TECHNICAL MEMORANDUM

DATE: **November 5, 2018**

TO: **Bill Deignan, City of Cambridge**
Jenny Raitt, Town of Arlington

FROM: **Katie Pincus Stetner, Manager, Transit Analysis and Planning**
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RE: **Bus Priority Feasibility at Alewife Station**

1 INTRODUCTION

The Town of Arlington and the City of Cambridge requested that the Boston Region Metropolitan Planning Organization (MPO) study the feasibility of bus priority improvements in the Alewife Station area on the Massachusetts Bay Transportation Authority (MBTA) Red Line. This is a follow-up study to work performed by MPO staff in state fiscal year 2016–17 that examined potential travel-time savings from proposed changes to bus routes and potential roadway improvements near Alewife Station.

Figure 1 shows the area of Alewife Station and the roadway segments previously studied, which are outlined in purple. The previous memorandum—"Potential Travel Time Impacts to Riders on Bus Routes Serving Route 2 from Priority Treatments at Alewife MBTA Station," dated July 13, 2017—documented estimated travel-time benefits for bus riders from two potential changes near Alewife Station: rerouting buses on Acorn Park Drive and adding a bus priority lane on the jug handle segment of Alewife Station Access Road. Table 1 summarizes the estimated travel time benefits of the proposed changes.

Table 1
Estimated Travel-time Savings from Potential Changes near Alewife Station

Study Roadway	Proposed Change	Travel-time Savings per Trip	Total Passenger Travel-time Savings
Acorn Park Drive	Reroute buses on Acorn Park Drive to access Alewife Station	1 minute 47 seconds in AM peak period	21.6 person-hours in AM peak period
Jug handle ramp	Add bus priority lane	11.7 seconds in PM peak hour	1.14 person-hours in PM peak hour

Source: MPO Staff. "Potential Travel-time Impacts to Riders on Bus Routes Serving Route 2 from Priority Treatments at Alewife MBTA Station," July 13, 2017.

