South Massachusetts Avenue Corridor Safety Improvements

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massDOT Transportation Innovation CONFERENCE

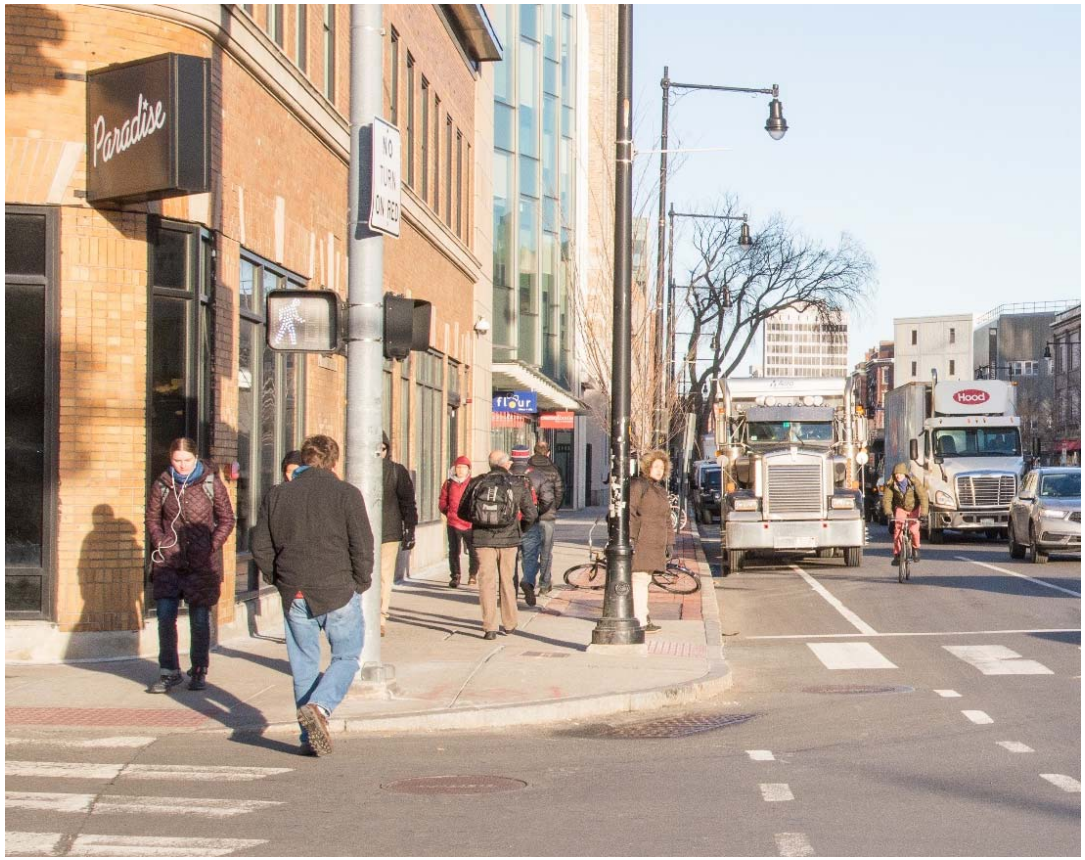
CIVICO LITERIS ANTIQVIS NOVIS INSTITVTIS DECORA
CANTABRIGIA
CONDITA A.D. 1630
CIVICO REGIMINE DONATA A.D. 1846

KLEINFELDER
Bright People. Right Solutions.

TOOLE DESIGN

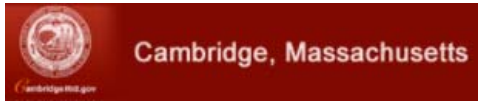
Agenda

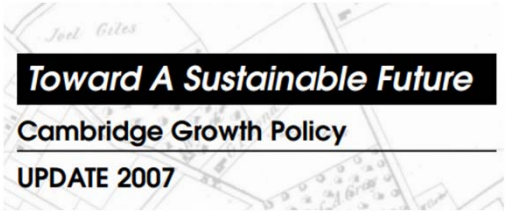
- **Project Background**
- **Corridor Information**
- **Design Toolbox**
- **Design**
- **Implementation**
- **Next Steps**
- **Questions**



Project Background

Municipal Policies





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

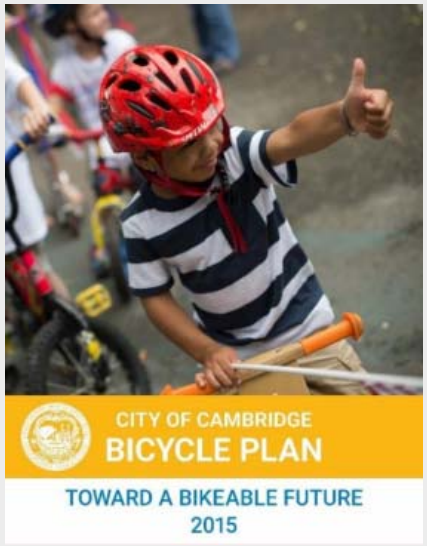
Complete Streets are designed and operated to enable safe access for *all* users – regardless of age, ability, or mode of transportation (2016).

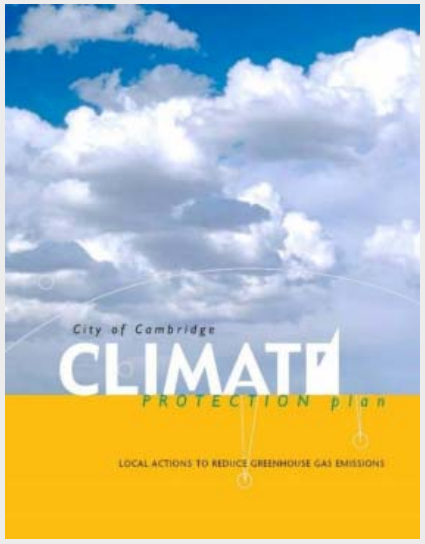
Vehicle Trip Reduction Ordinance established programs to encourage alternatives to single-occupancy vehicle travel (1992).

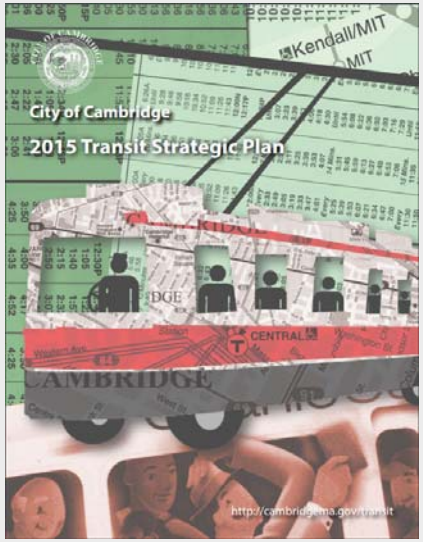
Cambridge Growth Policy emphasizes sustainable modes of transportation such as walking, biking and using transit and low-emission vehicles, which promote livability and help to improve air quality and reduce greenhouse gas emissions (1993/2007).

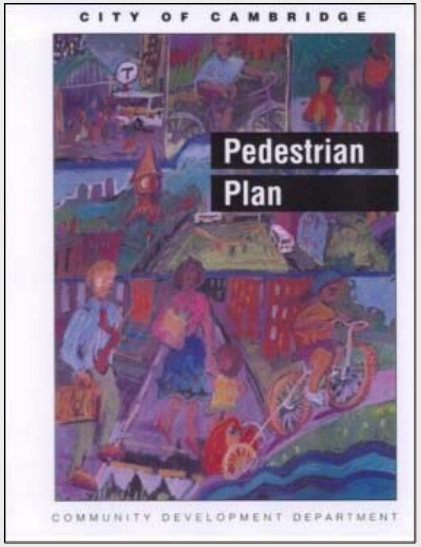
Project Background

Guiding Plans





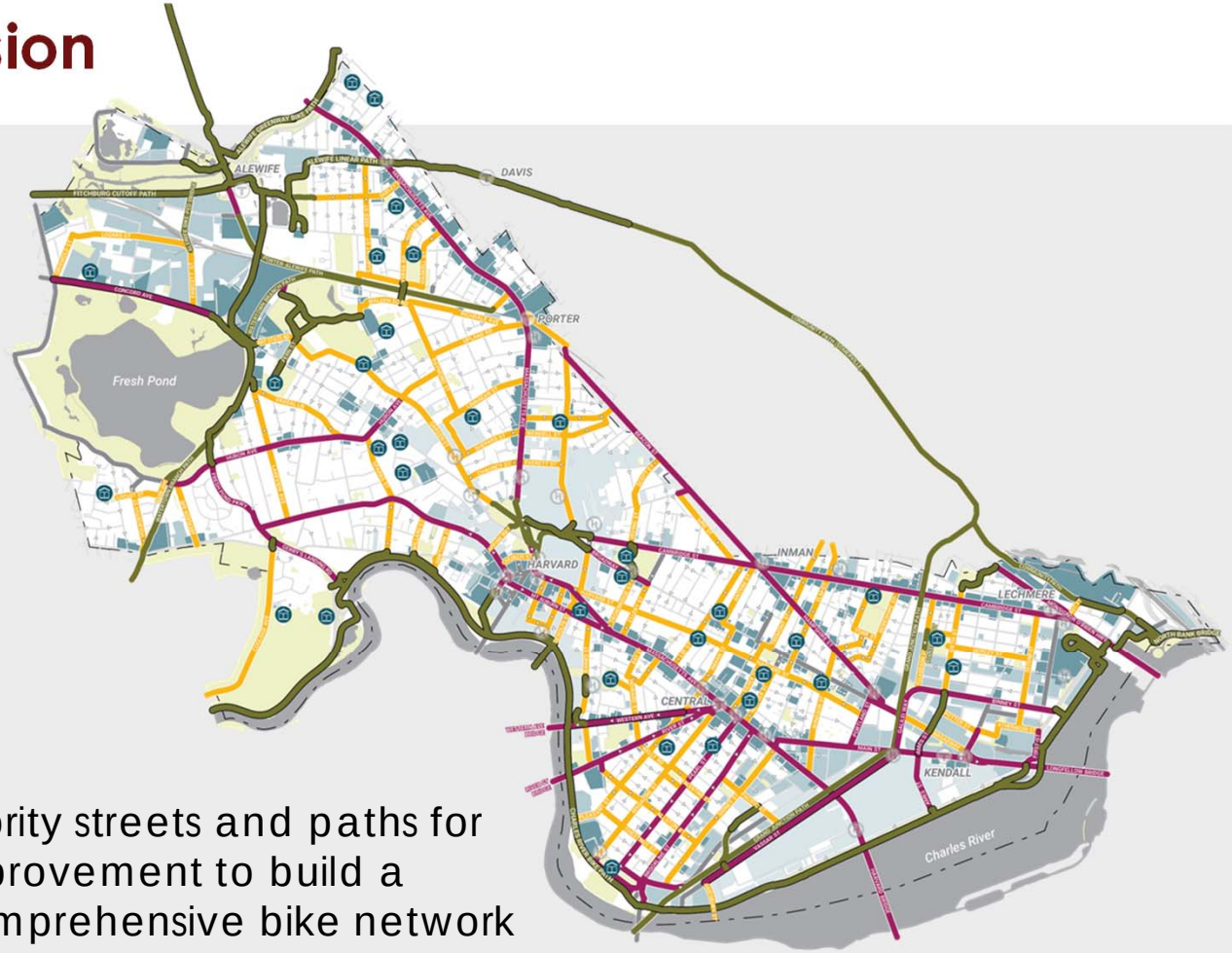




Project Background

Bicycle Network Vision

Cambridge will be a place designed to accommodate bicycling as a mode of transportation **for people of all ages and abilities.**



Priority streets and paths for improvement to build a comprehensive bike network

Corridor Information

Corridor Users: *People Biking*
Bicycle Level of Comfort (BLC) Analysis

- People have varying levels of tolerance for traffic stress created by volume, speed, proximity of adjacent traffic and on-street parking.
- An all-ages and ability network has BLC of 1 or 2
- Facilities with BLC 1 or 2 are generally safest

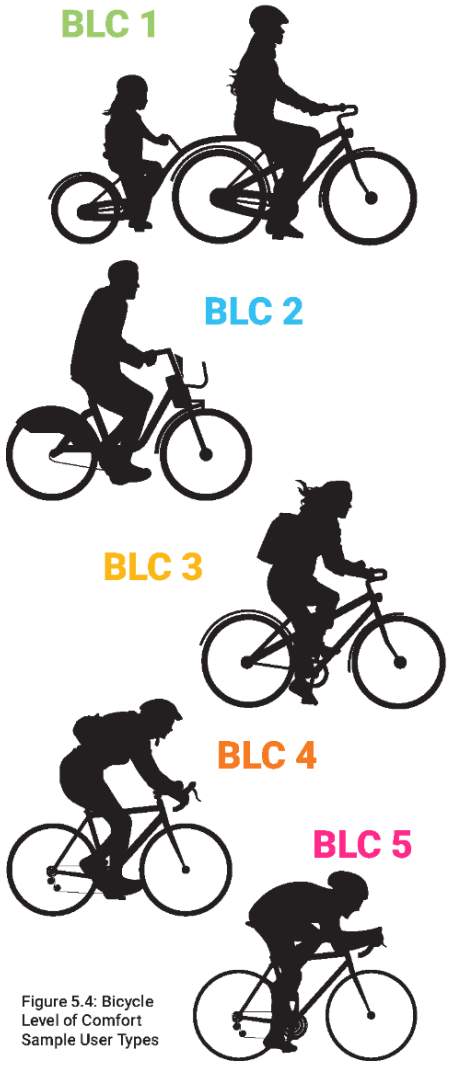
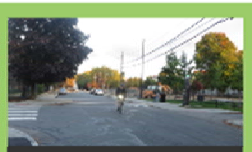
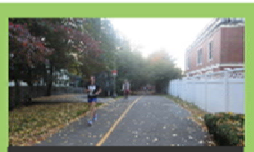
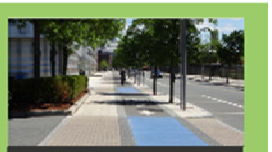
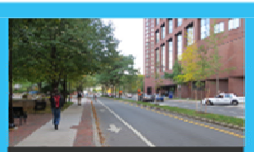
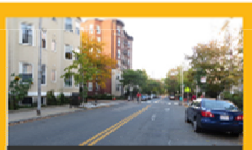
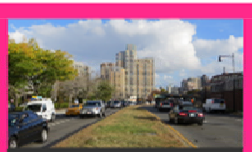


Figure 5.4: Bicycle Level of Comfort Sample User Types

Corridor Information

Corridor Users: *People Biking*

BICYCLE LEVEL OF COMFORT	TYPICAL CRITERIA	EXAMPLES		
1	Protected/Separated or Shared with ADT <2K or Shared with Speed <30 mph	 Pemberton Street	 Community Path	 Vassar Street
2	Wide/Buffered Bike Lane or Bike Lane w/out Parking adjacent or Shared with ADT 2-4K or Shared with Speed <30 mph	 Richdale Avenue	 Broadway	
3	Bike Lane adjacent to Parking or Shared with Speed 30 mph or Shared with ADT 4-6K or Narrow Operating Space	 Magazine Street	 Main Street	
4	Shared with Speed 30+ mph or Shared with ADT 6-15K or High Frequency Bus Route	 Massachusetts Avenue	 Broadway	
5	Shared with Speed 35+ mph or Shared with ADT 15+K and No Parking and 2+ Travel Lanes per direction	 Land Boulevard	 O'Brien Highway /Route 28	

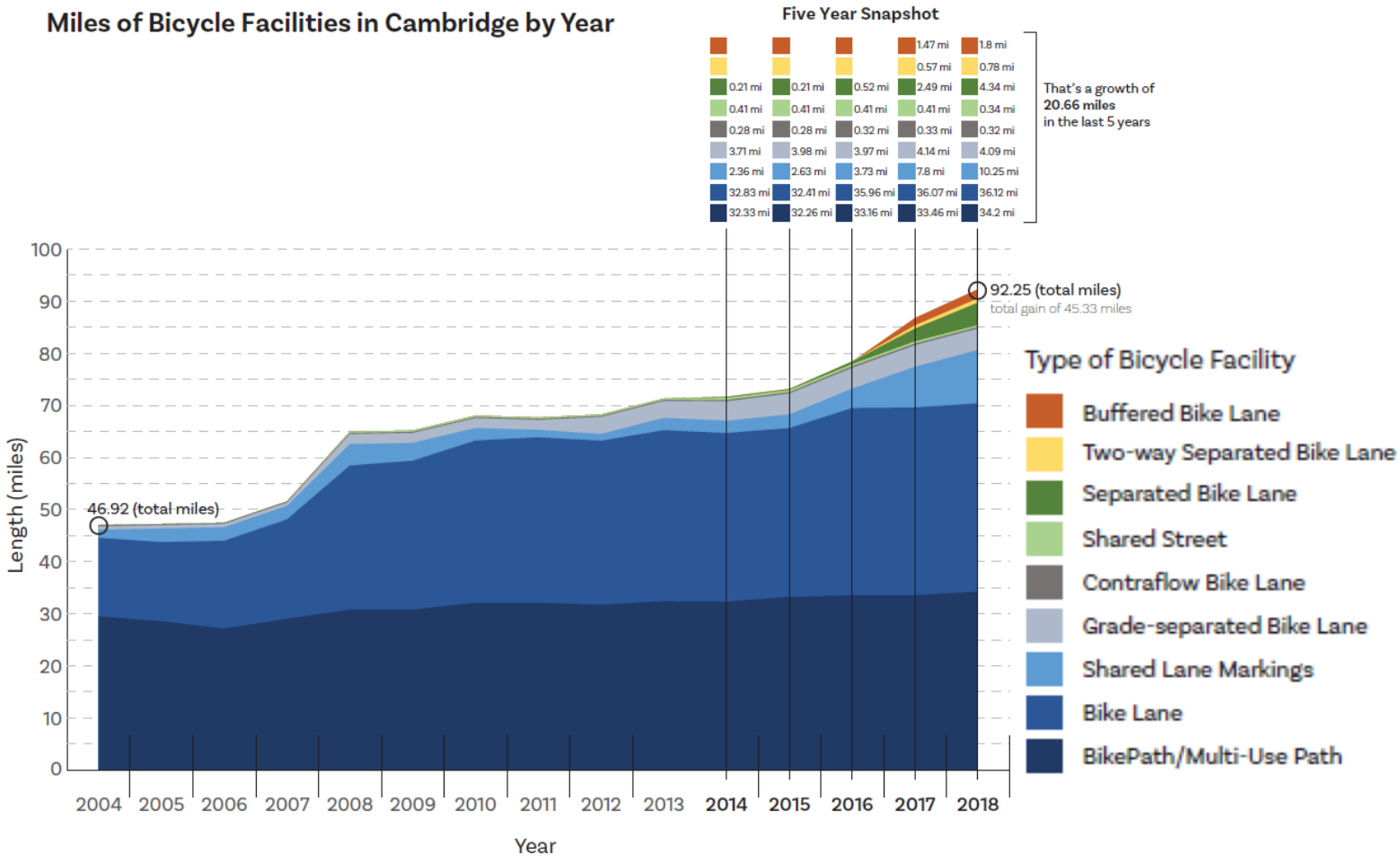
Project Background

Bicycle Network Implementation

- ✓ 5-year Plan for Sidewalk and Street Construction
- ✓ Development Mitigation
- ✓ Capital Projects
- ✓ Chapter 90 Work

