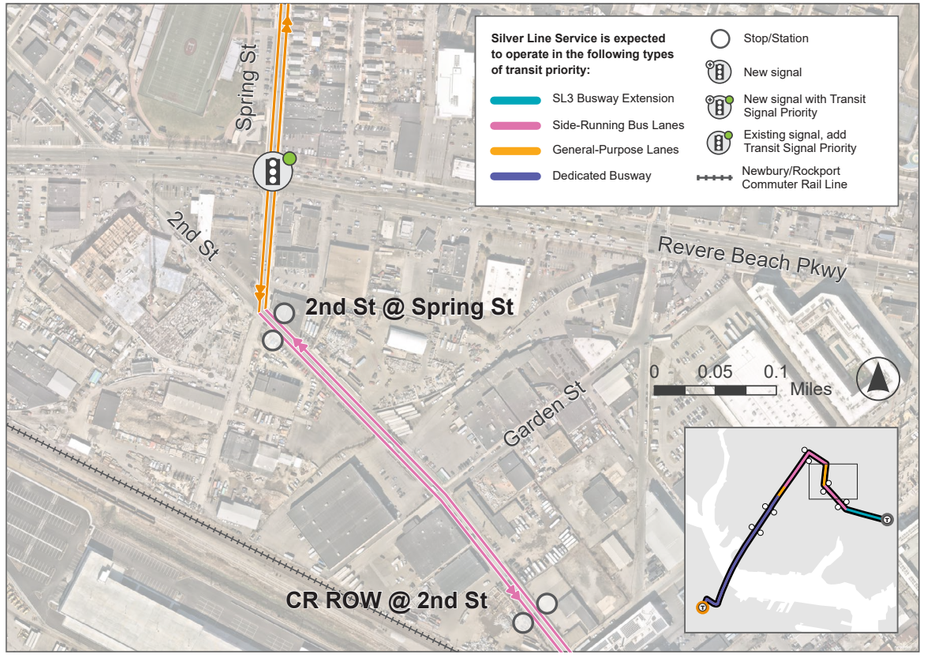


Figure 28 | Proposed Transit Configuration for the LPA - 2



From Everett Square to Sweetser Circle

Upon reaching Everett Square, Silver Line buses would turn south onto Broadway. To make this left turn more efficient for transit, the existing right turn lane on Chelsea Street is assumed to become a "right turn only except bus lane" and a bus turning phase will be added to the signal. In its current configuration, Broadway has peak-hour bus lanes and parking on both sides of the street. The LPA would convert these peak-hour bus lanes to become all-day bus lanes, which would remove on-street parking between Chelsea Street and Sweetser Circle crossing Route 16.

Circulation around Sweetser Circle will remain as it is today. Buses operate in the outer lanes of the circle using the existing bus-only lanes in both directions to reach Lower Broadway.

All intersection signals in this section are assumed to be equipped with TSP to improve the efficiency and reliability of Silver Line and local buses.

There is only one stop in this section:

- Broadway and Chelsea Street

Diagrams showing the proposed transit configuration in this section are shown in Figures 29 and 30.

