BOSTON REGION METROPOLITAN PLANNING ORGANIZATION

Stephanie Pollack, MassDOT Secretary and CEO and MPO Chair
Karl H. Quackenbush, Executive Director, MPO Staff

TECHNICAL MEMORANDUM

DATE: **June 9, 2016**

TO: **Scott Hamwey, Project Supervisor**
MassDOT Office of Transportation Planning

FROM: **Nicholas Hart, Principal Transportation Planner**
CTPS Transit Service Planning Group

RE: **Prioritization of Dedicated Bus Lanes**

The continued growth in demand for MBTA services, coupled with the challenging funding environment for major capital expansion projects, suggests that one of the best approaches to increasing the reach of high-quality transit service is through improvements in bus operations. This study was conducted to help MassDOT prioritize segments of Greater Boston roadways that might benefit from the installation of dedicated bus lanes.

This memorandum contains the following sections:

1 BACKGROUND

Typically, installation of dedicated bus lanes is considered on urban streets with relatively high bus and general traffic volumes where many buses and their passengers are subjected to delay, and where dedicated bus lanes can significantly increase bus travel speeds, bus reliability, and bus operating efficiency. In conjunction with other transit-supportive roadway strategies and long-term, transit-supportive planning goals, dedicated bus lanes help to improve service for current riders while also attracting new riders and creating more compact, walkable, transit-oriented neighborhoods.

The purpose of this study is to identify segments of Greater Boston roadways where installation of dedicated bus lanes would provide the most effective benefit to bus riders, as measured by the current rate of delay that they encounter. The results of this study will be used to inform city planners and city officials of the

locations of roadway segments with comparatively high rates of bus passenger delay, so that they may work with stakeholders to design and implement dedicated bus lanes where appropriate.

While this study assesses bus lane warrant based on existing travel conditions, it is not intended to discount the fact that bus lanes may provide further value by their potential to help achieve long-term, transit-supportive planning goals and policies. It is beyond the scope of this project to quantify the impact of bus lanes on automobile users, mode shift, the local economy, transit-oriented development, and other indirect effects that encompass the full scope of bus lane benefits.

2 ASSESSING THE RATE OF WEEKDAY BUS PASSENGER DELAY

The Central Transportation Planning Staff (CTPS) to the Boston Region Metropolitan Planning Organization (MPO) used traffic speed data and MBTA bus passenger load data derived from automatic passenger counter (APC) data to assess the average weekday rate of bus passenger delay over roadway segments that carry on average more than 1,500 weekday MBTA bus passengers in one direction. To calculate the rate of bus passenger delay over a specified roadway segment, CTPS multiplied the amount of roadway delay occurring at each point in time a bus trip is scheduled to traverse the roadway segment by the average weekday number of bus passengers who are on board that trip. CTPS aggregated the rate of bus passenger delay for each scheduled weekday trip for all trips over the specified roadway segment to form the total rate of bus passenger delay for an average weekday for that segment. Appendix A shows the network of roadways carrying, on average, more than 1,500 weekday MBTA bus passengers in one direction.

To assess the level of roadway delay on each roadway segment, staff used historical traffic speeds from the CTPS INRIX database. CTPS uploaded travel speed data for Tuesdays, Wednesdays, and Thursdays from April 1–April 13, 2012; April 23–May 25, 2012; and September 10–October 26, 2012, for a total of 42 days of data (21 days in the spring and 21 days in the fall). Staff calculated the amount of roadway delay on a roadway segment at each point in time from the difference in observed speed at that time and the baseline speed, where baseline speed is equivalent to either the posted speed limit of the roadway segment or the average speed over the roadway segment between 2:00 AM and 4:00 AM (free-flow speed), whichever is lowest. CTPS chose an approach using historical traffic speeds to assess the amount of roadway delay met by each bus trip because it provides a consistent and objective assessment across the study region. Staff did not use existing bus run-time data to estimate potential running time savings. It is difficult to properly estimate running time for a bus along a

roadway segment under peak passenger demand and free-flow (bus lane) conditions because existing data for bus running times under free-flow conditions often occurs at times of day when delay from passenger boarding and alighting activity is low and when stops are sometimes bypassed.

Figure 1 provides a sample of observed speed, average speed, and baseline speed by time of day for a specified roadway segment. As an example calculation of the rate of roadway delay, using a bus trip occurring at 5:00 PM over the sample roadway segment, the rate of roadway delay is measured as the difference between the observed speed of 18 miles per hour (mph) (3.33 minutes per mile) and the baseline speed of 30 mph (2.00 minutes per mile, circled in Figure 1), which equals 1.33 minutes per mile.

Figure 1
Observed Speed, Average Observed Speed, and Baseline Speed for a Sample Roadway Segment

