Project Context

Why are buses (MBTA and private) so important?

- MBTA Routes 71 and 73 provide 12,000 weekday daily passenger trips compared to 19,000 daily vehicle trips—while MBTA buses are only 3% of the vehicles on the street, MBTA buses carry over half of the people on the street at certain points.
- For private shuttles, Mt. Auburn Hospital runs shuttles continuously to two off-site parking lots in Watertown from roughly 5:30am to 10:00am and 2:00pm to 8:45pm, and another 8 midday trips. Athenahealth has 30 shuttle trips per day on Mount Auburn St.
- This pilot addresses some of the worst MBTA bus delay and unreliability in Cambridge. A 2014 transit delay and reliability study showed that in the morning rush hours (7-9am) there were a total of almost 80 hours of passenger delay experienced in the segment approaching Coolidge Ave (eastbound).
- The more transit ridership we can encourage, the less drivers will be contributing to congestion on the street, especially in the rush hours.

Pilot Area

MBTA Route 73 (Harvard to Waverly Square)
MBTA Route 71 (Harvard to Watertown Square)

City Policies

2016 Cambridge and 2017 Watertown Complete Streets policies:
Complete Streets are designed and operated to enable safe access for all users—regardless of age, ability, or mode of transportation.

2016 Vision Zero policy:
Calls for the elimination of fatalities and serious injuries resulting from traffic crashes, and emphasizes that they can and should be prevented.

Vehicle and MBTA bus counts compared to people counts on Mt. Auburn Street from Brattle to Coolidge in the morning rush hour

(Source: DCR Public Presentation, January 10, 2016, Slide 70)
Design – What did we do?

Pilot Features

- Partnership between Cambridge, Watertown, DCR, and MBTA
- Minimal or no construction, paint, signal changes, signs
- No specific timeframe, intended to test and evaluate to develop long-term plan
- Education and enforcement during transitional period

What do we mean by a “Pilot”?

Features/Elements

- All day bus/bike-only lanes eastbound (toward Harvard)
- All day bus/bike-only for a short section westbound (toward Watertown Square)
- One queue jump signal at DCR’s Coolidge Ave intersection
- Transit signal priority at two Cambridge intersections
- Bike lanes in Cambridge westbound (toward Watertown/Belmont)
- Two additional Watertown queue jump lanes (see below)

Watertown Queue Jump Lanes

- Inbound right turn/queue jump lanes which allow buses to get to the front of an intersection
- Right turns on red allowed at all times
- Parking restricted in AM

Outreach / Implementation Timeline

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan/Mar, 2018</td>
<td>Internal stakeholder City Advisory Committees</td>
</tr>
<tr>
<td>Feb 15, 2018</td>
<td>Watertown Mt. Auburn corridor transit meeting</td>
</tr>
<tr>
<td>Mar 27, 2019</td>
<td>Joint Strawberry Hill Neighborhood Meeting</td>
</tr>
<tr>
<td>Mar/April 2018</td>
<td>Outreach to external stakeholders (businesses, institutions)</td>
</tr>
<tr>
<td>April/May, 2018</td>
<td>Data collection for pre implementation evaluation</td>
</tr>
<tr>
<td>May 1, 2018</td>
<td>Joint Watertown/Cambridge public meeting</td>
</tr>
<tr>
<td>May 14, 2018</td>
<td>Watertown Mt. Auburn Project Open House</td>
</tr>
<tr>
<td>Summer 2018</td>
<td>Finalize design and prepare for implementation, Mayor’s Program youth street teams, partial implementation</td>
</tr>
<tr>
<td>October 2018</td>
<td>Full implementation, evaluate and refine</td>
</tr>
<tr>
<td>Spring 2019</td>
<td>Data collection for post implementation evaluation</td>
</tr>
</tbody>
</table>
We used MBTA Automatic Passenger Count (APC) data to look at the delay and unreliability for buses in bus stop-to-bus stop segments. The change in standard deviation of delay from segment to segment was used to estimate reliability. Mt. Auburn Street between Aberdeen and Coolidge Ave was identified to have some of the worst delay and reliability for buses in all of Cambridge.