Project Background

Bicycle Network Implementation



Project Background

Flexible Implementation

Based on Policies and Plans and direction of City leadership:

- Evaluate and implement **"quick build" solutions** to enhance the comfort and promote sustainable transportation for people walking, biking, driving and using transit
  - ✓ Designs that are **flexible** after implementation
  - ✓ **Modifications possible** based on evaluation (including feedback)

Project Background

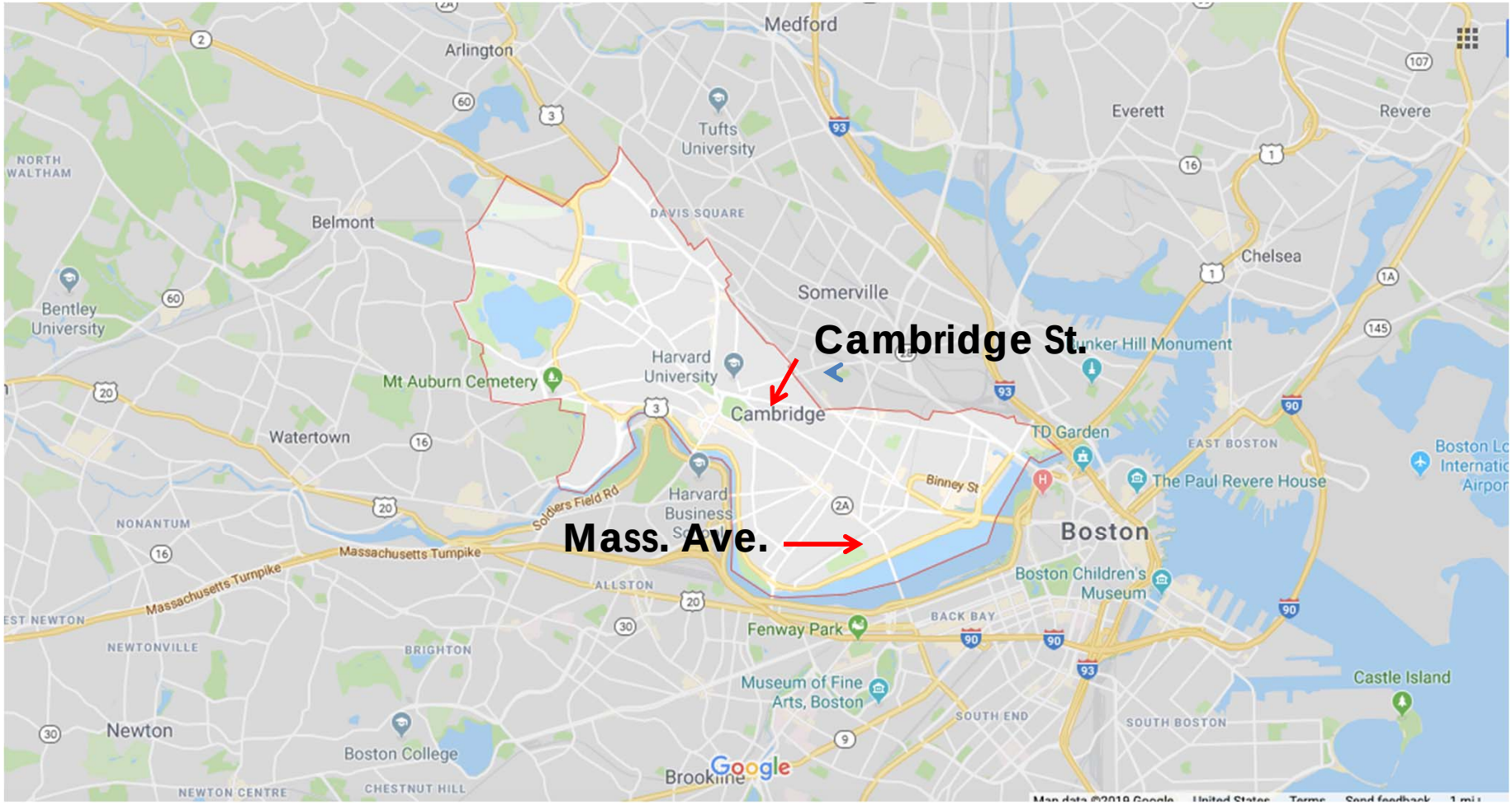
Separated Bicycle Facilities
Protected Bike Lane Safety Demonstration Projects

2016/2017

Mass. Ave. Northbound (east/odd side of the street) from Waterhouse Street to Everett Street

Cambridge Street

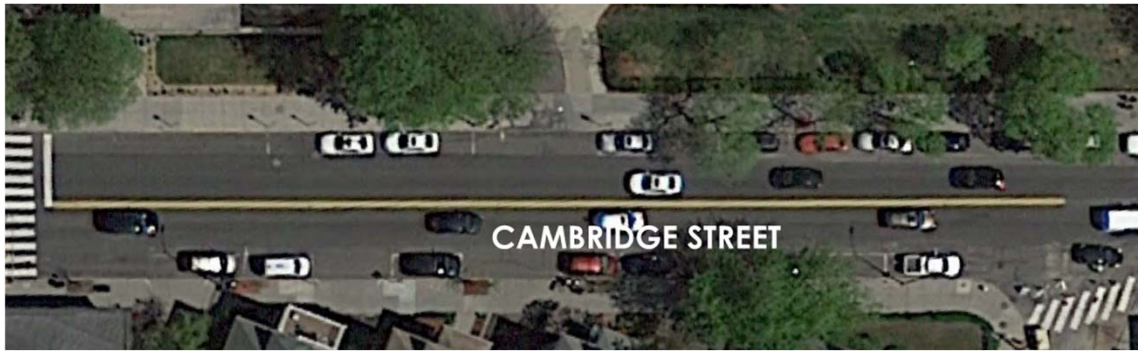
Project Background



Project Background

Separated Bicycle Facilities
Cambridge Street Project Features

- **One-way separated bicycle lanes** on each side of the roadway
- **Narrowed travel and parking lanes**
- Maintained curb to curb width
- **Removed approximately 60% of on-street parking** and reviewed curb uses and side street parking
- Used existing pavement
- Installation of **new signage**, **permanent lane striping**, and **flexible delineator posts**
- Introduced **shared bus stops**, using pavement markings and signs to delineate shared space



Project Background

Separated Bicycle Facilities
Cambridge Street Project Features

- Approximately $150,000 and 7 months to design and implement (March – September 2017)
- 2 public meetings, stakeholder group and targeted meetings
- 1 week to install with some punch list items
- 2 design concepts developed
- Existing roadway used

Project Background

Separated Bicycle Facilities
Cambridge Street Project Features

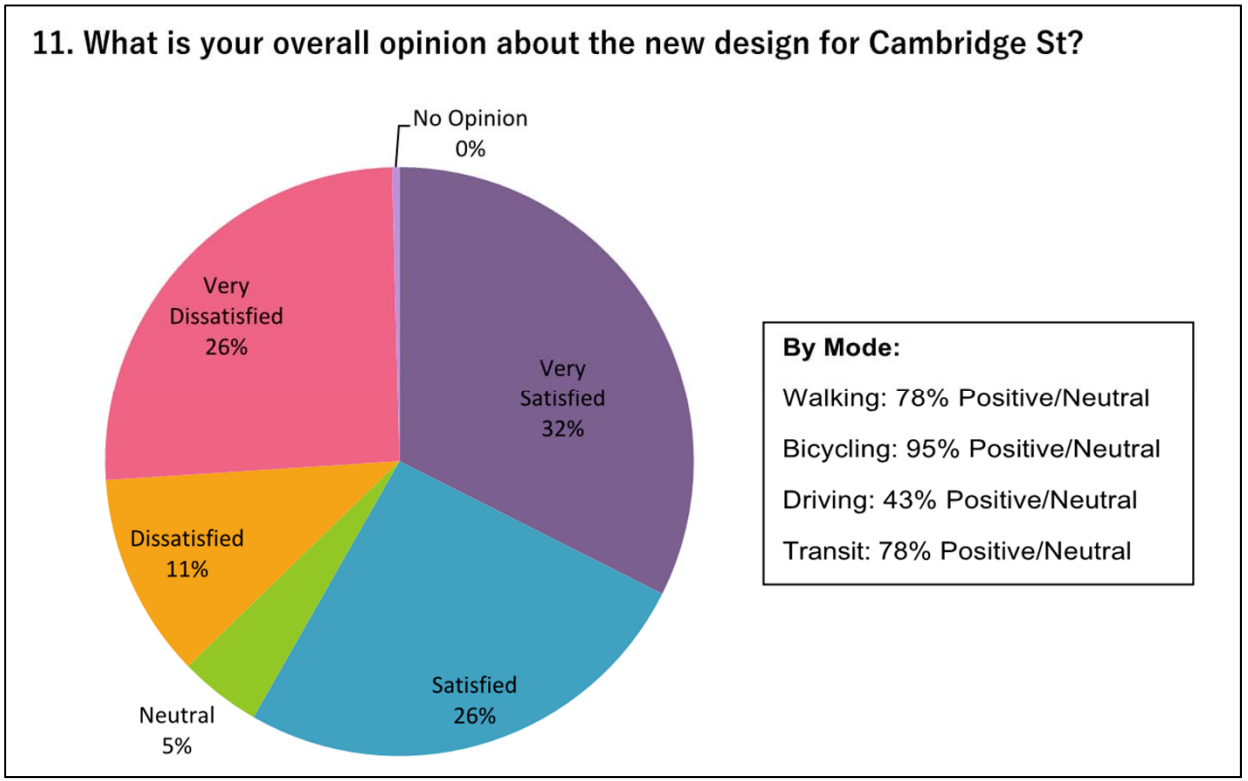
BEFORE

AFTER

Project Background

Separated Bicycle Facilities
Cambridge Street Project Post-Implementation Study

- Counts
- Speed measurements
- Observations
- Questionnaires
- Survey (paper and online): over 1,600 responses



Project Background

Separated Bicycle Facilities
Cambridge Street Project Post-Implementation Study

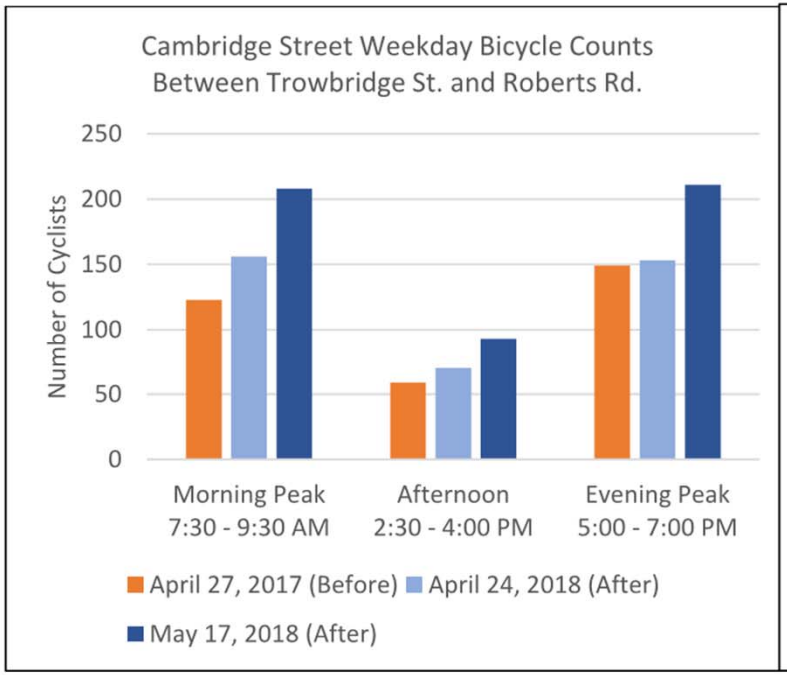
- **No significant difference in motor vehicle traffic volumes** before and after implementation (21,034 before/19,942 after from a 48-hour count).
- Motor vehicle **speeds were significantly reduced*** after the project was implemented.
- **Parking utilization rates were very similar** before and after implementation, with **some impacts on Cambridge Street**

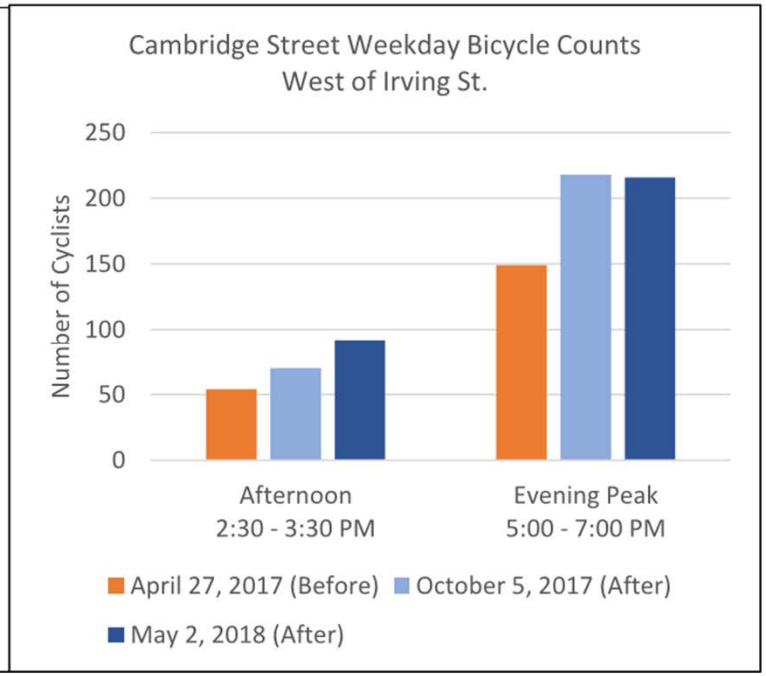
*After implementation, the 85th percentile speed for the corridor dropped by 6 MPH, from 31 MPH to 25 MPH. The speed limit on the street is 25 MPH.

Project Background

Separated Bicycle Facilities
Cambridge Street Project Post-Implementation Study

- Bicycle counts show **increases in people traveling by bicycle on the corridor during all time periods** after the implementation of the project.





Project Background

Separated Bicycle Facilities
Cambridge Street Project Post-Implementation Study

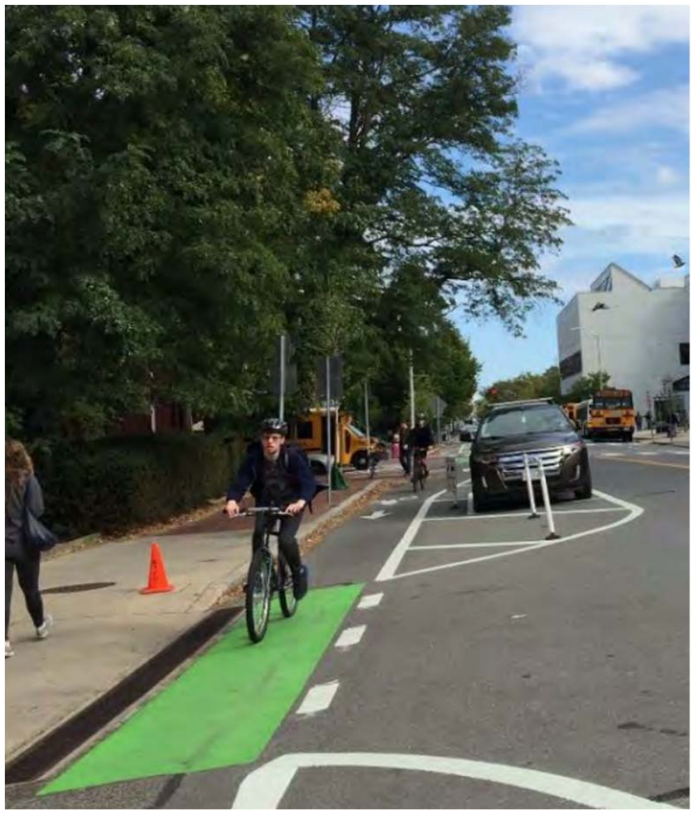
- **Pedestrian counts remain high** and show an 11% increase in pedestrian use during weekdays. On Saturdays, there is no significant change.
- **Traffic crash data -** too soon to draw statistical conclusions. In the one-year periods before and after the project implementation:
  - All Crashes

    Before: 16 crashes; 15 were moving vehicle incidents

    After: 13 crashes; half were limited to property damage to parked cars
  - Crashes involving a Pedestrian or Bicyclist

    Before: 3 Pedestrian, 5 Cyclist (4 total injuries for the two groups)

    After: 0 Pedestrian, 2 Cyclist (1 total injury)



Project Background

Cambridge Street Project Post-Implementation

Street Cleaning

- Performed with flex-posts in place, using smaller equipment
- Requires more frequent emptying at DPW yard due to lower capacity
- Eliminated City's typical "sweeping day" parking restrictions

Winter Operations

- Performance is impacted by flex-posts (additional snow banks; delays in fully restoring parking and bike lane operations)
- Difficult to remove/replace flex-posts on a storm-by-storm basis, so new strategy developed