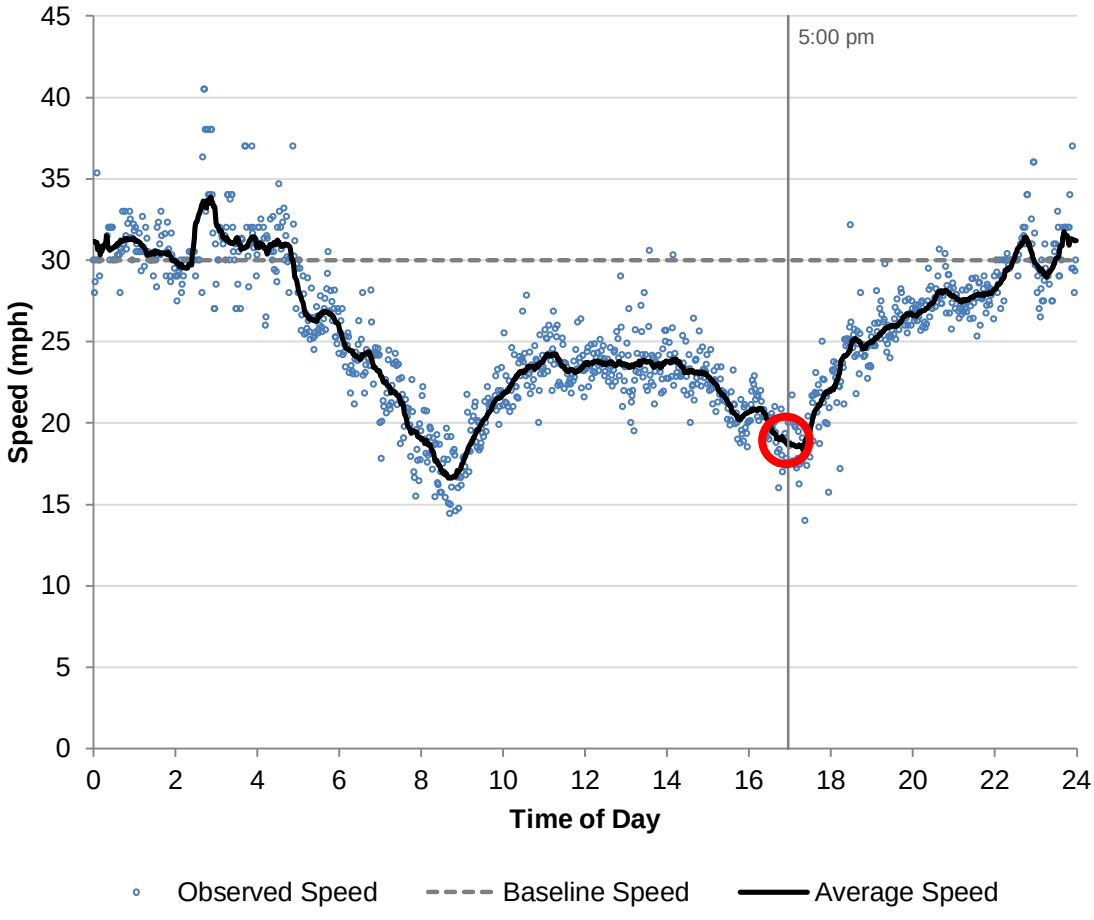
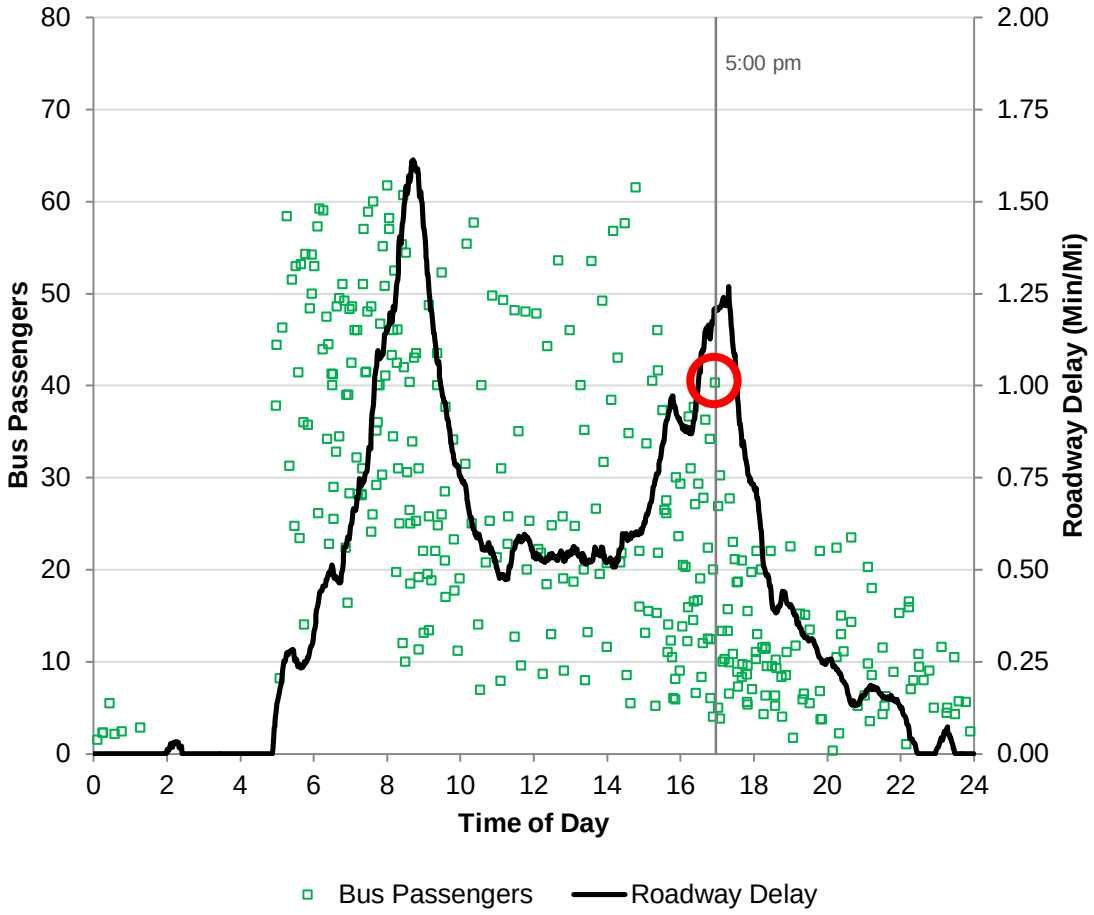


