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MEMORANDUM

DATE **September 29, 2011**

TO **Transportation Planning and Programming Committee of the Boston Region Metropolitan Planning Organization**

FROM **Mark S. Abbott, P.E.**
Steven Andrews

RE **Strategic Visioning for MBTA Bus Service: Bus Route 66**

The purpose of this MassDOT-funded study is to evaluate potential transit signal priority (TSP) strategies, including queue jumps, along three MBTA bus routes that are designated Key Routes: Routes 15, 66, and 111. This memorandum provides detailed intersection analysis and evaluation of TSP strategies for bus Route 66. Separate memoranda for Routes 15 and 111 were also completed.

The analysis in this memorandum demonstrates which intersections along the bus route could feasibly support TSP strategies, including green extension, early green, and queue jump lanes, without significant impacts on general traffic, bicyclists and pedestrians, parking, and side streets.

The primary tasks documented in this memorandum are:

- Evaluate existing conditions at signalized intersections along MBTA bus Route 66.
- Evaluate the potential for TSP and queue jump lanes under bus stop consolidation assumptions that resulted from the 2009 MBTA Key Routes Initiative.
- Project the intersection conditions and bus operations after implementation of TSP strategies. Delays, travel time for general traffic, queues, bus stop locations, pedestrian movement, parking, and bus travel time are assessed.

BACKGROUND

The MBTA has identified 15 Key Routes, which carry approximately 40% of all bus passengers. In the fall of 2009 and in early 2010, the MBTA collaborated with MassDOT and MPO staff on a Key Routes Initiative study to develop conceptual improvement strategies for six of the 15 Key Routes: Routes 1, 15, 23, 28, 66, and 111.

Typical conceptual strategies developed in that study included dedicated bus lanes; prepaid fares; TSP for buses; changing bus headways; and consolidating,

eliminating, and relocating bus stops to improve the quality of bus service for existing and potential new riders. Six memoranda, including one about Route 66,[1] completed by MPO staff included recommendations for bus stop consolidation, elimination, and relocation; analysis of bus travel time performance; and recommendations for conceptual plans for TSP strategies (green extension and early green) and possible queue jump lanes.

Transit Signal Priority

Transit signal priority (TSP) is an intelligent transportation systems (ITS) technology applied to traffic signals to improve traffic- and person-carrying capacity along a corridor. TSP allows buses equipped with communication devices to request priority as they approach a traffic signal. Priority strategies include extension of a green interval for the approach where the bus is traveling or return to a green interval to serve the bus. The bus may communicate with the signal in this manner every time it is approaching a traffic signal or only when the bus is late. A TSP system can improve bus travel time and schedule reliability. Such systems have been widely installed around the country, with documented benefits. Like signal coordination, TSP systems require careful examination of impacts on side street traffic delays and queues.

TSP can benefit buses by increasing speeds, reducing intersection delay, and reducing running time. According to "Implementing Transit Signal Priority (TSP)" (in the Research and Innovative Technology Administration (RITA) — Intelligent Transportation Systems website), speeds can increase by 25% to 40%, intersection delays can be reduced by 13%, and running time savings can range from 2% to 18%. Table A-1 in Appendix A provides an overview of these TSP benefits. In Transit Cooperative Research Program (TCRP) Report 118: *Bus Rapid Transit Practitioner's Guide* (2007) is a survey of selected transit agencies that have implemented TSP. This survey ascertained the location, type of transit service, TSP type, and benefit/impact for each TSP strategy. Table A-2 in Appendix A provides a summary of this survey's findings.

The MBTA and the City of Boston currently employ a TSP system on the Silver Line along the Washington Street corridor. The Silver Line TSP currently uses a system in which the bus communicates with the MBTA's transportation center as it approaches a signalized intersection. The MBTA's transportation center then determines if the bus is behind schedule or not. If it is behind schedule, the transportation center puts in a TSP request to the Boston Transportation Department's (BTD's) transportation center. BTD then determines if a signal priority request will be granted or not. If granted, BTD then sends the TSP request to the signal. This TSP approach is one of several which can be applied and is currently the preferred method within the City of Boston.

Another TSP approach is for the buses to communicate directly with the traffic signal to request a priority movement. This system is frequently used by emergency vehicles and is commonly known as an Opticon system. Using an Opticon system allows for different levels of signal priority to be implemented at each traffic signal and also does not require communication between a communication center and the traffic signal.

[1] MBTA Key Routes Initiative (completed 2009).

Queue Jump Lanes

A queue jump lane is a short stretch of bus-only lane combined with TSP. The idea is to enable buses to bypass waiting queues of traffic and to cut out in front by getting an early green signal. A special bus-only signal, with associated signing and pavement markings, may be required. A queue jump lane can be installed between right-turn and through lanes. A similar arrangement can be used to permit a bus to cross traffic lanes to make a left turn, immediately after serving a curbside stop, prior to the general traffic's receiving a green signal.

Another queue jump application utilizes a dedicated right-turn lane, either an existing one or one created by converting on-street parking. The right-turn lane is used by buses as a through movement across the intersection; general traffic must only turn right in the lane. This lane gets an advance signal indication to allow the buses and the right-turn-only traffic to precede the rest of the traffic at the intersection.

Bus Stop Location

One of the key components of TSP and queue jump lanes is bus stop location in relation to the signalized intersection. At an intersection without a queue jump lane, TSP works best when the bus stop is located on the far side of the intersection. This allows for buses to utilize a green extension/early green to pass through the intersection and stop on the far side to board/discharge passengers. When the bus stop is located on the near side of the intersection and buses stop before crossing the intersection, the priority call can be long in duration, thus impacting side street traffic significantly. Also, even if a priority call is underway when a bus is pulling away from the curb, it could encounter difficulty in entering the general traffic lane.

With standard queue jump lanes, however, where the bus has a dedicated bus-only through lane along the curb, it is preferable for the bus stop to be on the near side of the intersection. This allows for buses to serve the stop, pull forward in the queue jump lane, and activate the advance signal for the bus. With alternative queue jump lanes, where a right-turn-only lane is being used by buses as a queue jump lane, the bus stop should be located on the far side of the intersection so that buses do not block the right-turning traffic.

EXISTING BUS OPERATIONS

Route Description

The MBTA's bus Route 66 operates between Harvard Square in Cambridge and Dudley Station in Boston, serving not only Cambridge and Boston but also Brookline. Part of the Boston portion of the route serves the Allston/Brighton neighborhood. Route 66 has differing inbound and outbound routes.

It has 43 stops in the inbound direction (from Harvard Square to Dudley Station) and 41 stops in the outbound direction (from Dudley Station to Harvard Square). Figures 1 and 2 show the inbound and outbound routes, respectively, along with existing bus stop locations. Most of these stops are located near roadway intersections and maintain a pull-out area for the buses on the

outside travel or parking lane next to a sidewalk curb. The route travels through 39 signalized intersections in the inbound direction and 38 signalized intersections in the outbound direction. The intersections the route passes through, the bus movements at the intersections, and the bus stop locations (near side or far side of the intersection) are indicated in Appendix B in Tables B-1 and B-2 for the inbound and outbound directions, respectively. There are a few intersections where no bus stops are present nearby.

Existing Bus Performance

The 2009 memorandum on Route 66 included average bus speeds over the inbound and outbound routes during the AM and PM peak periods, average traffic signal delays, and daily boarding and alighting totals by stop. These data from that memo are provided below. For a detailed description of the methodologies used to obtain these data, please see the 2009 memorandum.

Average Speeds

Automatic vehicle location (AVL) data provided by the MBTA for the month of May 2009 was used to obtain the average bus speeds along the entire route by direction during the AM (6:00-10:00) and PM (3:00-7:00) peak periods. Peak periods were used instead of peak hours in order to gather enough data points along the route to calculate average speeds. The average speeds include both the travel time and the dwell time (when buses are stationary and serving a bus stop). The average speeds by route segment are presented for the AM peak period in Figures 3 and 4 for the inbound and outbound trips, respectively, and are presented for the PM peak period in Figures 5 and 6 for the inbound and outbound trips, respectively. Red indicates average speeds between 0 and 10 mph, yellow average speeds between 11 mph and 20 mph, and green average speeds greater than 20 mph.

In the AM peak period in the inbound direction, the slowest speeds occurred between Union Square and Harvard Avenue at Commonwealth Avenue and between Coolidge Corner and Brigham Circle. The average inbound speed for the entire route in the AM peak period was 11.73 mph.

In the AM peak period in the outbound direction, the slowest speeds occurred on Tremont Street between Roxbury Crossing Station and Brigham Circle and from north of Union Square to Harvard Square. The average outbound speed for the entire route in the AM peak period was 10.01 mph.

In the PM peak period in the inbound direction, as in the AM peak period, the slowest speeds occurred between Union Square and Harvard Avenue at Commonwealth Avenue and between Coolidge Corner and Brigham Circle. Average speeds below 10 mph also occurred from Brigham Circle to Dudley Station. The average inbound speed for the entire route in the PM peak period was 5.87 mph.

In the PM peak period in the outbound direction, all route segments have average speeds below 10 mph, with the slowest occurring in the first half of Route 66 before Coolidge Corner,

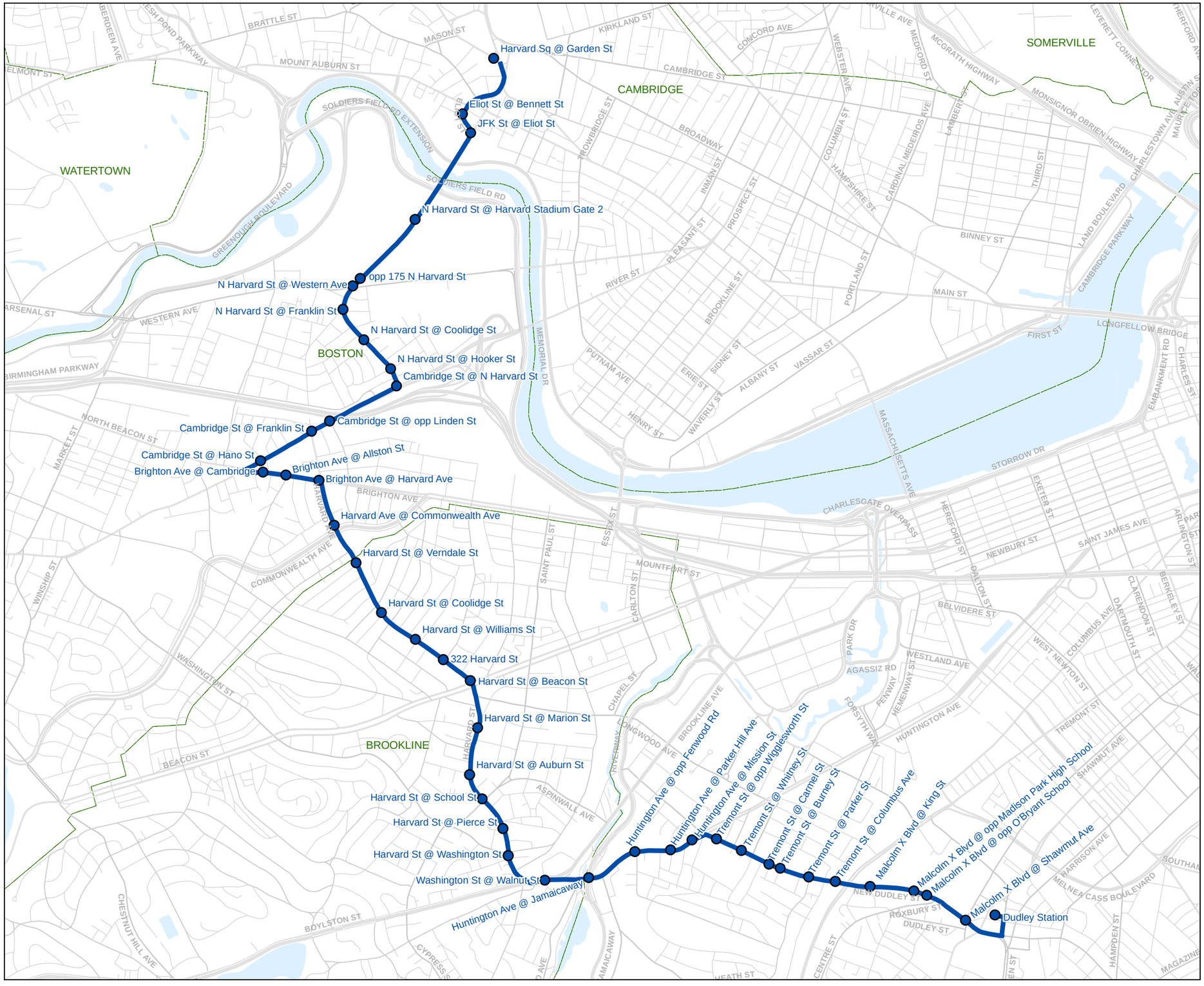

FIGURE 1
MBTA Bus Route 66
Route and Stop Locations: Inbound

Strategic Visioning for MBTA Bus Service: Route 66

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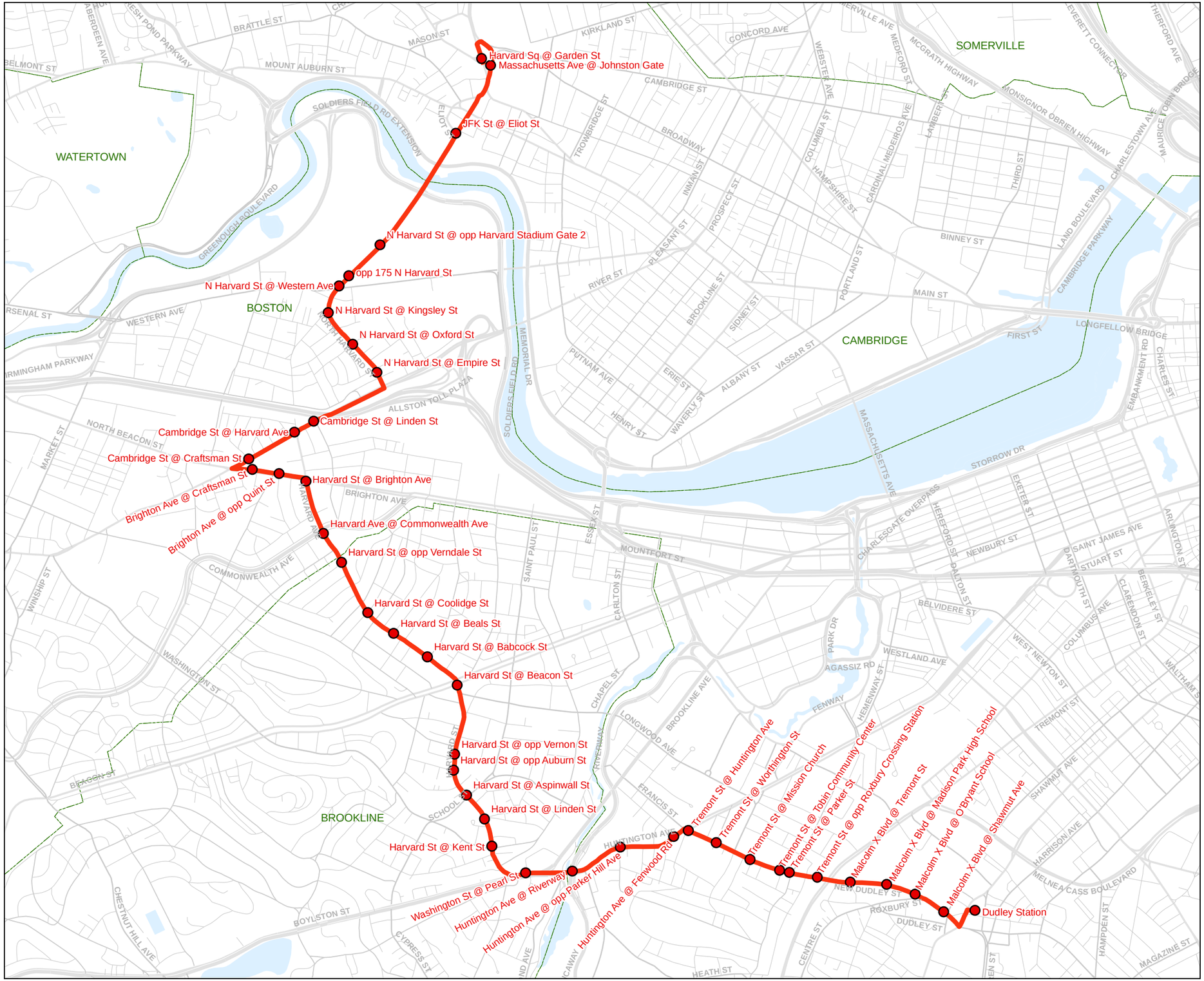