Figure 29 | Proposed Transit Configuration for the LPA -3

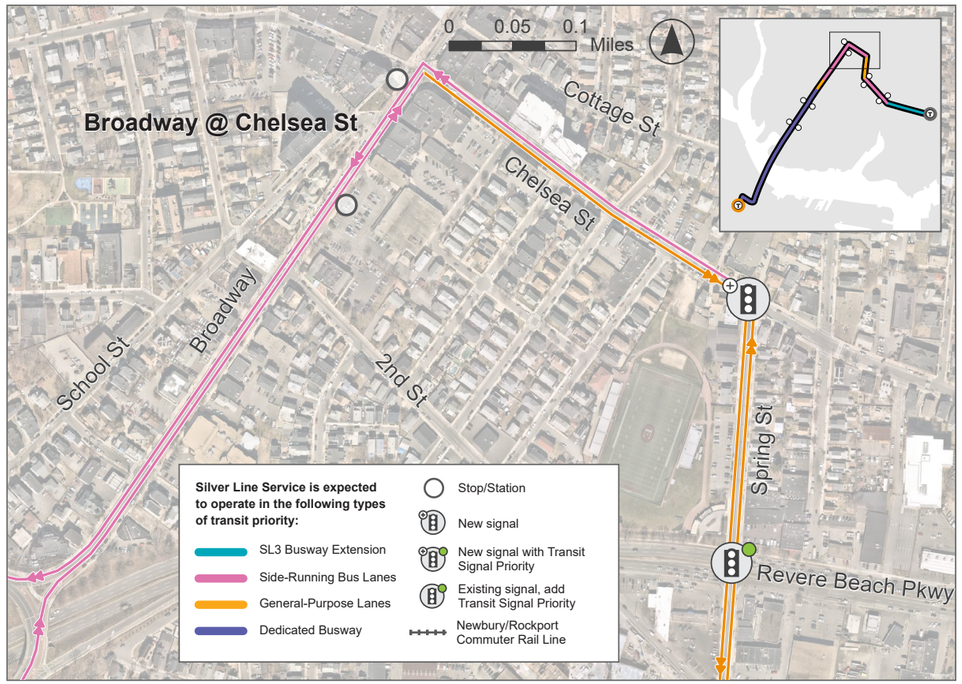
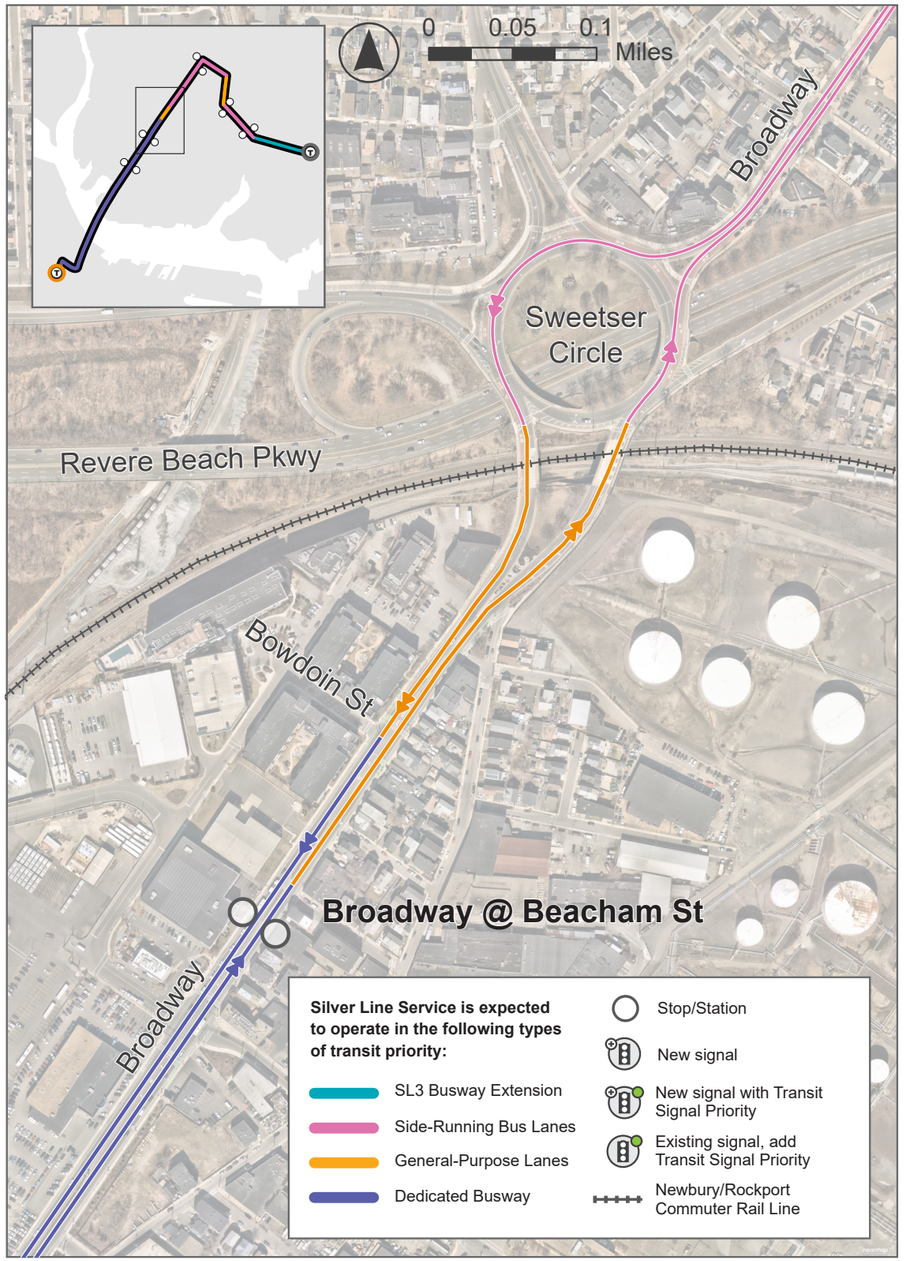