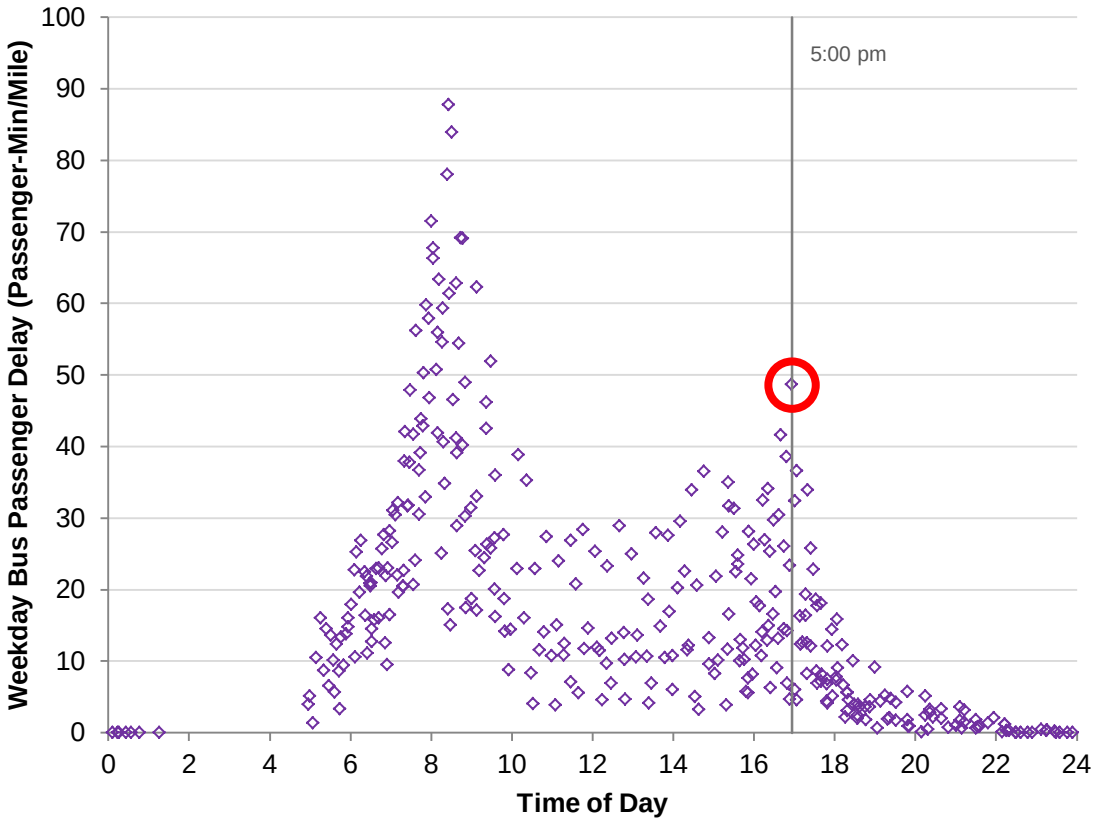
Figure 2 shows the average weekday passenger load on each scheduled trip by time of day that traverses the sample roadway segment with the continuous level of roadway delay at each point in time calculated from Figure 1. Using the same weekday bus trip scheduled to traverse over the sample roadway segment at 5:00 PM (circled in Figure 2), to determine the average rate of weekday bus passenger delay for that bus trip over the specified roadway segment (48.8 passenger-minutes/mile), one would multiply the average number of weekday passengers on board the bus (41) by the average roadway delay at 5:00 PM (1.19 min/mile).

Figure 2
Average Weekday Passenger Load and Roadway Delay for a Sample Roadway Segment



The resulting average rate of weekday bus passenger delay for the 5:00 PM bus trip over the specified roadway segment is circled in Figure 3, which shows the average rate of weekday bus passenger delay for each bus trip traversing the sample roadway segment. We aggregated the average rate of weekday bus passenger delay for each bus trip traversing the sample roadway to form the total average rate of weekday bus passenger delay over the roadway segment (6,489 passenger-minutes/mile).

Figure 3
Average Rate of Weekday Bus Passenger Delay per Trip over a Sample Roadway Segment



Appendix B shows the rate of weekday bus passenger delay for roadway segments that carry, on average, more than 1,500 weekday MBTA bus passengers in one direction.

3 ROADWAY SEGMENTS WITH COMPARATIVELY HIGH RATES OF WEEKDAY BUS PASSENGER DELAY

Once CTPS staff calculated the average weekday rate of bus passenger delay for roadway segments that carry, on average, more than 1,500 weekday MBTA bus passengers in one direction, we assessed the network for corridors that had comparatively high rates of weekday bus passenger delay. Installation of dedicated bus lanes would provide the most effective benefit to bus riders in these corridors. Table 1 and Appendix C show the locations of the identified corridors with comparatively high rates of weekday bus passenger delay. To determine the average rate of weekday bus passenger delay along each corridor, provided in Table 2, we weighted each segment by its length.

For intersections located along the identified corridors, CTPS staff obtained peak-hour turning movements from the Boston Transportation Department and the Cambridge Traffic, Parking, and Transportation Department. CTPS used these turning movements to estimate the bus passenger percentage of motorized roadway users along the corridor during the AM peak and PM peak hours of traffic volume, shown in Appendix D and Appendix E. From the turning movements, we derived the number of roadway users along each segment by assuming 1.38 occupants per car and 1 occupant per heavy vehicle. To determine the average bus passenger percentage of motorized roadway users along each corridor, provided in Table 3, we weighted each segment by its length.

