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PSU Safety Conference

Pedestrian/Bike Safety & Liability

Wednesday, December 6, 2017

Transportation Solutions Building Better Communities

Pedestrian/Bike Safety Design

Design Solutions

- Protected Intersections
- Crosswalks & Crossings
- Signal Phasing & Timing

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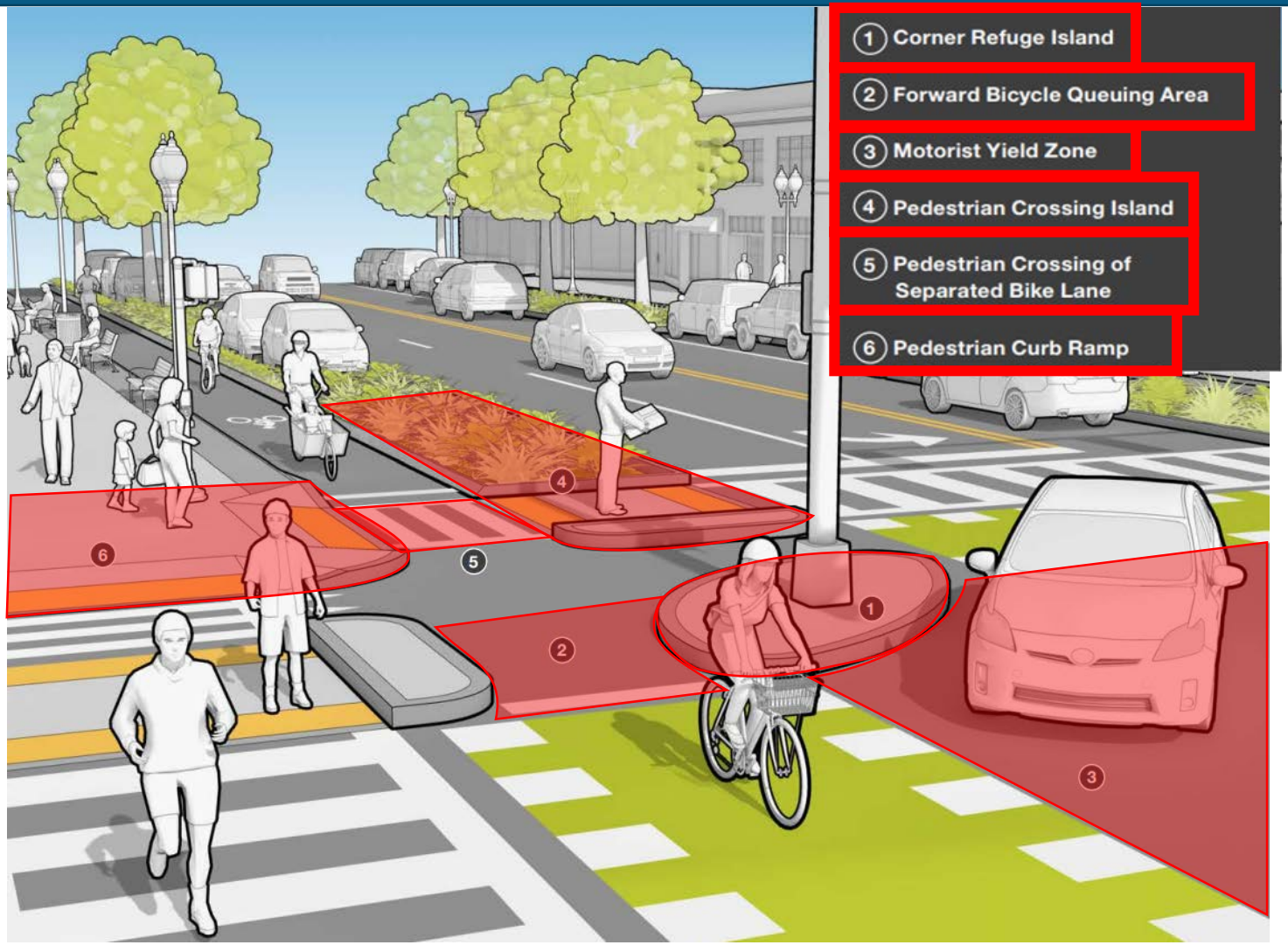
Protected Intersections

Source: Streetsblog NYC

Protected Intersections



Source: MassDOT Separated Bike Lane Planning & Design Guide

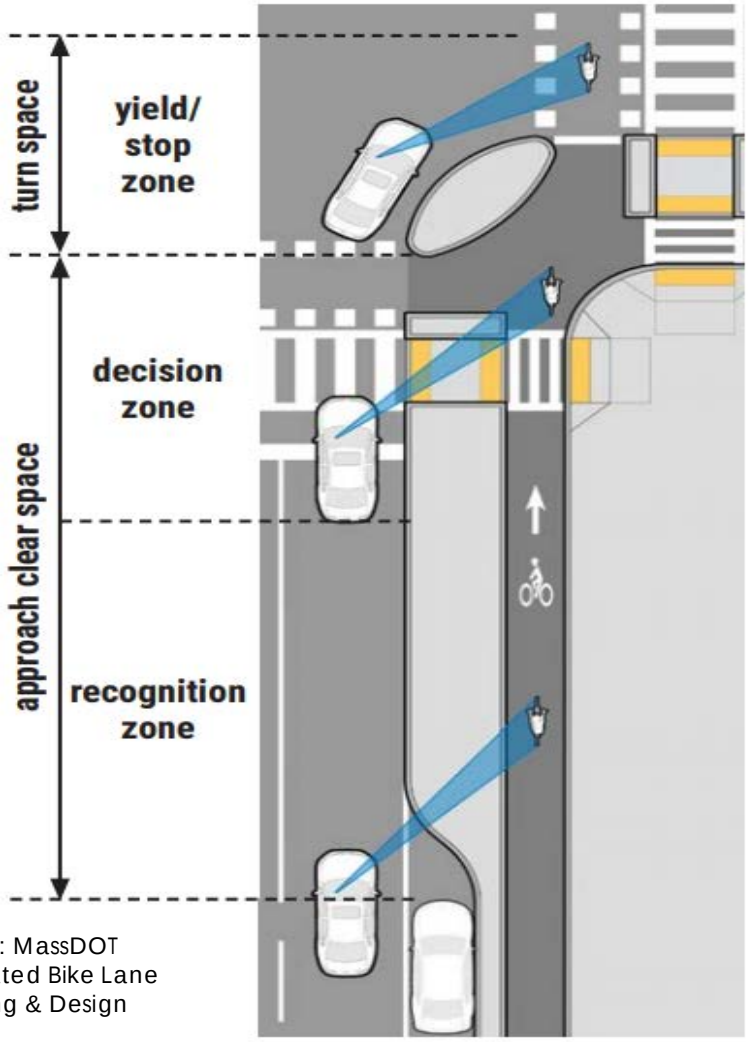
Protected Intersections

Pedestrian + Bicycle Benefits

- Physical separation
- “Head start” for crossing
- Shortened crossing distance
- Maximized visibility

