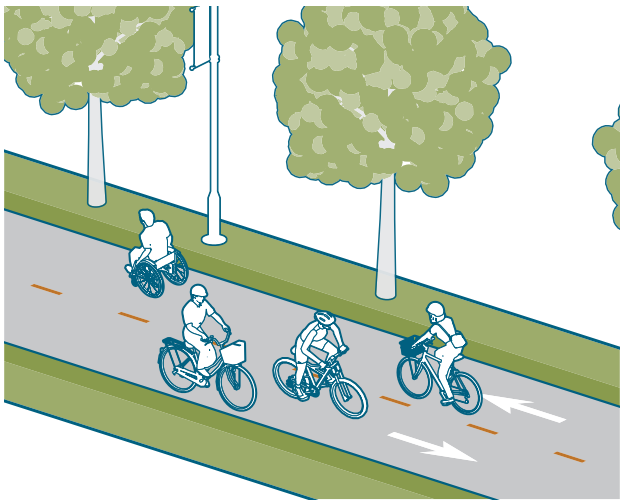
DRAFT Montgomery County Bicycle Master Plan Design Toolkit

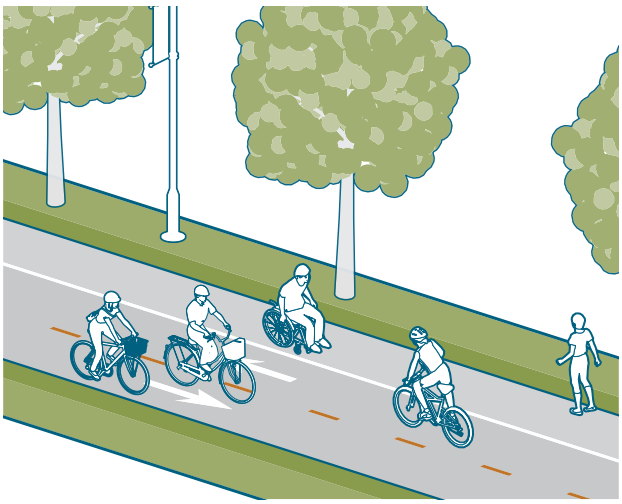
Fall 2016

Sidepaths

Sidepaths are shared use paths located parallel to and within the road right-of-way providing two-way travel for walking, bicycling, jogging and skating.



Sidepath with mixed use



Sidepath with separate uses

Typical Application

- Sidepaths will be considered on any road with one or more of the following characteristics:
  - Total traffic lanes: 3 lanes or greater.
  - Posted speed limit: 30 mph or more.
  - Average Daily Traffic: 6,000 vehicles or greater.
  - Parking turnover: frequent.
  - Bike lane obstruction: likely to be frequent.
  - Designated as truck or bus routes.
- Sidepaths may be preferable to separated bike lanes where low pedestrian volumes are anticipated.

Guidance

- A minimum of 2 ft graded area with clearance from lateral obstructions, such as bushes, large rocks, bridge piers, abutments, and poles.
- A minimum 1 ft clearance from "smooth" features, such as bicycle railings or fences with appropriate flaring and treatments.
- Ideally a graded shoulder area of 3 - 5 ft.

Considerations

Sidepaths are attractive to a wider range of bicyclists compared to striped bikeways. In low-density areas with low levels of pedestrian use, they can minimize right-of-way impacts.

Sidepaths design requires:

- High-quality construction and maintenance that avoids pavement cracking and buckling.
- Intuitive and safe intersection crossings.
- Separation between pedestrians and bicyclists in areas with higher levels of activity, including a 10 ft (min) bikeway and a 5 ft (min) walkway.
- Adequate widths to enable side-by-side travel and passing, typically at least 11 ft wide.
- Appropriate buffers from traffic, 5 ft minimum.
- Straight alignments to allow higher speed, and direct travel.
- Removal of poles, trees or other obstructions that are present in many existing sidepath locations.
- Direct and seamless connections to destinations and other bikeways.
- Lighting.

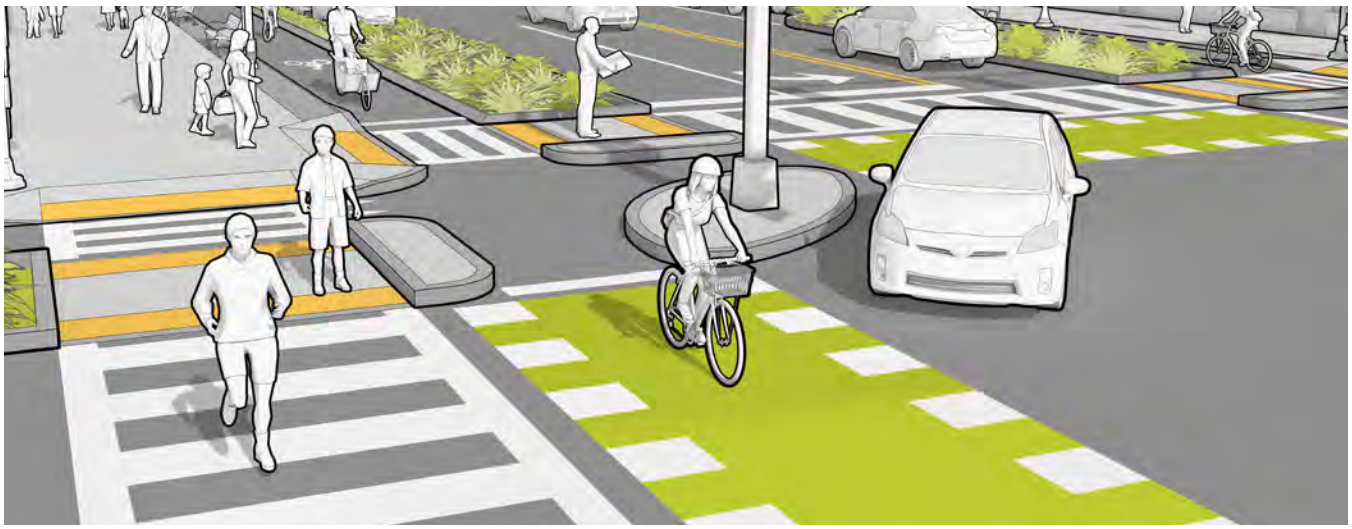
REFERENCES

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

AASHTO. Guide for the Development of Bicycle Facilities. 2012.

Separated Bike Lanes

Separated bike lanes (SBLs) are an exclusive bikeway that combines the user experience of a side-path with the on-street infrastructure of a conventional bike lane. They are physically separated from motor vehicle traffic and distinct from the sidewalk.



Typical Application

Considered on any road with one or more of the following characteristics:

- Total traffic lanes: 3 lanes or greater.
- Posted speed limit: 30 mph or higher.
- Average Daily Traffic: 6,000 vehicles or greater.
- Parking turnover: frequent.
- Bike lane obstruction: likely to be frequent.
- Streets that are designated as truck or bus routes.

