
14
BELIEVE IN
BOSTON

4

Intersections

Boston's neighborhoods are defined by its squares—Dudley, Hyde, Roslindale, Mattapan, Kenmore, and Maverick—where streets, sidewalks, and public spaces come together, and all modes of travel converge. Intersections at the heart of these squares take many forms, depending on street geometry, the character of buildings, and the presence of greenscape and art. Intersections can serve as neighborhood gateways and plazas. Ranging in scale and complexity, they can be simple or challenging to navigate. This chapter presents ways to balance the needs of all users while preserving a unique sense of place at Boston's intersections.

Intersection Design Principles

Accessible for All

Universal accessibility design principles should inform all aspects of intersection design, ranging from geometry to signal timing with a commitment to achieving the best outcome for all users within the constraints of each site.

Ease of Maintenance

Intersection materials should be long-lasting and sustainable, requiring a low amount of maintenance. Pavers are not allowed in crosswalks, and a clear accessible path should be provided across intersections.

Reclaiming Space

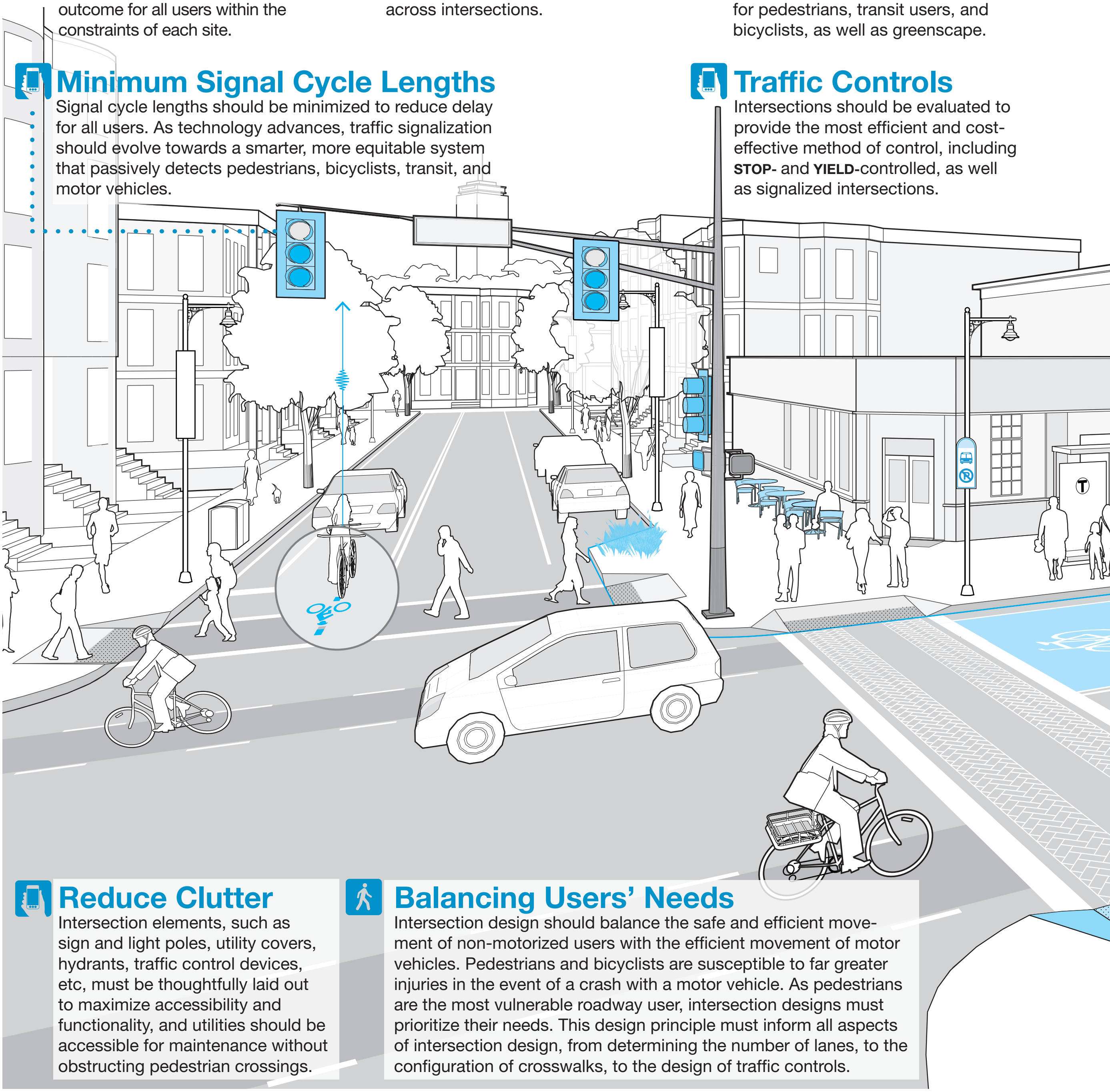
Intersections that contain wide, undefined areas of pavement not necessary for the efficient movement of motor vehicles provide opportunities to reclaim street space for pedestrians, transit users, and bicyclists, as well as greenscape.

Minimum Signal Cycle Lengths

Signal cycle lengths should be minimized to reduce delay for all users. As technology advances, traffic signalization should evolve towards a smarter, more equitable system that passively detects pedestrians, bicyclists, transit, and motor vehicles.

Traffic Controls

Intersections should be evaluated to provide the most efficient and cost-effective method of control, including **STOP**- and **YIELD**-controlled, as well as signalized intersections.



Reduce Clutter

Intersection elements, such as sign and light poles, utility covers, hydrants, traffic control devices, etc, must be thoughtfully laid out to maximize accessibility and functionality, and utilities should be accessible for maintenance without obstructing pedestrian crossings.

Balancing Users' Needs

Intersection design should balance the safe and efficient movement of non-motorized users with the efficient movement of motor vehicles. Pedestrians and bicyclists are susceptible to far greater injuries in the event of a crash with a motor vehicle. As pedestrians are the most vulnerable roadway user, intersection designs must prioritize their needs. This design principle must inform all aspects of intersection design, from determining the number of lanes, to the configuration of crosswalks, to the design of traffic controls.

Emissions Reductions

Coordinated signal timing can reduce energy consumption and emissions and should be considered in every project, but should not cause excessive delay to environmentally-friendly modes of travel such as walking and bicycling.

Stormwater Management

Green street elements should be incorporated whenever possible to reduce runoff and the amount of impervious surface at intersections and street corners. Greenscape should be incorporated not only to recharge groundwater, but to filter pollutants and improve air quality.

Smart Tags

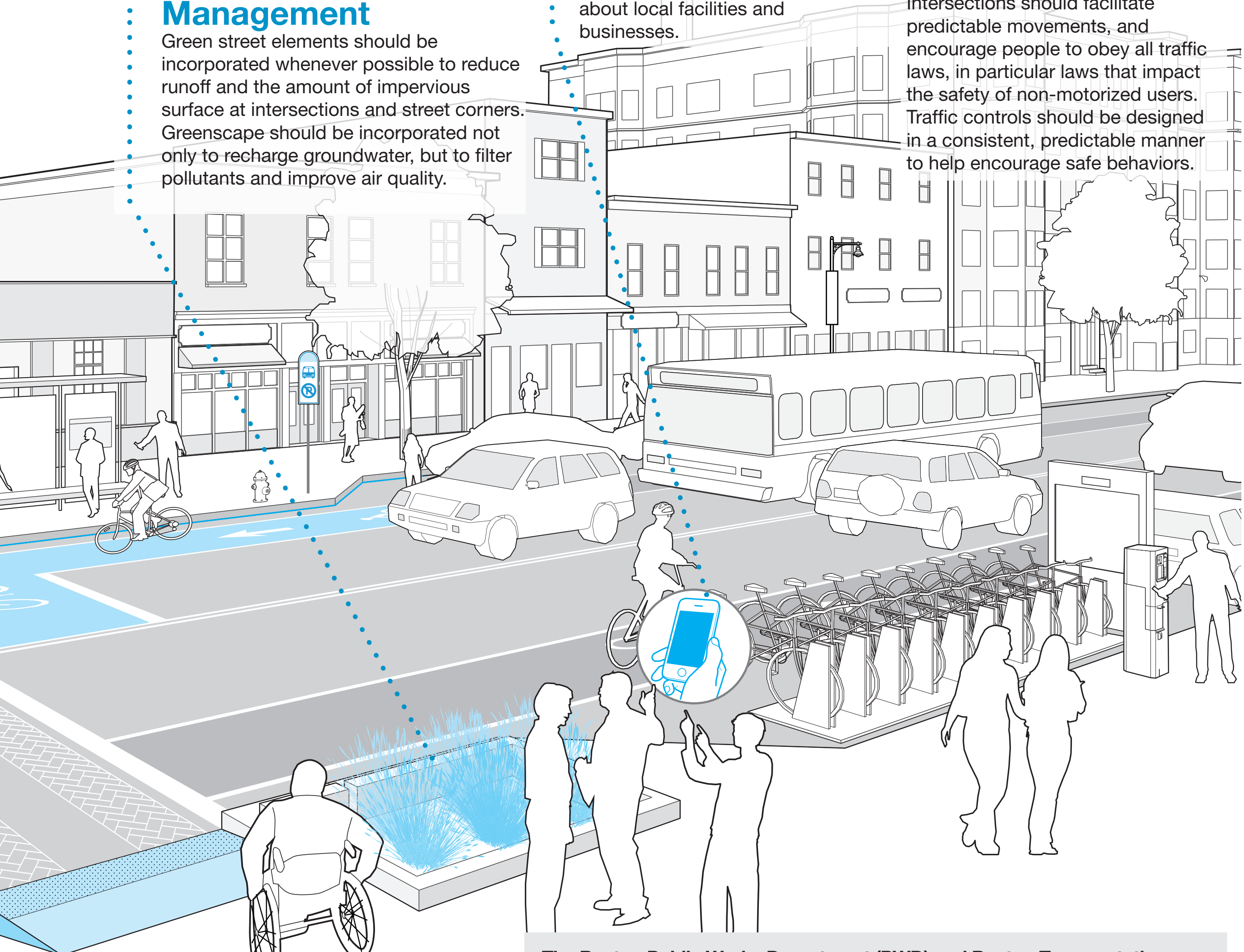
"Tags" are an evolving technology that provide information to people via mobile devices with internet access, which are particularly useful for people walking or using transit. Designs should consider including tags to provide way-finding information, as well as details about local facilities and businesses.

All-Weather Access

Intersections should function during all weather conditions including rain and snow. Designs should prevent ponding of precipitation at ramps, and provide storage space for snow during winter.

Obeying the Law

Intersections should facilitate predictable movements, and encourage people to obey all traffic laws, in particular laws that impact the safety of non-motorized users. Traffic controls should be designed in a consistent, predictable manner to help encourage safe behaviors.



Sensors

Opportunities should be explored to install sensors to monitor and study operations, traffic conditions, modal counts, and air-quality to improve efficiency.

The Boston Public Works Department (PWD) and Boston Transportation Department (BTD) are responsible for approving all intersection designs. The Public Improvement Commission (PIC) must approve all changes made to city-owned right-of-ways. Intersection designs may also require coordination with the Boston Fire Department, Emergency Medical Services (EMS), and the Mayor's Commission for Persons with Disabilities.


BOSTON UNIV
DO NOT ENTER

Multimodal Intersections

Intersections are locations where modes come together, and where the most conflicts and crashes occur on the roadway. People who travel on Boston's streets should feel safe and comfortable, and experience a minimal amount of delay during all trips regardless of whether they are made on foot, by bicycle, via transit, or in an automobile. Intersection designs must address three basic needs:

Safety – the most important objective of intersection design is the safety of all users.

Convenience – intersections should be convenient to access and comfortable for all users.

Minimal Delay – users should not be unduly delayed when moving through intersections.

Intersection safety is of paramount concern in the City of Boston. Intersection design should carefully balance the safety needs of all users, and should recognize that non-motorized users are more vulnerable and suffer far greater injuries in the event of a crash.

Intersections should be functional and easy to navigate, and designed with intuitive geometry and clear regulatory and wayfinding instructions through signage, pavement markings, and signalization. Also, designs should reflect users' desired travel paths as seamlessly as possible.

Traditional policies, both written and unwritten, have focused primarily on reducing motor vehicle delay, which offers benefits of reducing vehicle emissions and fuel consumption; however, these policies prioritized motorists over other users. Moving forward, intersection design in Boston will equally address the safety, comfort, and convenience of all modes.

The design of multimodal intersections will include the following considerations:

- The safety of all users will be the priority of intersection design.
- Decisions regarding intersection design will not be made solely on the delay to individual legs or movements occurring for short periods of time.
- Automatic pedestrian phases—not requiring pushbutton activation—should be used wherever feasible.
- Generally, concurrent pedestrian phases will be provided for the full length of the corresponding vehicle phase when feasible.

Different design elements of the roadway environment impact the basic needs described above. Unfortunately, several elements that improve conditions for one mode can have the effect of reducing the quality of service for other modes. Multimodal Level of Service (LOS), also termed "quality of service," provides a set of tools that can be used to measure how well intersections perform for various modes. In the context of intersections, the following pages illustrate the elements that matter most to each mode, as well as a discussion of the tradeoffs faced with trying to balance the needs of safety, convenience, and minimal delay for all users.

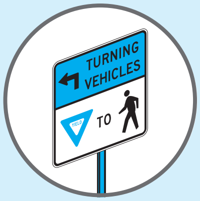
Pedestrian Experience

The primary needs of pedestrians at intersections include:

Safety

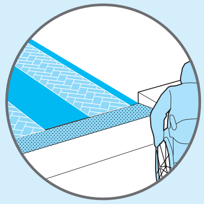
Lower motor vehicle speeds:

- Narrower motor vehicle lane widths
- Reduced turning radii
- Traffic calming measures



Less exposure to conflicts:

- Dedicated space
- Shorter crossing distances
- Improved sight lines and visibility
- Crossing islands where appropriate
- Appropriate signal timing and crossing treatments



Accessible crossings:

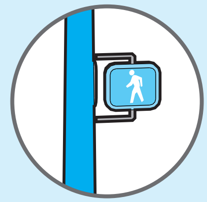
- American's with Disabilities Act (ADA) compliant curb ramps that prevent ponding of precipitation
- ADA compliant crosswalks
- Accessible pedestrian signals that inform users when signals have been activated

Convenience

Comfortable and inviting spaces:

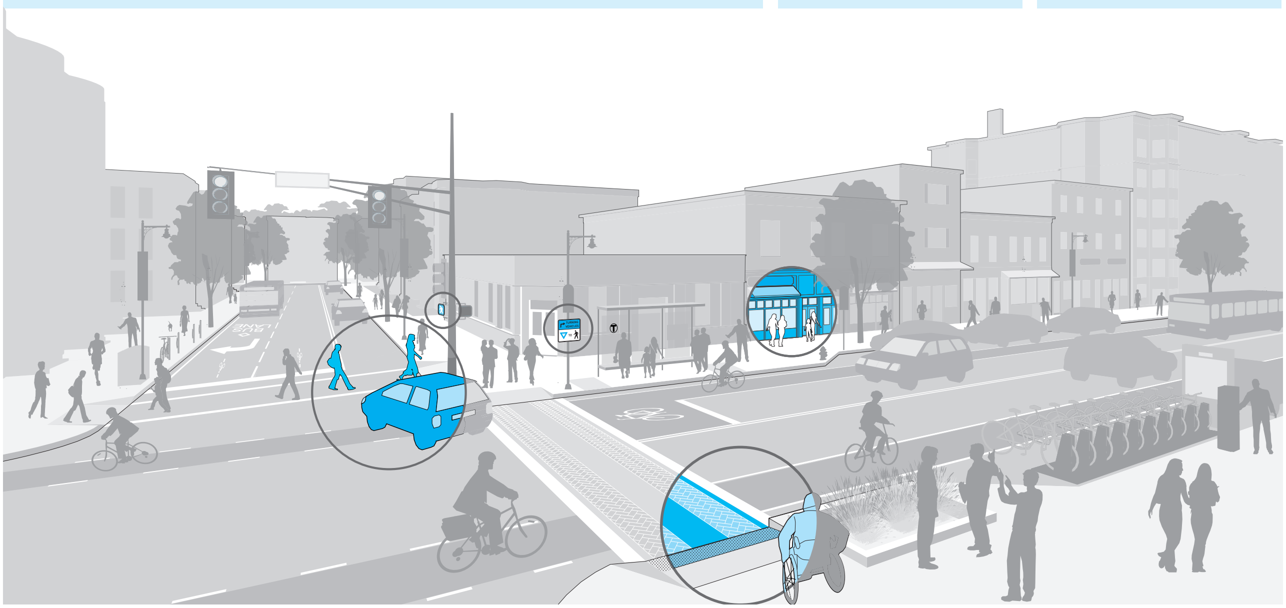
- Appropriate sidewalk widths for pedestrian volumes
- Crossings that reflect pedestrian desire lines
- Buildings that front the street
- Transparent store fronts
- Street trees
- Amenities such as benches, recycling and trash receptacles, public art, street cafés, etc.

Minimal Delay



Frequent opportunities to cross:

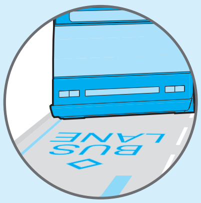
- Appropriate traffic controls (i.e., signage vs. signalization)
- Pre-timed pedestrian signals for every cycle
- Responsive pushbuttons where applicable
- Direct routes across complex intersections

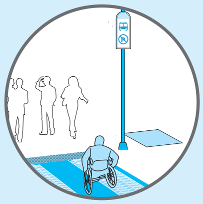


Transit User Experience

The primary needs of transit users at intersections include:

Safety



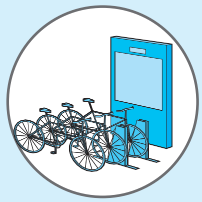


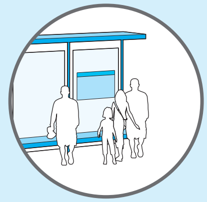
Good pedestrian and bicycle accommodations (see previous sections)

Less exposure to conflicts:
- Bus bulbs (Curb extensions at bus stops)
- Transit-only lanes
- Far-side bus stops

Accessible transit stops:
- ADA compliant landing zones at all doors
- Appropriate sidewalk widths for pedestrian volumes
- Well-lit transit stops

Convenience

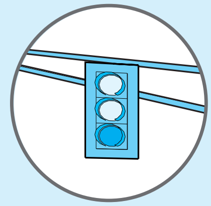




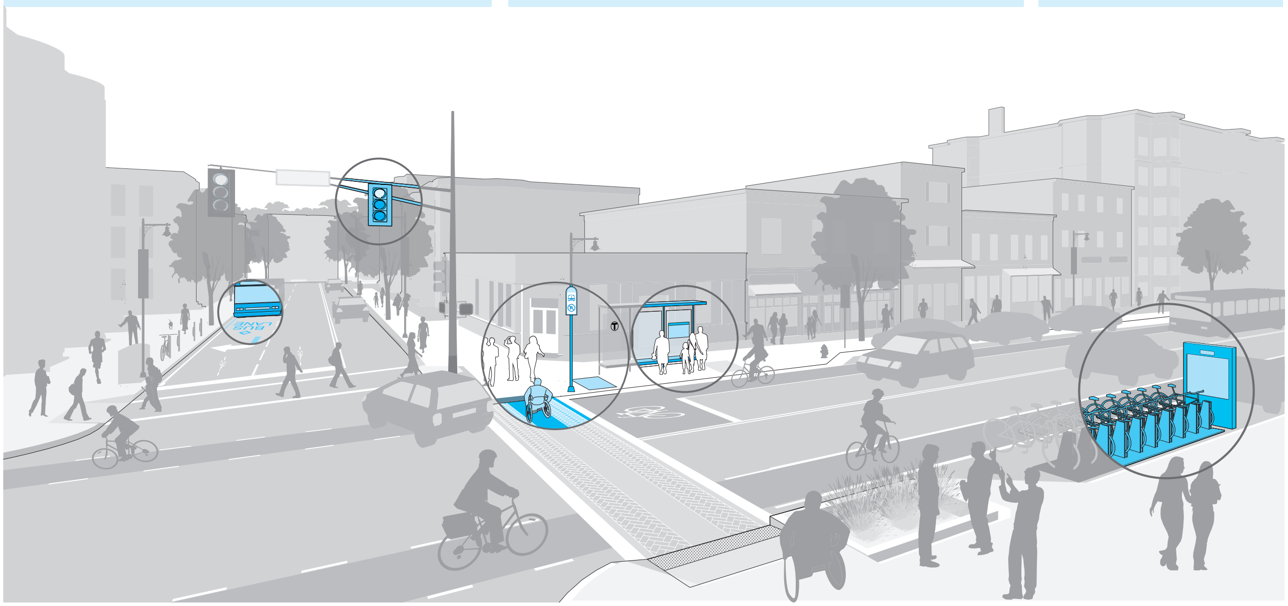
Connections to other modes:
- Good pedestrian and bicycle accommodations
- Bicycle share stations
- Wayfinding signage

Comfortable transit stop locations:
- Transit shelters
- Recycling and trash receptacles
- Route information
- Storage space for snow during winter

Minimal Delay



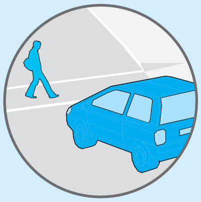
Minimal delay in service:
- Frequent headways
- Signal priority
- Queue jump lanes
- Off-bus fare collection



Bicyclist Experience

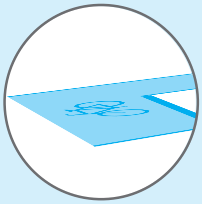
The primary needs of bicyclists at intersections include:

Safety



Lower motor vehicle speeds:

- Narrower motor vehicle lane widths
- Reduced turning radii
- Traffic calming measures



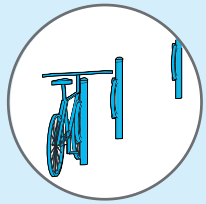
Less exposure to conflicts:

- Dedicated space
- Shorter crossing distances
- Signal design that accommodates bicycle speeds
- Signal design that reduces conflicts with other modes

Degree of separation:

- Intersection treatments for separate bicycle crossings
- Bicycle lanes
- Buffered bicycle lanes
- Cycle tracks

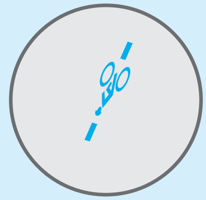
Convenience



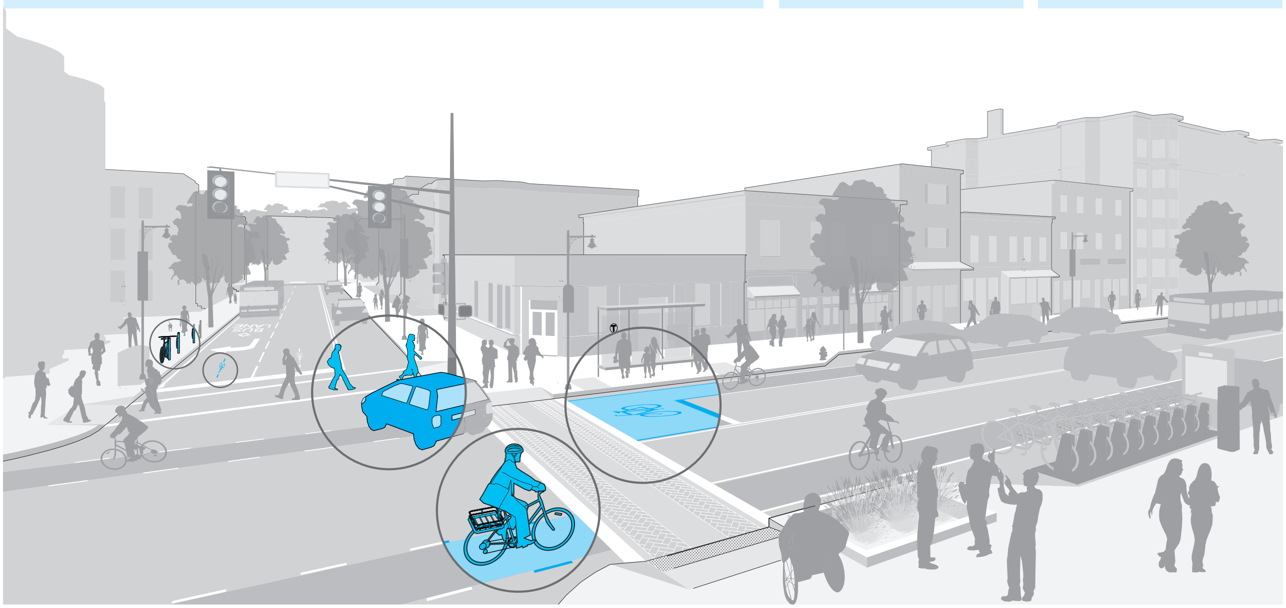
Well-maintained and bicycle-friendly intersections:

- Good pavement quality
- Materials that reduce vibrations
- Connections to other bikeways
- Wayfinding signs
- Bicycle parking

Minimal Delay



- Responsive traffic signals
- Bicycle signals
- Bicycle detection
- Direct routes across complex intersections



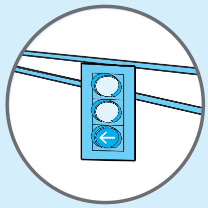
Motorist Experience

The primary needs of motorists include:

Safety

Designs that reduce conflicts and the severity of crashes:

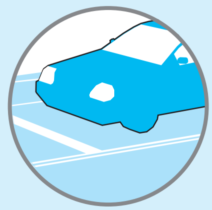
- Improved sight lines and visibility
- Dedicated space for all modes
- Warning signage and pavement markings
- Well-lit crossings



Safe options for turning movements:

- Phase-separated turning movements
- Advanced stop bars
- Separate turn lanes (only when necessary)

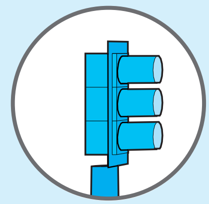
Convenience



Well-maintained intersections:

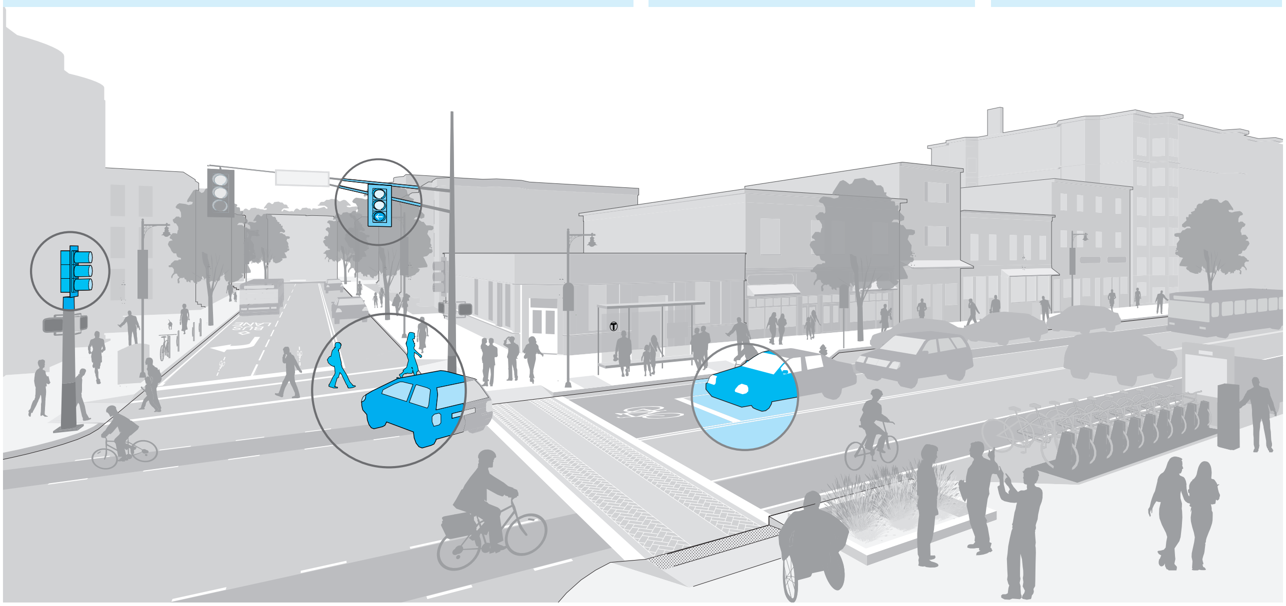
- Good pavement quality
- Wayfinding signage

Minimal Delay



Responsive signal design:

- Coordinated signal timing
- Responsive loop detectors and signals

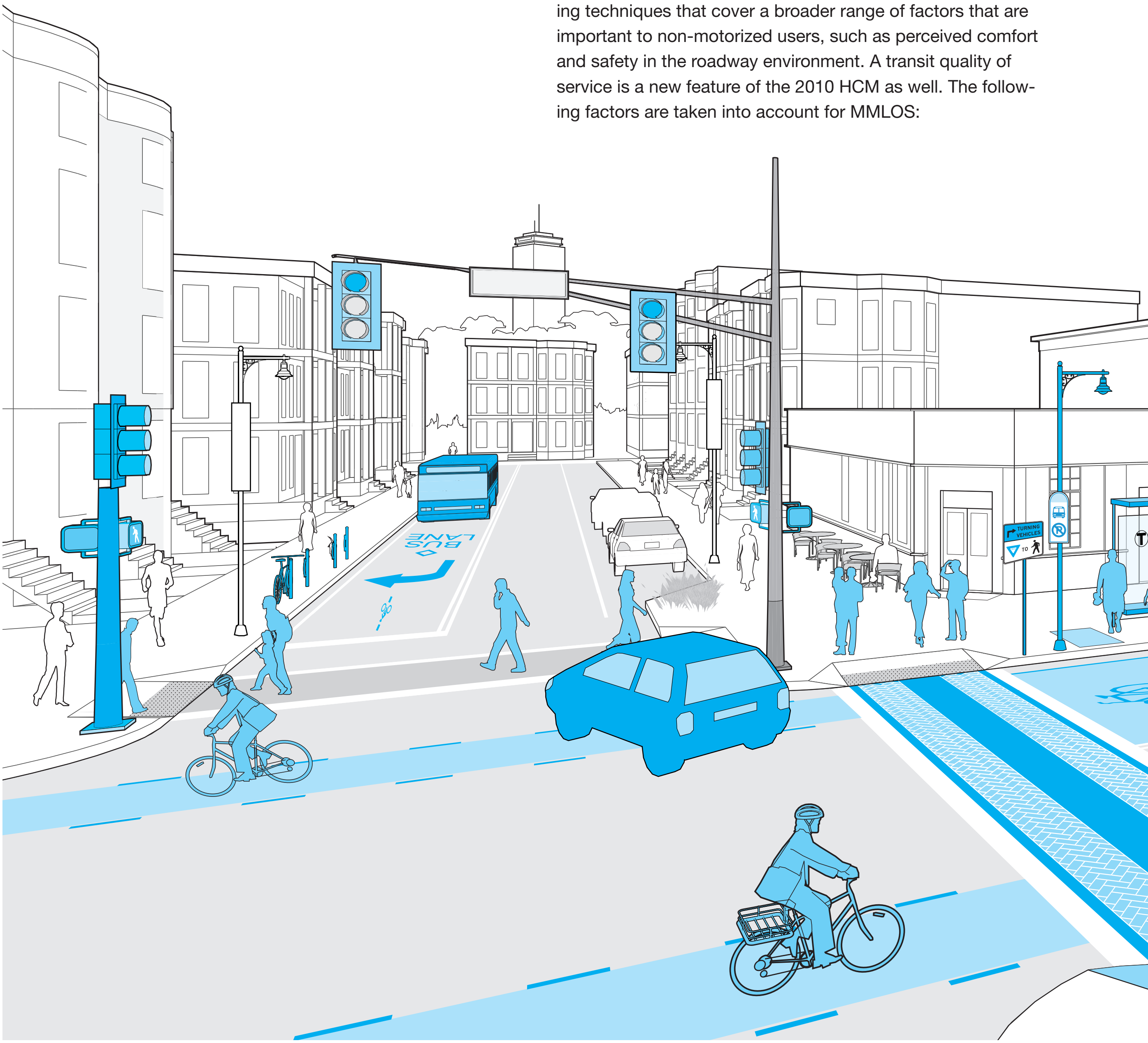


Multimodal Level of Service

Overview

Level of Service (LOS) is used to measure the effectiveness of streets and roadways in meeting the needs of travelers based on various modeling techniques. Traditionally, LOS in urban areas focused particularly on the capacity of intersections, specifically on the amount of delay caused to motorists.