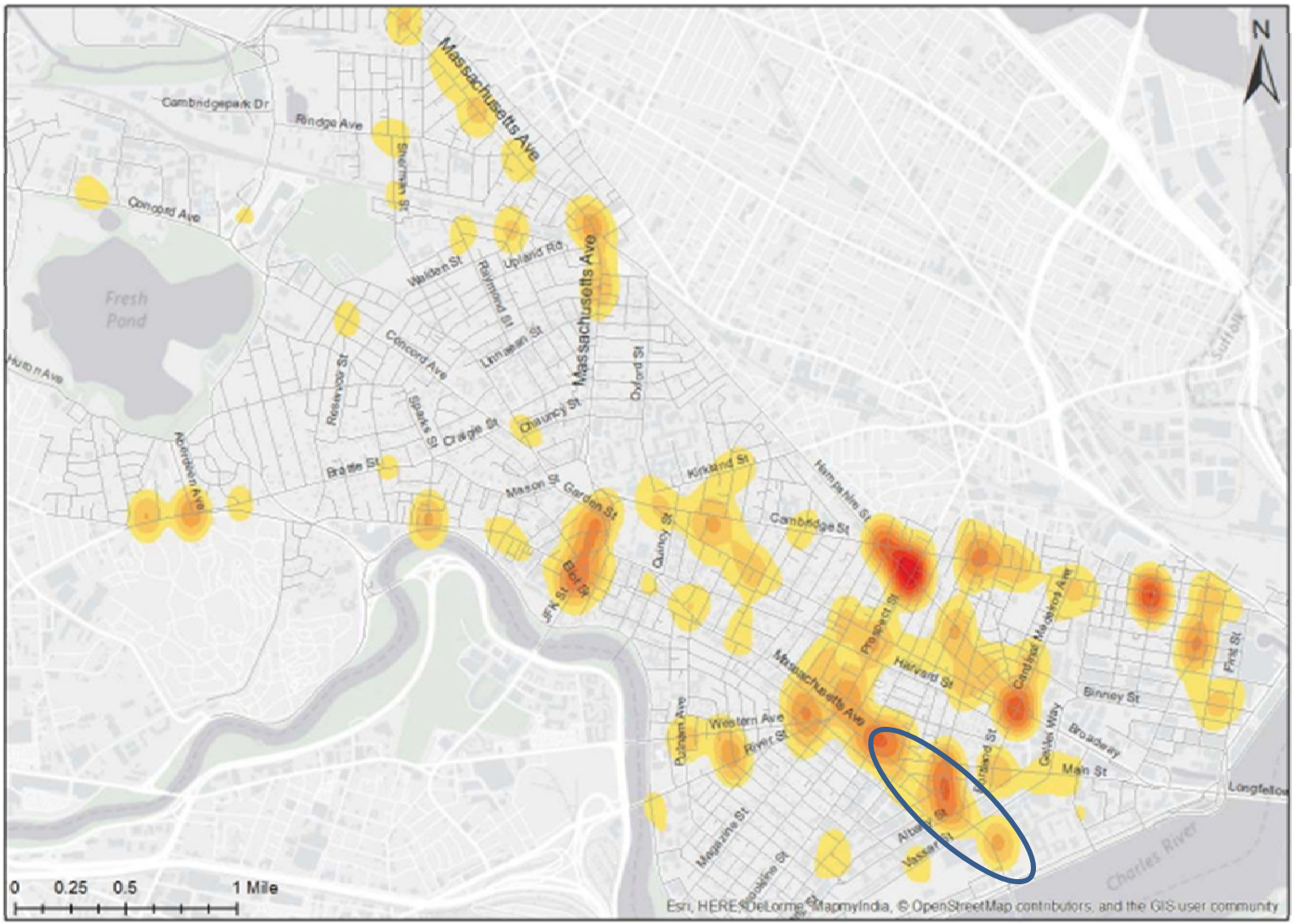
Flex Post Deployment

- Winter weather procedures standardized

Pavement Condition

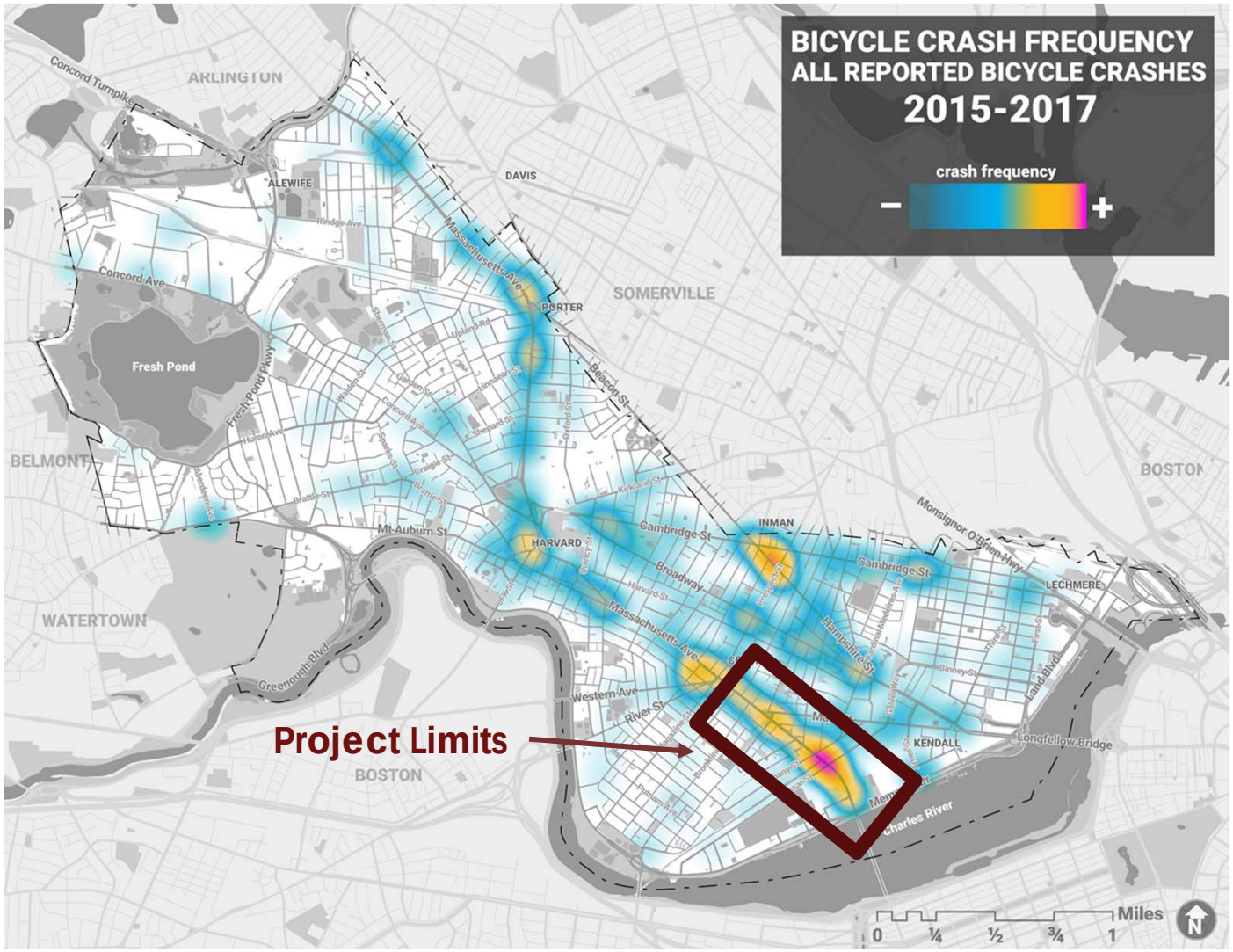
Project Background

Safety History: Reported Crashes Requiring EMS Transport, 2015-2016



Project Background

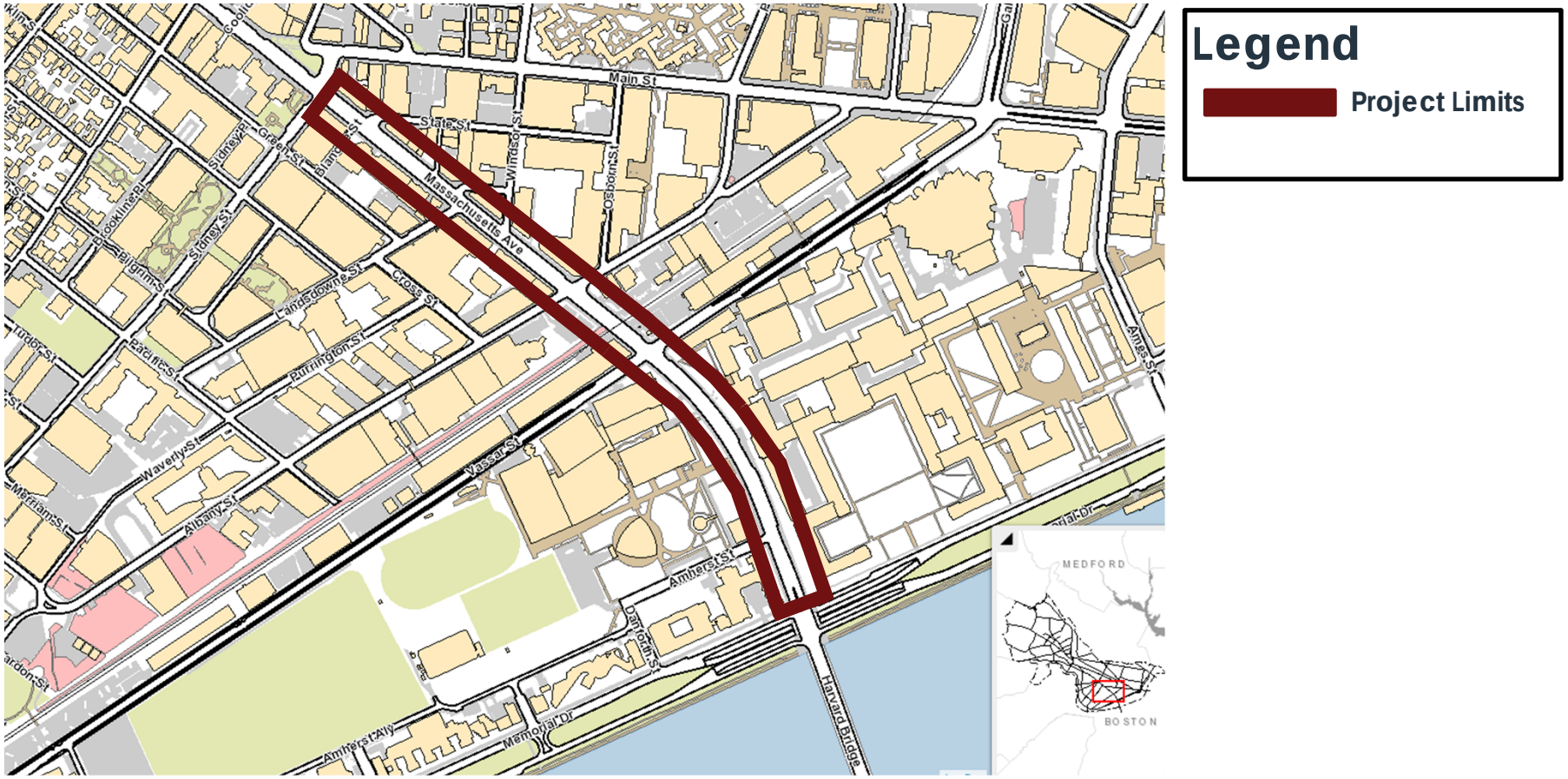
Safety History: Reported Bicycle Crashes, 2015-2017



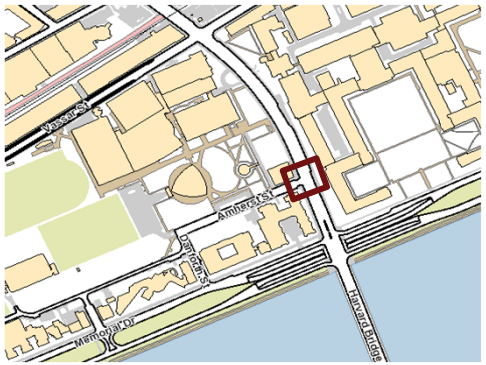
Corridor Information

Project Limits

Lafayette Square to the Charles River - *from Sidney Street to Memorial Drive*

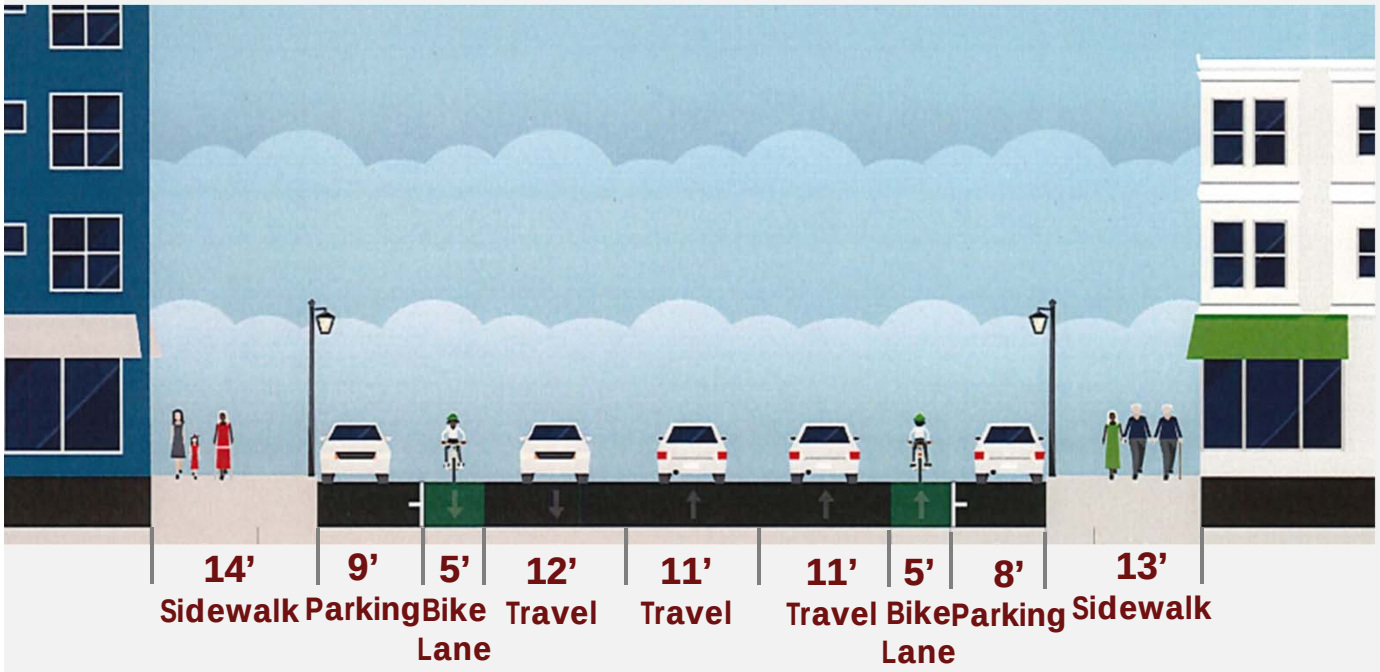


Corridor Information



Existing Conditions

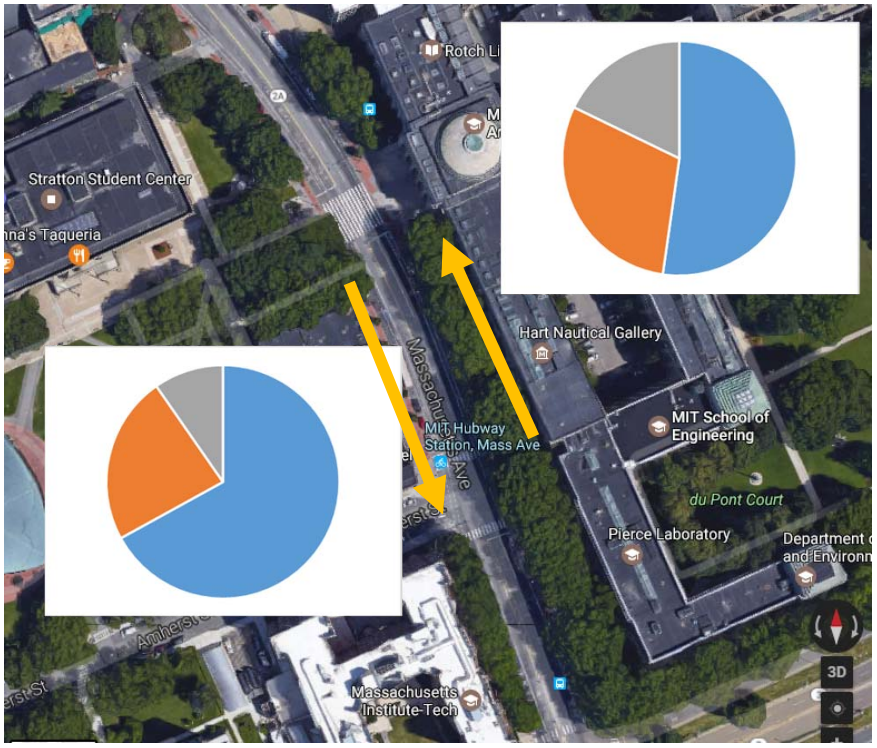
Mass. Ave. Cross-Section (at Amherst Street)



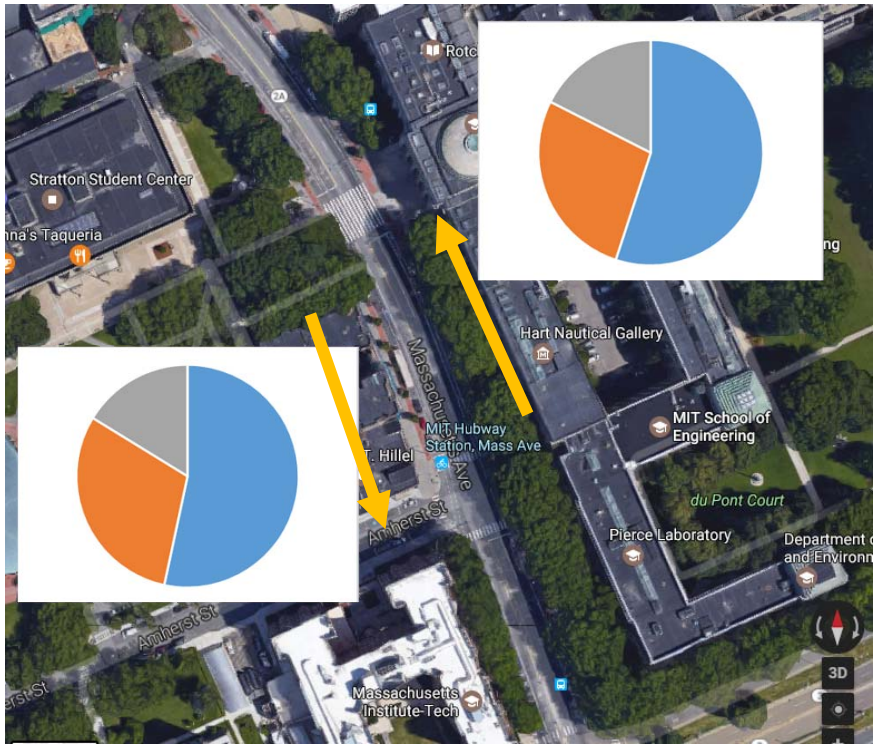
- ✓ 88’ wide
- ✓ On-street bike lane
- ✓ On-street vehicle parking
- ✓ Mix of meters and other parking
- ✓ Bus stops
- ✓ Curb extensions at multiple locations