- Primarily two lanes of travel in each direction
- On-street parking exists on Mt. Auburn Street only west of Belmont Street and on Belmont Street. We did not remove parking in the pilot, except for roughly one parking spot on Brattle Street near the reconfigured intersection with Mount Auburn.

Source: Google Maps

Density map of crashes requiring EMS transport, reported by responding officer

See City of Cambridge Crash Analysis Summary.
http://www.cambridgema.gov/cpd/Publications/2017/05/cityofcambridgecrashanalysissummary
**Post-Pilot Conditions**

### Interim Conditions (Summer to Fall of 2018)

- Lane markings, addition of bicycle lanes westbound, transit signal priority
- Two Watertown queue jumps to allow buses to move to the front of intersection
- Resulted in early safety improvements

**Final Pilot Conditions (fully in place in November of 2018)**

- Added bus lane markings and signs, including red paint
- Implemented signal timing changes at Mt. Auburn at Fresh Pond Parkway (DCR)

### Painted lane markings for bus/bike lanes without restricting to buses/bikes

- Mt. Auburn St @ Brattle St

### Clarified traffic flow and increase markings for pedestrian crossings

- Mt. Auburn St @ Homer bus stop

### Added westbound bicycle lanes

- Mt. Auburn St @ Homer bus stop

### Reduced number of lanes pedestrians cross on Mt. Auburn at Brattle Street

- Mt. Auburn St @ Brattle St

### Added green street markings at conflict areas for cyclists

- Mt. Auburn St @ Homer bus stop

### Added yield markings to pedestrian crossing on Brattle Street

- Brattle St @ Mount Auburn

### “Teed” off intersection at Brattle St. with cones and markings to give priority to traffic on Mt. Auburn Street and to improve safety

- Mt. Auburn St @ Brattle St

### Installed bus queue jumps at Walnut and School Streets to allow buses to bypass cars stopped at intersection

- Mt. Auburn St @ Homer bus stop

### Added bus/bike-only red lane and other markings and signs throughout the project area

- Mt. Auburn St @ School St

### Added bus lane eastbound on Mt. Auburn at Belmont St

- Mt. Auburn St @ Homer bus stop

### Bus lane westbound on Belmont St. at St. Mary’s St.

- Brattle St @ Mount Auburn

### Bus lane eastbound on Mt. Auburn at Watertown

- Mt. Auburn St @ Brattle St

### MBTA bus and private shuttle traveling westbound in bus lane

- Mt. Auburn St @ Homer bus stop

### Added new signal equipment and updated signal timings

- Mt. Auburn St @ Brattle St

### New, retimed signals at Coolidge Ave.

- Mt. Auburn St @ School St

### Added bus lane eastbound on Mt. Auburn St. in Watertown
Outreach & Education

Flyering & Bus Shelter PSAs

March 2018
Neighborhood Meeting

May 2018
Joint Community Meeting

June 2019
Open House
Outreach & Education

Youth-led Outreach: Flyering, Street Teams, Tabling

Through the Cambridge Mayor’s Summer Youth Employment Program, Cambridge high school students spoke to people about the Mt. Auburn Bus Priority Project throughout July and August 2018.

Factsheets & Information

Online, at events, and left at doors
- FAQs (April and September)
- User guide: bus/bike lane (October)
- Q’n’A on street designs (October)

Public Events

March 27, 2018: Strawberry Hill Meeting (Russell Youth Center)
May 1: Joint Watertown-Cambridge Meeting (Tufts Health Plan Building)
October 26: Launch event at 699 Mount Auburn St.
June 12, 2019: Open house for transportation analysis

City of Cambridge:
- 1-minute “What you need to know”
- 3-minute “Learn about the bus priority lanes”
- 5-minute “Learn about the details”

Videos

City of Cambridge:
- 1-minute “What you need to know”
- 3-minute “Learn about the bus priority lanes”
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Factsheets & Information

Online, at events, and left at doors
- FAQs (April and September)
- User guide: bus/bike lane (October)
- Q’n’A on street designs (October)
Before & After Results - Route 71

The Mount Auburn Bus Priority pilot aimed to improve travel time and reliability for people on buses in the pilot area as well as the route as a whole. Results indicate that the pilot achieved this goal, with significant time savings and improvements in reliability (seen in the 90th percentile figures) on both the Route 71 and 73.

