

# The Case for an Orange Line Extension to West Roxbury

## Rapid, Reliable Transit For Southwest Boston

### Executive Summary

The Needham Line connects downtown Boston with the dense inner suburban communities of Roslindale and West Roxbury, with population densities similar to those of areas currently served by the southern portion of the Orange Line. However, constrained infrastructure and outdated practices prevent the line from meeting these areas' transit needs of the corridor on which it runs. As a result, mode share for transit in West Roxbury is poor, at just over 14%, compared to 38% in nearby Jamaica Plain.<sup>1</sup> Roslindale residents must use the bus for transit, thus facing longer, less reliable trips, and tying up buses and drivers who could instead serve other routes rather than duplicating an existing rail corridor. Commuter Rail serves several such corridors throughout Boston, Cambridge, and the immediate suburbs which are not served by the existing rapid transit system. TransitMatters' proposed transformation of commuter rail into a modern Regional Rail operating model, with electrification, high-level platforms, frequent all-day service, and affordable rationalized fares, would transform the region's legacy

rail infrastructure into a modern rail system. In effect, Regional Rail adds new rapid transit lines without creating new rights-of-way at significant expense, transforming mobility in the Boston area.

But unique infrastructure constraints prevent Regional Rail improvements from serving this purpose on the Needham Line: the line uses the Northeast Corridor to reach downtown Boston, where train frequency will only grow with both Regional Rail Phase 1 and expansion of Amtrak service, and the junction to the Needham Line is at grade, forcing trains to cross in front of each other. For this reason, we propose converting the line to rapid transit, but this can be done along entirely existing rights of way. From Forest Hills to West Roxbury, an extended Orange Line will replace commuter rail, with a potential further extension of under a mile to VFW Parkway. The Needham portion would be converted into light rail, connecting to the Green Line's D branch at Newton Highlands.



TransitMatters is a 501(c)(3) nonprofit dedicated to improving transit in and around Boston by offering new perspectives, uniting transit advocates, and informing the public. We utilize a high level of critical analysis to advocate for plans and policies that promote convenient, effective, and equitable transportation for everyone.

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<sup>1</sup> "Go Boston 2030: Boston Today", p. 3.

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Consequently, West Roxbury and Roslindale will enjoy the same frequency benefits as those along the Fairmount, Environmental Justice, and Providence/Stoughton corridors within the Boston urban core. Trains at least every 6 minutes or better to West Roxbury would be possible, a major improvement over current hourly frequencies on the Needham Line. The extension will provide frequent, reliable all-day service to key hubs such as Roslindale Village and the VA Hospital, and provide faster trips for riders who must currently connect to the Orange Line at Forest Hills. Conversion of the Needham Line to rapid transit will also free up track and platform capacity at South Station, supporting a future where capacity is increased through best rail operational practices and reduced in-station dwell times, rather than a multibillion dollar expansion of the station itself onto extremely valuable land. While the Orange Line's state of good repair issues need to be addressed in any event, doing so will guarantee fast, reliable train service along the extension.

Conversion of the Needham Line to rapid transit can be done quickly and at reasonable cost so long as best project management practices are followed. We predict a high-end cost of \$285M in 2020 USD for Orange Line extension to West Roxbury, with an additional cost of \$96M to extend the Orange Line to VFW Parkway.

Extending the Orange Line to West Roxbury ultimately reflects the same vision as the overall Regional Rail proposal: making full use of existing infrastructure to provide the best possible service, particularly in the urban core. In this case, the capacity on the Northeast Corridor cannot accomplish this goal, but the Orange Line's capacity can. In concert with Regional Rail Phase 1's improvements to the Fairmount and Providence/Stoughton lines and the ongoing Bus Network Redesign effort, this extension will transform mobility in southwestern Boston, improving trip times and reliability alike. The improvements in planning capacity needed for Regional Rail will also benefit this project. Now is the best time to begin planning.

## Background

The Needham Line is a line of the MBTA Commuter Rail system, running 13.7 miles from Boston's South Station to Needham Heights through Roslindale and West Roxbury. Although it runs through populated areas in Boston and its neighboring suburb, the Needham Line is an underutilized asset. High neighborhood density and bus ridership indicate the need for frequent, reliable transit, but the line's current constrained infrastructure limits the benefits that Regional Rail improvements can provide to the Needham Line and the rest of the system. As such, it should instead become part of the existing rapid transit network as extensions of the Orange and Green Lines, which brings the same benefits as Regional Rail and is better suited to the characteristics of the corridor.