Preferred in higher density areas, adjacent to commercial and mixed-use development, and near major transit stations or locations where observed or anticipated pedestrian volumes will be higher.

Guidance

Separated bike lanes can provide different levels of separation:

- Flexible delineator posts ("flexposts") offer the least separation and are appropriate as an interim solution.
- Raised buffers provide the greatest level of separation from traffic, but will often require road reconstruction.
- On-street parking offers a high-degree of separation, but may require raised buffer treatments at intersections.

Considerations

- More attractive to a wider range of bicyclists than striped bikeways on higher volume and higher speed roads.
- Eliminate risk of a bicyclist being hit by an opening car door.
- Prevent motor vehicles from driving, stopping or waiting in the bikeway.
- Provide greater comfort to pedestrians by separating them from bicyclists.

REFERENCES

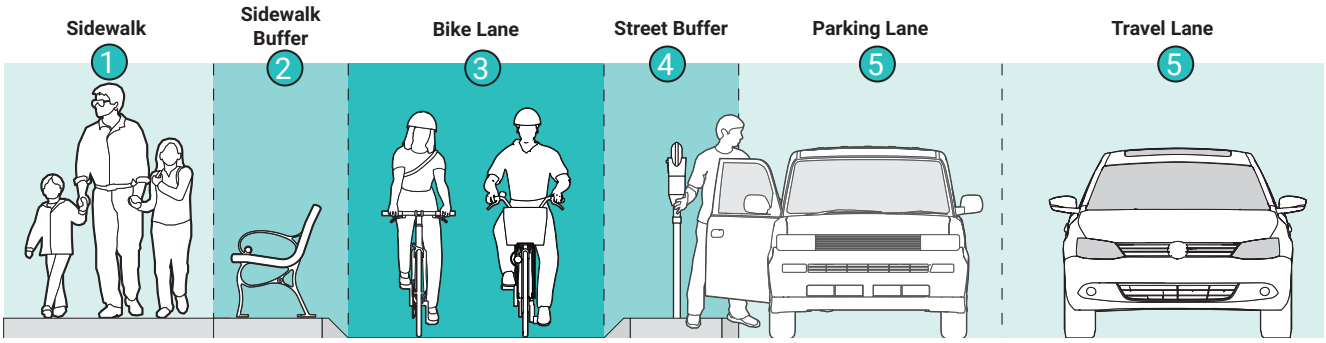
MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

NACTO. Urban Bikeway Design Guide. 2nd Edition.

Separated Bike Lane Zones

The cross section of a separated bike lane is composed of three separate zones:

- **Bike lane: the bicyclist operating space between the street buffer and the sidewalk buffer.**
- **Street buffer: the street buffer separates the bike lane from motor vehicle traffic.**
- **Sidewalk buffer: the sidewalk buffer separates the bike lane from the sidewalk.**



Typical Application

All separated bike lanes

Guidance

1. The sidewalk width should be determined by the anticipated peak hour pedestrian volume.
2. Sidewalk buffer is desirable, but not required.
3. The bike lane is required and may be at street level, intermediate level, or sidewalk level. (See pages 6-11).
   - Bike lane width should be determined by the anticipated peak hour bicycle volume. (See page 4).
   - A minimum shy distance of 2 feet should be provided adjacent to continuous vertical objects in the sidewalk buffer (e.g., railing), and 1 foot adjacent to non-continuous vertical objects (e.g., parking meters).
4. The street buffer is required and should be separated from the street by a median and/or other vertical objects.
5. Consider narrowing travel and parking lanes to the minimum widths in constrained corridors.

Considerations

- The street buffer provides safety and comfort for people bicycling and driving by physically separating them with a series of vertical objects or a raised median.
- The street buffer eliminates the risk of a bicyclist being hit by an opening car door.
- The width of the street buffer influences intersection operations and bicyclist safety.
- A sidewalk buffer minimizes encroachment between the bike lane and sidewalk zones.

REFERENCES

NACTO. Urban Bikeway Design Guide. 2nd Edition.

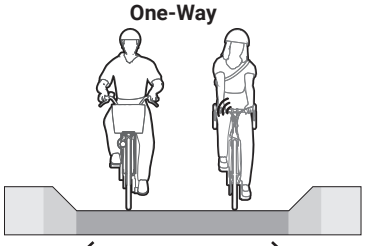
MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Separated Bike Lane Planning and Design Guide. 2015.

Separated Bike Lane Widths

Separated bike lane widths should be chosen based on the anticipated number of bicyclists in the typical peak hour.

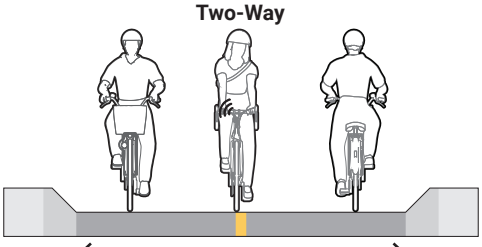
One-Way



at least 6.5 ft. recommended to enable passing movements

Same Direction Bicyclists/Peak Hour	Bike Lane Width (ft.)	
	Rec.	Min.
<150	6.5	5.0
150-750	8.0	6.5
>750	10.0	8.0

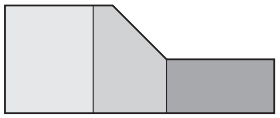
Two-Way



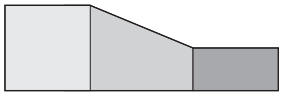
at least 10 ft. recommended to enable passing movements

Bidirectional Bicyclists/Peak Hour	Bike Lane Width (ft.)	
	Rec.	Min.
<150	10.0	8.0
150-400	11.0	10.0
>400	14.0	11.0

SBL Curb Options



Beveled slope = 1V:1H



Mountable slope = 1V:4H maximum

Typical Application

All separated bike lanes

Guidance

- Bike lane width should be determined by the anticipated peak hour bicycle volume shown in the tables above.
- The bike lane zone should be sufficiently wide to enable passing maneuvers between bicyclists.
- Beveled or mountable curbs are recommended adjacent to shops and other destinations to ease access to the adjacent sidewalk.
- Standard 6 inch vertical curbs are recommended adjacent to motor vehicle travel lanes and on-street parking to discourage encroachment into the separated bike lane.
- In major activity centers, it is likely that peak hour volumes will exceed 150 bicyclists per hour over time and necessitate wider lanes.

Considerations

- The effective width of the bike lane zone is impacted by the elevation of the bike lane and the design of curbs adjacent to the bike lane.
  - Beveled and mountable curbs provide a forgiving edge, reducing the likelihood of a bicycle crash due to striking a vertical curb.
  - Sidewalk level bike lanes may allow bicyclists to use part of the street or sidewalk buffer in constrained locations.
- Separated bike lanes generally attract a wider spectrum of bicyclists, some of whom ride at slower speeds, such as children or seniors.
- Separated bike lanes have been documented to significantly increase bicycling.
- Proximity to objects or vertical curbs along the bike lane edge can reduce the effective width of the bike lane and reduce user comfort.