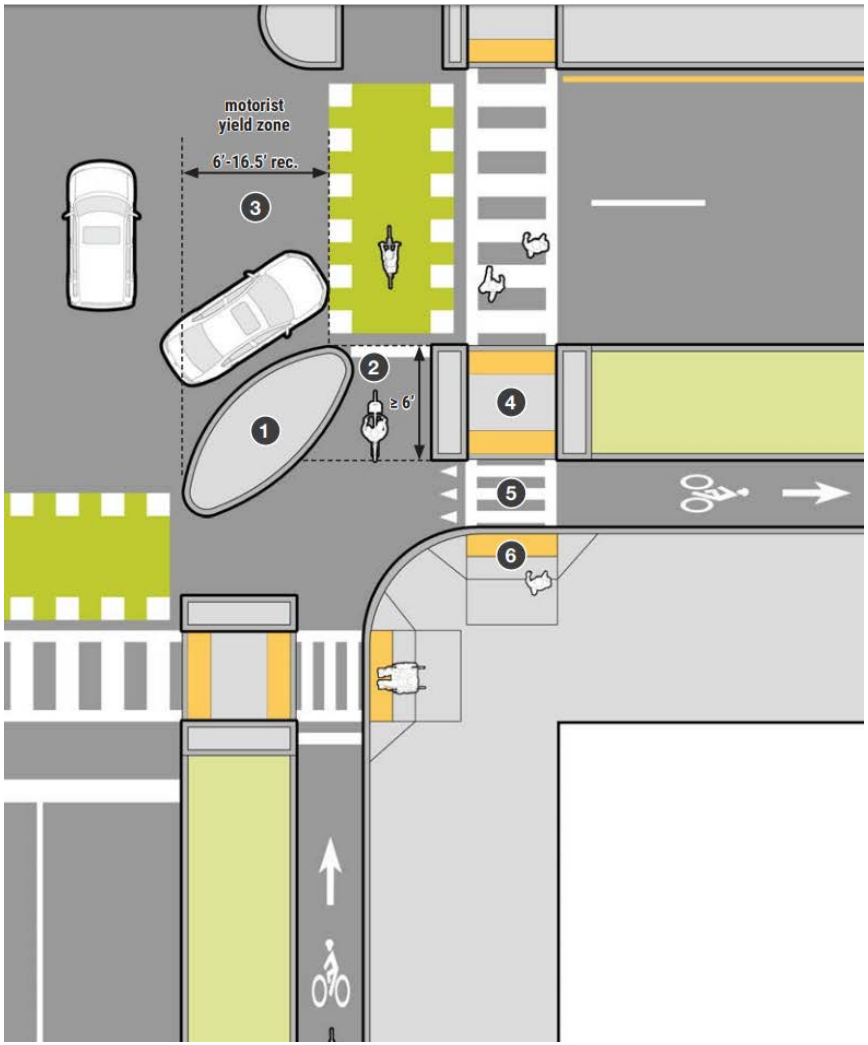
Other Considerations

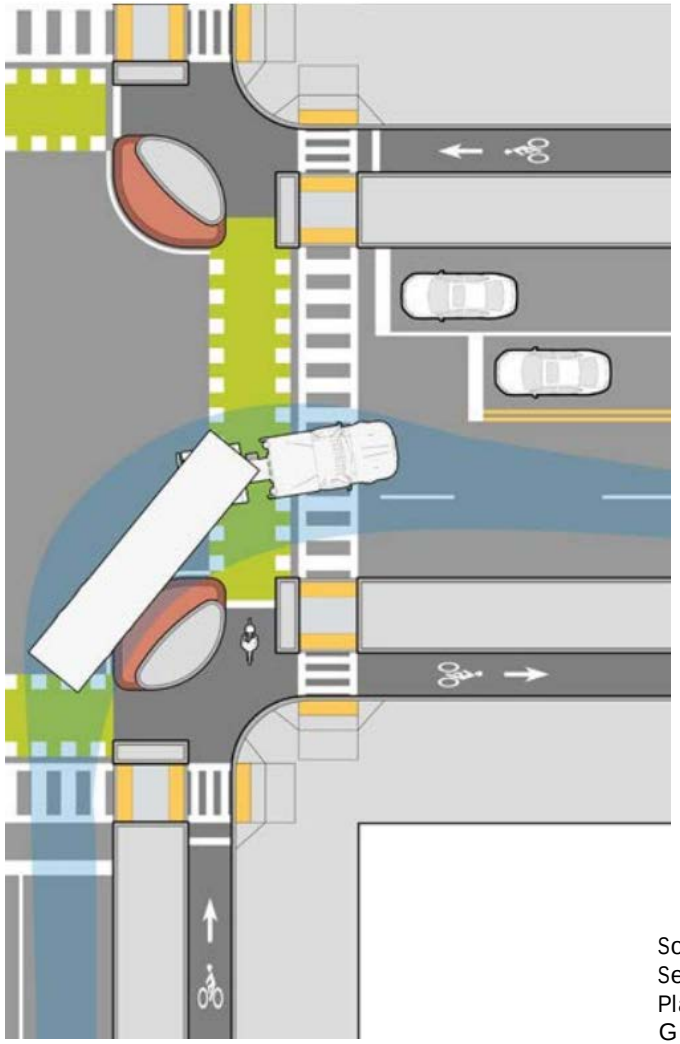
- Maintenance
- Snow Removal
- Vehicle Operations



Source: MassDOT Separated Bike Lane Planning & Design Guide

Protected Intersections





Source: MassDOT Separated Bike Lane Planning & Design Guide

Inman Square Safety Improvement Project

- Existing Conditions
  - Bikes in road
  - Long crossings
  - Indirect crossings
  - Long cycle length

Protected Intersections

Inman Square Safety Improvement

Corner Refuge Island

Forward Bicycle Stop Bar

Protected Signal Phasing

Tight Corner Radii

Separate Turn Lanes

Off-set Stop Bars

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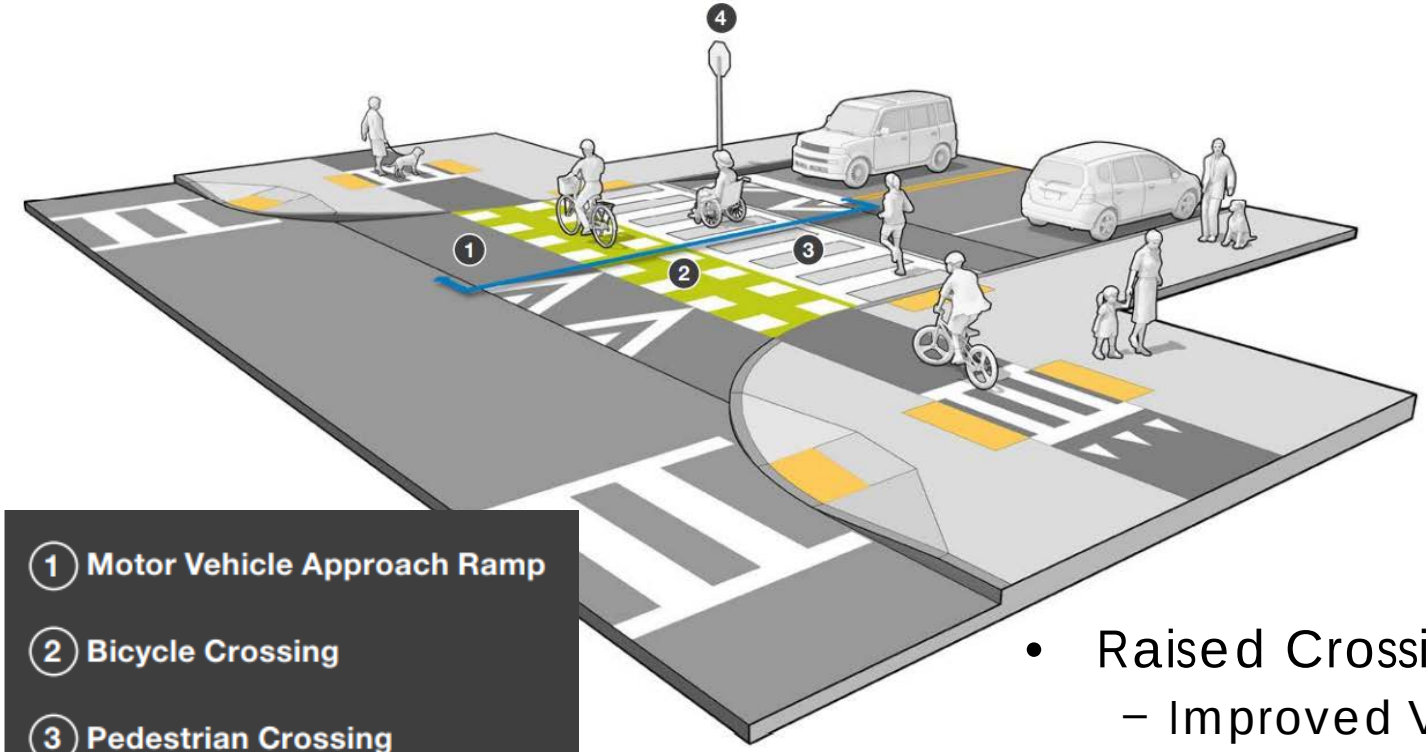
Prioritized Crossings