Corridor Information

Users: Transit, Driving, Bicycling- *Mass. Ave. (North of Amherst St. at MIT)*



Weekday AM peak hour



Weekday PM peak hour

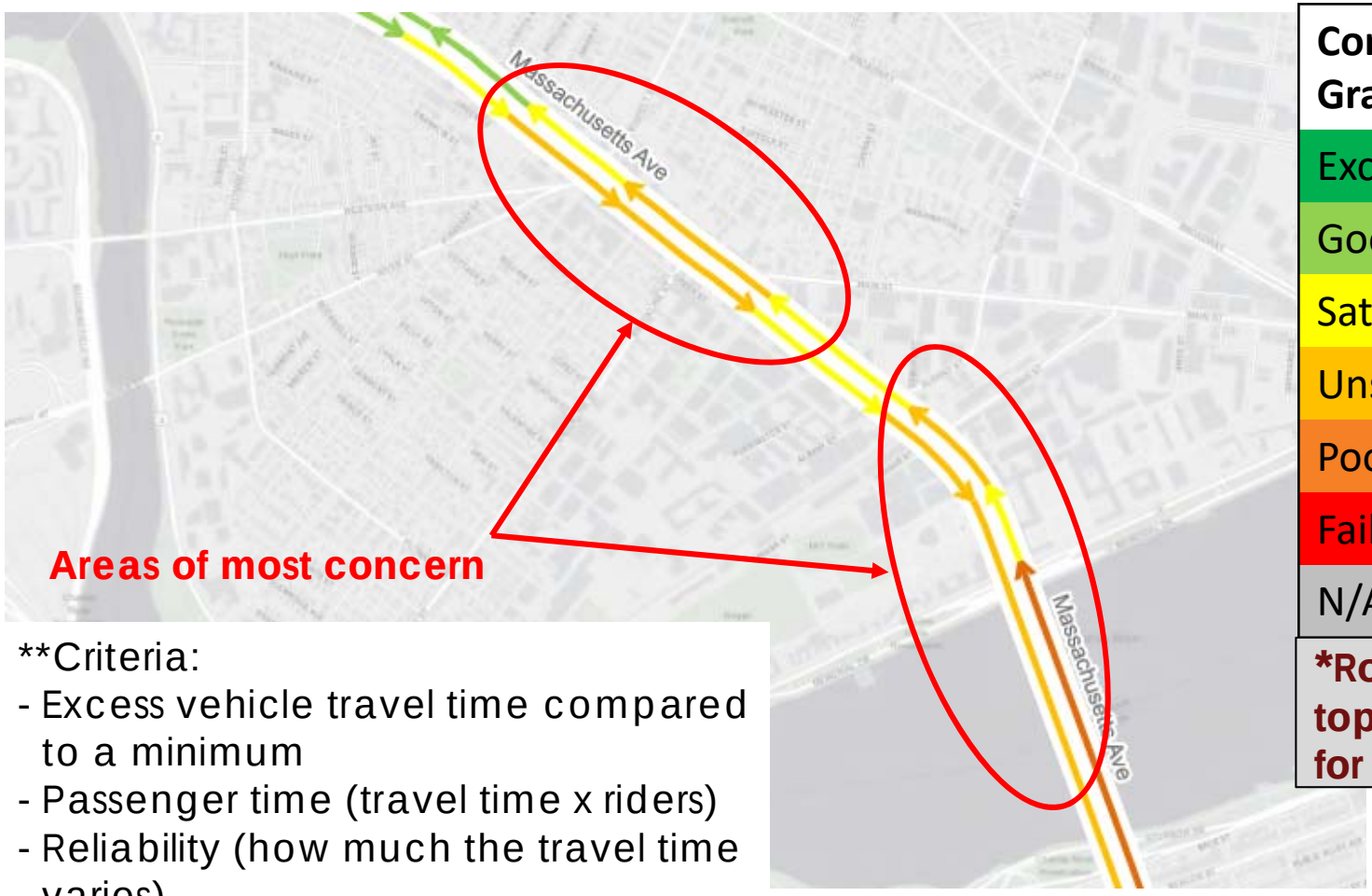
People using bus

People biking

Number of motor vehicles

Corridor Information

Transit Service Analysis: MBTA Bus Route 1*: AM Peak



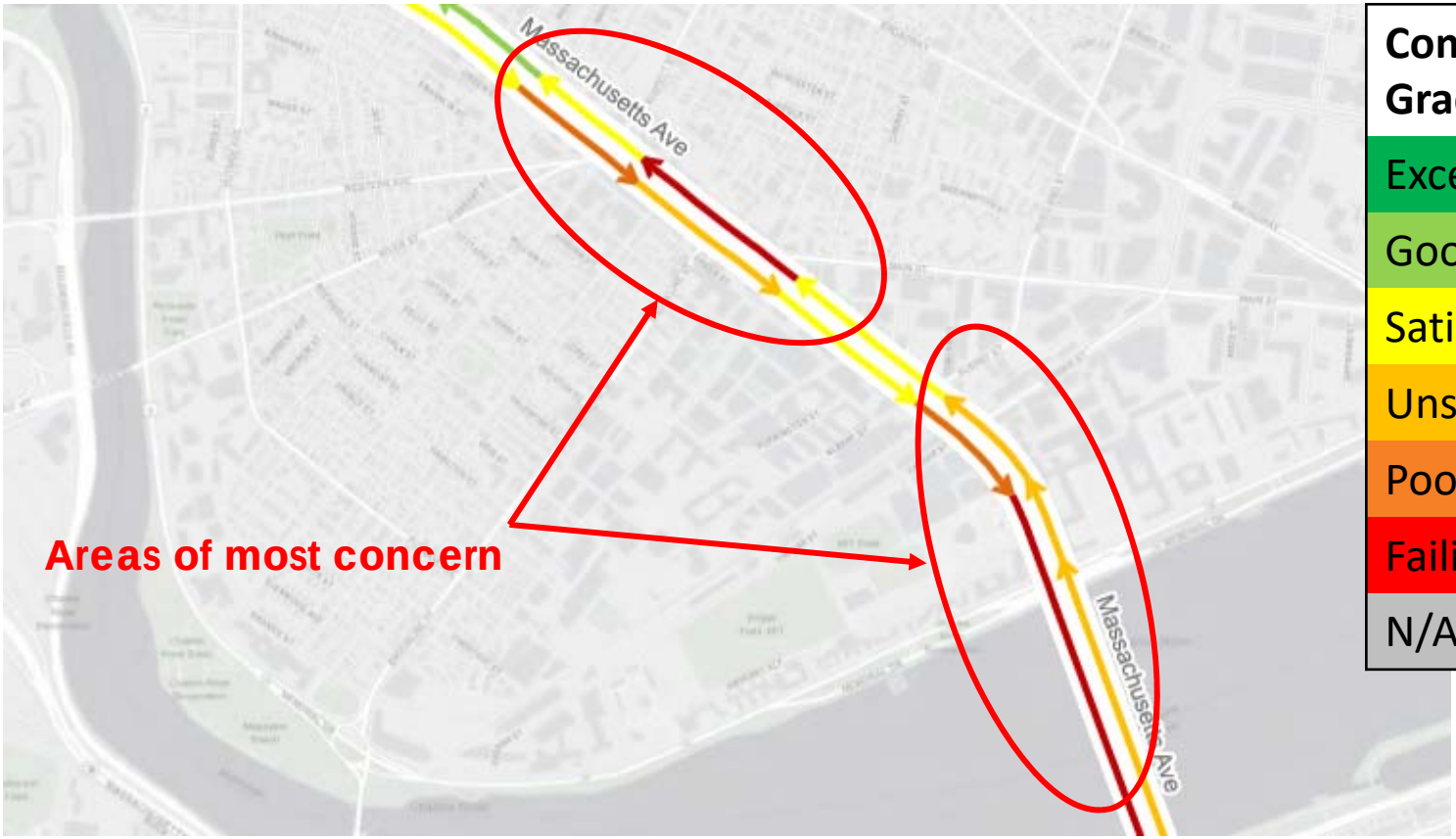
Composite Grade**
Excellent (A)
Good (B)
Satisfactory (C)
Unsatisfactory (D)
Poor (E)
Failing (F)
N/A

***Route 1 is ranked in top 5 MBTA bus routes for ridership.**

**Criteria:
- Excess vehicle travel time compared to a minimum
- Passenger time (travel time x riders)
- Reliability (how much the travel time varies)

Corridor Information

Transit Service Analysis: MBTA Bus Route 1: PM Peak

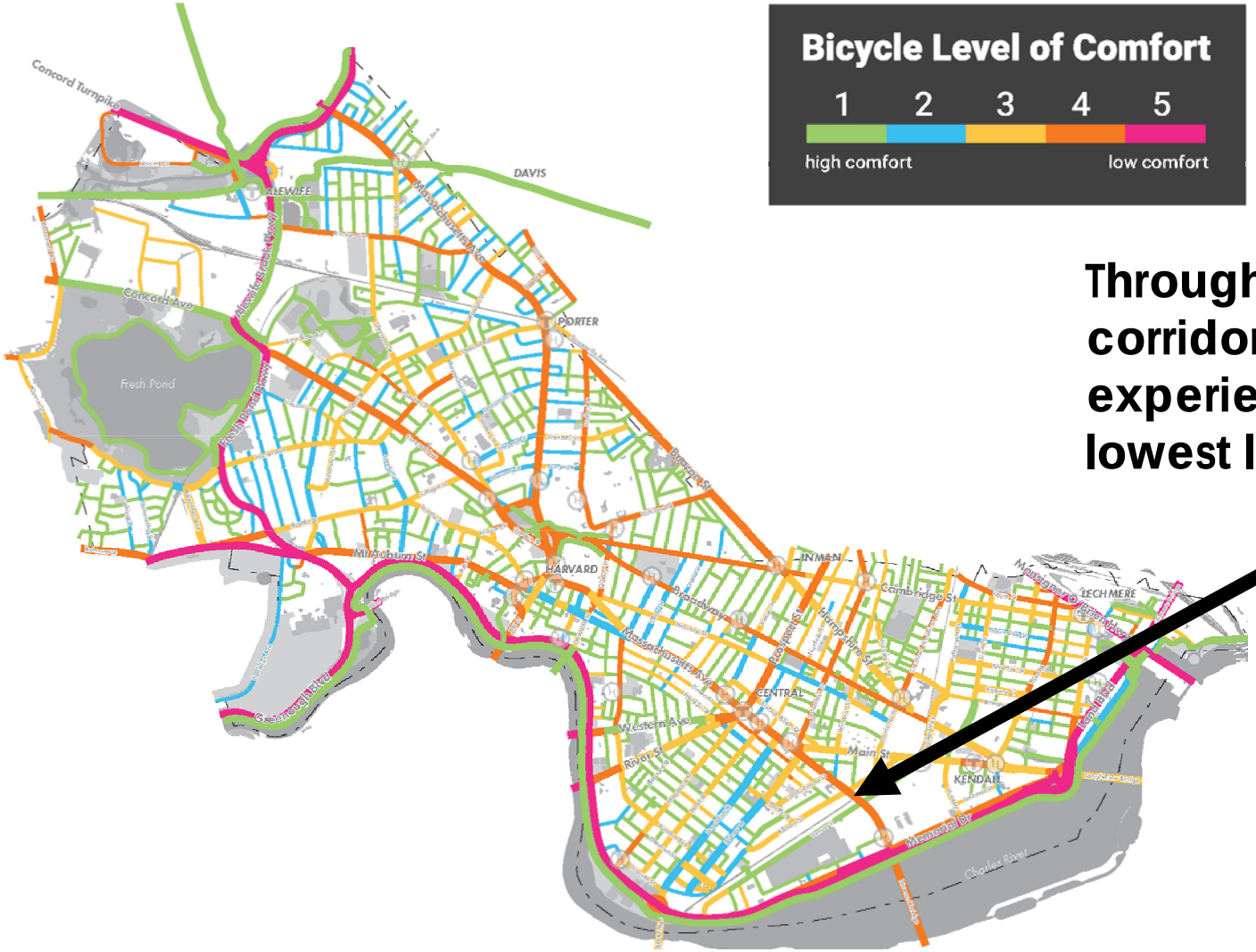


Composite Grade
Excellent (A)
Good (B)
Satisfactory (C)
Unsatisfactory (D)
Poor (E)
Failing (F)
N/A

Method: Automatic Passenger Counter (APC) Data (MBTA)

Corridor Information

Corridor Users: *People Biking*



Throughout the entire corridor length, users experience the second lowest level of comfort.

Corridor Information

Corridor Users - *People Walking*

Walking in this corridor:

- ✓ Local and regional destinations and connections
  - ✓ Boston/Cambridge connection
  - ✓ Charles River to Central Square
  - ✓ MIT intra-campus
  - ✓ Local businesses
- ✓ Evaluating ease and comfort of crossing at and between intersections

Corridor Information

Corridor Users: *People Driving*

2016 Massachusetts Avenue/Main Street Traffic Volume Study

Weekday Motor Vehicle Volumes

- Eastbound = **6,713 vehicles/day**
- Westbound = **6,166 vehicles/day**

Cambridge average vehicle occupancy = 1.1, therefore:

- Eastbound = **7,385 people/day**
- Westbound = **6,783 people/day**

Based on 2016 VHB study conducted on Massachusetts Avenue west of Sidney Street on a Tuesday and Wednesday in mid-May.

For more information: https://www.cambridgema.gov/~/media/Files/CDD/ZoningDevel/SpecialPermits/sp319/sp319_tis.pdf?la=en

Corridor Information

Existing Conditions
Differences between Mass. Ave. and Cambridge St.

- ✓ **Different cross-section**
- ✓ **More options for Mass. Ave. that did not impact parking counts**

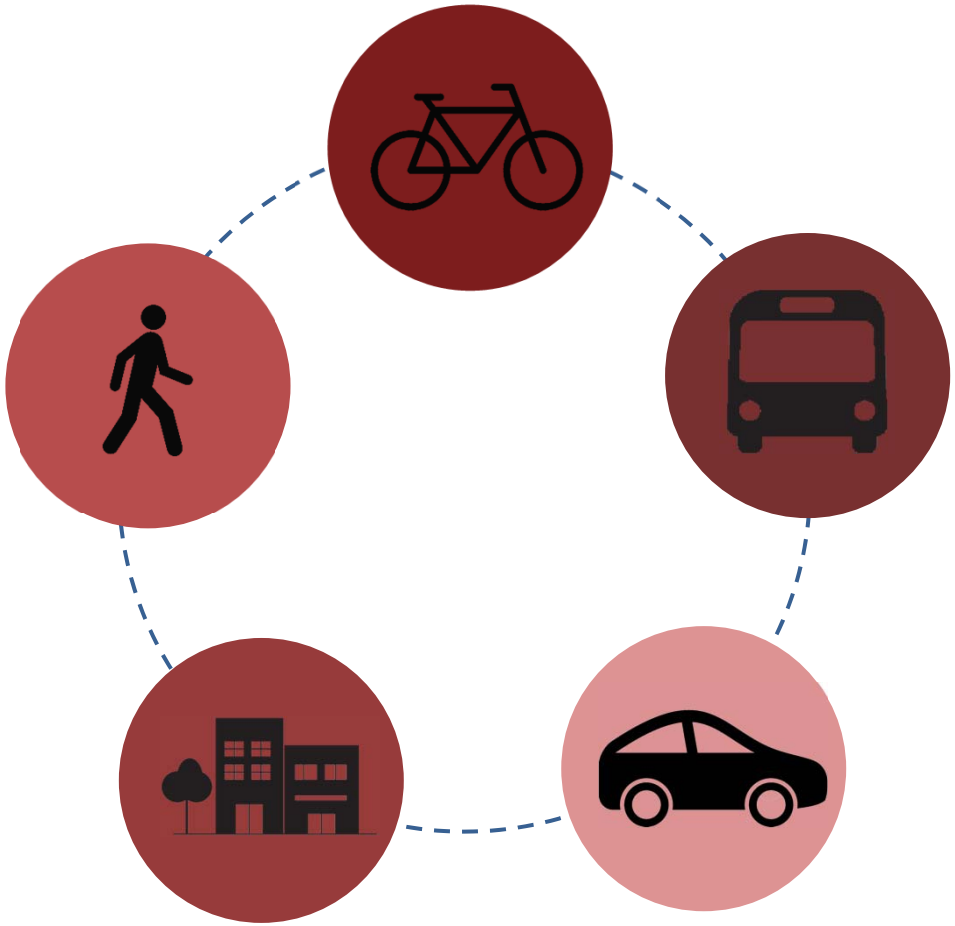
Design Toolbox

Project Goals

- ✓ Address safety issues and reduce crashes - Vision Zero
- ✓ Reduce transit delays
- ✓ Enable/encourage people of all ages and abilities to choose sustainable transportation

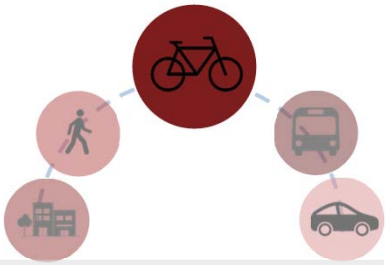
Design Toolbox

Design Considerations



- ✓ Safety for all users
- ✓ Level of comfort for people walking and bicycling
- ✓ MBTA Bus stops
- ✓ MBTA Bus reliability
- ✓ Other bus/shuttle vehicles
- ✓ Tour Bus activity
- ✓ Accessible parking
- ✓ Loading & deliveries
- ✓ Ride hail activities
- ✓ Street maintenance
- ✓ On-street parking

Design Toolbox



Design Considerations

✓ Bicyclist safety and comfort

Design Toolbox

Design Considerations

- ✓ Pedestrian safety & comfort: Crosswalks and sidewalks

Design Toolbox

Design Considerations

- ✓ Bus stops
- ✓ Reliability: Queue jumps, signal priority

Design Toolbox

Design Considerations

- ✓ Accessible parking
- ✓ Loading and deliveries

Design Toolbox

Design Considerations

- ✓ Street maintenance

Design Toolbox

Design Considerations

- ✓ On-street parking

Design Toolbox

Project Toolbox

✓ Signage

✓ Pavement Markings

✓ Flexible Delineator Posts

Design Toolbox

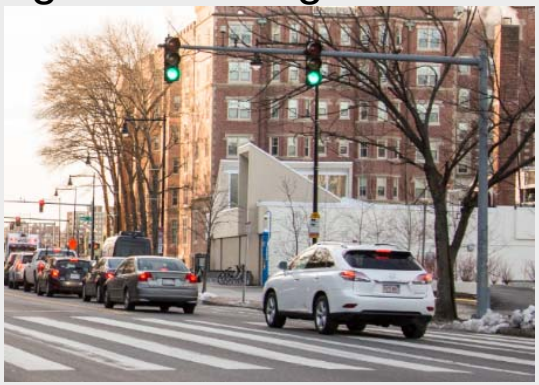
Project Toolbox

✓ Turn Lanes

✓ Bus Queue Jump/Priority Lane

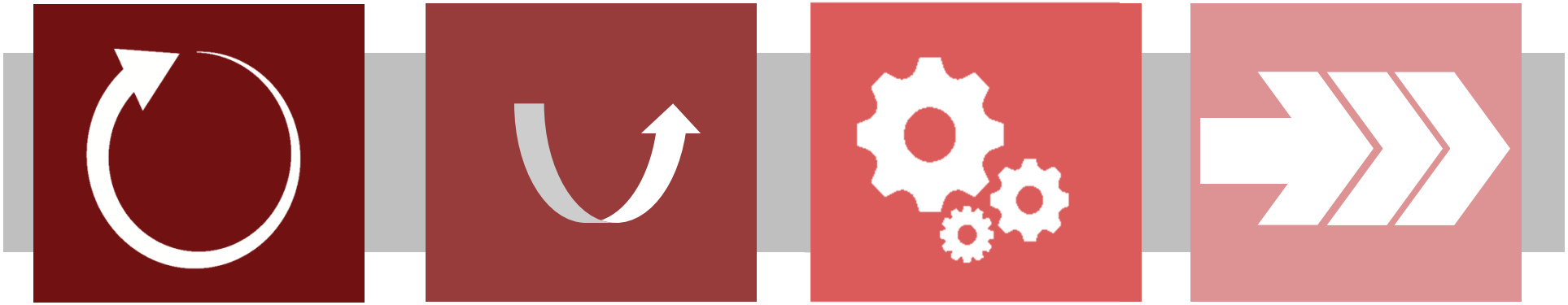
✓ Additional Crosswalks

✓ Signal Phasing and Timing



Timeline

Implementation Steps



PLANNING

- Identify measures of effectiveness
- Develop detailed plan
- Community engagement
- Develop mitigation measures

IMPLEMENTATION

- Procure materials
- Issue regulations
- Remove / reinstall pavement markings
- Installation of new elements

OPERATION

- Street cleaning
- Snow clearance
- Enforcement
- Communications strategy

EVALUATION

- After data collection and analysis
- Community engagement
- Decisions on next steps