Travel times in the pilot area

**Route 71 – Pilot Area 50th %ile (Average Day)**

- Inbound: 8.5 min, 50th percentile decrease in running time at 8 a.m.
- Outbound: 5.8 min, a 23% decrease in overall running time.

**Route 71 – Pilot Area 90th %ile (Typical Bad)**

- Inbound: 12.1 min, 90th percentile increase in running time at 9 a.m.
- Outbound: 8.1 min, a 32% increase in overall running time.

We used the 50th percentile travel time because it represents the time it takes a bus to travel through the project area on a typical weekday.

Travel time variance is the difference between the travel time on a typical day (50th percentile) and on the "typical bad day" (90th percentile) in the project area. We show travel time variance because it is how we measure the day-to-day reliability of buses. One way to describe variance is the "planning" time or additional time that people use as a "buffer" for in their trips to account for delays on the bus.

On the charts above, we show the travel times for typical weekdays, typical bad weekdays, and the change in the variance before and after we changed the street. Not only did the bus travel faster on typical and typical bad weekdays, but, the pilot also decreased the variance in the project area meaning that after all the changes, people could depend on the bus to travel even closer to the regular schedule.

For more information, visit the MBTA blog: https://www.mbtabackontrack.com/blog/46-how-the-mbta-tracks-vehicles

Notes on data

This data is from the "Main Pilot Area," the area marked in green on the map above. The MBTA collected data using 2 time frames:
- Pre-Pilot: March 19 - May 4, 2018, Monday through Friday
- Post-Pilot: March 18 - May 3, 2019, Monday through Friday

The source of this data is Automatic Vehicle Location (AVL) data that tracks vehicles by when they arrive and leave specific "timepoints" or bus stops on a route. Specifically, the "Main Pilot Area" is from the intersection of Mount Auburn and Belmont Streets to Mount Auburn Hospital stops, as shown above.

For more information, visit the MBTA blog: https://www.mbtabackontrack.com/blog/46-how-the-mbta-tracks-vehicles
Before & After Results - Route 73

The Mount Auburn Bus Priority pilot aimed to improve travel time and reliability for people on buses in the pilot area as well as the route as a whole. Results indicate that the pilot achieved this goal, with significant time savings and improvements in reliability (seen in the 90th percentile figures) on both the Route 73 and 71.

Travel times in the pilot area

**Route 73 – Pilot Area 50th %ile (Average Day)**

<table>
<thead>
<tr>
<th>Direction</th>
<th>Average Travel Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inbound</td>
<td>8.9 min</td>
</tr>
<tr>
<td>Outbound</td>
<td>6.0 min</td>
</tr>
</tbody>
</table>

**Route 73 – Pilot Area 90th %ile (Typical Bad)**

<table>
<thead>
<tr>
<th>Direction</th>
<th>Average Travel Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inbound</td>
<td>12.1 min</td>
</tr>
<tr>
<td>Outbound</td>
<td>8.3 min</td>
</tr>
</tbody>
</table>

We used the 50th percentile travel time because it represents the time it takes a bus to travel through the project area on a typical weekday. We chose the 90th percentile travel time because it represents the time it takes a bus to travel through the project area on a day with serious congestion. Here we call the 90th percentile travel time as “typical bad”. The 90th percentile travel time is the kind of trip where congestion is bad, an event is happening, or other factors can create slow travel. The 90th percentile travel time is also important because the MBTA plans its schedules based on the 90th percentile travel time.

Travel time variance is the difference between the travel time on a typical day (50th percentile) and on the “typical bad day” (90th percentile) in the project area. We show travel time variance because it is how we measure the day-to-day reliability of buses. One way to describe variance is the “planning” time or additional time that people use as a “buffer” for their trips to account for delays on the bus.