The 2010 Highway Capacity Manual (HCM) provides methods for measuring multimodal level of service (MMLOS) that enables road designers to balance the interrelated needs of all modes of transportation. This is a particularly useful tool for intersection design. The 2010 HCM introduces new modeling techniques that cover a broader range of factors that are important to non-motorized users, such as perceived comfort and safety in the roadway environment. A transit quality of service is a new feature of the 2010 HCM as well. The following factors are taken into account for MMLOS:



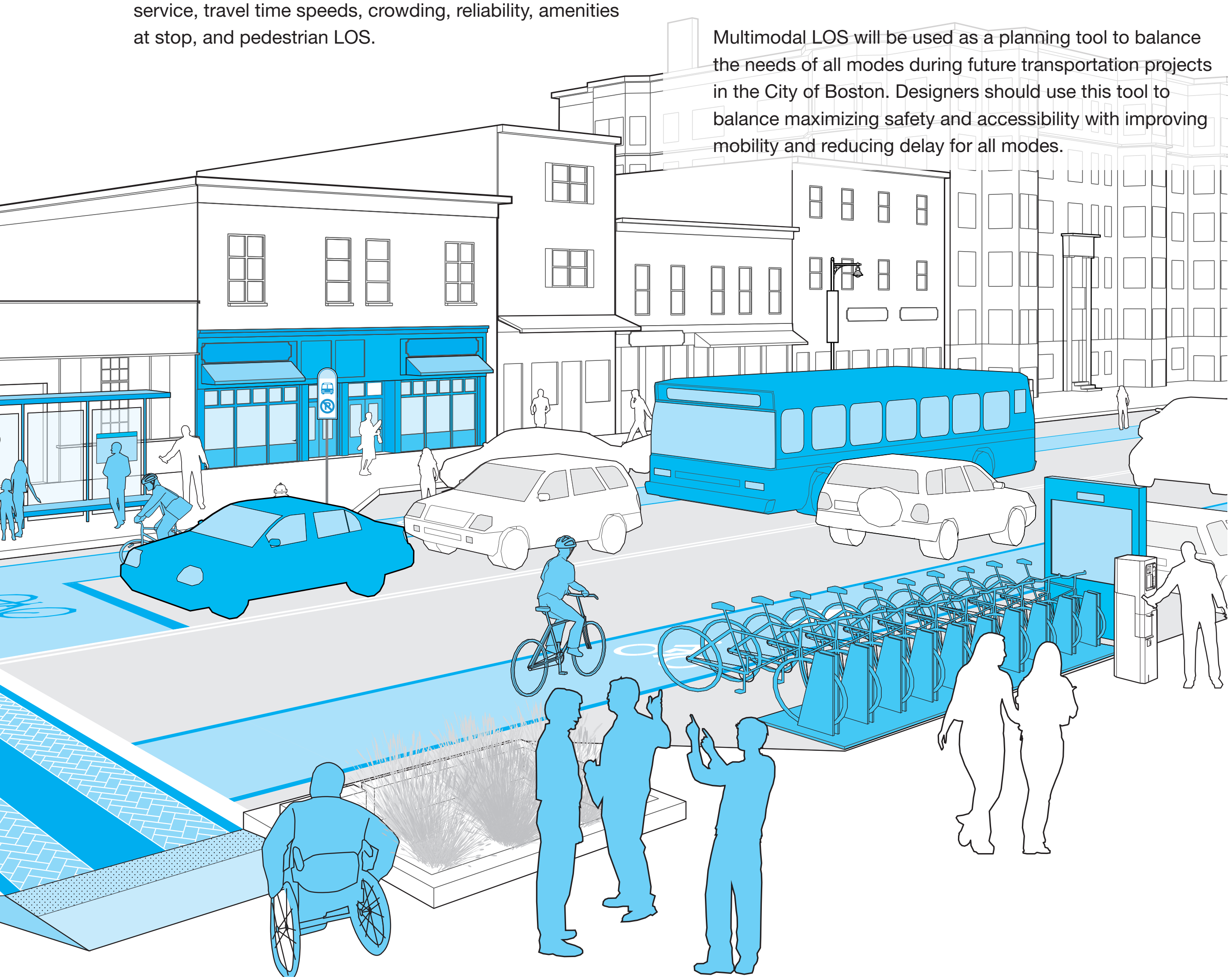
- Pedestrian LOS: includes the traditional measure of delay and sidewalk capacity (based on volumes and sidewalk width), but now also includes a pedestrian quality of service model. The model uses traffic volumes, speeds, and the quality of the buffer between the sidewalk and roadway to determine how comfortable and safe a typical pedestrian feels when walking adjacent to and crossing the road.

- Transit LOS: determined for “urban street facilities” and “urban street segments.” Factors include the frequency of service, travel time speeds, crowding, reliability, amenities at stop, and pedestrian LOS.

- Bicycle LOS: includes two models that measure capacity—one for roadways and one for shared use paths. A third model provides a measure of bicyclists’ feeling of comfort along a roadway, given various traffic factors including travel volumes, speeds, lane widths, presence of a shoulder or bicycle lane, presence of occupied on-street parking, etc.

- Motor vehicle LOS: the HCM continues to provide a motor vehicle LOS model that measures capacity (or delay) at intersections.

Multimodal LOS will be used as a planning tool to balance the needs of all modes during future transportation projects in the City of Boston. Designers should use this tool to balance maximizing safety and accessibility with improving mobility and reducing delay for all modes.



Intersections and Street Types

The design of an intersection should reflect the context of converging Street Types, surrounding land uses, and the neighborhood identity. Key elements of an intersection, such as lane and curb alignments, crosswalk locations, and bicycle accommodations, vary in design and configuration depending on the function of the street and role of the intersection in the surrounding neighborhood. For example, Dorchester Avenue, a Neighborhood Main Street in most sections, has been improved with new plazas and wider sidewalks at main intersections, such as Peabody Square and Andrews Square, to support a lively pedestrian realm with retail shops and restaurants.

Urban design elements on Downtown Commercial, Downtown Mixed-Use, and Neighborhood Main Streets, should take precedence over design features on Neighborhood Connector, Residential, and Industrial Street Types. Intersections that transition from one Street Type to another should alert all users of the change in the character of the roadway through obvious and intuitive design features. Intersections of the following Street Types involve important types of transitions and design considerations.

Intersections with Parkways and Boulevards

Parkways and **Boulevards** are characterized by longer block lengths and consistent design elements along the length of the corridor, and require special consideration at intersections. Where Parkways and Boulevards cross other Street Types, it is important that the character of the former be maintained. For example, Commonwealth Avenue, one of the Boston's most well-known Boulevards, intersects many Neighborhood Residential Streets; however, throughout the length of the corridor and at crossings the character of the Boulevard is maintained.

Intersections with Neighborhood Residential Streets

When other Streets Types intersect **Neighborhood Residential** Streets, the design of the intersection should reflect the change in use of the street. Users approaching the Residential Street should recognize a change in the roadway towards a slower speed environment. Treatments such as raised crossings and curb extensions can help facilitate slower speeds, and visually demarcate the change in Street Type.

Intersections between Neighborhood Main Street and Neighborhood Connector

As **Neighborhood Connectors** approach **Neighborhood Main Streets**, an increase in pedestrian and bicycle activity should be expected and must be considered in designs. Gateway treatments, traffic calming measures, and the creation of inviting spaces should characterize intersections between Neighborhood Connectors and Neighborhood Main Streets.


FENWAY PARK
YAWKEY WAY
GATE A
1903
1904
1912
1915
1975
1986
DO NOT ENTER


天下為公

Placemaking at Intersections

Intersections, while serving important transportation functions, are also outdoor rooms for the surrounding community. They are places for people to gather and enjoy rather than only to pass through. Factors that contribute to a sense of place at intersections and along roadways include:

- Physical elements such as building facades that help "enclose" the space, street trees, free standing walls, and decorative fences
- Public facilities like libraries, post offices, and community centers
- Local amenities including corner groceries, restaurants, and specialty retail stores
- The presence of a subway, bus-station hub, or Hubway bicycle share station
- Attractive sculptures and wall art such as murals that help to define community identity

Redesigning intersections to create a more lively, pedestrian-friendly environment can be achieved through simple, creative measures such as installing planters; benches at corners; neighborhood boards or kiosks to announce local events; curb extensions to create small plazas and parks; and pedestrian-scale lights.

Intersections also play an important role in wayfinding and urban recognition. Intersections are often where memorable landmarks are located, such as a building, plaza, or piece of art, which can help people recognize their location or remember a route through the city. Major intersections can also serve as gateways, indicating the arrival at a new district or neighborhood.

Street Name Signs and Multimodal Wayfinding

Street name signs and multimodal wayfinding signs are important for the safety and convenience of all users on Boston's roadways, and should be placed at strategic locations to maximize visibility. Street name signs can be mounted overhead or on posts. The placement of street name signs should be determined on a case-by-case basis using engineering judgement. Consideration should be given to possible obstructions including trees, utility poles, traffic signals, and other signs.

Post-mounted street name signs should be placed on existing posts wherever possible unless obstructions reduce visibility. Also, they should be placed diagonally opposite on the far-right side of a four-way intersection of two-way streets.

Street name signs that highlight local district or neighborhood character are encouraged, and should be similar in look and feel to enhance the sense of place.

As street name signs play an important role in wayfinding, specific pedestrian and bicycle wayfinding signs are also important for navigating Boston's complex street network. Innovative and creative wayfinding can include street names embedded in the sidewalk at corners or installed on building facades; simple ground markers used to distinguish walking or bicycling routes or highlight specific destinations; and special pavement markings on the sidewalk or roadway demarcate popular walking routes like the Freedom Trail or bicycle routes.

Pedestrian scale signage should include Braille and be multi-lingual as necessary and appropriate to the specific location. In general, bicycle wayfinding signs should be post-mounted and provide directional, distance, and/or time information to popular destinations, major transit hubs, and bicycle paths and routes.

All signs on Boston's streets should conform to the latest edition of the Manual on Uniform Traffic Control Devices (MUTCD) and meet all accessibility requirements. Locations for signs should be selected based on engineering judgment and must be approved by BTD and PWD.

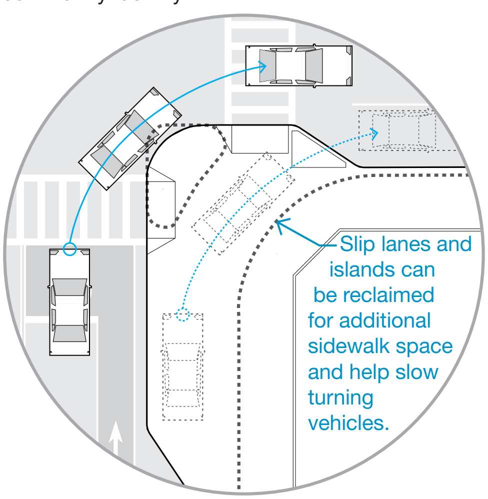
Reclaiming Space at Intersections

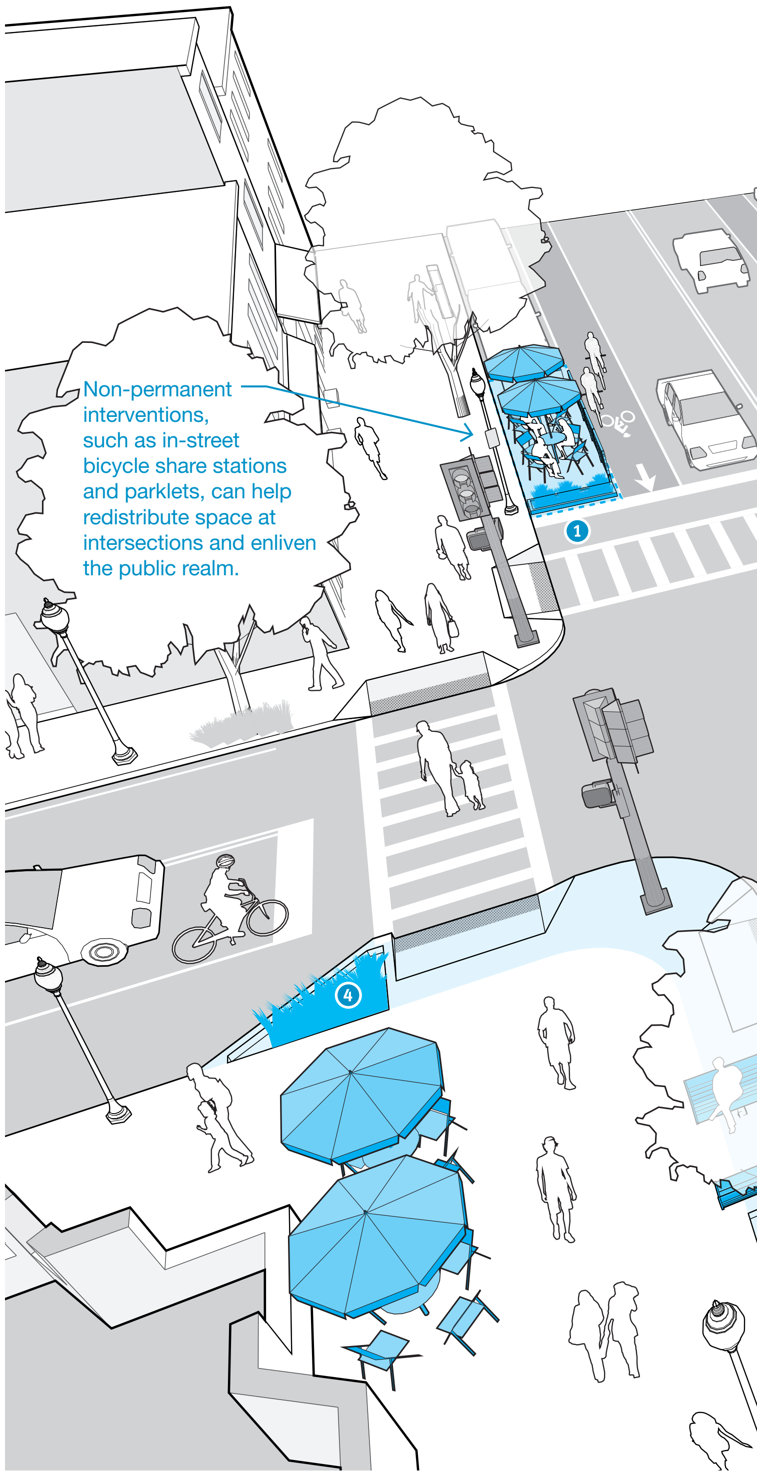
Reclaiming space for pedestrians and non-motorized users at intersections can be accomplished with short-term and long-term solutions:

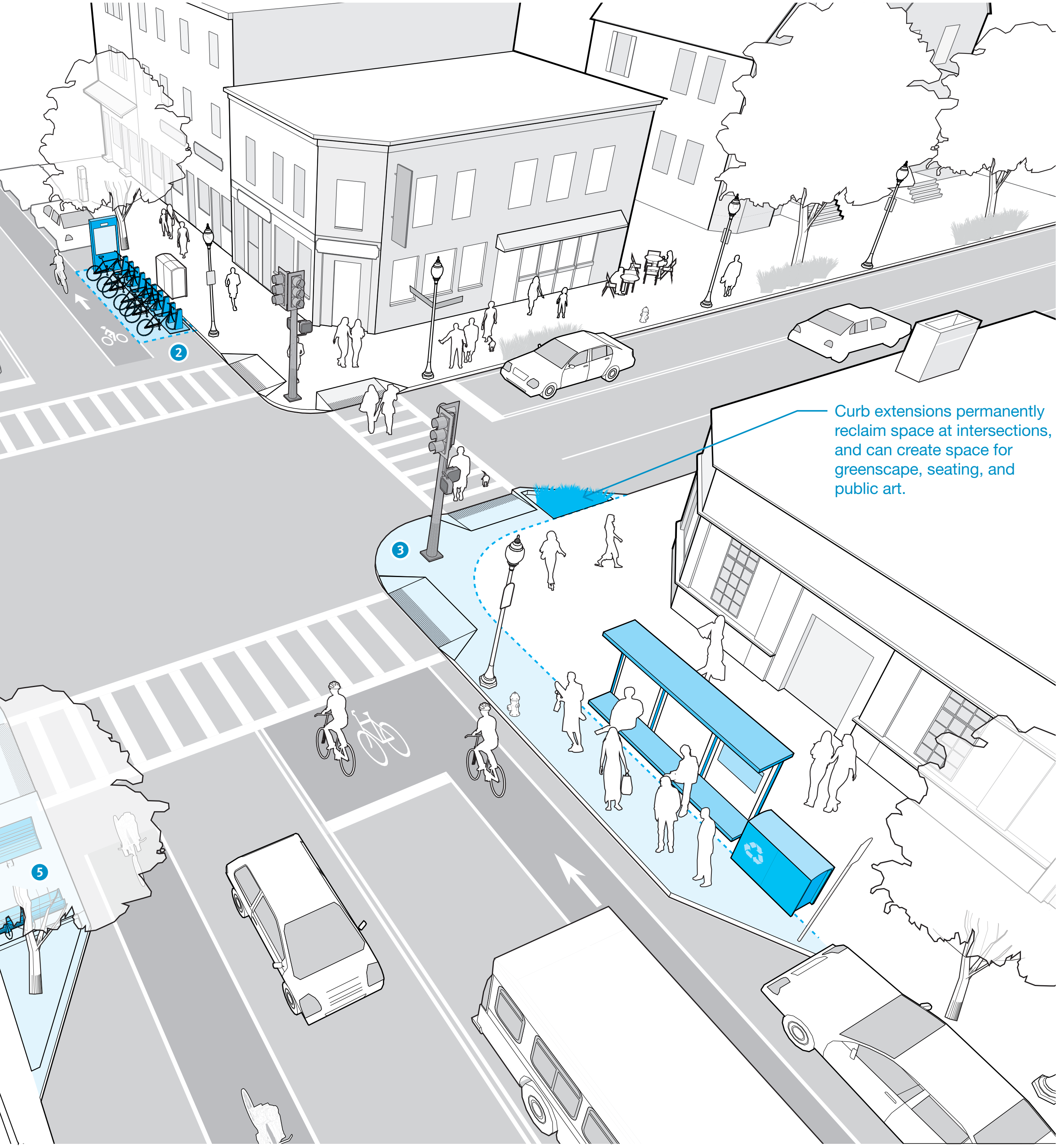
Short-term ways to creatively redistribute space at intersections include reclaiming parking spaces for parklets 1, bicycle share stations 2, temporary plazas, and mock curb extensions. Space can be redefined with seating areas, planters, and paint.

Long-term options include tightening corner radii, permanent curb extensions 3, the removal of turn lanes or parking lanes, the closure of slip lanes and incorporating the space into the sidewalk, or the narrowing of travel lanes. Space can be reclaimed for a variety of purposes including improving safety, widening sidewalks, adding bicycle facilities, and providing space for traffic control devices, utilities, greenscape 4, street furniture 5, vending, and public art. Space can be reclaimed in the middle of an intersection, extended from corners, or legs of an intersection can be closed to motor vehicle traffic and converted for other purposes such as a pedestrian plaza. Large sculptures can be incorporated to serve as a gateway treatment and landmark. An island or extension can also provide a location for a transit stop.

Some of Boston's intersections are especially broad for historic reasons. The evolution of Boston's transportation network produced streets that intersect at irregular angles, and often large corner radii were built to accommodate streetcar tracks; this additional roadway pavement at intersections can be reclaimed to make the space more comfortable for pedestrians and bicyclists, and to reinforce the sense of place and community identity.






Curb extensions permanently reclaim space at intersections, and can create space for greenscape, seating, and public art.
2
3
5

Gateways and Transitions

Overview

Major intersections often serve as transitions and gateways that mark a change between Street Types and neighborhoods. Gateways may not always mean the literal sense of the word, but can include a variety of visual cues—some are located on the surface of the roadway and sidewalks, while others are vertical elements that can be recognized from a distance. The visual cues at transitions help alert users of a change in the roadway environment, and are important features that contribute to the sense of place in the community.

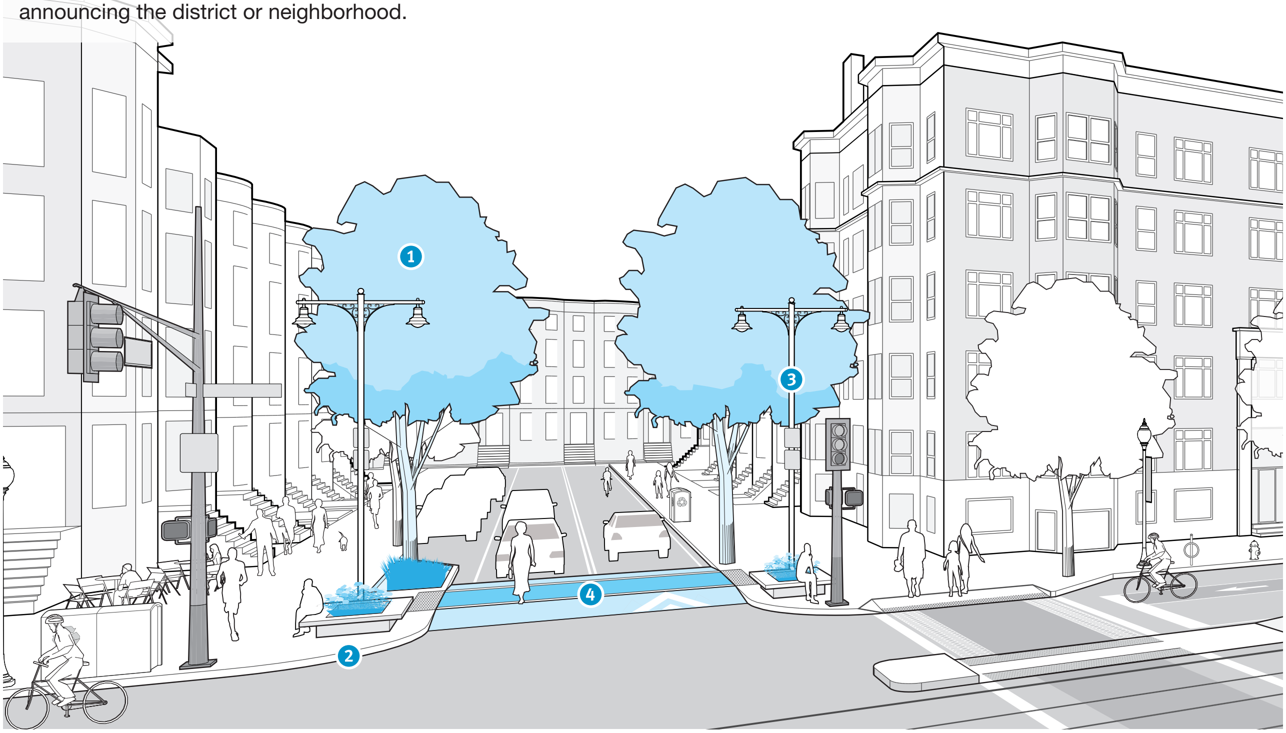
Use

Vertical cues include the massing and height of buildings at corners, which should be greater to create an architectural gateway marking the entrance to a new district or the heart of a Neighborhood Main Street. Corner building entrances should open at the corner, and help to form a visual frame around the intersection. Other vertical cues that can suggest a gateway or transition include sculptures, murals, and other forms of public art; varying heights of street trees 1; decorative stormwater planters 2; special lighting fixtures 3; and banners strung across the street or mounted on light poles announcing the district or neighborhood.

Horizontal cues at intersections may be more subtle but are effective at alerting drivers, bicyclists, and pedestrians that they are transitioning into a new space. Cues include the color and texture of the paving, the geometry of the intersection, and changes in the height of the roadway. Crosswalks can be wider, accented with colored paint, and/or include special markings along the edges while providing an accessible path along the center. Crosswalks or entire intersections can be raised 4 to provide easier crossings and calm traffic as motorists enter a neighborhood. Curb extensions can also slow speeds through intersections and reinforce the sense of enclosure, similar to the presence of larger buildings.

Considerations

All visual cues should be contextual and relate to the Street Type or district beyond the transition or gateway. A smaller gesture of the same elements—raised crosswalks, special paving, or lighting—could be repeated in subsequent, smaller intersections. In this way, the transition or gateway at the initial intersection introduces the palette for the neighborhood and helps to set the tone for the next several blocks.



Building Entrances

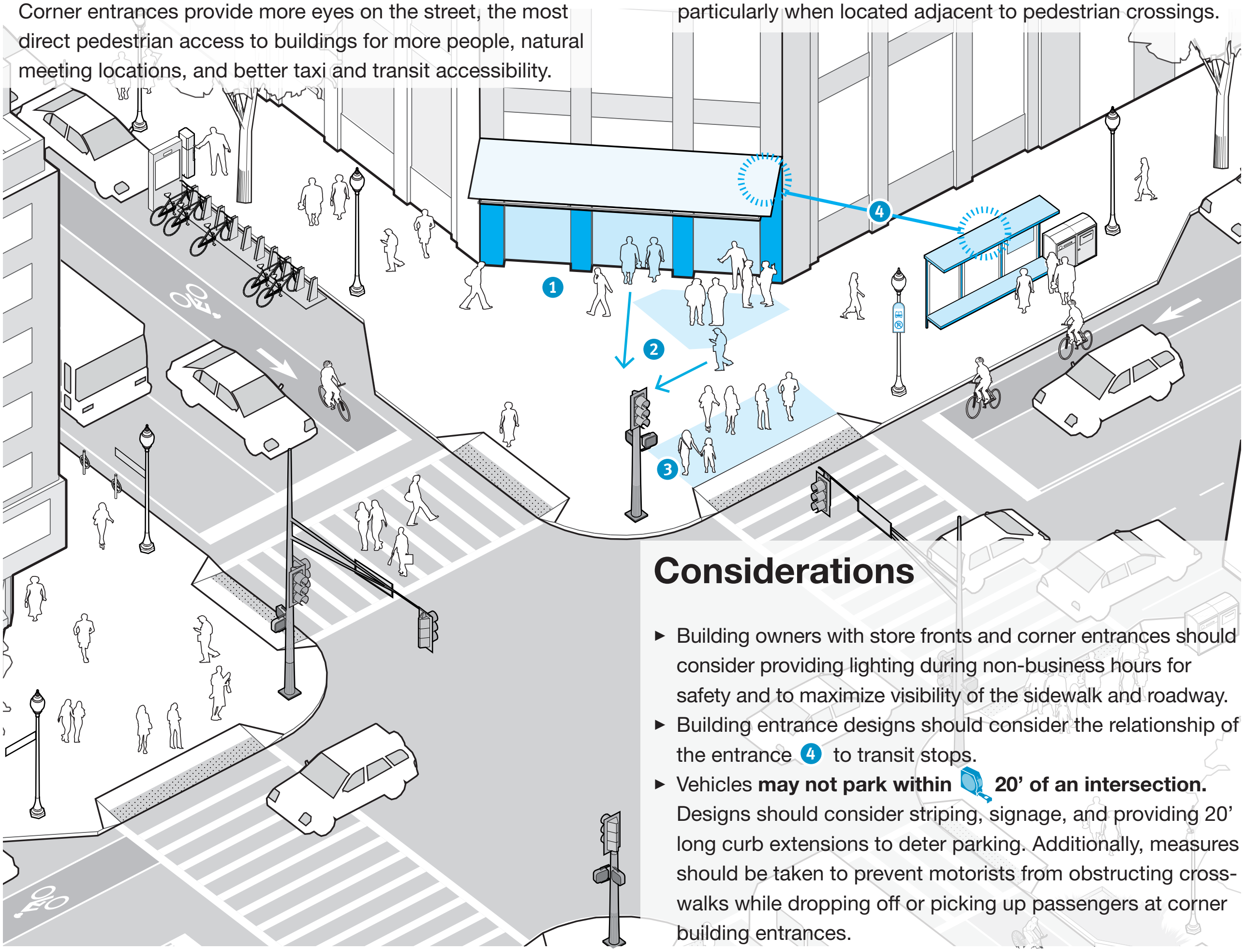
Overview

The way a building entrance relates to the street can have significant impacts on pedestrian flows, access, and safety. Ideally, buildings should front the sidewalk. Entrances should provide access to and from the sidewalk. Note, this section focuses on entrances at corners; for more general information on building entrances, see Chapter 2: Sidewalks Building Entrances.

Corner buildings should locate entrances at the corner rather than closer to mid-block. Building entrances located at mid-block are more likely to encourage mid-block pedestrian crossings, whereas building entrances located at corners are more likely to encourage crossing at intersections. Mid-block locations offer sight lines in two roadway directions; corner locations offer sight lines in three or more roadway directions. Corner entrances provide more eyes on the street, the most direct pedestrian access to buildings for more people, natural meeting locations, and better taxi and transit accessibility.

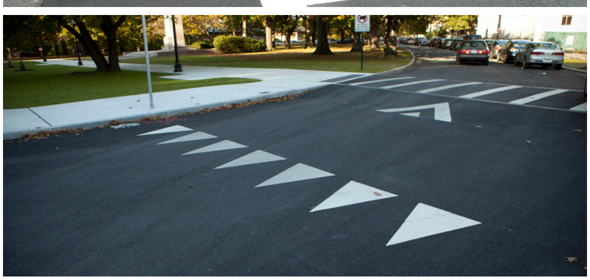
Use

- Building entrances should be placed at corners whenever possible, to encourage pedestrians, bicyclists, and transit users to cross at intersection locations rather than mid-block.
- Corner building entrances should be set at a diagonal to the corner (1) to optimize sidewalk space and help separate movements of pedestrians entering the building with those that are passing by.
- Sidewalks near building entrances should be wide enough to accommodate people who are standing, socializing, and walking through (2). Additional space based on pedestrian volumes may be needed at corners to accommodate people waiting to cross the street (3).
- It is important to maintain visibility at building entrances, particularly when located adjacent to pedestrian crossings.