Prioritized Crossings

Minor Street Intersections



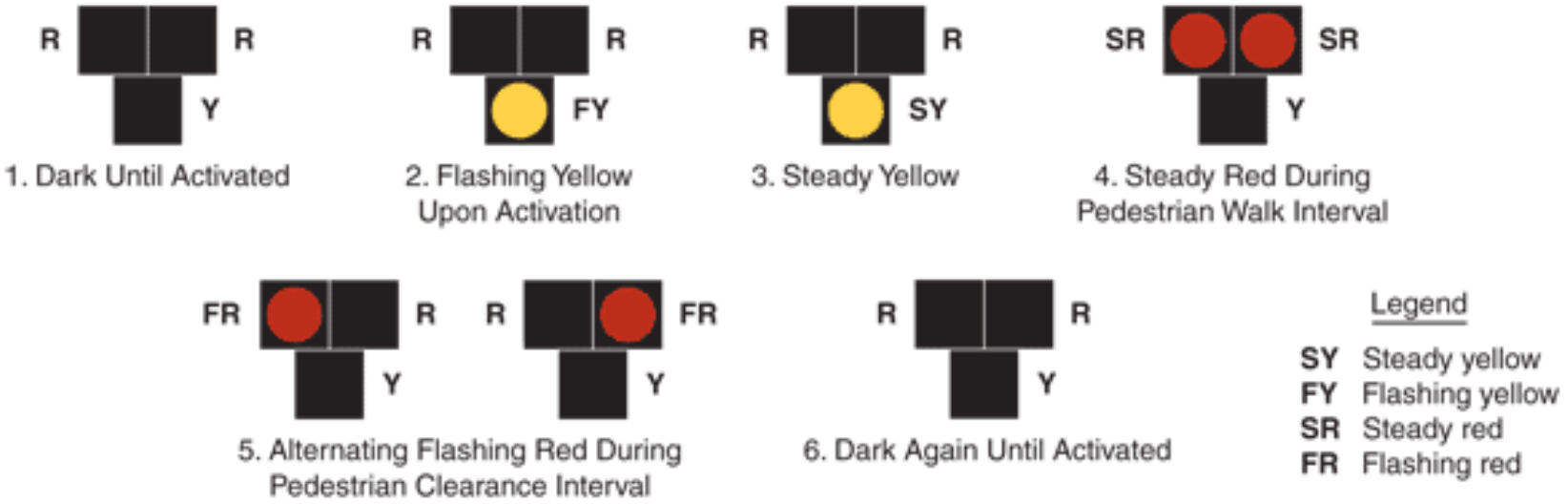
- Raised Crossings
  - Improved Visibility
  - Emphasizes Pedestrian & Bicycle Priority
  - Maintain Low Vehicle Speeds

Prioritized Crossings

Examples

HAWKS Signals/Pedestrian Hybrid Beacons

Figure 4F-3. Sequence for a Pedestrian Hybrid Beacon



- *Inadequate gaps in traffic*
- *High Vehicle Speeds*
- *Excessive Pedestrian Delay*

Prioritized Crossings

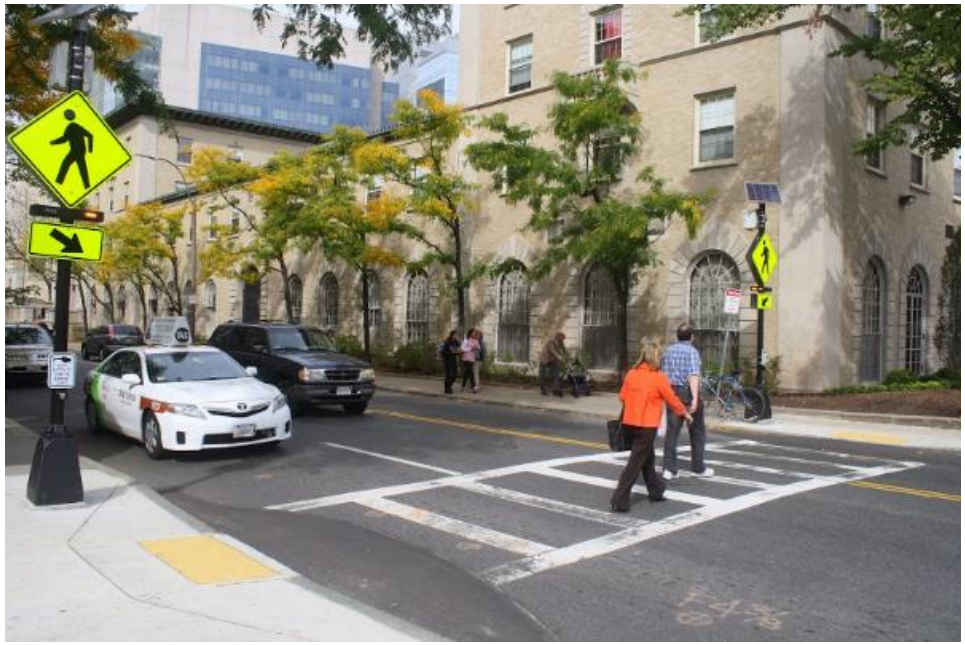
Morrissey Boulevard

Prioritized Crossings

Morrissey Boulevard Redesign

Rectangular Rapid Flash Beacon (RRFB)

- Lower Costs than Signals
- Increase Driver Yielding
- Increase Safety Effectiveness
- Reduce Incidence of Multiple-Threat Crashes



Prioritized Crossings

Medians & Curb Extensions

- Reduced crossing length
- Minimized exposure
- Decreased delay
- Traffic calming

