



STREET TYPOLOGY								
UC	E/F	MS	NB	CB	CC	NN	EN	LN
Opt.	Opt.	Opt.	Opt.	Opt.	Opt.	Opt.	Opt.	N/A

BICYCLE INTERSECTIONS

BICYCLE BOXES

DESCRIPTION & INTENT

A bicycle box (or bike box) is a dedicated area at the front of a traffic lane at a signalized intersection, which cyclists can maneuver within while waiting at the light in order to position themselves ahead of vehicles and in a proper position to turn.

Bike boxes make cyclists more visible to drivers by positioning them at the head of a queue during a stop cycle. They provide a space for cyclists to queue outside of crosswalk areas. Bike boxes enable cyclists to safely position for a left turn during a stop cycle at an intersection.

In corridors of high bicycle activity, bike boxes cluster multiple cyclists and enable them to progress forward at the onset of the green signal cycle. This clears a bicycle lane more quickly allowing for a sooner progression of right turning vehicles. Bike boxes can improve safety by reducing or eliminating the need for bicycles to weave across travel lanes to make a left turn and reducing conflicts with right turning vehicles, “right hooks.”

USE & APPLICATION

Location

- Bike boxes are used only at signalized intersections.
- Bike boxes are most beneficial on streets with high bicycle volumes (five or more in queue during peak hours), locations with significant left turn bicycle activity, and/or intersections where conflicts between right turning vehicles and bicycles are common.

- Bike boxes may be appropriate in any street type but generally should be reserved for areas where high bicycle activity is anticipated or desired, such as on bicycle emphasis streets.
- Bike boxes may also be desirable in high pedestrian zone areas to protect crosswalks from encroachment by bicycles or vehicles.
- While relatively logical, straightforward and easy to use, education and outreach to motorists, cyclists and pedestrians may be necessary to ensure their safe and appropriate use.

Related Design Elements

- **Right on Red:** Bike boxes must be used in conjunction with “No Right Turn on Red” (and “No Left Turn on Red”) restrictions. This limitation must be considered when determining appropriate locations for the use of bike boxes.

DESIGN & OPERATIONS

Design Requirements

- A Box Size:** The bike box is formed by two parallel pavement marking lines at least 6 inches wide forming a box at least 10-feet or more in depth and extending from the outside of the bicycle lane across all travel lanes in the direction of travel ⁽¹⁾.
 - » Green paint should be used to raise the visibility of the bike box.
- **Placement:** Bike boxes are located between the crosswalk and the vehicle stop bar.

- B** The vehicle stop bar is placed at the rear of the bike box. Vehicle stop bars may be moved back up to an additional 7-feet to provide additional clear space at intersections where there are high volumes of bicycle traffic.
- C** Bike boxes should be set back at least 1-foot from the nearest edge of a crosswalk, but can be setback further to create more separation and prevent cyclists from blocking the crosswalk.
- D Bicycle Markings:** Bicycle symbol pavement markings are located within the bike box in all lanes which it extends.
 - **No Right Turn on Red:** Right turn on red shall be prohibited where bike boxes are used and shall be signed accordingly.
 - **Signage:** To manage the stop positioning for vehicles, use a “STOP HERE ON RED” sign accompanied by an “EXCEPT FOR BICYCLES” sign ⁽¹⁾.

Additional Design Considerations

- E** “Wait Here” pavement marking or signs may be used to reinforce the proper stopping location for vehicles and to avoid encroachment on the bike box.
- **Special Pavement Markings:** Green pavement markings is commonly used in bike boxes but is not required.