REFERENCES

NACTO. Urban Bikeway Design Guide. 2nd Edition.

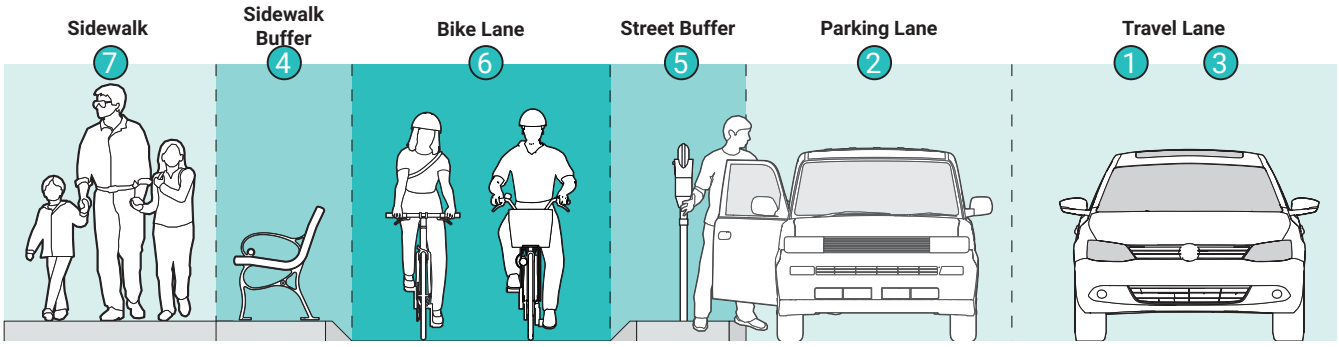
MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Separated Bike Lane Planning and Design Guide. 2015.

People for Bikes. The First Major Academic Study of Protected Bike Lanes in the U.S. is Out. 2014.

Determining Zone Widths in Constrained Corridors

When designing separated bike lanes in constrained corridors, designers may need to minimize some portions of the cross section to achieve a context-sensitive design that safely and comfortably accommodates all users.



Guidance

When it is desirable to add separated bike lanes in constrained corridors, designers should consider obtaining that space in the following order. This is general guidance and may be flexible based upon adjacent land uses.

1. Narrowing the **travel lane** to minimum widths (10 or 11 feet).
2. Eliminating **on-street parking**.
3. Eliminating **travel lanes**.
4. Narrowing or eliminating the **sidewalk buffer**.
5. Narrowing the **street buffer** to a minimum of 2 feet at midblock locations and a minimum of 6 feet at intersections. See page 20 for intersection dimensions.
6. Narrowing the **separated bike lanes** to minimum width. See page 4 for bike lane widths.
7. Narrowing **the sidewalk** to minimum width need to accommodate pedestrian demand, but no less than 5 feet.

Considerations

- The allocation of space can vary from midblock locations to intersection approaches.
- The street buffer is critical to the safety of separated bike lanes. Narrowing it should be avoided wherever possible, especially at intersections. Providing a larger street buffer at intersections can be achieved by tapering the bike lane toward the sidewalk as it approaches the intersection by narrowing or eliminating the sidewalk buffer.
- In constrained locations where physical separation is desirable because of higher pedestrian demand, raised separation in the sidewalk buffer is preferable to ensure pedestrians do not walk in the bike lane, and bicyclists do not ride on the sidewalk. Where it is not feasible to provide raised separation, it will be necessary to distinguish the bike lane from the sidewalk through the use of stained surfaces or applied surface colorization materials that provide a high degree of visual contrast between the two.

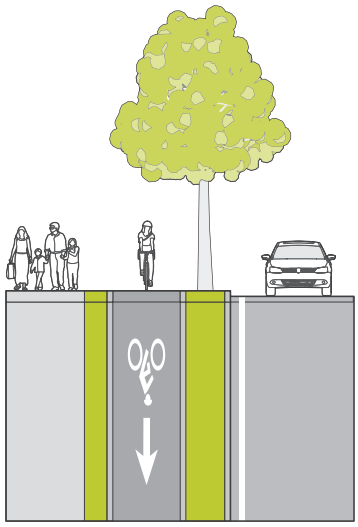
REFERENCES

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Separated Bike Lane Planning and Design Guide. 2015.

Separated Bike Lanes: One-Way at Sidewalk Level

This treatment provides an exclusive, unidirectional operating space for bicyclists between the street and sidewalk that is physically separated from motor vehicles and pedestrians by vertical and horizontal elements at the same elevation as the sidewalk.



Typical Application

- See page 2.
- Both sides of two-way streets.
- Right side of one-way streets.

Guidance

- For separated bike lane widths see page 4.
- To determine priorities in constrained corridors see page 5.
- A constrained bike lane width of 4 feet may be used for short distances to navigate around transit stops or accessible parking spaces.
- A significant visual contrast between the sidewalk and bike lane is required when the sidewalk buffer is eliminated.

Considerations

Sidewalk level bike lanes:

- May encourage pedestrian and bicyclist encroachment unless a continuous sidewalk buffer is provided.
- Allow separation from motor vehicles in locations with limited right-of-way.
- Requires no transition for raised bicycle crossings at driveways, alleys or streets.
- Allow use of bike lane as a level landing area for bus stops in constrained corridors with narrow street buffers.
- May reduce maintenance needs by prohibiting debris build up from roadway run-off.
- May simplify plowing operations.
- Allow bicyclists to use a portion of the sidewalk or street buffer to pass other bicyclists in constrained corridors where sidewalk buffers are eliminated.
- Provide intuitive and simplified transitions to existing bike lanes and shared travel lanes (see page 20).

REFERENCES

NACTO. Urban Bikeway Design Guide. 2nd Edition.

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Separated Bike Lane Planning and Design Guide. 2015.

Separated Bike Lanes: Two-Way at Sidewalk Level

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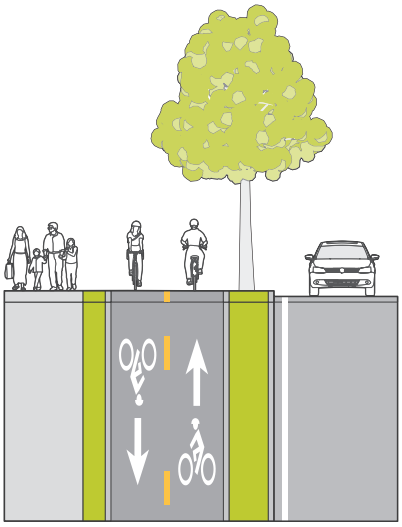


Typical Application

- See page 2.
- Roadway is >4 lanes in width.
- One side of arterial is <4 lanes in width.
- Right side of one-way streets.