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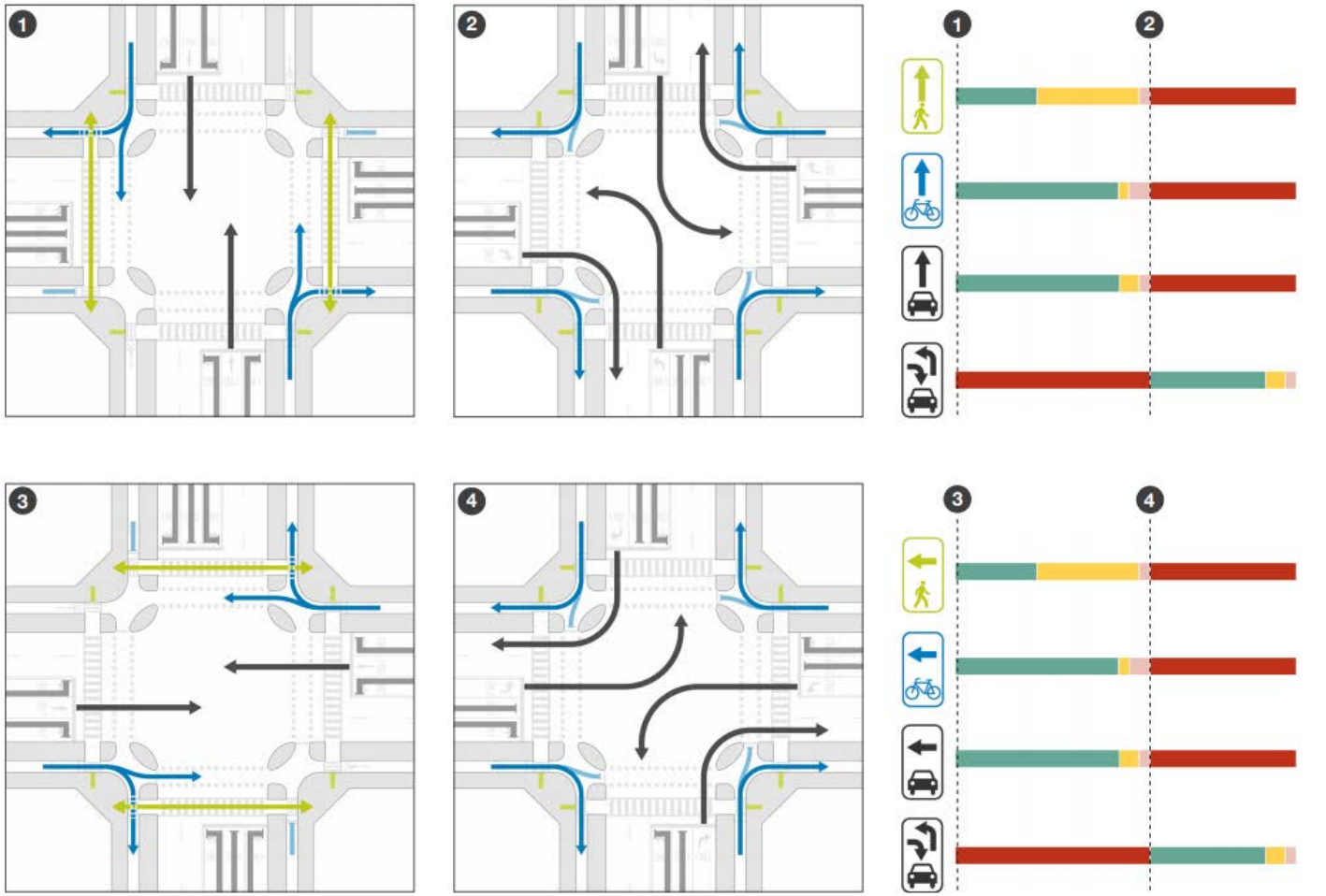
Signal Phasing & Timing

Signal Phasing & Timing

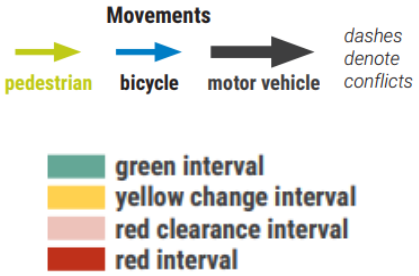
Time Separated Movements

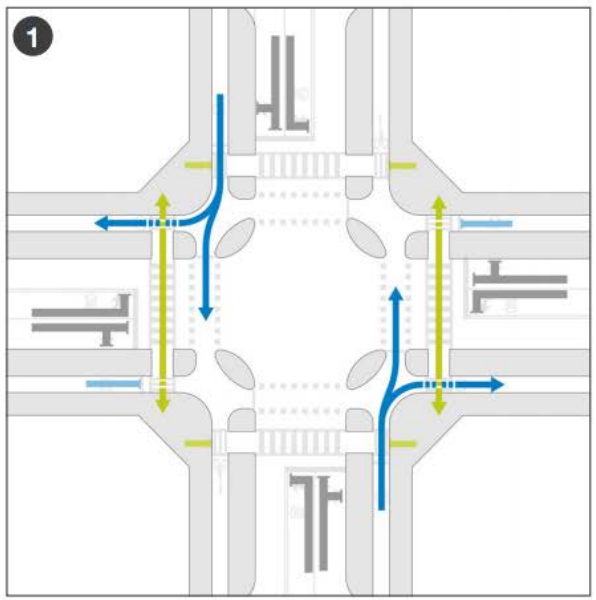


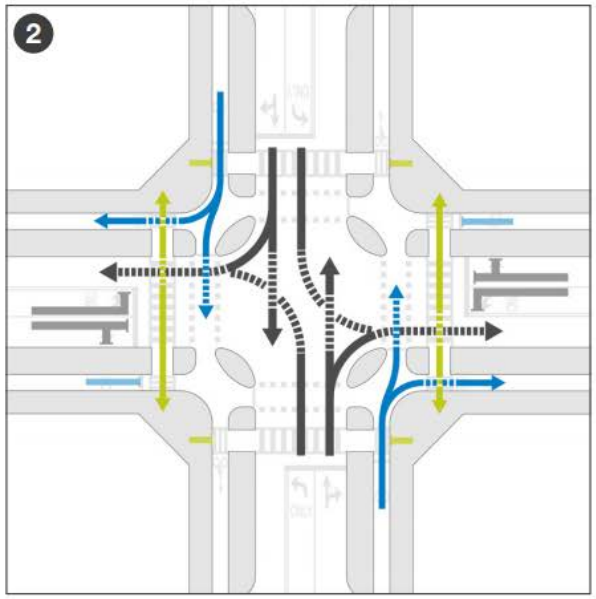
Source: MassDOT Separated Bike Lane Planning & Design Guide

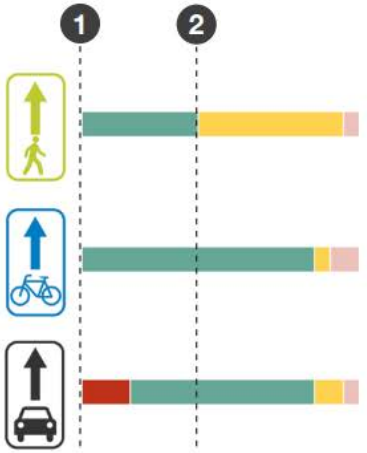
Lead Pedestrian and Bicycle Interval

- Establish Pedestrians and Bicycles within Crossings
- Enhance Visibility
- Reinforce Right of Way Over Vehicles