FIGURE 2
MBTA Bus Route 66
Route and Stop Locations: Outbound

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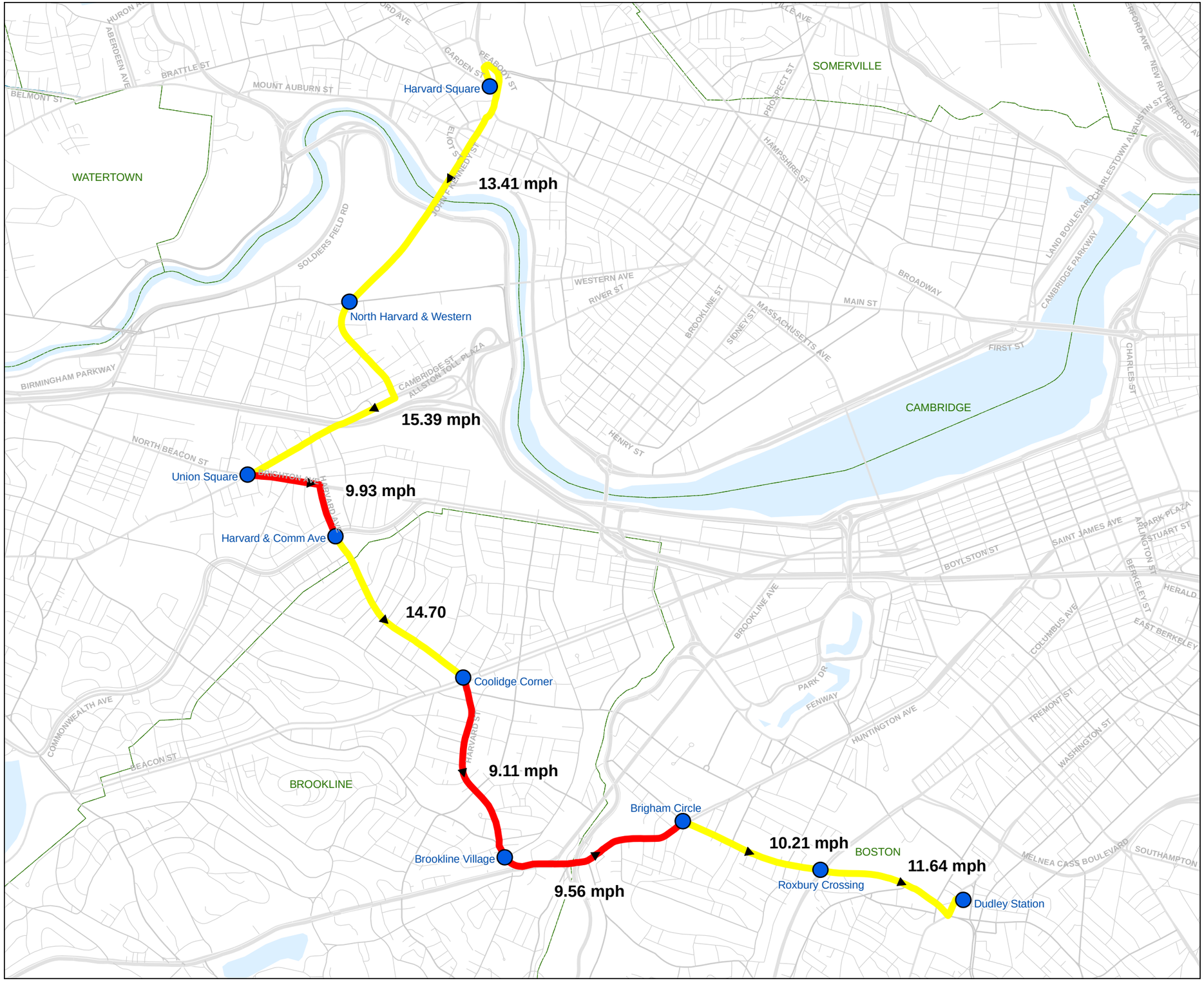

FIGURE 3
MBTA Bus Route 66
Average Travel Speeds:
AM Peak Period (6:00 - 10:00 AM)
Inbound

LEGEND

- Timepoint
- 0 – 10 mph
- 11 – 20 mph
- > 20 mph

Travel speed data estimated from the delay data provided by the MBTA AVL System for May 2009.

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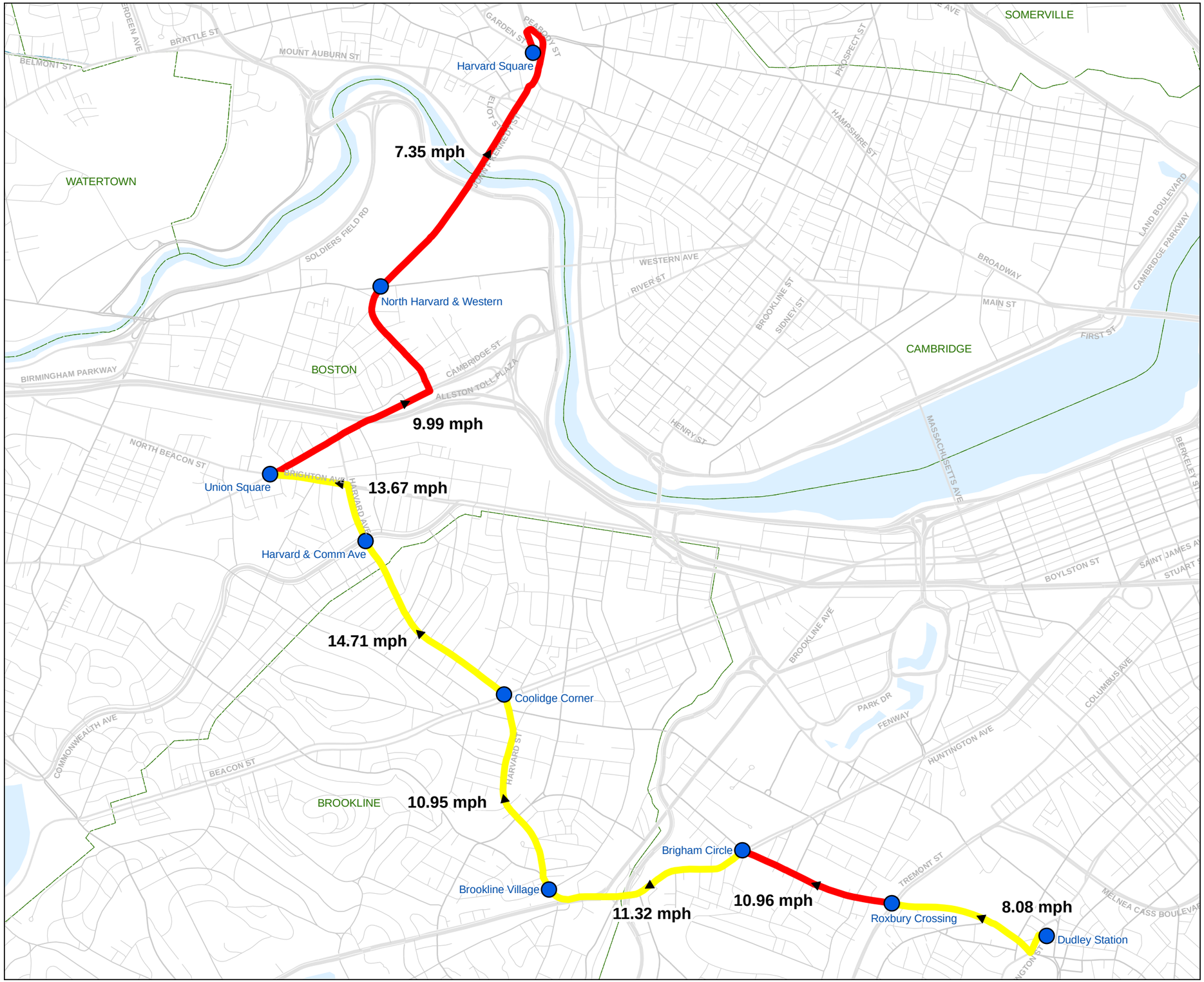

FIGURE 4
MBTA Bus Route 66
Average Travel Speeds:
AM Peak Period (6:00 - 10:00 AM)
Outbound

LEGEND

- Timepoint
- 0 – 10 mph
- 11 – 20 mph
- > 20 mph

Travel speed data estimated from the delay data provided by the MBTA AVL System for May 2009.

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FIGURE 5
MBTA Bus Route 66
Average Travel Speeds:
PM Peak Period (3:00 - 6:00 PM)
Inbound

LEGEND

- Timepoint
- 0 – 10 mph
- 11 – 20 mph
- > 20 mph

Travel speed data estimated from the delay data provided by the MBTA AVL System for May 2009.

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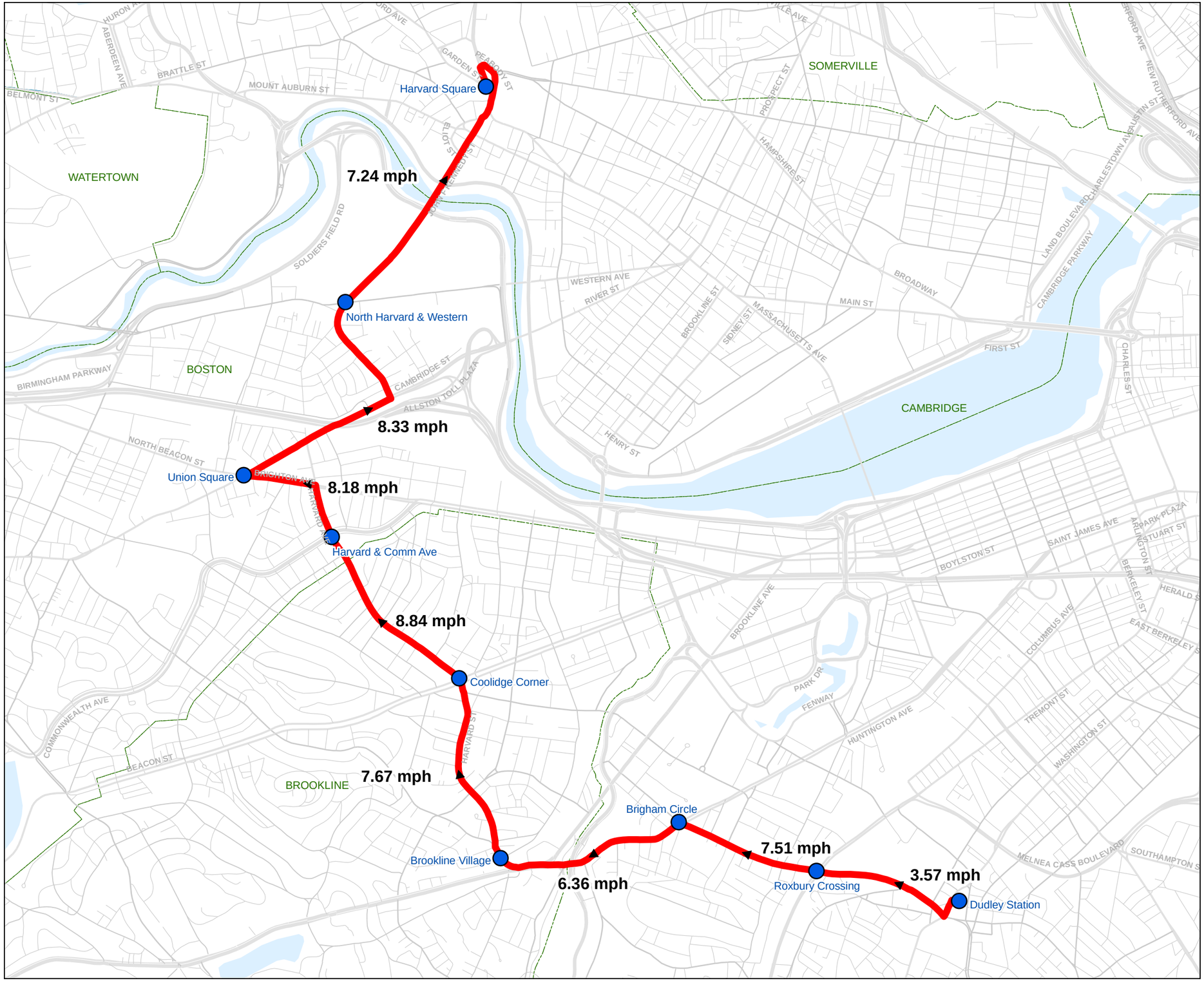

FIGURE 6
MBTA Bus Route 66
Average Travel Speeds:
PM Peak Period (3:00 - 6:00 PM)
Outbound

LEGEND

- Timepoint
- 0 – 10 mph
- 11 – 20 mph
- > 20 mph

Travel speed data estimated from the delay data provided by the MBTA AVL System for May 2009.

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particularly between Dudley and Roxbury Crossing Stations. The average outbound speed for the entire route in the PM peak period was 6.85 mph.

In summary, Route 66 experienced significantly slower travel speeds in the PM peak period compared to the AM peak period. It experienced slightly slower travel speeds in the outbound direction compared to the inbound direction in the AM peak period, with the reverse being true in the PM peak period. Segments in and around the Union Square commercial district consistently had some of the slowest travel speeds of any route segment in both directions and peak periods. Each route segment between Roxbury Crossing Station and Coolidge Corner also had relatively slow speeds.

Bus Boardings and Alightings

Daily bus boardings and alightings by stop and direction can be found in Appendix C in Tables C-1, Inbound Stops and Load Profiles, and C-2, Outbound Stops and Load Profiles. It should be noted that the information is provided by bus stop and not signalized intersection as in the tables found in Appendix B. An important finding is that for the inbound bus route approximately 50% of the daily boardings and 82% of the daily alightings occur on sections of the route where the buses' average speed is below 10 mph during the AM and PM peak periods. The entire outbound bus route during the PM peak has an average speed below 10 mph.

