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DEPARTMENT OF PLANNING and
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MEMORANDUM

To: Adam Chapdelaine, Town Manager/Select Board

From: Daniel Amstutz, Senior Transportation Planner

CC: Jennifer Raitt, Director of Planning and Community Development
Juliann Flaherty, Acting Chief of Police, Arlington Police Department

Date: February 21, 2019

RE: Final BRT Pilot Data & Recommendations to Install Dedicated Bus Lane on Mass Ave

From October 9 to November 9, 2018, elements of Bus Rapid Transit (BRT) were piloted in Arlington on the eastbound side of Mass Ave between Lake Street and Alewife Brook Parkway. The pilot was made possible by a grant from the Barr Foundation in support of implementing bus priority for routes 77, 79, and 350. The Town hired VHB to assist with designing the elements of the bus priority pilot and conduct traffic analysis. Other key partners in the pilot implementation included the MBTA, City of Cambridge, state Department of Conservation and Recreation, and the Institute for Transportation & Development Policy. Leading up to the fall pilot, the Town conducted a robust public outreach process, including three public forums, surveys, news items and email communications, and multiple stakeholder meetings and conversations with East Arlington residents and business owners.

The pilot included the following elements: relocation of the bus stop to the far side of the Mass Ave and Lake Street intersection; transit signal priority (TSP) and a queue jump at the same intersection; the repurposing of parking spaces from 6:00 a.m. to 9:00 a.m. for a dedicated bus and bike lane from the intersection of Mass Ave and Varnum Street to the Alewife Brook Parkway; and traffic signal and lane changes at the intersection of Mass Ave and Alewife Brook Parkway. Although not associated directly with the BRT pilot, TSP has also been installed at three additional locations on Mass Ave: at Bates Road/Marion Road, Franklin Street, and Mill Street/Jason Street. All elements of the pilot except for the dedicated lane have remained in place. The dedicated lane ended after November 9 pending further analysis of the impact of the dedicated lane on MBTA bus operations, post-pilot survey data, and a review of best practices for dedicated bus lane designs.

The goals of the pilot were to improve traffic flow, reduce travel time, and increase reliability. This memo reviews the results of the MBTA bus data analysis, post pilot survey data and other public comments, and provides recommendations for creating a permanent dedicated

bus lane on the eastbound side of Mass Ave between Varnum Street and Alewife Brook Parkway.

BRT Pilot Results – Overview and Post-Pilot Data

The Town successfully implemented elements of BRT during the pilot period. Data from the MBTA shows that the BRT elements and particularly the dedicated bus lane were extremely effective at reducing travel time and increasing reliability for MBTA buses. Survey data collected after the end of the pilot reflects mostly positive experiences with the BRT elements by users of all modes on Mass Ave. Traffic flow for general travel lanes was not substantially compromised by the pilot elements. The following sections discuss these results in more detail.

MBTA Data

MBTA data were analyzed by Stantec, hired by the Barr Foundation to help review data from the BRT pilots they funded across the region. Stantec used Automatic Vehicle Location (AVL) and Automated Passenger Count (APC) data provided by the MBTA collected across three time frames: before the pilot (September 9 – October 8), during the pilot (October 9 – November 9), and after the pilot (November 10 – December 14). They analyzed data for Routes 77, 79 and 350. From these data conclusions could be drawn about the impact of the pilot on overall route running times, bus travel time in the pilot area, reliability of bus routes, and bus on-time performance:

- **Buses ran faster through the pilot area than they did before the pilot. Improvements were especially significant in the 7:00-8:00 am and 8:00-9:00 am rush hours.**
    - The dedicated lane saved, on average, five minutes in commute time for all bus routes during the hours it was piloted. Time savings extended to the entire route, meaning that the five minutes saved on Route 77, for example, was not lost in later sections of the trip to Harvard Square. The entire route was five minutes faster, or 10% shorter than the before pilot conditions.
    - During the pilot, median travel times (50th percentile) through the pilot area were 41% and 53% faster at 7:00-8:00 a.m. and 8:00-9:00 a.m., respectively, for Route 77; and were 28% and 41% faster at 7:00-8:00 a.m. and 8:00-9:00 a.m., respectively, for Routes 79 and 350.
    - Worst case scenario (90th percentile) travel times were also significantly lower during the pilot, being between 7-10 minutes faster from 7:00-9:00 a.m. for all the routes studied.
    - Some improvements in running times were observed at the 6:00-7:00 a.m. hour, but were generally not as consistent or substantial as for the later hours.
- **Buses did not just run faster, they consistently ran faster and reliability increased. The variability during rush hour in the pilot area fell to below five minutes, for all routes.**
    - Whereas pre-pilot the time for Route 77 to travel from Lake Street to Alewife Brook Parkway could take anywhere from 11 to 17 minutes during the 8:00-

9:00 am period, the dedicated lane both reduced the overall travel time and reduced this spread considerably.
    - For Route 77, between 8:00-9:00 a.m., variability decreased 64% — from almost seven minutes before the pilot to only 2 minutes and 20 seconds during the pilot. Thus the bus became more reliable.
    - For Routes 79 and 350, between 8:00-9:00 a.m., variability decreased 52% — from seven and a half minutes to only 3 minutes and 3 seconds during the pilot.
- **On-Time Performance (OTP) for Routes 79 and 350 increased significantly during the pilot, and has continued to be higher than before the pilot was implemented.**
    - This is true for both inbound and outbound buses on both routes. Route 79 operated on schedule 22% more of the time inbound and 19% outbound, improving OTP over 70% in both directions. Similarly, Route 350 operated on schedule 11% more of the time inbound and 14% outbound, improving OTP to about 70% inbound and 60% outbound.
- **Moving the eastbound bus stop on Lake Street from the near side of the intersection to the far side of the intersection saved approximately one minute of travel time in the peak morning commute hours.**
- **Post-pilot, all bus routes are traveling faster than before the pilot was implemented, indicating that the elements that remained after the pilot are continuing to have a positive impact. However, the time savings are not as significant as they were during the pilot when the dedicated bus lane was in place.**

Overall, buses consistently ran faster and more reliably, creating a better experience for bus riders.

Post-Pilot Survey Data and Emailed Comments

A post-pilot survey to collect data on user experiences with the BRT pilot was open from November 14 to November 30, 2018. During this time 382 responses were collected. The breakdown of responses by transportation mode is 43% drivers, 36% public transit users, 14% bicyclists, 4% pedestrians, and 3% other modes (including ride-hail service users and commercial vehicle drivers). Over 90% of survey respondents travel on Mass Ave at least two days a week, and 89% had traveled on Mass Ave during the BRT pilot.

Out of all responses, 67% were very satisfied or satisfied with the pilot (47% and 20% respectively), 18% were neutral, and 15% were dissatisfied with the pilot. 73% of survey respondents said with the dedicated bus lane should remain, with a large majority (58%) saying the bus lane should be longer. 13% said the bus lane should not be brought back and 14% didn't know or had no opinion.

81% of bus riders were very satisfied or satisfied with the pilot (59% and 22% respectively), 94% of bicyclists were very satisfied or satisfied, and 50% of drivers were very satisfied or satisfied. Another 27% of drivers were neutral, and 24% of drivers were dissatisfied or very dissatisfied. Over 90% of bus riders and bicyclists said the bus lane should remain with over 70% of both saying the bus lane should be longer. Interestingly, 54% of drivers said the bus

lane should remain or be longer (38% said it should be longer). 24% of drivers said the Town should not keep the lane, and 22% did not know or had no opinion.