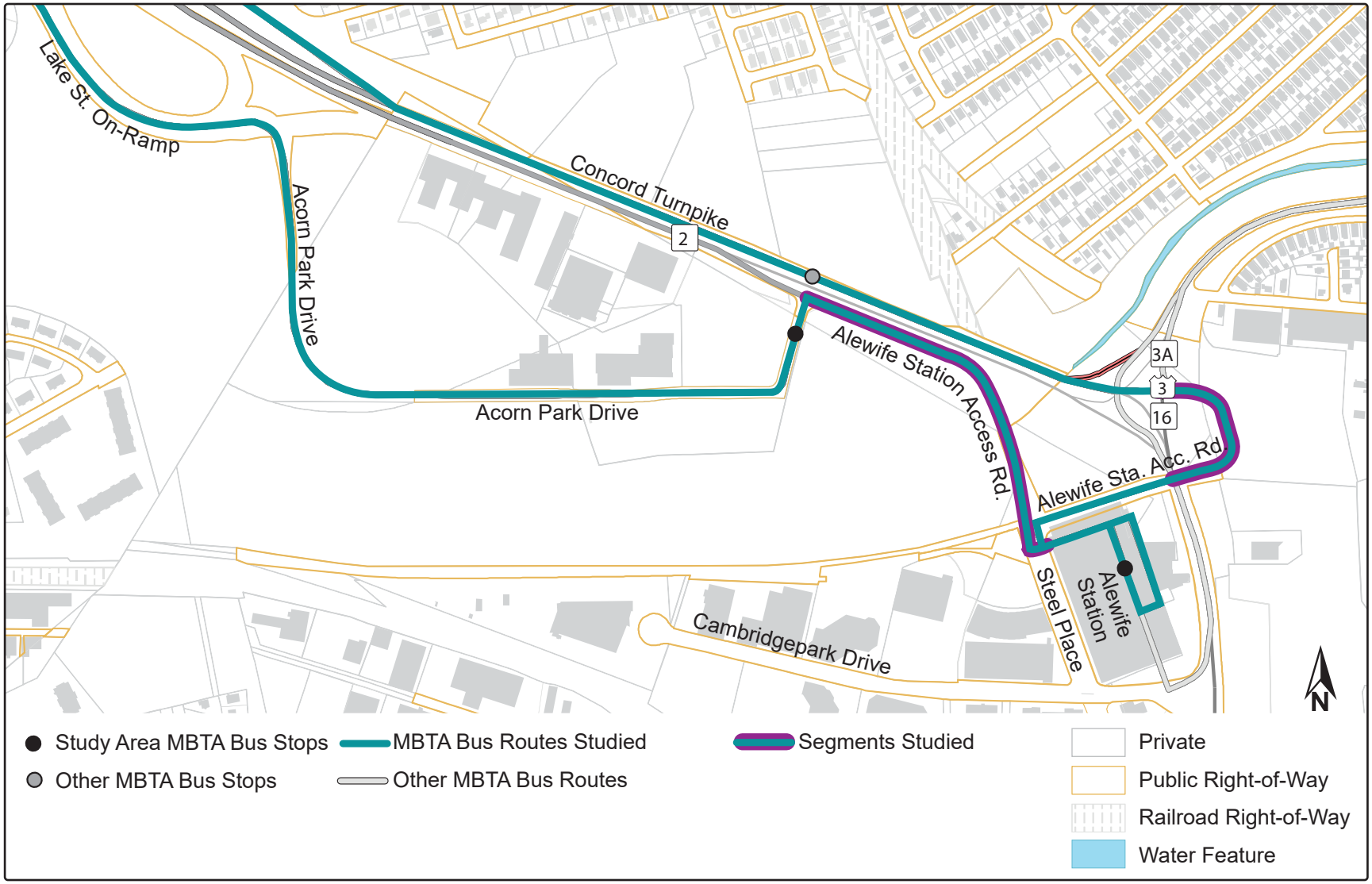

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FIGURE 1
Study Area and Bus Routes Serving Alewife Station

In the previous memorandum, MPO staff recommended further study to assess the feasibility of installing bus priority lanes on the jug handle ramp and Alewife Station Access Road using existing rights-of-way. Staff also recommended analyzing the potential travel-time savings of different routings of buses leaving Alewife Station.

This memorandum presents the results of the recommended additional analysis. Staff assessed the geometric feasibility of changes to two roadways that MBTA buses use to access and egress Alewife Station: 1) Alewife Station Access Road from Acorn Park Drive to the Alewife Station garage entrance, and 2) the last portion of the jug handle approach to Route 2 westbound from the Alewife Station garage exit. MPO staff also measured bus travel times from Alewife Station to Route 2 westbound.

This memorandum contains conceptual designs only. Going forward, the municipalities will have to further develop the conceptual designs for these roadways through coordination with roadway owners and engineering, design, and permitting studies.

2 JUG HANDLE BUS LANE

MPO staff analyzed the feasibility of adding a bus lane to the jug handle ramp connecting Steel Place and the Alewife Station busway with the intersection of Routes 2 and 16. The bus lane would serve MBTA bus Routes 62, 67, 74, and 84. In the previous study, staff estimated that the bus lane would save 11.7 seconds per passenger and a total of 1.14 passenger-hours during the PM peak hour (4:45 PM to 5:45 PM).

Using drawings and diagrams of the roadway and intersection acquired from the City of Cambridge, MPO staff assessed the potential to restripe the roadway, designating two lanes with enough space to allow for safe passage of a bus. Staff limited the scope of the analysis to the section of roadway from the Fresh Pond Parkway (Route 2/16) underpass to the intersection of Routes 2 and 16. Figure 2 shows a plan for a bus lane along the jug handle leading to Route 2 westbound. This design is largely consistent with a proposed design shared by the Cambridge Department of Traffic, Parking, and Transportation. A bus lane approximately 550 feet long could be added on the left-hand side of the roadway with a relatively small amount of widening on the right-hand side, starting from the tunnel under Alewife Brook Parkway.