Figure 30 | Proposed Transit Configuration for the LPA - 4



From Sweetser Circle to Sullivan Station

After emerging from Sweetser Circle, southbound Silver Line buses would travel in mixed traffic a short distance along Lower Broadway until the Bowdoin Street intersection, after which they would merge into a side-running southbound bus lane. Between the Bowdoin Street and Langdon Street intersections, one general-purpose lane in each direction would be removed and the remaining four general-purpose lanes would transition to the southern side of Broadway to accommodate a new bi-directional busway on the northern side. This configuration, with a busway on the north and general-purpose lanes on the south with bike lanes on both sides, would continue until the Dexter Street intersection, after which the available right-of-way narrows significantly.

To continue to accommodate the busway on Alford Street, bike lanes would be moved off-street between Dexter Street and the Alford Street Bridge onto adjacent private property. Once the LPA reaches the Alford Street Bridge, the bidirectional bike lanes would transition back into the street right-of-way via a separated cycle track. This configuration would continue across the bridge until the approach to Sullivan Station.

Sullivan Square is currently undergoing a planning and design effort that will dramatically reconfigure Sullivan Square station access and circulation. This process is in its early stages and the LPA does not assume specifics in relation to roadways, parking, or location of bus berths. However, it does assume a high level of transit priority accessing and within Sullivan Square, with bus passenger dropoff as close to the Orange Line station as possible.

All intersection signals in this section are assumed to be TSP equipped to improve the efficiency and reliability of Silver Line and local buses.

Three stops are assumed in this section:

- Broadway and Beacham Street
- Broadway and Horizon Street
- Sullivan Station

Diagrams showing the proposed transit configuration in this section are shown in Figures 30 and 31.