On the charts above, we show the travel times for typical weekdays, typical bad weekdays, and the change in the variance before and after we changed the street. Notably, the travel time through the pilot area segment on the worst day is now less than the travel time on an average day before the pilot. Therefore, the pilot significantly increased the overall reliability of the bus and made the worst day travel time more similar to the average day.

Travel times in the pilot areas throughout the entire day

**Notes on data**

Travel data is from the “Main Pilot Area,” the area marked in green on the map above. The MBTA collected data using 2 time frames:
• Pre-Pilot: March 19 - May 4, 2018, Monday through Friday
• Post-Pilot: March 18 - May 3, 2019, Monday through Friday

The source of this data is Automatic Vehicle Location (AVL) data that tracks vehicles by when they arrive and leave specific “timepoints” or bus stops on a route. Specifically, the “Main Pilot Area” is from the intersection of Mount Auburn and Belmont Streets to Mount Auburn Hospital stops, as shown above.

Travel time for bus riders in the pilot area segment traveling towards Harvard improved not only during the rush hour, but throughout the day. The pink in the charts to the left represents the time savings at each hour for both a typical (50th percentile) and “typical bad” (90th percentile) travel day.

This data is from the “Main Pilot Area,” the area marked in green on the map above. The MBTA collected data using 2 time frames:
• Pre-Pilot: March 19 - May 4, 2018, Monday through Friday
• Post-Pilot: March 18 - May 3, 2019, Monday through Friday

The source of this data is Automatic Vehicle Location (AVL) data that tracks vehicles by when they arrive and leave specific “timepoints” or bus stops on a route. Specifically, the “Main Pilot Area” is from the intersection of Mount Auburn and Belmont Streets to Mount Auburn Hospital stops, as shown above.

For more information, visit the MBTA blog: https://www.mbtabackontrack.com/blog/46-how-the-mbta-tracks-vehicles
Before & After Results – Vehicles

Traffic volume counts and a travel time survey were completed for the study corridor before and after implementation of the bus lanes to understand impacts to drivers.

Key Results

- Vehicle volumes are about the same throughout the day
- No indication of traffic diversion to parallel routes
- Vehicle travel times did not indicate a significant impact to drivers as a result of the pilot
- Off-peak traffic does not experience delay due to bus lanes

Vehicle Travel Times

- The largest increase was up to 2 minutes during evening rush hour towards Harvard. This increase affects about 1/3 of vehicles on the street at that time which is far less of the people travelling on the street at that time. 
- Measured travel time was more reliable in the morning rush hour: The maximum observed travel time was 13 minutes before vs. 9 minutes after. The largest increase in morning rush hour was 30 seconds. 
- The measured increase in travel time in the westbound direction in the evening rush hour doesn’t correlate with the more extensive bus data. In this direction, buses and vehicles are all operating in mixed traffic.

Data Collected

- Automated Traffic Recorders to understand daily traffic volumes;
- Turning Movement Counts at intersections on and parallel to the corridor to understand changes in peak hour traffic volumes
- Vehicle travel time observations where bus lanes were implemented
- Vehicle queues and turning delays for two unsignalized intersections during the AM and PM peak hours

*Additional study results available upon request*
Street User Perception

We surveyed people:
• who drive, walk, bike, or take transit in the project area
• to find out people’s feelings about the function of Mount Auburn St. and levels of comfort and if people changed how often they come to Mount Auburn Street
• before implementation, between July and October 2018, and again after implementation, mid-November 2018 to February 2019

People rated Mount Auburn Street on a scale of 1 to 5 for:
<table>
<thead>
<tr>
<th>Design and function</th>
<th>Comfort</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average</strong></td>
<td><strong>Before</strong></td>
</tr>
<tr>
<td>Overall</td>
<td>2.7</td>
</tr>
<tr>
<td>Walking</td>
<td>2.9</td>
</tr>
<tr>
<td>Biking</td>
<td>2.3</td>
</tr>
<tr>
<td>Taking bus</td>
<td>2.7</td>
</tr>
<tr>
<td>Driving</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Change in use or visits to Mount Auburn St. after changes to the street