Under this proposal, service quality along the line would be equal to that of the adjacent areas already served by rapid transit and to the Fairmount Line with Regional Rail improvements. The quality of service Needham would get under this scheme is similar to that along the Green Line in Newton, or the service Regional Rail upgrades would provide for comparable suburbs like Melrose, Norwood, and Waltham. Roslindale and West Roxbury would see the same service quality that other neighborhoods on the Orange Line have traditionally seen, and better than the current post-COVID and post-shutdown level of Orange Line service.

The different prescription is due to unique geographic and operational issues: The line shares tracks with multiple other lines and Amtrak between Forest Hills and South Station, and, crosses opposing traffic at-grade around Forest Hills, which limits capacity and reduces reliability, preventing the Needham Line from feasibly running at the levels of frequency required. Fortunately, the Needham line is well-poised to be served by existing rapid transit. Our proposal brings regional-rail-quality service to Needham line users while reducing system wide operational constraints and implementing long-discussed and highly desirable expansions of the Green and Orange lines.

## Service and Demand

The Needham Line serves two distinct clusters of stations. Running outbound, Roslindale Village, Bellevue, Highland, and West Roxbury stations serve Roslindale and West Roxbury in Boston. The Needham line crosses a portion of swamp, and then serves Hersey (largely a park-and-ride) and three stations in Needham.

Currently, the Needham Line has a weekday roughly hourly schedule inbound and outbound. Trains generally run every 2 hours on weekends in both directions.

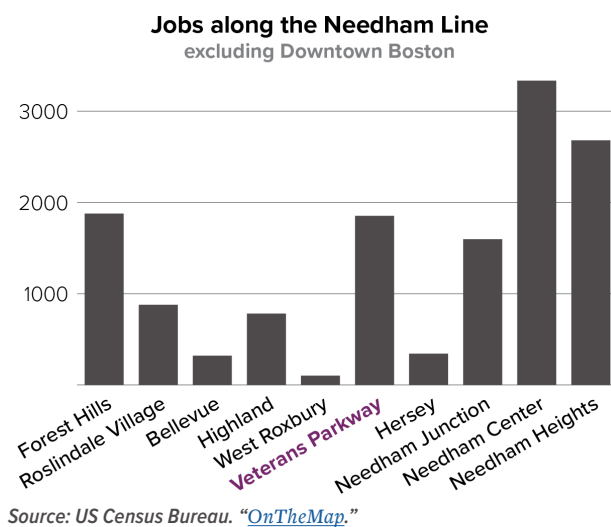
Jobs along the Needham Line grew 10.7% from 2011 to 2017. Jobs around all three Needham stations grew during this period. Between 2011 and 2017, jobs surrounding Needham Junction increased by 38%, Needham Center by 14%, and Needham Heights by 26%. Boston Children's Hospital is currently in the advanced planning stage of building a new pediatric outpatient surgery facility in the city, which will bring new jobs and visitors.<sup>2</sup>

Though several buses stop near Needham Line stations in the neighborhoods of Roslindale and West Roxbury, the Needham Line's low frequencies mean passengers ride over a mile further to connect to the Orange Line, which runs every 6 minutes at rush hour and every 8-12 minutes off-peak (at normal service levels). As a result, nine bus routes travel along Washington Street, connecting Roslindale Village with Forest Hills: Routes 30, 34, 34E, 35, 36, 37, 40, 50, and 51, totaling 19,490 weekday riders per the 2018 Blue Book, who ride between Roslindale Village and Forest Hills at less than 12 miles per hour. Because of the high ridership, heavy congestion, and long trip times, Boston installed a peak-hour bus lane on Washington Street, which yielded positive results, raising ridership further. Even with this important improvement, however, trip times are slower and more unreliable than rail.

Among these nine routes, three closely parallel the Needham Line to West Roxbury: routes 35, 36, and 37 along Belgrade Avenue, which carry a combined 8,359 weekday riders. If they were a single route, they would rank just below the top ten busiest buses. They run as

branches off a single trunk, with irregular frequencies. Even with bunching and slower service, buses along the Washington Street corridor are regularly overcrowded. In fact, in the MBTA's Bus Network Redesign Proposals, the MBTA recommends a new high-frequency bus corridor paralleling the entire Needham Line to West Roxbury.