Figure 31 | Proposed Transit Configuration for the LPA - 5

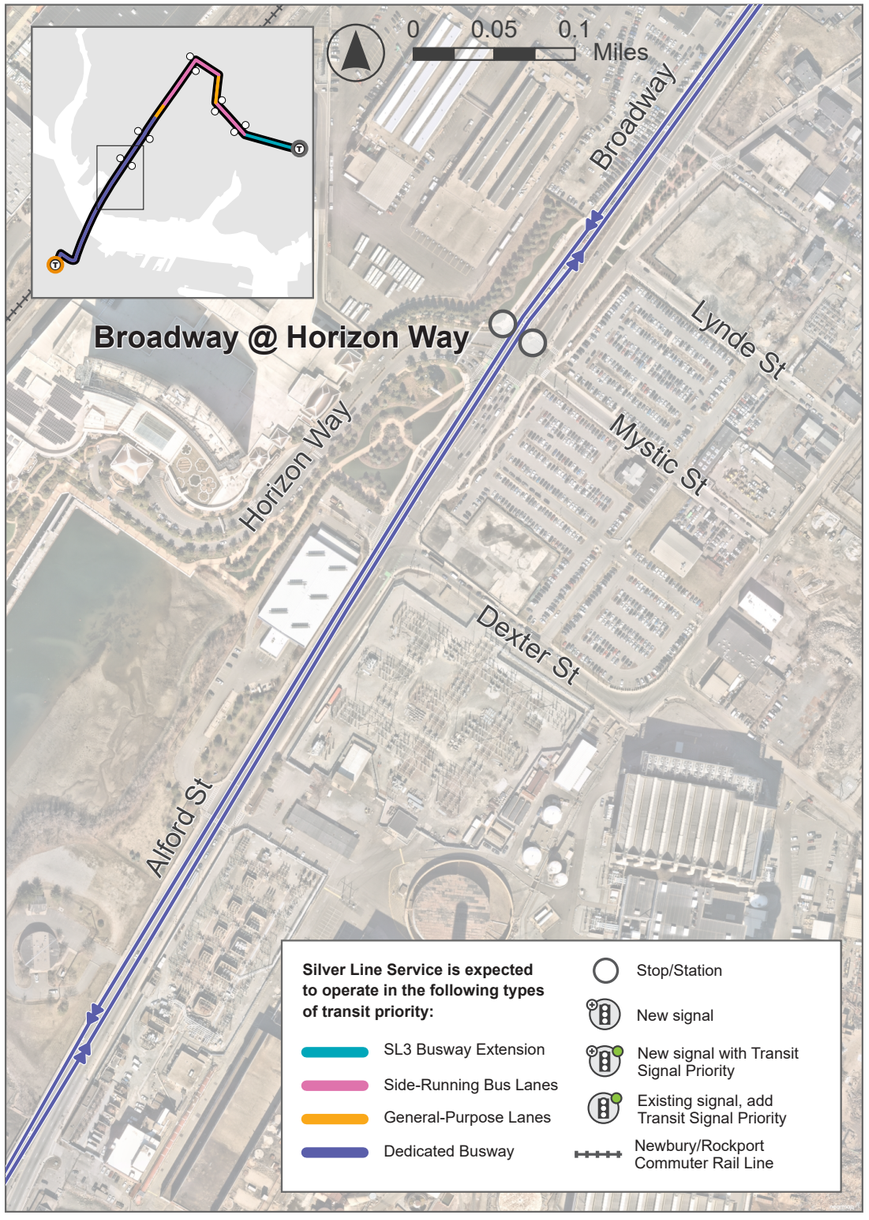
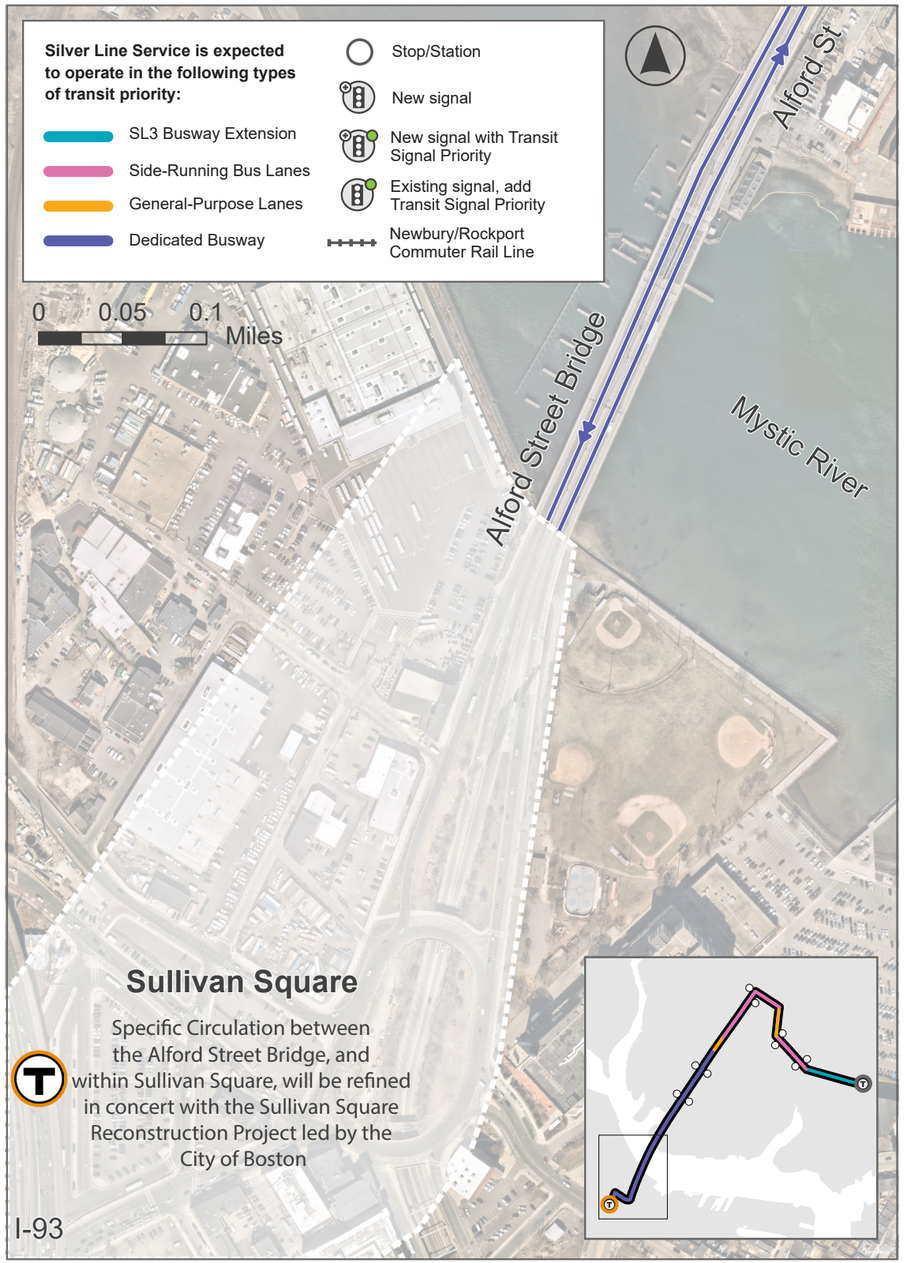