Table 1
Corridors with Comparatively High Rates of Weekday Bus Passenger Delay

Corridor	City	Bus Routes Affected
Between North Washington Street at the Route 1 off-ramp and North Washington Street at Valenti Way	Boston	MBTA Routes: 92, 93, 111, 426, 428 Partners Shuttles: Charlestown Navy Yard to MGH SRH to North Station
Between Massachusetts Avenue at Storrow Drive and Massachusetts Avenue at Albany Street	Boston	MBTA Routes: 1, CT1 MASCO Shuttle: Route M2 - Cambridge to HMS
Between Massachusetts Avenue at Western Avenue and Massachusetts Avenue at Memorial Drive	Cambridge	MBTA Routes: 1, CT1, 64, 70, 70A MASCO Shuttle: Route M2 - Cambridge to HMS
Between Washington Street at Warren Street and Washington Street at Melnea Cass Boulevard	Boston	MBTA Routes: 1, 8, 19, 47, SL4, SL5
Between Ruggles Street at Ruggles Station and Dudley Street at Warren Street	Boston	MBTA Routes: 14, 15, 22, 23, 28, 41, 44, 45, 66
Between Warren Street at Dudley Street and Blue Hill Avenue at Geneva Avenue	Boston	MBTA Routes: 14, 19, 23, 28, 44, 45
Between Blue Hill Avenue at Columbia Road and Blue Hill Avenue at Talbot Avenue	Boston	MBTA Routes: 14, 22, 28, 29, 45
Between Washington Street at Forest Hills Station and Washington Street at Cummins Highway	Boston	MBTA Routes: 30, 34, 34E, 35, 36, 37, 40, 50, 51
Between Huntington Avenue at South Huntington Avenue and Huntington Avenue at Tremont Street	Boston	MBTA Routes: 39, 66
Between Brighton Avenue at Cambridge Street and Brighton Avenue at Harvard Avenue	Boston	MBTA Routes: 57, 57A, 66

HMS = Harvard Medical School. MASCO = Medical Academic and Scientific Community Organization.
MGH = Massachusetts General Hospital. SRH = Spaulding Rehabilitation Hospital.

Table 2
Weekday Bus Passenger Delay along Identified Corridors

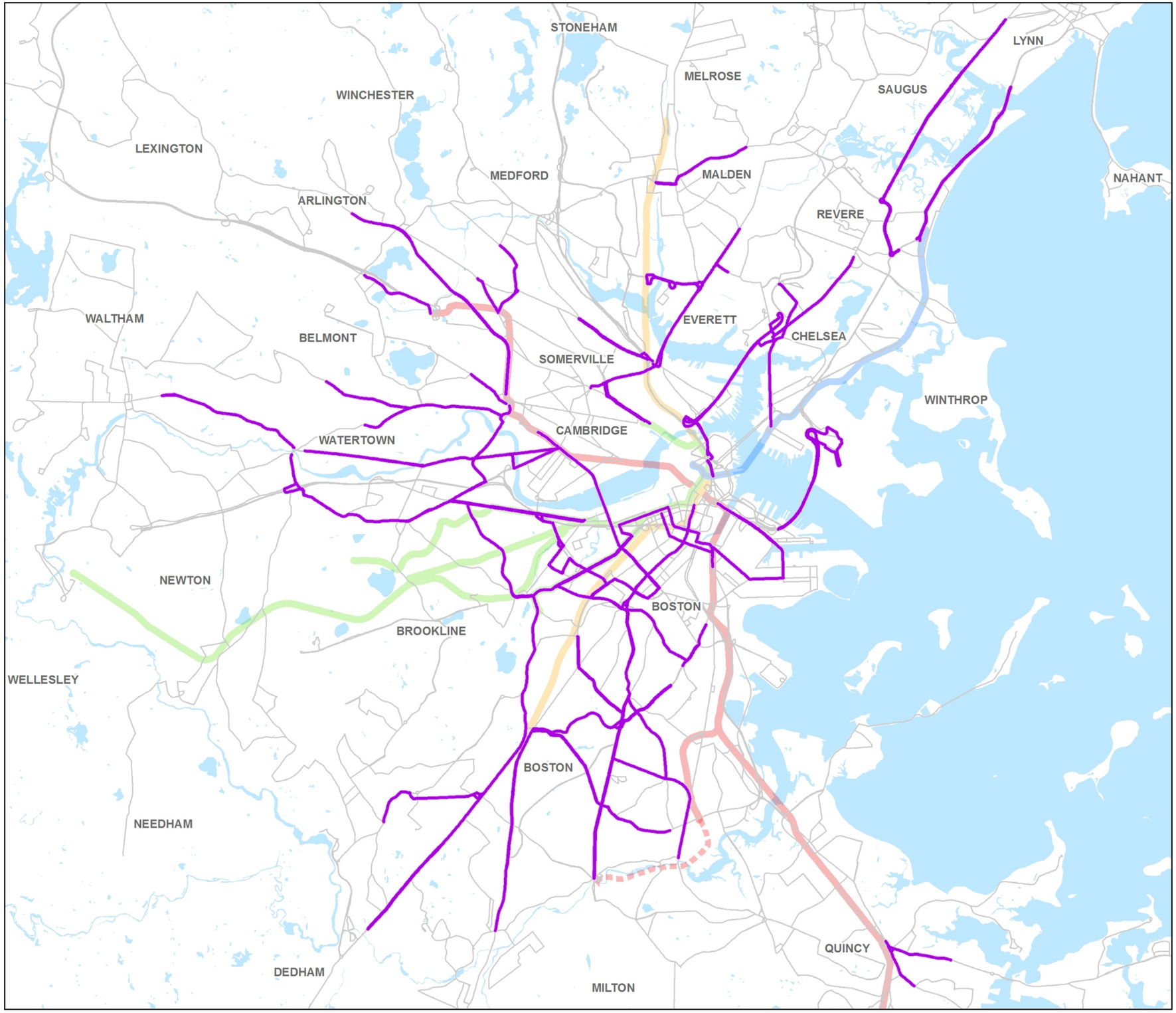
Corridor	Length	Average Rate of Weekday Bus Passenger Delay Along the Corridor (Passenger-Hours/Mile)	Cumulative Weekday Bus Passenger Delay Along the Corridor (Passenger-Hours)
Between North Washington Street at the Route 1 off-ramp and North Washington Street at Valenti Way	0.61 mile	Northbound: 55.5 Southbound: 99.0	Northbound: 33.9 Southbound: 60.4
Between Massachusetts Avenue at Storrow Drive and Massachusetts Avenue at Albany Street	1.93 miles	Westbound: 58.6 Eastbound: 74.3	Westbound: 113.1 Eastbound: 143.3
Between Massachusetts Avenue at Western Avenue and Massachusetts Avenue at Memorial Drive	0.79 mile	Westbound: 58.5 Eastbound: 70.1	Westbound: 46.2 Eastbound: 55.4
Between Washington Street at Warren Street and Washington Street at Melnea Cass Boulevard	0.17 mile	Northbound: 124.7 Southbound: 52.5	Northbound: 21.2 Southbound: 8.9
Between Ruggles Street at Ruggles Station and Dudley Street at Warren Street	0.99 mile	Westbound: 53.1 Eastbound: 73.7	Westbound: 52.6 Eastbound: 72.9
Between Warren Street at Dudley Street and Blue Hill Avenue at Geneva Avenue	1.53 miles	Northbound: 74.7 Southbound: 67.2	Northbound: 114.3 Southbound: 102.7
Between Blue Hill Avenue at Columbia Road and Blue Hill Avenue at Talbot Avenue	0.58 mile	Northbound: 60.4 Southbound: 51.9	Northbound: 35.0 Southbound: 30.1
Between Washington Street at Forest Hills Station and Washington Street at Cummins Highway	1.14 miles	Northbound: 58.8 Southbound: 49.4	Northbound: 67.1 Southbound: 56.3
Between Huntington Avenue at South Huntington Avenue and Huntington Avenue at Tremont Street	0.42 mile	Westbound: 103.2 Eastbound: 161.0	Westbound: 43.3 Eastbound: 67.6
Between Brighton Avenue at Cambridge Street and Brighton Avenue at Harvard Avenue	0.23 mile	Westbound: 81.5 Eastbound: 89.4	Westbound: 18.7 Eastbound: 20.6