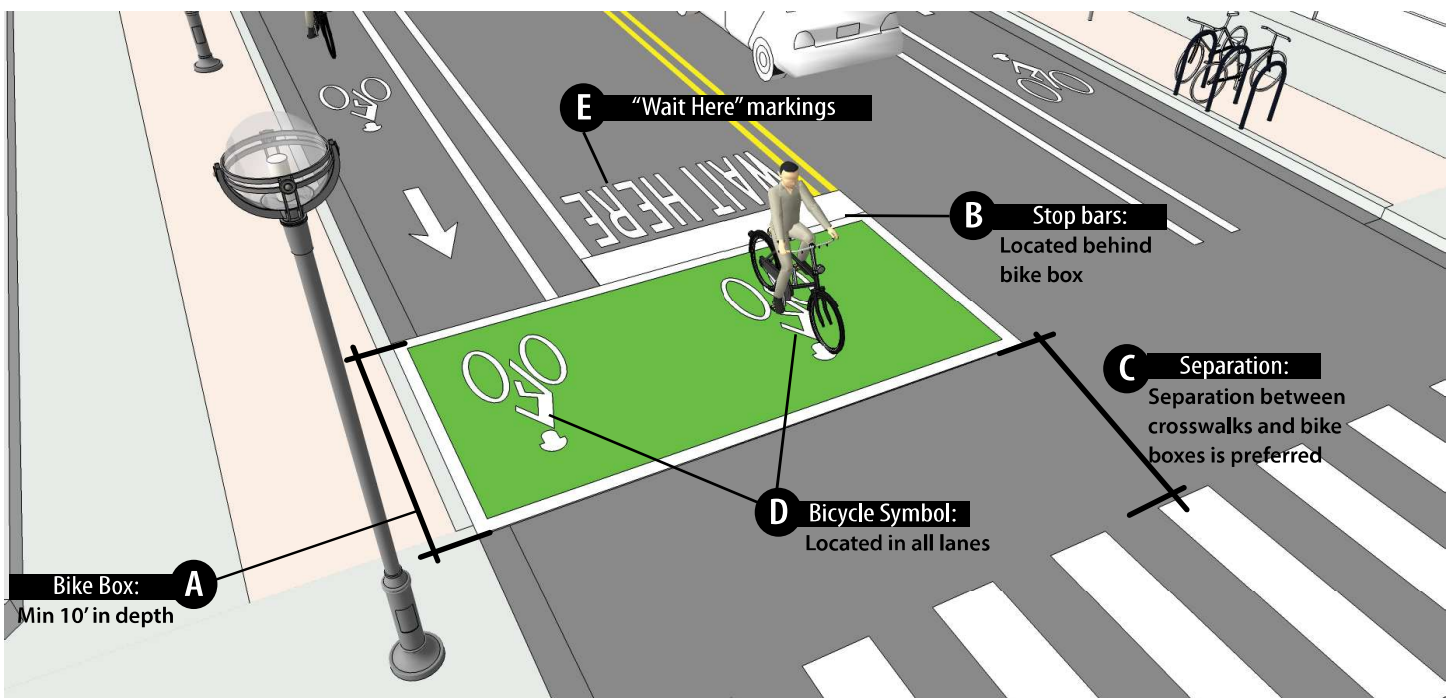
- **Bike Boxes without Bicycle Lanes:** When bicycle lanes are not present, bike boxes can still be used by providing a short ingress bicycle lane to provide bicycles access to the bike box as they approach the intersection.

Design References

- Bike boxes are currently authorized for use as an Interim Approval by FHWA. See MUTCD document IA-18 for approval information and design guidance.
- The NACTO Urban Bikeway Design Guide provides further guidance on the use and design of bike boxes.

MAINTENANCE & MANAGEMENT

- See *Bicycle Facility* section for overall guidance on maintenance of bicycle facilities.





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BICYCLE INTERSECTIONS

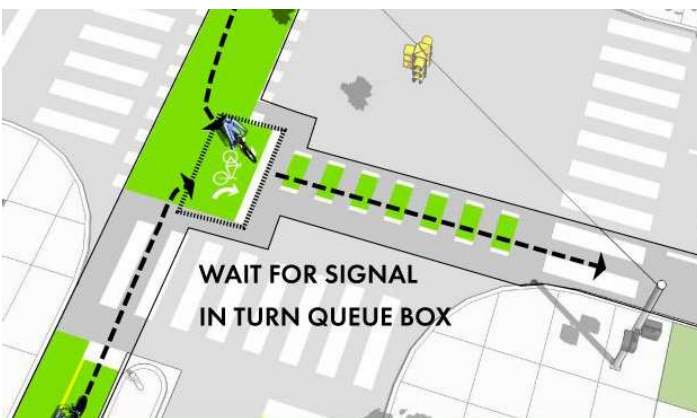
TWO-STAGE TURN BOX

DESCRIPTION & INTENT

Two-stage turn boxes (also called two-stage turn queue boxes or simply “turn boxes”) provides a mechanism for cyclists to make turning movements through an intersection, especially left turns, in ways that reduce the need to mix with turning or cross vehicle traffic within an intersection.