Survey comments were generally supportive of the BRT pilot and the changes that were implemented. While most bus riders were supportive of the changes, there were some concerns about moving the bus stop at Lake Street and that the bus lane was not long enough. Bicyclists mostly liked the function of the lane for buses and bicycles, and there were few comments about conflicts between the two modes. Drivers were split about the effect of the BRT pilot on traffic flow – many said that traffic was better or did not change, while others argued that traffic was worse than normal and blamed it on the pilot elements. Waze data reviewed by the town as part of its Connected Citizens Program participation indicated that, while the first week of the pilot suffered from increased travel times (likely due to the implementation of the pilot elements), traffic congestion was back to its usual condition by the second week. Variations in traffic conditions during the pilot period outside of the pilot area could also have contributed to differences in congestion along Mass Ave.

Several emailed comments were received by DPCD during and after the BRT pilot. Most comments were supportive of the pilot and the dedicated bus lane. Other comments referred to specific elements of the pilot, such as the signal adjustments at Alewife Brook Parkway, noted issues with MBTA bus scheduling beyond the scope of the pilot, or raised concerns about traffic conditions on side streets during the pilot.

From the survey data and other public comments, it is clear that public opinion is strongly in favor of implementing the dedicated bus lane and making it longer, if possible.

Implementation Strategy for the Dedicated Bus Lane

As noted earlier, time savings during the pilot were much more significant with the dedicated bus lane, which was removed at the end of the pilot. The following sections detail a recommended strategy to install a permanent, time-limited dedicated bus lane on Mass Ave in the same location as was piloted in October 2018. Permanent implementation involves determining the time of day restrictions, length of the bus lane, infrastructure needed to designate the lane, enforcement of the lane, and snow clearance.

Time of Day Restriction

In the BRT pilot, the dedicated bus lane ran in the parking lane on the eastbound side of Mass Ave between 6:00-9:00 a.m. Monday through Friday. Staff recommend keeping this same time restriction in the permanent installation. An argument could be made for reducing the hours of the bus lane to 7:00-9:00 a.m. because the MBTA data show the bus lane was most effective for reducing travel time and increasing reliability in the 7:00-8:00 and 8:00-9:00 hours, while it was not as effective during the 6:00-7:00 hours. In addition, the overnight parking ban ends at 7:00 a.m. However, beginning the dedicated lane earlier in the morning establishes the lane well in advance of the morning commute and allows additional time for ensuring the lane is clear of parked vehicles before the worst slowdowns start to occur. It is also likely that providing additional buffer time at the very beginning of the morning

commute contributes to the impressive benefits to travel time and reliability gained in the later hours.

Length of Dedicated Bus Lane

The dedicated bus lane was piloted between Varnum Street and Alewife Brook Parkway. At this time, Planning staff propose to install the permanent lane within the same geographic limits. Although post-pilot survey respondents indicated a preference for making the bus lane longer than in the pilot (at least back to Lake Street), and the MBTA is also supportive of extending the bus lane, there are complications with extending it west. In particular, there are three bump-outs serving uncontrolled crosswalks that were installed as part of the Mass Ave redesign project. The three bump outs are at Marathon Street, Milton Street, and Varnum Street. These would need to be removed to enable MBTA buses to travel freely in the parking lane from Lake Street to Alewife Brook Parkway, potentially reducing the pedestrian safety of these crosswalks. Staff must research additional methods to improve the safety of these crosswalks before proposing to lengthen the bus lane. The MBTA has indicated that it may be able to partner with the Town to create a design for an extended bus lane and provide funding for capital costs if the Town is willing to pursue this option.

In addition to the safety concerns outlined above, staff believe that the bus lane should be installed permanently as it was done in the pilot and monitored before attempting to extend or install new bus lanes in the Town. This will allow staff to analyze the effects of the lane on town staff time, its cost, and the effectiveness of infrastructure and enforcement, before committing the Town to a more ambitious installation.

Infrastructure

In the BRT pilot, the dedicated lane in the parking lane and the bike lane was separated from the general travel lanes by traffic cones that were placed by DPW each morning shortly before the hours of the bus lane went into effect. DPW picked up the traffic cones each day after the bus lane period was over. Implementing this as part of a permanent lane installation requires ongoing costs for the labor of dropping off and picking up traffic cones each weekday the bus lane operates. DPW estimates that it will cost $5,000 per month in additional costs to continue this practice indefinitely, which is not recommended as part of the implementation strategy. Permanent vertical infrastructure such as curbs or bollards to separate the bus lane from the general travel lanes cannot be used while the bus lane continues to operate as a parking lane outside of weekday morning commute hours.