The strong overall demand for service in Needham, West Roxbury, and Roslindale indicate that frequent, reliable rapid transit is necessary on the Needham Line.



## Why not Regional Rail?

For most of the MBTA Commuter Rail network, electrification of and deployment of EMUs on existing tracks and rights of way, strategic double-tracking, and other Regional Rail improvements can provide rapid transit levels of frequency (which we define as every 10 minutes or better). However, this is not possible on the Needham Line due to unique capacity constraints. First, the Northeast Corridor between Forest Hills and South Station is only wide enough for its current three tracks. This line is shared with the Providence, Stoughton, and Franklin lines, as well as Amtrak intercity services. All of these services are slated for frequency upgrades. The Orange Line subway runs on two parallel tracks, and the five tracks take up the space of the entire corridor, so additional mainline tracks cannot be added without significant time (on the order of a decade of construction) and expense (a 2011 Army Corps of Engineers study

2 ["About Us: Needham, Waltham, Weymouth Projects."](#) Boston Children's Hospital.

estimated a cost of around \$2.48 billion, over \$3.6 billion in 2020 USD; moreover, the existing Southwest Corridor would be disrupted and land takings required).

<sup>3</sup>This is an order of magnitude more than our high-end cost estimate for Orange Line Extension. Second, the junction between the Needham Line and Northeast Corridor at Forest Hills is at grade, creating conflicts with other train traffic, and grade separation would prove extremely expensive. Thus, running the Needham Line as frequently as justified is infeasible. This means that trains from the Needham Line cross southbound trains on the busy Northeast Corridor mainline at-grade, which creates scheduling conflicts. These conflicts limit capacity and force trains from other lines to skip Forest Hills, limiting commuter rail frequency, access, and connections, reducing ridership at the station.

After Forest Hills, the line curves west, passing through Roslindale, West Roxbury, and terminating north of Needham Center. The line has only one track for nearly its entire length, which severely limits frequency and service.

Even if the junction to the Needham Line were grade separated and Franklin Line service were moved to the Fairmount Line, the line's frequency would still be capped by sharing tracks with frequent Providence, Stoughton (including future South Coast Rail service), and Amtrak trains. At most, 4 Needham Line trains per hour per direction would be possible, insufficient for the growth potential on this corridor.

In contrast, the Orange and Green lines have spare capacity with state of good repair improved, they can provide similar quality of service as the Regional Rail model. According to the Lower Mystic Transit Working Group, the Orange Line is capable of a peak frequency of every 3 minutes.<sup>4</sup> Other rapid transit lines with similar stop spacing, such as some Paris Metro lines, run even more frequently. With Green Line Transformation, the Green Line will see added capacity and increased speeds with new vehicles and signals, making a Green Line extension to Needham viable and operationally beneficial.

While in this case we propose converting a commuter rail line to rapid transit standards, we do so due to the same philosophy that underlies our overall Regional Rail proposal: maximizing the value of existing infrastructure. Most of the commuter rail lines are equipped to handle far more frequent service without being subsumed by rapid transit, the extension of which would be more costly. This is not the case for the Needham Line. But with the Orange and Green lines' state of good repair addressed, it will be able to provide Regional Rail-equivalent service to residents of Roslindale, West Roxbury, Needham, and Newton at a cheaper capital cost than implementing Regional Rail would require in this case.

## State of Good Repair

Admittedly, in recent months, the Orange Line has become less frequent, unreliable, and much slower, as lack of maintenance has led to prominent slow zones, and vehicle and operator shortages have limited the amount of trains that can run. However, this is not a permanent situation, and must be fixed in the short term in any event. Increased frequency beyond levels prior to the COVID-19 pandemic are also important, given growth potential on the northern end of the Orange Line.

In a state of good repair, the Orange Line can provide fast, frequent, and reliable service to the quality of mainline regional rail, bringing riders from West Roxbury into Downtown Boston in just over 27 minutes, which can be further decreased with timekeeping and signal improvements.