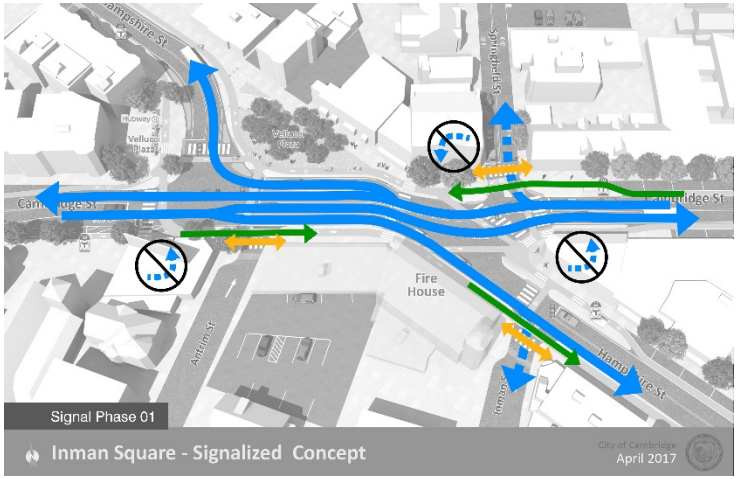


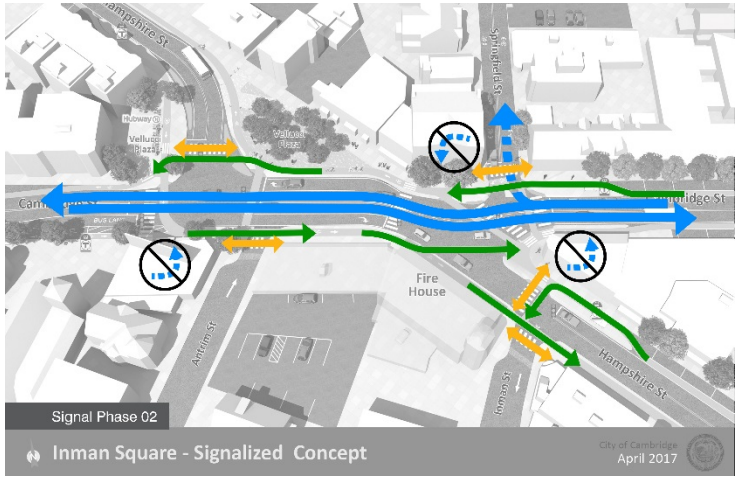


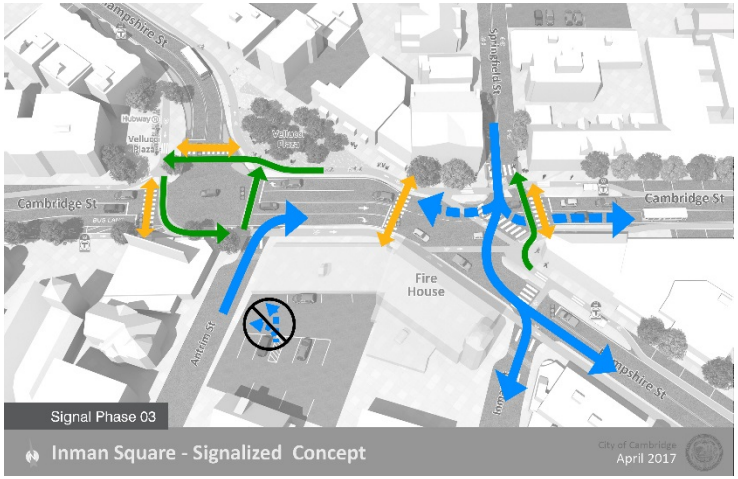
Source: MassDOT Separated Bike Lane Planning & Design Guide

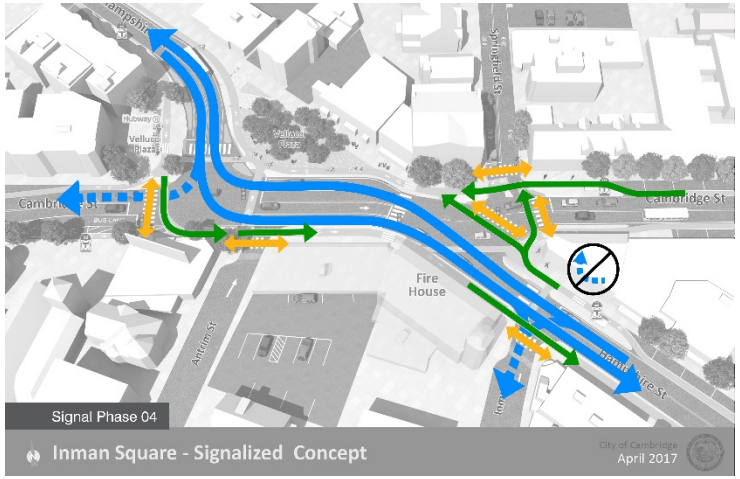
Signal Phasing & Timing

Inman Square



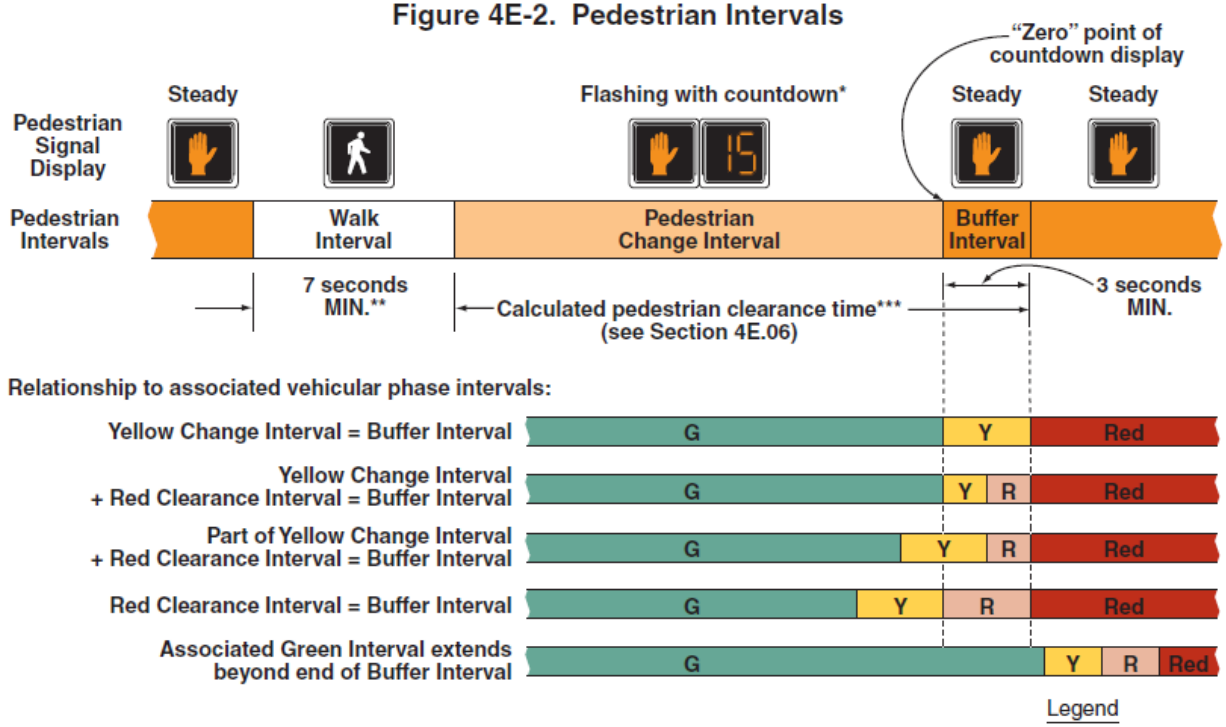






Pedestrian and Bicycle Clearance Time

Figure 4E-2. Pedestrian Intervals



* The countdown display is optional for Pedestrian Change Intervals of 7 seconds or less.