Infrastructure needed for the dedicated bus lane will consist of signage and pavement markings, similar to what has already been installed in Cambridge, Everett, and Boston. Signs and markings must be in conformance with the Manual on Uniform Traffic Control Devices (MUTCD). Chapter 2G of the MUTCD covers Preferential and Managed Lane Signs, while Chapter 3D covers Markings for Preferential Lanes. Chapter and figure references are based on the current MUTCD in force, which as of this writing is the 2009 edition.

Based on MUTCD guidelines and experiences from cities in the region, the following are suggested signs and markings:

- Regulatory signage should be placed along the dedicated bus lane to establish its location and that it will be enforced. Figure 1 includes three examples of regulatory signs for preferential bus lanes from the MUTCD, with further explanations below.
    - R3-11b: "RIGHT LANE – BUSES ONLY" with the times of day indicated (6-9 AM). To avoid confusion between where buses will travel (the parking lane, instead of the rightmost travel lane), "RIGHT LANE" may be replaced with "PARKING LANE". In addition, to specifically allow bicycles to travel in the bus lane, the content of the sign should say "BUSES AND BIKES ONLY", which is also what Cambridge is installing on their bus lane signage.
        - One sign should be installed per block at the beginning of the block to clearly note the limits of the lane. Five signs will be required for the five blocks of the dedicated lane, at Varnum Street, Magnolia Steet, Thorndike Street, Fairmount Street, and Lafayette Street.
        - Signs may need to be larger than the MUTCD standard to accommodate the text.
    - R3-12f: "BUS LANE AHEAD". If used, this should be modified to say "BUS AND BIKE LANE AHEAD" which is being used for the Cambridge bus lanes on Mt. Auburn Street. Since the bus lane does not impact the general travel lanes or require a merge/weave for general traffic, this sign may not be strictly necessary. This sign should be installed near Milton Street.
    - R3-12g: "BUS LANE ENDS". If used, this should be modified to say "BUS AND BIKE LANE ENDS" which is being used for the Cambridge bus lanes on Mt. Auburn Street. This sign should be used as it identifies the area where buses and bicycles will merge back into the general traffic lanes at Alewife Brook Parkway. It should be installed near Boulevard Road.

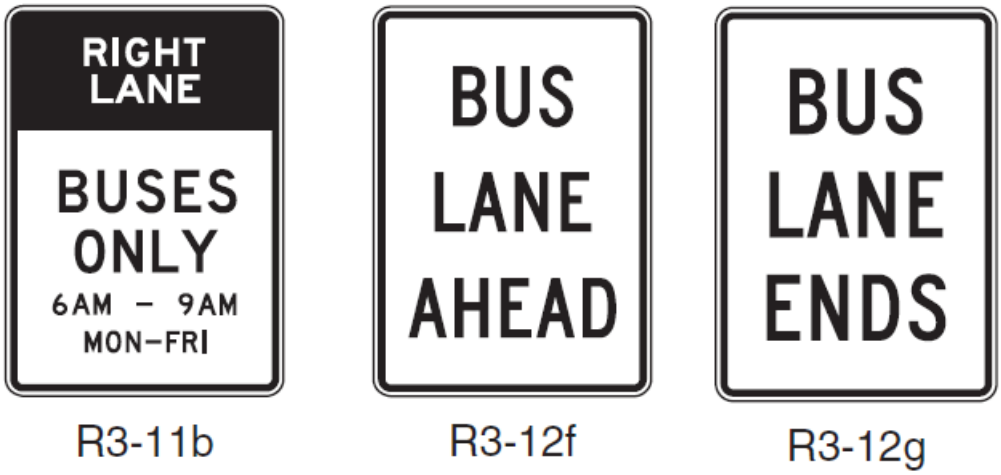

Figure 1 - Preferential Lane Signs, MUTCD 2009 (Section 2G.03, Figure 2G-1)