Table 3
Average Bus Passenger Percentage of Motorized Roadway Users along Identified Corridors

Corridor	Average Bus Passenger Percentage of Motorized Roadway Users Along the Corridor - AM Peak	Average Bus Passenger Percentage of Motorized Roadway Users Along the Corridor - PM Peak
Between North Washington Street at the Route 1 off-ramp and North Washington Street at Valenti Way	Northbound: 26.8% Southbound: 35.6%	Northbound: 35.8% Southbound: 23.4%
Between Massachusetts Avenue at Storrow Drive and Massachusetts Avenue at Albany Street	Westbound: 15.2% Eastbound: 23.0%	Westbound: 19.2% Eastbound: 15.9%
Between Massachusetts Avenue at Western Avenue and Massachusetts Avenue at Memorial Drive	Westbound: 24.6% Eastbound: 38.7%	Westbound: 26.8% Eastbound: 33.1%
Between Washington Street at Warren Street and Washington Street at Melnea Cass Boulevard	Northbound: 51.8% Southbound: 36.5%	Northbound: 44.0% Southbound: 39.7%
Between Ruggles Street at Ruggles Station and Dudley Street at Warren Street	Westbound: 37.1% Eastbound: 34.2%	Westbound: 22.9% Eastbound: 45.7%
Between Warren Street at Dudley Street and Blue Hill Avenue at Geneva Avenue	Northbound: 45.9% Southbound: 39.1%	Northbound: 32.3% Southbound: 44.7%
Between Blue Hill Avenue at Columbia Road and Blue Hill Avenue at Talbot Avenue	Northbound: 18.7% Southbound: 18.6%	Northbound: 17.1% Southbound: 19.6%
Between Washington Street at Forest Hills Station and Washington Street at Cummins Highway	Northbound: 58.4% Southbound: 46.1%	Northbound: 32.4% Southbound: 59.8%
Between Huntington Avenue at South Huntington Avenue and Huntington Avenue at Tremont Street	Westbound: 26.2% Eastbound: 44.7%	Westbound: 32.7% Eastbound: 29.1%
Between Brighton Avenue at Cambridge Street and Brighton Avenue at Harvard Avenue	Westbound: 42.3% Eastbound: 39.6%	Westbound: 33.0% Eastbound: 29.2%

4 SUMMARY

In this study, CTPS identified segments of Greater Boston roadways where installation of dedicated bus lanes would provide the most effective benefit to bus riders, as measured by the current rate of delay that they encounter. The results of this study will be used to inform city planners and city officials of the location of roadway segments with comparatively high rates of bus passenger delay, so that they may work with stakeholders to design and implement dedicated bus lanes where appropriate.