INTERSECTION SCREENING

Bus Route 66 has 39 signalized intersections along its inbound route and 38 along its outbound route. In the Key Bus Routes Initiative memorandum, all the intersections along the bus route were preliminarily evaluated to see if TSP or other strategies could possibly improve bus service. The resulting preliminary recommendations for the signalized intersections with bus stops were as follows:

Inbound Bus Route

- DeWolfe Street at Mt. Auburn Street (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Hancock Street (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Essex Street (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Pedestrian Signal North of Pearl Street (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Brookline Street (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Sidney Street (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Landsdowne Street (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Albany Street (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Vassar Street (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Pedestrian Signal at MIT (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Beacon Street (Boston) - Queue jump
- Massachusetts Avenue at Marlborough Street (Boston) - Red truncation/green extension

- Massachusetts Avenue at Newbury Street (Boston) - Red truncation/green extension
- Massachusetts Avenue at Belvidere Street (Boston) - Red truncation/green extension
- Massachusetts Avenue at Pedestrian Signal North of Westland Avenue (Boston) - Red truncation/green extension
- Massachusetts Avenue at Westland Avenue (Boston) - Queue jump
- Massachusetts Avenue at St. Botolph Street (Boston) - Queue jump
- Massachusetts Avenue at Tremont Street (Boston) - Queue jump
- Massachusetts Avenue at Shawmut Avenue (Boston) - Queue jump
- Massachusetts Avenue at Harrison Avenue (Boston) - Red truncation/green extension
- Massachusetts Avenue at Albany Street (Boston) - Red truncation/green extension
- Albany Street at Northampton Street (Boston) - Red truncation/green extension
- Albany Street at Melnea Cass Boulevard (Boston) - Red truncation/green extension
- Melnea Cass Boulevard at Harrison Avenue (Boston) - Bus-only signal

Outbound Bus Route

- Melnea Cass Boulevard at Harrison Avenue (Boston) - Red truncation/green extension
- Melnea Cass Boulevard at Albany Street (Boston) - Red truncation/green extension
- Albany Street at Northampton Street (Boston) - Red truncation/green extension
- Albany Street at Massachusetts Avenue (Boston) - Red truncation/green extension
- Massachusetts Avenue at Harrison Avenue (Boston) - Queue jump
- Massachusetts Avenue at Shawmut Avenue (Boston) - Queue jump
- Massachusetts Avenue at Tremont Street (Boston) - Queue jump
- Massachusetts Avenue at St. Botolph Street (Boston) - Red truncation/green extension
- Massachusetts Avenue at Westland Avenue (Boston) - Red truncation/green extension
- Massachusetts Avenue at Pedestrian Signal North of Westland Avenue (Boston) - Red truncation/green extension
- Massachusetts Avenue at Belvidere Street (Boston) - Red truncation/green extension
- Massachusetts Avenue at Marlborough Avenue (Boston) - Red truncation/green extension
- Massachusetts Avenue at Beacon Street (Boston) - Queue jump
- Massachusetts Avenue at Memorial Drive (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Pedestrian Signal at MIT (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Vassar Street (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Albany Street (Cambridge) – Queue jump
- Massachusetts Avenue at Landsdowne Street (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Sidney Street (Cambridge) - Queue bypass
- Massachusetts Avenue at Douglass Street (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Essex Street (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Prospect Street (Cambridge) – Queue jump
- Massachusetts Avenue at Pleasant Street (Cambridge) - Red truncation/green extension
- Massachusetts Avenue at Hancock Street (Cambridge) - Queue jump
- Massachusetts Avenue at Trowbridge Street (Cambridge) - Queue bypass

These intersection locations and preliminary recommendations from the 2009 Key Bus Routes Initiative memorandum were the basis for beginning the present study's evaluation of bus Route 66. The intersections found in Appendix D were further screened to eliminate locations that were not of interest to officials from Cambridge, Brookline, or Boston and locations that did not seem to warrant TSP applications. In the qualitative-analysis aspect of this screening, which was conducted by the MBTA, the MBTA's consultants, the Boston Transportation Department, Cambridge's Parking and Transportation Department, Town of Brookline personnel, and MPO staff, the intersections were reviewed one by one, for both the inbound and outbound directions, to determine if a location warranted further study for TSP. The following factors were considered to identify the intersection locations that should be analyzed:

- Overall intersection congestion
- Type of signal system available
- Side street volume and congestion
- Location of intersection along bus route
- Locations of bus stops
- Adjacent parking and land use
- Roadway speeds

The fourteen intersections listed below were selected for TSP analysis. Many of the intersections selected are located within roadway segments where the average speeds of the buses are below 10 mph, as shown in Figures 3 through 6.

- J.F.K. Street at Mount Auburn Street (Cambridge)
- Harvard Street at Verndale Street (Brookline)
- Harvard Street at Fuller Street (Brookline)
- Harvard Street at Stedman Street/Williams Street (Brookline)
- Harvard Street at Stop & Shop entrance/exit (Brookline)
- Harvard Street at Aspinwall Avenue (Brookline)
- Washington Street at Harvard Street (Brookline)
- Washington Street at Boylston Street/High Street (Brookline)
- Cambridge Street at Harvard Street (Allston/Brighton)
- Cambridge Street at North Beacon Street/Brighton Avenue (Allston/Brighton)
- Harvard Street at Commonwealth Avenue (Allston/Brighton)
- Huntington Avenue at Tremont Street/Francis Street (Mission Hill)
- Tremont Street at St. Alphonsus Street (Mission Hill)
- Tremont Street at Terrace Street/Parker Street (Mission Hill)

EXISTING CONDITIONS AND THREE ALTERNATIVES: ANALYSIS OF TRAFFIC OPERATIONS AND OTHER TRAVEL CHARACTERISTICS

Traffic operations at the selected intersections were analyzed using Synchro 7[2] and data provided by the Boston Transportation Department and Cambridge's Parking and Transportation Department and data collected by MPO staff in the field. Analysis was conducted for the existing intersection conditions and for three alternatives, as described below. Tabulations of the analysis results can be found in Appendix D in Tables D-1 and D-2 for the AM and PM peak hours, respectively. Tables D-1 and D-2 also show analysis results for other intersections along the route; these intersections were analyzed as part of determining what the overall effect on Route 66 buses' travel time would be of the proposed signal timing or phasing improvements.

The following scenarios were examined:

- **Existing Conditions** – Existing signal timings and phasing were used to evaluate the current operations of the intersection and provide a base which other alternatives would be compared with.
- **Alternative 1 (Optimized Intersection Timings)** – Signal timings and phasings were optimized and checked to evaluate if new signal timings would decrease intersection delays to improve bus service. Some intersection timings are already optimal or are very close to optimal. In these cases, no recommendations are made.
- **Alternative 2 (Added Green Time on Bus Approaches)** – Signal timings were adjusted to favor the Route 66 bus approaches and decrease bus delays. This alternative usually has various levels of impact on the operations of the non-bus approaches, depending on the amount of additional green time allocated to the bus approach signal phase; typically, two to three seconds were added to the bus approach phases. This additional time was taken away from the side street phases and other underutilized phases. When the bus approaches at an intersection were already heavily favored or when adding time to the bus approach yielded little benefit to the bus approach and significantly affected the side street approaches, "Not recommended" appears in Tables E-1 and E-2.
- **Alternative 3 (Transit Signal Priority and Queue Jumps)** – Early green and green extensions were simulated to evaluate the benefits for the Route 66 bus. Queue jumps were also analyzed as part of this alternative. Where applicable, signal timings were optimized as a part of the queue jump or TSP evaluation.

The Synchro analysis and observations of the intersections were used to assess these scenarios in terms of intersection level of service, bus service, and other characteristics. The results in those three respects are presented in the following three sections.

[2] SYNCHRO 7 – Trafficware traffic analysis software, version 7.

INTERSECTION LEVEL OF SERVICE

Existing Conditions

The results of the existing conditions analysis indicate that there are five intersections that are operating at level of service (LOS) F and one intersection operating at LOS E during the AM peak hour. The PM peak hour has six intersections operating at LOS F and three at LOS E.

Alternative 1: Optimized Intersection Timings

In the analysis of Alternative 1, it was found that at the majority of the intersections the LOS did not change significantly for individual approaches or the overall intersection, indicating that the existing timings and phasings are optimal or very nearly optimal. However, in the AM peak hour, the Brighton Avenue at Harvard Street intersection improved from an overall LOS E to LOS D. In the PM peak hour, the Dudley Street at Washington Street intersection improved overall from LOS E to LOS D, and the intersections of Tremont Street at Parker Street and Washington Street at Boylston Street improved from LOS F to LOS E, overall.

Alternative 2: Added Green Time on Bus Approaches

Of the three alternatives, this one, lengthening the green time for the bus approaches to the intersection, brought about the largest reductions in intersection delay for the buses. However, this alternative frequently added delays to the side street (non-bus approach lanes) because the added green time for the bus approaches was taken from these phases.

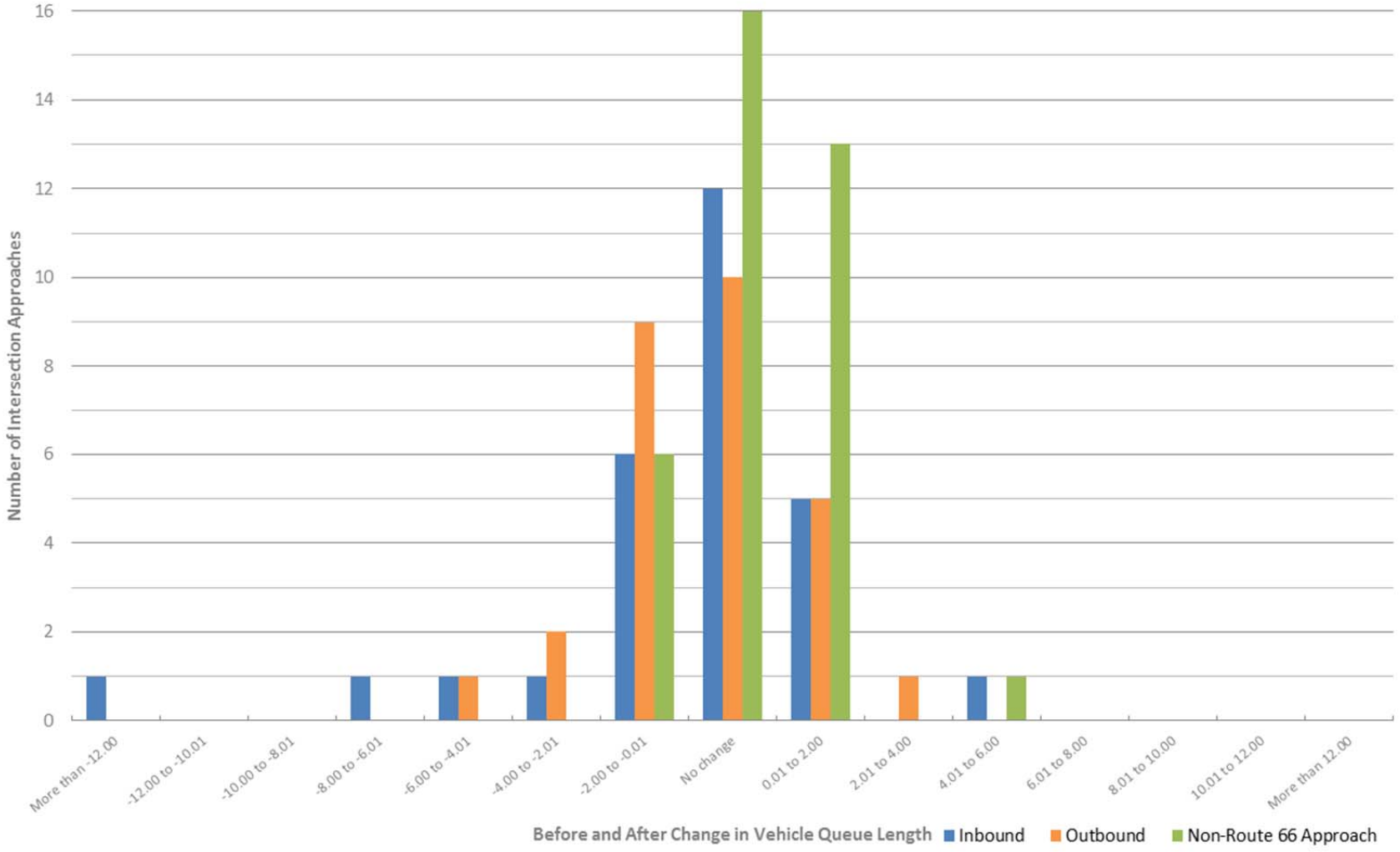
Alternative 3: Transit Signal Priority and Queue Jumps

The intersections that were analyzed simulating TSP improvements also had decreased delay for the buses. However, as in Alternative 2, there were frequently negative impacts on the side street traffic. There were also minor improvements to queuing at the intersections. Figure 7 presents the various amounts of change in vehicle queue length that occurred and the number of approaches that experienced each amount.

For 40% of the bus approaches, queue length remained unchanged with TSP; for 27% it decreased by two or fewer vehicles; and for 18% it increased by two or fewer vehicles. Of the non-bus approaches, 44% had no queue change due to TSP, 17% had a two-vehicle or less reduction due to TSP, and 36% had a two-vehicle or less increase due to TSP.

FIGURE 7 Route 66 Transit Signal Priority AM and PM Peak Hour

Change in Vehicle Queue Length by Number of Intersection Approaches due to Priority Treatments



BUS SERVICE: IMPACTS OF THE POTENTIAL IMPROVEMENTS

The impacts on bus service that would result from implementation of all of the potential improvements in the three alternatives combined were estimated.

Bus Delays

Under existing conditions, both inbound and outbound, bus delays are higher during the PM peak hour compared to the AM peak hour. In the outbound direction, the delay per bus was approximately 30% higher in the afternoon; in the inbound direction, the delay per bus was approximately 40% higher in the afternoon.

Implementing transit signal priority or modifying signal timings for intersections along Route 66 can decrease bus delay. Information about the number of peak-hour Route 66 buses can be found in Table 1; Table 2 gives the passenger delays and bus delays under existing conditions and with implementation of all of the possible improvements from the three alternatives.

With the improvements, in the outbound direction, total bus delay decreases by approximately 7% both in the morning and afternoon; in the inbound direction, total bus delay decreases by 14% in the morning and 9% in the afternoon.

Bus Travel Times

Directional, peak-hour travel times for Route 66 vary from 40 to 70 minutes depending on the time of day. Travel time savings will likely be small for buses operating in the off-peak; these buses likely make it through most of the intersections without being delayed at a signal or caught in queues. Travel times for the longer trips, during the peak hours, when buses are currently delayed by queues or stuck at a light because passengers needed to board and alight, will decrease. Actual travel time savings depend on how many times a bus receives priority when it would otherwise have to wait. The average travel time for a bus will decrease by about one to two minutes per trip. The inbound direction will benefit more than the outbound direction.

Passenger Delay

Passenger-minutes of delay for a single intersection were calculated by multiplying the number of passengers on a bus as it passed through an intersection by the amount of delay the bus incurred at the intersection. To find the total passenger delay in a given direction during a given time period, the passenger delays at all the intersections were summed.

Applying signal priority, modified signal timings, and modified signal phasing decreases total peak-hour passenger delay by about 8% in the outbound direction and about 20% in the inbound direction (23% in the morning and 17% in the evening). In the outbound direction, the treatments decrease delay by just over 40 passenger-minutes per bus. In the inbound direction, delay is reduced by approximately 90 passenger-minutes per bus.