Guidance

- For separated bike lane widths see page 4.
- To determine priorities in constrained corridors see page 5.
- A constrained bike lane width of 8 feet may be used for short distances to navigate around transit stops or accessible parking spaces.
- A significant visual contrast between the sidewalk and bike lane is required when the sidewalk buffer is eliminated.

Considerations

Sidewalk level bike lanes:

- May encourage pedestrian and bicyclist encroachment unless discouraged with a continuous sidewalk buffer.
- Maximize usable bike lane width by allowing temporary bicycle use of street or sidewalk buffer.
- Requires no transition for raised bicycle crossings at driveways, alleys or streets.
- Allow use of bike lane as a level landing area for bus stops in constrained corridors with narrow street buffers.
- May reduce maintenance needs by prohibiting debris build up from roadway run-off.
- May simplify snow plowing operations.
- Allow bicyclists to use a portion of the sidewalk or street buffer to pass other bicyclists in constrained corridors where sidewalk buffers are eliminated.
- Require special attention to transition the contra-flow bicyclist into existing bike lanes and shared travel lanes.

REFERENCES

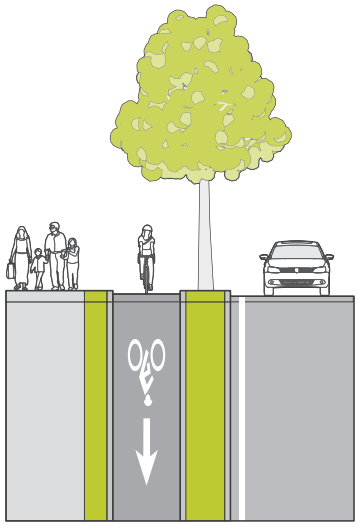
NACTO. Urban Bikeway Design Guide. 2nd Edition.

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Separated Bike Lane Planning and Design Guide. 2015.

Separated Bike Lanes: One-Way at Intermediate Level

This treatment provides an exclusive, unidirectional operating space for bicyclists between the street and sidewalk that is physically separated from motor vehicles and pedestrians by vertical and horizontal elements at an elevation below the sidewalk, but above the street.



Typical Application

- See page 2.
- Both sides of two-way streets.
- Right side of one-way streets.

Guidance

- For separated bike lane widths see page 4.
- To determine priorities in constrained corridors see page 5.
- A minimum curb reveal of 2 inches below sidewalk level is required to provide a detectable edge for visually impaired pedestrians.
- A constrained bike lane width of 4 feet may be used for short distances to navigate around transit stops or accessible parking spaces.

Considerations

Intermediate level bike lanes:

- Create a separation between bicyclists and pedestrians where sidewalk buffers are eliminated.
- Ensure a detectable edge is provided for people with vision disabilities.
- Make it easier to create raised bicycle crossings at driveways, alleys or streets.
- May reduce maintenance needs by prohibiting debris build up from roadway run-off.
- May complicate snow plowing operations.
- May require careful consideration of drainage design and in some cases may require catch basins to manage bike lane runoff.
- Provide intuitive and simplified transitions to existing bike lanes and shared travel lanes (see page 20).

REFERENCES

NACTO. Urban Bikeway Design Guide. 2nd Edition.

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Separated Bike Lane Planning and Design Guide. 2015.

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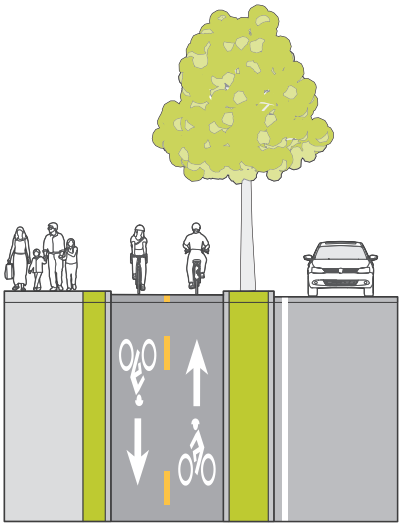


Typical Application

- See page 2.
- Roadway is >4 lanes in width.
- One side of arterial is <4 lanes in width.
- Right side of one-way streets.

Guidance

- For separated bike lane widths see page 4.
- To determine priorities in constrained corridors see page 5.
- A minimum curb reveal of 2 inches below sidewalk level is required to provide a detectable edge for visually impaired pedestrians.
- A constrained bike lane width of 8 feet may be used for short distances to navigate around transit stops or accessible parking spaces.

Considerations

Intermediate level bike lanes:

- Create a separation between bicyclists and pedestrians where sidewalk buffers are eliminated.
- Ensure a detectable edge is provided for people with vision disabilities.
- May reduce maintenance needs by prohibiting debris build up from roadway run-off.
- May complicate snow plowing operations.
- May require careful consideration of drainage design and in some cases may require catch basins to manage bike lane runoff.
- Require special attention to transition the contra-flow bicyclist into existing bike lanes and shared travel lanes.

REFERENCES

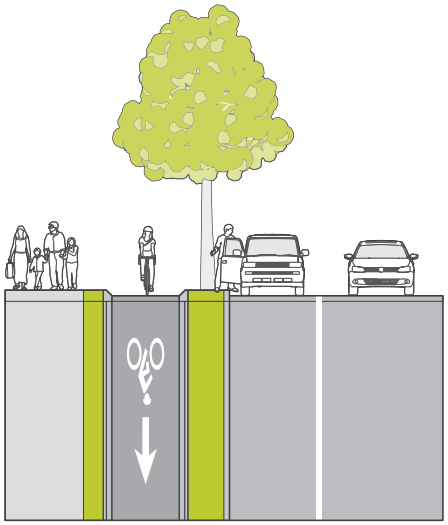
NACTO. Urban Bikeway Design Guide. 2nd Edition.

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Separated Bike Lane Planning and Design Guide. 2015.

Separated Bike Lanes: One-Way at Street Level

This treatment provides an exclusive, uni-directional operating space for bicyclists between the street and sidewalk that is physically separated from motor vehicles and pedestrians by vertical and horizontal elements located at the same elevation as the street.



Typical Application

- See page 2.
- Both sides of two-way streets.
- Right side of one-way streets.

Guidance

- For separated bike lane widths see page 4.
- To determine priorities in constrained corridors see page 5.
- A constrained bike lane width of 4 feet may be used for short distances to navigate around transit stops or accessible parking spaces.

Considerations

Street level bike lanes:

- Create a separation between bicyclists and pedestrians where sidewalk buffers are eliminated.
- Ensure a detectable edge is provided for people with vision disabilities.
- May increase maintenance needs to remove debris from roadway run-off unless street buffer is raised.
- May complicate snow plowing operations.
- May require careful consideration of drainage design and in some cases may require catch basins to manage bike lane runoff.
- Provide intuitive and simplified transitions to existing bike lanes and shared travel lanes (see page 20).