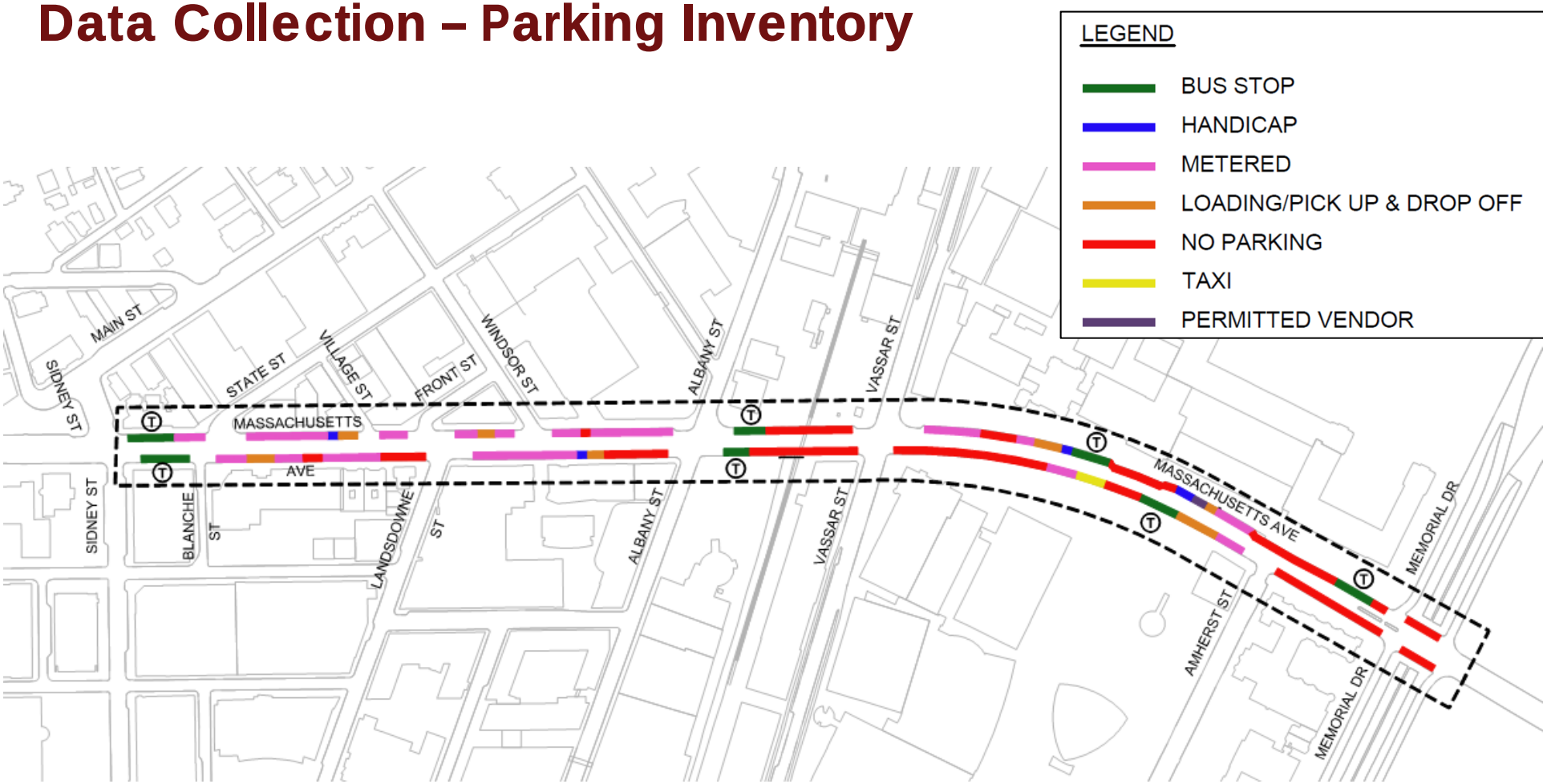
Design

Data Collection

- ✓ Motor vehicle parking study
  - Inventory existing on-street parking
  - Inventory public streets only
  - Conduct occupancy study
- ✓ Bicycle & pedestrian counts
- ✓ Bus travel time/delay analysis
- ✓ Conduct traffic counts at key intersections

Design

Data Collection – Parking Inventory



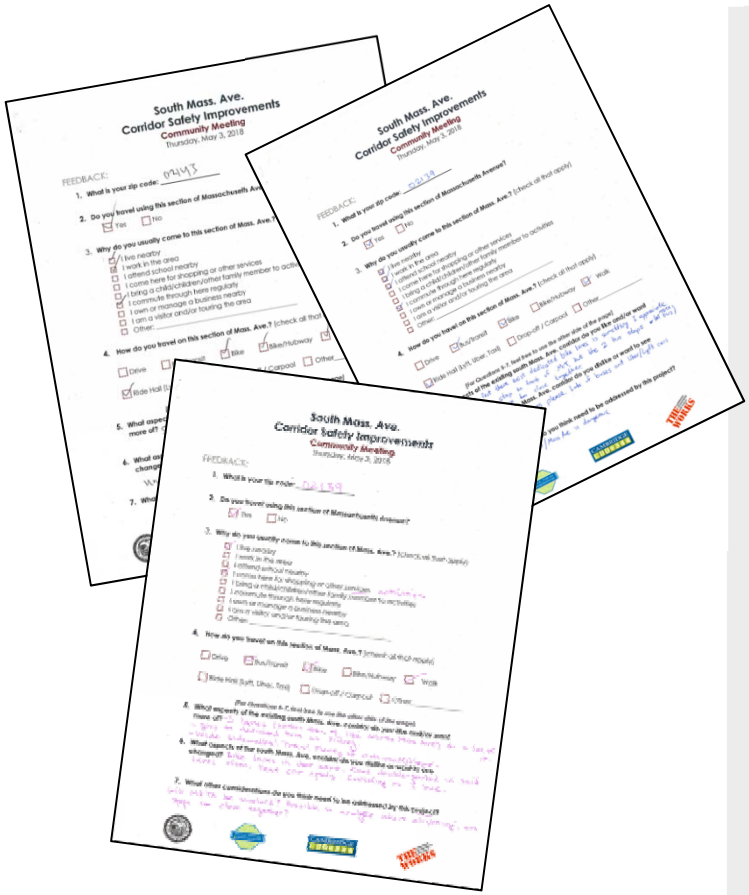
Design

Public Process

- ✓ Appointed Advisory Committee
- ✓ Wikimap online
- ✓ Survey online and feedback at public meetings
- ✓ Outreach to Businesses
- ✓ Street Teams and Tabling at Events
- ✓ Individual Stakeholder meetings (e.g. MIT)
- ✓ Transit/Ped/Bike Committees
- ✓ Communitywide Meetings
- ✓ Posted and electronic announcements

Design

Public Feedback



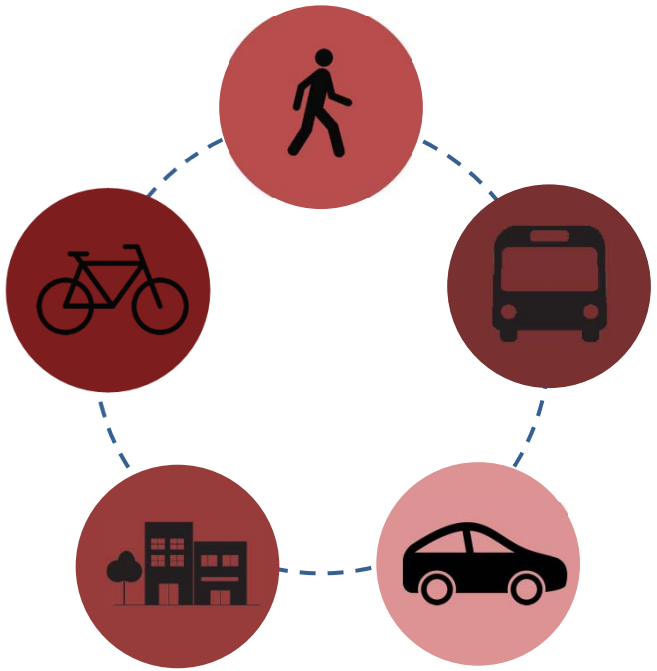
- ✓ Need for **safer conditions for bicyclists**
  - ✓ Motorists and delivery vehicles block bike lanes
  - ✓ Desire for greater separation from moving vehicles
- ✓ Need for **additional crosswalks** traversing Mass Ave
- ✓ Desire to **improve transit operations**
- ✓ Concerns about **unpredictable ride hail stopping, tour bus, food truck, commercial loading & pick-up/drop-off activity**
- ✓ **Relocate MIT-related tour buses** loading/unloading
- ✓ Concerns about **long vehicle queues, traffic at Vassar Street**
- ✓ **Minimize conflicts**
  - ✓ Bus/bike conflicts
  - ✓ Bike/ped conflicts esp. at 77 Mass Ave.

Design

Transportation/Traffic Analysis

Corridor-wide transportation analysis to determine where:

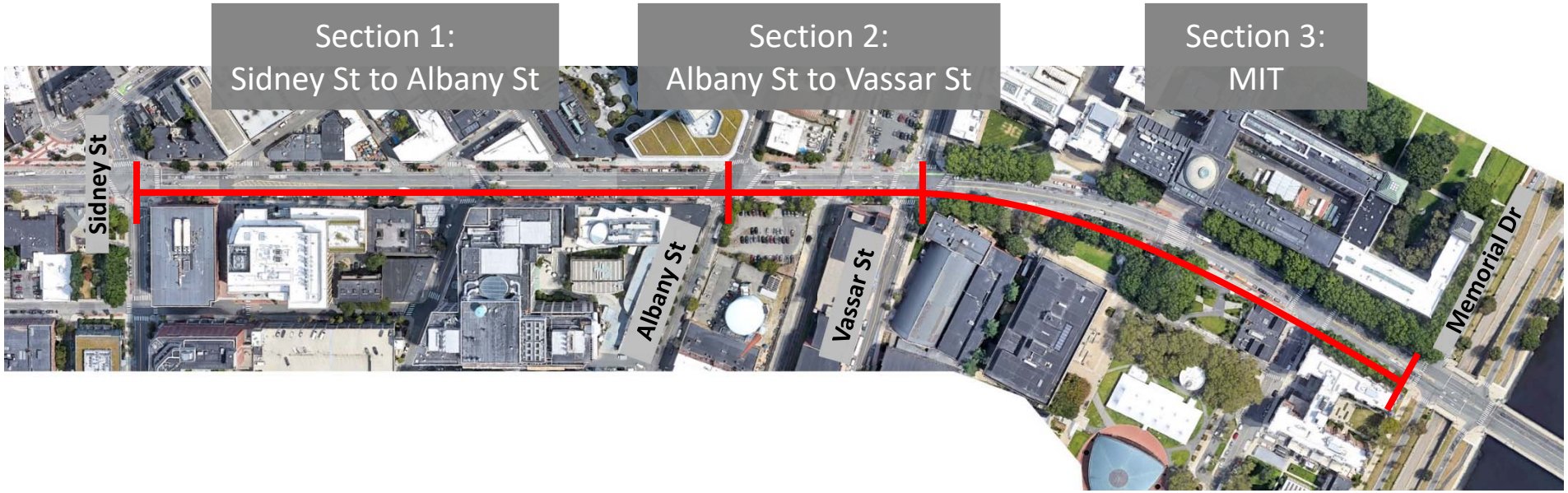
- ✓ **Bus lanes** can be added
- ✓ **Vehicle lanes** can be repurposed
- ✓ **Signal** operations can be modified
- ✓ **Bicycle lanes** can be separated
- ✓ **Bicycle buffers** can be added
- ✓ **Parking** can be re-located for better operations



Design

Transportation/Traffic Analysis

Corridor **divided into 3 sections** for clarity:



Design

Transportation/Traffic Analysis

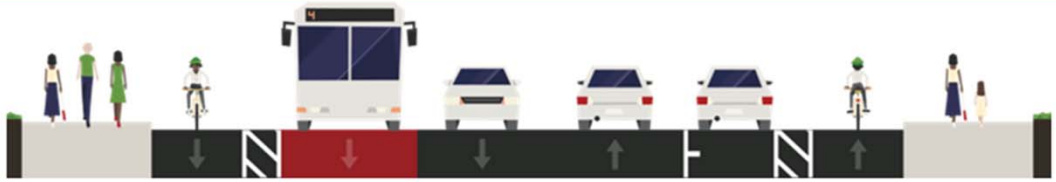
- The three general cross sections (intersections vary)

Section 1:
Sidney St to Albany St

Section 2:
Albany St to Vassar St

Most Complicated

Section 3:
MIT



Design

Bus Facilities

Bus lanes proposed for two sections, to address the key areas of delay

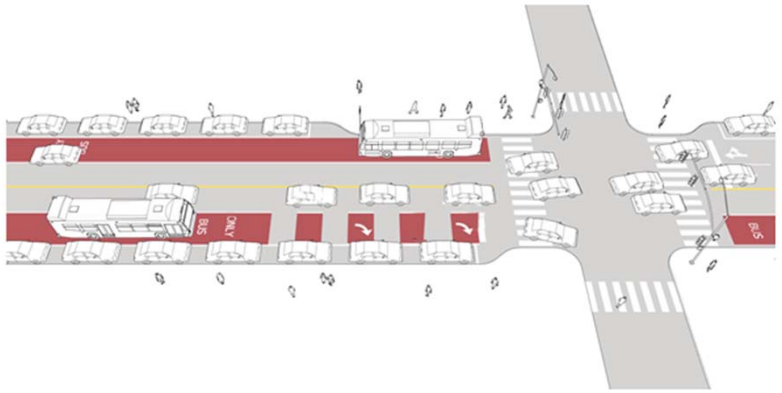
Design

Bus Facility Details

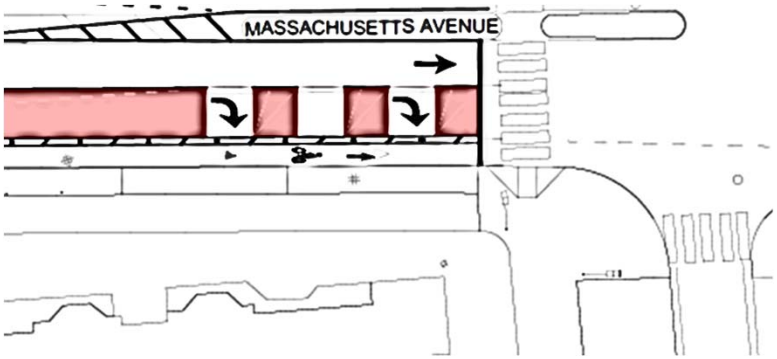
Bus lanes at intersections:

Right turning motorists may use bus lane

National Precedent



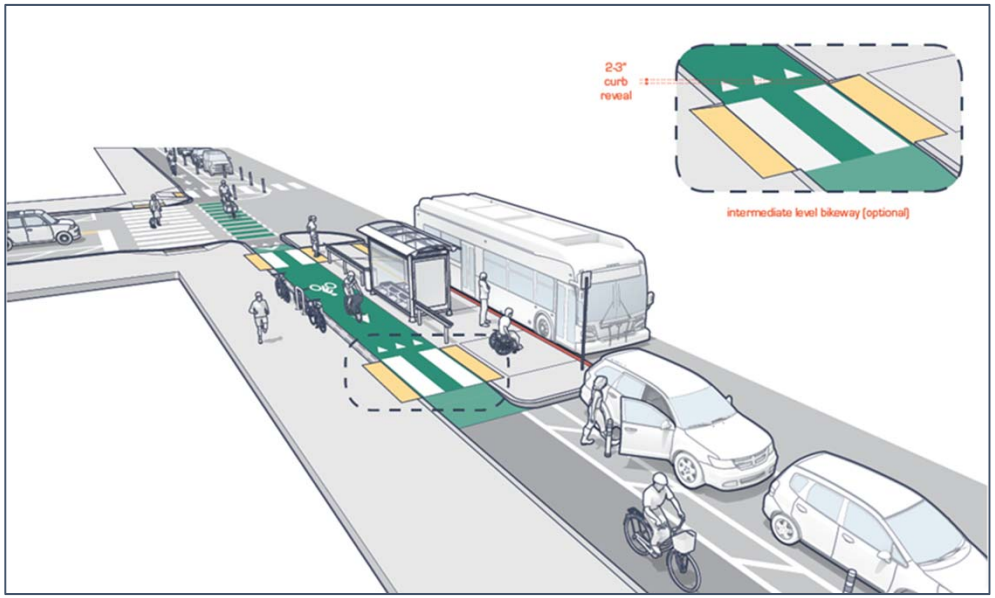
Design Sample



Design

Bus Stop Operations

Bus stop at curb

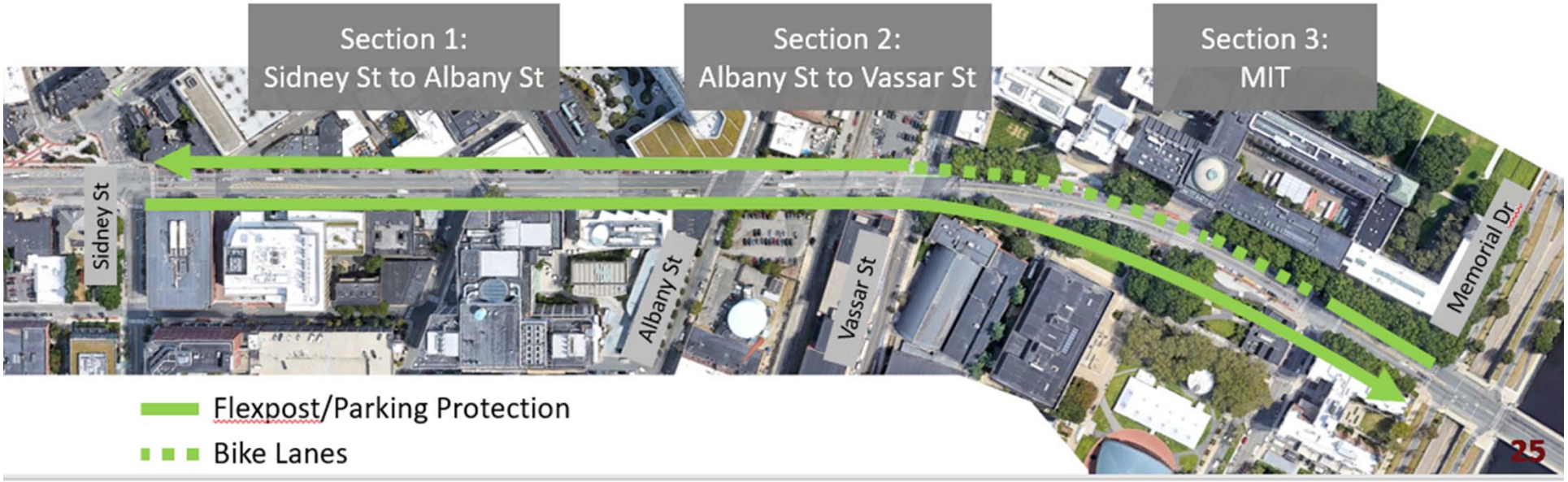


Floating bus stop
(possible future consideration)

Design

Bicycle Facilities

For most of the corridor, separated bike lanes can be created using on-street parking and flex posts.