TABLE 1
Number of Peak-Hour Buses and Passengers

Period/Direction	Buses	Passengers
AM Inbound	8	665
AM Outbound	8	905
PM Inbound	7	698
PM Outbound	7	718

TABLE 2
Peak-Hour Bus and Passenger Delays (in Minutes)

Period and Direction	Total: Existing	Total with Recommended Improvements[1]	Per Bus[2]: Existing	Per Bus with Recommended Improvements	Per Bus: Absolute Change with Improvements	Percentage Change with Improvements
AM Inbound						
Total Passenger-Minutes of Peak Hour Delay	3,136	2,407	392	301	-91.1	-23.2%
Total Bus-Minutes of Peak Hour Delay	97	84	12	10	-1.7	-14.0%
AM Outbound						
Total Passenger-Minutes of Peak Hour Delay	4,582	4,252	573	531	-41.3	-7.2%
Total Bus-Minutes of Peak Hour Delay	121	112	15	14	-1.1	-7.1%
PM Inbound						
Total Passenger-Minutes of Peak Hour Delay	3,661	3,048	523	435	-87.6	-16.7%
Total Bus-Minutes of Peak Hour Delay	117	107	17	15	-1.4	-8.5%
PM Outbound						
Total Passenger-Minutes of Peak Hour Delay	4,063	3,738	580	534	-46.5	-8.0%
Total Bus-Minutes of Peak Hour Delay	140	130	20	19	-1.5	-7.4%

1. Recommended improvements to intersection include intersection signal timing modifications, TSP, and queue-jumps.
2. Existing delays divided by the number of buses per hour
3. Delays with the recommended improvements divided by the number of buses per hour

Bus Stops

Where transit signal priority or a shared right-turn/queue-jump lane is recommended, the bus stop must be moved to the far side of the intersection. Given the recommended modifications, five inbound bus stops would need to change from near-side to far-side bus stops. In one case, a bus stop should be eliminated because moving it to the far side of the intersection would put it far too close to a another, major stop. In the outbound direction, two stops would need to be moved from the near side of the intersection to the far side.

OTHER IMPACTS OF THE POTENTIAL IMPROVEMENTS

Other impacts that would result from implementation of all of the potential improvements in the three alternatives combined were estimated.

General-Traffic Travel Times

On average, traffic traveling along Route 66's route (in other words, using the same approach as the bus at each intersection) is delayed less at intersections. When a bus receives traffic signal priority, other vehicles traveling along that road also receive extra green time. The analyzed queue jump lanes move buses from the main approach lanes and put them in the right-turn lane; this decreases delay for the main approach. The delays for vehicles traveling on the same approach as Route 66 buses are shown in Table 3 for existing conditions and with the recommended improvements. Total vehicle delay for general traffic traveling along the route is expected to decrease by about 9% in the outbound direction and 12% in the inbound direction.

TABLE 3
Total Peak-Hour Vehicle Delay for General Traffic on Route 66
(Total Vehicle-Minutes at All Intersection Approaches Used)

Period and Direction	Existing Conditions	With Recommended Improvements[1]	Absolute Change	Percentage Change
AM Inbound				
Total Vehicle-Minutes of Peak Hour Delay	6,610	5,708	-902.4	-13.7%
AM Outbound				
Total Vehicle-Minutes of Peak Hour Delay	6,632	6,071	-561.5	-8.5%
PM Inbound				
Total Vehicle-Minutes of Peak Hour Delay	11,260	10,012	-1,247.7	-11.1%
PM Outbound				
Total Vehicle-Minutes of Peak Hour Delay	10,937	9,839	-1,097.3	-10.0%

1. Recommended improvements to intersections include intersection signal timing modifications, TSP, and queue jumps.

Parking

The number of parking spaces would not change significantly. When a bus stop moves from the near side of an intersection to the far side, the overall number of parking spaces should stay the same. Given that far-side bus stops tend to occupy less space than near-side bus stops (about 60 feet for a far-side stop compared to about 80 feet for a near-side stop), a few extra parking spaces might be gained through moving bus stops. However, if the original bus stops were too short and the stops that replace them were longer, parking would be reduced.

At the intersection of Tremont Street and St. Alphonsus Street, a shared right-turn/queue-jump lane is recommended. At this location, approximately four to five parking spaces would be lost to create a turn bay; fewer spaces could be taken, but this would limit the efficacy of the queue jump. The near-side bus stop a few hundred feet before the intersection would be relocated to the

far side of the intersection. If the recommended shared right-turn/queue-jump lane were implemented at Cambridge Street at Harvard Avenue westbound, approximately three to four parking spaces would be lost due to moving the bus stop to the far side of the intersection. Currently, the westbound bus stop at this intersection is located in the right-turn lane.

Pedestrian

Pedestrians are mostly unaffected by the changes proposed in this memorandum. Dedicated pedestrian phases are not modified. Most pedestrian phases are actuated dedicated pedestrian phases. Under existing conditions, at locations where pedestrian phases run concurrently, which is the case at a few intersections, more time is given to people crossing the cross street than would be given with a dedicated pedestrian phase.

There is still adequate time for crossing in the improved scenarios. Under TSP, concurrent pedestrian movements are set to end normally when an extended phase is called for; that is, the pedestrian phase ends when it usually would end, and pedestrians are shown a solid "don't walk" signal during the extended phase. In these cases, pedestrians wishing to cross the primary street would have to wait a few seconds longer than usual to receive a walk signal.

RECOMMENDATIONS AND FINDINGS

Table 4 lists the improvements that are recommended. These are the improvements which this study's analysis showed to provide the greatest benefit for bus route operations.

TABLE 4
Recommended Improvements

Intersection	Municipality	Recommended Improvement
J.F.K. Street at Eliot Street	Cambridge	• Retime signal (AM/PM peak hours)
North Harvard Street at Western Avenue	Boston	• Retime signal (AM/PM peak hours)
Brighton Avenue at Cambridge Street	Boston	• Retime signal (PM peak hour)
Harvard Street at Verndale Street	Brookline	• Retime signal (AM/PM peak hours), *or* • TSP (IB/OB)
Harvard Street at Fuller Street	Brookline	• TSP (IB/OB)
Harvard Street at School Street	Brookline	• Retime signal (AM/PM peak hours), *or* • TSP (IB/OB)
Washington Street at Boylston Street	Brookline	• TSP (IB/OB)
Tremont Street at St. Alphonsus	Boston	• Add a shared right-turn/queue-jump lane (IB)
Tremont Street at Parker Street	Boston	• TSP (IB/OB, in conjunction with Tremont Street at Terrace Street)
Tremont Street at Terrace Street	Boston	• TSP (IB/OB, in conjunction with Tremont Street at Parker Street)

Two intersections are strong candidates for immediate implementation of recommended improvements: *Washington Street at Boylston Street* in Brookline and *Tremont Street at St. Alphonsus Street* in Boston.

Adding green extensions at *Washington Street at Boylston Street* (without a queue jump lane) helps inbound and outbound Route 66 buses. Inbound delays during the afternoon peak hour are expected to decrease significantly. During the morning peak hour, however, more vehicles use competing intersection approaches, and these extra vehicles limit the overall effectiveness of signal priority in the morning. The inbound bus stop is currently a far-side stop and should remain in its current location. The outbound bus stop is a near-side bus stop. Depending on plans for the surrounding area, this stop may need to be moved or eliminated.

Adding an inbound shared right-turn/queue-jump lane at the intersection of *Tremont Street at St. Alphonsus* is a low-cost way to decrease delay along the route. Several parking spaces would need to be eliminated to make room for the lane. The bus stop would also need to be moved to the far side of the intersection. This improvement decreases delay for the mainline by removing right-turning vehicles and buses from the southbound approach. Eastbound vehicles should see shorter queues at this intersection, while other approaches should not see any increase in queue lengths or delays.

The following TSP and signal timing improvements could also improve bus travel times through intersections:

Cambridge

- *J.F.K. Street at Eliot Street:* retime signal, AM and PM peak hours

Boston

- *North Harvard Street at Western Avenue:* retime signal, AM and PM peak hours
- *Brighton Avenue at Cambridge Street:* retime signal, PM peak hour
- *Tremont Street at Parker Street:* TSP
- *Tremont Street at Terrace Street:* TSP

Brookline

- *Harvard Street at Verndale Street:* retime signal, AM and PM peak hours; or TSP
- *Harvard Street at Fuller Street:* TSP
- *Harvard Street at School Street:* retime signal, AM and PM peak hours; or TSP

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APPENDIX A

Examples of TSP Benefits

TABLE A-1 Reported Initial Estimates of Benefits to Buses from Traffic Signal Priority

Location	% Running Time Saved	% Increase in Speeds	% Reduced Intersection Delay
Anne Arundel County, MD	13–18	-	-
Bremerton, WA	10	-	-
Chicago: Cermak Road	15–18	-	-
Hamburg, Germany	-	25–40	-
Los Angeles: Wilshire-Whittier Metro Rapid	8–10	-	-
Pierce County, WA	6	-	-
Portland, OR	5–12	-	-
Seattle: Rainier Avenue	8	-	13
Toronto	2–4	-	-

Sources: Research and Innovative Technology Administration (RITA), Intelligent Transportation Systems website, which cites: TCRP Report 100 (2003); TCRP Report 90 (2003); TRR 1841 (2003)[3]

[3] TCRP Report 100, Transit Capacity and Quality of Service Manual 2nd Edition, Washington, DC, 2003. TCRP Report 90, Bus Rapid Transit Volume 1: Case Studies in Bus Rapid Transit, Washington, DC, 2003. Transportion Research Record 1841, "Evaluation of Service Reliability Impacts of Traffic Signal Priority Strategies for Bus Transit," Transportation Research Board of the National Academies, Washington, DC, 2003, pp. 23–31.

TABLE A-2 ITS America's Summary of TSP Benefits and Impacts

Location	Transit	# of Intersections	TSP Type	Strategy Benefit/Impact
Portland, OR: Tualatin Valley Hwy	Bus	10	Early green, green extension	Bus travel time savings = 1.4%–6.4%. Average bus signal delay reduction = 20%.
Portland, OR: Powell Blvd	Bus	4	Early green, green extension, queue jump	5%–8% bus travel time reduction. Bus person delay generally decreased. Inconclusive impacts of TSP on traffic.
Seattle: Rainier Ave at Genesee	Bus	1	Early green, green extension	For prioritized buses: • 50% reduction of signal-related stops. • 57% reduction in average signal delay. 13.5% decrease in intersection average person delay. Average intersection delay did not change for traffic. 35% reduction in bus travel time variability. Side street effects insignificant.
Seattle: Rainier Ave (Midday)	Bus	3	Early green, green extension	For TSP-eligible buses: • 24% average reduction in stops for eligible buses. • 34% reduction in average intersection delay. 8% reduction in travel times. Side street drivers do not miss green signal when TSP is granted to bus.
Europe	Bus	5 study sites		10 seconds/intersection average signal delay reduction. 40%–80% potential reduction in transit signal delay. Transit travel times in England and France reduced 2%–6%.
Sapporo City, Japan: Rt 36	Bus	Unknown		6.1% reduction in bus travel time. 9.9% increase in ridership.
Toronto	Streetcar	36	Early green, green extension	15%–49% reduction in transit signal delay. One streetcar removed from service.
Chicago: Cermak Rd	Bus	15	Early green, green extension	7%–20% reduction in transit travel time. Transit schedule reliability improved. Reduced number of buses needed to operate the service. Passenger satisfaction level increased. 1.5 seconds/vehicle average decrease in vehicle delay. 8.2 seconds/vehicle average increase in cross-street delay.
San Francisco	LRT & Trolley	16	Early green, green extension	6%–25% reduction in transit signal delay.
Minneapolis: Louisiana Ave	Bus	3	Early green, green extension, actuated transit phase	0%–38% reduction in bus travel times depending on TSP strategy. 23% (4.4 seconds/vehicle) increase in traffic delay. Skipping signal phases caused some driver frustration.
Los Angeles: Wilshire and Ventura Blvd	Bus	211	Early green, green extension, actuated transit phase	7.5% reduction in average running time. 35% decrease in bus delay at signalized intersections.

Source: Transit Cooperative Research Program (TCRP) Report 118, *Bus Rapid Transit Practitioner's Guide,* 2007.

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APPENDIX B

Bus Route Intersections, Bus Movement, and Stop Locations

TABLE B-1 Locations of Traffic Signals and Bus Stops: Inbound

Signalized Intersection	Bus Movement	Stop Location
Cambridge		
Massachusetts Avenue at Garden Street	Through	Near-side
Massachusetts Avenue at Brattle Street/J.F.K. Street	Right	
Eliot Street at Bennett Street	Through	Near-side
Eliot Street at J.F.K. Street	Right	Far-side
J.F.K. Street at Memorial Drive	Through	
North Harvard Street at Soldiers Field Road	Through	
Allston/Brighton		
North Harvard Street at Western Avenue	Through	Near-side
North Harvard Street at Coolidge Road (Ped. Crossing Signal)	Through	Far-side
North Harvard Street at Cambridge Street	Right	Far-side
Cambridge Street at Lincoln Street	Through	
Cambridge Street at Harvard Avenue	Through	Near-side
Cambridge Street at Brighton Avenue/N. Beacon Street	Left	Near-side
Brighton Avenue at Allston Street	Through	
Brighton Avenue at Harvard Avenue	Right	Near-side
Harvard Avenue at Commonwealth Avenue	Through	Near-side
Brookline		
Harvard Street at Verndale Street	Through	Near-side
Harvard Street at Fuller Street	Through	
Harvard Street at Stedman Street/Williams Street	Through	Near-side
Harvard Street at Babcock Street	Through	Near-side
Harvard Street at Beacon Street (Coolidge Corner)	Through	Near-side
Harvard Street at Stop & Shop Driveway	Through	
Harvard Street at School Street/Aspinwall Street	Through	Near-side
Harvard Street at Washington Street/Kent Street	Through	Near-side
Washington Street at Boylston Street/High Street	Left	
Washington Street (Route 9) at Brookline Avenue	Through	
Mission Hill		
Huntington Avenue (Route 9) at South Huntington Avenue	Through	
Huntington Avenue at Parker Hill Avenue	Through	Near-side
Huntington Avenue at Fenwood Road (Ped. Crossing Signal)	Through	Near-side
Huntington Avenue at Tremont Street/Francis Street	Right	
Tremont Street at St. Alphonsus Street	Through	
Tremont Street at Carmel Street (Ped. Crossing Signal)	Through	Near-side
Tremont Street at Parker Street	Through	Near-side
Tremont Street at Terrace Street	Through	
Roxbury		
Tremont Street/New Dudley Street at Columbus Avenue	Through	Near-side
New Dudley Street at Roxbury Street (Ped. Crossing Signal)	Through	
New Dudley Street at Shawmut Avenue	Through	Near-side
Dudley Street at Washington Street	Through	
Dudley Street at Warren Street	Left	