** The Walk Interval may be reduced under some conditions (see Section 4E.06).

*** The Buffer Interval, which shall always be provided and displayed, may be used to help satisfy the calculated pedestrian clearance time, or may begin after the calculated pedestrian clearance time has ended.

Legend

G = Green Interval

Y = Yellow Change Interval (of at least 3 seconds)

R = Red Clearance Interval

Red = Red because conflicting traffic has been released

Source: Manual on Uniform Traffic Control Devices for Streets and Highways 2009 Edition

Key Takeaways

- Safety Improvements on Any Scale
- Improving Visibility
- Physical Separation
- Separation in Time

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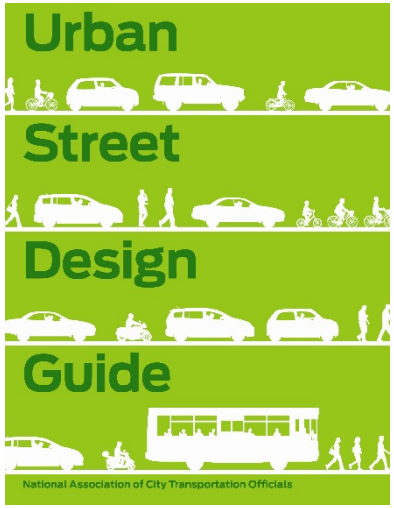
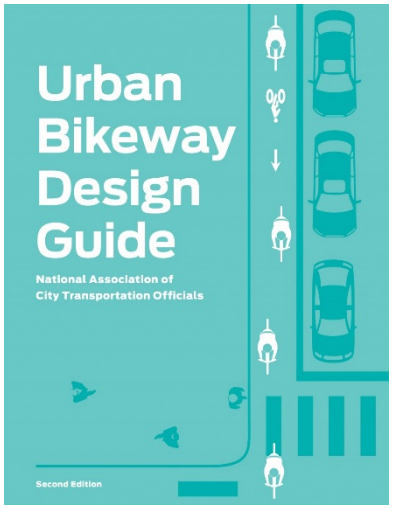
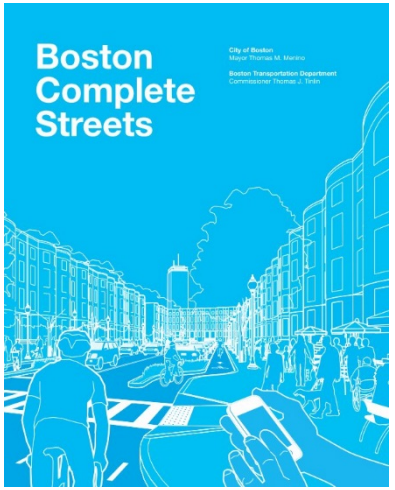
Resources & Guidelines

Resources

- National Association of City Transportation Officials (NACTO)
  - Urban Bikeway Design Guide
  - Urban Street Design Guide
- MassDOT Separated Bike Lane Planning & Design Guide
- Boston Complete Streets Design Guidelines







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Questions?

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Back up Slides

Prioritized Crossings

HAWKS Signals/Pedestrian Hybrid Beacons

Figure 4F-2. Guidelines for the Installation of Pedestrian Hybrid Beacons on High-Speed Roadways

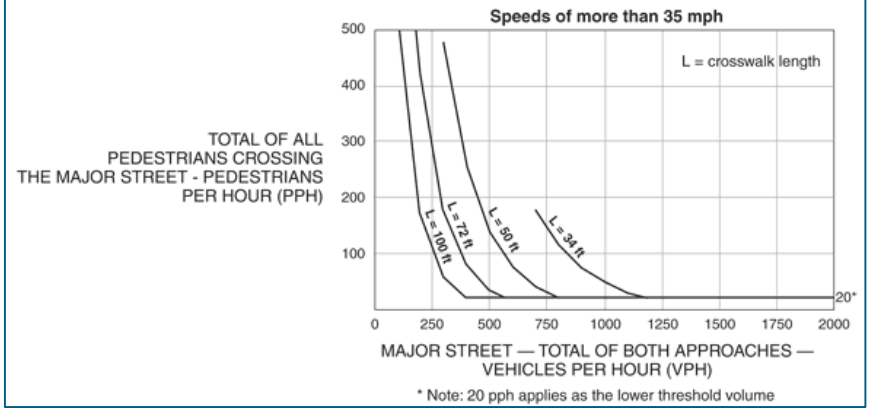
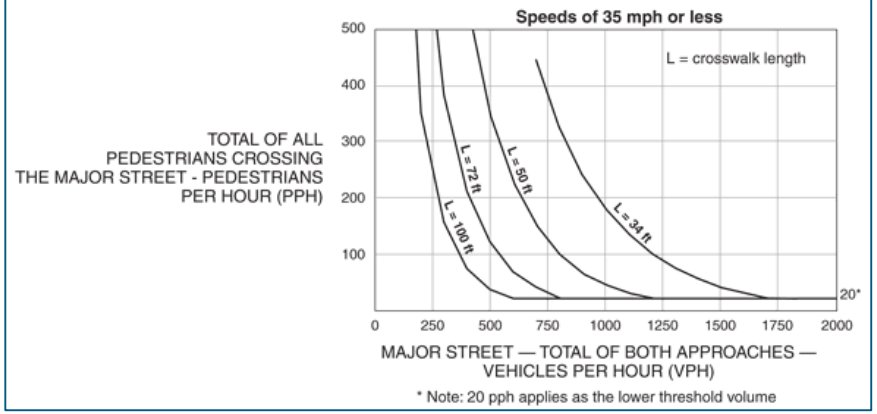


Figure 4F-1. Guidelines for the Installation of Pedestrian Hybrid Beacons on Low-Speed Roadways



Time Separated Movements

Separated Bike Lane Operation	Motor Vehicles per Hour Turning across Separated Bike Lane			
	Two-way Street			One-way Street
	Right Turn	Left Turn across One Lane	Left Turn across Two Lanes	Right or Left Turn
One-way	150	100	50	150
Two-way	100	50	0	100