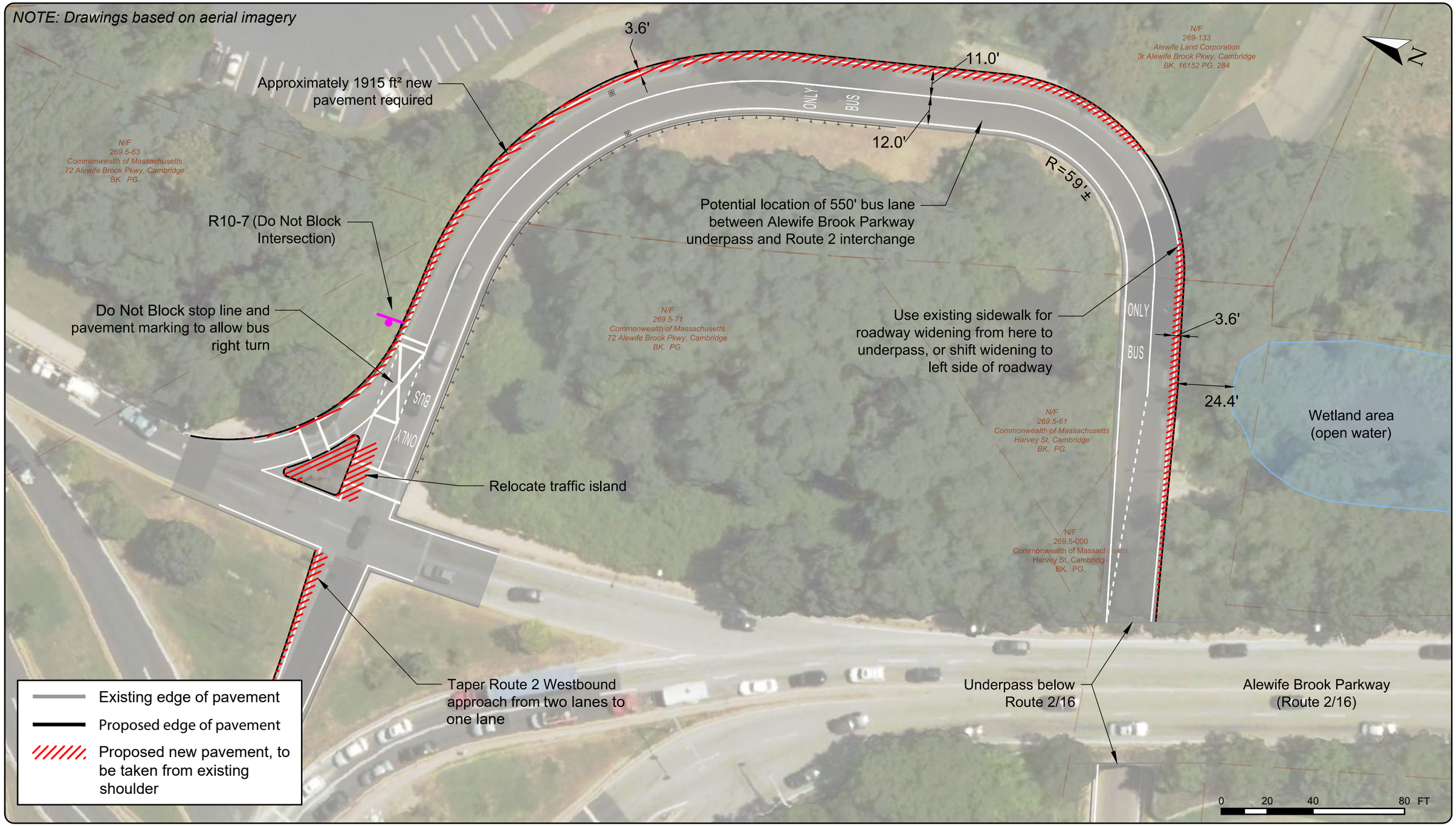

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Figure 2
Bus Lane Concept at Jug Handle Approach

Bus Priority Feasibility at Alewife Station

Because restricted-use lanes are an emerging discipline within the American roadway system, there are currently no guidelines for designing a bus priority lane. The design featured in Figure 2 is based on similar implementations in other municipalities on the East Coast, as well as standard guidelines for general-purpose roadways. The proposed configuration features a 27-foot pavement cross section: one 11-foot general-purpose lane, one 12-foot bus lane, and two two-foot shoulders. These lane widths are consistent with Massachusetts Department of Transportation (MassDOT) guidelines.[1] The new lane widths will also serve to reduce travel speeds and improve safety in comparison to the existing single-lane 20-foot roadway, which is a lane width typically reserved for high-speed freeway ramps. One-foot shoulders are the minimum recommended width, but two-foot shoulders are proposed for driver comfort and to accommodate bus maneuvers.[2] The inner curb radius as the bus rounds the tightest curve of the jug handle ramp is approximately 59 feet, which exceeds the American Association of State Highway Transportation Officials (AASHTO) recommended minimum radius of 24.5 feet for a turning city transit bus.[3]

One potential design feature, shown on Figure 2, would help buses heading to Route 16 from the bus priority lane. Before the intersection with Route 16, a “Do Not Block Intersection” sign and pavement markings consistent with the Manual on Uniform Traffic Control Devices (MUTCD) are recommended for the general-purpose lane.[4] This signage and pavement marking will ensure that passenger vehicle queues will not block the right-turn movement onto Route 16 required for MBTA bus routes 79 and 350.