TABLE B-2 Locations of Traffic Signals and Bus Stops: Outbound

Signalized Intersection	Bus Movement	Stop Location
Roxbury		
Washington Street at Dudley Street	Right	
New Dudley Street at Shawmut Avenue	Through	Far-side
New Dudley Street at Roxbury Street (Ped. Crossing Signal)	Through	
New Dudley Street/Tremont Street at Columbus Avenue	Through	Far-side
Mission Hill		
Tremont Street at Terrace Street	Through	
Tremont Street at Parker Street	Through	Near-side
Tremont Street at Carmel Street (Ped. Crossing Signal)	Through	Far-side
Tremont Street at St. Alphonsus Street	Through	
Tremont Street at Huntington Avenue	Left	Near-side
Huntington Avenue at Fenwood Road (Ped. Crossing Signal)	Through	Far-side
Huntington Avenue at Parker Hill Avenue	Through	Near-side
Huntington Avenue at South Huntington Avenue	Through	
Brookline		
Washington Street (Route 9) at Brookline Avenue	Through	
Washington Street (Route 9) at Boylston Street/High Street	Right	Near-side
Washington Street at Harvard Street/Kent Street	Right	Far-side
Harvard Street at Aspinwall Street/School Street	Through	Far-side
Harvard Street at Stop & Shop Driveway	Through	Far-side
Harvard Street at Beacon Street (Coolidge Corner)	Through	Near-side
Harvard Street at Babcock Street	Through	Far-side
Harvard Street at Stedman Street/Williams Street	Through	
Harvard Street at Fuller Street	Through	
Harvard Street at Verndale Street	Through	Near-side
Allston/Brighton		
Harvard Avenue at Commonwealth Avenue	Through	Near-side
Harvard Avenue at Brighton Avenue	Left	Near-side
Brighton Avenue at Allston Street	Through	Near-side
Brighton Avenue at Cambridge Street/North Beacon Street	Right	
Cambridge Street at Harvard Avenue	Through	
Cambridge Street at Lincoln Street	Through	
Cambridge Street at North Harvard Street	Left	
North Harvard Street at Coolidge Road (Ped. Crossing Signal)	Through	
North Harvard Street at Western Avenue	Through	Far-side
North Harvard Street at Soldiers Field Road	Through	
Cambridge		
J.F.K. Street at Memorial Drive	Through	
J.F.K. Street at Eliot Street	Through	Far-side
J.F.K. Street at Mount Auburn Street	Through	
J.F.K. Street at Massachusetts Avenue/Brattle Street	Through	
Massachusetts Avenue at Garden Street	Through	Near-side

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APPENDIX C

Bus Boardings and Alightings

TABLE C-1 Inbound Stops and Load Profiles

Stop Name	Ons	Offs
Cambridge		
BOL Dummy	5	0
Harvard Square at Garden Street	840	0
Eliot Street at Bennett Street	666	0
J.F.K Street at Eliot Street	258	0
Allston/Brighton		
North Harvard Street at Gate 2 Harvard Stadium	39	23
Opposite 175 North Harvard Street	29	28
North Harvard Street at Western Avenue	182	93
North Harvard Street at Franklin Street	114	88
North Harvard Street at Coolidge Street	53	78
North Harvard Street at Hooker Street	67	70
Cambridge Street at North Harvard Street	91	35
Cambridge Street opposite Linden Street	16	32
Cambridge Street at Franklin Street	32	84
Cambridge Street at Hano Street	55	190
Brighton Avenue at Cambridge Street	340	101
Brighton Avenue at Allston Street	107	115
Brighton Avenue at Harvard Avenue	274	145
Harvard Avenue at Commonwealth Avenue	504	418
Brookline		
Harvard Street at Verndale Street	120	41
Harvard Street at Coolidge Street	22	23
Harvard Street at Williams Street	46	43
322 Harvard Street	36	111
Harvard Street at Beacon Street	312	349
Harvard Street at Marion Street	48	49
Harvard Street at Auburn Street	59	61
Harvard Street at School Street	30	102
Harvard Street at Pierce Street	34	58
Harvard Street at Washington Street	75	160
Washington Street at Walnut Street	106	108
Mission Hill		
Huntington Avenue at Jamaicaway	64	321
Huntington Avenue at Parker Hill Avenue	137	147
Huntington Avenue at Mission Street	30	40
Huntington Avenue opposite Fenwood Road	28	107
Huntington Avenue opposite Wigglesworth Street	326	80
Tremont Street at Whitney Street	39	32
Tremont Street at Carmel Street	7	14
Tremont Street at Burney Street	8	9
Tremont Street at Parker Street	14	54
Roxbury		
Tremont Street at Columbus Avenue	53	377
Malcolm X Boulevard at King Street	29	145
Malcolm X Boulevard opposite Madison Park High School	3	76
Malcolm X Boulevard opposite O'Bryant High School	5	76
Malcolm X Boulevard at Shawmut Avenue	0	73
Dudley Station	0	954
EOL Dummy	0	6

TABLE C-2 Outbound Stops and Load Profiles

Stop Name	Ons	Offs
Roxbury		
BOL Dummy	0	0
Dudley Station	1380	0
Malcolm X Boulevard at Shawmut Avenue	34	0
Malcolm X Boulevard opposite O'Bryant High School	56	2
Malcolm X Boulevard opposite Madison Park High School	26	1
Malcolm X Boulevard at Tremont Street	25	5
Tremont Street opposite Roxbury Crossing Station	445	42
Mission Hill		
Tremont Street at Parker Street	19	14
Tremont Street at Tobin Community Center	19	14
Tremont Street at Mission Church	19	42
Tremont Street at Worthington Street	44	37
Tremont Street at Huntington Avenue	317	508
Huntington Avenue at Fenwood Road	153	52
835 Huntington Avenue opposite Parker Hill Avenue	153	111
Huntington Avenue at Riverway	311	68
Brookline		243
Washington Street at Pearl Street	193	56
Harvard Street at Kent Street	117	36
Harvard Street at Linden Street	38	25
Harvard Street at Aspinwall Street	91	60
Harvard Street opposite Vernon Street	86	26
Harvard Street at Beacon Street	23	328
Harvard Street at Babcock Street	321	71
Harvard Street at Beals Street	225	24
Harvard Street at Coolidge Street	48	40
Harvard Street at Verndale Street	23	20
Allston/Brighton	18	
Harvard Avenue at Commonwealth Avenue	340	640
Harvard Avenue at Brighton Avenue	175	265
Brighton Avenue opposite Quint Street	142	330
Brighton Avenue at Craftsman Street	94	257
Cambridge Street at Craftsman Street	156	26
Cambridge Street at Harvard Avenue	61	24
Cambridge Street at Linden Street	91	34
North Harvard Avenue at Empire Street	65	100
North Harvard Avenue at Oxford Street	70	43
North Harvard Avenue at Kingsley Street	35	83
North Harvard Avenue at Western Avenue	95	200
Opposite 175 North Harvard Street	45	37
North Harvard Street opposite Harvard Stadium Gate 2	46	59
Cambridge		
J.F.K. Street at Eliot Street	4	611
Massachusetts Avenue at Johnston Gate	1	926
Harvard Square at Garden Street	0	171
EOL Dummy	0	9

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APPENDIX D

Peak-Hour Traffic Analysis
Using Synchro 7

TABLE D-1 AM-Peak-Hour Level-of-Service Summary

Intersection/Approach[1]	Mvmt	Existing Conditions				Alt. 1 (Intersect. Timings)				Alt. 2 (Bus Timings)				Alt. 3 (TSP)			
		LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]
Cambridge Intersections																	
J.F.K. at Eliot										Not recommended				Queue jump – OB			
Eliot – EB	L	C	25.3	0.19	26	D	35.9	0.30	30					C	25.3	0.19	26
Eliot – EB	**R**	**A**	**8.5**	**0.60**	**131**	**A**	**8.5**	**0.60**	**131**					**A**	**8.5**	**0.60**	**131**
J.F.K Street – NB	LT	–	–	–	–	–	–	–	–	–	–	–	–	B	42.2	0.86	230
J.F.K Street – NB	**QJ**	–	–	–	–	–	–	–	–	–	–	–	–	**D**	**17.0**	**0.02**	**4**
J.F.K Street – NB	**T**	**C**	**21.6**	**0.44**	**99**	**B**	**14.3**	**0.34**	**79**					–	–	–	–
Overall		**B**	**15.0**	**0.60**	–	**B**	**12.5**	**0.60**	–					**C**	**23.5**	**0.73**	–
Boston Intersections																	
N. Harvard at Western														Not recommended			
Western Ave – EB	LTR	B	15.8	0.56	71	B	14.8	0.55	64	B	16.5	0.59	70				
Western Ave – WB	L	B	15.2	0.48	38	B	14.2	0.47	35	B	15.7	0.50	38				
Western Ave – WB	T	B	16.5	0.59	113	B	15.6	0.59	102	B	17.3	0.61	111				
Western Ave – WB	R	B	12.3	0.09	11	B	11.6	0.09	10	B	12.7	0.10	11				
North Harvard St – NB	L	B	14.3	0.52	53	B	14.7	0.55	49	B	13.3	0.50	50				
North Harvard St – NB	**TR**	**B**	**14.0**	**0.56**	**92**	**B**	**13.7**	**0.57**	**85**	**B**	**13.0**	**0.55**	**57**				
North Harvard St – SB	**LT**	**C**	**23.2**	**0.56**	**70**	**B**	**18.4**	**0.49**	**60**	**C**	**21.8**	**0.55**	**68**				
North Harvard St – SB	R	B	19.4	0.23	4	B	16.2	0.21	2	B	18.7	0.24	6				
Overall		**B**	**16.4**	**0.56**	–	**B**	**15.1**	**0.57**	–	**B**	**16.3**	**0.57**	–				
N. Harvard at Cambridge														Not recommended			
Cambridge St – EB	**L**	**E**	**71.8**	**0.93**	**164**	**F**	**98.0**	**1.01**	**202**	**E**	**70.8**	**0.91**	**168**				
Cambridge St – EB	T	B	10.6	0.74	232	B	12.0	0.74	134	A	9.3	0.73	97				
Cambridge St – WB	L	F	81.7	0.75	47	F	81.7	0.75	47	F	110.8	0.87	47				
Cambridge St – WB	T	D	40.6	0.99	432	C	30.7	0.94	377	D	42.5	1.00	443				
Cambridge St – WB	R	C	21.1	0.76	209	B	17.2	0.72	187	C	21.6	0.76	209				
North Harvard St – SB	L	D	47.8	0.81	173	D	47.8	0.81	173	D	47.8	0.81	173				
North Harvard St – SB	**R**	**B**	**17.5**	**0.38**	**72**	**B**	**18.7**	**0.40**	**75**	**B**	**17.3**	**0.38**	**70**				
Overall		**C**	**28.0**	**0.92**	–	**C**	**27.5**	**0.92**	–	**C**	**28.4**	**0.92**	–				

TABLE D-1 cont. AM-Peak-Hour Level-of-Service Summary

Intersection/Approach[1]	Mvmt	Existing Conditions				Alt. 1 (Intersect. Timings)				Alt. 2 (Bus Timings)				Alt. 3 (TSP)			
		LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]
Harvard at Cambridge														Shared RT lane and TSP[4]			
Cambridge St – EB	**LTR**	**D**	**41.6**	**0.80**	**245**	**D**	**46.6**	**0.85**	**265**	**D**	**38.2**	**0.76**	**217**	**C**	**33.1**	**0.64**	**220**
Cambridge St – WB	L	B	10.5	0.67	69	B	12.6	0.67	62	A	9.1	0.66	60	C	20.1	0.71	139
Cambridge St – WB	**T**	**A**	**6.9**	**0.71**	**87**	**A**	**6.2**	**0.71**	**72**	**A**	**6.4**	**0.69**	**83**	B	14.9	0.67	294
Cambridge St – WB	R	A	1.8	0.10	1	A	1.3	0.10	0	A	1.6	0.41	1	**B**	**10.8**	**0.11**	**3**
Harvard Ave – NB	LT	D	44.8	0.57	51	D	42.9	0.53	51	D	52.2	0.66	52	E	56.8	0.63	59
Harvard Ave –NB	R	F	115.5	1.15	396	F	97.4	1.10	368	F	134.1	1.19	434	F	183.2	1.29	518
Franklin St – SB	L	E	58.9	0.72	55	D	52.4	0.68	54	F	86.4	0.85	56	F	96.2	0.85	63
Franklin St – SB	TR	D	40.7	0.29	34	D	40.1	0.28	33	D	42.4	0.34	34	D	49.1	0.33	39
Overall		**D**	**44.3**	**0.99**	**–**	**D**	**41.1**	**0.99**	**–**	**D**	**48.7**	**0.99**	**–**	**E**	**63.5**	**0.94**	**–**
Brighton at Cambridge										Not recommended				SB LT for MBTA bus only			
North Beacon St – EB	LTR	E	57.9	0.94	209	E	57.9	0.94	209					E	57.9	0.94	209
Brighton Ave – WB	L	C	30.1	0.19	33	C	29.7	0.18	32					C	30.1	0.19	33
Brighton Ave – WB	T	E	68.5	0.94	222	E	63.5	0.92	218					E	68.5	0.94	222
Brighton Ave – WB	**R**	**C**	**28.9**	**0.02**	**0**	**C**	**28.5**	**0.02**	**0**					**C**	**28.9**	**0.02**	**0**
Cambridge St – NB	LT	D	39.9	0.76	183	D	38.8	0.75	183					C	33.6	0.67	158
Cambridge St – NB	R	B	13.5	0.30	71	B	12.9	0.29	69					B	11.5	0.28	54
Cambridge St – SB	**LTR**	**C**	**27.7**	**0.59**	**143**	**C**	**28.3**	**0.60**	**146**					**C**	**27.9**	**0.60**	**147**
Overall		**D**	**42.8**	**0.88**	**–**	**D**	**41.9**	**0.87**	**–**					**D**	**41.3**	**0.85**	**–**
Brighton at Harvard														Not recommended			
Brighton Ave – EB	L	C	20.2	0.18	12	C	22.5	0.22	13	C	20.4	0.19	13				
Brighton Ave – EB	**TR**	**C**	**24.5**	**0.31**	**72**	**C**	**26.1**	**0.33**	**74**	**C**	**23.7**	**0.30**	**71**				
Brighton Ave – WB	L	B	19.9	0.42	51	C	24.7	0.49	55	C	22.1	0.45	52				
Brighton Ave – WB	TR	C	27.4	0.58	155	C	30.4	0.62	161	C	27.2	0.57	152				
Harvard Ave – NB	**LTR**	**D**	**51.7**	**0.91**	**242**	**C**	**33.5**	**0.81**	**221**	**D**	**45.5**	**0.89**	**237**				
Harvard Ave – SB	LTR	F	140.0	1.20	425	F	84.4	1.06	384	F	124.1	1.16	415				
Overall		**E**	**60.1**	**0.84**	**–**	**D**	**43.7**	**0.51**	**–**	**D**	**54.8**	**0.82**	**–**				