Figure 32 | Proposed Transit Configuration for the LPA - 6



Service Characteristics

Table 10 | SL3 Assumed Levels of Service

Weekday	Saturday	Sunday	Sunday
Span of Service	4:20 – 1:15 AM	4:55 – 1:45 AM	5:50 – 1:50 AM
Time Period*	Frequency (minutes)	Frequency (minutes)	Frequency (minutes)
Early Before 6:00 AM	10	12	12
AM 6:00 – 8:59 AM	10	12	12
Midday 9:00 AM – 2:59 PM	10	12	12
PM 3:00 – 5:59 PM	10	12	12
Night 6:00 – 11:59 PM	12	12	12
Late 12:00 AM and later	12	12	12

* Based on CTPS-defined time periods

Assumed Vehicle Load:
65 passengers

Assumed Average Dwell Time:
24 seconds[1]

Major Transfer Locations:
Everett Square, Sullivan Station

- Everett Square: On-street bus stops. Transfer to bus routes serving the same stop or serving on-street stops across the street.
- Sullivan Station: Outdoor bus berths adjacent to MBTA Orange Line station and parking lot. Transfer to buses in the same designated area. Transfer to Orange Line platforms via escalator or elevator.

1 All-Door Boarding Pilot on the Silver Line (2017), OPMI Data Blog: https://massdottracker.com/datablog/?p=154. Assuming front-door boarding.

Basis for the LPA

Table 11 highlights some of the key benefits that provide the basis for this LPA.