2.1 Impact on Existing Facilities

Based on aerial imagery, the roadway in this location is approximately 23 to 24 feet wide. The design recommended by MPO staff would require three to four feet of widening to bring the total width to 27 feet. The estimated amount of new pavement required is slightly less than 2,000 square feet, with 350 feet of that appropriated from existing sidewalk. The pedestrian island at the intersection with Alewife Brook Parkway will have to be moved.

[1] MassDOT recommends an 11- to 12-foot lane width for all multilane roadways with more than 2,000 average daily traffic or travel speeds above 45 miles per hour. Source: MassDOT Project Development and Design Guide, Exhibit 5-14.
[2] MassDOT Project Development and Design Guide, Exhibit 5-11.
[3] AASHTO—Geometric Design of Highways and Streets, Exhibits 2-2 and 2-7.
[4] MUTCD—2009 Edition, Section 3B.17: Do Not Block Intersection Markings.

2.2 Right-of-Way

The widening will not cross into any additional properties. The owner of record is the Alewife Land Corporation. Staff recommends additional research into easements and property ownership because the jug handle approach is located on this parcel. A wetland to the south means that the first portion of the widening will likely involve environmental permitting.

2.3 Implementation

Implementation of a bus lane in this location is relatively straightforward in terms of design. The bus lane would begin once the required pavement width is reached and would be distinguished from the travel lane with signage and pavement markings. The bus lane would end at the traffic signal at Route 16. The bus lane and the general-purpose lane would merge to a single lane before the next signal; a taper on this approach would ease the transition. Transit signal priority could also be employed at the Route 16 traffic signal to give waiting buses a leading green interval. However, implementation of a bus lane may negatively affect intersection operations in other ways, as described in the next subsection.

2.4 Other Considerations

Under existing conditions, many drivers who turn right onto Route 16 northbound use the right-hand shoulder of the jug handle as a second travel lane. This can begin 100 to 200 feet ahead of the traffic signal and allows drivers to bypass the queue for Route 2 westbound and take advantage of the channelized right turn. If a bus lane is added, the extra capacity from the shoulder would be removed, and those vehicles would be added to the end of the queue in the general travel lane. In addition to increasing delay for all vehicles, the queue could block buses from entering the bus lane if it reaches the Route 16 underpass. This effect would be more likely during the PM peak period, when the through and right-turn movements are nearly equal.

3 ALEWIFE STATION ACCESS ROAD BUS LANE

MPO staff also analyzed the feasibility of adding a bus lane to the ramp from Route 2 to the Alewife Station area, which is used for the MBTA bus routes 62, 67, 76, and 84. Staff limited the scope of this analysis to the roadway segment from the intersection of Acorn Park Drive and the Route 2 off-ramp to the intersection of Steel Place and the jug handle egress ramp to Routes 2 and 16. Again, using drawings and diagrams of the ramp and adjacent intersections acquired from the City of Cambridge, staff analyzed the potential to restripe the roadway to two lanes with enough space to allow for safe passage of a bus.

In addition, during two weekday AM peak hours, staff conducted field observations to understand how automobiles queued on this ramp. Though this roadway is wide, drivers currently do not form two lanes on this ramp when there is traffic congestion.

As it currently exists, this roadway is not wide enough to stripe both a bus lane and a general travel lane. A bus lane approximately one-quarter mile long is possible from Acorn Park Drive to Alewife Station. Figure 3 shows a plan for a bus lane on Alewife Station Access Road by adding width to the existing roadway.

