1.1.1 Proposed Sullivan Station – Kenmore Station Route

The route shown in Figure 5-5 was proposed in previous work by Jamie Rosen as a service mitigation proposal for the GLX (Rosen, 2013).[1] Based on this proposal, the route could run between Sullivan and Kenmore (via Lechmere and Kendall) using the following headways: 15 minutes from 5:30 – 6:30 AM, 10 minutes from 6:30 AM – 8:00 PM, and 20 minutes from 8:00 PM – 12:40 AM.[2]

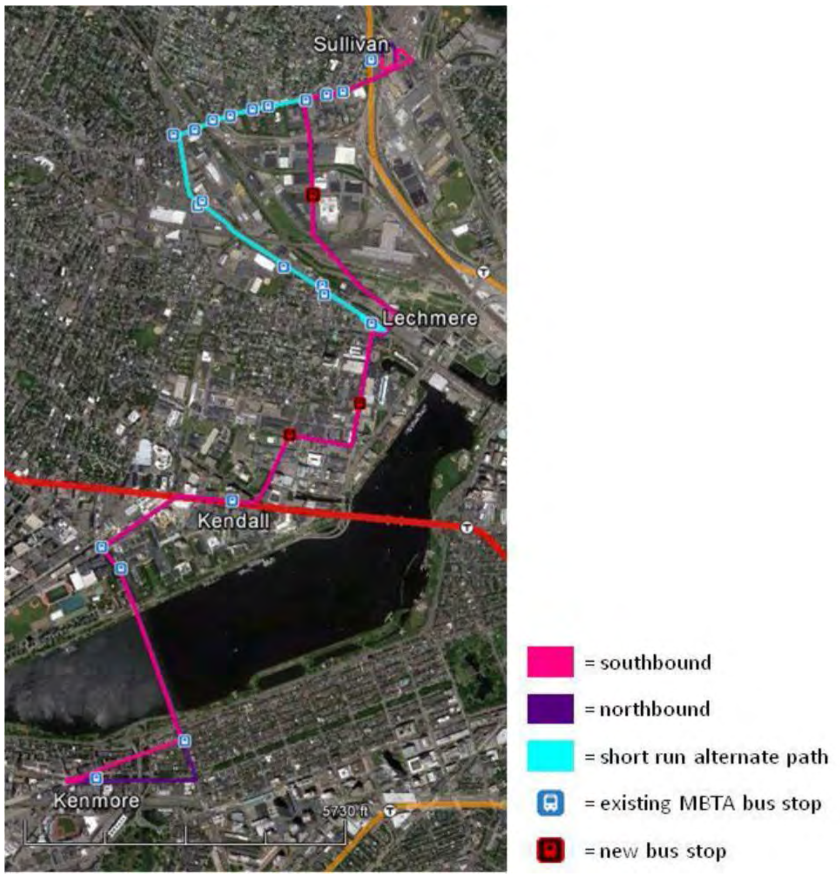

Figure 5-1. Proposed Sullivan – Lechmere – Kendall – Kenmore Route

Source: Reproduced from (Rosen, 2013, p. 123)

Rosen estimates that establishing the route based on her proposed headways, in combination with improved frequency in Green Line service to Lechmere, would increase transit system ridership by 2.2%, helping to offset the air quality effects of the Green Line Extension delay (Rosen, 2013). It would also provide new direct transit connections for the population in the

[1] Note that this route was based on similar proposals by the City of Cambridge, MASCO, and A Better City.
[2] For details on specific routing and calculations, *see* (Rosen, 2013).

corridor affected by the Green Line Extension delay, and improve access to the growing Kendall Square area both from the northern parts of the region and from the Kenmore Square area of Boston. Access could be improved even further by reopening consideration of a Commuter Rail stop at Sullivan Station, as was originally proposed as part of the Urban Ring project.[3]

1.1.2 Route Implementation – Full Operation

Using the full schedule proposed in previous work, the Sullivan – Lechmere – Kendall – Kenmore route would operate with 15 minute headways during the Early Morning period from 5:30 AM – 6:30 AM, 10 minute headways from 6:30 AM through 8:00 PM, and 20 minute headways from 8:00 PM until the end of service at 12:40 AM (Rosen, 2013).

This research re-estimates the cycle times using a different methodology from the original research. The original research estimated the cycle times through the use of comparable routes, the MBTA #87 and #88 routes, and resulted in estimated cycle times of 64-65 minutes (Rosen, 2013). The original analysis was done as follows:

1) Dwell time per stop for the comparable routes was estimated as the difference between the Google Maps travel time and the median running time, divided by the number of stops on each route.
2) Recovery time for the comparable routes was estimated as the difference between the 90^{th} and 50^{th} running time percentiles. This was converted to a percentage of the median running time.
3) The estimated dwell time per stop calculated for the comparable routes was then multiplied by the number of new route stops and added to the Google Maps Travel time for the new route. This provided the estimated running time.
4) The estimated cycle time was then calculated by applying the recovery time percentage from comparable routes to the estimated running time for the new route.