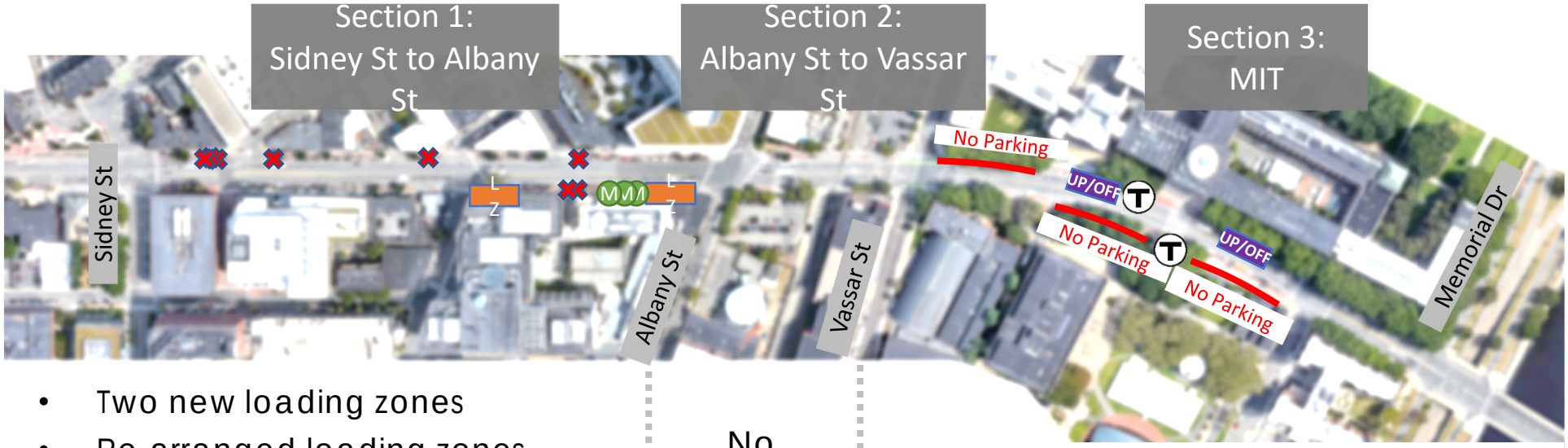
Design

Pedestrian Facilities

- ✓ Pedestrian safety improved through modifications to signalized intersections
  - ✓ Turn Lanes
  - ✓ Unconflicted crossings
- ✓ Additional Crosswalk in corridor
- ✓ RRFB Indicator Added
- ✓ Sidewalks more reliantly unencumbered (people less likely to use sidewalks for bicycling)

Design

Vehicle Parking Analysis



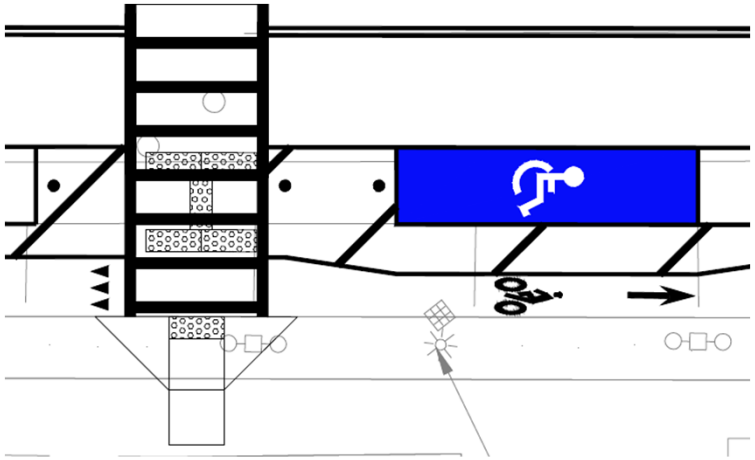
- Two new loading zones
- Re-arranged loading zones
- Seven fewer metered spaces out of 51 metered spaces (due to added crosswalk, loading zones and sight lines)
- Sufficient parking availability on side streets

No Change

- No parking eastbound (six fewer)
- New pick-up/drop-off spaces westbound
- Change metered parking westbound (12) to loading, pickup-dropoff, added space for bus stop
- Maintain food truck location
- Clearer MBTA boarding/alighting areas

Design

Parking Facilities – Floating Accessible Parking



Design follows federal and state standards

Design

Parking Facilities – Benefits

- ✓ Food truck location maintained
- ✓ Additional and clear loading zones
- ✓ Create drop-off/pick-up locations
- ✓ Create new tour bus location

Design

Draft Design – Before and After

Before

After

Design

Draft Design – Before and After

Before

After

Design

Changes at 25% Design

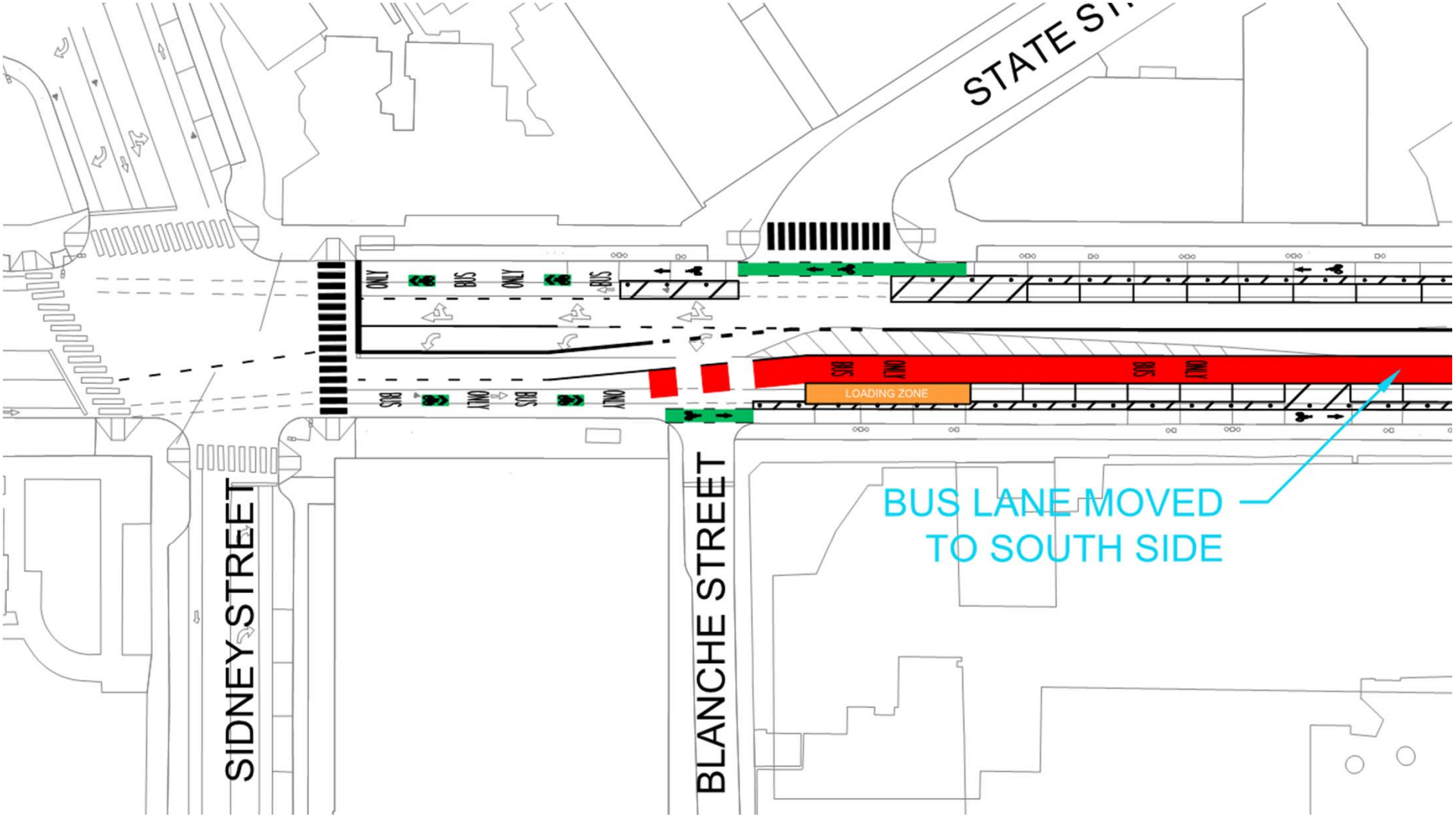
- Additional traffic analysis with some simulation modeling
- Additional traffic data collection on Mass. Ave.
- Reviewed location of bus lane; proposing revisions
- Revisions to Albany and Vassar intersections, with turn lanes, signal changes, and cross section change on Mass Ave between intersections
- Coordination with state agencies on additional measures for bus in short and long-term on state facilities
- Reviewed implementation; modifications include some phasing
- Enforcement meetings requested before implementation

Design

Three Main Sections

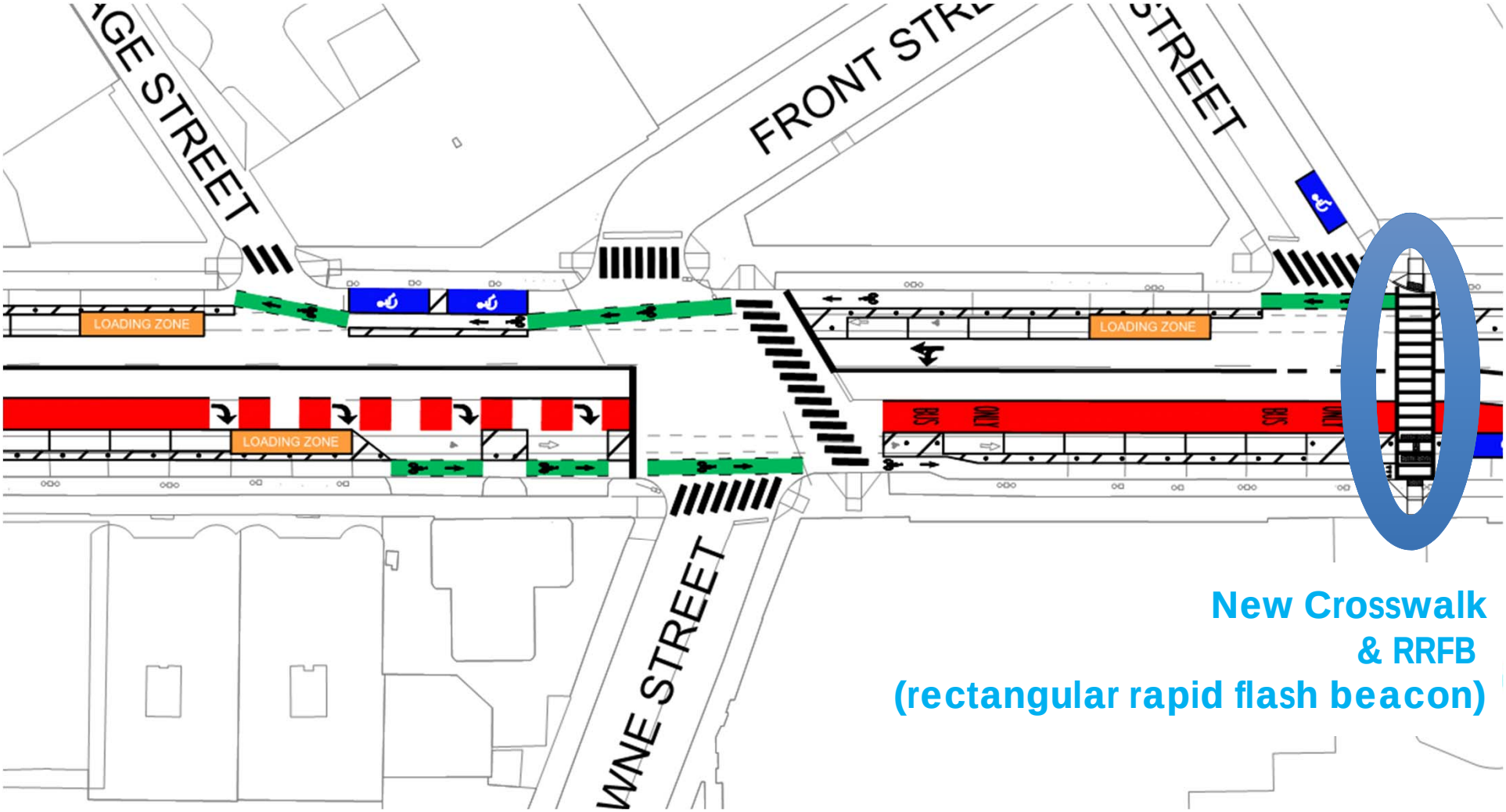
Design

Section 1: Sidney St to Albany St (A)



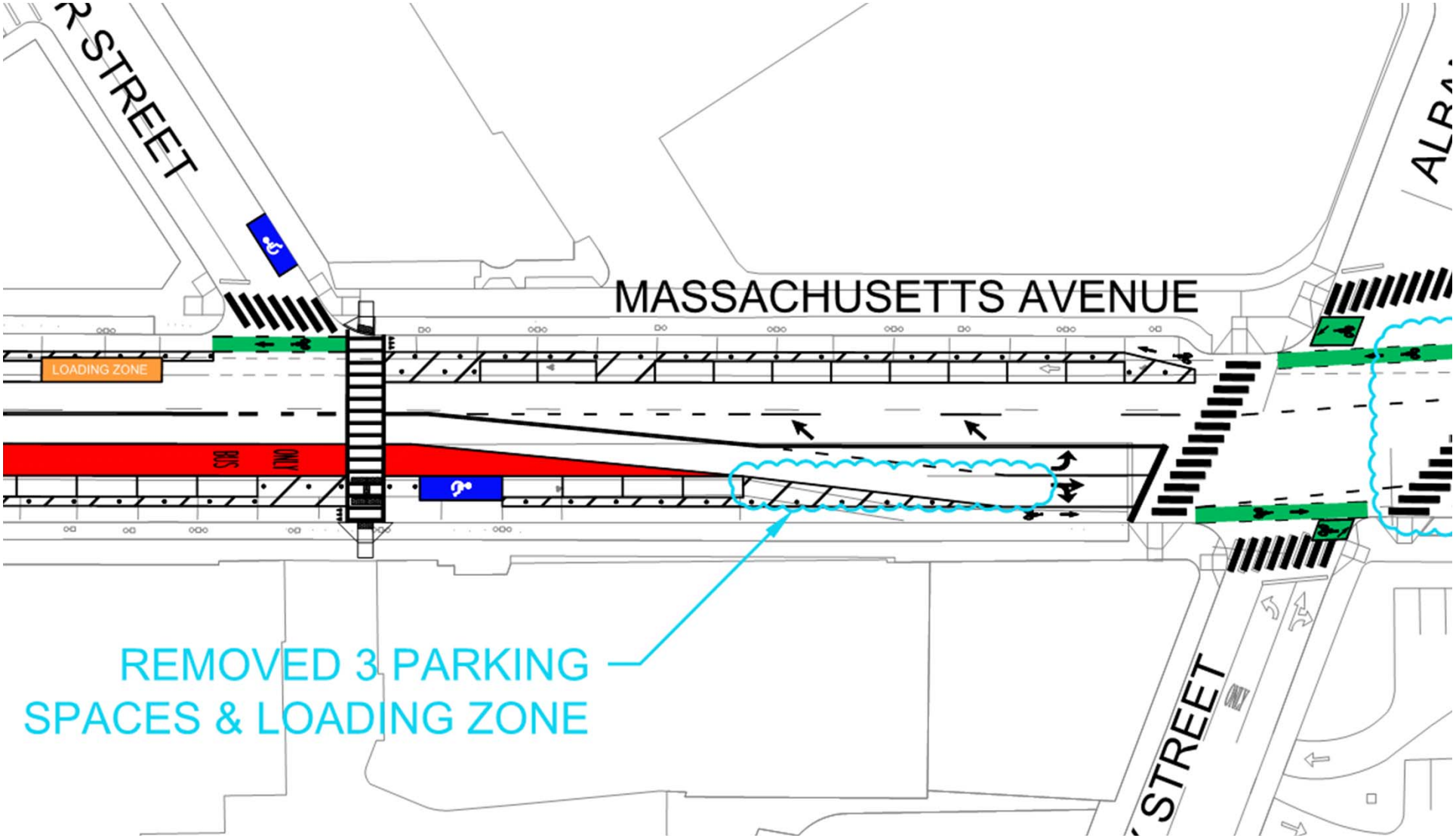
Design

Section 1: Sidney St to Albany St (B)



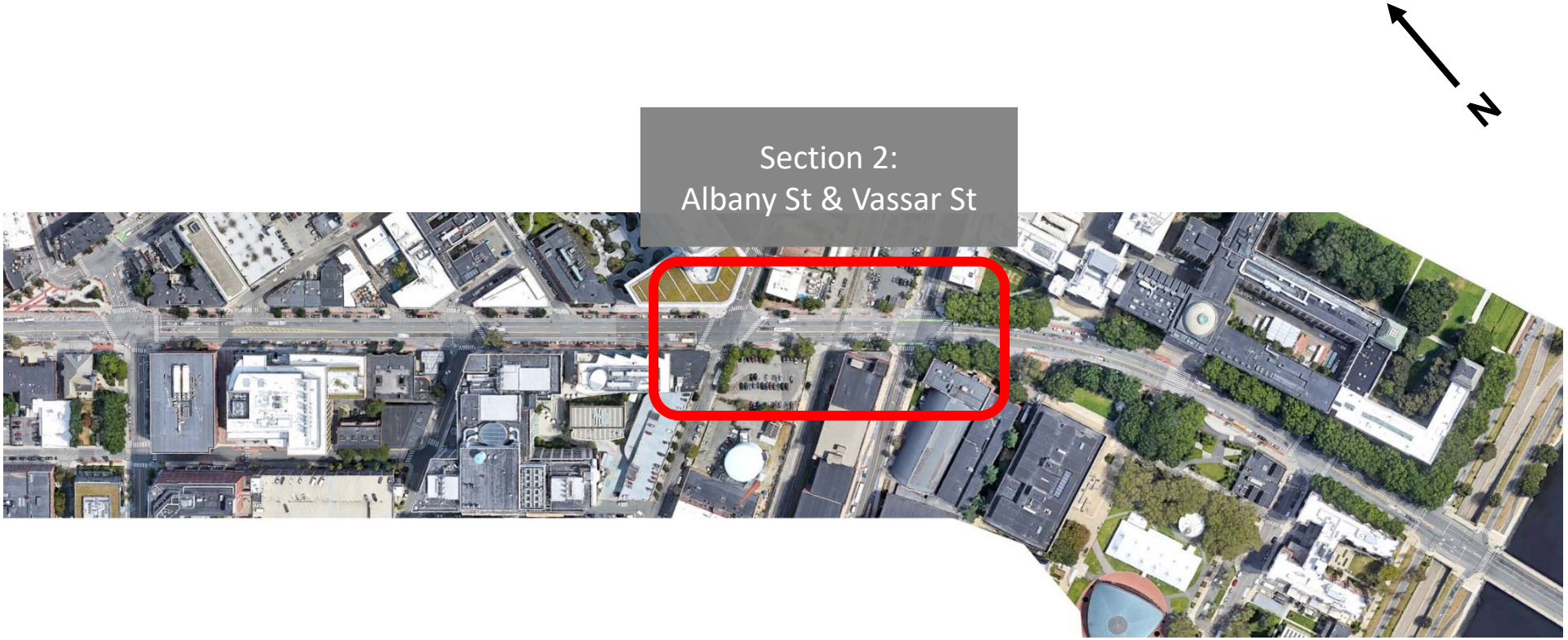
Design

Section 1: Sidney St to Albany St (C)