Appendix A
Roadways Carrying on Average More than 1,500 Weekday MBTA Bus Passengers in One Direction

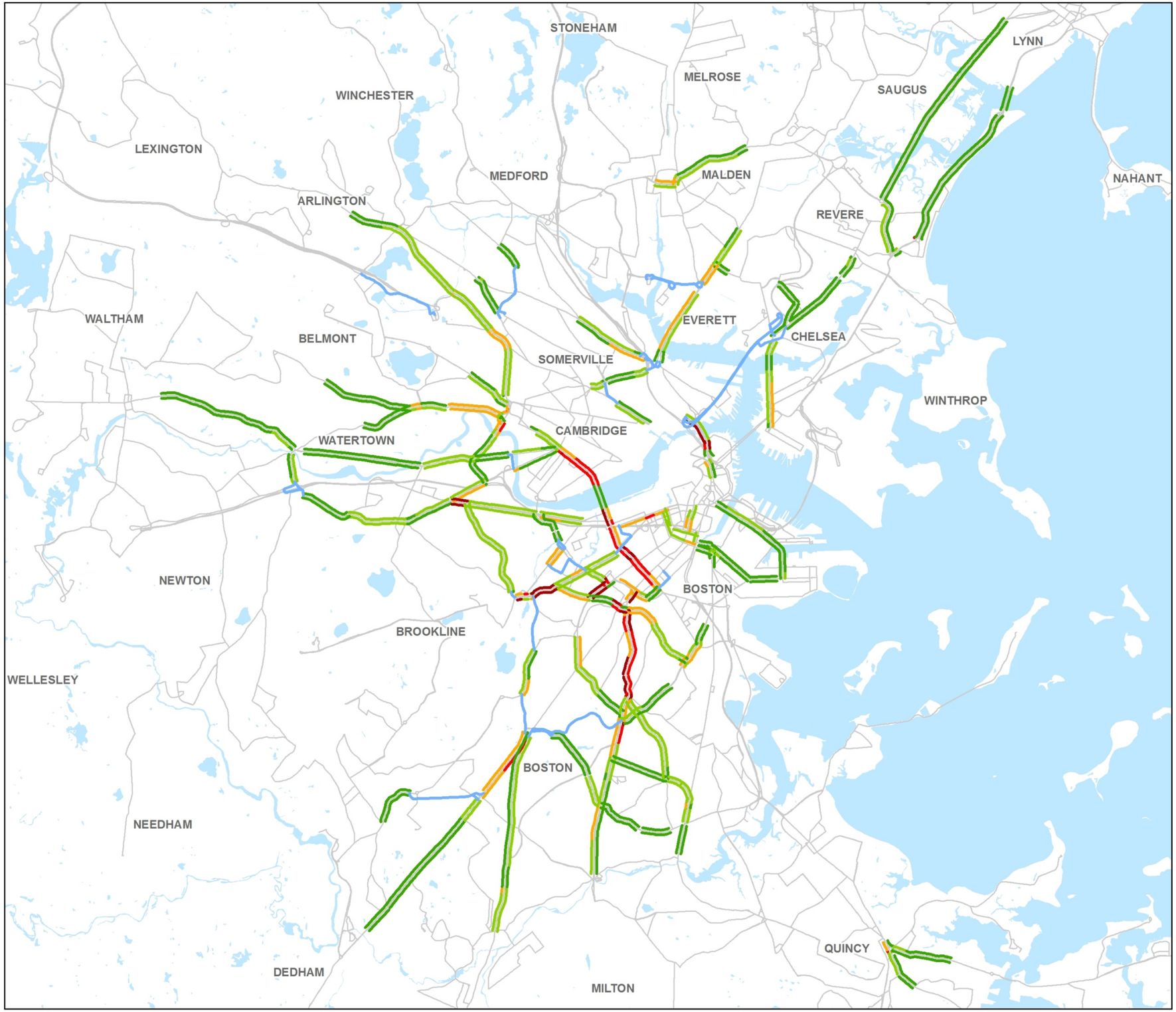
- Roadways with more than 1,500 bus passengers
- MBTA bus route
- Blue Line
- Green Line
- Orange Line
- Red Line
- Mattapan High Speed Line