Table 11 | Metrics and LPA Findings

Goal	Metric	LPA Findings	
1: Expand Mobility & Access	1.1	Total Daily Riders	SL3 No Build: 12,400 riders SL3 Build Alternative: 27,800 riders (+15,400 No-Build)
1: Expand Mobility & Access	1.2	Access to Jobs via 45-minute Transit Commute	AM Peak: 347,000 jobs Midday: 344,000 jobs
1: Expand Mobility & Access	1.3	Ratio of transit time to drive travel time (AM Peak, midday)	Estimated Transit Travel Time (one-way): 17 mins Ratio of transit travel time to drive travel time: 61% (mid-day)
2: Advance Equity	2.2	Average reduction in daily passenger minutes of delay on bus routes that overlap with the alternative	2.9 minutes
	Goal 5: Advance Feasible and Implementable Solutions		
5: Advance Feasible & Implementable Solutions	5.1	Number of Silver Line buses needed to operate the alternative	12 vehicles (Estimated fleet surplus: 6 vehicles)
5: Advance Feasible & Implementable Solutions	5.2	Extent of Silver Line that could operate within exclusive transit right-of-way	High (80%)
5: Advance Feasible & Implementable Solutions	5.4	Planning Level Cost Estimate	Cost Effectiveness: High ($95 M)

There were several key differentiators between the SL3 Extension to Sullivan and the other SL3 Extension alternatives, described in the paragraphs below.

While the existing part-time, side-running bus lanes on Upper Broadway in Everett have helped ease some of the congestion during the peak commute hours along the Broadway corridor, transit users still face tremendous congestion, amounting to thousands of daily passenger minutes in delay between Chelsea Street and Sweetser Circle alone, due to the part-time nature of this investment.[1]

The SL3 LPA would provide full-time dedicated bus lanes along 80% of its alignment and transit signal priority at 14 intersections, providing travel times that are faster and more reliable than drive-alone times. With dedicated transit lanes, Silver Line vehicles are not vulnerable to the traffic congestion experienced in the adjacent general-purpose lanes. The level of transit priority achieved under the LPA is higher than for any of the other SL3 Extension alternatives. Studies[2] have shown that travel time reliability is as important to riders as total travel time, and in some cases more important. Reliability is especially important for workers operating on a time clock and for families who must pick up children at a specific time, like so many in Everett and Chelsea.

In addition, other local bus routes that operate along the alignment can benefit from the bus lanes. These include MBTA Routes 97, 104, 105, 109, 110, and 112, several of which have among the MBTA's highest and most resilient ridership. On average, the proposed infrastructure could save each transit rider three daily minutes in delay – a substantial travel time savings, and important to the region from a transit equity perspective. This is higher than any of the other SL3 Extension alternatives. The existing MBTA bus routes that operate along this alignment are more likely to serve people of color, people without access to a vehicle, and people with lower incomes.

1 MBTA Winter 2020
2 The Transit Capacity and Quality of Service Manual is one of many studies that document the importance of transit travel time reliability. See Chapter 6 https://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_165ch-06.pdf.

The CTPS Travel Demand Model estimated that extending the SL3 to Sullivan could see up to 27,800 daily boardings by 2040. This is 15,000 more daily boardings than the SL3 would experience if it were to end at its current terminus at Chelsea Station, or a 120% increase. While some of these riders would have otherwise used local bus routes, the analysis shows that extending the SL3 to Sullivan Station could add up to 11,000 net new daily boardings to the system.

The SL3 could be extended to Sullivan using the existing and anticipated Silver Line fleet. The extended service is assumed to operate with 10-minute headways during most of the day,[3] which results in a requirement for 12 Silver Line vehicles, four more than what is demanded by the existing SL3.

While the technical analysis showed that a bus rapid transit (BRT) capital investment connection between Chelsea and Sullivan aligned the best with the study goals and objectives, pursuing this LPA would not preclude transit service to Malden Station and to Wellington Station. In fact, Bus Network Redesign includes high-frequency route T104 connecting Airport Station to Malden Center via Everett, and high-frequency route T110 connecting Wonderland to Wellington via Everett.