REFERENCES

NACTO. Urban Bikeway Design Guide. 2nd Edition.

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Separated Bike Lane Planning and Design Guide. 2015.

Separated Bike Lanes: Two-Way at Street Level

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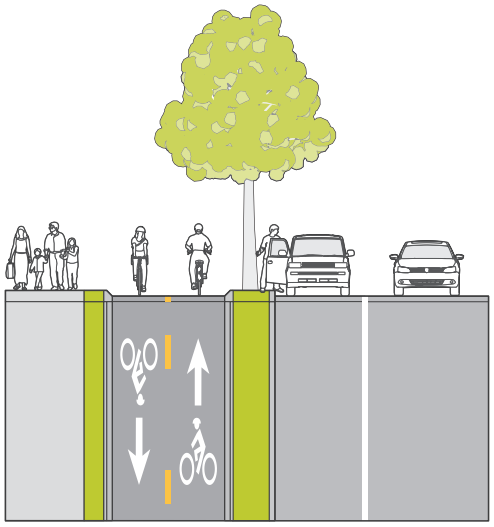


Typical Application

- See page 2.
- Both sides of two-way streets.
- Right side of one-way streets.

Guidance

- For separated bike lane widths see page 4.
- To determine priorities in constrained corridors see page 5.
- A constrained bike lane width of 8 feet may be used for short distances to navigate around transit stops or accessible parking spaces.

Considerations

Street level bike lanes:

- Create a separation between bicyclists and pedestrians where sidewalk buffers are eliminated.
- Ensure a detectable edge is provided for people with vision disabilities.
- May increase maintenance needs to remove debris from roadway run-off unless street buffer is raised.
- May complicate snow plowing operations.
- May require careful consideration of drainage design and in some cases may require catch basins to manage bike lane runoff.
- Require special attention to transition the contra-flow bicyclist into existing bike lanes and shared travel lanes.

REFERENCES

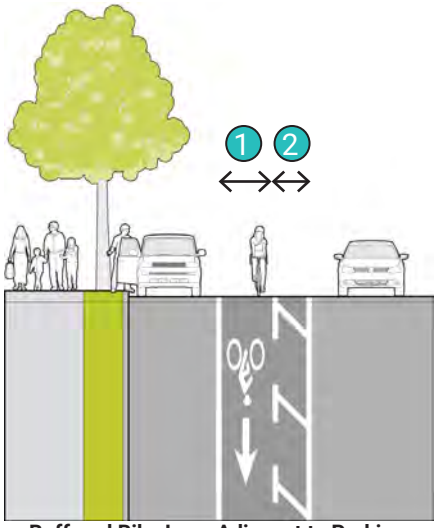
NACTO. Urban Bikeway Design Guide. 2nd Edition.

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

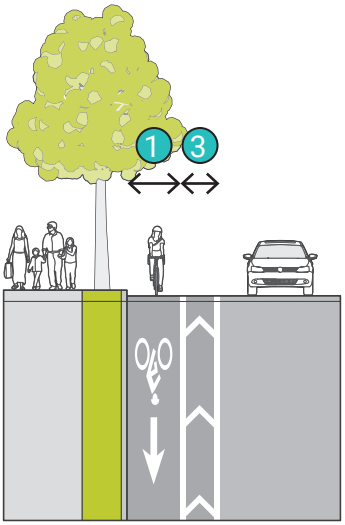
FHWA. Separated Bike Lane Planning and Design Guide. 2015.

Buffered Bike Lanes

Buffered bike lanes are conventional bike lanes paired with a designated buffer space separating the bike lane from the adjacent motor vehicle travel lane and/or parking lane to increase the comfort of bicyclists.



Buffered Bike Lane Adjacent to Parking



Buffered Bike Lane Adjacent to a Curb

Typical Application

Buffered bike lanes will generally be considered on any road with one or more of the following characteristics:

- Total traffic lanes: 3 lanes or fewer.
- Posted speed limit: 30 mph or lower.
- Average Daily Traffic: 9,000 vehicles or fewer.
- Parking turnover: infrequent.
- Bike lane obstruction: likely to be infrequent.
- Where a separated bike lane or sidepath is infeasible or not desirable.

Guidance

1. The minimum width of a buffered bike lane, exclusive of the buffer, is 4 feet adjacent to parking. A desirable width is 6 feet.
2. Buffers are to be broken where curbside parking is present to allow cars to cross the bike lane.
3. The minimum buffer width is 18 inches. There is no maximum. Diagonal cross hatching should be used for buffers <3 feet in width. Chevron cross hatching should be used for buffers >3 feet in width.

Considerations

- Preferable to conventional bike lanes when used as a contra-flow bike lane on one-way streets.
- Typically installed by reallocating existing street space.
- Can be used on one-way or two-way streets.
- Consider placing buffer next to parking lane where there is commercial or metered parking.
- Consider placing buffer next to travel lane when traffic volume exceeds 6,000 vehicles per day.
- Where there is 7 feet of roadway width available, a buffered bike lane should be installed instead of a conventional bike lane
- Allow bicyclists to ride side by side or to pass slower moving bicyclists.
- Research has documented buffered bike lanes increase the perception of safety.

REFERENCES

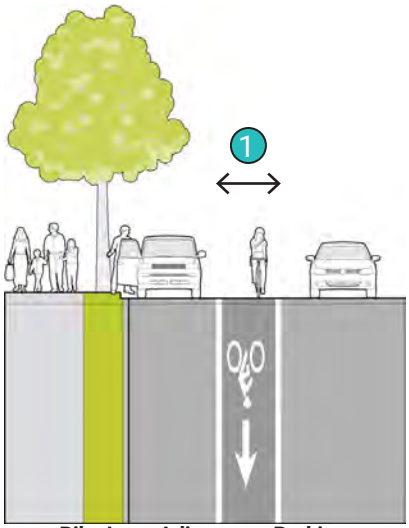
AASHTO. Guide for the Development of Bicycle Facilities. 2012.

NACTO. Urban Bikeway Design Guide. 2nd Edition.

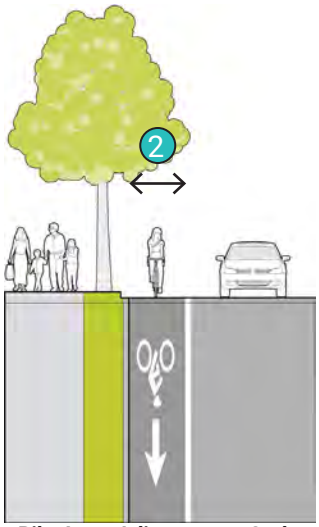
Portland State University, Center for Transportation Studies. Evaluation of Innovative Bicycle Facilities: SW Broadway Cycle Track & SW Stark/Oak Street Buffered Bike Lanes FINAL REPORT. 2011.