Considerations

- Building owners with store fronts and corner entrances should consider providing lighting during non-business hours for safety and to maximize visibility of the sidewalk and roadway.
- Building entrance designs should consider the relationship of the entrance (4) to transit stops.
- Vehicles **may not park within 20' of an intersection.** Designs should consider striping, signage, and providing 20' long curb extensions to deter parking. Additionally, measures should be taken to prevent motorists from obstructing crosswalks while dropping off or picking up passengers at corner building entrances.



Intersection Geometry

Well-designed intersection geometry is crucial for creating safe and efficient multimodal intersections. Many of Boston's intersections have complicated geometric configurations as the result of patchwork, centuries-old street patterns meeting more regular street grids built over the city's various landfills. While typical right-angled, four-legged approaches are abundant in most neighborhoods, there are also many instances of odd-angled intersections such as those along Dorchester Avenue, and multi-legged approaches such as at Kenmore Square, Grove Hall, and Andrews Square. The geometry of many of Boston's major intersections provides a unique sense of place and can help define a neighborhood.

Designing multimodal intersections requires geometry that increases safety for all users in combination with effective and efficient traffic control measures. Changes in geometry can help to reduce vehicle turning speeds, increase pedestrian comfort and safety, and create space for dedicated bicycle facilities. One of the key considerations of intersection geometry is the location of pedestrian crossing ramps and crossings relative to vehicle paths.

Intersection geometry must be approved by BTD and PWD in consultation with the Boston Fire Department, Boston EMS, and the Mayor's Commission for Persons with Disabilities. For additional roadway design guidance, reference the MUTCD, the National Association of City Transportation Officials (NACTO) Urban Street and Bikeway Design Guides, and the American Association of State Highway Transportation Officials (AASHTO) "Green Book" and "Bike Guide."

Corners and Curb Radii

Overview

As one of the great walking cities, Boston intersections require well designed and pedestrian-friendly corners. Corner design has a significant impact on how well an intersection serves the diversity of roadway users. Two of the most important corner design elements are the **effective** curb radius and the **actual** curb radius. Actual curb radius refers to the curve that the curb line makes at the corner, while effective curb radius refers to the curve which vehicles follow when turning, which may be affected by on-street parking, bicycle lanes, medians, and other roadway features.

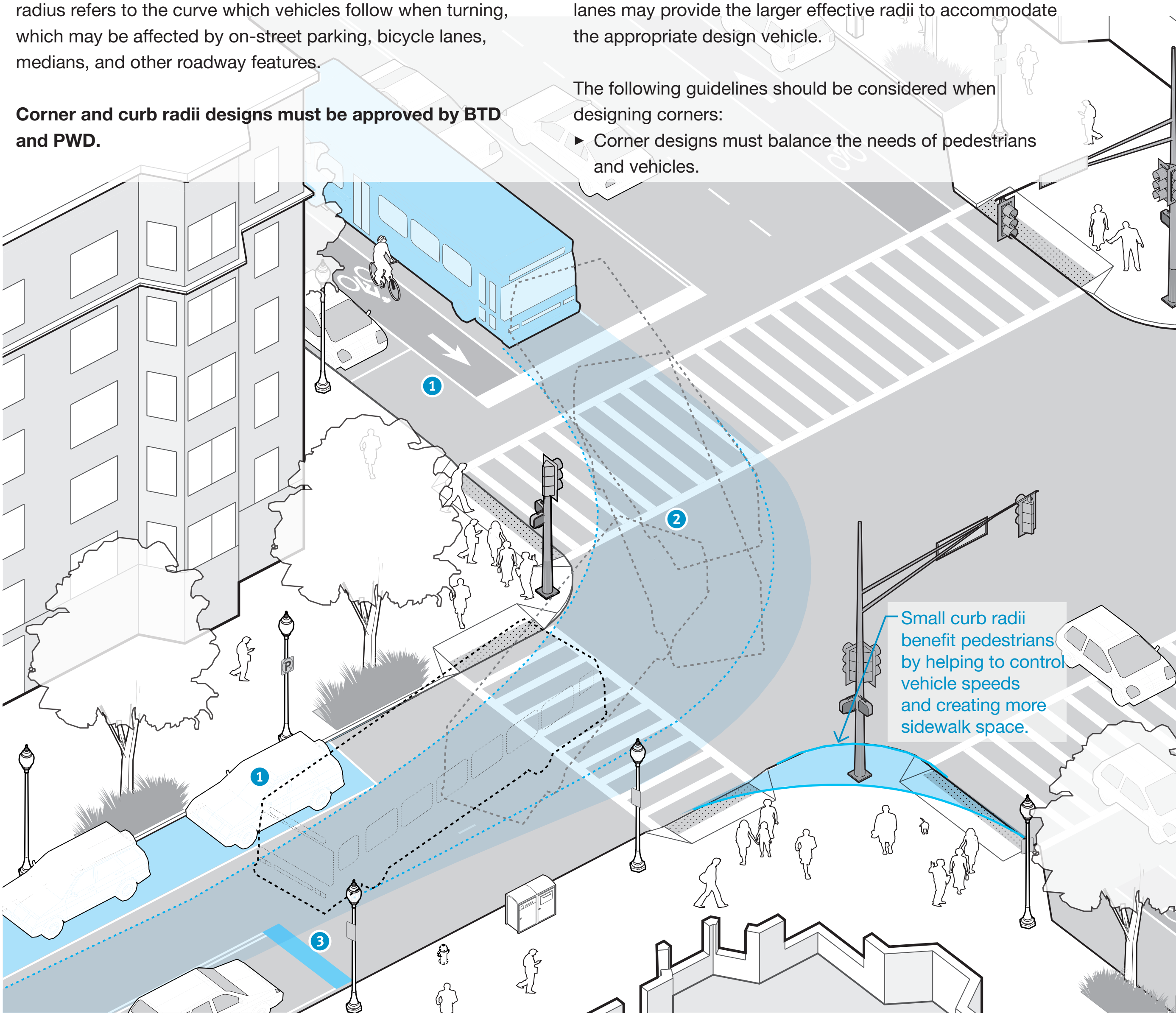
Corner and curb radii designs must be approved by BTD and PWD.

Use

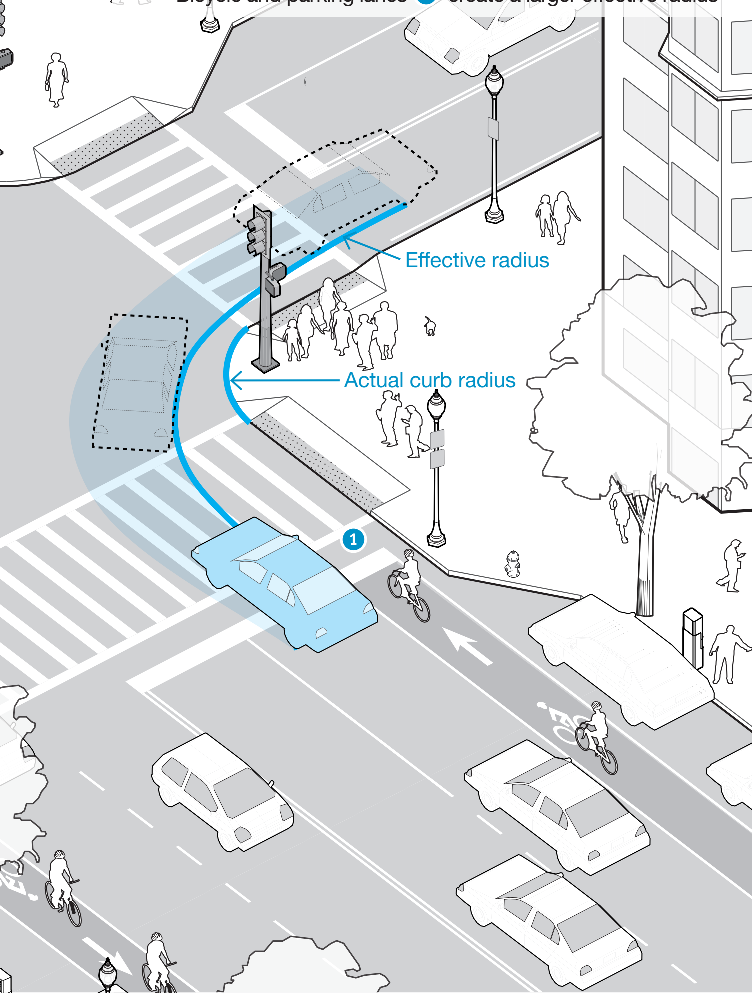
The smallest feasible curb radii should be selected for corner designs. Small curb radii benefit pedestrians by creating sharper turns requiring motorists to slow down, increasing the size of waiting areas, allowing for greater flexibility in the placement of curb ramps, and reducing pedestrian crossing distances. Small curb radii may be more difficult for large vehicles to negotiate, however on-street parking or bicycle lanes may provide the larger effective radii to accommodate the appropriate design vehicle.

The following guidelines should be considered when designing corners:

- Corner designs must balance the needs of pedestrians and vehicles.



- Corner designs should maximize pedestrian safety and comfort by minimizing the actual curb radii while providing an adequate effective radii to accommodate large trucks.
- The design of the actual curb radius should be based on the elements that create the effective radius, which must accommodate the selected design vehicle's turning radius. The design vehicle should be selected according to the types of vehicles using the intersection with considerations to relative volumes and frequencies.
- An actual curb radius of **5' to 10'** should be used wherever possible including where:
  - There are higher pedestrian volumes
  - There are low volumes of large vehicles
  - Bicycle and parking lanes 1 create a larger effective radius

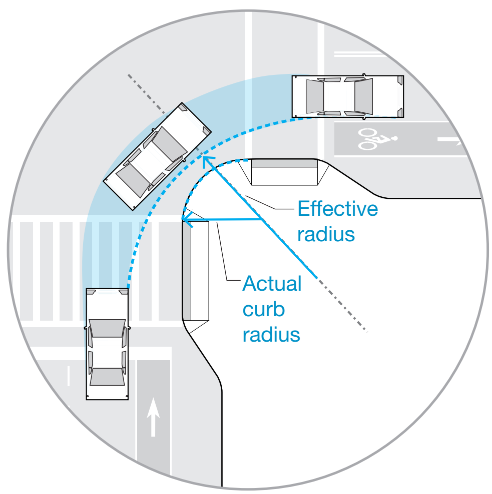


- The **maximum desired effective curb radius is 35'** to accommodate large vehicles 2; however all factors that may affect the curb radii must be taken into consideration. These include:
  - The Street Types
  - The angle of the intersection
  - Curb extensions
  - The number and width of receiving lanes
  - Where there are high volumes of large vehicles making turns, inadequate curb radii could cause large vehicles to regularly travel across the curb and into the pedestrian waiting area

Considerations

A variety of strategies can be used to maximize pedestrian safety while accommodating large vehicles, including:

- Adding parking and/or bicycle lanes to increase the effective radius of the corner
- Striping advance stop lines 3 on destination streets to enable large vehicles to make the turn by encroaching into the adjacent roadway space
- Varying the actual curb radius over the length of the turn so that the radius is smaller as vehicles approach a crosswalk and larger when making the turn
- Installing a textured, at-grade paving treatment to discourage high-speed turns while permitting turns by larger vehicles
- Restricting access and operational changes prohibiting certain movements

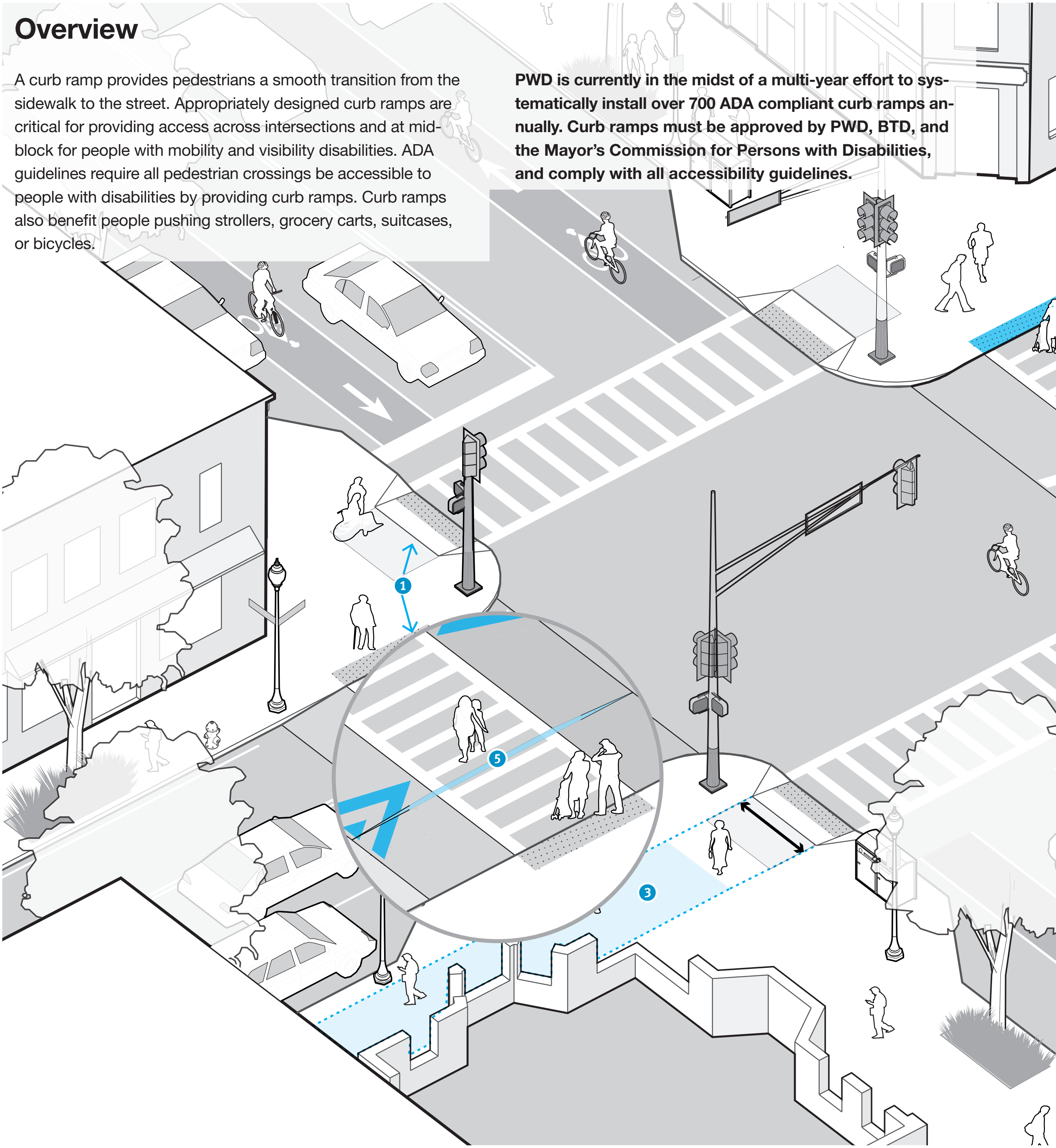


Curb Ramps

Overview

A curb ramp provides pedestrians a smooth transition from the sidewalk to the street. Appropriately designed curb ramps are critical for providing access across intersections and at mid-block for people with mobility and visibility disabilities. ADA guidelines require all pedestrian crossings be accessible to people with disabilities by providing curb ramps. Curb ramps also benefit people pushing strollers, grocery carts, suitcases, or bicycles.

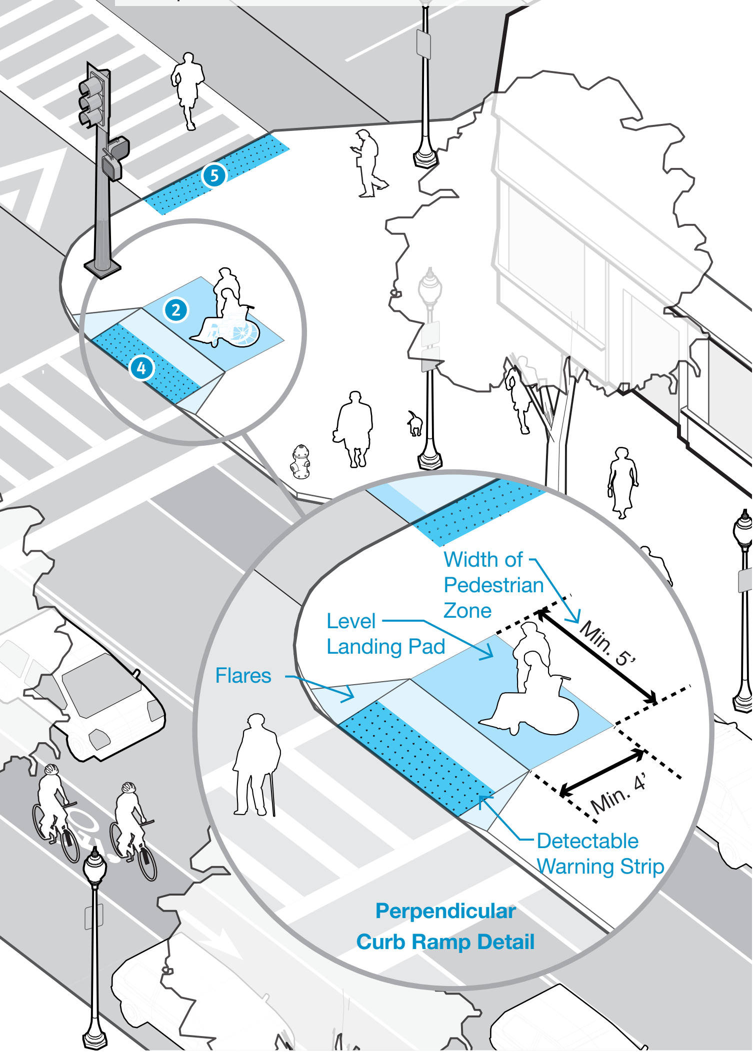
PWD is currently in the midst of a multi-year effort to systematically install over 700 ADA compliant curb ramps annually. Curb ramps must be approved by PWD, BTD, and the Mayor's Commission for Persons with Disabilities, and comply with all accessibility guidelines.



Use

Intersection geometry should be influenced by the following curb ramp design principles:

- Wherever feasible, curb ramp locations should reflect a pedestrian's desired path of travel through an intersection. In general, this means providing two separate curb ramps at a corner 1 instead of a single ramp that opens diagonally at the intersection.
- Curb ramps should be designed to avoid the accumulation of water or debris. One strategy for preventing water accumulation is to locate drainage inlets on the uphill side of the ramp. During winter, snow must be cleared from curb ramps to provide an accessible route.



Perpendicular Curb Ramp Detail

- A level landing pad 2, no greater than 2% slope in any direction and **a minimum of 4' wide perpendicular to the curb**, must be provided on the sidewalk.
- Curb ramps should generally be as wide as the Pedestrian Zone 3 on the approaching sidewalk.
- Curb ramps must include ADA compliant detectable warning strips 4 to alert people who have visual impairments that they are about to enter a roadway. Detectable warnings strips include a series of truncated domes. Detectable warning strips must ensure a 70% contrast in color to with the surrounding pavement, and the standard color is yellow. Detectable warning strips must be designed according to specifications determined by PWD.
- Detectable warning strips are required at all roadway crossings, regardless of whether there is grade separation, such as at raised crossings and raised intersections 5, at crossing islands, or at crossings along Shared Streets.
- If used, pedestrian pushbuttons should be easily activated and conveniently located near each end of the crosswalk, between the edge of the crosswalk line and the side of a curb ramp.

Considerations

- There are a variety of standard curb ramp designs, including perpendicular ramps and parallel ramps. In the case of perpendicular ramps, the ramp is perpendicular to the curb line; for parallel ramps, the ramp is parallel to the curb line. The appropriate design should be determined on a site-by-site basis. Key factors to consider include pedestrian crossing distances, desire lines, sidewalk width, proximity to traffic, curb height, street slope, and drainage.
- Flares are required when the surface adjacent to the ramp's sides is walkable but they are unnecessary when this space is occupied by a landscaped buffer. Excluding flares can also increase the overall capacity of a ramp in high-pedestrian areas.
- Consider installing raised crossings or raising the entire intersection 5. Raising the crossing or intersection eliminates the need for curb ramps because a continuous sidewalk realm is provided across the intersection. Note, detectable warning strips still must be provided at raised crossings and intersections. For more information, refer to Raised Crossings and Intersections later in this chapter.

Curb Extensions

Overview

Curb extensions, also known as neckdowns, bulb-outs, or bumpouts, are created by extending the sidewalk at corners or mid-block. Curb extensions are intended to increase safety, calm traffic, and provide extra space along sidewalks for users and amenities.

Curb extensions have a variety of potential benefits including:

- Additional space for pedestrians to queue before crossing
- Improved safety by slowing motor vehicle traffic and emphasizing pedestrian crossing locations
- Less exposure to motor vehicles by reducing crossing distances (1)
- Space for ADA compliant curb ramps (2) where sidewalks are too narrow
- Enhanced visibility between pedestrians and other roadway users
- Restricting cars from parking too close to the crosswalk area
- Space for utilities, signs, and amenities such as bus shelters or waiting areas, bicycle parking (3), public seating (4), street vendors, newspaper stands, trash and recycling receptacles, and greenscape elements

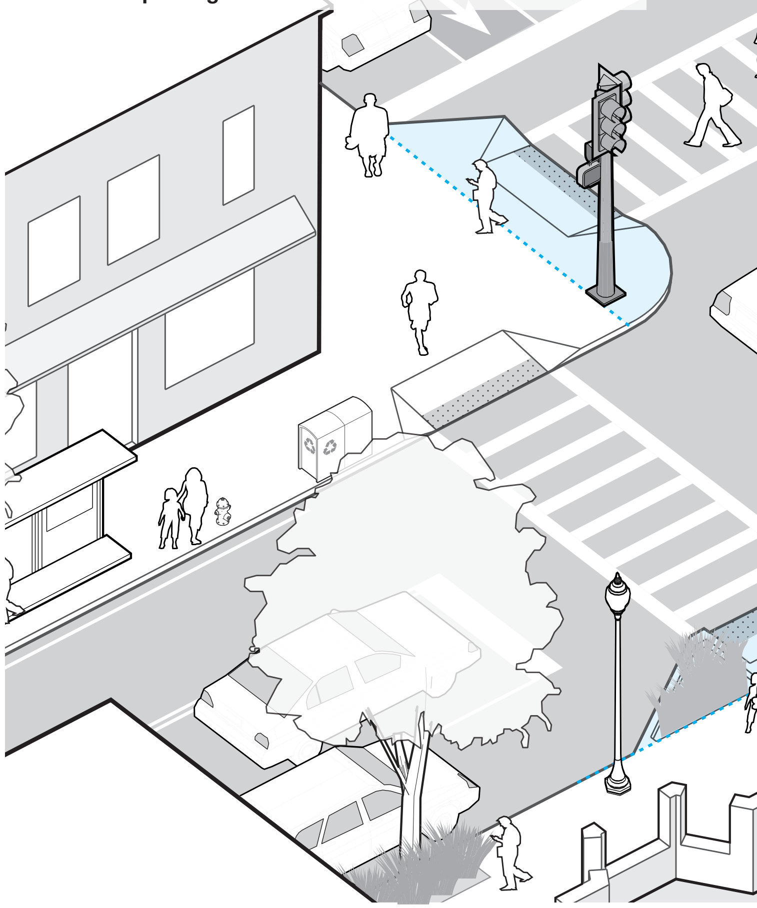
Curb extension designs must be approved by BTD and PWD.

Use

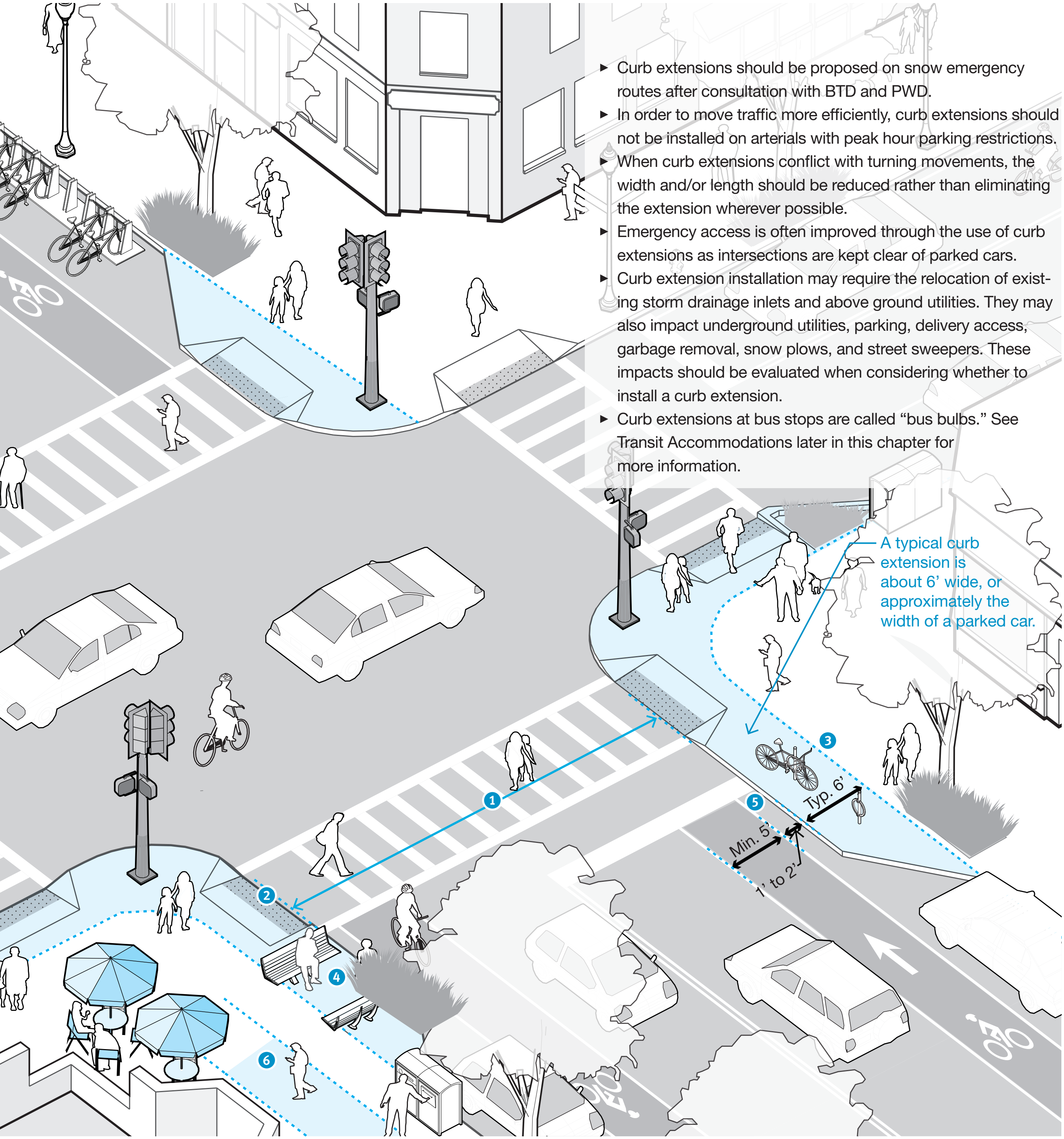
- Curb extensions should be considered at corners or mid-block only where parking is present or where motor vehicle traffic deflection is provided through other curbside uses such as bicycle share stations or parklets.
- Curb extensions are particularly valuable in locations with high volumes of pedestrian traffic, near schools, at unsignalized pedestrian crossings, or where there are demonstrated pedestrian safety issues.
- A typical curb extension extends the approximate width of a parked car, or **about 6' from the curb.**
- The minimum length of a curb extension is the width of the crosswalk, allowing the curvature of the curb extension to start after the crosswalk which should deter parking; NO STOPPING signs should also be used to discourage parking. The length of a curb extension can vary depending on the intended use (i.e., stormwater management, bus stop waiting areas, restrict parking).
- Curb extensions should not reduce a travel lane or a bicycle lane to an unsafe width (5).
- Curb extensions at intersections may extend into either one or multiple legs of the intersection, depending on the configuration of parking.
- Street furniture, trees, plantings, and other amenities must not interfere with pedestrian flow (6), emergency access, or visibility between pedestrians and other roadway users.

Considerations

- The turning needs of larger vehicles should be considered in curb extension design.
- Care should be taken to maintain direct routes across intersections aligning pedestrian desire lines on either side of the sidewalk. Curb extensions often make this possible as they provide extra space for grade transitions.
- Consider providing a **20' long curb extension to restrict parking within 20' of an intersection.**



- Curb extensions should be proposed on snow emergency routes after consultation with BTD and PWD.
- In order to move traffic more efficiently, curb extensions should not be installed on arterials with peak hour parking restrictions.
- When curb extensions conflict with turning movements, the width and/or length should be reduced rather than eliminating the extension wherever possible.
- Emergency access is often improved through the use of curb extensions as intersections are kept clear of parked cars.
- Curb extension installation may require the relocation of existing storm drainage inlets and above ground utilities. They may also impact underground utilities, parking, delivery access, garbage removal, snow plows, and street sweepers. These impacts should be evaluated when considering whether to install a curb extension.
- Curb extensions at bus stops are called “bus bulbs.” See Transit Accommodations later in this chapter for more information.



Crossing Islands

Overview

Crossing islands are raised islands that provide a pedestrian refuge while crossing multilane roadways. Crossing islands improve pedestrian safety by reducing pedestrian exposure in the roadway and improve access at intersections and mid-block crossings. They are particularly valuable when used at unsignalized crossings along multilane roads because they make it easier for pedestrians to find gaps in traffic and allow pedestrians to cross in two stages. At mid-block crossings, islands should be designed with a stagger, or in a "z" pattern, forcing pedestrians to face oncoming traffic before progressing through the second phase of the crossing. For an illustration, see Chapter 3: Roadways, Center Islands.