Source: MassDOT Separated Bike Lane Planning & Design Guide

Signal Phasing & Timing

Phasing Scheme	Description	Pros	Cons
Concurrent Bike Phase with Concurrent Permissive Vehicle Turns (see EXHIBIT 6H)	Provides a bicycle phase that runs concurrently with the parallel vehicle phase.	• Increased compliance when compared to following vehicle signals.	• Not appropriate in locations with high vehicle turning volumes. • Requires vehicles to yield when turning.
Concurrent Bike Phase with Leading Interval (see EXHIBIT 6I)	Provides an advanced green indication for the bike signal. Lead interval may provide **3 to 7 seconds** of green time for bicycles prior to the green phase for the concurrent vehicle traffic. Lead bike intervals may typically be provided concurrently with lead pedestrian intervals.	• Allows bicyclists to enter the intersection prior to vehicles. • Improved visibility for turning vehicles.	• Small increase to delay and queueing for vehicles. • Concurrent turns may not be appropriate with higher vehicle or bike volumes.
Concurrent Protected Bike Phase (see EXHIBIT 6J and EXHIBIT 6K)	Provides a bicycle phase that runs concurrently with the parallel through vehicle phase. Right and left vehicle turns across the bicycle facility operate under protected phases before or after the through phase.	• Provides full separation between turning vehicles and bicyclists. • Motorists are not required to yield when turning.	• Additional signal phase may increase delay, require longer cycle length. • Protected right turns require the provision of a right-turn lane.
Protected Bike Phase (see EXHIBIT 6L)	Provides a protected bike phase where all motor vehicle traffic is stopped. This may run concurrently with a parallel pedestrian phase. May be appropriate at locations with complex signal phasing for vehicles and/or unusual geometry for a bicycle facility may result in unexpected conflicts between users.	• Provides maximum separation between vehicles and bicyclists. • Allows turns from the bike facility across the vehicle lanes.	• Increases delay for motor vehicles. • Increases delay for bicyclists.

Source: MassDOT Separated Bike Lane Planning & Design Guide

Design Guidance

Bicycle Signal Heads

Required Features

1. The bicycle signal head shall be placed in a location clearly visible to oncoming bicycles.

2. If the bicycle phase is not set to recall each cycle, bicycle signals shall be installed with appropriate detection and actuation.

3. An adequate clearance interval (i.e., the movement's combined time for the yellow and all-red phases) shall be provided to ensure that bicyclists entering the intersection during the green phase have sufficient time to safely clear the intersection before conflicting movements receive a green indication.[84]

4. If the bicycle signal is used to separate through bicycle movements from right turning vehicles, then right turn on red shall be prohibited when the bicycle signal is active. This can be accomplished with the provision of a traffic signal with red, yellow, and green arrow displays. An active display to help emphasize this restriction is recommended.

5. Bicycle signal heads are generally the preferred option over installing a sign instructing bicycles to use pedestrian signals.

While instructing bicyclists to use pedestrian signals is a low-cost option, the length of the pedestrian clearance interval (typically timed at 3.5 feet per second) is usually inappropriate for bicyclists. The result is that approaching bicyclists have poor information about when it is safe and legal to enter the intersection.

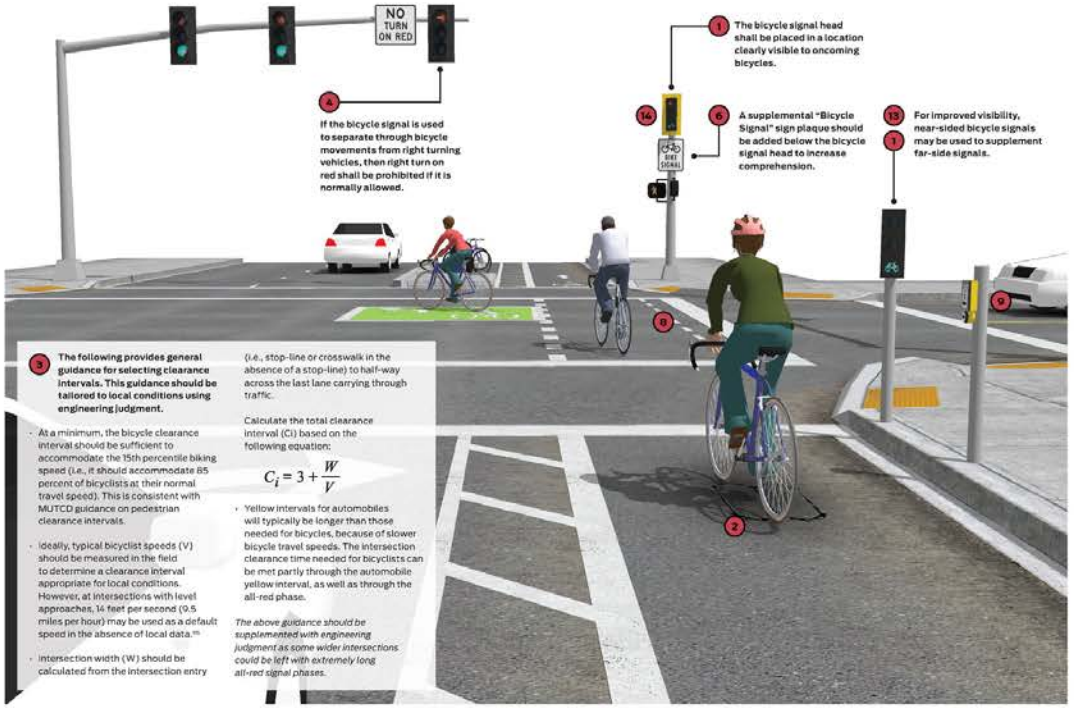
Recommended Features

6. A supplemental "Bicycle Signal" sign plaque should be added below the bicycle signal head to increase comprehension.

7. Signal timing with bicycle-only indications should consider activating the signal with each cycle prior to implementation with detection. This will increase awareness of the interval for motorists and bicyclists. In a close network of signals, the timing should consider how often a bicyclist will be stopped in the system to insure that undue delay is not a result of the bicycle-only signal.

8. Intersection crossing markings should be used where the bicycle travel path through the intersection is unusual (e.g., diagonal crossing) or needed to separate conflicts.

9. Passive actuation of bicycle signals through loops or another detection method is preferred to the use of push-buttons for actuation where practical. Passive actuation is more convenient for bicyclists. If push buttons are used, they should be mounted such that bicyclists do not have to dismount to actuate the signal.



3 The following provides general guidance for selecting clearance intervals. This guidance should be tailored to local conditions using engineering judgment.

- At a minimum, the bicycle clearance interval should be sufficient to accommodate the 15th percentile biking speed (i.e., it should accommodate 85 percent of bicyclists at their normal travel speed). This is consistent with MUTCD guidance on pedestrian clearance intervals.
- Ideally, typical bicyclist speeds (V) should be measured in the field to determine a clearance interval appropriate for local conditions. However, at intersections with level approaches, 14 feet per second (9.5 miles per hour) may be used as a default speed in the absence of local data.[85]
- Intersection width (W) should be calculated from the intersection entry (i.e., stop-line or crosswalk in the absence of a stop-line) to half-way across the last lane carrying through traffic.

Calculate the total clearance interval (Ci) based on the following equation:

$$C_i = 3 + \frac{W}{V}$$

- Yellow intervals for automobiles will typically be longer than those needed for bicycles, because of slower bicycle travel speeds. The intersection clearance time needed for bicyclists can be met partly through the automobile yellow interval, as well as through the all-red phase.

The above guidance should be supplemented with engineering judgment as some wider intersections could be left with extremely long all-red signal phases.

10. There are currently no national standards for determining the appropriate clearance intervals for bicycle signals. However, the primary factors in choosing an appropriate clearance interval are bicyclist travel speed and intersection width. At most signalized intersections, vehicular clearance intervals will likely function well for bicyclists. Exceptions requiring consideration include signals along cycle tracks or bicycle facilities that may be likely to serve significant levels of novice cyclists. See guidance for selecting clearance intervals at left.