Conventional Bike Lanes

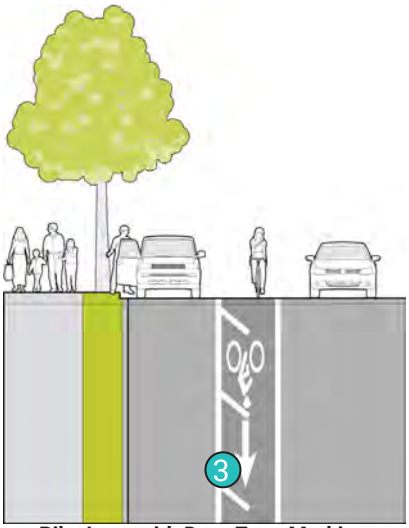
A conventional bike lane is a portion of a street designated for the exclusive use of bicycles distinguished from traffic lanes by striping, signing and pavement markings.



Bike Lane Adjacent to Parking



Bike Lane Adjacent to a Curb



Bike Lane with Door Zone Marking

Typical Application

Conventional bike lanes will generally be considered on any road with one or more of the following characteristics:

- Total traffic lanes: 3 lanes or fewer.
- Posted speed limit: 30 mph or lower.
- Average Daily Traffic: 9,000 vehicles or fewer.
- Parking turnover: infrequent.
- Bike lane obstruction: likely to be infrequent.

Where a separated bike lane or sidepath is infeasible or not desirable.

Guidance

1. The minimum width of a bike lane adjacent to parking is 5 feet, a desirable width is 6 feet.
2. The minimum width of a bike lane adjacent to a curb is 5 feet exclusive of a gutter, a desirable width is 6 feet.
3. Parking T's or hatch marks can highlight the door zone on constrained corridors with high parking turnover to guide bicyclists away from doors.

Considerations

- Typically installed by reallocating existing street space.
- Can be used on one-way or two-way streets.
- Contra-flow bike lanes may be used to allow two-way bicycle travel on streets designated for one-way travel for motorists to improve bicycle network connectivity.
- Stopping, standing and parking in bike lanes may be problematic in areas of high parking demand and deliveries, especially in commercial areas.
- Wider bike lanes or buffered bike lanes are preferable at locations with high parking turnover.

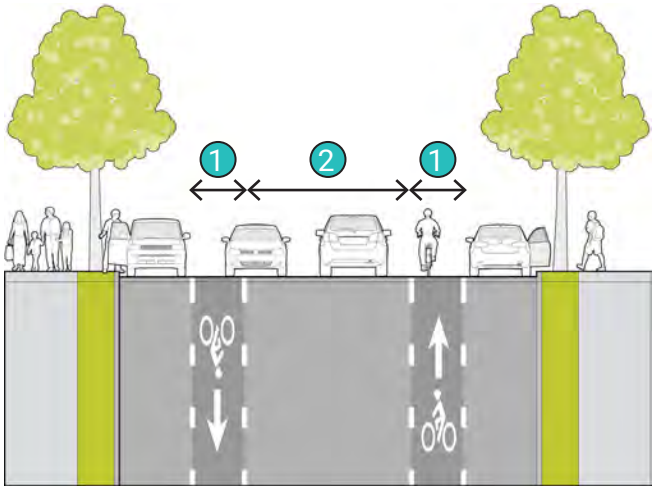
REFERENCES

AASHTO. Guide for the Development of Bicycle Facilities. 2012.

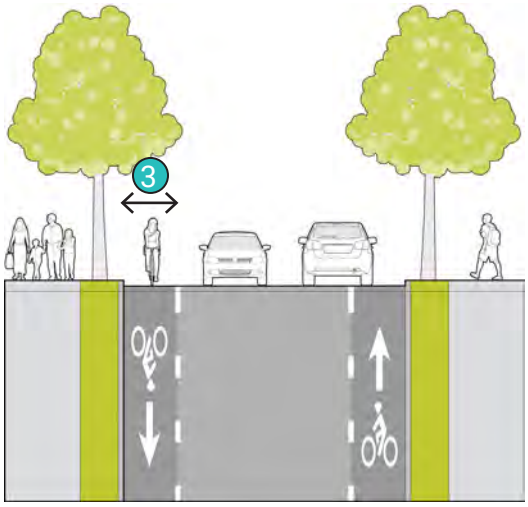
NACTO. Urban Bikeway Design Guide. 2nd Edition.

Advisory Bike lanes

Advisory bike lanes (ABLs) are dashed bike lanes that allow motorists to temporarily enter the bike lane to provide oncoming traffic sufficient space to safely pass on narrow unlaned roads in residential land use contexts.



Advisory Bike Lane with Parking



Advisory Bike Lane without Parking

Typical Application

Advisory bikeways will generally be considered on any road with one or more of the following characteristics:

- Total traffic lanes: 2 lanes or fewer.
- Posted speed limit: 30 mph or lower.
- Average Daily Traffic: 2,000-4,000 vehicles per day desirable, 6,000 vehicles per day or 300 vehicles or fewer maximum during the peak hour.
- Parking turnover: infrequent.
- Street is not a designated truck or bus route.

Guidance

1. The minimum width of an advisory bike lane adjacent to parking is 5 feet, a desirable width is 6 feet.
2. The minimum width of the unlaned motorist space should be 12 feet between the bike lanes. The maximum width should be 18 feet.
3. The minimum width of an advisory bike lane adjacent to a curb is 4 feet exclusive of a gutter, a desirable width is 6 feet.

Considerations

- **Requires FHWA permission to experiment.**
- For use on streets too narrow for bike lanes and normal width travel lanes.
- Provide two separate minimum width bike lanes, on either side of a single shared (unlaned) two-way "yielding" motorist travel space.
- Motorists must yield to on-coming motor vehicles by pulling into the bike lane.
- This treatment should only be used on streets with >60% continuous daytime parking occupancy.
- Where parking occupancy is continuously <50%, consolidate the parking to one side of the street.
- A Two-Way Traffic warning sign (W6-3) may increase motorists understanding of the intended two-way operation of the street.

MUTCD W6-3 Sign

REFERENCES

AASHTO. Guide for the Development of Bicycle Facilities. 2012.

FHWA. Bicycle Facilities and the Manual on Uniform Traffic Control Devices – Dashed Bicycle Lanes. 2015.

Neighborhood Greenway

Neighborhood greenways are streets with low motorized vehicle traffic volumes and speeds, designated and designed to give walking and bicycling priority. They use signs, pavement markings, and speed and volume management measures to discourage through trips by motor vehicles and create safe, comfortable crossings of busy arterial streets.

Typical Application

- Neighborhood greenways use existing low-stress streets that parallel a major corridor.
- Roads with speeds ≤25mph and volumes <3,000 ADT.
- If these conditions are not met, the treatments explained on the following pages should be employed to reach these guidelines.