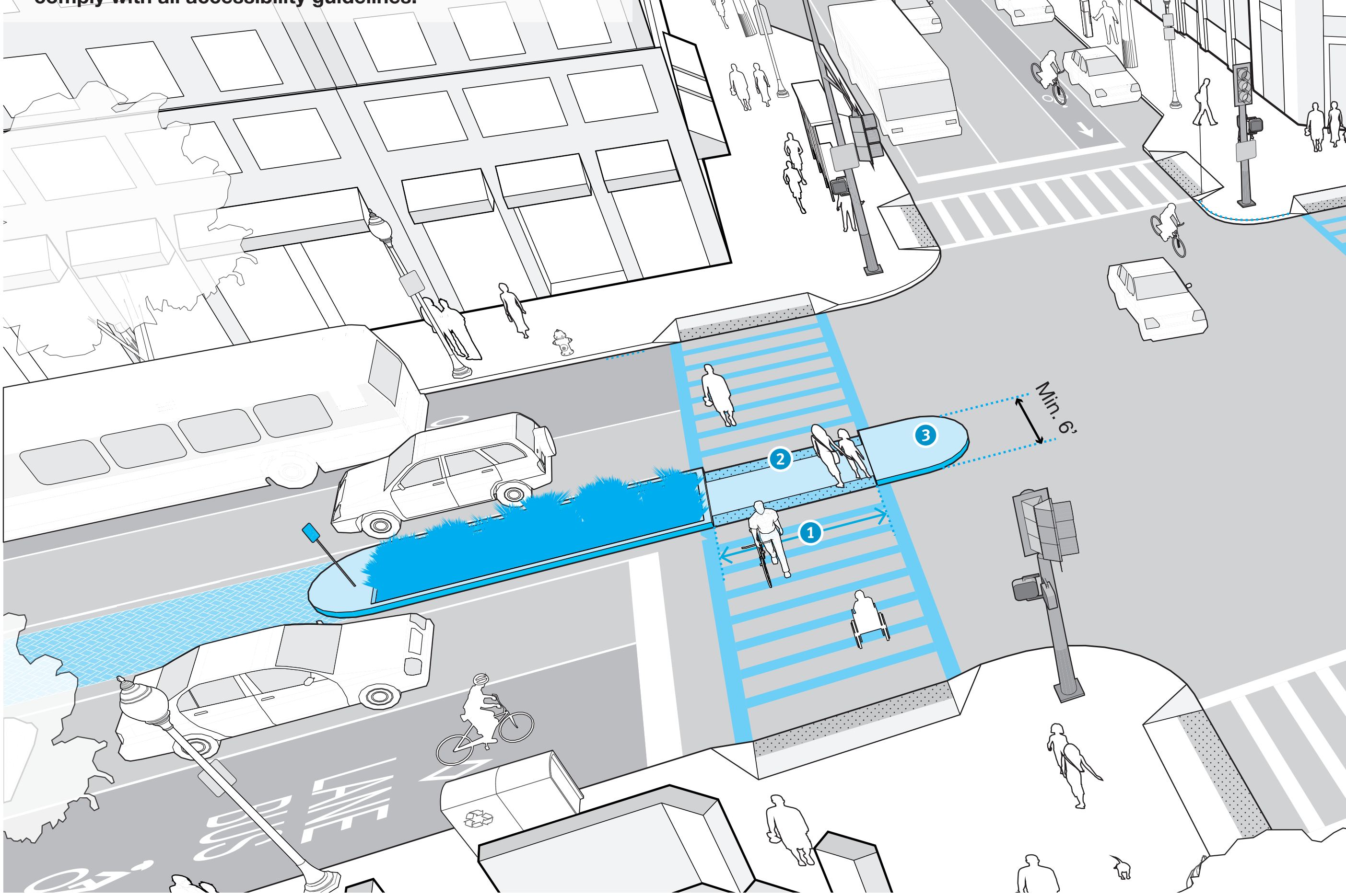
Crossing islands must be approved by BTD, PWD, and the Mayor's Commission for Persons with Disabilities, and comply with all accessibility guidelines.

Use

Crossing islands should:

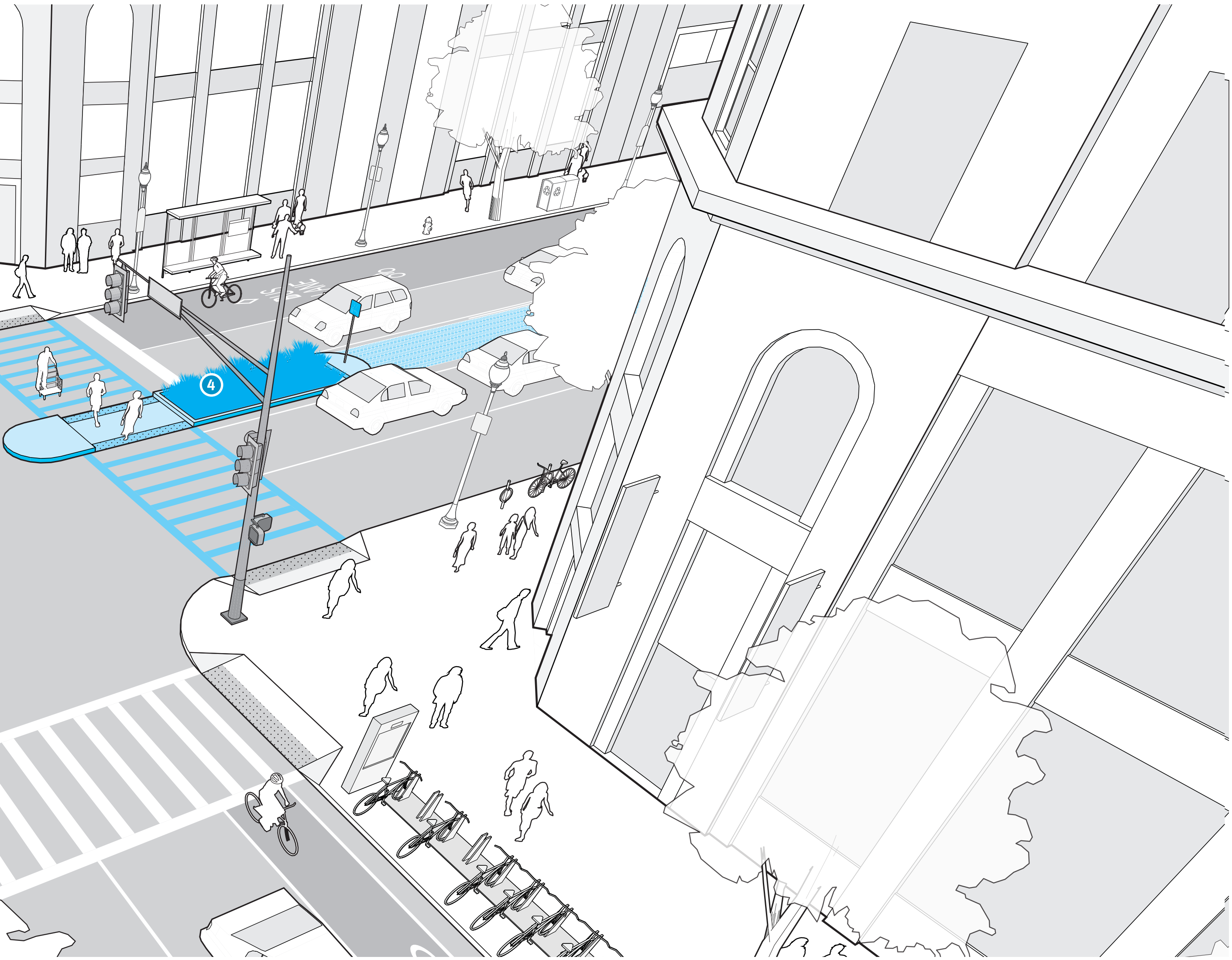
- Include at-grade pedestrian cut-throughs as wide as the connecting crosswalks (1), detectable warnings (2), and be gently sloped to prevent ponding of water and ensure proper drainage
- Be at least **6' wide, preferably** **8' wide**, to provide adequate refuge for pedestrians with strollers or bicycles
- Accommodate turning vehicles
- Extend beyond both sides of the crosswalk at intersections (3)

Signalized intersections with crossing islands must be designed to allow pedestrians to cross in one stage. Please refer to BTD's Signal Operations Design Guidelines for more information.



Considerations

- Crossing Islands should be considered where crossing distances are greater than **50’.**
- Crossing islands should generally not be considered for two- or three-lane roads.
- To guide motorists around crossing islands, consider incorporating diverging longitudinal lines on approaches to crossing islands.
- If there is enough width, center crossing islands and curb extensions can be used together to create a highly visible pedestrian crossing and effectively calm traffic.
- Where possible, stormwater management techniques (4) should be utilized on crossings islands with adequate space, however not in the pedestrian clear path to and from crosswalks. Plantings should be low growing to maximize visibility, and ideally involve minimum maintenance.
- For more information regarding median crossing islands at mid-block, see Chapter 3: Roadways, Center Islands.



Raised Crossings and Intersections

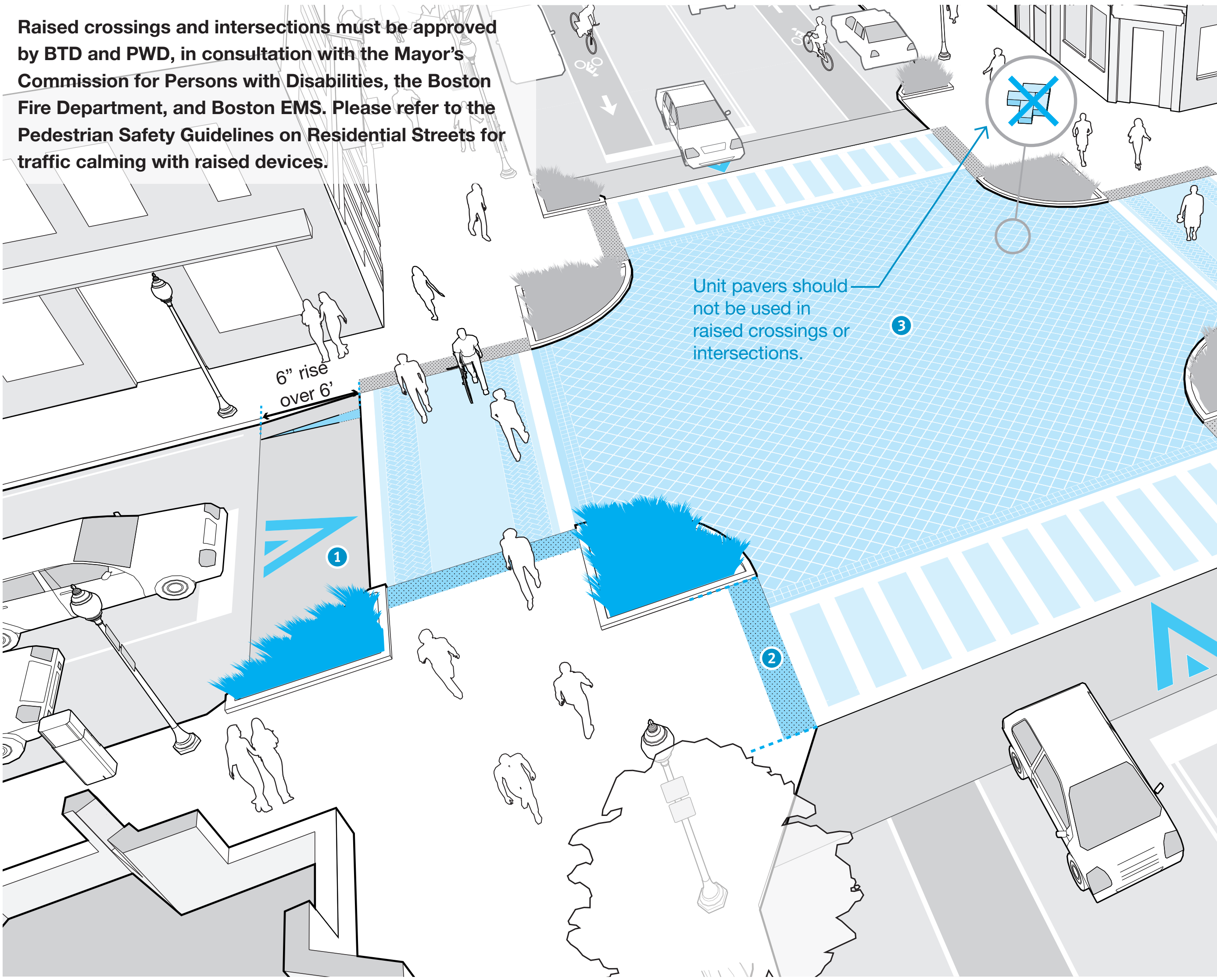
Overview

Raised crossings and intersections are created by raising the roadway to the same level as the sidewalk. Raised crossings are essentially speed tables that include crosswalks across the top of the table. Raised intersections are a similar concept to speed tables applied to an entire intersection. These treatments provide an array of benefits especially for people with mobility and visual impairments because there are no vertical transitions to navigate. See Chapter 3: Roadways for more information on Speed Tables.

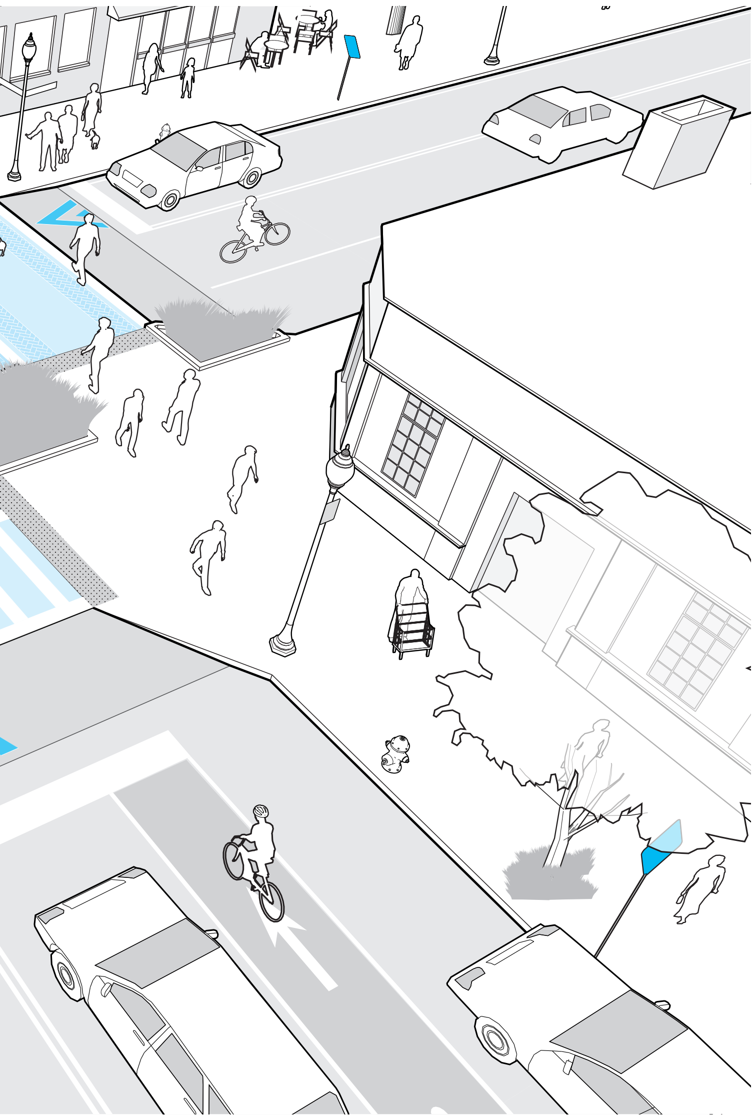
Raised crossings and intersections:

- Make it physically more difficult for drivers to go through crossings and intersections at unsafe speeds
- Improve drivers' awareness by prioritizing pedestrian crossings and helping define locations where pedestrians are expected
- Eliminate water ponding and debris collection at the base of ramps

Raised crossings and intersections must be approved by BTD and PWD, in consultation with the Mayor's Commission for Persons with Disabilities, the Boston Fire Department, and Boston EMS. Please refer to the Pedestrian Safety Guidelines on Residential Streets for traffic calming with raised devices.



- Increase visibility between drivers and pedestrians by raising pedestrians in the motorists' field of view and giving pedestrians an elevated vantage point from which to look for oncoming traffic
- Create pedestrian crossings which are more comfortable, convenient and accessible since transitioning between the sidewalk and roadway does not require negotiating a curb ramp



Use

- Raised crossings and intersections are appropriate in areas of high pedestrian demand, including commercial and shopping districts, college campuses, and school zones. They should also be considered at locations where pedestrian visibility and motorist yielding have been identified as issues.
- Raised crossings can be provided along side streets of major thoroughfares to slow traffic exiting the main street.
- Raised crossings should provide pavement markings (1) for motorists and appropriate signage at crosswalks per the MUTCD.
- Raised crossings and intersections may not appropriate for high-speed roadways such as Parkways, Neighborhood Connectors, or Industrial Streets Types. Vehicle speeds, volumes, and the types of vehicles using the roadways are also factors to consider when implementing raised crossings.
- Design speeds and emergency vehicle routes must be considered when designing approach ramps.
- Unit pavers should not be used in raised crossings or intersections.
- Raised crossings and intersections require detectable warnings for the visually impaired at the curb line (2).

Considerations

- Care should be taken to maintain direct routes across intersections aligning pedestrian desire lines on either side of the sidewalk.
- Raised crossings are particularly valuable at unsignalized mid-block locations, where drivers are less likely to expect or yield to pedestrians.
- High-visibility or textured paving materials (3) can be used to enhance the contrast between the raised crossing or intersection and the surrounding roadway.
- Installation of raised crossings and intersections may affect snow removal operations. Snow plow operators should be adequately warned and trained.
- Raised intersections and crossings can be used as gateway treatments to signal to drivers when there are transitions to a slower speed environment that is more pedestrian-oriented.
- Designs should be carefully thought out to ensure proper drainage. Raised intersections can simplify drainage inlet placement by directing water away from the intersection. If the intersecting streets are sloped, catch basins should be placed on the high side of the intersection at the base of the ramp.

Neighborhood Traffic Circles

Overview

Traffic circles, or small roundabouts, can reduce speeds and accidents in low-volume areas. They are also good for Neighborways because they can be used in lieu of **STOP** signs which force bicyclists to lose momentum. Traffic circles also move vehicles efficiently and moderate vehicular speeds through the intersection, and thereby help to reduce emissions.

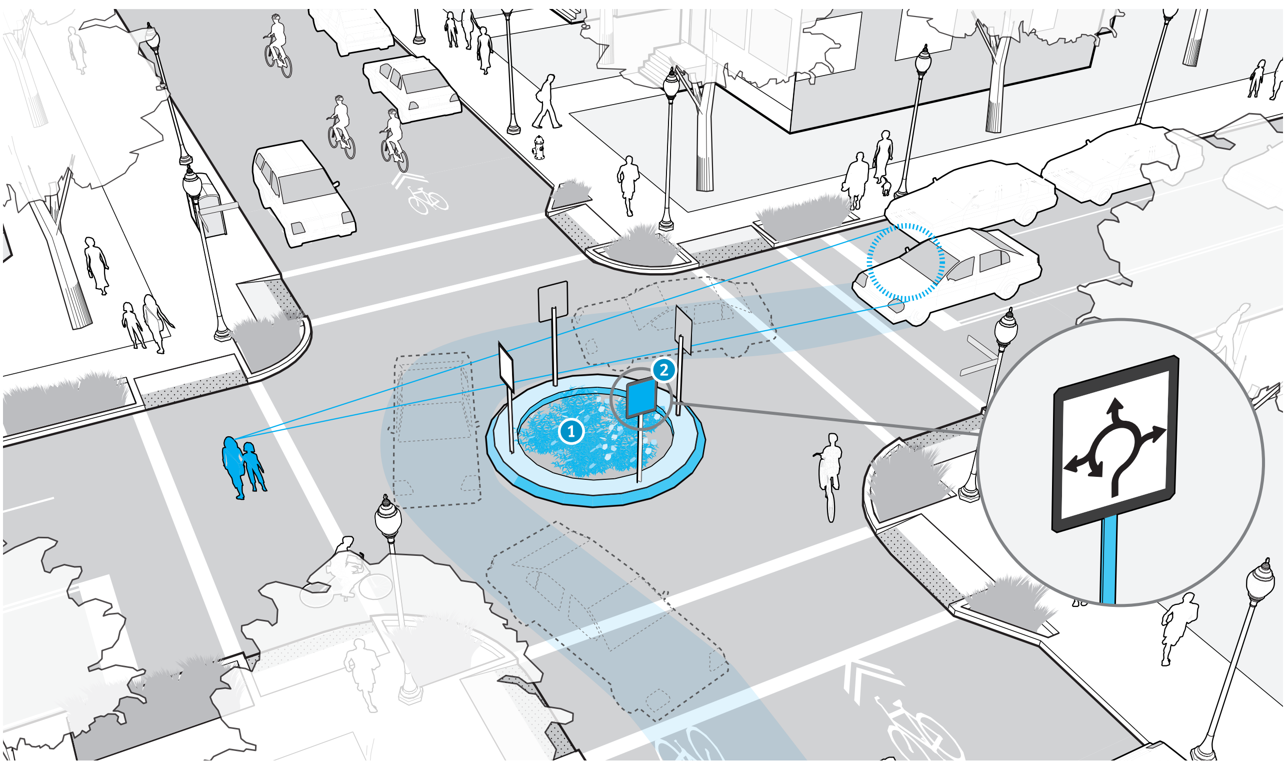
Traffic circle designs must be approved by BTD and PWD, in consultation with the Boston Fire Department, and the Boston EMS.

Use

- Traffic circles are a good alternative to **STOP**-controlled intersections, particularly at four-way stops, and are designed to slow traffic at the intersection of Residential Streets.
- Create a mountable curb for areas with large trucks or where emergency vehicles require access in constrained spaces.
- Traffic circles provide great opportunities to include green infrastructure 1. They can be designed with greenscape elements that capture stormwater and help create a sense of community. Plant material should be maintained in order to not obstruct visibility.

Considerations

- Designs should consider the speed of the roadway.
- Access to underground utilities must be considered.
- A neighborhood partner should be identified for maintenance of any plantings.
- Circles are ideal locations for art or neighborhood gateway treatments, however elements must not obstruct visibility.
- Maintain circle visibility with paint and reflectors.
- Regulatory and/or warning signage 2 should be provided to remind traffic to proceed counterclockwise around the circle.



Diverters

Overview

Boston's Neighborhood Residential Streets are often used as cut-through routes by traffic headed to regional destinations. Diverters are curb extensions or traffic islands used at intersections specifically to deter heavy volumes of through vehicle traffic on Residential Street Types. Well-designed diverters can enhance the comfort and accessibility of a street for pedestrians and bicyclists by reducing motor vehicle volumes and speeds, preventing turning conflicts, and reducing pedestrian crossing distances. Diverters also provide opportunities to introduce green elements at intersections, and can be used to absorb stormwater and reduce the heat island effect.

Two types of diverters are used in Boston: half-closures and diagonal diverters. Half closures block travel in one direction on an otherwise two-way street and diagonal diverters are placed diagonally across an intersection, preventing through traffic by forcing turns in one direction.

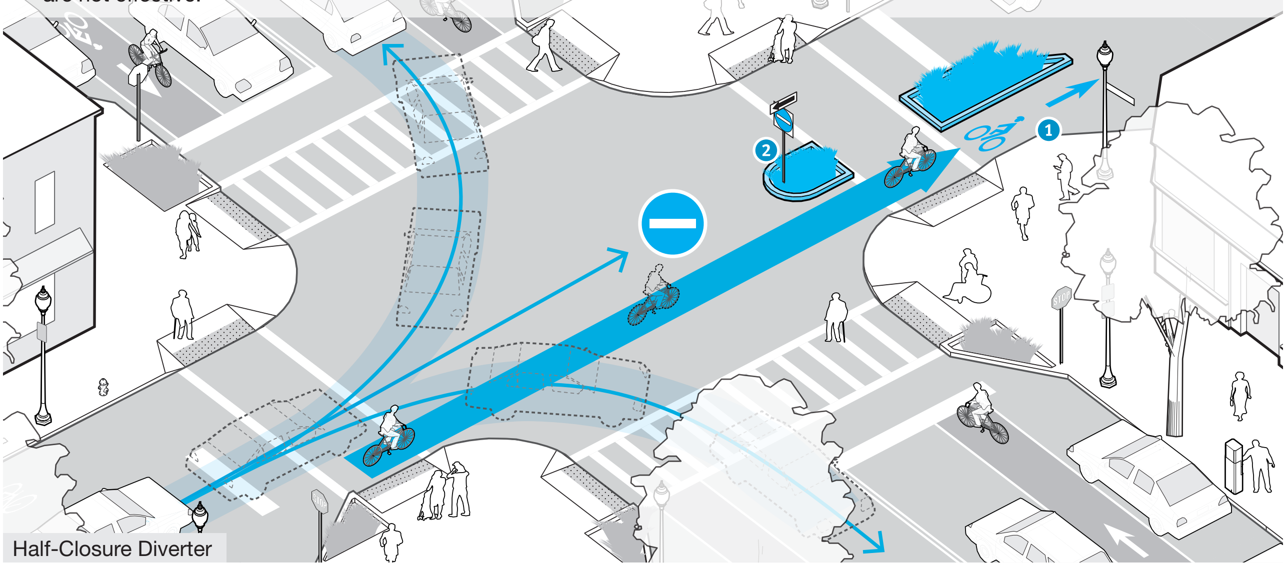
Diverter designs must be approved by BTD, PWD, the Boston Fire Department, and the Boston EMS.

Use

- Diverters should only be considered as part of an overall traffic calming strategy, including street direction changes for an area when less restrictive measures such as signs are not effective.
- Appropriate regulatory and warning signage should be provided to alert traffic of changes in the roadway.
- Diverters should be designed to impact motor vehicle movement but should facilitate bicycle and pedestrian access (1). Accessible pedestrian pathways must be provided.
- Diverter designs should be carefully thought out to ensure proper drainage and maximize the potential for on-site stormwater retention and infiltration.
- Vegetation used in diverters should be low-growing and drought-resistant (2).

Considerations

- Consideration must be given to the impact of diverters on emergency vehicles; designs that allow emergency vehicle access are preferred and should be coordinated with a local emergency response program.
- Diverters require strong support from the local community. A highly interactive public input process is essential.
- Temporary diverters can be installed to test how a permanent diverter might affect traffic flows in a neighborhood.
- Diverters are an important component of Neighborways, which allow through bicycle and pedestrian traffic but discourage through motor vehicle traffic.
- A diverter's impact on speeding is generally limited to the intersection; additional countermeasures are usually necessary to address speeding at mid-block locations.



Half-Closure Diverter


7-ELEVEN
Olympia Flower Store


MARKET
617-567-1415
RAMOS MARKET


NO TURN ON RED
T

Crosswalk Design

Well-designed crosswalks are key to maintaining Boston's status as a pedestrian-friendly city. While most of Boston's intersections have marked crosswalks at each approach, specific locations can be specially marked to emphasize unique pedestrian desire lines. Examples include a wide crosswalk across the Greenway connecting South Station to the Financial District, and a diagonal crosswalk connecting the Park Plaza area to the Boston Common. In Boston's neighborhoods, crosswalks are located to provide safe access to jobs, homes, and destinations such as local institutions, parks, and housing for the elderly.

Safety for all pedestrians, especially for those with disabilities, is the single most important criteria informing crosswalk design. Crosswalks help guide pedestrians to locations where they should cross the street as well as inform drivers of pedestrian movements. In addition to intersections, crosswalks are used in locations where pedestrians may not be expected, such as at mid-block crossings or uncontrolled crossings (crossings where motorists do not have signals or stop signs).

This section describes Boston's Standard and Enhanced crosswalk designs. As the pace of innovation and technology advances, new techniques and treatments should be considered and tested in order to maximize safety and accessibility.

Crosswalk designs must be approved by BTD and PWD, in consultation with the Mayor's Commission for Persons with Disabilities.

Standard Crosswalks

Overview

The City of Boston has two primary crosswalk marking styles:

The **continental style** 1, also called a "high visibility" crosswalk, typically consists of **12" wide** bars spaced **4'** on center perpendicular to the path of travel, and two **12" wide** transverse lines placed **10' apart** (outside dimension) parallel to the path of travel.

The **transverse marking style** 2 typically consists of two transverse (parallel) lines **12"** wide placed **10'** apart (outside dimension) to delineate the outside edges of the crosswalk, parallel to the pedestrian path of travel.

All crosswalk designs must adhere to the City of Boston's Traffic Engineering Standard Plans and Specifications.

Use

- Crosswalks should be **at least** **10' wide** or the width of the approaching sidewalk 3 if it is greater. In areas of heavy pedestrian volumes, crosswalks can be **up to** **25' wide.**
- Crosswalks should be aligned with the approaching sidewalk and should be located to maximize the visibility 4 of pedestrians while minimizing their exposure to conflicting traffic. Designs should balance the need to reflect the desired pedestrian walking path with orienting the crosswalk perpendicular to the curb; perpendicular crosswalks minimize crossing distances and therefore limit the time of exposure.
- The MUTCD provides guidance on crosswalk markings for intersections with exclusive pedestrian phases that permit diagonal crossings.
- ADA-compliant curb ramps should direct pedestrians into the crosswalk. The bottom of the ramp should lie within the area of the crosswalk (flares do not need to fall within the crosswalk).
- Stop lines at stop-controlled and signalized intersections should be striped **no less than** **4' and no more than** **30' from the approach of crosswalks.**

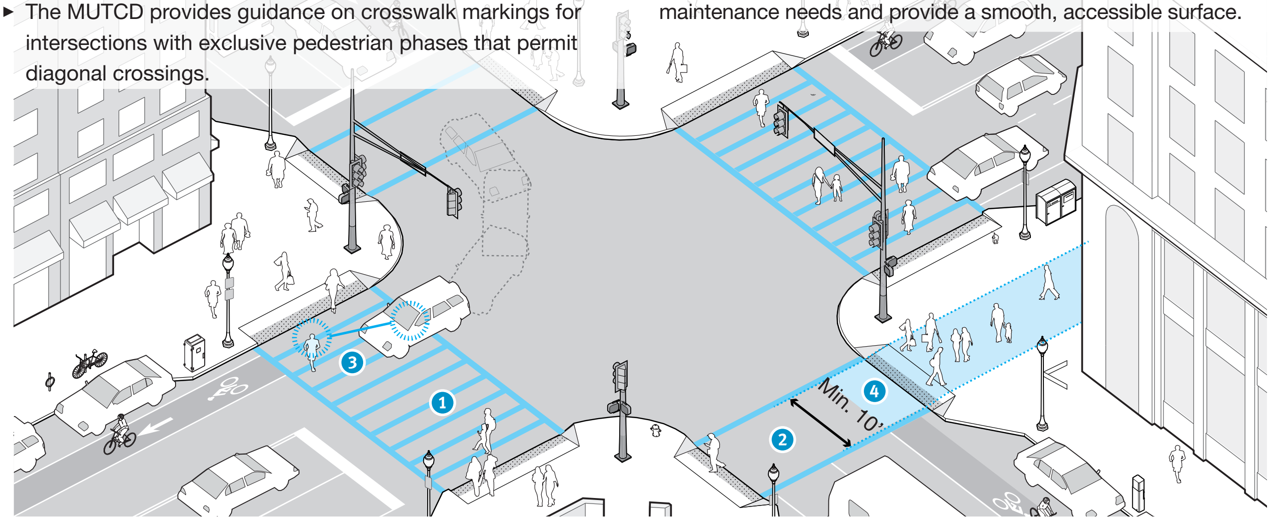
Considerations

Continental style crosswalks are generally considered safer because they are more visible to drivers. Continental crosswalks should be considered at:

- Mid-block uncontrolled crossings
- Intersections and mid-block crossings along school walking routes
- Transit stops and stations
- Intersection legs with concurrent pedestrian phases
- Locations with heavy pedestrian volumes as determined by BTD

In all other controlled locations, transverse style crosswalks may be considered. Transverse style are more common at the intersection of Neighborhood Residential Streets.