Two-stage turn boxes work by creating a designed waiting or queuing space outside of the flows of traffic (including bicycle lanes) where cyclists can wait for a signal change. When the signal changes, cyclists are already positioned ahead of vehicle traffic in a visible location where they can complete their turning movement.

Two-stage turn queues reduce bicycle/vehicle conflicts and provide a less stressful turn option for users. While two-stage turn queues increase bicycle comfort, they do require two separate stages to complete a left turn (first proceeding across, then proceeding through to the left). This may increase travel time for cyclists, although the benefit of comfort typically outweighs the time penalty.



Even where two-stage turn boxes are provided, their use is optional. Cyclists may still lawfully complete a left turn from the left most travel lane where vehicular left turns are permitted.

USE & APPLICATION

Location

- **Usage:** Two-stage turn boxes should be utilized alongside other dedicated bicycle facilities as part of their design. Where low stress facilities are implemented (e.g. separated bicycle lanes in the downtown environment) two-stage turn boxes are an essential component of the overall facility design.
- Two-stage turn queues are especially beneficial on multi-lane streets, where cyclists would otherwise need to cross over multiple lanes of traffic in order to make a left turn.

Related Design Elements

- **Two-way Separated Bikeways:** Two-way separated bikeways create some additional complexity in managing how cyclists enter or exit the bikeway, depending on direction of travel. Turn boxes may also be needed to accommodate certain right turn movements.
- **No Turn on Red:** Two-stage turn boxes should be used in conjunction with No Turn on Red to prevent stopped vehicles from turning right on red across the turn box where cyclists may be waiting.

DESIGN & OPERATIONS

Design Requirements

- A Turn Box Position:** The turn box should be positioned between the crosswalk and nearest edge of the crossing bicycle lane or travel lane (whichever is closest). This ensures that the turn is box out of the flow of crossing traffic.
- B Turn Box Size - Depth:** The two-stage turn box must be at least 6-feet deep, measured from the nearest edge of the crossing bicycle or travel lane. The turn box should be further deepened as space allows
- **Turn Box Size - Width:** The turn box should be at least 6-feet wide (oriented in the direction of the second stage of movement). Preferably, it should be as wide as the travel lanes behind the turn box where bicycle movements are desired (e.g. 10-feet wide to the match the travel lane width).
- **Pavement Markings:** The turn box must be painted green, with a 6-inch white border around it. The departing edge of the turn box must have a 12-inch wide stop bar.
 - » Inside the turn box, a bicycle symbol and turn arrow must be provided, indicating the receiving and departing direction for bicycle movements.

- » At complex intersections, such as those with two-way separated bikeways, a single turn box may combine multiple flows of turning movements.