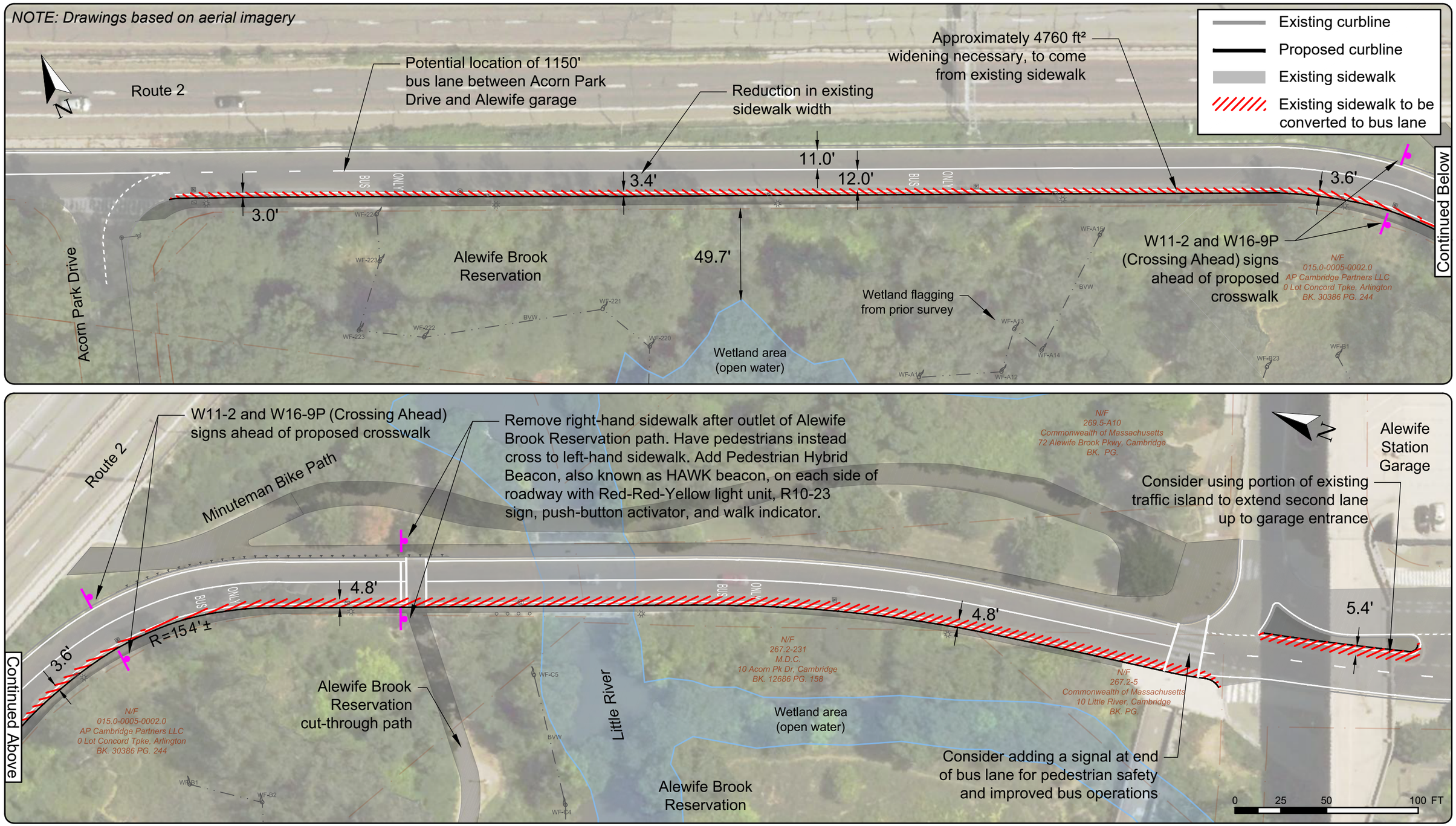

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Figure 3
Bus Lane Concept at Alewife Station Access Road

Bus Priority Feasibility at Alewife Station

3.1 Impact on Existing Facilities

Based on aerial imagery and a 2005 survey, the existing roadway is a consistent 23 to 25 feet wide. A continuous eight-foot sidewalk is present on the right side of the road. After the bend, the access road draws alongside the Minuteman Commuter Bikeway (MCB), after which point a second eight-foot sidewalk is added on the left side of the road. The access road contains two bridges, one over a small stream near Acorn Park Drive and a larger bridge over Alewife Brook about 400 feet from the station.

As in the case of the jug handle, one 12-foot bus lane, one 11-foot travel lane, and two two-foot shoulders are recommended, with a total required pavement width of 27 feet. Again, this design is based on recommendations from the MassDOT Design Guide.[5,6] The curb radius as the access road turns south is approximately 200 feet, making it wide enough for bus maneuvers per AASHTO recommendations.[7]

Some widening will be required to accommodate the extra lane. Near the beginning of the access road, only approximately two feet of widening will be required, but the road narrows slightly as it approaches the garage; up to four feet of widening will be required towards the end of the segment.