TABLE D-1 cont. AM-Peak-Hour Level-of-Service Summary

Intersection/Approach[1]	Mvmt	Existing Conditions				Alt. 1 (Intersect. Timings)				Alt. 2 (Bus Timings)				Alt. 3 (TSP)			
		LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]
Brookline Intersections																	
Harvard at Verndale														Transit signal priority[4]			
Verndale St – EB	L	C	34.8	0.28	11	D	35.4	0.32	11	C	34.8	0.28	11	D	39.0	0.34	11
Verndale St – EB	T	C	33.6	0.01	0	C	34.0	0.01	0	C	33.6	0.01	0	D	37.5	0.01	0
Driveway – WB	L	C	33.7	0.03	1	C	34.1	0.03	1	C	33.7	0.03	1	D	37.6	0.04	1
Driveway – WB	R	C	34.2	0.16	6	C	34.7	0.18	6	C	34.2	0.16	6	D	38.2	0.19	6
Harvard St – NB	**TR**	**B**	**10.5**	**0.65**	**158**	**B**	**10.2**	**0.64**	**158**	**A**	**10.0**	**0.64**	**149**	**A**	**7.5**	**0.61**	**158**
Harvard St – SB	**LT**	**A**	**3.8**	**0.47**	**42**	**A**	**3.7**	**0.47**	**42**	**A**	**3.8**	**0.47**	**43**	**A**	**4.8**	**0.48**	**42**
Overall		**A**	**8.7**	**0.61**	**–**	**A**	**8.4**	**0.61**	**–**	**A**	**8.4**	**0.60**	**–**	**A**	**7.6**	**0.56**	**–**
Harvard at Fuller						Existing timings optimal				Not recommended				Transit signal priority[4]			
Fuller St – EB	LTR	D	44.7	0.74	67									D	53.6	0.77	66
Fuller St – WB	LTR	C	30.3	0.21	18									D	35.0	0.23	18
Harvard St – NB	L	A	4.2	0.03	1									A	3.6	0.03	1
Harvard St – NB	**T**	**A**	**8.5**	**0.55**	**94**									**A**	**6.1**	**0.52**	**99**
Harvard St – SB	L	A	4.2	0.03	1									A	3.6	0.03	2
Harvard St – SB	**T**	**A**	**8.6**	**0.56**	**105**									**A**	**6.2**	**0.54**	**110**
Overall		**B**	**12.8**	**0.59**	**–**									**B**	**11.8**	**0.57**	**–**
Harvard at Stedman/Wllms.						Existing timings optimal				Not recommended				Transit signal priority[4]			
Stedman St – WB	L	D	41.8	0.25	10									D	47.3	0.30	10
Stedman St – WB	TR	D	43.6	0.45	15									D	51.3	0.53	15
Harvard St – NB	L	A	3.3	0.13	4									A	2.8	0.13	4
Harvard St – NB	**T**	**A**	**3.3**	**0.53**	**64**									**A**	**2.7**	**0.51**	**65**
Harvard St – SB	**TR**	**A**	**8.8**	**0.53**	**109**									**A**	**6.3**	**0.50**	**109**
Overall		**A**	**7.0**	**0.52**	**–**									**A**	**5.9**	**0.51**	**–**
Harvard at Stop & Shop														Transit signal priority[4]			
Stop & Shop Dr. – WB	LR	F	163.3	1.20	156	F	121.5	1.10	145	F	163.3	1.20	156	F	258.1	1.41	174
Harvard St – NB	**T**	**B**	**10.6**	**0.60**	**173**	**B**	**10.8**	**0.60**	**173**	**A**	**9.7**	**0.59**	**158**	**B**	**10.7**	**0.60**	**168**
Harvard St – NB	R	A	5.2	0.06	9	A	5.4	0.06	9	A	4.8	0.06	8	A	6.4	0.07	11
Harvard St – SB	L	A	4.8	0.14	5	A	5.2	0.14	6	A	4.7	0.14	5	A	2.1	0.14	5
Harvard St – SB	**T**	**A**	**4.7**	**0.56**	**115**	**A**	**5.2**	**0.57**	**124**	**A**	**4.7**	**0.56**	**115**	**A**	**3.9**	**0.54**	**115**
Overall		**C**	**30.9**	**0.71**	**–**	**C**	**24.9**	**0.71**	**–**	**C**	**30.5**	**0.65**	**–**	**D**	**45.0**	**0.71**	**–**

TABLE D-1 cont. AM-Peak-Hour Level-of-Service Summary

Intersection/Approach[1]	Mvmt	Existing Conditions				Alt. 1 (Intersect. Timings)				Alt. 2 (Bus Timings)				Alt. 3 (TSP)			
		LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]
Harvard at Aspinwall/School																	
School St – EB	L	F	517.4	1.99	157	F	235.6	1.36	116	F	517.4	1.99	157	F	642.5	2.25	159
School St – EB	TR	F	123.6	1.16	418	F	140.5	1.20	429	F	123.6	1.16	418	F	186.1	1.29	419
Aspinwall Ave – WB	L	F	144.6	1.00	41	F	151.7	1.01	42	F	144.6	1.00	41	F	191.5	1.11	43
Aspinwall Ave – WB	TR	F	110.0	1.09	274	F	205.3	1.33	315	F	110.0	1.09	274	F	167.9	1.23	277
Harvard St – NB	L	C	21.5	0.22	21	B	16.8	0.19	18	B	19.9	0.20	20	B	17.4	0.18	21
Harvard St – NB	**TR**	**D**	**53.4**	**0.92**	**219**	**C**	**31.0**	**0.77**	**184**	**D**	**44.1**	**0.87**	**209**	**C**	**30.3**	**0.77**	**216**
Harvard St – SB	L	B	15.2	0.38	31	B	15.1	0.40	30	B	15.1	0.39	31	B	13.3	0.32	31
Harvard St – SB	**TR**	**B**	**16.1**	**0.59**	**152**	**B**	**15.3**	**0.58**	**147**	**B**	**16.1**	**0.59**	**152**	**B**	**13.7**	**0.54**	**152**
Overall		**F**	**110.5**	**1.27**	**–**	**F**	**103.9**	**0.99**		**F**	**108.7**	**1.25**	**–**	**F**	**142.5**	**1.21**	**–**
Harvard at Washington/Kent										Same as Alternative 1				Transit signal priority (OB)[4]			
South Int. Davis Ave – EB	LTR	D	52.6	0.79	93	F	81.4	0.92	99	F	81.4	0.92	99	E	55.9	0.80	104
Andem Pl – WB	LTR	C	31.3	0.04	4	C	33.2	0.04	4	C	33.2	0.04	4	C	33.0	0.04	5
Washington St – NB	L	B	18.7	0.55	65	B	12.6	0.44	53	B	12.6	0.44	53	A	9.1	0.25	61
Washington St – NB	**TR**	**B**	**15.1**	**0.58**	**170**	**A**	**9.5**	**0.50**	**138**	**A**	**9.5**	**0.50**	**138**	**A**	**9.1**	**0.51**	**159**
Harvard St – SB	**TR**	**A**	**2.2**	**0.57**	**0**	**A**	**2.2**	**0.63**	**0**	**A**	**2.2**	**0.63**	**0**	**A**	**1.1**	**0.55**	**0**
Washington St – SE	TR	F	229.1	1.37	248	F	86.7	1.01	191	F	86.7	1.01	191	F	254.5	1.43	282
North Int. Kent St – WB	L	D	35.9	0.09	8	D	42.4	0.21	9	D	42.4	0.21	9	D	45.0	0.23	10
Kent St – WB	R	D	36.0	0.10	9	D	42.8	0.23	9	D	42.8	0.23	9	D	45.5	0.25	10
Harvard St – NB	**T**	**A**	**0.7**	**0.44**	**8**	**A**	**0.5**	**0.40**	**8**	**A**	**0.5**	**0.40**	**8**	**A**	**0.5**	**0.39**	**8**
Harvard St – SB	**T**	**D**	**53.2**	**0.93**	**276**	**D**	**43.2**	**0.87**	**275**	**D**	**43.2**	**0.87**	**275**	**C**	**27.1**	**0.79**	**266**
Overall (Note: acts as 2 ints.)		**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**
Washington at Boylston/High														Transit signal priority[4]			
Boylston St – EB	TR	F	254.2	1.48	688	F	203.5	1.37	655	F	216.6	1.40	677	F	321.4	1.62	688
Washington St – WB	T	D	39.4	0.86	258	C	33.7	0.79	245	D	35.1	0.81	254	D	53.2	0.94	258
Washington St – WB	**R**	**A**	**6.1**	**0.31**	**59**	**A**	**5.3**	**0.30**	**53**	**A**	**5.0**	**0.29**	**51**	**A**	**5.7**	**0.30**	**59**
High St – NB	LTR	F	103.6	1.10	237	F	153.2	1.22	257	F	184.3	1.29	267	F	132.9	1.17	237
Washington St – SB	**L**	**C**	**29.8**	**0.62**	**143**	**C**	**30.4**	**0.63**	**145**	**C**	**28.4**	**0.60**	**138**	**C**	**26.2**	**0.54**	**143**
Washington St – SB	TR	E	57.4	0.92	223	E	61.6	0.93	226	D	49.6	0.88	215	D	37.3	0.79	223
Overall		**F**	**120.3**	**1.18**	**–**	**F**	**109.2**	**1.18**	**–**	**F**	**117.4**	**1.18**	**–**	**F**	**148.6**	**1.17**	**–**

TABLE D-1 cont. AM-Peak-Hour Level-of-Service Summary

Intersection/Approach[1]	Mvmt	Existing Conditions				Alt. 1 (Intersect. Timings)				Alt. 2 (Bus Timings)				Alt. 3 (TSP)			
		LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]
Boston Intersections																	
Huntington at S. Huntington						Existing timings optimal								Not recommended			
Huntington Ave – EB	**T**	**E**	**74.1**	**1.05**	**311**					**E**	**70.0**	**1.03**	**311**				
Huntington Ave – EB	R	A	9.3	0.49	70					A	9.3	0.49	70				
Huntington Ave – WB	L	E	56.6	0.77	100					E	56.6	0.77	100				
Huntington Ave – WB	**T**	**B**	**16.7**	**0.35**	**72**					**B**	**16.4**	**0.35**	**72**				
South Huntington Ave – NB	L	D	39.1	0.78	206					D	40.2	0.79	206				
South Huntington Ave – NB	R	D	49.5	0.85	188					D	51.7	0.86	188				
Overall		**D**	**45.9**	**0.92**	**–**					**D**	**44.7**	**0.92**	**–**				
Huntington at Parker Hill														Not recommended			
Huntington Ave – EB	**TR**	**B**	**13.7**	**0.60**	**154**	**B**	**14.6**	**0.61**	**173**	**B**	**12.7**	**0.59**	**141**				
Huntington Ave – WB	**LT**	**B**	**14.1**	**0.60**	**114**	**B**	**15.0**	**0.61**	**128**	**B**	**13.0**	**0.58**	**104**				
Parker Hill Ave – NB	LR	F	93.3	0.95	156	E	75.3	0.89	151	F	120.6	1.03	169				
Overall		**C**	**21.9**	**0.67**	**–**	**C**	**20.9**	**0.67**	**–**	**C**	**23.7**	**0.68**	**–**				
Huntington at Tremont														Restripe Tremont WB L/T			
Huntington Ave – EB	**LTR**	**F**	**127.7**	**1.18**	**274**	**F**	**161.4**	**1.26**	**289**	**F**	**99.1**	**1.11**	**259**	**F**	**127.7**	**1.18**	**274**
Huntington Ave – WB	L	C	20.5	0.40	16	C	22.1	0.43	17	C	20.6	0.44	16	C	20.5	0.40	16
Huntington Ave – WB	TR	C	22.1	0.52	97	C	23.7	0.55	103	C	22.1	0.52	97	C	22.1	0.52	98
Tremont St – NB	**L**	–	–	–	–	–	–	–	–	–	–	–	–	**F**	**201.6**	**1.31**	**186**
Tremont St – NB	**LTR**	**F**	**184.6**	**1.38**	**262**	**F**	**134.1**	**1.22**	**231**	**F**	**184.6**	**1.38**	**262**	**D**	**54.0**	**0.90**	**215**
Francis St – SB	LTR	F	176.4	1.25	164	F	171.5	1.24	163	F	176.4	1.25	164	F	126.5	1.12	152
Calumet St – NB	R	C	24.4	0.15	20	C	22.9	0.14	19	C	24.4	0.15	20	C	24.4	0.15	20
Overall		**F**	**121.8**	**1.17**	**–**	**F**	**120.2**	**1.20**	**–**	**F**	**112.0**	**1.15**	**–**	**F**	**98.6**	**1.18**	**–**
Tremont at St. Alphonsus						Existing timings optimal								IB: shared RT/QJ			
Tremont St – EB	**R**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**B**	**11.4**	**0.07**	**7**
Tremont St – EB	**LTR**	**C**	**26.7**	**0.78**	**157**					**C**	**22.8**	**0.73**	**145**	C	24.0	0.72	140
Tremont St – WB	**LTR**	**C**	**24.4**	**0.75**	**167**					**C**	**21.4**	**0.72**	**156**	**C**	**24.4**	**0.75**	**167**
St. Alphonsus St – NB	LTR	D	42.6	0.85	142					E	59.7	0.94	149	D	42.6	0.85	142
St. Alphonsus St. – SB	LTR	D	40.1	0.80	90					E	65.5	0.92	96	D	40.1	0.80	90
Overall		**C**	**31.3**	**0.81**	**–**					**D**	**36.4**	**0.81**	**–**	**C**	**30.2**	**0.79**	**–**

TABLE D-1 cont. AM-Peak-Hour Level-of-Service Summary

Intersection/Approach[1]	Mvmt	Existing Conditions				Alt. 1 (Intersect. Timings)				Alt. 2 (Bus Timings)				Alt. 3 (TSP)			
		LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]
Tremont at Parker														Transit signal priority[4]			
Tremont St – EB	**LTR**	**D**	**41.5**	**0.89**	**194**	**D**	**41.5**	**0.89**	**194**	**C**	**32.3**	**0.83**	**176**	**C**	**22.3**	**0.75**	**184**
Tremont St – WB	**LT**	**D**	**40.1**	**0.97**	**233**	**D**	**44.0**	**0.97**	**377**	**D**	**45.9**	**0.93**	**308**	**C**	**32.8**	**0.88**	**256**
Tremont St – WB	R	B	11.9	0.34	29	A	7.7	0.34	31	B	16.9	0.33	100	B	12.5	0.30	65
Parker St – SB	LTR	E	79.8	1.00	243	E	79.8	1.00	243	F	103.4	1.07	272	F	118.8	1.10	228
Overall		**D**	**45.5**	**0.98**	**–**	**D**	**46.2**	**0.98**	**–**	**D**	**51.0**	**0.98**	**–**	**D**	**46.6**	**0.95**	**–**
Tremont at Terrace														Transit signal priority[4]			
Tremont St – EB	**LTR**	**A**	**6.7**	**0.60**	**110**	**B**	**12.7**	**0.78**	**195**	**A**	**3.7**	**0.60**	**96**	**A**	**7.5**	**0.58**	**143**
Tremont St – WB	**LTR**	**A**	**4.8**	**0.47**	**61**	**C**	**25.4**	**0.61**	**228**	**A**	**0.5**	**0.47**	**0**	**A**	**5.8**	**0.46**	**88**
Terrace St – NB	LTR	F	364.0	1.69	503	D	48.4	0.91	302	F	364.0	1.67	503	F	408.5	1.78	504
Overall		**F**	**108.7**	**0.83**	**–**	**C**	**28.3**	**0.83**	**–**	**F**	**107.0**	**0.83**	**–**	**F**	**122.2**	**0.83**	**–**
Tremont at Columbus														Not recommended			
Tremont St – EB	**LTR**	**F**	**145.6**	**1.22**	**255**	**F**	**142.7**	**1.22**	**274**	**B**	**114.9**	**1.13**	**242**				
Tremont St – WB	**LT**	**F**	**256.0**	**1.45**	**264**	**F**	**256.0**	**1.45**	**264**	**A**	**201.7**	**1.32**	**251**				
Tremont St – WB	R	D	36.1	0.33	0	D	36.1	0.33	0	D	35.3	0.33	0				
Columbus Ave – NB	L	F	235.9	1.34	170	F	219.7	1.34	170	B	223.1	1.34	179				
Columbus Ave – NB	TR	F	85.6	1.11	349	F	83.7	1.11	357	C	145.8	1.20	370				
Columbus Ave – SB	L	F	1351.1	3.80	203	F	1361.7	3.80	200	C	1348.7	3.80	204				
Columbus Ave – SB	TR	D	42.4	0.76	147	C	31.4	0.76	90	C	42.7	0.82	195				
Overall		**F**	**165.8**	**1.65**	**–**	**F**	**162.2**	**1.65**	**–**	**F**	**172.0**	**1.64**	**–**				
Malcolm X at Shawmut														Not recommended			
Malcolm X Blvd – EB	**LTR**	**B**	**16.6**	**0.29**	**70**	**B**	**16.8**	**0.29**	**70**	**B**	**16.2**	**0.29**	**71**				
Malcolm X Blvd – WB	**LTR**	**A**	**2.6**	**0.38**	**13**	**A**	**3.1**	**0.68**	**12**	**A**	**2.6**	**0.37**	**13**				
Shawmut Ave – NB	L	D	47.9	0.91	215	D	47.1	0.90	213	D	52.1	0.92	217				
Shawmut Ave – NB	TR	B	18.8	0.27	45	B	18.7	0.27	46	B	19.2	0.27	46				
Shawmut Ave – SB	L	C	21.4	0.19	40	C	21.3	0.19	40	C	21.9	0.19	39				
Shawmut Ave – SB	T	C	22.2	0.27	68	C	22.0	0.27	69	C	22.6	0.27	68				
Shawmut Ave – SB	R	C	24.6	0.50	117	C	24.5	0.49	118	C	25.1	0.50	117				
Overall		**C**	**20.5**	**0.61**	**–**	**C**	**20.4**	**0.61**	**–**	**C**	**21.3**	**0.61**	**–**				