Additional Design Considerations

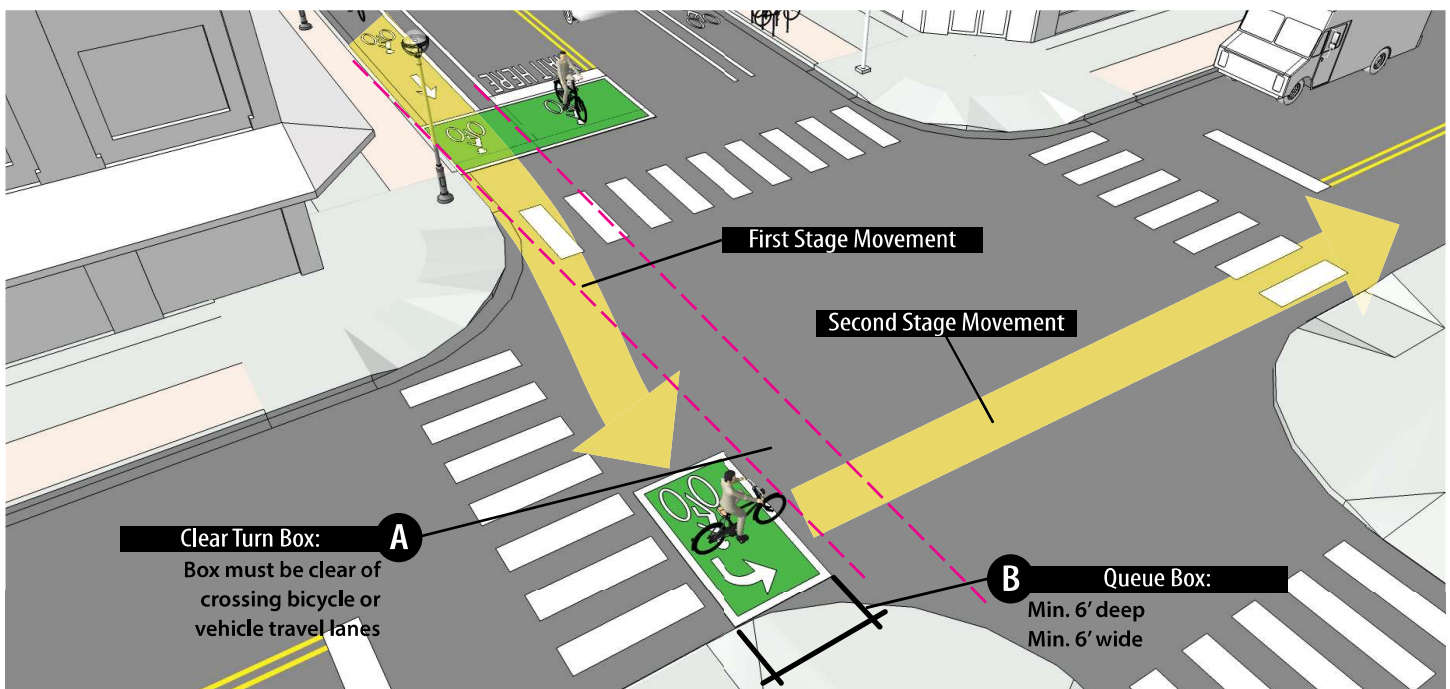
- **Crosswalks and Bike Boxes:** Under constrained circumstances, crosswalks may be adapted to enable space for bicycle queuing. Alternatively a standard bike box (see [Bicycle Boxes](#)) may be used; this, however, requires cyclists to cross the pedestrian line of travel and should only be used where pedestrian volumes are low.

Design References

- Two-stage turn queue boxes are currently authorized for use as an Interim Approval by FHWA. See MUTCD document IA-20 for approval information and design guidance.
- The NACTO Urban Bikeway Design Guide provides further guidance on the use and design of turn queue boxes.

MAINTENANCE & MANAGEMENT

- See [Bicycle Facility](#) section for overall guidance on maintenance of bicycle facilities.





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BICYCLE INTERSECTIONS

PROTECTED INTERSECTIONS

DESCRIPTION & INTENT

Protected intersections are special corner treatments that create waiting and queuing space for cyclists behind raised curb islands. This treatment helps extend protections provided by separated bicycle lanes into the intersection area, although they may also be used with other bicycle facilities.

Protected intersections guide cyclists to more controlled and demarcated crossing points. The corner geometry changes can also be designed to reduce turning speeds for motor vehicles, but must still accommodate designated design vehicles.

USE & APPLICATION

Location

- Protected intersections should be considered as part of the design for low stress bicycle routes, especially at intersections where buffered or separated bicycle lanes are used.
- Protected intersections are especially beneficial at larger intersections, multi-lane intersections, and/or locations with wider rights-of-way, such as on urban center, commercial business, city connector, and network neighborhood streets types.

Related Design Elements

- **Corner Geometry:** Protected intersections function similar to bumpouts, except that they extend further into the intersection zone. Turning radii for vehicles must consider the intended design vehicle on the street and ensure that vehicle movements are accommodated.
- **Bumpouts:** Protected intersections work well alongside bumpouts, and typically require the additional depth provided by bumpouts to create the waiting space for cyclists (see [Design Diagram](#) on the next page).