Crosswalk markings should consist of non-skid, thermoplastic, retro-reflective material. On new pavement, thermoplastic markings should be recessed when possible so that the surface of the marking is flush with the pavement to reduce maintenance needs and provide a smooth, accessible surface.



Enhanced Crosswalks

Overview

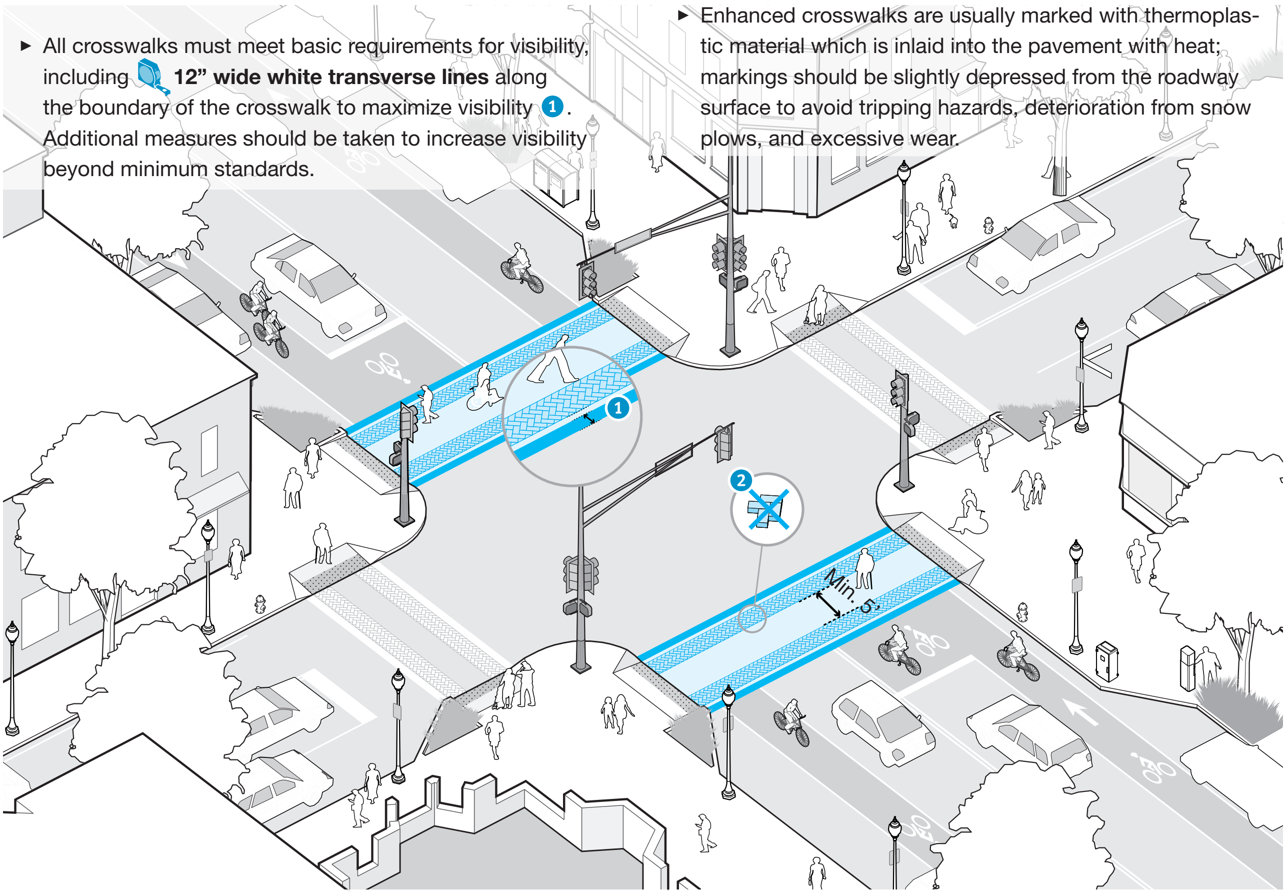
Boston recently began using an enhanced crosswalk design in addition to the standard designs, particularly along Neighborhood Connector and Neighborhood Main Streets. Keeping in mind that all crosswalk widths must be **a minimum of 10' wide**, enhanced crosswalks are typically designed with two decorative bands along the path of travel which can be **2' to 3' wide, with a minimum of a 5' wide unmarked center** to provide a smooth, accessible path for wheelchairs and walkers. Crosswalks can also be enhanced with different colored pavements. The decorative bands or colored pavement can help improve crosswalk visibility, create a more aesthetically pleasing pedestrian-friendly environment, and support branding along a district or corridor. Newly reconstructed sections of Dorchester Avenue and Massachusetts Avenue have enhanced crosswalks.

Use

- All crosswalks must meet basic requirements for visibility, including **12" wide white transverse lines** along the boundary of the crosswalk to maximize visibility 1. Additional measures should be taken to increase visibility beyond minimum standards.
- Enhanced crosswalks should only be used at intersections where they are secondary to other traffic control devices. See Guidelines for Crosswalk Installation on the following page for additional design features that increase safety.
- Decorative markings should be restricted to outside the pedestrian path of travel.

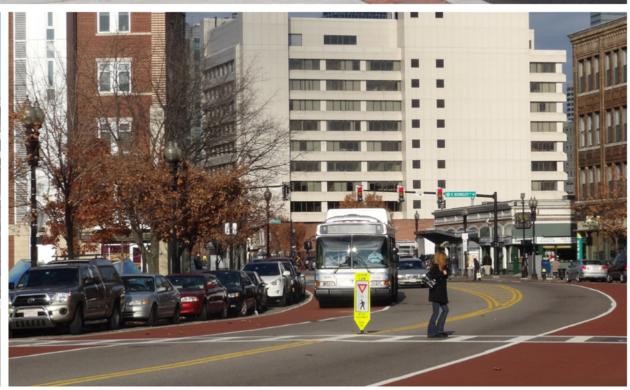
Considerations

- Unit pavers and materials that differ from the surrounding pavement 2, such as concrete placed on an asphalt street, may not be used in crosswalks. Pavers can be susceptible to settling and damage, and can become uncomfortable and unsafe over time.
- Durability and ease of maintenance must be a consideration in material selection. Paint applied to the surface of paving often wears off but is relatively easy to restore.
- Enhanced crosswalks are usually marked with thermoplastic material which is inlaid into the pavement with heat; markings should be slightly depressed from the roadway surface to avoid tripping hazards, deterioration from snow plows, and excessive wear.




Citizens Bank
nationalgrid


YUMON




CLEANERS

Guidelines for Crosswalk Installation

Crosswalks are defined as follows:

Marked crosswalks are distinctly indicated as a pedestrian crossing through pavement markings and can be supplemented with paving treatments and signage.

Unmarked crosswalks legally exist at every corner of an intersection but are not marked with pavement markings; they are essentially an extension of the sidewalk where pedestrians cross the street.

There are two types of marked crosswalks typically found in Boston:

- Marked crosswalk at controlled locations: crosswalks are striped and vehicle traffic is controlled by signage, signalization, or pavement markings.
- Marked crosswalks at uncontrolled locations: crosswalks are striped at locations where traffic is not controlled by signage, signalization, or pavement markings. Motorists and bicyclists must yield the right-of-way to pedestrians in crosswalks determined by Massachusetts State Law.

Unmarked crosswalks are mostly found on streets with low vehicle volumes where marked crosswalks are not needed for safety. Otherwise, crosswalks are not marked in specific locations where pedestrian crossings are not encouraged because of safety concerns.

Massachusetts Crosswalk Laws

In accordance with **Massachusetts State Law Chapter 89 Section 11**, when traffic control signals are not in place or not in operation, motorists shall slow down or stop for a pedestrian within a crosswalk marked in accordance with the MUTCD if:

- The pedestrian is on the half of the traveled way on which the motorist is traveling
- The pedestrian approaching from the opposite side of the traveled way is within **10' of that half of the traveled way** on which the motorist is traveling

Motorists shall not pass any other vehicle stopped at a marked crosswalk to permit a pedestrian to cross, and shall not enter a marked crosswalk while a pedestrian is crossing.

Ultimately it is the responsibility of each motorist to drive cautiously to avoid collisions with pedestrians to the maximum extent feasible, and likewise, it is the responsibility of each pedestrian to exercise care and caution to avoid injury.

Unfortunately, Massachusetts laws are silent on the rights of pedestrians in unmarked crosswalks at locations that are not signalized. In most other states, the right-of-way is granted to pedestrians in unmarked crosswalks. Because of this, crosswalk markings are a critical consideration in order to establish the legal right-of-way for pedestrians at stop-controlled and uncontrolled intersections in Massachusetts. The City of Boston supports creating new legislation that grants explicit rights to pedestrians in unmarked crosswalks.

However, there are many locations where installing marked crosswalks alone is insufficient to address pedestrian safety. For more information on additional treatments to improve safety for pedestrians at uncontrolled locations, see Marked Crosswalks at Uncontrolled Locations later in this section.

Marked Crosswalks at Controlled Locations

Overview

Intersection controls are one of the most important factors in intersection design. The goal of controlling intersections is to provide the safest, most efficient means to move people across an intersection, whether walking, riding a bicycle, taking the bus, or driving. Specific attention should be given to vulnerable users, such as pedestrians and bicyclists, at intersections. Intersection controls range from uncontrolled intersections with no marked crosswalk, to complex signalized intersections with crosswalks striped on all legs, multiple phases, intervals, and indications.

Engineering judgment should be used to establish the most appropriate controls on a site-specific basis. The following factors should be considered when determining intersection controls:

- Vehicular, bicycle, and pedestrian traffic volumes on all approaches
- Number and angle of approaches
- Approach speeds
- Sight distance available on each approach
- Reported crash experience

Depending on the type of intersection and the selected control devices, it may not always be appropriate or cost effective to mark crosswalks at all intersections. Alternate treatments may be necessary to optimize safety and visibility, which are discussed in the sections that follow.

Marked Crosswalks at Stop-Controlled Intersections

Stop-controlled approaches are easiest for pedestrians to cross because motorists and bicyclists must stop and yield the right of way to pedestrians. Stop-controlled intersections also help reduce pedestrian wait times. However, the use of **STOP** signs must balance safety with efficient traffic flow for all modes, including bicycles and transit vehicles. **STOP** sign installation requires specific warrants be met as determined by the MUTCD.

Typically, marked crosswalks should be installed at each leg of all stop-controlled intersections, unless otherwise directed by BTD. Stop lines should be striped at stop-controlled intersections **no less than 4' and no more than 30'** from the approach of crosswalks, unless determined otherwise by an engineering study. Where marked crosswalks are not provided, stop lines should be placed using engineering judgment.

In general, **STOP** signs may be appropriate if one or more of the following conditions exist:

- Where the application of the normal right-of-way rule (yield to those already in the intersection or to those approaching from the right) would not provide reasonable compliance with the law
- A street entering a highway or through street
- An unsignalized intersection in a signalized area
- High speeds, restricted view, or crash records indicate a need for control by a **STOP** sign

At intersections where a full stop is not necessary at all times, consideration should be given to using less restrictive measures, such as **YIELD** signs. **YIELD** or **STOP** signs should not be used for speed control. The use of **STOP** signs should also be limited on streets with bikeways where feasible, especially on Neighborways, as it requires significant energy to stop and start and signs resulting in lower levels of compliance.

Crosswalk designs at stop-controlled intersections must be approved by BTD and PWD in consultation with the Mayor's Commission for Persons with Disabilities.

Marked Crosswalks at Circular Intersections

Circular intersections, such as rotaries, modern roundabouts, and traffic circles, permit traffic to travel in one direction around a center island. The City of Boston has a significant amount of rotaries which are built for higher speeds, and can use signals, **STOP** signs, or **YIELD** signs at one or more entries. Rotaries tend to be difficult for pedestrians and bicyclists to navigate. Modern roundabouts have different design specifications than rotaries; the important difference is the reduction in speeds and diameters, as well as yield-controlled entry. Rotaries and modern roundabouts require channelization of vehicles into the circular part of the roadway. In general, multilane roundabouts are not recommended because of safety concerns for pedestrians, especially those with visual impairments, and bicyclists.

For rotaries and roundabouts, marked crosswalks are required to be set back **at least** **20’** from the entry of the roundabout. Sight distance for drivers entering the roundabout should be maintained to the left so that drivers are aware of vehicles and bicycles in the circle (visibility across the center of the circle is not critical), as well as to the right when exiting the roundabout for pedestrian crossings.

Neighborhood traffic circles are generally used in lower speed and lower volume environments, such as on Neighborhood Residential Street Types. Neighborhood traffic circles are smaller and do not require channelization for entry. Crosswalks may be marked across the legs of the intersecting streets, and do not require setbacks or yield lines. For more information, see Intersection Geometry, Neighborhood Traffic Circles, found earlier in this chapter.

Crosswalk designs at circular intersections must be approved by BTD and PWD, in consultation with the Mayor’s Commission for Persons with Disabilities, the Boston Fire Department, and Boston EMS.

Marked Crosswalks at Signalized Intersections

Signalized intersections are used throughout the City of Boston to assist in safely moving pedestrians, bicyclists, motor vehicles, and transit vehicles. All signalized intersections should contain indications for motor vehicles and pedestrians, and special signals for bicyclists and transit where appropriate.

Typically, marked crosswalks should be installed at each leg of all signalized intersections, unless otherwise determined by an engineering study. Stop lines should be striped at signalized intersections **no less than** **4’**, to help deter motorists from encroaching in crosswalks, and **no more than** **30’** from the approach of crosswalks. Where marked crosswalks are not provided, stop lines should be placed using engineering judgment. Signalized intersections are discussed in further detail later in this chapter.

Crosswalk designs at signalized intersections must be approved by BTD and PWD, in consultation with the Mayor’s Commission for Persons with Disabilities.

Marked Crosswalks at Uncontrolled Locations

Overview

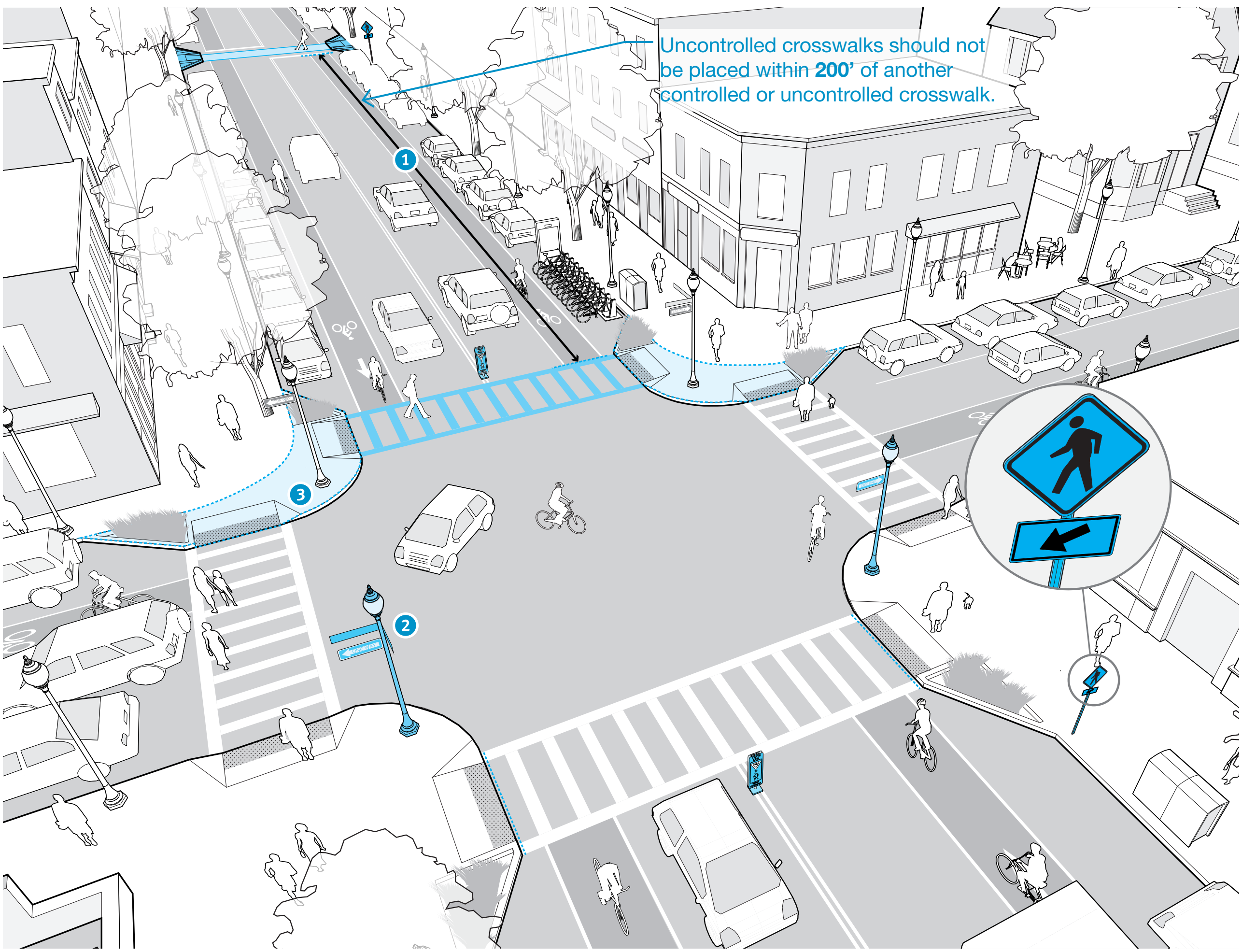
This section presents guidance for when and where it is appropriate to provide marked crosswalks at uncontrolled locations (intersections that are not controlled by signage or signalization). The subsequent sections discuss when installing crosswalks alone is insufficient, and additional safety enhancements are required to increase visibility, awareness, and yielding to pedestrians. Some specialized treatments, such as the pedestrian hybrid beacon (HAWK), are not included here and will be considered on a case-by-case basis.

Crosswalk designs must be approved by BTD and PWD, in consultation with the Mayor's Commission for Persons with Disabilities.

Use

Crosswalks are necessary for getting around as a pedestrian in Boston, and should be implemented in appropriate locations. An engineering study should be performed to determine the feasibility of a marked crosswalk at uncontrolled locations. Components of such a study include the following:

- **Traffic speeds** – higher motor vehicles speeds are directly correlated with more significant injuries and higher numbers of fatalities. The installation of crosswalks at uncontrolled locations should be carefully examined based on traffic speeds. If speeds exceed 40 mph, studies must consider the installation of additional safety treatments. Studies should evaluate whether speed and safety concerns warrant installing traffic control devices.



- **Traffic volumes** – studies should consider the volumes of all modes, including bicycles, transit, heavy vehicles, and motor vehicles.
- **Crossing distances** – crossing distances should be evaluated to determine whether a marked crosswalk is appropriate and sufficient for the crossing. Additional treatments based on crossing distances, such as crossing islands, may be appropriate.
- **Crash history** – engineers should identify locations within the study area that pose safety concerns based on crash history for all modes.
- **Distance from adjacent signalized intersections and other crosswalks** – multiple marked crosswalks or crossing treatments in close proximity may desensitize motorists and decrease the effectiveness of the treatment. In general, crosswalks at uncontrolled locations **should not be placed within 200' of another intersection** with traffic control devices 1.
- **Need/demand for crossing** – it is important to prioritize new marked crosswalks at uncontrolled locations based on trip generators, pedestrian volumes, pedestrian delay, crash history, and other issues. Studies should also consider the age and mobility of pedestrians at a particular location.
- **Sight distance/geometry of the location** – marked crosswalks at uncontrolled locations must provide adequate sight distances to enable drivers to slow down and yield to a pedestrian in the crossing.
- **Possible consolidation of multiple crossing points** – if multiple crossing locations are identified in close proximity, it may be possible to consolidate these into one marked crosswalk based on trip generators, pedestrian volumes, and the most visible location.
- **Availability of street lighting** – the proposed crosswalk location should have adequate lighting 2 or have lighting installation planned.
- **Locations of drainage structures** – drainage structures impact the ability to provide curb ramps and other changes that are necessary at crosswalks.

Considerations

At uncontrolled intersections on major, high speed arterials, marked crosswalks may not be appropriate on each leg of the intersection. For safety and visibility, it may be more suitable to mark only a single side of the intersection, particularly in cases where pedestrians can easily be directed to one location. Note this discussion does not apply to stop-controlled or signalized intersections. In selecting the most appropriate side of an uncontrolled intersection for installing a marked crosswalk, the following should be considered:

- Sight distance
- Pedestrian demand (such as bus stops or transit stations)
- Vehicle turning movements at multi-leg intersections (three or more legs) to reduce conflicts between turning vehicles and pedestrians
- Proximity to other marked crosswalks or crossing locations

There are many locations where installing marked crosswalks alone are insufficient to address pedestrian safety without providing additional measures to increase visibility and reduce traffic speeds. Recent research by the Federal Highway Administration (FHWA) provides specific guidance on when additional safety treatments should be provided at uncontrolled locations with marked crosswalks based on speeds, traffic volumes, number of travel lanes. These locations include any street where speeds exceed 40 mph and either:

- The roadway has four or more lanes of travel without a raised median or pedestrian refuge island and an average daily traffic (ADT) of 12,000 vehicles per day or greater; or
- The roadway has four or more lanes of travel with a raised median or pedestrian refuge island and an ADT of 15,000 vehicles per day or greater.

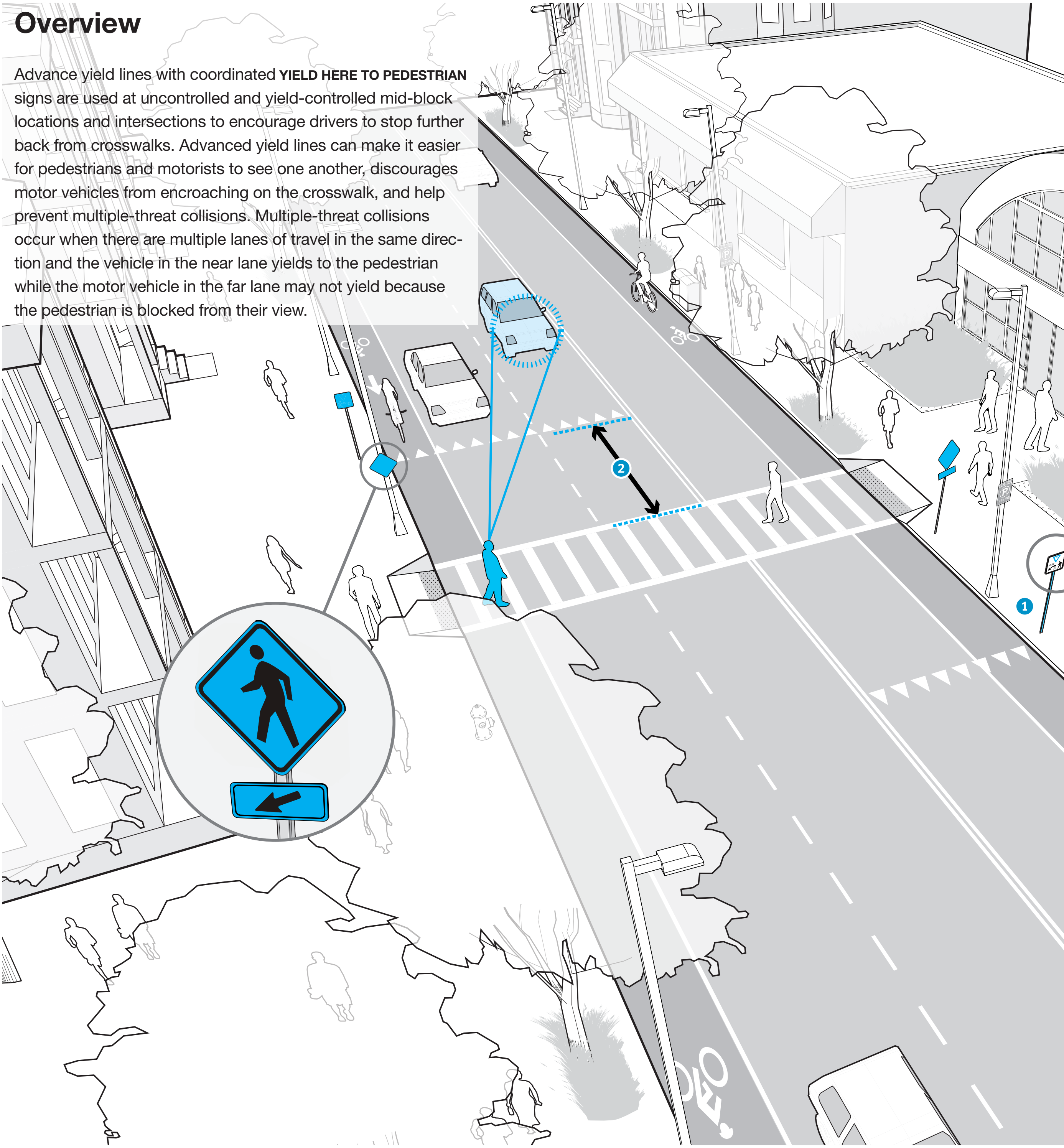
There are a number of measures that can compliment marked crosswalks at uncontrolled locations to improve pedestrian safety. The topics below are covered in depth elsewhere in this chapter:

- Reducing the effective crossing distance for pedestrians by:
  - Providing curb extensions 3
  - Providing raised pedestrian refuge islands
  - Completing road diets or lane diets
- Installing traffic calming measures to slow vehicle speeds
- Providing adequate nighttime lighting for pedestrians
- Using various pedestrian warning signs, advanced yield lines, rapid flash beacons, and other traffic control devices to supplement marked crosswalks
- Providing traffic signals (with pedestrian signals) where warranted

Advanced Yield Markings and Signs

Overview

Advance yield lines with coordinated **YIELD HERE TO PEDESTRIAN** signs are used at uncontrolled and yield-controlled mid-block locations and intersections to encourage drivers to stop further back from crosswalks. Advanced yield lines can make it easier for pedestrians and motorists to see one another, discourages motor vehicles from encroaching on the crosswalk, and help prevent multiple-threat collisions. Multiple-threat collisions occur when there are multiple lanes of travel in the same direction and the vehicle in the near lane yields to the pedestrian while the motor vehicle in the far lane may not yield because the pedestrian is blocked from their view.



Use

- Advanced yield lines should not be used at locations where drivers are required to stop in compliance with a **STOP** sign or a signal. Note advanced stop lines can be used at signalized and stop-controlled intersections.
- Advanced yield lines and signs can be used on two-lane, three-lane, and four-lane roadways, however they are less effective on four-lane roadways unless vehicle operating speeds are 25 mph or less. On four-lane roads with higher speeds, the rapid flash beacon may be a better solution. See Rectangular Rapid Flash Pedestrian Beacon later in this section.
- Yield lines at unsignalized crossings should be accompanied by **YIELD HERE TO PEDESTRIAN** signs 1.
- Advance yield lines and signs should be placed **20' to 50' in advance of crosswalks** 2 on uncontrolled multilane approaches, and parking should be prohibited in the area between the yield line and the crosswalk. Pavement markings can be used to reinforce **NO PARKING** signage.

Considerations

- When determining where to place advance yield lines and signs within the **20' to 50' range**, consideration should be given to the number of lanes pedestrians must cross, motor vehicle speeds, sight lines, on-street parking, and turning movements.
- Advance yield lines may be staggered, so that yield lines in one lane are closer to the crosswalk than the yield lines in an adjacent lane. Staggered yield lines can improve drivers' view of pedestrians, provide better sight distance for turning vehicles, and increase the turning radius for left-turning vehicles.

In-Street YIELD TO PEDESTRIAN Signs

Overview

In-street **YIELD TO PEDESTRIAN** signs are signs placed in the roadway at crosswalk locations to remind roadway users of the laws regarding the right of way at unsignalized mid-block locations and intersections. They also increase awareness and visibility of pedestrians crossing. They are often used in busy business districts; at school crossings and other locations with vulnerable populations; or where high pedestrian volumes occur in unexpected locations. In-street signs can be used in conjunction with advanced warning signs and pedestrian crossing signs at crosswalks.

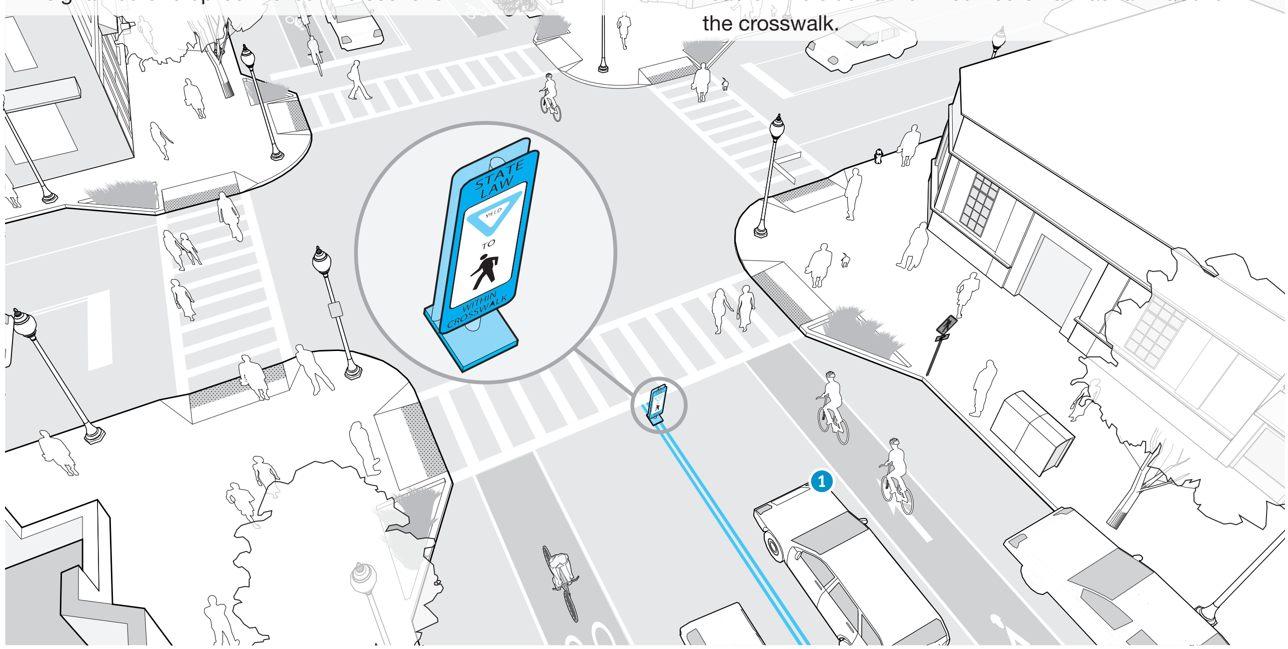
In addition to in-street **YIELD TO PEDESTRIAN** signs, a variety of signs may be used to indicate locations where drivers must yield to pedestrians, including **YIELD HERE TO PEDESTRIAN** signs, previously discussed in Advanced Yield Lines and Signs, **TURNING TRAFFIC YIELD TO PEDESTRIAN** signs, and overhead **YIELD TO PEDESTRIAN** signs. Studies have shown that these signs can help to increase motorist compliance with pedestrian laws.