N

0 0.5 1 2 3 4 Miles

Prioritization of Dedicated Bus Lanes Study

CTPS



Appendix B
Rate of Weekday Bus Passenger Delay

Delay in Passenger-Hours/Mile

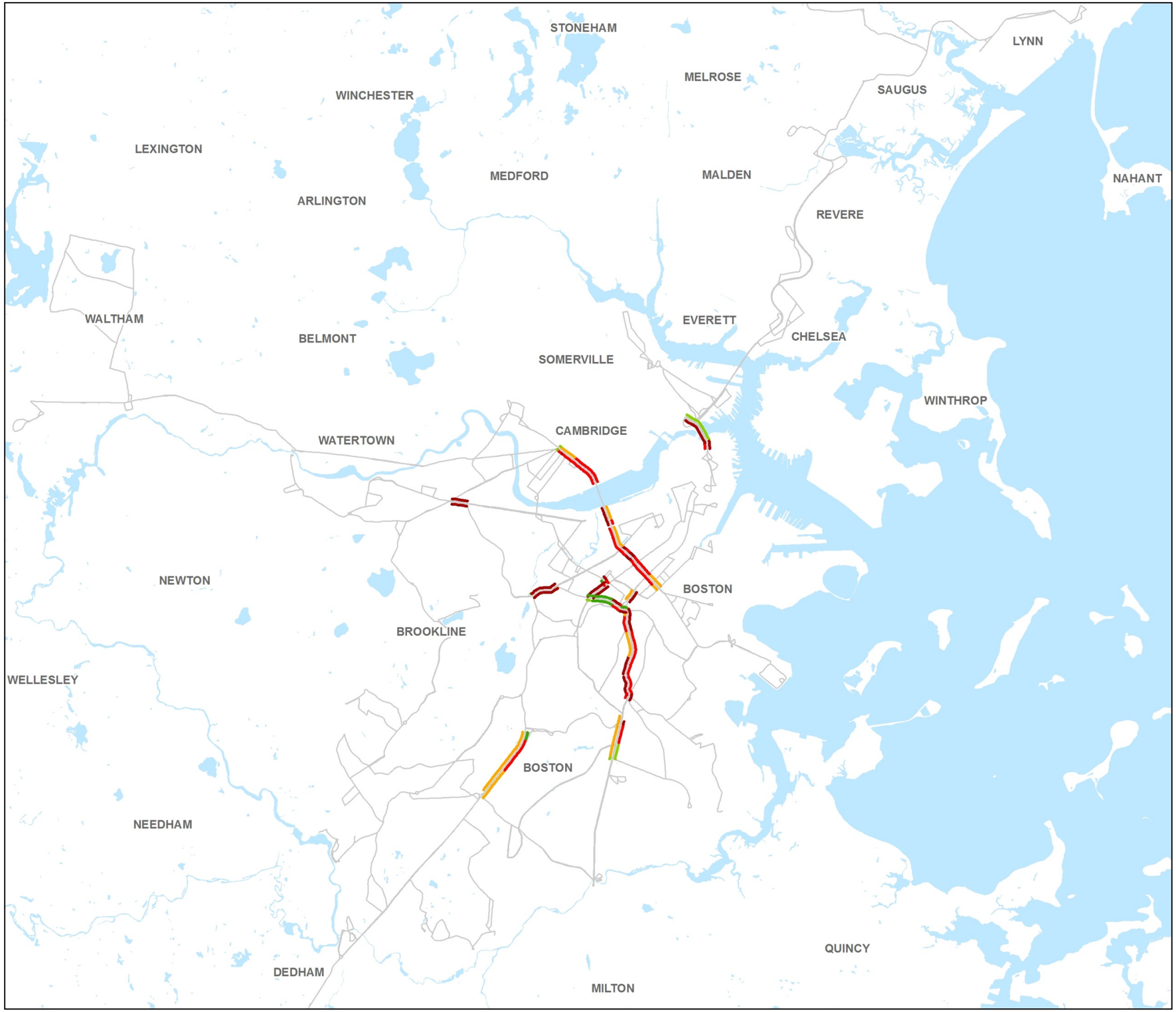
- 0 - 20
- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 235
- MBTA bus route
- INRIX speed data not available

N

0 0.5 1 2 3 4 Miles

Prioritization of Dedicated Bus Lanes Study

CTPS



Appendix C
Corridors With Comparatively High Rates of Weekday Bus Passenger Delay

Delay in Passenger-Hours/Mile

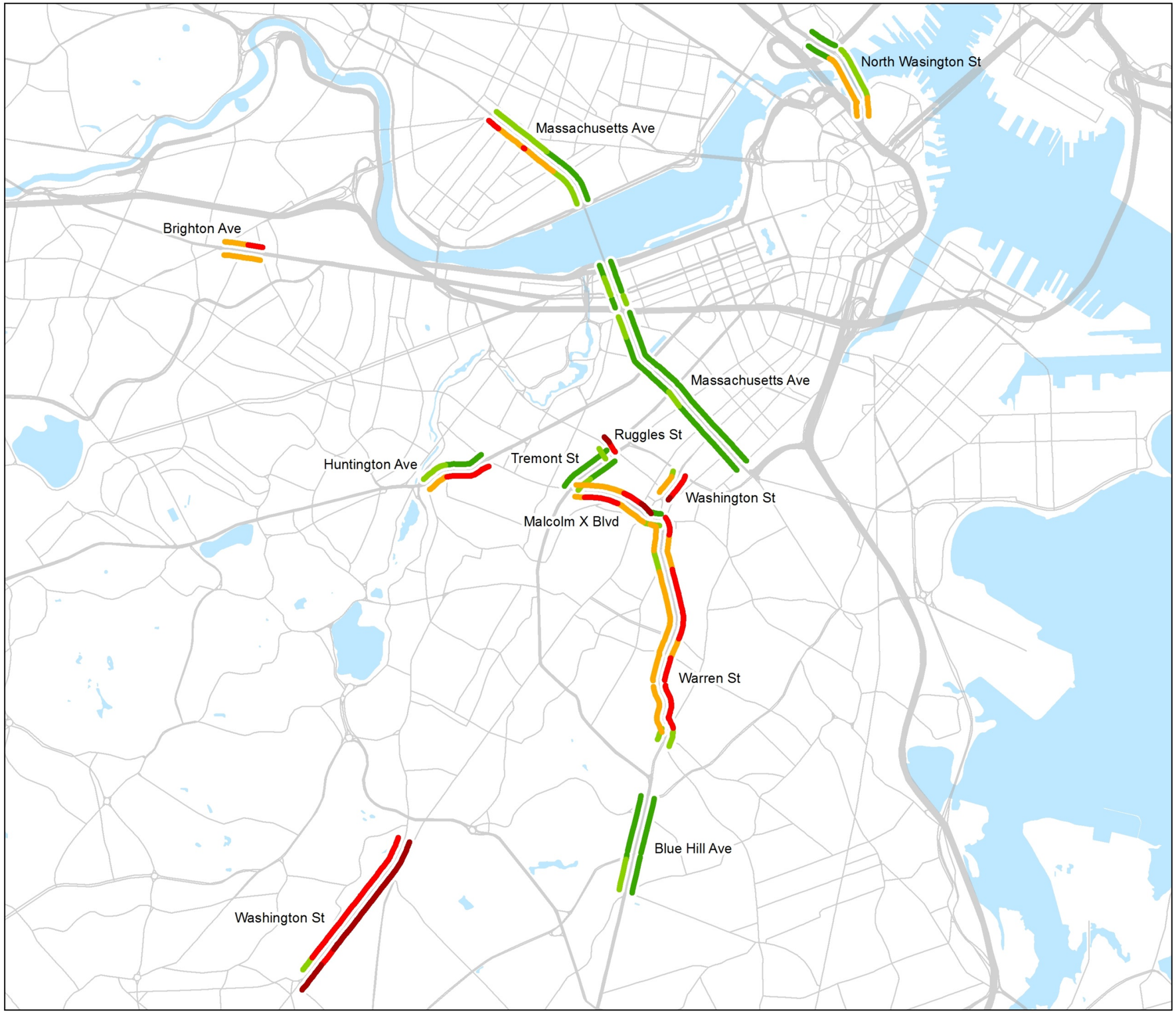
- 0 - 20
- 21 - 40
- 41 - 60
- 61 - 80
- 81 - 235
- MBTA bus route traversing high delay corridor