3.2 Sidewalks

Any widening must be taken from the existing sidewalk on the southern side of the roadway because the northern edge of the access road abuts a retaining structure supporting Route 2 and is protected by jersey barriers. The sidewalk is eight feet wide, which is enough to spare some width, but as the roadway approaches Alewife Station, up to five feet must be borrowed to widen to two lanes. This does not leave enough space to meet a minimum three-foot wide American with Disabilities (ADA)-compliant space to allow a wheelchair to pass the light posts that are present at 150-foot intervals.[8]

One potential solution, shown in Figure 3, is to divert pedestrians along this portion of the access road onto an existing paved path between Acorn Park Drive and Alewife Station Access Road through Alewife Brook Reservation. The path begins at a small parking lot near the Acorn Park Drive bus stop and is likely a more direct route for pedestrians, although pedestrian counts are not available

[5] MassDOT Project Development and Design Guide, Exhibit 5-14.
[6] MassDOT Project Development and Design Guide, Exhibit 5-11.
[7] AASHTO Geometric Design of Highways and Streets, Exhibit 2-2 and 2-7.
[8] MassDOT recommends a minimum sidewalk width of five feet. Source: MassDOT Project Development and Design Guide, Section 5.3.1.1.

for this location. At the other end of this path, near the MCB and Alewife Station, a signalized pedestrian crossing can be installed to enable pedestrians to cross Alewife Station Access Road and access the sidewalk on the eastern side of the roadway. This would maintain an ADA-compliant pedestrian route linking Acorn Park Drive and Alewife Station. The western sidewalk should be converted into expanded shoulder space. If the sidewalk is not converted, the remaining sidewalk would not meet ADA standards for accessible pathways.

Two Pedestrian Hybrid Beacons, also known as HAWK beacons, are recommended for the signalized pedestrian crossing on Alewife Station Access Road at the Alewife Brook Reservation path, as shown in Figure 3. These beacons are suitable for crossing locations with high pedestrian or vehicle traffic and require two signal heads per approach direction. According to the MUTCD, each signal head must contain two red lights, one yellow light, an R10-23 Crosswalk Stop on Red sign, and a pushbutton activator, and may be mounted on the roadside or on an overhead mast. Additionally, it would be recommended to install W11-2 and W16-9P Crossing Ahead signs about 200 feet ahead of the crossing, before the bend in the access road.[9]

While the pathway through Alewife Brook Reservation is only 800 feet long and has ample lighting, some consideration should be made for individuals who may feel safer walking along the road in sight of vehicle traffic.

3.3 Right-of-Way

The right-of-way for the access road ends at the fence at the back edge of the sidewalk. Beyond this point, there is a steep drop-off into Alewife Brook Reservation. Alewife Brook Reservation is divided into two parcels, with a thin strip on the north side owned by AP Cambridge Partners, LLC, and the rest owned by the Massachusetts Department of Conservation and Recreation.

Even though no additional right-of-way will be needed if the existing sidewalk is used for widening, the proximity to Alewife Brook Reservation means environmental permitting will almost certainly be necessary. A 2005 survey shows wetland flagging beginning barely 10 feet from the edge of the sidewalk.

3.4 Implementation

Implementation of a bus lane along the access road is more complicated than in the jug handle location. At the beginning of the segment, buses enter from Acorn Park Drive and passenger vehicles enter from both Acorn Park Drive and the Route 2 exit. The volumes from Route 2 are much larger than those from Acorn

[9] MUTCD—2009 Edition, Chapter 4F: Pedestrian Hybrid Beacons.

Park Drive. One possible design, shown in Figure 3, would direct Acorn Park Drive traffic into the new bus lane, and then have traffic merge left into the general-purpose lane. Another potential design would be to merge both traffic streams into a single general-purpose lane, and then add the bus lane on the right. A third strategy would be to signalize the intersection of Acorn Park Drive and the Route 2 off-ramp, and use transit signal priority to ensure that transit vehicles could easily access the bus lane. Staff recommends further assessment of turning movements to create a safe bus lane concept at this location.