11. Bicyclists typically need longer minimum green times than motor vehicles due to slower acceleration speeds. This time is usually more critical for bicyclists on minor-road approaches, since crossing distance of major roads is typically greater than that of minor roads, and crossings from minor roads are often subject to short green intervals. Bicycle minimum green time is determined using the bicycle crossing time for standing bicycles.[86]

12. Design and operation of bicycle signal heads should consider general MUTCD guidance on standards for traffic signals where applicable (e.g., positions of signal indications; visibility, aiming, and shielding of signal faces). Many of the MUTCD considerations for traffic signals will not apply to bicycle signals. Existing experience with bicycle signal installations in some cities has resulted in post mounted signals being utilized adjacent to the bikeway with a lower overall height. Some existing designs use shields and louvers to limit the driver's visibility of the bicycle signal to avoid potential confusion. Engineering judgment should be used to ensure that the positioning of bicycle signal heads is optimal for each installation. It is recommended that bicycle signal heads be separated from motor vehicle signal heads by at least two feet to increase comprehension.

Optional Features

13. For improved visibility, near-sided bicycle signals may be used to supplement far-side signals. Smaller, half-sized signal heads with 4 inch lenses may be more appropriate in scale for near side installations.

14. Visual variation in signal head housing for the bicycle signal when compared to adjacent traffic signals may increase contrast and awareness.

15. If signal controlled bicycle turning movements are desired, consider pairing the bicycle signal head with a turn signal head to clarify protected, permissive, or restricted turning movements.

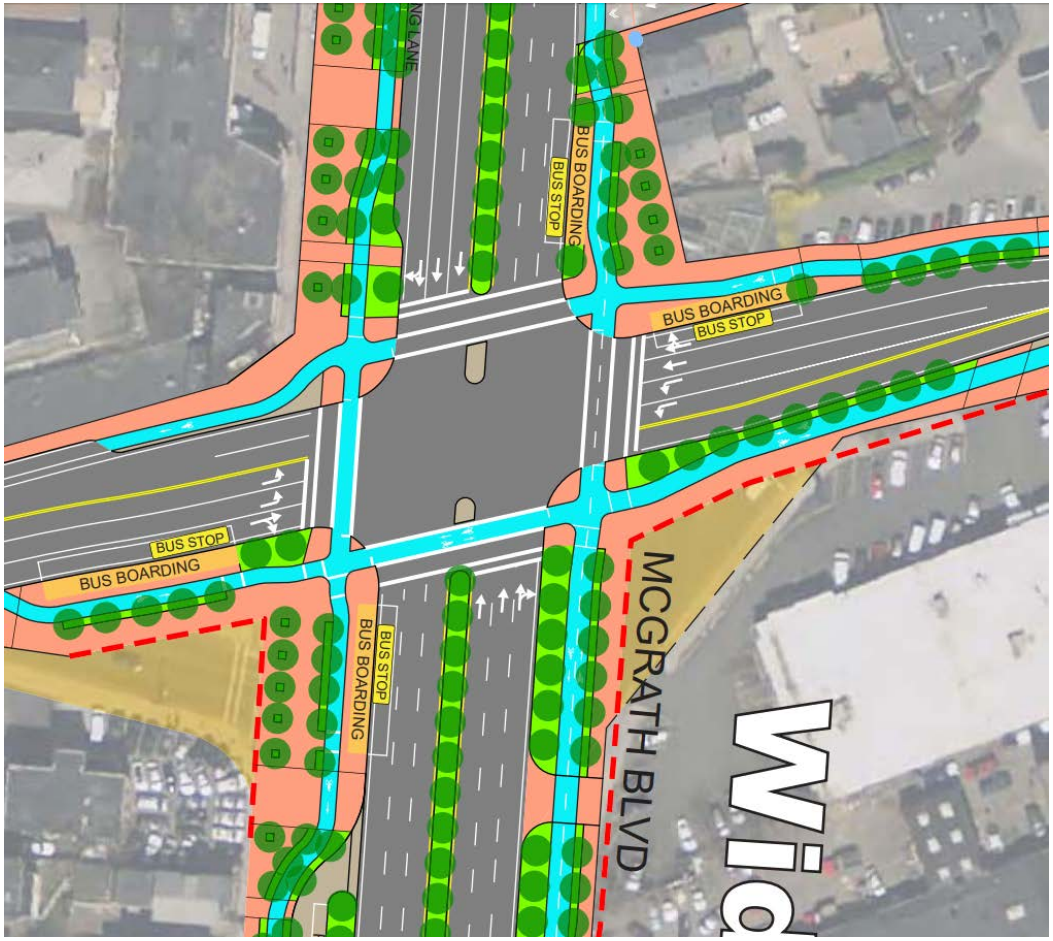
16. Near-side bicycle signals may incorporate a "countdown to green" display to provide information about when a green bicycle indication will be provided. This treatment has proved popular in Europe, but there are currently no known installations in the United States.

Protected Intersections

McGrath Highway/Boulevard

Protected Intersections

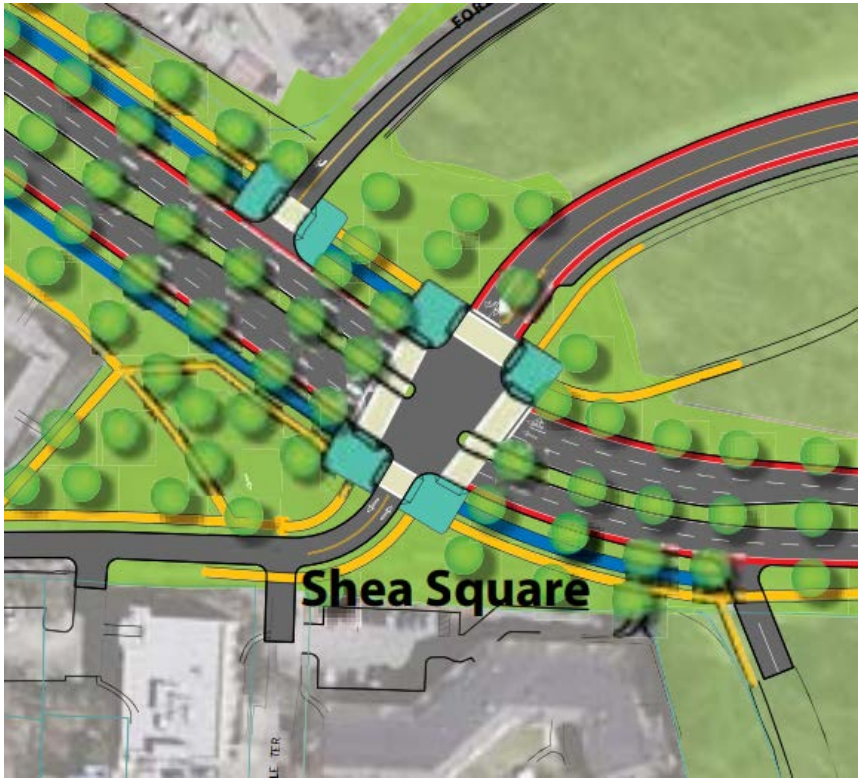
McGrath Highway/Boulevard



- Corner Refuge Island
- Forward Bicycle Stop Bar
- Protected Signal Phasing
- Tight Corner Radii
- Separate Turn Lanes

Protected Intersections

Shea Circle – Casey Arborway Project



Protected Intersections

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