TABLE D-1 cont. AM-Peak-Hour Level-of-Service Summary

Intersection/Approach[1]	Mvmt	Existing Conditions				Alt. 1 (Intersect. Timings)				Alt. 2 (Bus Timings)				Alt. 3 (TSP)			
		LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]
Dudley at Washington														Not recommended			
Malcolm X Blvd – EB	**TR**	**C**	**22.0**	**0.95**	**88**	**C**	**23.5**	**0.44**	**88**	**C**	**20.2**	**0.42**	**87**				
Dudley St – WB	**LT**	**C**	**23.3**	**0.75**	**141**	**C**	**25.5**	**0.73**	**152**	**C**	**22.4**	**0.69**	**136**				
Washington St – NB	L	C	20.5	0.66	3	B	19.6	0.02	3	C	20.9	0.02	3				
Washington St – NB	R	D	51.3	0.79	162	D	46.0	0.91	159	E	57.1	0.96	166				
Washington St – SB	L	E	56.0	0.91	102	D	52.9	0.83	102	E	59.3	0.86	112				
Washington St – SB	T	C	33.0	0.92	77	C	32.7	0.47	77	C	33.0	0.49	77				
Washington St – SB	R	C	30.3	0.94	0	C	30.3	0.04	0	C	29.0	0.04	0				
Overall		**C**	**33.7**	**0.80**	**–**	**C**	**33.2**	**0.81**	**–**	**C**	**34.7**	**0.80**	**–**				
Dudley at Warren St														Not recommended			
Dudley St – EB	L	D	46.0	0.90	73	D	40.8	0.88	72	D	36.6	0.86	69				
Dudley St – EB	**T**	**B**	**18.0**	**0.40**	**66**	**B**	**17.3**	**0.39**	**64**	**B**	**16.6**	**0.38**	**58**				
Dudley St – EB	R	B	15.6	0.27	0	B	15.4	0.27	0	B	15.5	0.27	0				
Dudley St – WB	TR	C	22.0	0.48	33	C	21.9	0.48	33	C	21.6	0.46	33				
Warren St – NB	T	C	24.6	0.73	223	C	26.2	0.75	231	C	27.6	0.78	234				
Warren St – NB	R	A	7.7	0.05	2	A	8.3	0.05	2	A	8.6	0.05	3				
Overall		**C**	**23.9**	**0.81**	**–**	**C**	**23.5**	**0.81**	**–**	**C**	**23.2**	**0.81**	**–**				

1. Route 66 approaches shown in bold.
2. Delay is measured in seconds.
3. 50th percentile queue, measured in feet.
4. TSP was modeled by changing the signal from an actuated, coordinated signal to a semi-actuated, uncoordinated signal. Cycle lengths may vary.

TABLE D-2 PM-Peak-Hour Level-of-Service Summary

Intersection/Approach[1]	Mvmt	Existing Conditions				Alt. 1 (Intersect. Timings)				Alt. 2 (Bus Timings)				Alt. 3 (TSP)			
		LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]
Cambridge Intersections																	
J.F.K. at Eliot										Not recommended				Queue jump – OB			
Eliot – EB	L	C	25.2	0.20	36	D	45.5	0.47	45					C	25.2	0.20	36
Eliot – EB	**R**	**B**	**10.9**	**0.70**	**186**	**B**	**10.9**	**0.70**	**186**					**B**	**10.9**	**0.70**	**186**
J.F.K Street – NB	LT	–	–	–	–	–	–	–	–	–	–	–	–	F	418.3	1.85	867
J.F.K Street – NB	**QJ**	–	–	–	–	–	–	–	–	–	–	–	–	**B**	**17.0**	**0.02**	**4**
J.F.K Street – NB	**T**	**D**	**41.8**	**0.93**	**282**	**B**	**16.1**	**0.65**	**195**					–	–	–	–
Overall		**C**	**29.1**	**0.81**	**–**	**B**	**15.5**	**0.71**	**–**					**F**	**240.5**	**1.31**	**–**
Boston Intersections																	
N. Harvard at Western														Not recommended			
Western Ave – EB	LTR	C	20.7	0.68	99	B	18.2	0.68	87	C	21.4	0.70	100				
Western Ave – WB	L	B	16.5	0.40	35	B	14.4	0.40	31	B	16.9	0.41	35				
Western Ave – WB	T	C	23.4	0.75	190	C	21.3	0.75	168	C	24.5	0.76	191				
Western Ave – WB	R	B	14.0	0.08	12	B	12.3	0.08	10	B	14.3	0.08	12				
North Harvard St – NB	L	B	14.4	0.49	49	B	14.2	0.53	42	B	13.9	0.48	48				
North Harvard St – NB	**TR**	**B**	**13.2**	**0.43**	**90**	**B**	**12.1**	**0.45**	**77**	**B**	**12.7**	**0.73**	**88**				
North Harvard St – SB	**LT**	**C**	**24.7**	**0.62**	**115**	**B**	**19.7**	**0.58**	**94**	**C**	**24.1**	**0.62**	**113**				
North Harvard St – SB	R	B	19.9	0.28	20	B	16.0	0.25	14	B	19.6	0.28	21				
Overall		**B**	**19.8**	**0.66**	**–**	**B**	**17.3**	**0.66**	**–**	**B**	**20.0**	**0.66**	**–**				
N. Harvard at Cambridge														Not recommended			
Cambridge St – EB	**L**	**E**	**77.1**	**0.88**	**155**	**F**	**100.3**	**0.99**	**184**	**E**	**77.2**	**0.87**	**165**				
Cambridge St – EB	T	A	5.2	0.54	64	B	12.7	0.53	253	A	4.7	0.53	65				
Cambridge St – WB	L	E	66.7	0.58	35	E	68.4	0.58	42	E	71.9	0.62	35				
Cambridge St – WB	T	D	52.9	1.03	573	D	35.9	0.97	478	E	55.0	1.03	572				
Cambridge St – WB	R	B	18.2	0.58	172	B	11.0	0.54	69	B	17.9	0.59	170				
North Harvard St – SB	L	E	68.0	0.93	245	E	72.7	0.95	248	E	68.0	0.93	245				
North Harvard St – SB	**R**	**C**	**20.6**	**0.37**	**84**	**C**	**22.5**	**0.39**	**91**	**C**	**20.4**	**0.37**	**85**				
Overall		**C**	**34.7**	**0.97**	**–**	**C**	**32.9**	**0.97**	**–**	**D**	**35.3**	**0.97**	**–**				

TABLE D-2 cont. PM-Peak-Hour Level-of-Service Summary

Intersection/Approach[1]	Mvmt	Existing Conditions				Alt. 1 (Intersect. Timings)				Alt. 2 (Bus Timings)				Alt. 3 (TSP)			
		LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]
Harvard at Cambridge														Shared RT lane and TSP[4]			
Cambridge St – EB	**LTR**	**D**	**42.1**	**0.85**	**261**	**D**	**42.9**	**0.86**	**262**	**D**	**35.5**	**0.77**	**247**	**D**	**36.7**	**0.79**	**257**
Cambridge St – WB	L	E	66.5	1.08	259	F	99.5	1.12	272	D	53.2	1.05	303	F	124.9	1.17	279
Cambridge St – WB	**T**	**C**	**23.8**	**0.83**	**589**	**A**	**4.5**	**0.85**	**19**	**C**	**22.1**	**0.81**	**588**	C	26.0	0.81	422
Cambridge St – WB	R	A	8.8	0.10	15	A	0.1	0.11	0	A	8.4	0.10	18	**B**	**14.6**	**0.13**	**12**
Harvard Ave – NB	LT	E	66.1	0.79	91	E	57.1	0.74	90	F	97.0	0.92	93	F	85.5	0.86	92
Harvard Ave –NB	R	E	71.8	0.97	258	E	71.8	0.97	258	F	90.7	1.03	266	F	93.9	1.03	258
Franklin St – SB	L	F	153.9	1.09	112	F	127.0	1.01	101	F	243.9	1.32	128	F	209.3	1.23	117
Franklin St – SB	TR	D	42.7	0.36	54	D	41.8	0.34	54	D	44.7	0.41	55	D	47.2	0.38	55
Overall		**D**	**50.2**	**1.07**	**–**	**D**	**48.2**	**1.08**	**–**	**D**	**54.5**	**1.08**	**–**	**E**	**65.6**	**1.08**	**–**
Brighton at Cambridge														SB LT for MBTA bus only			
North Beacon St – EB	LTR	F	118.5	1.13	307	F	118.5	1.13	307	F	118.5	1.13	307	F	118.5	1.13	307
Brighton Ave – WB	L	C	31.0	0.22	48	C	33.4	0.25	51	C	31.0	0.22	48	C	31.0	0.22	48
Brighton Ave – WB	T	F	121.9	1.12	393	F	173.9	1.25	424	F	121.9	1.12	393	F	121.9	1.12	393
Brighton Ave – WB	**R**	**C**	**30.3**	**0.14**	**1**	**C**	**32.7**	**0.16**	**4**	**C**	**30.3**	**0.14**	**1**	**C**	**30.3**	**0.14**	**1**
Cambridge St – NB	LT	E	63.1	0.94	218	D	45.3	0.81	205	E	74.1	0.99	222	D	40.9	0.77	182
Cambridge St – NB	R	B	12.0	0.10	22	B	12.0	0.10	22	B	12.5	0.10	22	A	9.8	0.09	16
Cambridge St – SB	**LTR**	**F**	**110.4**	**1.13**	**327**	**E**	**75.6**	**1.03**	**283**	**F**	**106.8**	**1.12**	**325**	**F**	**126.8**	**1.17**	**348**
Overall		**F**	**92.8**	**1.15**	**–**	**F**	**88.6**	**1.15**	**–**	**F**	**94.0**	**1.15**	**–**	**F**	**92.7**	**1.17**	**–**
Brighton at Harvard														Not recommended			
Brighton Ave – EB	L	C	20.6	0.33	25	C	25.6	0.42	29	C	23.4	0.35	25				
Brighton Ave – EB	**TR**	**C**	**26.0**	**0.40**	**109**	**C**	**32.0**	**0.48**	**123**	**C**	**25.2**	**0.39**	**107**				
Brighton Ave – WB	L	B	19.0	0.36	41	C	25.5	0.45	48	C	22.8	0.40	43				
Brighton Ave – WB	TR	C	29.1	0.60	182	D	37.2	0.71	205	C	28.5	0.59	178				
Harvard Ave – NB	**LTR**	**F**	**413.9**	**1.82**	**741**	**F**	**274.9**	**1.52**	**685**	**F**	**390.4**	**1.77**	**734**				
Harvard Ave – SB	LTR	F	290.9	1.54	558	F	178.5	1.29	507	F	272.1	1.50	551				
Overall		**F**	**187.8**	**1.10**	**–**	**F**	**129.8**	**1.09**	**–**	**F**	**177.4**	**1.10**	**–**				

TABLE D-2 cont. PM-Peak-Hour Level-of-Service Summary

Intersection/Approach[1]	Mvmt	Existing Conditions				Alt. 1 (Intersect. Timings)				Alt. 2 (Bus Timings)				Alt. 3 (TSP)			
		LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]
Brookline Intersections																	
Harvard at Verndale						See Alternative 2								Transit signal priority[4]			
Verndale St – EB	L	C	31.2	0.08	5					C	31.5	0.08	5	D	35.6	0.09	5
Verndale St – EB	T	C	31.0	0.01	0					C	31.2	0.01	0	D	35.3	0.01	0
Driveway – WB	L	C	31.5	0.15	8					C	31.8	0.15	8	D	36.0	0.17	8
Driveway – WB	R	D	35.2	0.55	35					D	36.5	0.58	35	D	44.8	0.63	35
Harvard St – NB	**TR**	**B**	**12.4**	**0.65**	**156**					**B**	**11.3**	**0.63**	**149**	**A**	**9.0**	**0.60**	**156**
Harvard St – SB	**LT**	**A**	**9.4**	**0.75**	**99**					**A**	**9.2**	**0.75**	**99**	**B**	**11.2**	**0.76**	**99**
Overall		**B**	**12.6**	**0.71**	**–**					**B**	**12.1**	**0.72**	**–**	**B**	**12.7**	**0.68**	**–**
Harvard at Fuller						Existing timings optimal				Not recommended				Transit signal priority[4]			
Fuller St – EB	LTR	D	52.5	0.82	83									E	62.9	0.85	83
Fuller St – WB	LTR	C	30.0	0.29	27									C	34.4	0.30	27
Harvard St – NB	L	A	5.7	0.15	8									A	4.7	0.14	7
Harvard St – NB	**T**	**B**	**10.7**	**0.64**	**128**									**A**	**8.3**	**0.62**	**128**
Harvard St – SB	L	A	4.4	0.01	1									A	4.1	0.01	1
Harvard St – SB	**T**	**A**	**8.8**	**0.55**	**103**									**A**	**6.9**	**0.52**	**103**
Overall		**B**	**15.3**	**0.68**	**–**									**B**	**14.8**	**0.66**	**–**
Harvard at Stedman/Wllms.						Existing timings optimal				Not recommended				Transit signal priority[4]			
Stedman St – WB	L	D	42.2	0.25	9									D	47.5	0.30	9
Stedman St – WB	TR	D	43.0	0.35	11									D	48.8	0.42	11
Harvard St – NB	L	A	4.5	0.31	7									A	3.8	0.29	7
Harvard St – NB	**T**	**A**	**3.4**	**0.55**	**64**									**A**	**2.7**	**0.53**	**66**
Harvard St – SB	**TR**	**B**	**12.0**	**0.69**	**169**									**A**	**8.5**	**0.66**	**171**
Overall		**A**	**8.4**	**0.67**	**–**									**A**	**6.6**	**0.65**	**–**
Harvard at Stop & Shop														Transit signal priority[4]			
Stop & Shop Dr. – WB	LR	F	163.3	1.20	156	F	121.5	1.10	145	F	163.3	1.20	156	F	265.4	1.43	174
Harvard St – NB	**T**	**B**	**12.6**	**0.64**	**183**	**B**	**11.3**	**0.62**	**183**	**B**	**10.9**	**0.62**	**183**	**B**	**11.4**	**0.62**	**177**
Harvard St – NB	R	A	6.0	0.06	9	A	5.4	0.06	9	A	5.2	0.06	9	A	6.3	0.07	11
Harvard St – SB	L	A	5.1	0.14	5	A	5.3	0.15	6	A	4.9	0.14	5	A	5.6	0.14	5
Harvard St – SB	**T**	**A**	**6.6**	**0.69**	**171**	**A**	**7.3**	**0.70**	**183**	**A**	**6.6**	**0.69**	**171**	**A**	**5.3**	**0.66**	**171**
Overall		**C**	**30.0**	**0.77**	**–**	**C**	**24.2**	**0.77**	**–**	**C**	**29.4**	**0.77**	**–**	**D**	**43.0**	**0.75**	**–**