At the intersection at the end of the segment near Alewife Station, passenger vehicles can turn right into the garage, use the first left to the jug handle, or continue straight to Cambridgepark Drive. Buses exclusively use the second left to enter the Alewife busway. These conflicting movements complicate the treatment at the end of the bus lane and could cause safety and congestion issues. In addition, there is significant pedestrian traffic—approximately 80 people per hour during the AM peak period—crossing the access road at the same location. While further study will be necessary to determine how to configure the bus lane at this intersection, one possible option is shown in Figure 3.

4 BUS TRAVEL TIMES FROM ALEWIFE TO ROUTE 2 WESTBOUND

MPO staff collected travel time estimates for MBTA bus routes 62, 67, 76, and 84 departing Alewife Station on two weekdays in September 2017 during the PM peak period (4:00 PM to 6:00 PM). Field staff observed buses traveling using two routings: 1) the officially listed routing exiting the Alewife Station busway using the northwestern exit, traveling along Steel Place, then making a right turn onto the Alewife Station Access Road to the jug handle ramp to Route 2 westbound, and 2) an unofficial routing using the southeastern exit from the Alewife Station busway to Cambridgepark Drive to Routes 2 and 16.

On these two weekdays, staff counted five trips using the MBTA’s official routing and 29 trips using the alternate routing. Staff noted that bus operators use the routing that appears to be least congested at the time of the departure. Given that bus operators primarily use the unofficial routing, it is evident that bus egress from Alewife Station has been heavily affected by traffic. Field staff observations and previous work indicate that the largest delays are likely to start at the intersection of Alewife Station Access Road, Steel Place, and the Alewife Station garage and busway exit.

Staff also calculated average travel times for these 34 observed trips based on departure time at the Alewife Station busway and arrival time at the bus stop at

the pedestrian overpass of Route 2 near the former Lanes and Games 10-pin bowling site:

- Average travel time for buses using official route was 2 minutes 15 seconds
- Average travel time for buses using alternative route was 2 minutes 45 seconds

The calculations of travel time reveal a counterintuitive conclusion; the travel times for the route used less often were lower than the times for the more favored route. Given that staff is only able to measure travel times for the route that is taken for each trip and unable to measure the travel time for the other routing, we cannot directly compare the two average travel times. In addition, the average travel times that staff estimated are not likely to be a reasonable estimate were all buses to use a given routing over the peak time period.

Given these findings, staff recommends additional fieldwork of bus operations for the busway egress. This additional fieldwork would involve coordinating with MBTA bus operations staff to instruct bus operators to use only the official routing for a selected period then use either their preferred route or only the alternative route for another selected period. Staff recommends that the selected periods be back-to-back workweeks without holidays or school vacations.

5 NEXT STEPS

Both the feasibility analysis for a bus lane on Alewife Station Access Road and the field observations for bus travel times indicate that the intersection of Alewife Station Access Road, Steel Place, and the Alewife Station garage and busway exit is the lynchpin for any bus priority improvements in the study area. Further engineering design work is required for the last section of any bus priority treatment on Alewife Station Access Road. This would also include designs for people on foot and on bike on the last section of Alewife Station Access Road.

It is also possible that some of the traffic volumes on Alewife Station Access Road are people traveling from Route 2 eastbound to Route 16 southbound. That is, to avoid congestion at the end of Route 2, some traffic headed to Route 16 southbound will divert from Route 2 near Lake Street and use Acorn Park Drive and/or Alewife Station Access Road. The degree to which this flow affects traffic conditions should be determined.

Rethinking the busway exit from Alewife garage is also worth consideration. Currently buses experience difficulties finding adequate gaps to exit Alewife Station to the jug handle ramp. Moving the location of the bus exit could help. In addition, adding a signal or changing the signage to indicate priority for buses

exiting in this location could help. Another option is to change the official bus routing to use the southeastern exit of the busway. Many experienced MBTA bus operators already use this routing. Additional analysis of bus egress travel times could be used to inform this decision. Staff recommends studying traffic operations for bus operators entering and exiting the busway at Alewife station.

Finally, given the number of issues identified in this and previous memos that affect bus access and egress from Alewife station, MPO staff recommends that the municipalities undertake a comprehensive traffic study of Alewife station, connecting roadways, and nearby developments with a focus on improving travel for bus riders.

6 CONCLUSIONS

Based on preliminary analysis, it is possible to create bus lanes in both described locations with relatively few changes to the existing roadway. Next steps will require further study, which should identify conceptual solutions to the final segment of bus access to the station. In addition, to develop further these design concepts, the municipalities will have to coordinate with the roadway owners and contract with design companies for further surveying and design efforts.

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