This analysis was conducted for both the AM Peak and PM Peak periods, and for average and maximum values from the comparable routes. The cycle time is re-estimated in this research for two reasons. First, because the area is rapidly developing, congestion has increased even in the limited time since the original proposal, and it is likely that this has caused travel times to

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[3] This proposed station would serve the Newburyport/Rockport and Haverhill Lines, and would link these Commuter Rail lines to the Orange Line and various bus routes (including the proposed route). *See* (Massachusetts Executive Office of Transportation and U.S. Department of Transportation - Federal Transit Administration, 2008).

increase. Second, because traffic levels vary so widely in the Boston area, this research uses specific route segments as comparable segments in an attempt to better approximate the travel conditions on the route.

Various travel time statistics were calculated for the Sullivan – Vassar / Mass Ave segment on Route #CT2 and for the Hynes – MIT segment on Route #1. These segments were chosen to approximate the travel conditions on the proposed route. A summary of travel speeds on these comparable segments is presented in Table 5-1.

	Route # 1 Inbound: MIT - Hynes			Route #CT2 Inbound: Sullivan - Vassar / Massachusetts Ave.		
Speed (miles per hour)	**AM Peak**	**Midday Base**	**PM Peak**	**AM Peak**	**Midday Base**	**PM Peak**
Average	9.8	9.7	5.3	7.1	9.0	7.9
10th Percentile	13.3	12.9	9.1	8.6	11.1	10.0
50th Percentile	10.1	10.0	5.5	6.9	9.3	8.0
90th Percentile	7.5	7.5	3.6	6.0	7.5	6.5
95th Percentile	6.9	7.0	3.2	5.8	7.0	6.3
99th Percentile	6.1	5.8	2.8	5.6	6.4	5.9
	Route #1 Outbound: Hynes - MIT			**Route #CT2 Outbound: Vassar / Massachusetts Ave. - Sullivan**		
Speed (miles per hour)	**AM Peak**	**Midday Base**	**PM Peak**	**AM Peak**	**Midday Base**	**PM Peak**
Average	10.5	9.7	9.9	9.7	9.8	7.0
10th Percentile	17.0	14.0	17.6	10.9	11.2	8.4
50th Percentile	11.5	10.4	11.2	9.7	9.9	7.3
90th Percentile	6.6	6.7	6.8	8.7	8.6	5.7
95th Percentile	6.1	6.1	5.9	8.3	8.4	5.3
99th Percentile	4.7	4.8	3.7	7.1	7.5	4.8

Table 5-1. Travel Speeds by Period on MBTA Route Segments Comparable to Proposed Route

Although the 90th percentile speeds have a fairly narrow range in each period, there is enough of a difference between the segment travel times that it is worth considering which comparable route best approximates the new route. It is then possible to use these comparable 90th percentile speeds, in combination with the distance of the new route, to estimate a cycle time for the new route.

Because the Route #CT2 segment from Sullivan – Vassar St. / Massachusetts Ave. is representative of the majority of the new route in terms of road type and level of congestion, it is appropriate to use to estimate cycle time for the majority of the new route. However, as the Route #1 Inbound PM Peak time exemplifies, the congestion and delay across the Massachusetts Ave. bridge from Cambridge into Boston is unique and should be considered separately. As such, this research uses the Route #1 as a comparable route for travel along Massachusetts Ave. Using the

90th percentile speeds from Table 5-1, in conjunction with segment distances, produces the results of the estimated cycle times in Table 5-2. Notable in these results is that the estimated cycle time is significantly greater in the PM Peak than in the other periods, due to both the lower speed in the inbound direction across the Massachusetts Ave. bridge, and to the lower speeds elsewhere along the route in the outbound direction during the PM Peak. Based on these results, estimated cycle times of the proposed route would be 78 and 94 minutes during the AM and PM Peaks, respectively (and 70 minutes in other periods, based on "Midday Base" speeds).

			AM Peak		PM Peak		Other	
Segment	**Direction**	**Distance**	**Speed**	**Time**	**Speed**	**Time**	**Speed**	**Time**
All, Excluding Massachusetts Ave.	IB	3.81	6.0	38.0	6.5	35.0	7.5	30.4
Massachusetts Ave.	IB	0.71	7.5	5.7	3.6	11.8	7.5	5.7
All, Excluding Massachusetts Ave.	OB	3.81	8.7	26.3	5.7	40.0	8.6	26.7
Massachusetts Ave.	OB	0.85	6.6	7.7	6.8	7.5	6.7	7.6
Total		*9.18*	*7.1*	*77.7*	*5.8*	*94.4*	*7.8*	*70.3*

Table 5-2. Estimated Cycle Times by Period on Proposed Route

These cycle times can then be applied to proposed headways to estimate the fleet size required to operate the route throughout the day. Although it is possible that EZRide could shift spare buses to the route, the calculations in the remainder of this chapter will assume that the current EZRide fleet is fully utilized and as such, it would be necessary to procure a new fleet to operate the Sullivan – Kenmore route.