TABLE D-2 cont. PM-Peak-Hour Level-of-Service Summary

Intersection/Approach[1]	Mvmt	Existing Conditions				Alt. 1 (Intersect. Timings)				Alt. 2 (Bus Timings)				Alt. 3 (TSP)			
		LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]
Harvard at Aspinwall/School						Existing timings optimal				Not recommended				Transit signal priority[4]			
School St – EB	L	D	50.3	0.67	26									E	59.8	0.71	26
School St – EB	TR	E	79.4	1.02	288									F	122.0	1.13	293
Aspinwall Ave – WB	L	D	47.7	0.67	30									F	137.7	0.95	32
Aspinwall Ave – WB	TR	F	168.9	1.25	345									F	240.8	1.40	349
Harvard St – NB	L	C	21.5	0.23	21									B	17.7	0.19	21
Harvard St –NB	**TR**	**D**	**36.2**	**0.77**	**182**									**C**	**25.2**	**0.66**	**181**
Harvard St – SB	L	B	18.4	0.64	61									B	15.0	0.56	61
Harvard St – SB	**TR**	**B**	**16.3**	**0.62**	**173**									**B**	**14.1**	**0.56**	**172**
Overall		**E**	**66.0**	**0.95**	**–**									**F**	**89.1**	**0.90**	**–**
Harvard at Washington/Kent										Not recommended				Transit signal priority (OB)[4]			
South Int. Davis Ave – EB	LTR	D	43.8	0.56	41	D	45.6	0.59	41					D	53.4	0.62	46
Andem Pl – WB	LTR	D	36.7	0.06	5	D	37.0	0.06	5					D	41.8	0.07	5
Washington St – NB	L	D	35.0	0.81	110	C	30.2	0.74	111					C	5.4	0.25	62
Washington St – NB	**TR**	**A**	**6.1**	**0.45**	**116**	**A**	**5.9**	**0.45**	**116**					**A**	**9.0**	**0.48**	**112**
Harvard St – SB	**TR**	**B**	**16.1**	**0.80**	**436**	**C**	**24.5**	**0.88**	**485**					**A**	**3.2**	**0.79**	**0**
Washington St – SB	TR	F	180.1	1.26	228	E	78.1	0.98	179					F	231.0	1.37	267
North Int. Kent St – WB	L	D	42.4	0.21	9	D	42.4	0.21	9					D	48.7	0.25	10
Kent St – WB	R	D	42.8	0.23	9	D	42.8	0.23	9					D	49.3	0.28	10
Harvard St – NB	**T**	**A**	**0.6**	**0.37**	**8**	**A**	**0.6**	**0.37**	**8**					**A**	**1.0**	**0.39**	**8**
Harvard St – SB	**T**	**A**	**9.2**	**0.68**	**253**	**A**	**8.9**	**0.68**	**253**					**D**	**36.0**	**0.92**	**552**
Overall (Note: acts as 2 ints.)		**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**					**–**	**–**	**–**	**–**
Washington at Boylston/High										Not recommended				Transit signal priority[4]			
Boylston St – EB	TR	D	39.2	0.89	303	C	33.6	0.84	296					D	47.9	0.94	303
Washington St – WB	T	F	140.6	1.23	345	F	109.7	1.16	530					F	170.1	1.29	542
Washington St – WB	**R**	**A**	**4.5**	**0.31**	**52**	**A**	**4.1**	**0.31**	**52**					**A**	**4.2**	**0.30**	**52**
High St – NB	LTR	D	40.9	0.66	92	D	44.0	0.71	92					F	45.9	0.70	92
Washington St – SB	**L**	**D**	**50.7**	**0.91**	**145**	**E**	**25.5**	**0.94**	**147**					**C**	**26.0**	**0.48**	**125**
Washington St – SB	TR	F	182.0	1.29	426	F	201.8	1.34	435					F	98.7	1.08	409
Overall		**F**	**86.4**	**1.14**	**–**	**E**	**78.2**	**1.14**	**–**					**F**	**85.9**	**1.10**	**–**

TABLE D-2 cont. PM-Peak-Hour Level-of-Service Summary

Intersection/Approach[1]	Mvmt	Existing Conditions				Alt. 1 (Intersect. Timings)				Alt. 2 (Bus Timings)				Alt. 3 (TSP)			
		LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]
Boston Intersections																	
Huntington at S. Huntington						Existing timings optimal								Not recommended			
Huntington Ave – EB	**T**	**D**	**36.5**	**0.72**	**165**					**D**	**35.4**	**0.70**	**160**				
Huntington Ave – EB	R	B	12.2	0.35	57					B	12.2	0.35	57				
Huntington Ave – WB	L	D	43.2	0.74	151					D	43.2	0.74	151				
Huntington Ave – WB	**T**	**B**	**13.8**	**0.45**	**104**					**B**	**13.4**	**0.44**	**97**				
South Huntington Ave – NB	L	E	57.7	0.90	216					E	63.3	0.93	223				
South Huntington Ave – NB	R	D	38.5	0.69	126					D	40.3	0.71	129				
Overall		**C**	**31.2**	**0.79**	**–**					**C**	**31.8**	**0.79**	**–**				
Huntington at Parker Hill														Not recommended			
Huntington Ave – EB	**TR**	**B**	**13.8**	**0.60**	**170**	**B**	**11.7**	**0.57**	**143**	**B**	**12.9**	**0.59**	**156**				
Huntington Ave – WB	**LT**	**C**	**24.8**	**0.86**	**235**	**B**	**19.8**	**0.81**	**196**	**C**	**22.6**	**0.84**	**216**				
Parker Hill Ave – NB	LR	F	95.7	0.95	170	F	157.6	1.13	199	F	118.5	1.01	177				
Overall		**C**	**26.0**	**0.88**	**–**	**C**	**28.3**	**0.87**	**–**	**C**	**26.7**	**0.87**	**–**				
Huntington at Tremont						Existing timings optimal								Restripe Tremont WB L/T			
Huntington Ave – EB	**LTR**	**F**	**229.7**	**1.41**	**505**					**F**	**188.8**	**1.32**	**480**	**F**	**230.5**	**1.41**	**505**
Huntington Ave – WB	L	F	106.7	0.98	40					E	79.9	0.91	37	F	106.7	0.98	40
Huntington Ave – WB	TR	C	32.2	0.76	224					C	29.8	0.73	214	C	32.6	0.77	225
Tremont St – NB	**L**	–	–	–	–					–	–	–	–	F	256.9	1.44	263
Tremont St – NB	**LTR**	**E**	**58.8**	**1.49**	**176**					**E**	**72.3**	**1.63**	**182**	**C**	**30.3**	**0.49**	**140**
Francis St – SB	LTR	F	46.0	1.34	298					F	236.1	1.39	304	F	158.8	1.21	278
Calumet St – NB	R	C	25.9	0.13	22					C	27.4	0.14	23	C	26.0	0.13	22
Overall		**F**	**136.3**	**1.30**	**–**					**F**	**127.4**	**1.27**	**–**	**F**	**144.3**	**1.38**	**–**
Tremont at St. Alphonsus														IB: shared RT/QJ			
Tremont St – EB	**R**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	**–**	B	11.4	0.07	9
Tremont St – EB	**LTR**	**C**	**26.3**	**0.79**	**181**	**C**	**30.8**	**0.83**	**194**	**C**	**22.8**	**0.75**	**169**	C	23.0	0.72	159
Tremont St – WB	**LTR**	**D**	**49.6**	**0.97**	**253**	**E**	**63.2**	**1.02**	**270**	**D**	**38.8**	**0.93**	**236**	**D**	**50.0**	**0.98**	**253**
St. Alphonsus St – NB	LTR	C	27.6	0.64	93	C	24.6	0.59	89	C	31.9	0.71	98	C	27.6	0.64	93
St. Alphonsus St. – SB	LTR	F	115.7	1.12	187	F	81.0	1.02	162	F	166.5	1.25	204	F	115.7	1.12	187
Overall		**D**	**52.9**	**1.03**	**–**	**D**	**51.7**	**1.02**	**–**	**E**	**58.8**	**1.04**	**–**	**D**	**51.7**	**1.03**	**–**

TABLE D-2 cont. PM-Peak-Hour Level-of-Service Summary

Intersection/Approach[1]	Mvmt	Existing Conditions				Alt. 1 (Intersect. Timings)				Alt. 2 (Bus Timings)				Alt. 3 (TSP)			
		LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]
Tremont at Parker														Transit signal priority[4]			
Tremont St – EB	**LTR**	**D**	**50.6**	**0.95**	**464**	**D**	**46.0**	**0.93**	**455**	**D**	**42.3**	**0.92**	**446**	**D**	**42.6**	**0.92**	**461**
Tremont St – WB	**LT**	**D**	**47.0**	**0.84**	**292**	**C**	**24.4**	**0.82**	**310**	**D**	**41.3**	**0.79**	**281**	**C**	**30.0**	**0.81**	**280**
Tremont St – WB	R	C	24.2	0.17	70	A	5.1	0.17	17	C	23.0	0.16	69	B	14.4	0.16	46
Parker St – SB	LTR	F	164.7	1.25	405	F	182.6	1.29	414	F	203.4	1.33	423	F	177.0	1.27	446
Overall		**F**	**82.2**	**1.07**	**–**	**E**	**78.6**	**1.07**	**–**	**F**	**89.2**	**1.07**	**–**	**E**	**77.8**	**1.04**	**–**
Tremont at Terrace														Transit signal priority[4]			
Tremont St – EB	**LTR**	**B**	**10.9**	**0.68**	**210**	**A**	**4.4**	**0.78**	**91**	**B**	**10.5**	**0.68**	**214**	**A**	**8.7**	**0.67**	**191**
Tremont St – WB	**LTR**	**B**	**18.1**	**0.45**	**217**	**B**	**19.0**	**0.52**	**218**	**B**	**18.5**	**0.45**	**217**	**A**	**5.6**	**0.45**	**76**
Terrace St – NB	LTR	F	218.0	1.35	343	E	61.2	0.93	241	F	218.0	1.35	343	F	255.8	1.43	346
Overall		**E**	**62.5**	**0.83**	**–**	**C**	**23.6**	**0.83**	**–**	**E**	**62.6**	**0.83**	**–**	**E**	**65.6**	**0.83**	**–**
Tremont at Columbus														Not recommended			
Tremont St – EB	**LTR**	**F**	**233.4**	**1.93**	**297**	**F**	**140.6**	**1.93**	**359**	**F**	**175.3**	**1.69**	**277**				
Tremont St – WB	**LT**	**F**	**222.9**	**1.37**	**212**	**F**	**96.6**	**1.06**	**176**	**F**	**169.5**	**1.24**	**200**				
Tremont St – WB	R	D	35.9	0.24	0	C	32.5	0.24	0	C	34.9	0.24	0				
Columbus Ave – NB	L	F	887.9	2.76	206	F	887.5	2.76	207	F	887.9	2.76	206				
Columbus Ave – NB	TR	C	31.6	0.87	193	E	61.8	1.03	209	D	40.4	0.94	204				
Columbus Ave – SB	L	F	955.9	3.00	188	F	956.3	3.00	188	F	955.9	3.00	188				
Columbus Ave – SB	TR	D	42.6	0.90	237	E	205.5	1.06	257	D	51.8	0.97	238				
Overall		**F**	**179.0**	**1.49**	**–**	**F**	**161.3**	**1.48**	**–**	**F**	**165.8**	**1.48**	**–**				
Malcolm X at Shawmut														Not recommended			
Malcolm X Blvd – EB	**LTR**	**B**	**15.6**	**0.37**	**96**	**B**	**15.8**	**0.37**	**102**	**B**	**15.6**	**0.37**	**96**				
Malcolm X Blvd – WB	**LTR**	**A**	**9.9**	**0.31**	**30**	**A**	**3.38**	**0.31**	**14**	**A**	**6.3**	**0.31**	**17**				
Shawmut Ave – NB	L	F	143.9	1.15	135	F	124.1	1.12	125	D	146.9	1.15	135				
Shawmut Ave – NB	TR	B	19.5	0.29	55	B	19.8	0.29	56	C	21.7	0.29	64				
Shawmut Ave – SB	L	C	25.4	0.37	93	C	25.1	0.36	89	C	25.4	0.37	93				
Shawmut Ave – SB	T	D	35.1	0.76	244	C	34.4	0.76	234	D	35.1	0.76	244				
Shawmut Ave – SB	R	D	35.6	0.76	206	D	35.1	0.75	197	D	35.6	0.76	206				
Overall		**C**	**31.7**	**0.68**	**–**	**C**	**29.5**	**0.67**	**–**	**C**	**31.1**	**0.68**	**–**				

TABLE D-2 cont. PM-Peak-Hour Level-of-Service Summary

Intersection/Approach[1]	Mvmt	Existing Conditions				Alt. 1 (Intersect. Timings)				Alt. 2 (Bus Timings)				Alt. 3 (TSP)			
		LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]	LOS	Delay[2]	V/C	Q[3]
Dudley at Washington														Not recommended			
Malcolm X Blvd – EB	**TR**	**B**	**18.7**	**0.54**	**216**	**C**	**21.2**	**0.59**	**142**	**B**	**18.2**	**0.51**	**135**				
Dudley St – WB	**L**	D	41.2	0.73	88	E	25.1	0.85	69	C	32.7	0.68	76				
Dudley St – WB	T	**C**	**23.9**	**0.63**	**265**	**C**	**22.6**	**0.69**	**302**	**C**	**20.7**	**0.61**	**231**				
Washington St – NB	**L**	C	29.6	0.05	7	C	35.6	0.05	7	C	30.3	0.06	7				
Washington St – NB	R	F	138.9	1.17	167	F	42.0	1.02	148	F	178.3	1.26	176				
Washington St – SB	L	F	117.0	1.10	236	F	39.4	0.99	208	F	141.2	1.16	251				
Washington St – SB	T	D	37.4	0.70	156	C	33.6	0.63	152	D	42.3	0.74	162				
Washington St – SB	R	C	23.5	0.08	9	C	22.5	0.07	4	C	27.2	0.08	10				
Overall		**E**	**55.3**	**0.89**	**–**	**D**	**47.0**	**0.92**	**–**	**E**	**64.1**	**0.88**	**–**				
Dudley at Warren St														Not recommended			
Dudley St – EB	L	C	28.3	0.66	113	C	25.9	0.64	108	C	23.1	0.62	105				
Dudley St – EB	**T**	**B**	**19.3**	**0.38**	**148**	**B**	**17.5**	**0.38**	**141**	**B**	**15.8**	**0.36**	**137**				
Dudley St – EB	R	A	4.1	0.45	0	A	4.7	0.45	0	A	2.8	0.45	0				
Dudley St – WB	TR	C	22.5	0.44	36	C	26.2	0.46	42	C	22.7	0.42	38				
Warren St – NB	T	C	20.6	0.63	176	C	20.9	0.63	155	C	22.9	0.67	177				
Warren St – NB	R	A	7.3	0.02	1	A	9.6	0.02	1	A	9.0	0.02	0				
Overall		**B**	**17.3**	**0.64**	**–**	**B**	**17.5**	**0.63**	**–**	**B**	**16.4**	**0.64**	**–**				

1. Route 66 approaches are shown in bold.
2. Delay is measured in seconds.
3. 50th percentile queue, measured in feet.
4. TSP was modeled by changing the signal from an actuated, coordinated signal to a semi-actuated, uncoordinated signal. Cycle lengths may vary.