<table>
<thead>
<tr>
<th></th>
<th>Less</th>
<th>Same</th>
<th>More</th>
<th>Ride in the new lanes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Overall</strong></td>
<td>9%</td>
<td>70%</td>
<td>21%</td>
<td>--</td>
</tr>
<tr>
<td>Walking</td>
<td>5%</td>
<td>80%</td>
<td>15%</td>
<td>--</td>
</tr>
<tr>
<td>Biking</td>
<td>0%</td>
<td>33%</td>
<td>42%</td>
<td>25%</td>
</tr>
<tr>
<td>Taking bus</td>
<td>0</td>
<td>60%</td>
<td>40%</td>
<td>--</td>
</tr>
<tr>
<td>Driving</td>
<td>20%</td>
<td>77%</td>
<td>3%</td>
<td>--</td>
</tr>
</tbody>
</table>

People told us their thoughts about Mount Auburn Street after implementation:

**Walking**
It has made walking on Mount Auburn Street near Belmont St much more pleasant.
It’s better than it was; automobile traffic flows better, but at some places pedestrians still have a hard time.

**Biking**
It feels much safer to bike on Mount Auburn, now.
Awesome to have a safer, almost continuous bike lane on Mount Auburn St. This street used to be terrifying to ride, and there were few alternative routes. The only downside is where the bike lane has a gap.

**Taking transit**
In the afternoons, I am able to stay at work 15 minutes longer and still arrive home at the same time as I did before. I could not be happier.
The buses are more consistent, reliable, and faster. I used to take 70 but now I take the 71 and Red Line for my commute.

**Driving**
It took a little while, but the bus-bike separated lane is great and traffic seems to be back to normal.
The new markings make it easier to navigate in a car. Much clearer which lanes are for which purpose.
Key Takeaways

Lessons Learned During Implementation

Phase 1, Summer 2018
Lane markings and two Watertown queue jumps
- Realized early safety improvements
- Maintained momentum and interest in the project

Phase 2, October 2018
Full implementation of bus priority (red lanes, TSP, queue jump signal) and signal changes at Fresh Pond Parkway
- Cold weather meant that work could not be done at night
- Took place over almost one month with ongoing signal timing adjustments

Lessons Learned Throughout the Project

- Significant resources needed for communication and monitoring
- Lane width matters – narrow lanes can be blocked
- Painting during daytime has operational impacts, and paint is less durable
- Trackless trolley wires limit changes we can make to the street
- Enforcement is challenging without safe places for police to observe traffic, i.e. no parking lanes

Key Points

More than half of the people on Mount Auburn Street headed toward Harvard Square in the morning rush hour are on the bus

People are more comfortable, especially biking
When we asked people how comfortable they are on Mount Auburn Street, the improvement was for people biking increasing from an average 2.4 to an average 3.6 out of 5.

36,000 person-hours saved on the bus
On an annual basis, we calculated a significant time savings for people on buses in the project area.

Limited negative impacts to people driving
Even though the project team made a lot of changes to the street, all our traffic data show limited negative impacts for drivers:
- Average rush hour travel times increased by less than 1 minute
- People driving told us the street feels about as comfortable and functional and almost 80% didn’t change how often they drive on Mount Auburn St.
What’s next?

Pilot Improvements

Unfunded Potential Capital Improvements to Pilot

- Make the configuration of the new Brattle-Mt. Auburn intersection more permanent, enhance plaza, improve bicycle and pedestrian facilities, and re-locate bus stop
- Improve pedestrian crossings and bicycle facilities

City of Cambridge Belmont Street Construction

- New sidewalks and paving, improve accessibility, make improvements for all users
- All of Belmont St. and Holworthy St., up to #37-39

Contact: Melissa A. Miguel, P.E., Supervising Engineer
617-349-9351, mmiguel@cambridgema.gov

Watertown’s Mt. Auburn Street

- Create a safer street through traffic calming and street design, while also maintaining street capacity
- Promote alternative modes of transportation such as walking, biking and public transit to decrease congestion
- Schedule: Design underway, construction begins 2022

More information: https://mountauburnstreet.com/