As detailed in Table 5-3, operating with the specified frequencies and an estimated operating cost of $95 per bus-hour and 250 operating days per year, the route would cost approximately $13,000 daily and $3.27 million annually. It would require the acquisition of ten new buses. The options proposed in Section 5.2.4 operate with more limited schedules and as such require smaller vehicle fleets and have lower costs; these could serve as good intermediate phases with the goal of building the fleet over time to allow for the full implementation as described in this section.

Period	Time	Headway	Buses Required	Daily Op. Cost	Annual Op. Cost
Early Morning	5:30 AM - 6:30 AM	15	5	$475	$118,750
AM Peak	6:30 AM - 9:00 AM	10	8	$1,900	$475,000
Midday	9:00 AM - 3:30 PM	10	8	$4,940	$1,235,000
PM Peak	3:30 PM - 6:30 PM	10	10	$2,850	$712,500
Evening	6:30 PM - 8:00 PM	10	8	$1,140	$285,000
Late Night	8:00 PM - 12:40 AM	20	4	$1,773	$443,333
Total	5:30 AM - 12:40 AM	10 - 20	10	$13,078	$3,269,583

Table 5-3. Detailed Headway, Fleet, and Cost Information for Original Proposal

1.1.3 Route Implementation – Phased Operations

For options with more limited resources, it is possible to look at the level of service that could be provided by adding *x* buses on the new route, and limiting service to the same periods as the existing EZRide shuttle (Morning: 6:20 AM – 10:50 AM; Midday: 10:44 AM – 3:00 PM; Evening: 3:00 AM – 8:00 PM).

There are four strategies for adding buses to the new route if contracting with EZRide:

(1) EZRide could continue operating its existing service at the same frequencies by procuring new vehicles for the new route;

(2) EZRide could continue operating its existing service at the same frequencies by assigning previously unassigned vehicles from its fleet to the new route;

(3) EZRide could shift vehicles operating on its existing route to the new route, which would require lower frequencies on the non-overlapping segments of the existing route; and

(4) A mixture of the above strategies, with EZRide shifting some buses from the existing route to the new route while also adding new buses to the new route (either through procurement or through the use of unassigned vehicles).

This proposal will focus on the first strategy, although similar calculations could be produced if the other options were preferred. Service on the new route could be increased over multiple phases depending on vehicle availability and financial resources. An example multi-phase operation is presented below.

Phase #1. Procure four buses to operate on new route. If EZRide were to procure four new buses, it would not affect service on the existing EZRide route. Furthermore, it would decrease the headways on the Lechmere-Kendall segment during the Morning and Evening periods due to the overlap between the existing and new routes, and provide service in that segment during the Midday when the EZRide route does cover it. This increased frequency at Lechmere (although minimal in this phase) serves two purposes: first, it benefits passengers in the GLX corridor for mitigation purposes; second, it develops usage patterns for future GLX passengers that will become increasingly important when the GLX begins passenger service.

However, service in the non-overlapping segments of the new route would have lower frequencies than desired. The estimated operating cost for this scenario would be approximately

$5,200 per day and $1.31 million per year, based on assumptions of a $95 operating cost per bus hour, and service on 250 days per year. The summary of this option is presented in Table 5-4.

		Headway			Change in Operating Cost	
Period	Time	Non-Overlapping New Route	Lechmere - Kendall	Non-Overlapping EZRide	Daily	Annual
Morning	6:20 AM - 10:50 AM	20	6	7	$1,710	$427,500
Midday	10:44 AM - 3:00 PM	18	18	20	$1,621	$405,333
Evening	3:00 PM - 8:00 PM	24	6	8	$1,900	$475,000
Total	6:20 AM - 8:00 PM	-	-	-	$5,231	$1,307,833

Table 5-4. Operating Summary with Four New Buses Available

Phase #2. Procure an additional three buses (total of seven buses) to operate on new route. With similar logic as presented in the first phase, Table 5-5 examines what would happen if a total of seven new buses were available. Again, in this phase, the existing EZRide route operations would remain unchanged from the status quo. Because of the increase of three buses from the previous phase, frequencies increase closer to the desired levels. This does come at an additional cost, with the new route now expected to increase Charles River TMA's operating costs by approximately $9,100 daily and $2.29 million annually.