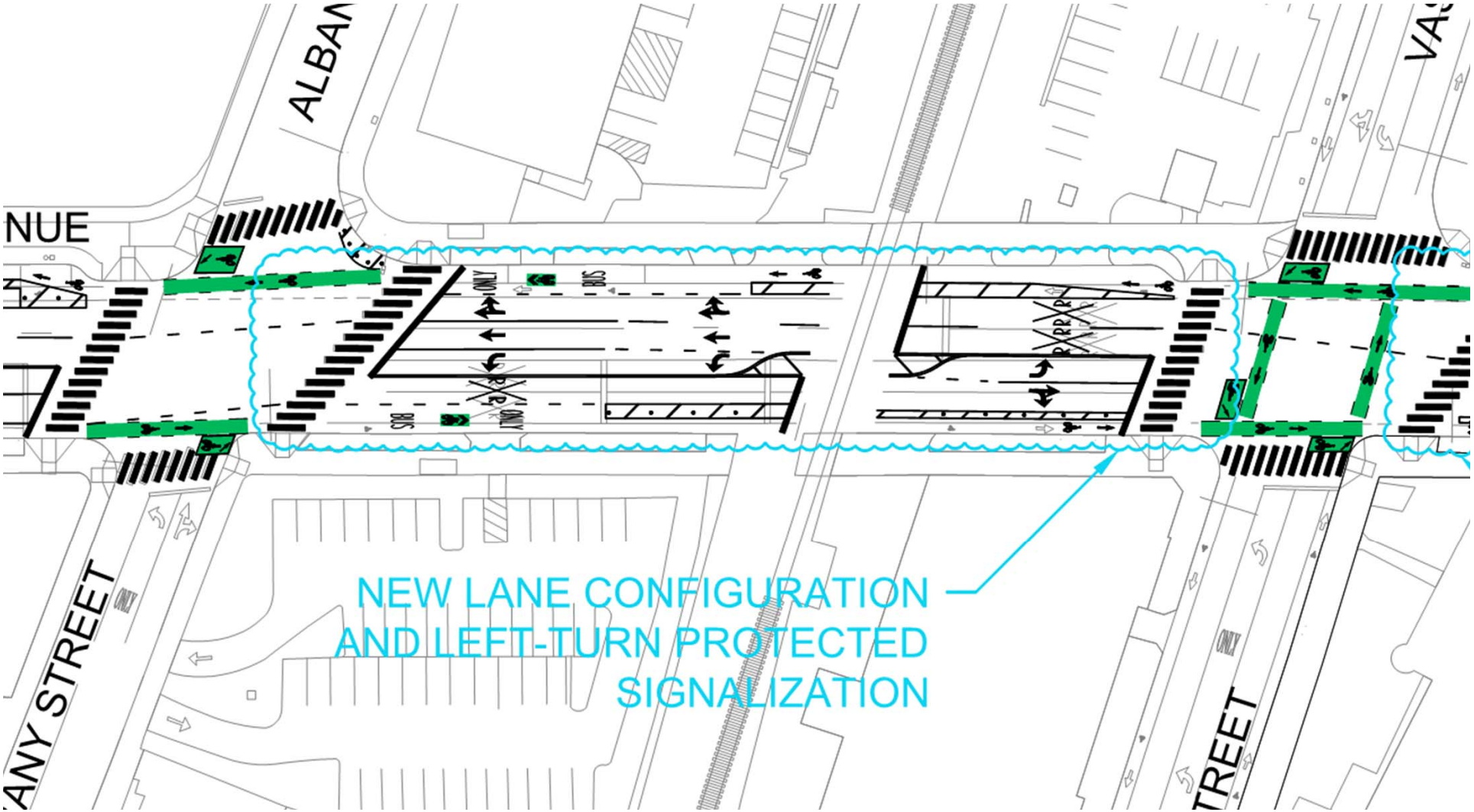
Design

Three Main Sections



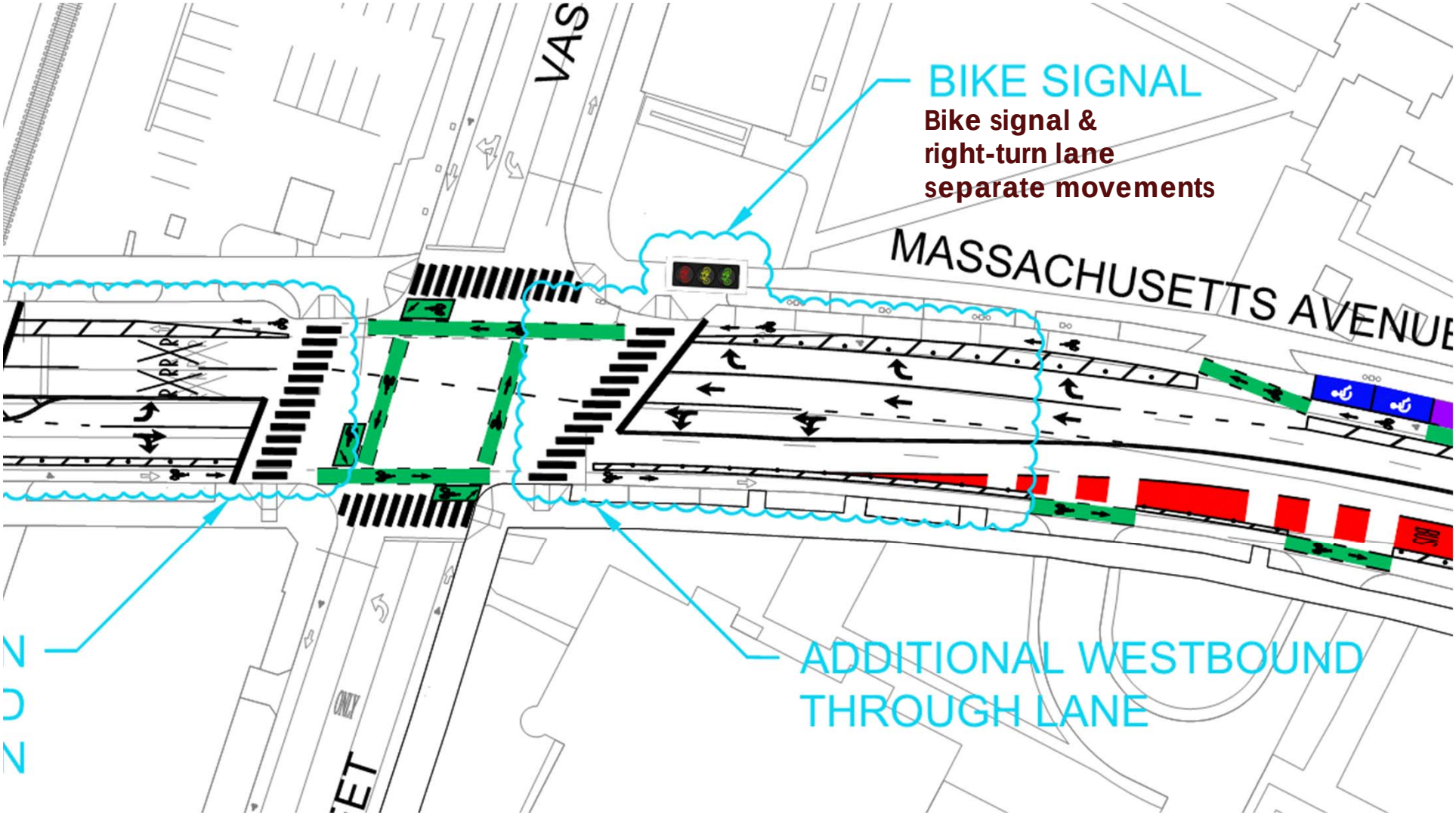
Design

Section 2: Albany St & Vassar St



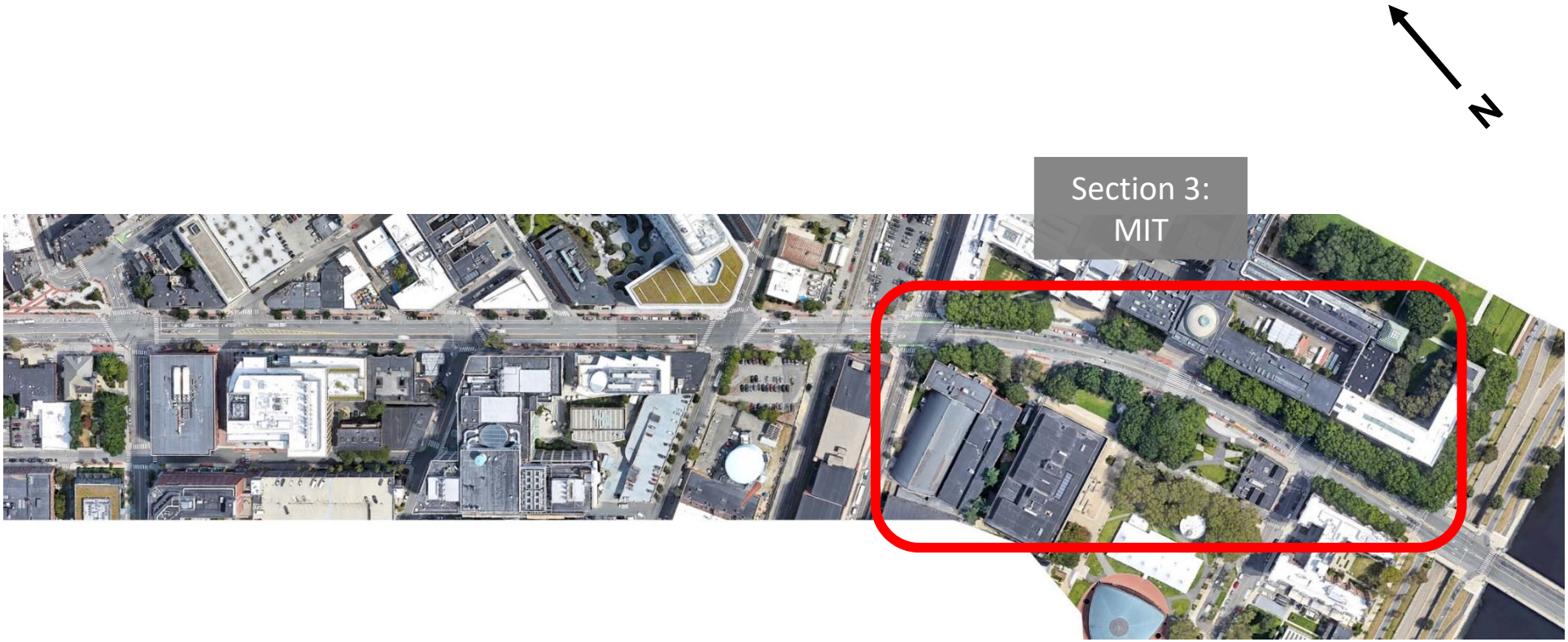
Design

Section 2: Albany St & Vassar St



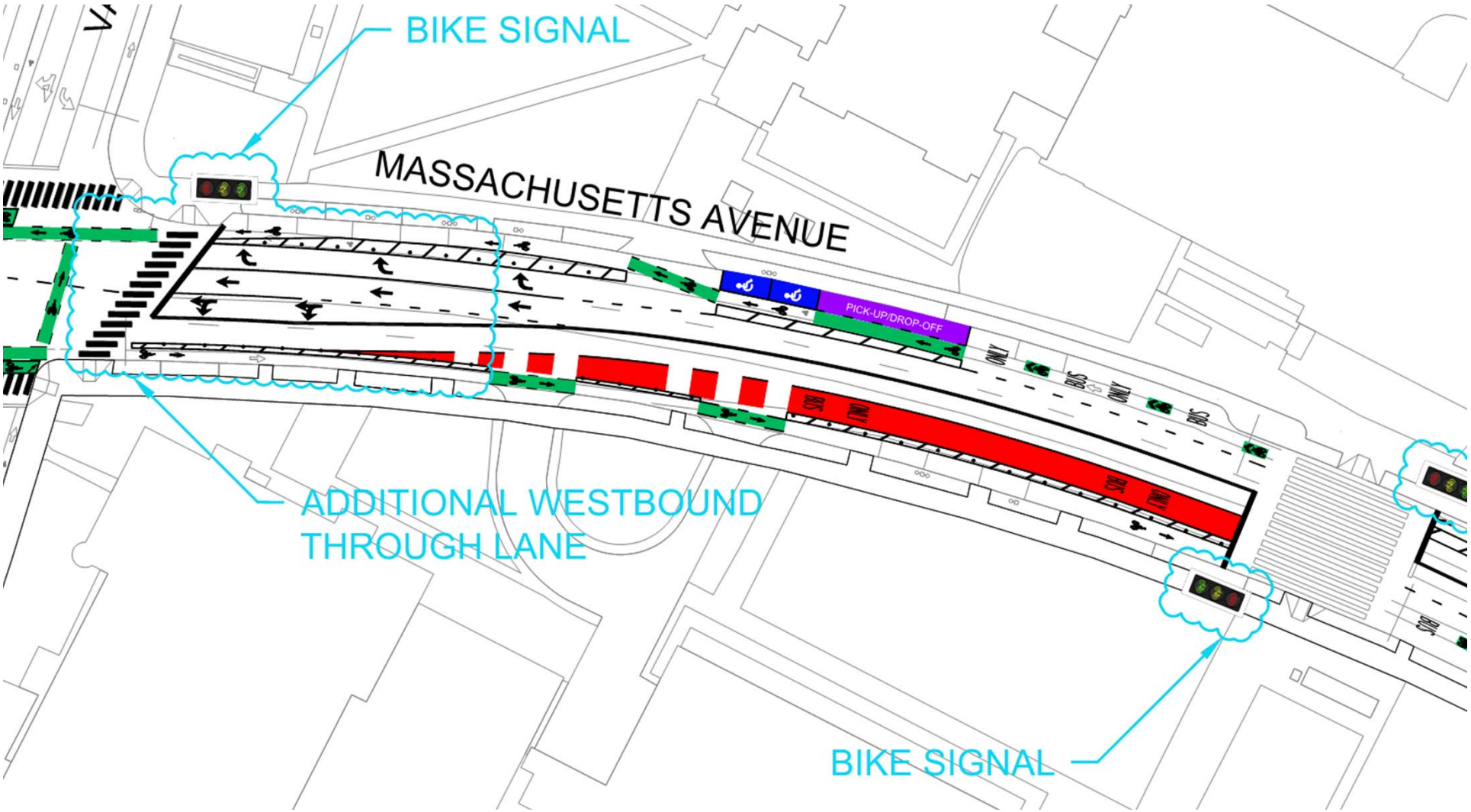
Design

Three Main Sections



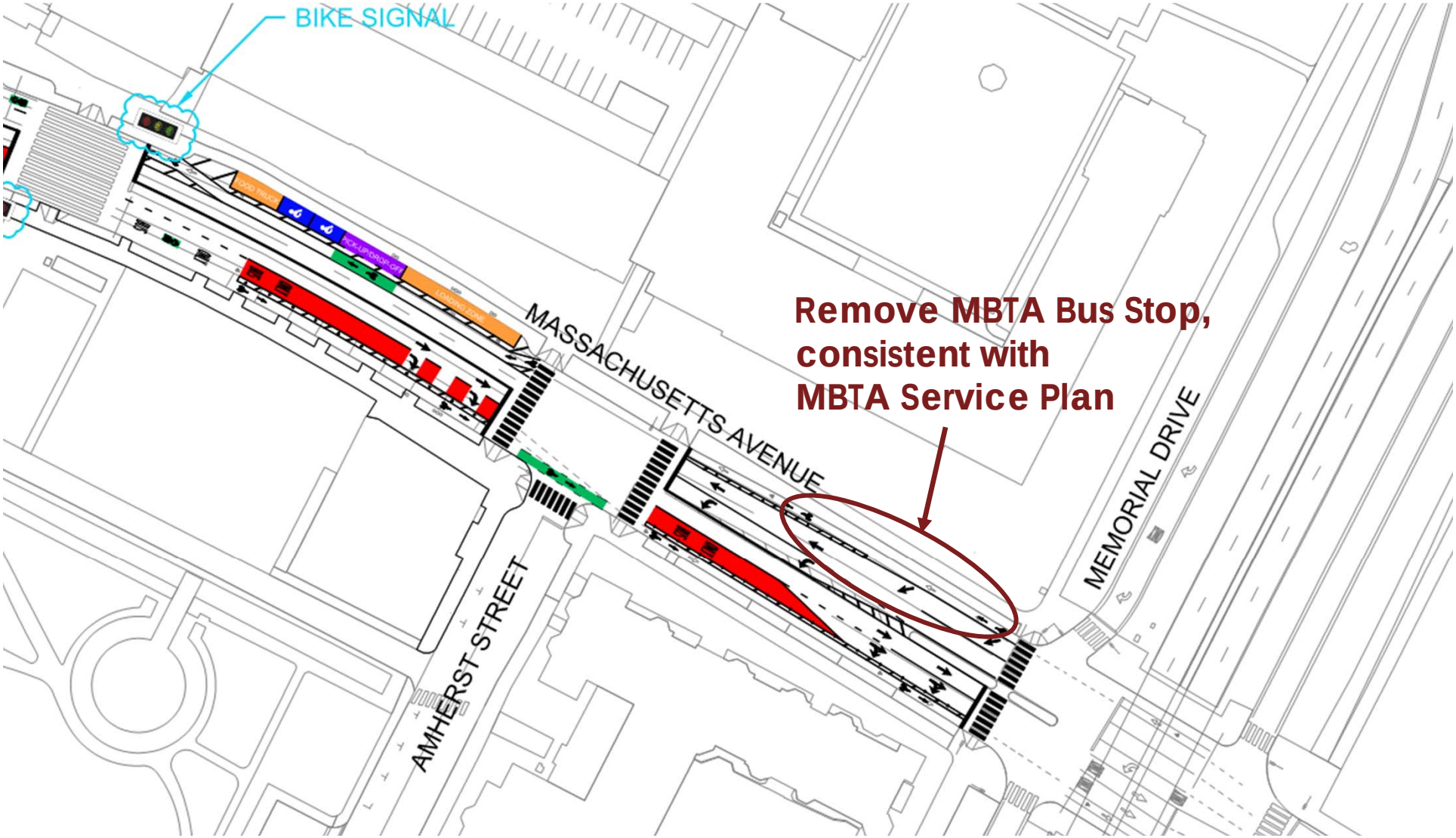
Design

Section 3: MIT (A)



Design

Section 3: MIT (B)



Implementation

Final Design

- $300k to design and implement over 10 months
- Design changes pushed implementation into the Fall
- Paint put down during colder weather/wore away quickly
- Permanent markings after evaluation
- Crosswalk being constructed by private company; still not done
- Intersection at Memorial Drive – continued conversations

Next Steps

Project Evaluation & Data Collection

User Feedback

- On-line survey; hard copies available
- Wikimap
- Intercept surveys

Technical Data

- Counts: motor vehicles, pedestrian, cyclists
- Speeds
- Travel times along corridor
  - Transit vehicles
  - Motor vehicles

Safety Data

- Crash analysis: requires 3 years for statistical validity, but will monitor for issues and trends

Next Steps

Project Evaluation & Data Collection

Signal intersections
- Vehicle queues
- LOS for Pedestrians
- Conflicts

New Pedestrian Crossing
- Counts: number of users
- Yield study (based on standard protocols)

Parking/Loading/Ride Hail
- Parking study
- Delivery vehicles
- Observations: where are ride hail vehicles stopping?