Use

- In-street **YIELD TO PEDESTRIAN** signs must only be used at unsignalized intersections. They are prohibited from use at signalized or stop-controlled intersections.
- In-street **YIELD TO PEDESTRIAN** signs should be placed in the roadway close to the crosswalk location on the center line (1), on a lane line, or on a median island, but they should not obstruct the crosswalk. In-street signs should also be placed to avoid turning vehicles from knocking over the sign, and should be designed to bend over and bounce back when struck.
- In-street **YIELD TO PEDESTRIAN** signs work best on low speed, two lane roads. They are not recommended for roads with high speeds or volumes where drivers are less likely to see them.

Considerations

In-street signs:
- May be permanent or temporary. It may be preferable to remove them during winter for snow removal operations.
- Require regular monitoring and should be replaced when damaged. Damaged signs send the message to pedestrians that a crossing is not safe.
- Are typically not used at yield-controlled intersections, and should only be installed using engineering judgment.
- May be used in combination with pedestrian warning signs. Warning signs should be placed on the right side of the road on the sidewalk or mounted on a mast arm above the crosswalk.



Rectangular Rapid-Flash Beacons

Overview

At some unsignalized crossings, particularly those with four or more lanes, it can be very challenging to enforce that drivers yield to pedestrians. Vehicle speeds and poor pedestrian visibility combine to create conditions in which very few drivers are compelled to yield. One type of device proven to be successful in improving yielding compliance at these locations is the Rectangular Rapid Flash Beacon, which has been confirmed by multiple studies, including an FHWA study, the “Effects of Yellow Rectangular Rapid flashing Beacons on Yielding at Multilane Uncontrolled Crosswalks.”

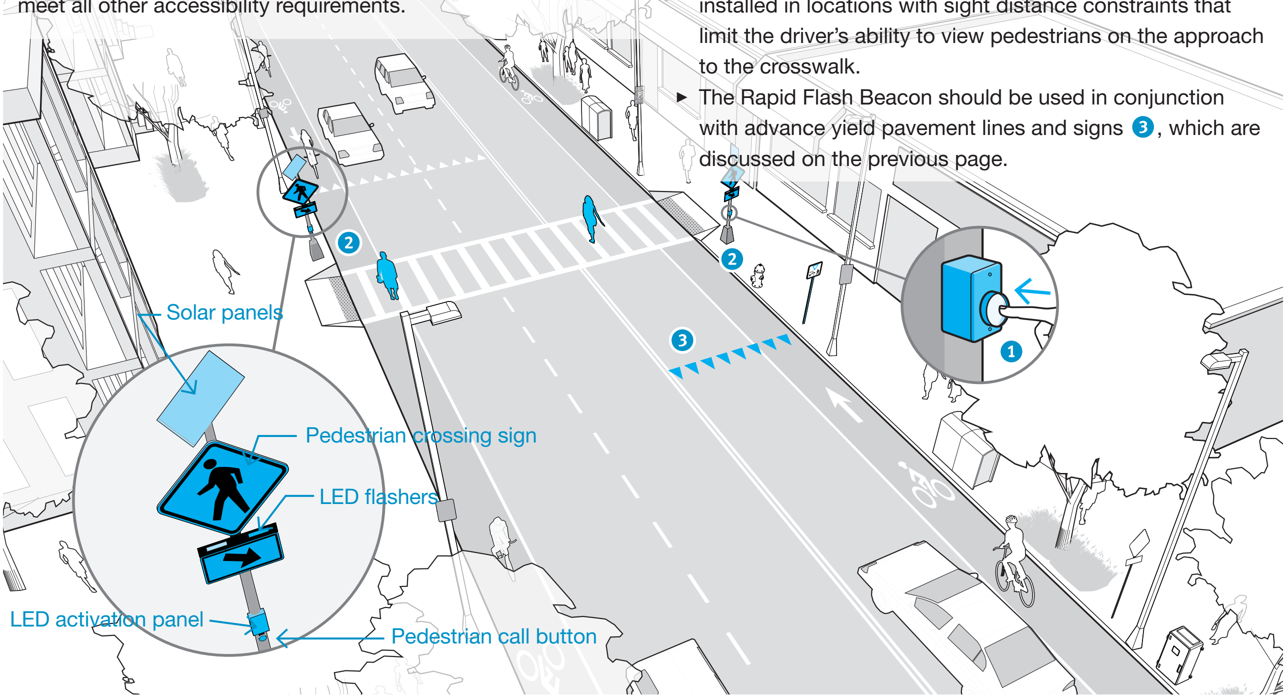
Rectangular Rapid Flash Beacons are placed curbside below the pedestrian crossing sign and above the arrow indication pointing at the crossing. They should not be used without the presence of a pedestrian crossing sign. The light-emitting diode (LED) flash is a “wig-wag” flickering pattern at a rate of 190 flashes per minute. The beacons are activated by a pedestrian call button (1). The installation should include an audible message confirming that the device is activated and instructing pedestrians to wait until cars have stopped before crossing. Another LED panel should be placed facing the pedestrian to indicate that the beacon has been activated. The pushbutton and other components of the crosswalk must meet all other accessibility requirements.

Use

- Massachusetts Department of Transportation (MassDOT) has received Interim Approval for the use of Rectangular Rapid Flash Beacons for all cities and towns within the Commonwealth of Massachusetts.
- The design of Rectangular Rapid Flash Beacons should be in accordance with FHWA’s Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons issued July 16, 2008.
- Rectangular Rapid Flash Beacons can be used when a signal is not warranted at an unsignalized crossing. They are not appropriate at intersections with signals or **STOP** signs.
- Rectangular Rapid Flash Beacons are installed on both sides of the roadway at the edge of the crosswalk (2). If there is a pedestrian refuge or other type of median, an additional beacon should be installed in the median.

Considerations

- Rectangular Rapid Flash Beacons are considerably less expensive to install than mast-arm mounted signals. They can also be installed with solar-power panels to eliminate the need for a power source.
- Rectangular Rapid Flash Beacons should be limited to locations with critical safety concerns, and should not be installed in locations with sight distance constraints that limit the driver’s ability to view pedestrians on the approach to the crosswalk.
- The Rapid Flash Beacon should be used in conjunction with advance yield pavement lines and signs (3), which are discussed on the previous page.



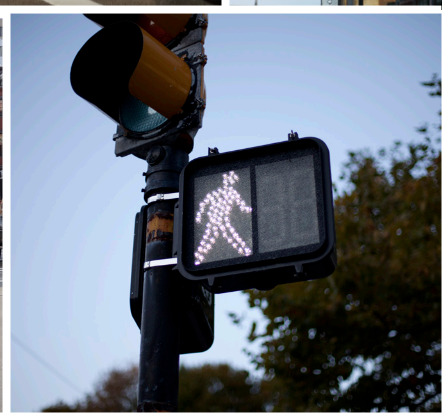

CITY CAB
o/o DETTY & MAPHY INC.


Citizens Bank
CHECKCASHERS
YIELD
TO
PEDESTRIANS
ON TURNS


TO REQUEST
GREEN
WAIT
ON
SIGNALS
SET FOR
30
MPH


START CROSSING
Watch For
Vehicles
DON'T START
Finish Crossing
If Started
DON'T CROSS
PUSH BUTTON
TO CROSS


CRU



Signalized Intersections

The Boston Transportation Department operates over 800 traffic signals located in Boston. Its Transportation Management Center (TMC) monitors, coordinates, and adjusts signals to improve traffic flow and pedestrian safety on city streets. The TMC computers control over 450 key signals, allowing for real-time adjustments to be made in response to unusual traffic conditions and emergencies. In addition, BTD owns over 100 closed-circuit televisions (CCTV) to monitor traffic conditions, and has access to Boston Police and state agency cameras.

The City of Boston's policy is to prioritize the safety, comfort, and convenience of all users at signalized intersections. All signalized intersections should contain indications for motor vehicles and pedestrians, and signals for bicyclists and transit where appropriate. By optimizing signal phasing and timings, multiple modes are able to safely move through the intersection with limited conflicts, low delay, and more comfort.

All signal designs must be approved by BTD. For additional signal design guidance, reference BTD's Traffic Signal Operations Design Guidelines, the MUTCD, and the HCM.

Signal Timing for Pedestrians

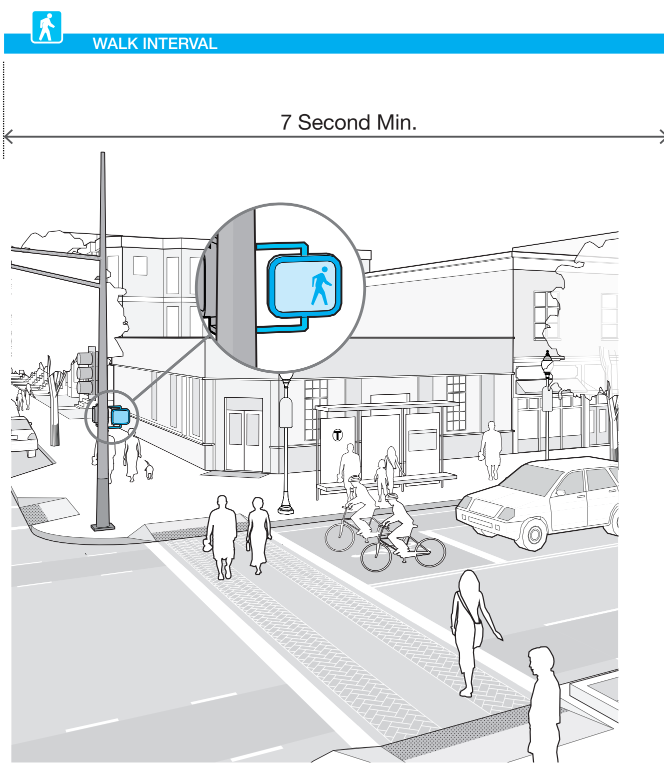
Overview

Signal timing for pedestrians is provided through the use of pedestrian signal heads. Pedestrian signal heads display the three intervals of the pedestrian phase:

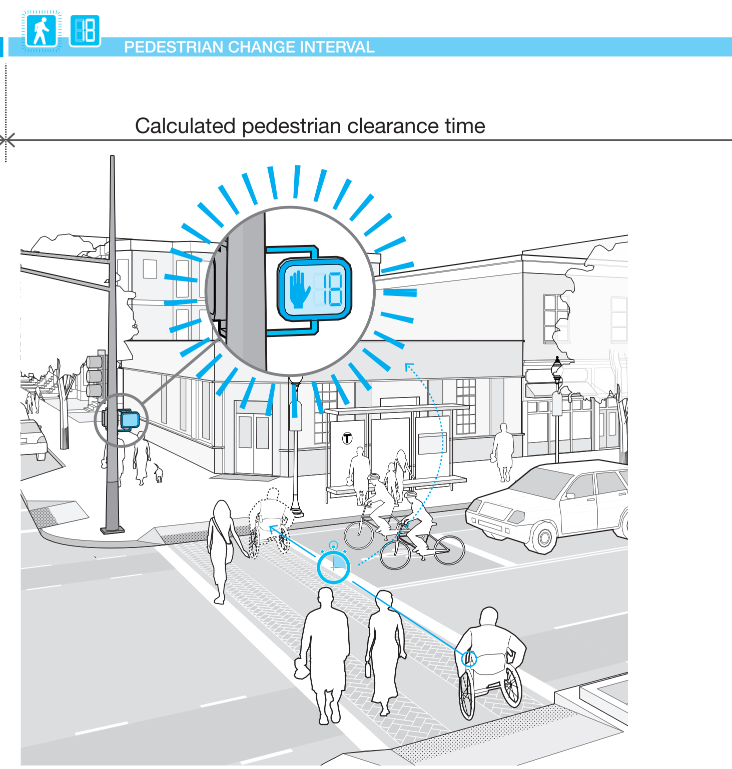
- **The Walk Interval**, signified by the **WALK** indication—the walking person symbol—alerts pedestrians to begin crossing the street.
- **The Pedestrian Change Interval,** signified by the flashing **DON'T WALK** indication—the flashing upraised hand symbol accompanied by a countdown display—alerts pedestrians approaching the crosswalk that they should not begin crossing the street. The countdown display alerts pedestrians in the crosswalk how much time they have left to cross the street.
- **The Don't Walk Interval**, signified by a steady **DON'T WALK** indication—the steady upraised hand symbol – alerts pedestrians that they should not cross the street. The beginning of the Don't Walk Interval is called the Buffer Interval, which should be displayed for a minimum of a three seconds prior to the release of any conflicting motor vehicle movements.

The total time for the pedestrian change interval plus the buffer interval is called the pedestrian clearance time, or the time it takes for a pedestrian to clear the intersection leaving at the onset of the **DON'T WALK** indication.

Pedestrian signal heads should be provided at all signalized intersections for all crosswalks; additionally, it is highly recommended to install crosswalks on all legs of a signalized intersection unless determined otherwise by an engineering study. Signal timing for pedestrians should be provided at all newly constructed signalized intersections and incorporated into all signalized intersection improvements. For information on requirements for accessible pedestrian signals, see Accessible Pedestrian Signals later in this chapter.



Walk Interval

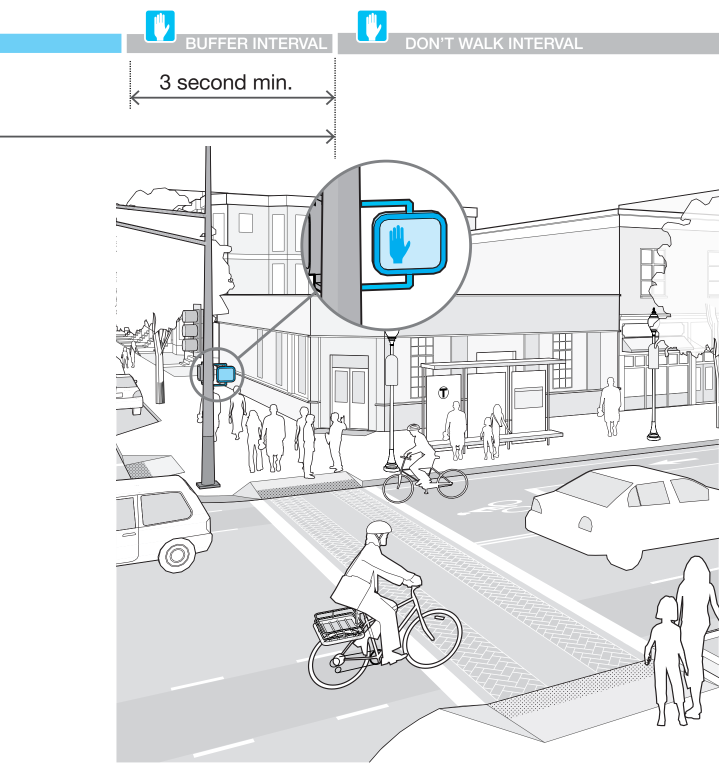


Pedestrian Change Interval

The following design goals can help improve pedestrian crossing safety and comfort at signalized intersections:

- Reduce vehicle speeds
- Minimize crossing distance
- Minimize delay for **WALK** indication
- Minimize conflicts with turning vehicles
- Provide sufficient signal time to cross the street

All signal designs must be approved by BTD.



Don't Walk Interval

Use

Walking Speed

Pedestrian signals should allocate enough time for pedestrians of all abilities to safely cross the roadway. The MUTCD specified pedestrian walking speed is 3.5 feet per second to account for an aging population. The pedestrian clearance time, which is the total time for the pedestrian change interval plus the buffer interval, is calculated using the pedestrian walking speed and the distance a pedestrian has to cross the street.

Countdown Pedestrian Displays

Countdown pedestrian displays inform pedestrians of the amount of time in seconds that is available to safely cross during the flashing Don't Walk Interval. Research has shown that pedestrians have a better understanding of the pedestrian phase when countdown displays are provided. All pedestrian signal heads should contain a countdown display provided with the **DON'T WALK** indication.

Considerations

One of primary challenges for designers is to balance the goals of minimizing conflicts between turning vehicles with the goal of minimizing the time required to wait at the curb for a **WALK** indication. Intersection geometry and traffic controls should facilitate turning vehicles to yield the right-of-way to pedestrians. Requiring pedestrians to wait for extended periods can encourage crossing against the signal. Concurrent phasing should be considered to reduce delay for pedestrians and motorists. The 2010 HCM states that pedestrians have an increased likelihood of risk-taking behavior (e.g., jay-walking) after waiting longer than 30 seconds at signalized intersections. Strategies to achieve this balance include minimizing signal cycle lengths, concurrent phasing, discussed on the next page, the use of a Leading Pedestrian Interval, discussed later in this chapter, and reducing turning speeds to increase yielding, discussed in Curb Radii and Corners found earlier in this chapter.

Opportunities to provide a WALK indication should be maximized whenever possible. Vehicular movements should be analyzed at every intersection in order to utilize non-conflicting phases to implement Walk Intervals. For example, pedestrians can always cross the approach where vehicles cannot turn at a four-leg intersection with the major road intersecting a one-way street, when the major road has the green indication.

Exclusive vs. Concurrent Phasing

Overview

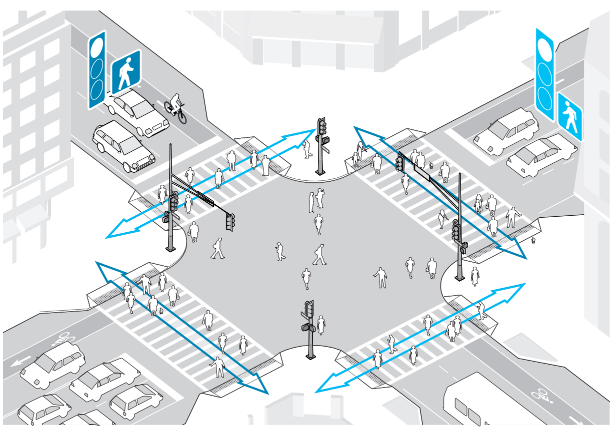
There are two primary approaches to time the pedestrian phase; an exclusive or a concurrent phase. An **exclusive pedestrian phase** is an additional phase in the signal cycle that is provided only for pedestrian movements while all vehicular traffic is stopped. A **concurrent pedestrian phase** is when pedestrians are able to cross while parallel and conflicting vehicular traffic are also moving. Concurrent pedestrian phasing usually provides the least amount of delay for pedestrians, and motorists in most circumstances due to shorter cycle lengths, and therefore can reduce non-compliance (jaywalking) and increase safety.

Another type of phasing is a **protected pedestrian phase,** which is when pedestrians are able to cross when there are no conflicting movements with motorists resulting from geometry, one-way allocations, or conflicting motorists have a red indication.

BTD's Traffic Signal Operations Design Guidelines encourage using concurrent pedestrian phases to promote pedestrians crossing with the Walk Interval, and to help reduce delays to pedestrians and motor vehicles.

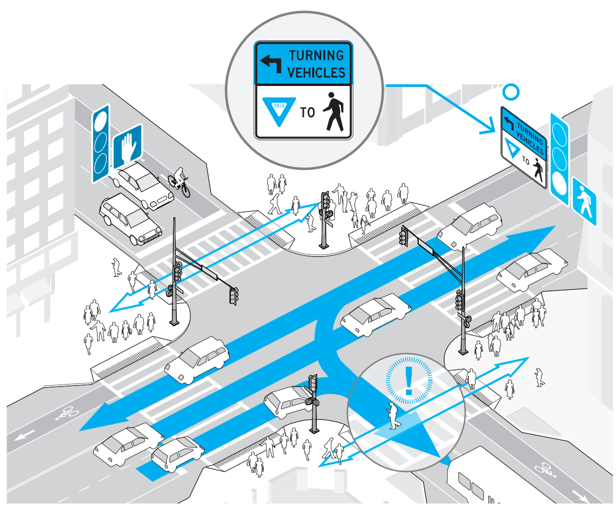
Use

- Protected pedestrian phases should always be used when there are no conflicting movements with other modes.
- Exclusive pedestrian phases and protected pedestrian phases should generally be used at intersections:
  - Where conflicting turning vehicles are equal to or greater than 250 vehicles per hour
  - Where sight distance is restricted
  - With complex intersection geometry
  - Near elderly housing, schools, recreational areas, medical facilities, or other facilities within a safety zone
- Concurrent pedestrian phases should be used at all intersections where the above conditions are not present. Concurrent phasing should be accompanied by proper signage, such as **TURNING VEHICLES YIELD TO PEDESTRIANS** and **WATCH FOR TURNING VEHICLES.**



Considerations

- Exclusive pedestrian phases increase pedestrian safety but can also increase delay for all intersection users.
- Leading pedestrian intervals may be considered in conjunction with concurrent phasing and are discussed later in this section.
- **NO TURN ON RED** signs should be considered at intersections with exclusive pedestrian phases and are discussed later in this section.
- **TURNING VEHICLES YIELD TO PEDESTRIANS** and **WATCH FOR TURNING VEHICLES** signs should be used at intersections with concurrent pedestrian phases where conflicting vehicle movements are present.
- A leading left-turn (i.e., left-turn arrow) can be confusing for pedestrians who expect it to be safe to step into the roadway once crossing traffic receives a red indication. Where a left-turn arrow is provided for motor vehicles, a lagging left-turn phase should be used wherever possible.



Automatic vs. Actuated Pedestrian Phases

Overview

Pedestrian phases can be programmed to be automatic each cycle, or be actuated using pushbuttons. Automatic pedestrian phases are preferred and should be used in high pedestrian volume areas where the pedestrian phase is needed during every intersection cycle. Research has shown that only 50% of pedestrians actually use pushbuttons when provided. Vehicles at signalized intersections are detected automatically, so pedestrians should be provided the same service. Pedestrian pushbuttons should be used rarely, and only when absolutely necessary.

Use

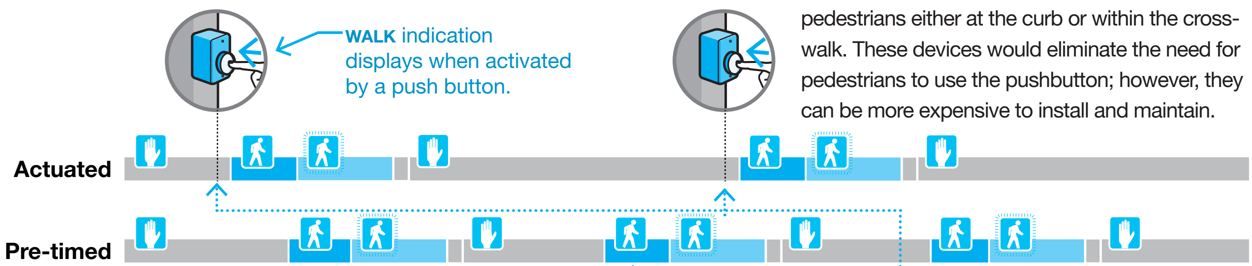
Where feasible, the pedestrian phase should be automatic during every cycle. In limited situations where pedestrians are present for less that 50% of the time during peak hours, pushbuttons may be considered. In Boston there are very few intersections where this is not the case, and automatic pedestrian phasing may still be appropriate even where pedestrian volumes do not meet 50% during peak hours when determined by an engineering study on a case-by-case basis.

- Accessible pedestrian signals and pushbuttons are required in the U.S. Access Board's proposed Accessibility Guidelines in Public Right-of-Way when new pedestrian signals are installed. Note accessible pedestrian signals and pushbuttons may be used at automatically timed pedestrian signals; however, they will only call accessible features, not the pedestrian WALK indication. For more information, see Accessible Pedestrian Signals found later in this section.

Where concurrent pedestrian phasing is used at locations where motor vehicles cannot turn onto a one-way street, pedestrian signals provided to cross the one-way street should be given a WALK indication and clearance interval each time while the major street is being served.

Considerations

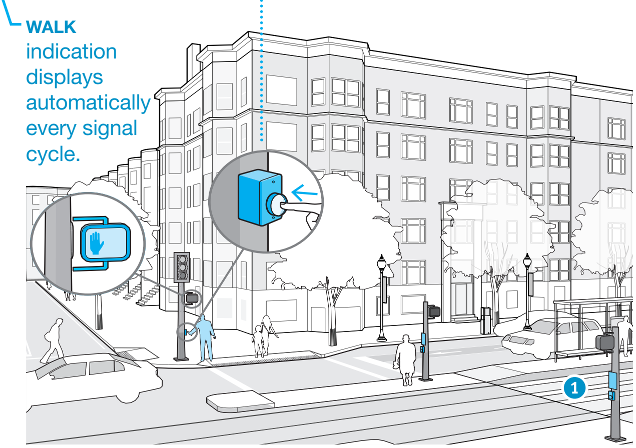
Details on where pushbuttons should be provided are located in the latest edition of the MUTCD. Research is also being conducted on developing passive pedestrian detection devices that would activate the pedestrian phase based on the presence of pedestrians either at the curb or within the crosswalk. These devices would eliminate the need for pedestrians to use the pushbutton; however, they can be more expensive to install and maintain.



Overall the goals of signal design are reliability and consistency. Consistent and predictable movements are crucial for making Boston's streets safe. Boston has one of the oldest signal systems in the country, and BTD is working to update the system to accommodate all modes equitably and efficiently.

Pushbuttons may be considered in the following situations:

- At intersections that experience infrequent pedestrian use.
- At intersections designed to operate with motor vehicle detection that is actuated or semi-actuated.
- In cases where pedestrians are not able to cross the entire street in one phase. In this situation, a pedestrian pushbutton must be provided in the median (1) and the median must be a **minimum of 6' wide.**



Leading Pedestrian Interval

Overview

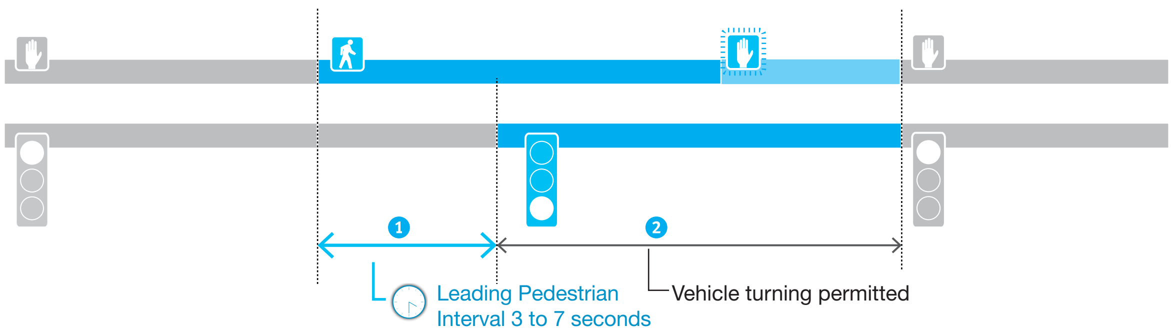
The Leading Pedestrian Interval (LPI) is when pedestrians are given the **WALK** indication **3 to 7 seconds** before conflicting motor vehicles traveling in the same direction are given a green indication. Essentially, pedestrians are given a head start, allowing people to enter the crosswalk prior to turning vehicles, increasing visibility between all modes. The LPI should be timed so a pedestrian can travel across one lane of traffic or establish themselves in the intersection in front of turning vehicles. The FHWA has determined that the LPI currently provides a crash reduction factor for pedestrians of 5%, and especially benefits slower pedestrians.

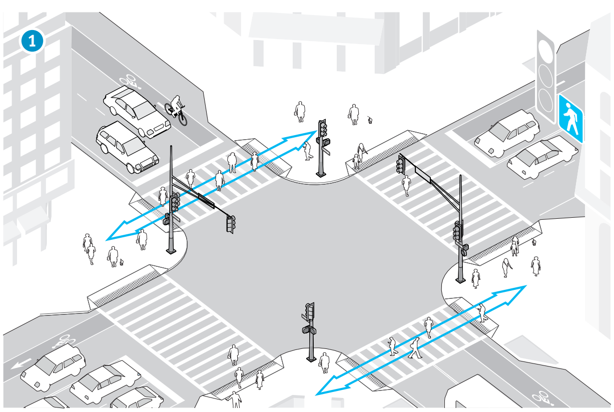
Use

- The City is looking to expand the use of LPIs with concurrent phasing as an alternative to exclusive phases. LPIs should be considered at intersections with high conflicts of pedestrians and turning vehicles as determined by BTD.
- A lagging protected left arrow for vehicles should be provided to accommodate the LPI.
- Intersections with LPIs should be accompanied by appropriate signage, such as **TURNING VEHICLES YIELD TO PEDESTRIANS.**
- Newly installed LPIs must provide accessible pedestrian signals and pushbuttons.

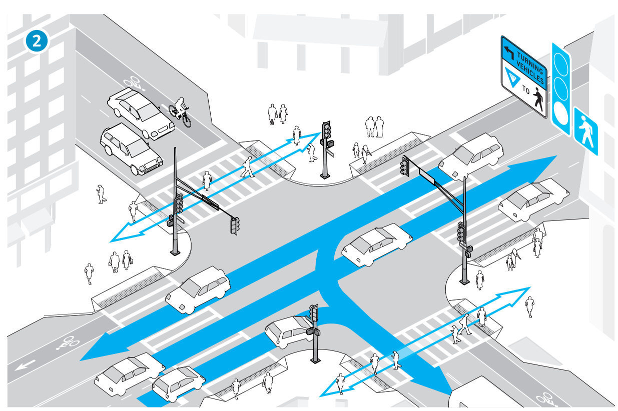
Considerations

- **NO TURN ON RED** signs should be considered with LPIs.
- In general, concurrent pedestrian phasing should appropriately match the motor vehicle signal phasing. At intersections with high pedestrian volumes where drivers have difficulty finding gaps to turn, the green time can be intentionally extended past the Don't Walk Interval in order to allow the turning movement.
- In addition to the LPI, bicyclists traveling in the same direction as pedestrians should be provided a leading bicycle interval using a bicycle signal head.





Leading Pedestrian Interval



Vehicle turning permitted

No Turn On Red

Overview

NO TURN ON RED signs are used to restrict vehicles from turning right, or left on intersecting one-way streets, during the red indication. Restricting this movement eliminates conflicts with pedestrians crossing in front of vehicles making turns.