		Headway			Change in Operating Cost	
Period	Time	Non-Overlapping New Route	Lechmere - Kendall	Non-Overlapping EZRide	Daily	Annual
Morning	6:20 AM - 10:50 AM	12	5	7	$2,993	$748,125
Midday	10:44 AM - 3:00 PM	11	11	20	$2,837	$709,333
Evening	3:00 PM - 8:00 PM	14	6	8	$3,325	$831,250
Total	6:20 AM - 8:00 PM	-	-	-	$9,155	$2,288,708

Table 5-5. Operating Summary with Seven New Buses Available

In addition to the two phases proposed above, there are a number of intermediary options that would be possible, including using some of the other strategies described at the beginning of this section. This research suggests a few alternatives, but it would be fairly straightforward to calculate the effects on costs and frequencies for any of the strategies.

It should also be stressed that these phases could serve as sequential implementation phases in building up to or beyond the service proposed in Section 5.2.3. For example, one phased alternative would be to: (1) purchase four buses for the new route; (2) purchase an additional three buses so that the new route has seven new buses; (3) purchase an additional three buses (for a total of ten) to provide the full level of service as identified in the original proposal in Section 5.2.3, but only operate during the existing EZRide span of service; (4) further expand service to the MBTA's span of service as identified in the original proposal in Section 5.2.3; and (5) continue service expansion as desired.

1.1.4 Institutional and Financial Considerations

As mentioned previously, the heavy rail system is approaching capacity. This is especially true on Red Line trips going to Kendall in the AM Peak and originating at Kendall in the PM Peak. The roads in the Kendall area are also heavily congested during the peaks, with limited opportunity for growth in road capacity. It is clear that any significant increases in the capacity of the transportation network around Kendall Square will need to come from transit in order to allow for continued growth. Although the Red Line vehicle procurement will help marginally alleviate the capacity constraint, the vehicles are not due until 2019 at the earliest (see Section 4.2.1 for more details). A similar description applies to Sullivan and the Orange Line, even with a small increase in capacity once new vehicles are delivered. Kenmore and the Green Line central subway are also approaching capacity, with limited operational improvements likely in the near future since peak vehicle throughput is already near its maximum level with the current signal system in place. In the interim, this route can provide a necessary increase in capacity while also improving service for those affected by the GLX delay. In the longer term, more significant measures will be needed for continued growth. This proposal addresses the immediate need while also providing a pilot for future similar types of system growth.

Because it will improve service for passengers affected by the GLX delay, the route could use GLX mitigation funding, which would be granted through the state. The GLX mitigation is a state obligation, so if it needs to be strengthened, this route is a viable contributor at moderate cost. Moreover, if the route is funded through GLX mitigation funding, the MBTA would not need to reduce service elsewhere, since the funding source would be outside of the agency. This is important, as the goal of the route is not to shift resources dedicated to transit service, but to increase resources dedicated to transit service.

Furthermore, contracting the route through MassDOT might limit MBTA labor concerns. It would, in a sense, further remove the contract from the MBTA's operations and consequently further remove the operations from similarities to services previously provided by MBTA employees. As discussed further in Section 7.2.1, the route should not warrant a Pacheco Law challenge, but perception is nonetheless important and therefore contracting the route through MassDOT might be more appealing than contracting it through the MBTA. The MBTA labor unions' high levels of cooperation in the aftermath of the January-February 2015 storms also suggests that the current unions might not oppose contracting a service that they would not otherwise have the capacity to provide directly. This route could serve as a test to see if contracting routes through MassDOT would be a feasible way to grow service going forward.

The Charles River TMA currently contracts the EZRide route through Paul Revere, and this route would also serve the Kendall Square area where many of the Charles River TMA employers are located. The route would provide significant additional service to the employers of the TMA, and as such should be well received by them. The Charles River TMA would likely only face a cost increase if it is necessary to hire additional staff to manage the additional routes; however, this would be unlikely if MassDOT were to fund the route.

It is also possible that the area employers would contribute to improve the level of service on the route in a similar way as they have with EZRide. Although the employers have demonstrated that they would not fund the route without any additional subsidization, it is possible that they would be willing to fund a portion of the route so that it has an adequate level of service. For example, if MassDOT were to fund the operation of seven buses, it is possible that area employers would fund the operation of another three buses to achieve ten-minute headways and make the route a high-frequency service. MassDOT should not depend on area employers to entirely fund the route, but the additional benefits (e.g., improved access to employees, decreased parking costs, etc., as described in Chapter 3) should make it worthwhile to allow for some level of employer contributions. In exchange for partial subsidization of the new route, the employers could be given employee passes for the route or for the system. Or alternatively, if the state provided the capital for buses, EZRide might be able to operate the increased service without an operating subsidy, an idea discussed further in Section 6.2.