The Green Line has seen an ongoing transformation program aimed at addressing repair deficits, increasing capacity particularly on the trunk section of the line, and switching the fleet from legacy trolleys to modern light-rail rolling stock. The acquisition of Type 10 Green Line cars, which are modern light-rail vehicles rather than the more bespoke vehicles currently used by the MBTA, will increase passenger capacity and are expected to remove speed constraints associated with the troubled Type 8 vehicles.

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3 *South Coast Rail DEIS/DEIR, 3-Alternatives*, Army Corps of Engineers, February 1011, p. 3-137

4 "*Lower Mystic Regional Working Group: Planning for Improved Transportation and Mobility in the Sullivan Square Area.*" p. 43



## South Station Capacity Benefits

The conversion of the Needham Line to rapid transit will also alleviate capacity issues at South Station over the next few decades. The MBTA is currently planning to expand South Station, at a cost of \$2.2 billion in 2023 dollars. As TransitMatters has previously argued, doing so is unnecessary given the adoption of best practices and a shift to more reliable equipment.<sup>5</sup> South Station Expansion would further negatively impact development potential on valuable downtown land, as air rights development over rail is extremely expensive even in high-value circumstances. Fortunately, combined with Phase 1 electrification improving reliability on the Providence/Stoughton and Fairmount lines, converting the Needham Line will free up additional capacity on the existing platforms.

## Orange Line Extension to West Roxbury

An Orange Line extension would give Roslindale and West Roxbury very frequent and reliable service. Today, Roslindale and West Roxbury's transit shares are low, at 25.7 % and 14.5%, respectively.<sup>6</sup> Existing service on the Needham Line is generally hourly. With the Orange Line's current speed and reliability issues addressed, a shift to rapid transit from existing commuter rail would offer significant increases in frequency and thus ridership potential. The Orange Line could serve West Roxbury at least every 6 minutes, an almost ten-fold increase.

Based on Orange Line speeds from 2016, trains would connect West Roxbury with Downtown Crossing in 27 minutes, essentially equivalent to today's trip time from West Roxbury to South Station. Improved infrastructure, timekeeping, and signaling could cut trip times by 10-20% and raise frequency by a similar amount. Even for riders who are traveling to points closer to South Station

than Downtown Crossing, the higher frequencies and benefits of electrified rail service will result in a faster, more pleasant, and reliable commute.

The Orange Line will also offer one-seat rides to more destinations - the North End, TD Garden, Assembly Square, and Malden Center - and two-seat rides to destinations along the Blue and Green lines, like Logan Airport and Somerville's Union Square, and all North Side Regional Rail lines.

The extension to West Roxbury would not cause capacity constraints or overcrowding, because there is more capacity on the southern half of the line than the northern half. Before the COVID-19 pandemic, about 6,714 passengers entered from stations south of downtown, and 7,930 from the north, between 8 and 9 am.<sup>7</sup> This means that increasing ridership from the south through improved service to West Roxbury would not create capacity constraints along the line, but instead uses existing, underused capacity more efficiently.

## Capital Costs

Based on comparable rapid transit projects in the United States, we estimate that the infrastructure needed for extending the Orange Line to the current West Roxbury station would cost between \$124.2M to 284.5M million 2020 USD. This is an extension of approximately 2 miles., 1.5 of which would need to be double tracked.

Recent MBTA experience with double-tracking the Franklin Line—an existing corridor with similar conditions—suggests a per-mile cost for double tracking of \$8 million.<sup>8</sup> Third rail would also be required for the entire corridor, which costs around \$4 million a mile.<sup>9</sup> As such, the total cost for double-tracking and electrical power comes out to around \$18 million. Additionally, the Roberts Street bridge and Lagrange street bridge will

5 [“Regional Rail Proof of Concept: How Modern Operating Practice Adds Capacity to the Current Commuter Rail Network.”](#) TransitMatters, Fall 2019.

6 Data from GO Boston 2030, Boston Today, 2017 p.36-37

7 Kuttner, William, “[Core Capacity Constraints: Appendices](#)”, Accommodating Growth on Greater Boston's Congested Roads and Crowded Transit System, Central Transportation Planning Staff, August 2016 p.38

8 <https://www.mbta.com/projects/franklin-line-double-track>

9 Data taken from the [Metropolitan Transportation Authority's Proposed Program of Projects Federal Fiscal Year 2023](#), Hudson Line Track 1 Electrification, p. 83

each need a second span for double track; fortunately, the single-span bridge installed on the Roberts Bridge in 2021 at a cost of \$10 million contains provisions for a second span<sup>10</sup>, and the Lagrange Bridge abutments should likewise be able to support a second span.