Questions

More Information and Contact

Project Website:

http://www.cambridgema.gov/CDD/Projects/Transportation/southmassave

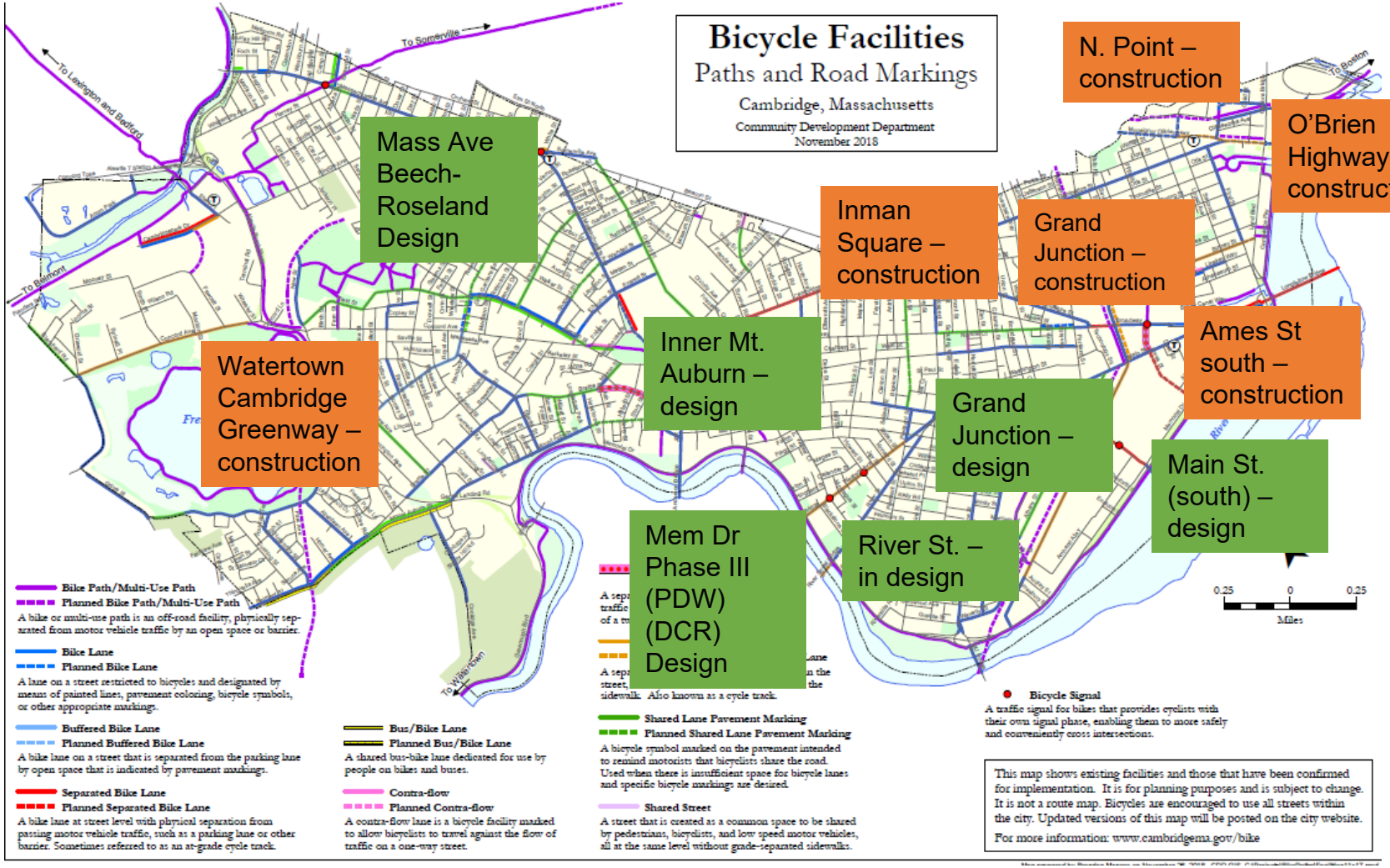
Contact:

Cara Seiderman, Transportation Program Manager, Community Development Dept., cseiderman@cambridgema.gov

Chris Balerna, Sr. Project Manager, Kleinfelder, cbalerna@kleinfelder.com

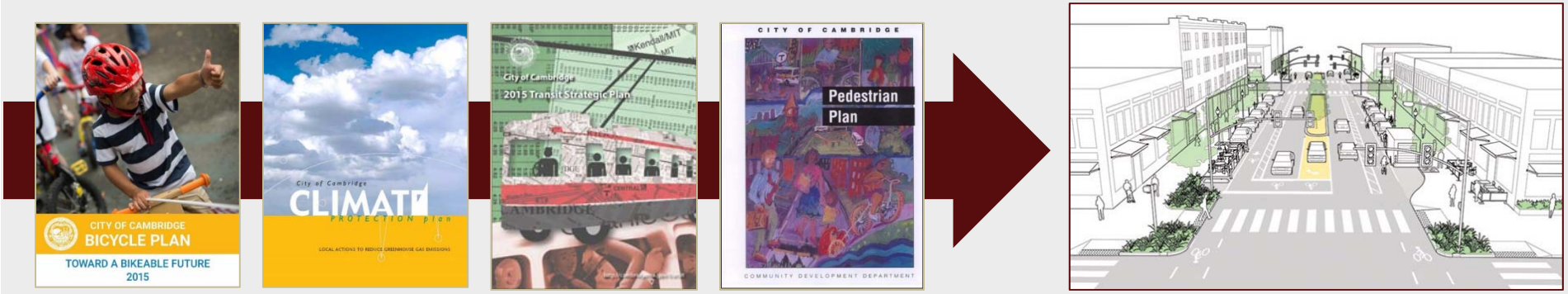
Jason Degray, Director of Engineering, Toole Design, jdegray@tooledesign.com

Major Projects Underway



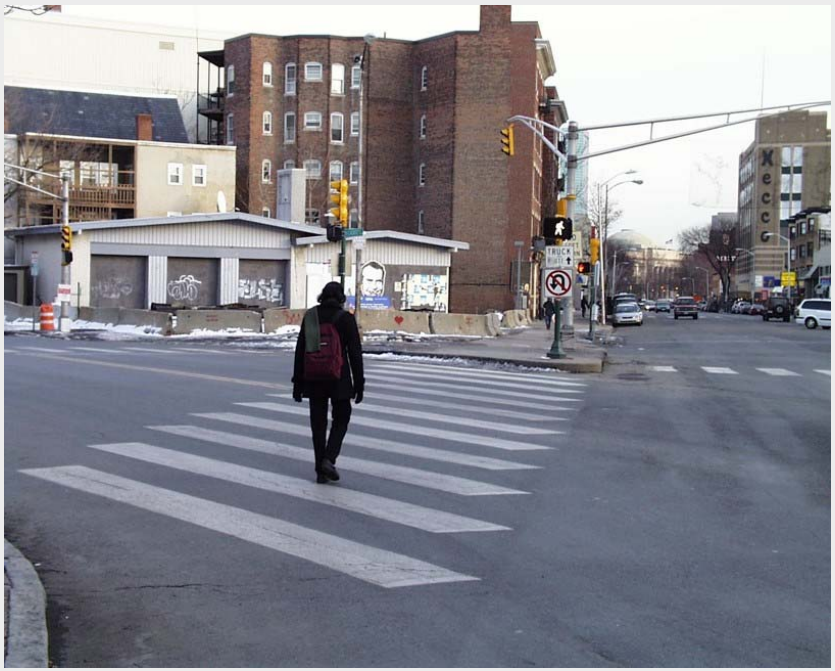
Project Background

From Plans to Actions



Project Background

Mass. Ave. Reconstruction
Completed in 2008

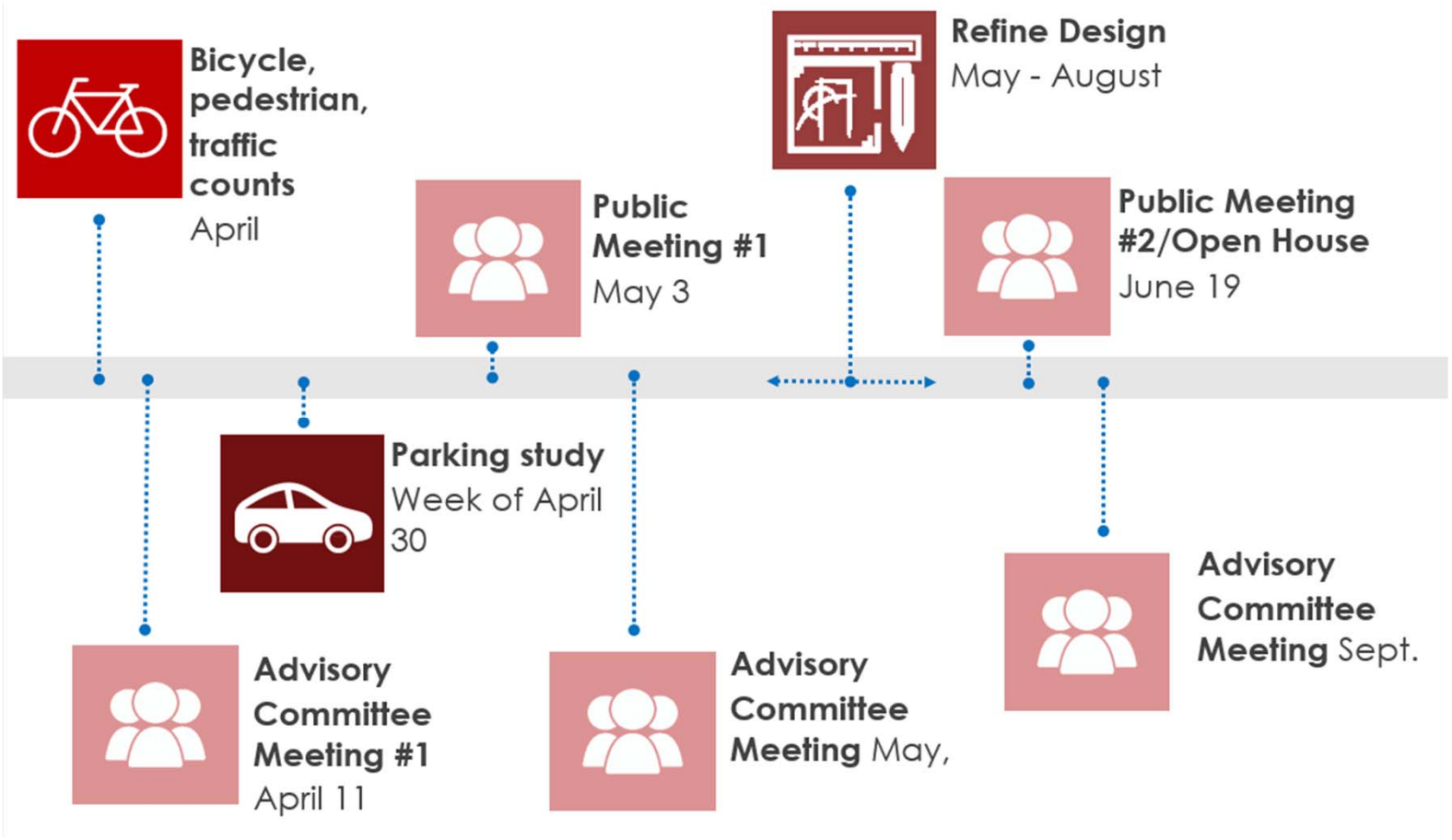


Before

After

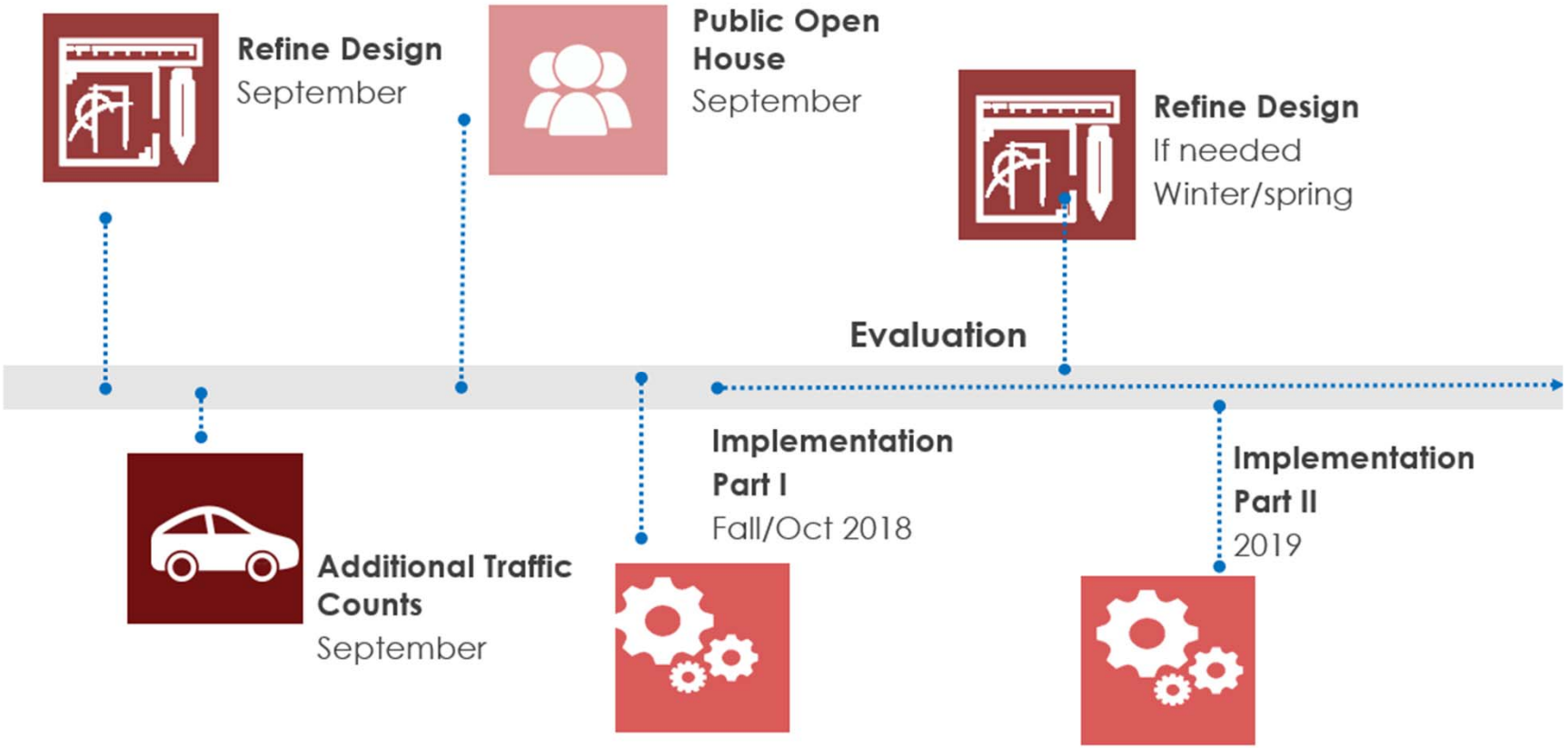
Timeline

Schedule



Timeline

Schedule



Design

Community Engagement

Feedback from Stakeholders and the Public

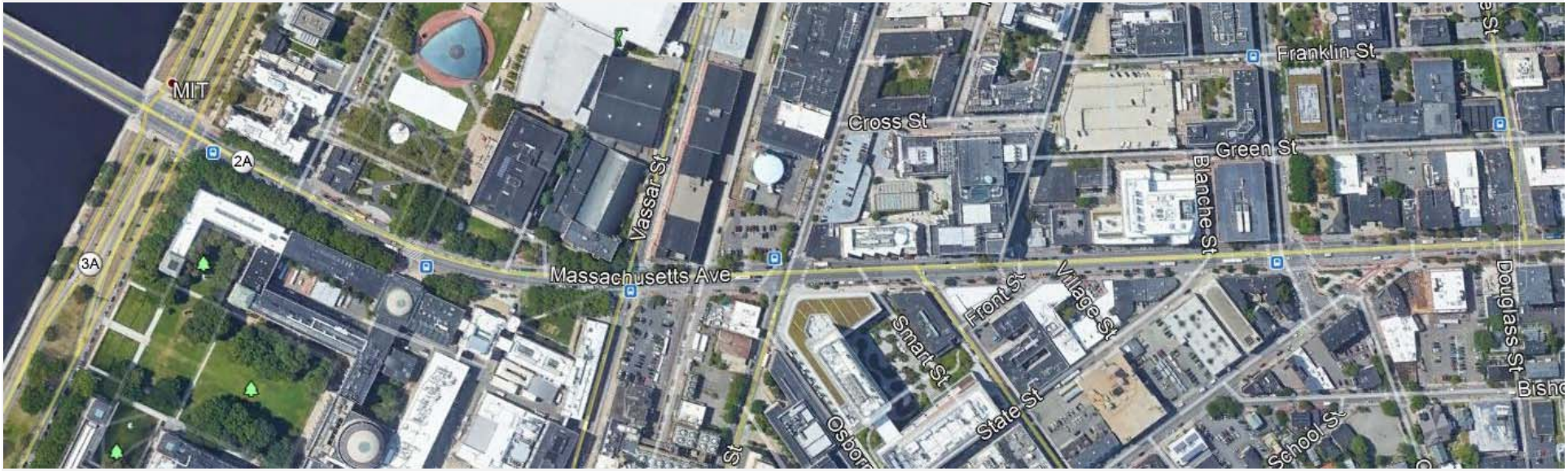
- Project Website

  http://www.cambridgema.gov/CDD/Projects/Transportation/southmassave
- Wikimap
- 3 advisory group meetings
- 2 public workshops and open house
- Additional community engagement
- Post-implementation feedback and evaluation

Design

Community Engagement

Breakout Discussions



- ✓ What aspects of the existing south Mass. Ave. corridor do you like and/or want to see more of?
- ✓ What aspects of the south Mass. Ave. corridor do you dislike or want to see changed?
- ✓ What other considerations do you think need to be addressed by this project?

Design

Bus Stop Operations

Modular floating bus stop under evaluation

Design

Transit Facilities - Benefits

- ✓ Bus priority lane in key stretches
- ✓ Serves all bus transit, including shuttle services

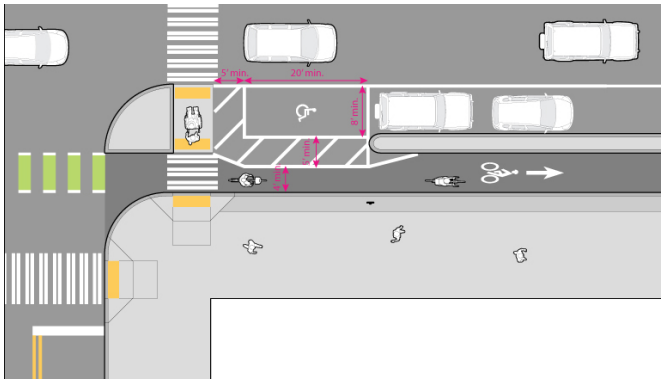
Design

Bicycle Facilities

- ✓ Bicyclist safety improved
  - ✓ Separated lanes
  - ✓ Separated turning movements
  - ✓ Bicycle Signals
- ✓ Level of comfort increased
  - ✓ Supports all ages and abilities goal
  - ✓ All users prefer separation, including people driving and walking

Design

Parking Facilities – Benefits



- ✓ Accessible parking spaces improved
- ✓ On-street parking maintained in retail sections

Design

Final Design

- Average vehicle delay and queues will likely be shorter as compared with the prior proposed design
- Intersections will require new left-turn signals, which can be “lagging.” Separated left turns improves comfort and reduces stress for all users; lagging left-turns also improve safety.
- The signals may be implemented with “Flashing Yellow-Arrow” as the “Proceed”
- Improved driver continuity, expectation, and safety management are anticipated with a single southbound lane on Mass Ave

Design

Possible Future Additions – To Be Evaluated

- ? **Additional crosswalk/RRFB** in Section 1
- ? **Move bus stops** to the far side of intersections (for better operations)
- ? Construct **modular (or permanent) floating bus stops**
- ? **Remove/modify curb extensions** to allow better bicyclist protection
- ? **Work with state DCR and MassDOT on changes at Memorial Dr and bridge**