N

0 0.5 1 2 3 4 Miles

Prioritization of Dedicated Bus Lanes Study

CTPS



Appendix D
Bus Passenger Percentage of Motorized Roadway Users
AM Peak

Percentage bus passengers

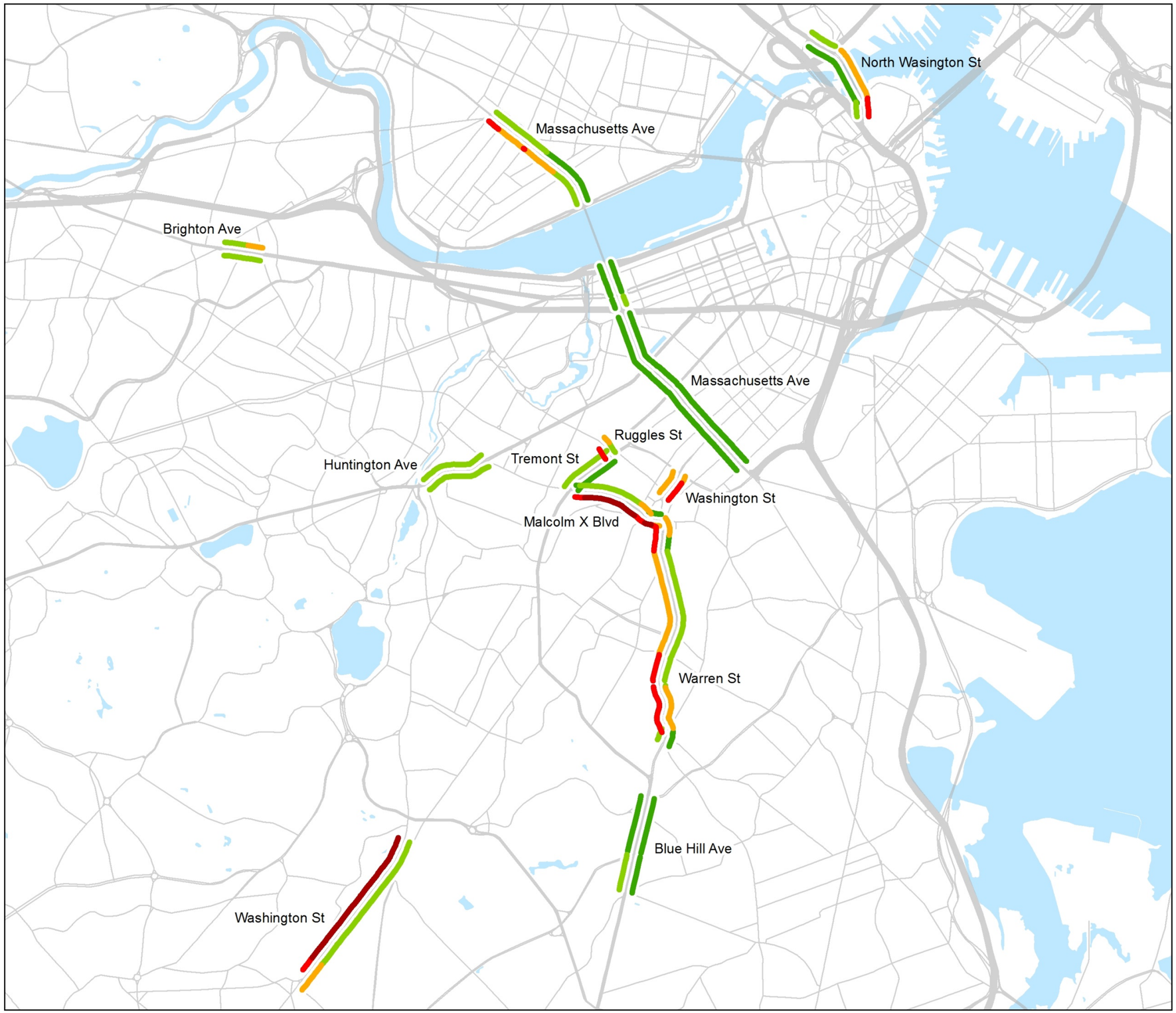
- 7 - 25
- 26 - 35
- 36 - 45
- 46 - 55
- 56 - 62
- Road network

N

0 0.25 0.5 1 Miles

Prioritization of Dedicated Bus Lanes Study

CTPS



Appendix E
Bus Passenger Percentage of Motorized Roadway Users
PM Peak

Percentage bus passengers

- 5 - 25
- 26 - 35
- 36 - 45
- 46 - 55
- 56 - 63
- Road network

N

0 0.25 0.5 1 Miles

Prioritization of Dedicated Bus Lanes Study

CTPS