To maintain or increase frequencies, three additional train sets will be required for service every 6 minutes, or six train sets for service every 3 minutes, at a cost of \$18 million per train set.<sup>11</sup>

## The Issue of Station Costs

The stations on the line would also need to be upgraded for mass transit, just as they would be for Regional Rail. For one, high-level platforms are necessary at all stations, at a cost of approximately \$10 million each.<sup>12</sup> In addition to platforms, rapid transit stations require the following elements, which “mainline” train stations generally do not:

- » Fare control, assuming that fares are collected by fare gates
- » Sufficient egress capacity to handle rapid transit trains
- » Vertical circulation to reach alternate sides of the station
- » Seating and shelter
- » Plumbing, at least at stations with restrooms, which the terminal and Roslindale Village will require

Vertical circulation and plumbing in particular can add significant cost. Assembly Square, the most recently built rapid transit station on the MBTA network, cost around \$66 million in 2020 dollars. We note that in that case, some additional cost was incurred from keeping Orange Line service running during construction, whereas we

argue for closing the Needham Line during conversion. Plumbing in particular is highly variable, depending on water and sewer connection points.

Fortunately, there may be opportunities to value engineer elements and deliver an otherwise cheaper project. We caution that these considerations must be borne out by engineering assessments to determine whether they meet code requirements and are compliant with the Americans with Disabilities Act.

If vertical circulation can be provided by existing street, bridge, and pedestrian infrastructure, the per-station cost could be drastically reduced. We provide a range of costs in the interest of advancing an informed discussion of how stations can be delivered more quickly and at lower cost.

## Orange Line Extension from Forest Hills to West Roxbury<sup>13</sup>

Project Component	Component Cost (2020 USD)
Third Rail Electrification	\$8M
Double-Tracking	\$12M
Platforms and Stations	\$40M—\$200M
Bridge Upgrades	\$15M
Rolling Stock	\$49M
<b>Total Cost</b>	<b>\$124M—284M</b>

## Project Management

Even if it is not possible to reduce station costs through value engineering, disciplined project management and reasonable station scope are essential to keep costs manageable. As we wrote in our most recent Regional Rail report, it is crucial for the MBTA to have sufficient in-house planning capacity to plan the project and supervise consultants and outside contractors sufficiently. This is consistent with the practice of countries which have

<sup>10</sup> <https://www.mbta.com/projects/robert-street-bridge-replacement>

<sup>11</sup> This cost is based on an average of bid costs from Hyundai Rotem, Bombardier, and Kawasaki during the new Orange Line Car bidding process and adjusting to 2020 USD.

<sup>12</sup> Based on Salem platform installation and Holyoke Station projects.

<sup>13</sup> Construction cost inflation has been rapid and heterogenous; moreover, the outlook for specific materials and components remains uncertain. We use 2020 dollars to give a sense of this project’s relative cost, and we stress that this project does not rely on overly unique materials or exceed the complexity of projects successfully completed recently.

recently built transit projects cost effectively and on time. Adopting these measures will make the City of Boston and the MBTA a leader in improved capital delivery.

We stress that cost-effective stations need not be lacking in functionality or unattractive, a common criticism of GLX stations following the scope reductions. Consistent design standards for recent projects in Denmark, Finland, and Italy have resulted in functional and attractive rapid transit stations. But showpiece stations add significant expense and complexity, and thus conflict with the primary goal of providing rapid transit to underserved neighborhoods, particularly under inflationary conditions.

### Extension to VFW Parkway

Furthermore, we recommend continuing the line 0.8 miles west to terminate at a new station at the VFW Parkway, which has more than 1,800 jobs within walking distance. This extension would reduce automotive use and improve access to the West Roxbury VA hospital and administrative facility, Millenium Park, and West Roxbury High School, and would open viable reverse-commute opportunities to the VA Hospital and nearby Rivermoor Industrial Park. The additional extension would also encourage higher density development east of the marshland and provide congestion relief, but would require double tracking as well. This extension would require an additional half mile of double tracking and expansion of two bridges, but the marginal cost is not high relative to the rest of the project: \$5 million for double track and \$15 million for the Temple Street bridge. The additional one mile of third rail would cost \$4 million. Most significantly, an entirely new station would need to be constructed; this would cost \$50 million.