DESIGN & OPERATIONS

Design Requirements

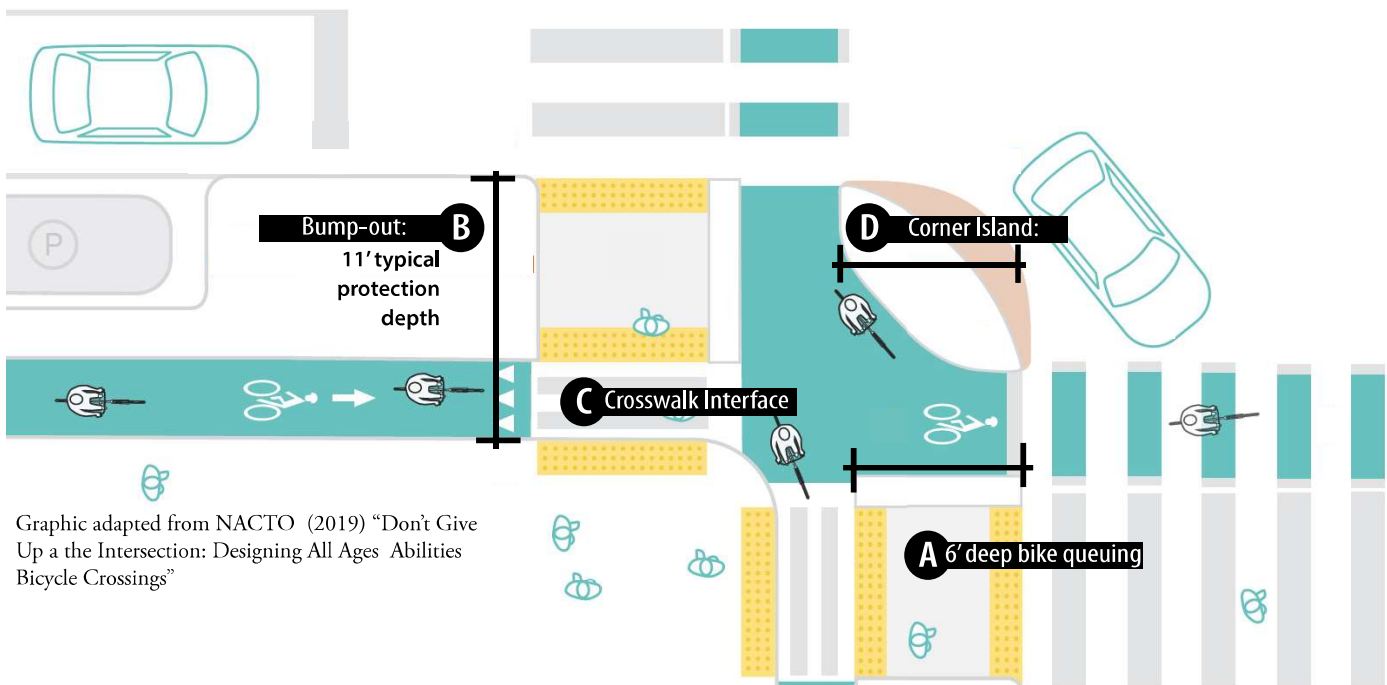
- A Bicycle Queuing Area:** The bicycle queuing area should be at least 6-feet deep to provide space for cyclists to wait and be clear from cross traffic. This also provides adequate width for a pedestrian waiting zone between the roadway curb and bicycle lanes.
- B Protection Depth:** The overall depth will depend on the queuing depth plus the width of the incoming bicycle lane. This should be a minimum of 11-feet (6-feet for the bicycle queuing area plus 5-feet for the bicycle lane width).
 - » It may be necessary to shift the approaching bikeway towards the sidewalk (reducing the amenity zone width) in order to achieve the necessary width.
- C Crosswalk Interface:** Approaching bicycle lanes should use yield markings and signage ahead of pedestrian crosswalks. Crosswalks should use detectable warning pavement flanking the bicycle lane crossing and at the normal edge of the roadway.
- D Corner Island:** The corner island should be designed to accommodate the roadway design vehicle based on an appropriate effective turning radius. Where larger vehicles must be accommodated, use a mountable apron adjacent to the curb to accommodate larger turning radii.