Guidance

- Each of the subsequent pages provide additional guidance for implementation:
  - Traffic calming via raised pavement (page 21),
  - Street narrowing (page 22),
  - Traffic diversion (page 23), and
  - Crossing treatments (page 24).

Considerations

- Given Montgomery County's non-grid street network, identification of connected, parallel routes may be difficult in some areas. It may be necessary to re-route short segments of neighborhood greenways along higher-stress routes in which case separated bikeways, such as sidepaths or separated bike lanes, will be necessary.

REFERENCES

IPBI, Alta Planning + Design, Portland State University. Bicycle Boulevard Planning and Design Guidebook. 2009.

NACTO. Urban Bikeway Design Guide. 2nd Edition.

Portland Bureau of Transportation. Neighborhood Greenway Assessment Report. 2015.

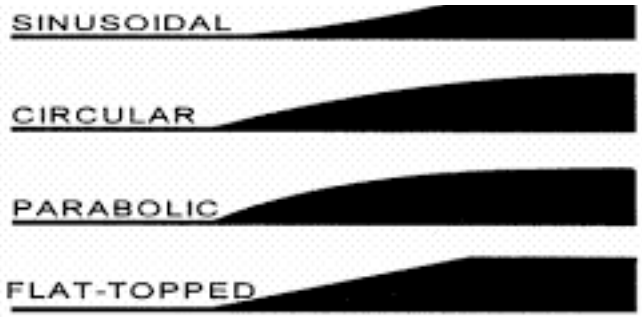
Traffic Calming via Raised Pavement

Vertical traffic calming forces motorists to drive at slower speeds. This lowers the speed differential between bicyclists and cars, increasing bicyclist comfort. These treatments are typically used where traffic controls are less frequent, for instance along a segment where stop signs may have been removed to ease bicyclist travel.

Speed cushion

Speed hump

Raised crosswalk



Curve profile options

Typical Application

Vertical traffic calming will not be necessary on all neighborhood greenways. It should be considered on any road with measured or observed speeding issues, where the 50th percentile of traffic exceeds 25mph.

Guidance

Continuous devices, such as speed humps and raised crosswalks, are more effective to achieve slower speeds than speed cushions.

Considerations

- Speed humps and raised crosswalks impact bicyclist comfort. The approach profile should preferably be sinusoidal or flat-topped.
- Where traffic calming must not slow an emergency vehicle speed cushions or raised crosswalks should be considered. Speed cushions provide gaps spaced for an emergency vehicles wheelbase to pass through without slowing.
- Consider using raised crosswalks at intersections to slow traffic turning on to the neighborhood greenway from a major street.

REFERENCES

IPBI, Alta Planning + Design, Portland State University. Bicycle Boulevard Planning and Design Guidebook. 2009.

NACTO. Urban Bikeway Design Guide. 2nd Edition.

Portland Bureau of Transportation. Neighborhood Greenway Assessment Report. 2015.

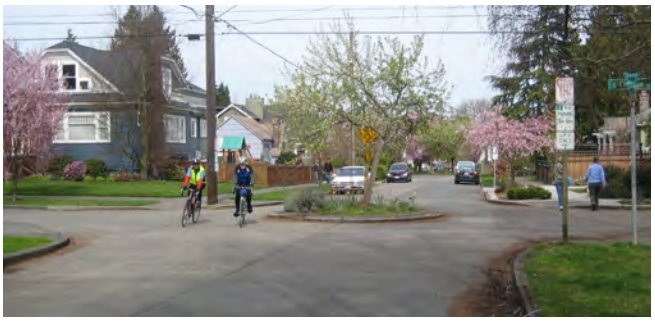
Traffic Calming via Street Narrowing

Horizontal traffic calming reduces speeds by narrowing lanes which creates a sense of enclosure and additional friction between passing vehicles. Narrower conditions require more careful maneuvering around fixed objects and when passing bicyclists or oncoming automobile traffic. Some treatments may slow traffic by requiring motorists to yield to oncoming traffic.

Chicane

Neckdown

Curb extension



Neighborhood traffic circle

Typical Application

Street segments or intersections where street width contributes to higher motor vehicle speeds. Especially where:

- On-street parking has low rate of occupancy during most times of day.
- There is desire to remove or decrease stop control at a minor intersection.

Guidance

Horizontal treatments are most effective if they deflect motorists midblock (with chicanes) or within intersections (with neighborhood traffic circles).

Considerations

- Must be designed to deflect motor vehicle traffic without forcing the bicycle path of travel to be directed into a merging motorist.
- Neighborhood traffic circles should be considered at local street intersections to prioritize the through movement of bicyclists (by removing stop control or converting to yield control) without increasing motorists speeds.
- Costs for infrastructure will range depending upon complexity and permanence of design. Simple, interim treatments such as striping and flexposts are low-cost. Curbed, permanent treatments that integrate plantings or green infrastructure are higher-cost.

REFERENCES

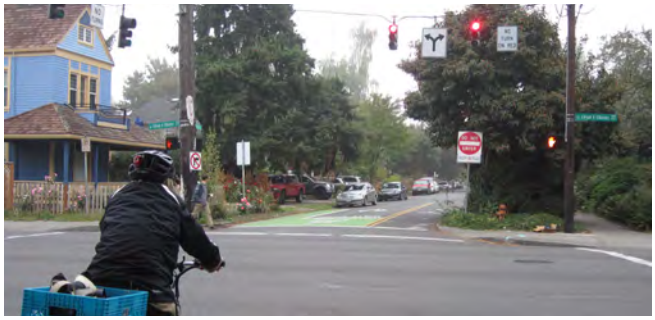
IPBI, Alta Planning + Design, Portland State University. Bicycle Boulevard Planning and Design Guidebook. 2009.

NACTO. Urban Bikeway Design Guide. 2nd Edition.

Portland Bureau of Transportation. Neighborhood Greenway Assessment Report. 2015.

Traffic Diversion

Traffic diversion strategies are used to reroute traffic from a neighborhood greenway onto other adjacent streets by installing design treatments that restrict motorized traffic from passing through.



Partial closure - permanent, signalized

Diagonal diverter

Partial closure - interim, stop-control

Full closure

Typical Application

Street segments with daily traffic volumes of:

- Preferred: 1,000 - 1,500 vehicles per day.
- Acceptable: up to 3,000 vehicles per day.

Guidance

- Diversion treatments must be designed to provide a minimum clear width of 6 feet for a bicyclist to pass through.
- Some treatments may require a separate pedestrian accommodation.

Considerations

- Diversion is most applicable in areas with a grid of streets to disperse traffic and may not be appropriate in many areas of Montgomery County.
- Diversion shifts trips from the neighborhood greenway onto adjacent streets. This change in traffic volume on other local streets must be identified and addressed during the planning, design and evaluation process.
- Temporary materials may be used to test diversion impacts before permanent, curbed diverters are installed.
- Consultation with emergency services will be necessary to understand their routing needs.