- Pavement markings should be placed along the dedicated bus lane to establish its location and clearly communicate to drivers that parking is not allowed at certain times of the day. Markings can also call attention to the parking lane as being different from parking lanes in other parts of the town. Two types of pavement markings are appropriate:
    - BUS ONLY – the preferential lane-use marking for a bus only lane. A dedicated bus lane on Washington Street in Boston also marks the time restriction of the lane in pavement markings. To clearly communicate that the bus lane in the parking lane is not an all-day feature, it would be beneficial to include this restriction in the markings.
        - Similar to regulatory signage, BUS ONLY pavement markings could be installed in five locations -- at Varnum Street, Magnolia Steet, Thorndike Street, Fairmount Street, and Lafayette Street. Due to space constraints, the time restrictions may need to be removed or the markings may need to be made smaller than preferred.
    - Red colored pavement – Boston, Everett, and Cambridge have all used red paint or other marking materials to call attention to their bus lanes. To reduce the amount of red coloring applied to the pavement, painting around the BUS ONLY wording and around the parking stall markings should be sufficient. See the picture in Figure 2 for an example of this painting scheme.

Figure 2 – Red pavement markings on Mass Ave in Central Square, Cambridge

Enforcement

With only signs and pavement markings to delineate the bus lane and its time restrictions, consistent and frequent enforcement becomes much more important to preventing drivers of private vehicles from parking or driving indiscriminately in the lane. What is most important, however, is that the lane is clear during the times that a bus travels down the lane. Drivers using the lane to make a right turn onto a side street or momentarily entering the lane to merge into the general travel lane should be discouraged, but not necessarily penalized. Once the bus lane is permanently established it is expected that drivers will become used to having the bus lane there and will self-enforce.

To ensure the bus lane is free from vehicle obstructions,the Arlington Police Department recommends that one traffic officer is dedicated to the area for the first 30 calendar days of the bus lane implementation to enforce the parking restriction in the bus lane during its operation, 6:00-9:00 a.m. on weekdays. This is estimated to cost approximately $5,400.

After this 30 day period, a Sector Officer will be assigned to the area who can periodically monitor the bus lane for illegally parked vehicles and take enforcement action as necessary. The Sector Officer will have a regular assignment in East Arlington and may be called away for other police duties when needed. Thus this assignment will not come at additional cost to the town above and beyond existing police operations budgets.

Ideally, the traffic officer will travel up and down the parking lane and direct drivers to move out of the lane at the beginning of the bus lane period and throughout the three hours. In Everett, a parking control officer drives through the parking lane with a megaphone and orders vehicles out of the way. Generally, towing vehicles would be considered a last resort, unless it is necessary to address an especially obstinate driver.

Snow Clearance

Keeping the parking lane clear of snow and ice is an important consideration to ensuring MBTA buses can travel through the lane in its hours of operation. The parking lane should be cleared as normal to the extent that parked vehicles and buses can use the lane after the snow event has finished. However, if there is so much snow in a winter that snow storage along the roadway is maxed out and the parking lane cannot be fully cleared, buses can continue to use the regular travel lane during the morning commute, as they do currently. Ocassional impedements to using the parking lane as a bus lane due to challenges of snow removal should not be considered a failure of the bus lane, as it will still be useable the vast majority of the year.

Conclusion

The dedicated bus lane implemented in the BRT pilot was overwhlemingly successful in improving public transportation and is strongly supported by the public. Examples of bus lanes in neighboring communities prove that they can be successfully implemented in the Boston region and Arlington can learn from their experiences. In addition, the town has strong support from the MBTA to implement the dedicated lane permanently.

The dedicated bus lane should be implemented as early as spring 2019, once weather allows for pavement markings to be easily applied to the road surface.