Public Input

Broad community feedback was sought on the SL3 Extension and SL6 alternatives, both before the Tier 2 evaluation was complete, as well as after evaluation results were available. Feedback was gathered through an online feedback form. This form was released to the public on September 25, 2022, and closed January 31, 2023, with 406 responses. Respondents were provided with information on each of the proposed Tier 2 alternatives and asked to rank each alternative based on how likely they would be to use each of them.

There is strong support for the recommended LPA among municipal leaders as well as from the community at large. Respondents of the online feedback form ranked the LPA as the SL3 Extension alternative they would be most

3 Consistent with SL3 Winter 2020 schedule.

likely to use, ahead of connections to the Orange Line via Malden Center or Wellington. Over 55% of respondents to the feedback form said they were either “extremely likely” or “likely” to use Alternative 3, whereas only 23% responded the same for Alternative 1 and 43% for the Alternative 2. Many respondents also offered comments that Alternative 3 would provide the greatest benefit due to its ability to allow riders to connect to other communities and transit lines, as well as the extent that it would operate primarily on transit priority infrastructure relative to the other alternatives.

“Sending the SL3 to Sullivan gets a key connection with the other ring bus routes. Plus, it gives a ton of bus connections to Chelsea and Everett residents.”

-Feedback Form Respondent

Next Steps

The LPA has been developed to the conceptual design level based on GIS mapping, aerial imagery, and limited field measurements. The conceptual design illustrates the intended cross sections and overall transit infrastructure along the alignment. Those conceptual plans will need to undergo more detailed engineering based on professional field survey, including detailed utility and right-of-way information. The overall steps in the design process will include data collection for: survey data, utilities, property information, etc.; traffic count information; and existing and proposed traffic signal and roadway plans. The existing conditions information will inform the detailed analysis and design process with traffic analysis of existing and proposed conditions and development of preliminary and final design plans built upon the survey data.

The specific process for engineering each segment will vary based on roadway jurisdiction and funding source. For the SL3 LPA, the alignment falls on MBTA right-of-way and roadways under the jurisdiction of Everett and Boston, with a short segment under MassDOT jurisdiction (Sweetser Circle). Coordination with MassDOT will also be required for the intersection of Spring Street and Revere Beach Parkway (Route 16) as Route 16 is under MassDOT jurisdiction. Similar coordination will be required with the City of Chelsea for the crossing of the commuter rail right-of-way at Third Street. However, if MassDOT-Highway funding is used for construction, the design will be required to follow MassDOT’s process and standards regardless of roadway jurisdiction.

Elements of the project may also be implemented in phases, allowing Silver Line service to commence earlier, but this requires transit vehicles to use existing roadway infrastructure. Early implementation elements may include improvements to signal timing or implementation of signal priority that would require review and approval by the appropriate agency or municipality.

While extending Silver Line service beyond the Orange Line to either Kendall Square or downtown Boston provides potential ridership benefits, further study and the completion of ongoing planning efforts by others is required to determine the feasibility of implementing a Silver Line service to either location. Moreover, this study found that procuring additional Silver Line vehicles, and expanding vehicle maintenance and storage capacity would be required. A future study should consider the following:

1. The ridership analysis should model the potential ridership using the Redesigned Bus Network that is currently being implemented by the MBTA;
2. Further work be done on the Rutherford Avenue redesign effort and the Gilmore Bridge project to better understand the potential for bus priority lanes within roadway infrastructure right of way; and
3. More work be done to evaluate transit priority initiatives within Kendall Square specifically.

In the near term, Bus Network Redesign will implement high frequency bus services from Chelsea to the Orange Line, and Sullivan Square to Kendall Square, creating the connections evaluated in this study to build market demand. Transitioning to Silver Line will be dependent on future operational resources, and fleet and on-street capital investments.


massDOT
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Massachusetts Bay
Transportation Authority