Project Component	Component Cost (2020 USD)
Third Rail Electrification	\$8M
Double-Tracking	\$5M
Platforms and Stations	\$50M
Bridge Upgrades	\$15M
Rolling Stock	\$18M
<b>Marginal Cost of Extension</b>	<b>\$96M</b>
<b>Total Cost of Conversion</b>	<b>\$230M</b>

An Orange Line Extension to West Roxbury would give passengers in Roslindale and West Roxbury a fast, one-seat ride to Downtown Boston and other major destinations, reducing 50-minute commutes to 30-minute commutes. Frequent service brings new connections, and allows for increased freedom; riders will no longer have to plan their lives around 60 minute intervals, but can show up at a station and go. The OLX would have major benefits for the communities involved, but would require closing the Needham Line for good. This requires a solution for Needham riders, as we discuss below.

### Green Line Extension to Needham

While in theory, the entirety of the Needham Line could be subsumed by the Orange Line extension, we strongly recommend that the section of the line in Needham instead become a Green Line branch from Newton Highlands. The primary reason is the substantially lower population density means that shorter trains are more suitable than the additional Orange Line trains that would be needed to cover the entire distance. The ongoing Green Line Transformation project will add capacity, but frequency is likely to drop absent more substantial investments. However, the stations between

Such an extension would provide the following benefits for Boston, Newton, and Needham:

- » More frequent service than is possible with Regional Rail given the capacity constraints: a train every 8-12 minutes
- » A one-seat ride for Newton and Needham residents to the Longwood Medical Area, as well as to Fenway Park and the surrounding entertainment district, providing strong potential to reduce auto traffic
- » Facilitating transit-oriented development, particularly additional housing growth, along the Needham Street corridor; the City of Newton has prioritized this corridor for increased density

The right-of-way is currently being preserved for a bike and pedestrian trail parallel to the Needham Street corridor; most of the span is wide enough for both a trail and tracks.

Building such an extension requires widening a bridge for double tracking, restoring the tracks, and installing power, communication, and signal systems, GLTPS (a safety system currently being implemented) and new stations. There appears to be room for both a multi-use trail, currently the Upper Falls Greenway, and two tracks. However, it will be necessary to build two new elevated railway bridges, one over the Charles River, the other over Route 128 in Needham.

### Feasibility and implementation

The existing rail infrastructure is very favorable to conversion to mass transit service; minimal new bridges and right of way expansion are needed. Fortunately, all of the necessary projects discussed above are within the MBTA's realm of experience. This prior experience both suggests feasibility and provides a base against which to credibly estimate project costs.

The Green Line Extension (GLX) in Somerville, from Lechmere to Tufts and Union Square; it parallels existing commuter rail lines for the entire length, yet transfers are not being considered. Moreover, the costs were very high,<sup>7</sup> \$2.3 billion for 4 miles of route, one of the highest ever seen in a transit project. But we believe that it is possible to replace the Needham Line with Orange and Green Line service for a fraction of the cost, for two reasons.

First, the overall scope of the project is smaller. GLX required some right-of-way widening to add two more light rail tracks running alongside the Lowell and Fitchburg Lines. In contrast, minimal civil infrastructure is needed in order to replace Needham Line service with Orange and Green Line trains, which would replace the commuter line rather than running alongside it, avoiding the need for right-of-way widening.

Second, GLX's high costs stemmed largely from managerial problems that the MBTA can avoid in the future. It can hire more in-house project management at competitive salaries rather than outsource expertise to consultants. It can avoid political micromanagement, and design the project without bearing the cost of related local improvements, like the Somerville Community Path.

Third, GLX project costs were inflated by the decision to keep open the commuter rail corridors on which the line was being constructed. Cost savings can be realized through an expedited construction schedule and complete shutdown of service along the corridor during the construction phase. While it is possible to build the project in phases, we do not believe this would be a wise course of action. We recommend replacing the entire Needham Line with Green and Orange Line service at once, as opposed to a phased effort during which limited or truncated commuter rail service continues until the extension is completed. Although this would mean that all rail service would be closed for a period of time, it would ultimately be a shorter timeframe than keeping service partially open, reducing disruption to Needham Line riders.