Design References

- Don't Give Up at the Intersection (NACTO, 2019) provides detailed guidance on the design of protected intersections and corners.

MAINTENANCE & MANAGEMENT

- See *Bicycle Facility* section for overall guidance on maintenance of bicycle facilities.



Graphic adapted from NACTO (2019) "Don't Give Up at the Intersection: Designing All Ages Abilities Bicycle Crossings"



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BICYCLE INTERSECTION

BICYCLE SIGNALS

DESCRIPTION & INTENT

Bicycle signals are separate traffic signals used to guide and direct cyclists at intersections. Dedicated bicycle signals enable more complex and controlled timing at complex intersections, allowing for dedicated bicycle turning phases and/or allowing for concurrent bicycle travel with other roadway users. Bicycle signals are designed to reduce conflicts by separating bicycle and motor vehicle movements.

At present, there are no nationally established thresholds or warrants for bicycle signals.

USE & APPLICATION

Location

Bicycle signals are used only at signalized intersections and when bicycle-only and/or leading bicycle intervals are required during a signal cycle. The situations below may suggest the use of a bicycle signal:

- Where bicycle and pedestrian volumes are sufficiently high that a bicycle leading interval would be advantageous to safety and/or operations.
- At intersections with separated bicycle lanes where the volumes of vehicle turning movement counts exceed those listed in the chart below, bicycle signals and phase separation should be considered.

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

Source: MassDOT Separated Bicycle Lane Planning & Design Guide (Chapter 6, Signals) ⁽¹⁾.

- Where two-way separated bicycle lanes are used, intersections are geometrically complex, and other intersection controls are not desired.
- As an alternative to bicycle signals, “BIKES USE PED SIGNAL” signage may be used where the need for phase separation is reduced. In these cases, it is important that the geometrics of the bicycle lanes be close to crosswalk and visible to pedestrian signal.
 - » If this treatment is used, it should be combined with leading pedestrian intervals (LPIs) to allow cyclists to enter intersections ahead of vehicles and be more visible.

Related Design Elements

- Bicycle signals shall not be used in conjunction with sharrows.
- Bicycle signals and their associated stop zone should not impede the sidewalk or crosswalk zones.
- Bicycle signals may necessitate prohibition of right on red.

DESIGN & OPERATIONS

Design Requirements

- **Orient signal heads** to be clearly visible to on coming cyclists.
- **Signal Activation:** Automatic detection is preferred. If manual activation is required, push buttons shall be located where cyclists can easily access them without leaving the bicycle facility. If the bicycle signal is not programmed into each light cycle, actuate bicycle signal manually (e.g. push-button) or automatically (e.g. in-pavement loop detector or video detection).
- **Bicycle Symbol Face:** Use of the bicycle symbol face inside of the signal head requires obtaining FHWA interim approval. Alternatively, solid color signal faces may be used in conjunction with a sign next to the signal indicated that it is a “BICYCLE SIGNAL.”

Additional Design Considerations

- **Right Turn On Red:** If the bicycle signal separates bicycle movements from motor vehicle turning movements, right turn on red should be prohibited.
- **Signage:** Bicycle signals may be accompanied by unique signage targeted at the cyclist to explain the function and use of the signal. This is particularly valuable if bicycle signals are uncommon or if the movement governed by the signal is unique to bicycles.
- **Signal Timing:** The introduction of bicycle signals may require overall signal re-timing and periodic timing reassessment. There is no specific established guidance at present as to bicycle clearance intervals or other phasing.

Design References

- MassDOT Separated Bike Lane Planning & Design Guide (Chapter 6, Signals).
- The FHWA has provided interim approval for the optional use of a bicycle signal face (December 2013).
- The NACTO Urban Bikeway Design Guide provides additional guidance on the use and design of bicycle signals.
- MMUTCD provides standards for traditional traffic signals, however not all guidance may be applicable specifically to bicycle signals.

MAINTENANCE & MANAGEMENT

- Bicycle signals will require additional infrastructure and maintenance and long-term maintenance will be the same as other signalized intersections.