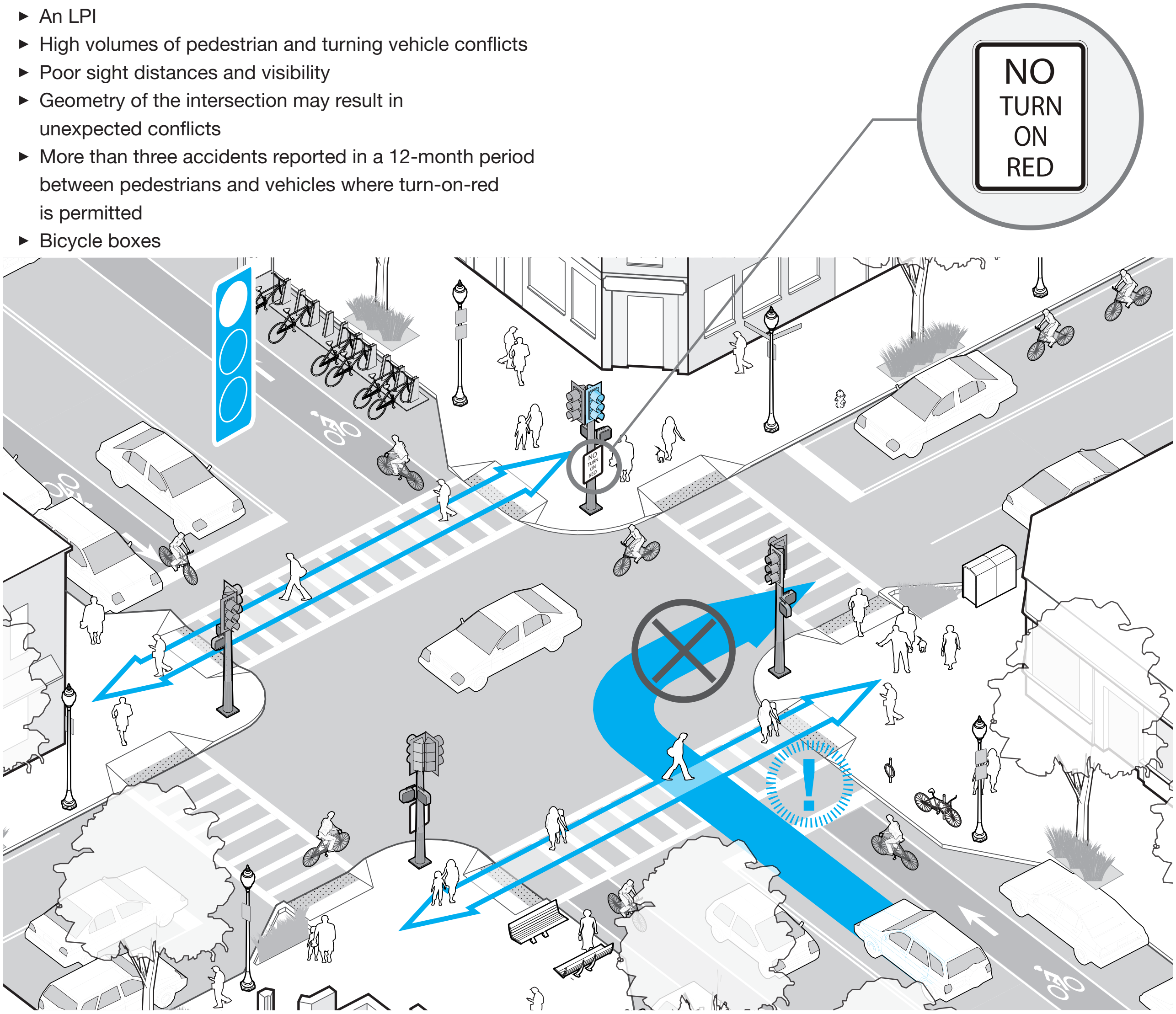
Use

NO TURN ON RED signs should be considered when one or more of the following conditions apply:

- An exclusive pedestrian phase
- An LPI
- High volumes of pedestrian and turning vehicle conflicts
- Poor sight distances and visibility
- Geometry of the intersection may result in unexpected conflicts
- More than three accidents reported in a 12-month period between pedestrians and vehicles where turn-on-red is permitted
- Bicycle boxes

Considerations

- **NO TURN ON RED** signs can be provided at all times or by a dynamic sign that changes when pedestrians are present, by time of day, by a call made by an emergency vehicle, and/or at rail or light transit crossings.
- **NO TURN ON RED** signs can also be used in conjunction with LPIs, or bicycle signals that allow through movements when turning vehicular traffic is stopped.



Coordinated Signal Timing

Overview

Coordinated signal timing is the synchronization of multiple signalized intersections in close proximity to improve operations, and is often referred to as the "green wave" for roadway users. The green wave is achieved by designing traffic signals to allow vehicles to progress along a corridor at a set speed in order to obtain green lights at signalized intersections. By coordinating signals, vehicular platoons move through signalized intersections along a corridor with ease and can minimize mid-block speeding.

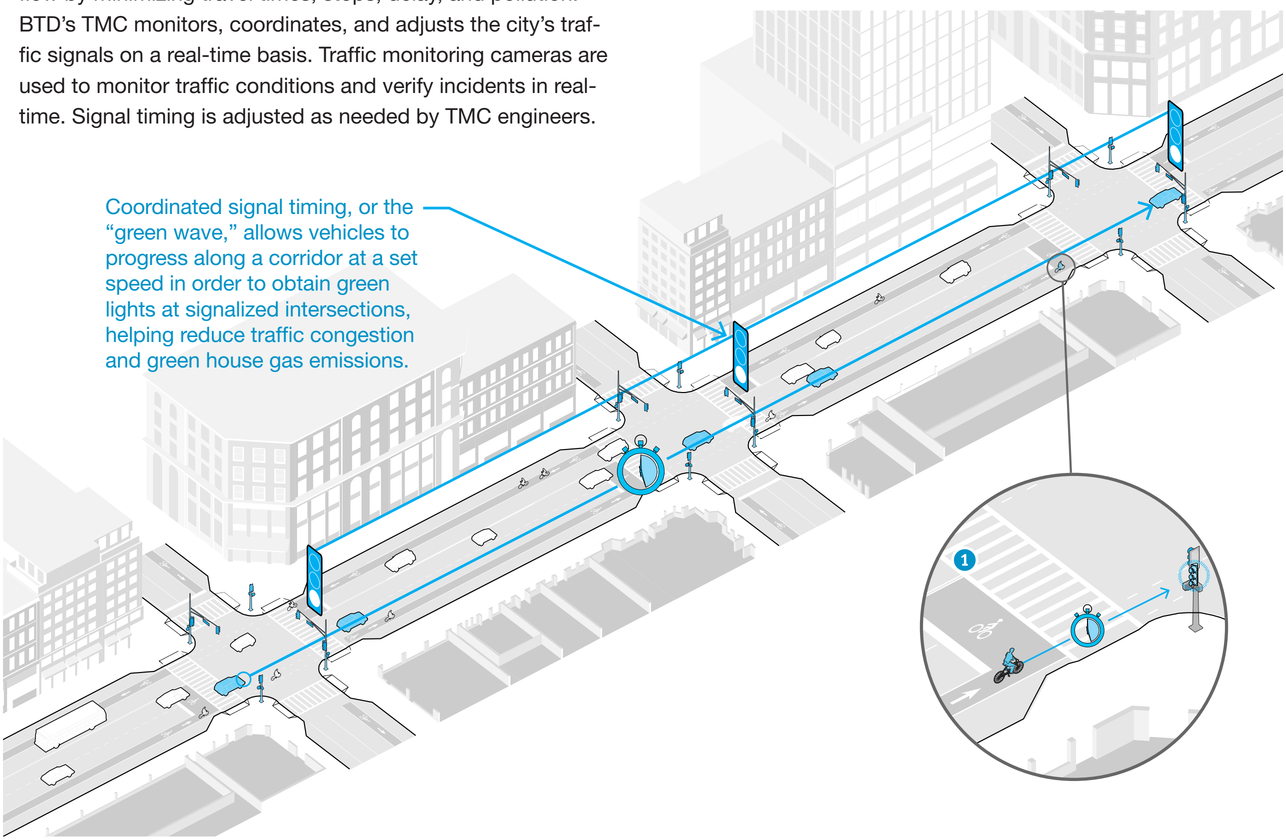
All signal timing should be developed with an engineering study in conformance to BTD Traffic Signal Operations Design Guidelines.

Use

A well coordinated signalized corridor can enhance traffic flow by minimizing travel times, stops, delay, and pollution. BTD's TMC monitors, coordinates, and adjusts the city's traffic signals on a real-time basis. Traffic monitoring cameras are used to monitor traffic conditions and verify incidents in real-time. Signal timing is adjusted as needed by TMC engineers.

Considerations

- Signal progression at slower speeds is a tool that can help calm traffic, however it should be used in conjunction with other methods to deter speed spiking between signals.
- The impacts of coordinated signals for vehicles along a corridor must consider and mitigate the impacts on other users.
- The overall goal of signal design is to minimize cycle lengths to reduce delay for all users. Long cycle lengths make walking less convenient and may encourage unsafe behavior such as pedestrians jay walking and bicyclists running red lights. Signal coordination should be optimized to balance the needs of all users and to minimize the delay for pedestrians, bicyclists, and transit vehicles.
- Bicycle speeds should be considered when designing a coordinated signal system along priority bicycle routes. To the extent possible, the coordination should allow both motorists and bicyclists to travel through multiple intersections without stopping.



Accessible Pedestrian Signals (APS)

Overview

Accessible pedestrian signals (APS) and accessible detectors are devices that communicate information in non-visual formats about the pedestrian phase to pedestrians with visual and/or hearing disabilities. APS and detectors may include features such as audible tones, speech messages, detectable arrow indications and/or vibrating surfaces.

The major functions of the APS are to provide information for:

- Location of pushbuttons, if used
- Beginning of **WALK** interval
- Direction of crosswalk
- Location of destination sidewalk
- Intersection street name in Braille or raised print
- Intersection signalization with speech messages
- Intersection geometry through detectable maps or diagrams or through speech messages

Non-visual pedestrian signal features should be provided at signalized intersections based on engineering judgment as outlined in the MUTCD.

Vibrodetectable devices vibrate to communicate information through touch. Vibrodetectable arrows indicate when the **WALK** indication is in effect, and which direction to cross.

Pushbutton locator tones are used for locating the pedestrian pushbutton needed to actuate the **WALK** interval. Detectable arrows should be located on pushbuttons to point in the same direction as the crosswalk. At corners of signalized locations where two pushbuttons are present, they should be **separated by at least 10'.**

For automatically called pedestrian phases, pushbuttons can be used to activate accessible pedestrian signal features such as detectable arrow indications and/or speech messages.

All accessible pedestrian signal designs must be approved by BTD and conform to the guidelines set by the U.S. Access Board.

Use

- When new pedestrian signals are installed, APS and pushbuttons are required in the accessibility guidelines for the public right-of-way by the U.S. Access Board.
- For existing pedestrian signals, the proposed guidelines require APS and pedestrian pushbuttons to be provided when the signal controller and software are altered, or the signal head is replaced.
- At new locations where the pedestrian phase is automatic (pushbutton activation is not required as the pedestrian phase recalls every signal cycle) accessible pedestrian pushbuttons only call accessible features, not the pedestrian WALK signal indication.

Considerations

- Audible walk indications should have the same duration as the pedestrian walk indication unless the pedestrian signal rests during the pedestrian phase, in which the audible indication should be provided in the first 7 seconds of the Walk Interval.
- For detailed information on accessible signals and pushbuttons, please refer to the United States Access Board's website.


Brigham Circle
Huntington Ave.
FRANCIS
3809
3816
new balance


NORTH
93
1002
Public Parking
DUDLEY


8 VIA U MASS


3872

Transit Accommodations at Intersections

When designing intersections to accommodate transit vehicles, the major goals are to improve the reliability and efficiency of transit service. Intersections are where most transit stops occur and are a major source of delay for transit vehicles. Waiting at traffic signals accounts for at least 10% of overall bus trip time and up to 50% or more of bus delay.

A majority of the Masachusetts Bay Transit Authority's (MBTA) transit stops are located at intersections on Boston streets. While many stops are demarcated only by signs, several hundred bus shelters have been installed through Boston's Coordinated Street Furniture program. In addition, as part of the MBTA's ongoing Key Bus Routes initiative, several streets such as Cambridge Street in Allston/Brighton, Dudley Street, and Blue Hill Avenue are being improved with new bus stops and shelters.

It is important to minimize conflicts between transit vehicles and vulnerable users such as pedestrians and bicyclists. With one of the highest mode shares for walking in the country and a growing presence of bicyclists on Boston's Streets, the interactions of all modes at intersections should be taken into consideration. Ideally, space will be provided for each mode, however, where space is not available, designs must maximize safety, sight lines, and minimize conflicts wherever possible. Bus drivers should be professionally trained to learn techniques that minimize conflicts with pedestrians and bicyclists.

This section covers design strategies to improve transit operations and safety, and reduce delay for transit vehicles at intersections. While individual strategies can be implemented independently, in many cases a combination of strategies, including the appropriate location of the stop and signal prioritization, will be most effective. Implementation of these strategies should also be complemented by operational improvements being carried out by the MBTA, including smart fare payment systems and real-time tracking. Transit lanes are covered in Chapter 3: Roadways. Bus stop and shelter designs are covered in Chapter 2: Sidewalks.

All transit accommodations at intersections must be approved by BTD, PWD, and the MBTA. The MBTA Bus Stop Planning and Design Guidelines serve as the primary reference for the design, location and spacing of transit stops in Boston.

Bus Stop Location

Overview

All bus stop locations must be ADA compliant, and should be safe, convenient, well-lit, and clearly visible. Proper spacing and siting of bus stops involves many considerations such as the bus route, population density, popular destinations, transfer locations, intersection operations and geometry, parking restrictions, and sightlines.

Bus stop locations should be determined on a site-by-site basis and must be approved by BTD and the MBTA.

Use

Where buses are required to pull out of traffic, bus stops should be located at the near- or far-side of intersections wherever possible and not at mid-block locations. Intersections are also convenient for passengers because they can intercept other transit connections, crosswalks, pedestrian routes, and building entrances easily. At signalized intersections, far-side placement is generally recommended.

The charts below are from the MBTA Bus Stop Planning and Design Guidelines.

MBTA Bus Stop Spacing Distances

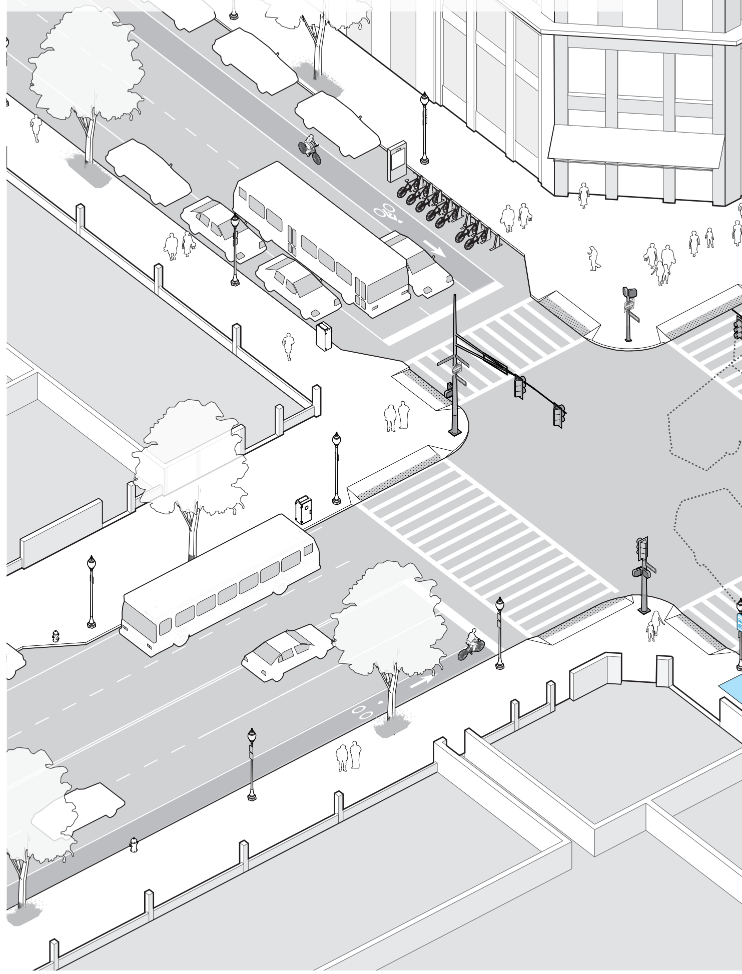
	Density Population / Square Mile	Distance between Stops
Minimum (2)	-	750'
High Density (Urban)	5,000' >	750'
Medium Density	3,500' to 5,000'	750' to 1,000'
Low Density (Suburban)	< 3,500'	> 1,000' to 1,320'
Bus Rapid Transit (BRT) Route	5,000' >	1,500'

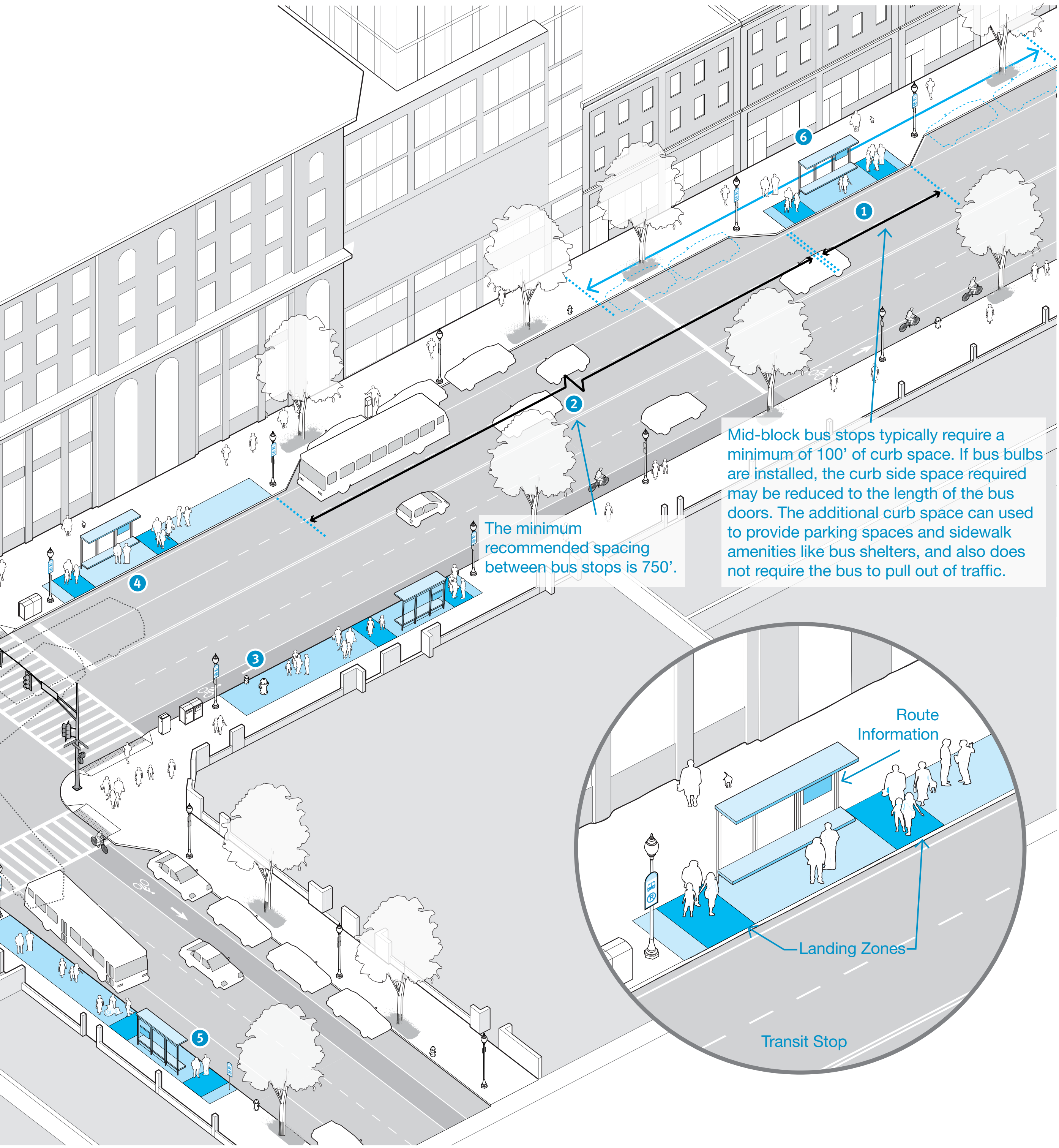
MBTA Bus Stop Lengths

	40' Bus		60' Bus	
Placement	Preferred	Minimum	Preferred	Minimum
Far-Side (3)	80'	60'	100'	80'
Near-Side (4)	100'	80'	120'	100'
Far-Side, after Left Turn (5)	130'	100'	150'	120'
Mid-block (6)	130'	100'	150'	120'

Typically, mid-block bus stops require the greatest amount of curbside space unless curb extensions are provided. Where curb extensions at bus stops are provided, also known as bus bulbs, the length of the bus stop can be less than the prescribed minimums listed below because buses will not be required to pull out of traffic. The minimum bus stop length at bus bulbs should provide a clear and level landing zone at each door of the bus (1). For more information, see Bus Bulbs later in this section.

The frequency of stops should balance passenger convenience and minimizing bus travel times. Spacing is typically determined by population density. **The minimum spacing between bus stops is 750'.**





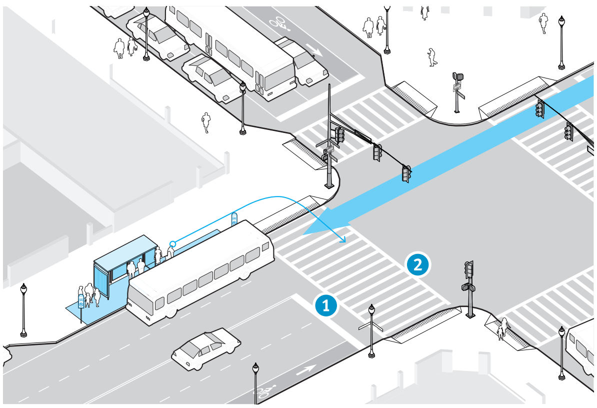
4 INTERSECTIONS

Bus Stop Location (Cont.)

Considerations

Selecting a location for a bus stop at an intersection depends on a variety of factors, such as the available curbside space, condition of sidewalks, width of sidewalks, traffic and pedestrian volumes, the number and width of travel lanes, turning movements, sight distances, and the presence of parking, bicycle facilities, and/or crosswalks.

The charts below are from the MBTA Bus Stop Planning and Design Guidelines.



Far-side Stop

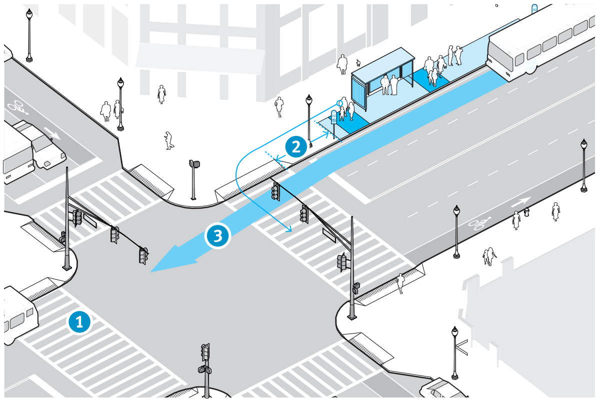
Advantages
Minimizes conflicts between buses and right turning vehicles traveling in the same direction
Provides additional right turn capacity by making curb space available
Minimizes sight distance problems on approaches to the intersection
Encourages pedestrians to cross behind the bus 1
Creates shorter deceleration distances for buses since the bus can use the intersection to decelerate 2
Bus drivers can take advantage of the gaps in traffic flow that are created at signalized intersection behind the stop

Far-side bus stop locations may:

- Reduce delays as buses do not have to wait for a green indication after loading passengers. Locating bus stops on the far-side of intersections also helps:
  - Encourage pedestrians to cross behind the bus, reduces conflicts and bus delay, and improves pedestrian safety
  - Allow buses to take advantage of gaps in traffic flow, especially with signal prioritization, rather than needing to be at the front of the queue at an intersection for a near-side stop
  - Minimize conflicts between buses and right turning vehicles, and provides additional right turn capacity on the near-side of the intersection

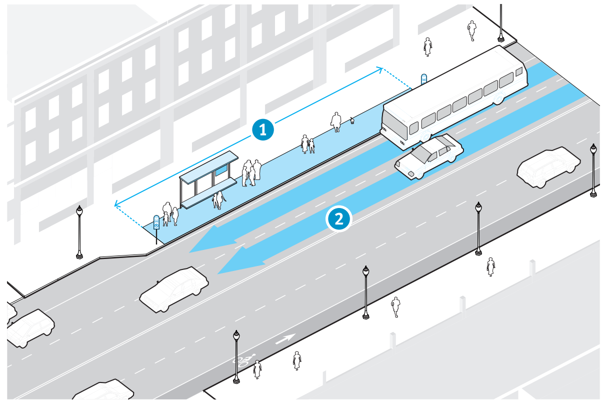
Disadvantages
May block the intersection during peak periods with queuing buses
May obscure sight distances for vehicles exiting the side street and crossing the intersection/turning left
May increase sight distance problems at the far-side of the crosswalk for crossing pedestrians
May result in traffic queued into intersection when a bus is stopped in travel lane/queuing buses
May increase number of rear-end accidents since drivers do not expect buses to stop again after stopping at a red light
Can result in the bus stopping twice, firstly for a red light and then again at the far-side stop, which interferences with both bus operations and all other traffic

Recommended Circumstances
When traffic is heavier on the near-side of an intersection
At intersections with heavy right turns on the major approach, or heavy left and through movements from the side street
When pedestrian access and existing landing area condition are better than the near-side
At intersections where traffic condition and signal patterns may cause delays
At intersections with transit signal priority treatments
At signalized intersections



Near-side Stop

Advantages
Minimizes interference when traffic is heavy on the far-side of the intersection 1
Allows passengers to board bus closest to crosswalk 2
Width of intersection is available for the bus to pull away from curb and reenter traffic 3
Eliminates the potential for double stopping/parking
Disadvantages
Increases sight distance problems for crossing pedestrians
Increases conflicts with right-turning vehicles traveling in the same direction
May result in stopped buses obscuring curbside traffic control devices and crossing pedestrians
May block the through lane during peak periods with queuing buses
Recommended Circumstances
When street crossings and other pedestrian movements are safer with the bus stop on the near-side
When traffic is heavier on the far-side of the intersection
When pedestrian access and existing landing area conditions are better than the far-side
When a bus route continues straight through an intersection or set back a reasonable distance to enable right turns



Mid-block Stop

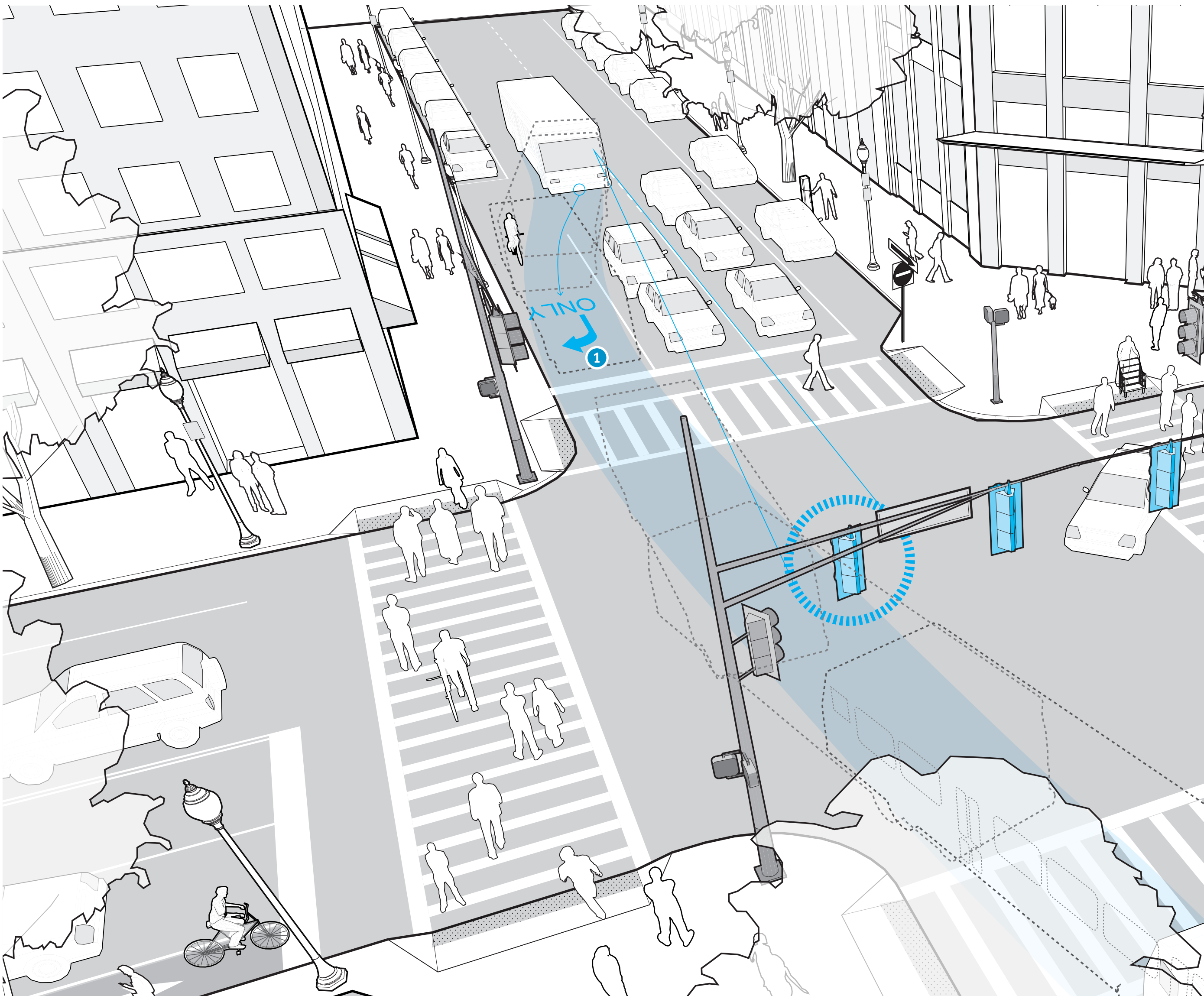
Advantages
Passenger waiting areas experience less pedestrian congestion 1
Minimizes sight distances problems for vehicles and pedestrians
May result in less interference with traffic flow 2
Disadvantages
Requires additional curb space for no-parking restriction unless bus bulb is provided
Encourages passengers to cross street at mid-block (jaywalking)
Increases walking distances for passengers crossing at intersection
Recommended Circumstances
When traffic or street/sidewalk conditions at the intersection are not conducive to a near- or far-side stop
When the passenger traffic generator is located in the middle of the block
If the distance between intersections is too far apart

Transit Prioritization at Intersections

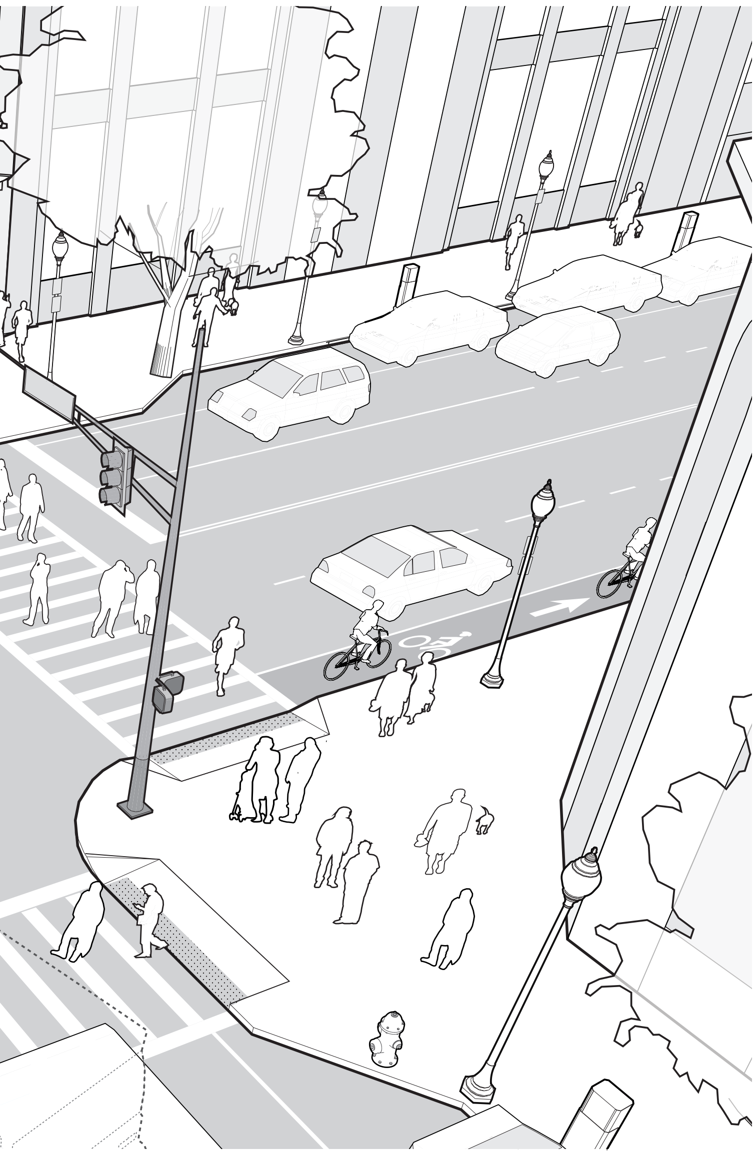
Overview

By prioritizing transit at intersections, service can become more reliable, efficient, and environmentally friendly due to less queuing and stopping and starting, thus making transit a more attractive mode of transportation. Transit prioritization strategies include signal coordination, signal priority, transit only lanes, and queue jump or bypass lanes.