The one possible exception is the extension of the Green Line from Newton Highlands to Needham Heights, as this portion of the extension would not involve sharing right of way with active rail service, and early action here could shorten the timeline of the full shutdown as well as provide immediate mobility benefits for the Needham Street corridor.

In contrast, a phased construction of the Orange Line extension with an initial terminus at Roslindale would add considerable cost and complexity. In order to accommodate the continuation of commuter rail service until the extension to West Roxbury is completed, the right-of-way would need to be widened at Roslindale Village station.

Since the whole line must be shuttered to begin work on the Orange Line extension in any event, the MBTA should consolidate timeframes and build the Green Line extension simultaneously. This will reduce the overall period of disruption to service for riders and the duration and thus cost of interim replacement bus service.

We also believe that this represents the fastest path to transportation decarbonization in Boston, and will result in air-quality and quality-of-life improvements for those along the project corridor. An extended Orange Line or Green Line will be electrified from day one, and will



displace both single-occupancy internal combustion vehicles—which have by far the highest emissions per passenger—but also diesel buses.

## Fare Integration

Currently, stations along the Needham Line are located in Commuter Rail Fare Zones 1-2, which cost as much as \$7 for a one way trip into Downtown Boston with no free transfers to buses or subway, or \$232.00 for a monthly pass. These high fares are likely a deterrent for many potential riders along the corridor, where a slower bus-to-subway transfer is only \$2.40. Even before conversion to rapid transit, fares should be equalized to the subway fare zone, \$2.40 for the entire line, or \$90.00 for a monthly pass, with free transfers to buses, subways, and Regional Rail lines, creating a seamless, integrated network under one affordable, equitable fare.

## Bus Improvements

Several bus lines intersect the Needham Line in West Roxbury and Roslindale, but the line is too infrequent (and fares are too high) for transfers to be useful. Consequently, all of these buses run to Forest Hills to provide connections with the Orange Line. The Orange Line extension and fare integration would allow these routes to instead connect to rapid transit along the current Needham Line corridor rather than running all the way to Forest Hills. Doing so facilitates more frequent, reliable, and potentially expanded service with current resources, while providing bus riders, most of whom are already connecting to the Orange Line, with a faster trip. A full redesign of bus service in this area is outside the scope of our analysis, particularly given the ongoing Bus Network Redesign efforts by the MBTA; the potential Orange Line extension ought to be given consideration in future revisions.

Bus routes 35-37 run nearly parallel to the Needham Line, and 72%-83% of these routes' inbound riders alight at Forest Hills. Thus, we propose eliminating Routes 36 and 37, and redirecting their drivers and fleet to increase frequency on other routes, while truncating Route 35

at West Roxbury.<sup>14</sup> Most of the remaining routes can then connect to the Orange Line at Roslindale Village.<sup>15</sup> One important consideration is that Roslindale Village will have less space to accommodate turning buses. To address this issue, some routes could be combined or interlined rather than laying over at Roslindale Village itself.

## The Wider System: Regional Rail or Subway

Subway replacement is optimal for the Needham Line, because of the Needham Line's unique circumstances; most importantly its unique capacity constraints and the fact that it is already close to the ends of existing subway lines. For other lines that warrant frequent service, such as the Fairmount Line or the Newburyport/Rockport Line, mainline Regional Rail is preferred over subway extensions, as it can be implemented more quickly with lower cost and disruption, mainline EMUs can provide increased speed and comfort over subway trains, and mainline Regional Rail would be able to provide superior service. Without the capacity constraints seen on the Needham Line, and the layout of the existing rapid transit network complicates subway replacement of other lines.

The conversion of the Needham Line will bring rapid transit to dense and growing communities currently ill-served by the antiquated commuter rail operating model. The extension of the Orange Line and Green Line will bring rapid, frequent decarbonized transit to Boston, Needham, and Newton. It will also reduce system demand on the Northeast Corridor and at South Station, allowing a more effective and expeditious rollout of Regional Rail.

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<sup>14</sup> Route 36 continues past West Roxbury to the VA Hospital; with our preferred option of continuing the Orange Line to VFW Parkway, riders could enjoy a faster trip, even with a transfer to replacement shuttle service from the new terminal, with paratransit serving riders with mobility constraints.

<sup>15</sup> One route, likely the 34, should ideally continue to serve Forest Hills.