The first strategy for improved traffic flow is coordinated signal timing; for more information, see Coordinated Signal Timing discussed previously in this chapter. In addition to signal coordination, transit signal priority enables transit vehicles to shorten or extend a traffic signal phase without disrupting the phase sequence or overall signal timing. Signal priority is being considered for the MBTA Key Bus Routes program.



Transit only lanes at intersections provide transit vehicles a dedicated space to bypass traffic. Queue jump or bypass lanes 1 are specially designated transit lanes at intersections that share a similar idea to the leading pedestrian interval discussed previously in this chapter. Queue jump lanes can provide an early green signal or hold a green signal for transit vehicles while other vehicles traveling in the same direction are given a red light.



Transit only and queue jump lanes must be approved by BTD, PWD, and the MBTA. All signal coordination and prioritization must be approved by BTD and the MBTA.

Use

Signal coordination can reduce delay for transit as well as motor vehicles. In addition to coordination, signal priority for transit vehicles allows transit to stay on schedule during peak hours when there is congestion. Signal priority allows delay to be reduced by extending a green for an approaching bus or shortening a red phase for a bus that is waiting. The difference in the time can be made up in the next cycle of the signal, but all other signal operations can remain intact.

Signal coordination and signal priority can be used with or without the presence of dedicated transit only lanes or queue jump and bypass lanes at intersections. Queue jump lanes can be used at intersections without a bus stop as well as with one at either the near- or far-side so long as there is enough space on the roadway.

Considerations

- Providing a queue jump lane with a leading signal phase must take into consideration the overall signal cycle lengths and impacts to delay for other users.
- If space is not available for a queue jump lane or bypass lane, consider using a right-hand turn lane to double as a bus advantage lane by allowing buses to move up in the queue at a signal where right turn on red is permitted. If right-turn lanes are used, appropriate signage such as **RIGHT LANE MUST TURN RIGHT** must be accompanied by **EXCEPT BUSES** placards.
- Transit signal priority should be considered on all priority transit routes.
- Transit signal priority studies should be conducted to understand the impact to traffic on cross streets of the transit route.
- Signal coordination should not increase delay for all modes, and take into consideration the acceleration rates and speeds of bicyclists.
- Transit agencies must address and train employees on how to handle bus and bicycle interactions in transit and bus-only lanes.
- Transit priority may be considered for late buses only in order to keep on schedule.

Bus Bulbs

Overview

Bus bulbs are curb extensions along the length of a bus stop that eliminate the need for buses to pull in and out of traffic. Similar to normal curb extensions found at intersections, bus bulbs have the same advantages of reducing crossing distances for pedestrians and providing additional space for street furniture, landscaping and pedestrian queuing.

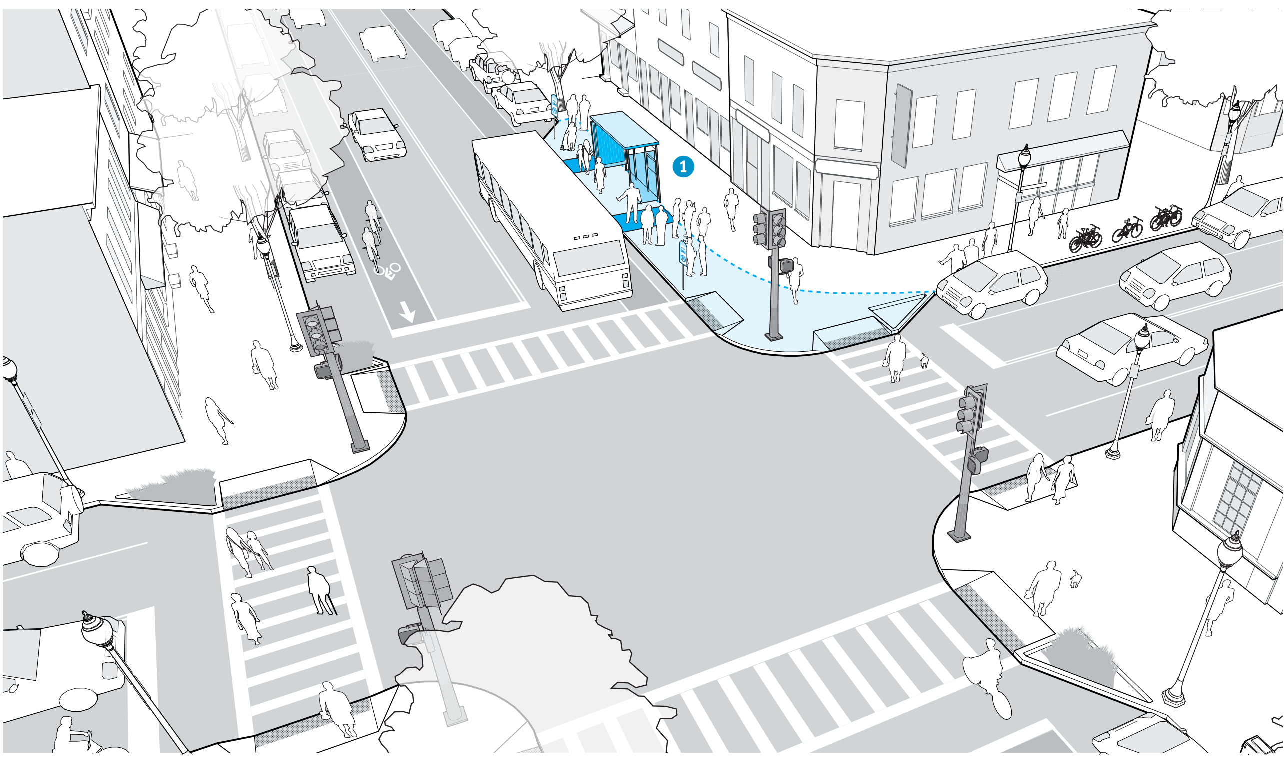
Bus bulbs will be installed on a case-by-case basis determined by an engineering study, and all designs must be approved by BTD and PWD in consultation with the MBTA.

Use

Bus bulbs are only appropriate on streets where on-street parking is present. Bus bulbs provide extra passenger queuing space (1) and are most appropriate at stops with higher passenger volumes. Bus bulbs are effective in enforcing parking restrictions within bus stops and do not require as much space as curbside stops because the bus does not need space to pull in and out of the stop, but may cause occasional traffic delay behind them.

Considerations

- ▶ Since the bus remains in the travel lane while stopped, bus bulbs can result in traffic delays or unsafe maneuvers by drivers and bicyclists to steer around buses. Designs must consider the Street Type, number of travel lanes, and headways of buses.
- ▶ Bus bulbs can interfere with right-turning vehicle movements at near-side intersections
- ▶ Bus bulbs are most effective at reducing travel time if they are utilized throughout a corridor by eliminating the need for buses to pull in and out of traffic all together.
- ▶ The MBTA operates different length buses. Bus bulbs will require different lengths depending on the service provided on the bus route. Consultation should be done with the MBTA and BTD to determine the appropriate design.



Off-Bus Fare Collection

Overview

A significant cause of delay for transit vehicles is the queuing of customers paying fare on the vehicle. In addition to promoting "smart card" fares, pre-payment is the fastest method of fare collection, and allows passengers to enter the vehicle from all doors without waiting in line to pay. Compared to an additional minute for exact fare or dip/swipe systems, off-bus fare collection can save up to a minute over 10 passengers.[§]

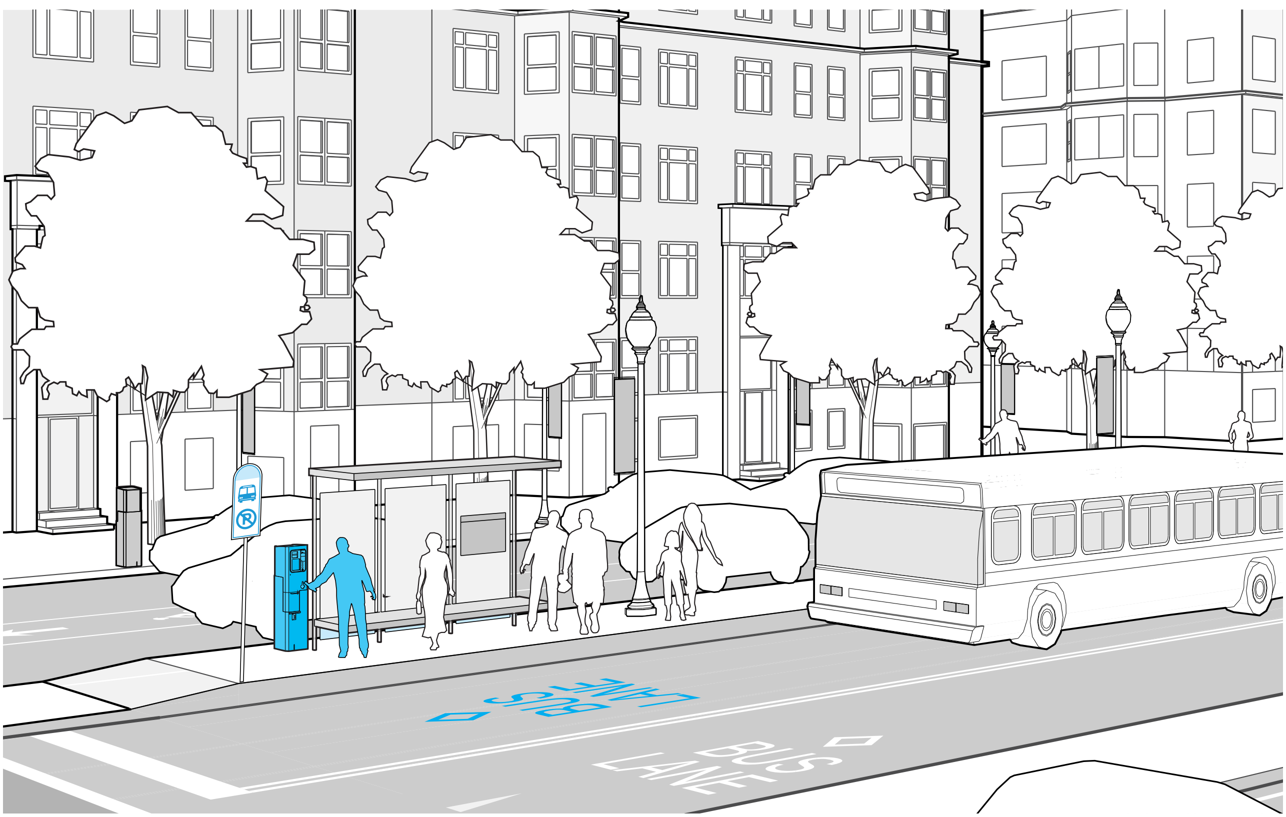
Use

- Off-bus fare collection should be used at transit stops where high ridership counts delay vehicles due to large amounts of passengers boarding.

[§] TCRP Report 90 "Bus Rapid Transit, Volume 2: Implementation Guidelines"; Transportation Research Board, Washington, D.C., 2003.

Considerations

- Off-bus fare collection requires more space and infrastructure than standard bus-stops.
- Electronic fare equipment may require staffing. If left unattended at stops, weather and compliance may become problems.
- An alternative to off-bus fare collection methods could be to have a second electronic fare collector to allow patrons with Charlie Cards to bypass cash-fare customers.
- Fare-free zones could be considered in extremely high-volume destinations.



Washington, D.C.

Bicycle Accommodations at Intersections

With the City of Boston installing over 20 miles of new bicycle facilities annually for the past several years throughout the city, providing appropriate accommodations for bicyclists at intersections has become increasingly important. Providing continuity through difficult intersections is crucial, as many of Boston's several-mile long streets, such as Dorchester Avenue and Commonwealth Avenue, have bicycle lanes traversing intersections with complicated geometries and large stretches between approaching and departing legs.

The majority of motor vehicle crashes involving bicycles occur at intersections. Good intersection design makes bicycling more comfortable and attractive, reduces conflicts with motor vehicles and pedestrians, and contributes to reduced crashes and injuries. The following principles are applied to intersection design in order to accommodate bicyclists:

- Provide a direct, continuous facility to the intersection
- Provide a clear route for bicyclists through the intersection
- Reduce and manage conflicts with turning vehicles
- Provide access to off-street destinations
- Provide signal design and timing to accommodate bicyclists based on an engineering study

Intersection improvements for bicycles should be considered during all roadway improvement projects, street redesign, and safety improvements or upgrades. Dedicated facilities, such as bicycle lanes or cycle track markings, can be extended through intersections by means of dashed lines, pavement marking symbols, and/or colorized pavement. Special intersection treatments such as cross bicycle markings and two stage queue boxes can also be provided at difficult intersections. For more information on these treatments, reference the latest edition of the NACTO Bicycle Guide. For design treatments at intersections of shared use paths and roadways, consult the latest edition of the AASHTO "Bike Guide" and the MUTCD.

Guidance on different types of bicycle facilities, such as bicycle lanes and cycle tracks, beyond intersection design, is covered in Chapter 3: Roadways.

Bicycle facility designs must be approved by BTD and Boston Bikes. Additional guidance for the design of bicycle facilities can be found in the MUTCD, the NACTO Urban Street and Bikeway Design Guides, and the AASHTO "Bike Guide."

Bicycle Lanes at Intersections

Overview

The approaches of an intersection are important aspects to designing bicycle-friendly intersections. The approaches should maintain continuity of bicycle facilities to the maximum extent possible.

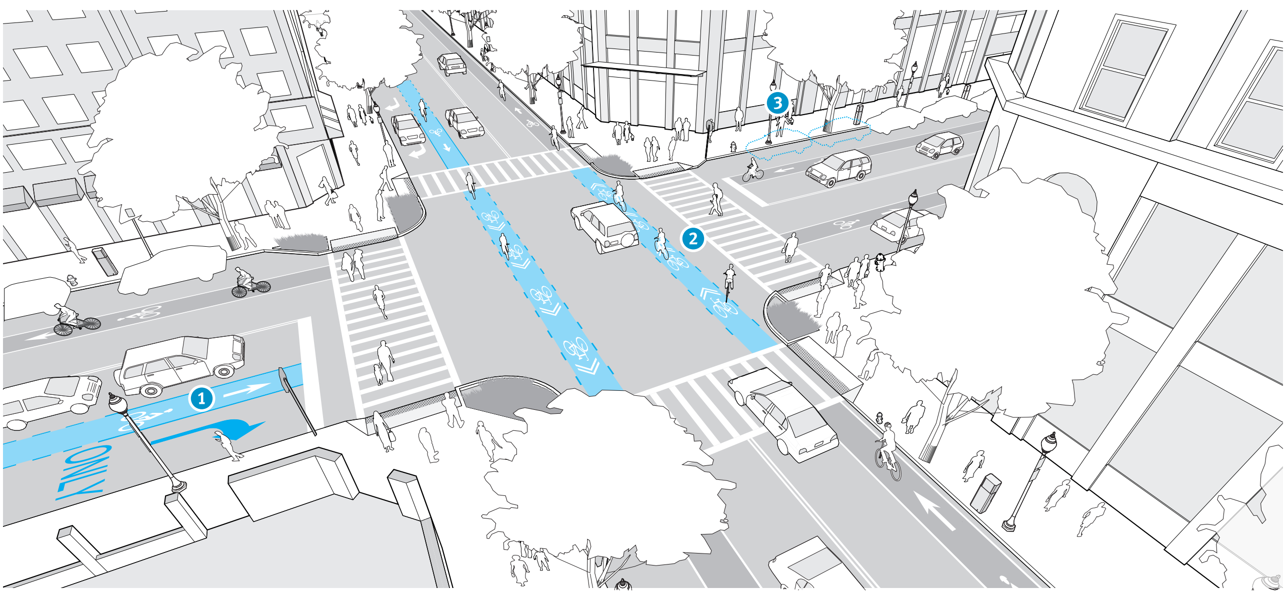
On streets with dedicated bicycle lanes, the City of Boston's policy is for bicycle lanes to be striped through unsignalized and complicated intersections to provide additional guidance and safety measures for bicyclists. This design principle is especially important at intersections where there are conflicting vehicular movements, unsignalized crossings, and/or crossings of more than four moving traffic lanes. Shared lane markings should be supplemented by dashed lines at crossings where bicycles may not be anticipated, such as in contra-flow bicycle lanes or cycle tracks. Signalized intersections may not require striping through each intersection, and should be evaluated on a case-by-case basis.

Use

- Standard details for bicycle lane markings at intersections are provided in the MUTCD and AASHTO "Bike Guide." Additional guidance can also be found in the NACTO Urban Bikeway Design Guide.
- Dedicated bicycle lanes should be provided on all major intersection approaches where space is available.
- At intersections with a dedicated right turn lane (1), bicycle lanes should be provided to the left of the right turn only lane unless bicycle signals and dedicated phasing is provided.

Considerations

- Bicycle lane markings, including green-colored pavement, shared lane markings, dashed bicycle lane lines, and signage (2) may be provided through intersections per engineering judgment.
- Selective removal of parking spaces (3) may be needed to provide adequate visibility and to establish sufficient bicycle lane width at approaches to intersections.
- Shared lane markings may be used where space is not available for bicycle lanes at intersections.
- Although the **minimum recommended width of a bicycle lane is 5', 4' bicycle lanes may be considered** at constrained intersections with lower speeds in order to provide a dedicated space for bicyclists.
- Bicycle lanes at the entrance and exit of a circular intersection should allow direct access to a shared use bicycle/pedestrian path around the perimeter of the intersection via curb ramps; ramps should be provided for bicyclists to mount the sidewalk prior to the intersection. Designs should also enable bicyclists to mix with traffic and proceed through the intersection.



Bicycles at Signalized Intersections

Overview

Bicycles have different operating characteristic than motor vehicles, and special consideration is necessary in designing traffic signals that accommodate both motorists and bicyclists. In general, bicyclists have slower acceleration and velocity rates than motorists 1; to offset this disadvantage, traffic signal design should include consideration of minimum green intervals, clearance time, and extension time to ensure that bicyclists can safely cross intersections. Signal progression should be designed in order to balance the needs of all users, with appropriate design speeds and traffic signal coordination settings. Appropriate signal timing also can reduce delay, discourage bicyclists from running red lights, and help minimize conflicts.

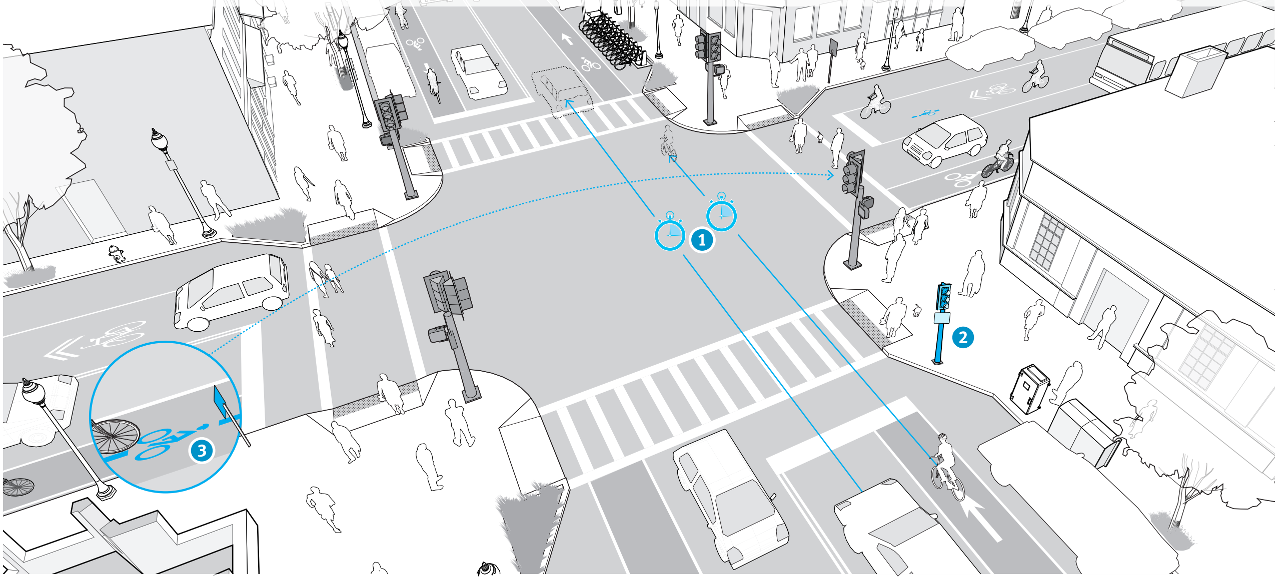
All signal design and timing must be approved by BTD in consultation with Boston Bikes.

Use

- Where actuated signals are present, the signal system should automatically detect bicycles as well as motor vehicles. Typically, the City of Boston uses loop detectors at actuated or semi-actuated intersections. In order for bicyclists to prompt the green phase at these intersections, bicycle detection devices should be installed.
- Detection devices should be located within bicycle lanes or bicycle boxes, marked with a bicycle detector symbol, and supplemented by appropriate signage 3.
- When it is not feasible for the detection device to be located within the bicycle lane or bicycle box, detection devices should be located prior to the stop bar and span an appropriate distance to provide for left, through, and right turning bicyclists.
- Bicycle signal heads should be considered to separate conflicting movements, such as bicyclists traveling straight conflicting with turning motor vehicles, or to accommodate an exclusive left turn phase, such as via a "jughandle" layout. Jughandle movements are where bicyclists turn right onto a jughandle shaped ramp, and then turn left.

Considerations

- Reference the latest edition of the AASHTO "Bike Guide" and the NACTO Urban Bikeway Guide for more details on the signal timing needs of bicycles at intersections.
- Special attention should be given to signal timing at locations with higher vehicular speeds and longer crossing distances; at these locations, bicyclists are more likely to have different signal timing needs than motorists.
- Bicycle signal heads 2 provide dedicated signal indications to bicyclists and should be positioned to maximize visibility to bicycle traffic. They should be coordinated with pedestrian and non-conflicting vehicular movements to increase safety and minimize overall delay. Bicycle signal heads will be installed on a case-by-case basis determined by an engineering study and must be approved by BTD.



Bicycle Boxes

Overview

A bicycle box is dedicated space located between the cross-walk, and the motor vehicle stop line used to provide bicyclists a dedicated space to wait during the red light at signalized intersections. Placing bicyclists ahead of stopped vehicular traffic (1) at a red light improves visibility and reduces conflicts among all users. They also provide bicyclists a head start to get through the intersection, which aids in bicyclists making difficult turning movements and improves safety and comfort due to the difference in acceleration rates between bicycles and motor vehicles. Bicycle boxes also provide more space for multiple bicyclists to wait at a red light as opposed to being constrained to a 5’ wide bicycle lane. In all cases, the bicycle box allows a bicyclist to be in front of motor vehicles, which not only improves visibility and motorists awareness, but allows bicyclists to “claim the lane” if desired.

In Boston, the first bicycle boxes were installed on Commonwealth Avenue in Back Bay. Bicycle boxes should be considered for every bicycle facility improvement project.

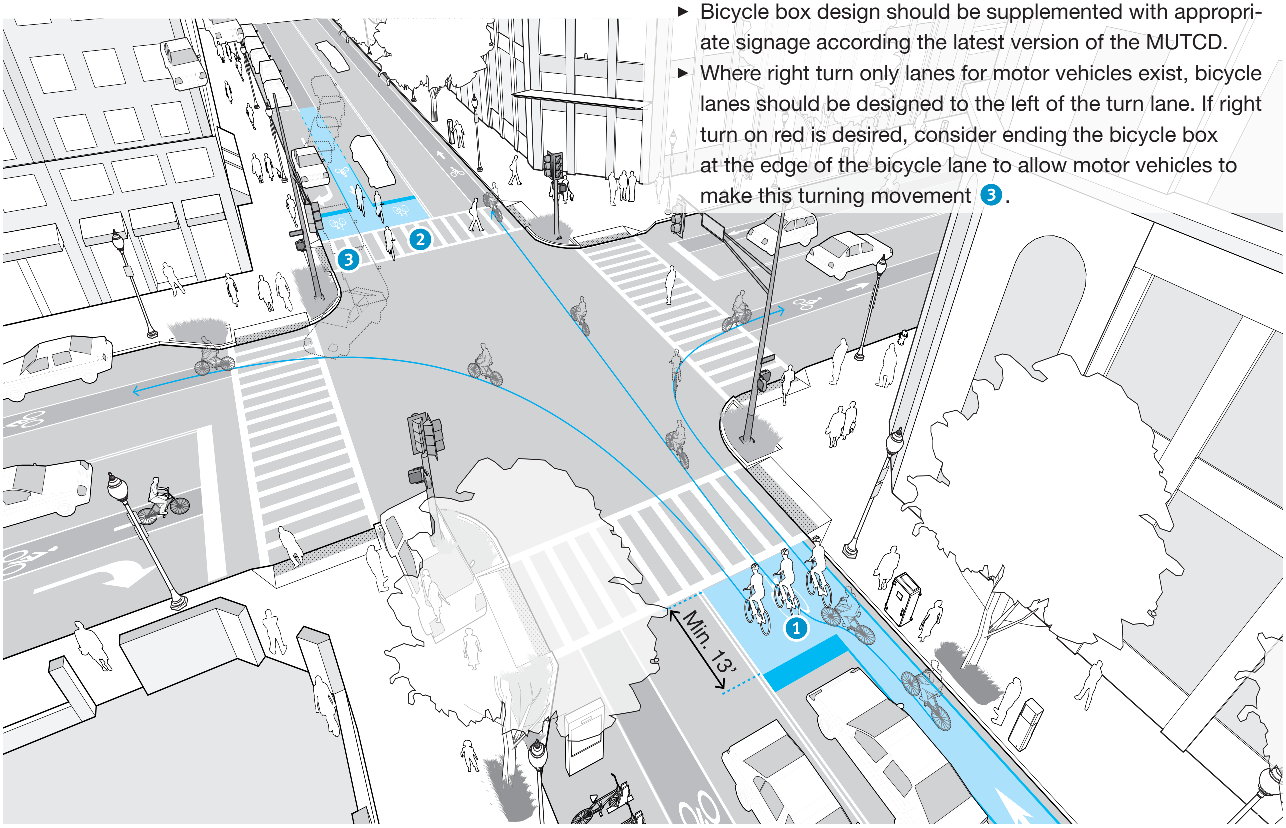
Use

In locations with high volumes of turning movements by bicyclists, a bicycle box should be used to allow bicyclist to shift towards the desired side of the travel way. Depending on the context of the bicycle lane, left or right side, bicyclists can shift sides of the street to align themselves with vehicles making the same movement through the intersection.

In locations where motor vehicles can continue straight, or turn right crossing a right side bicycle lane (2), the bicycle box allows bicyclists to move to the front of the traffic queue and make their movement first, minimizing conflicts between the right turning motorist and the bicyclist. Where designs place bicycle boxes in front of a vehicle lane that may turn right on red, **NO TURN ON RED** signs must be provided.

Considerations

- In the City of Boston bicycle boxes are typically painted green, and are **a minimum of 13’ in depth.**
- Bicycle box design should be supplemented with appropri-ate signage according the latest version of the MUTCD.
- Where right turn only lanes for motor vehicles exist, bicycle lanes should be designed to the left of the turn lane. If right turn on red is desired, consider ending the bicycle box at the edge of the bicycle lane to allow motor vehicles to make this turning movement (3).



Cycle Tracks at Intersections

Overview

Cycle tracks are protected bicycle facilities physically separated from adjacent travel lanes through a variety of measures, including a parking lane, grade separation, medians, or flex posts. This separation may increase comfort for bicyclists, however, at intersections, cycle track designs must manage conflicts with turning vehicles, and increase visibility for all users.

Use

Increasing visibility and awareness are two key design goals for cycle tracks at intersections. **Parking restrictions between 20’ to 40’ minimum** should be provided at the near and far-side of intersections 1, however additional space may be needed based on sight distance calculations.

If possible, cycle tracks should be routed behind transit stops 2 (i.e., the transit stop should be between the cycle track and motor vehicle travel lanes). If this is not feasible, the cycle track should be designed to include treatments such as signage and pavement markings to alert the bicyclist to stop for buses and pedestrians accessing transit stops. Cycle track designs often involve relocating transit stops to the far-side of the intersection 3 to reduce conflicts.

Cycle tracks should be given priority at low-volume intersections, through the use of markings and signage.

Considerations

- Cycle track designs at intersections must give consideration to signal operation and phasing in order to manage conflicts between turning vehicles and bicyclists. Bicycle signal heads 4 should be considered in order to separate conflicts.
- Left turning bicycle movements may require specific accommodations including bicycle signals for “jughandle” movements 5. Jughandle movements are where bicyclists turn right in a jughandle shape, either onto a ramp or a side street, and then turn left.
- Shared lane markings and/or colored pavement can supplement short dashed lines through intersections where engineering judgment deems appropriate.
- At non-signalized intersections, design treatments to increase visibility and safety include:
  - Warning signs
  - Raised intersections
  - Special pavement markings (including green surface treatment)
  - Removal of parking prior to the intersection
- Consider narrowing cycle tracks at intersections to slow bicycle traffic. Another option is to remove the separation prior to the intersection and provide standard bicycle lanes with bicycle boxes where appropriate to raise awareness and increase visibility.