REFERENCES

IPBI, Alta Planning + Design, Portland State University. Bicycle Boulevard Planning and Design Guidebook. 2009.

NACTO. Urban Bikeway Design Guide. 2nd Edition.

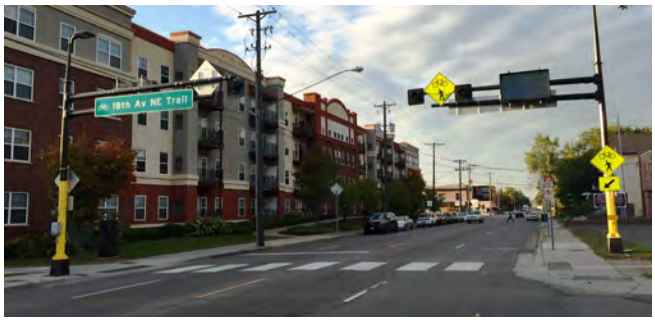
Portland Bureau of Transportation. Neighborhood Greenway Assessment Report. 2015.

Crossing Treatments

While the street segments of a neighborhood greenway may be generally comfortable for bicyclists without significant improvement, major street crossings must be addressed to provide safe, convenient and comfortable travel along the entire route. Treatments provide waiting space for bicyclists, control cross traffic, or ease bicyclist use by removing traffic control for travel along the neighborhood greenway route.

Off-Set Intersection Bicyclist Left Turn Median Diverter

Bicycle Box with Lead-In Bike Lane



HAWK beacon

Offset Crossing Left Turn Box with Lead-In Bike Lane

Typical Application

Intersections along a neighborhood greenway route may need treatment in the following situations:

- Unsignalized crossings of arterial or collector streets with high traffic volumes and speeds.
- Offset intersections where the greenway route makes two turns in short succession.
- Two-way stop-controlled intersections where the traffic calming benefit of the stop control is not needed for motor vehicle traffic.

Guidance

Medians should be a minimum of 6 feet in length, though 8 feet is desirable to allow adequate space for a bicycle.

Considerations

- Adjustments to traffic control such as a HAWK beacon or stop sign adjustments may necessitate a traffic study.
- Median islands may be constructed to require right-in/right-out turns by motor vehicles while still allowing left turns by bicyclists at off-set intersections.
- Numerous treatments exist to accommodate offset intersection crossings, and the full range of design treatments should be considered in these situations. These treatments include left turn queue boxes, two-way center left turn lanes, median left turn pockets and short sidepath segments.

REFERENCES

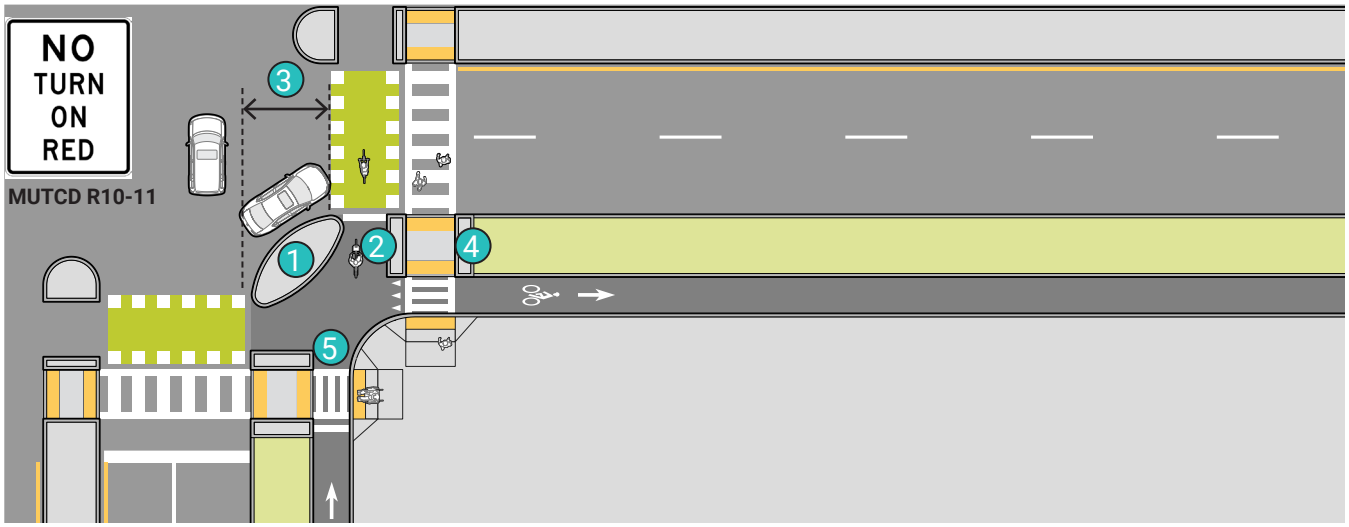
IPBI, Alta Planning + Design, Portland State University. Bicycle Boulevard Planning and Design Guidebook. 2009.

NACTO. Urban Bikeway Design Guide. 2nd Edition.

Portland Bureau of Transportation. Neighborhood Greenway Assessment Report. 2015.

Protected Intersections

Protected intersections are intuitive and comfortable, provide clear right-of-way assignment, promote predictability of movement, and allow eye contact between motorists, bicyclists and pedestrians. They clearly define pedestrian and bicyclist operating spaces within the intersection and minimize potential conflicts between users maintaining the comfort of the separated bike lane up to the intersection.



Typical Application

All separated bike lane intersections

Guidance

1. Corner refuge island size may vary. The curb radius along the path of travel of motor vehicles should minimize turning motorist speeds to 15mph or less.
2. The forward bicycle queuing area should allow at least one bicyclist to wait without obstructing crossing bicyclists or pedestrians.
3. The motorist yield zone should be a minimum of 6 feet in length up to a typical car length (20 feet) to create space for a turning motorist to yield to a through moving bicyclist.
4. A pedestrian crossing island should be a minimum of 6 feet in width to minimize pedestrian crossing distances of the street.
5. Marked pedestrian crosswalks should be provided across all bike lane crossings.

Considerations

To convey which user has the right of way, intersections with separated bike lanes should be designed to minimize bicyclist exposure to motorized traffic and should minimize the speed differential at conflict points. This can be accomplished by:

- Creating space for a motorists to yield to bicyclists and pedestrians. Research has found crash reduction benefits at locations where bicycle crossings are set back from the motorist travel way by a distance of 6 to 20 feet, creating space for turning motorists to yield. At locations where the street buffer is <6 feet midblock, additional dedication from developments may be necessary at intersections to create a ≥6 foot setback.
- Minimizing the turning speed of motor vehicles through the use of small curb radii (<20 feet) along the corner refuge island. Where larger radii are required to accommodate trucks, provide truck aprons to maintain the smaller curb radii for the majority of vehicles.
- Providing a No Turn On Red sign where turning motorists are likely to block crosswalks, or where protected signal phasing is provided.

REFERENCES

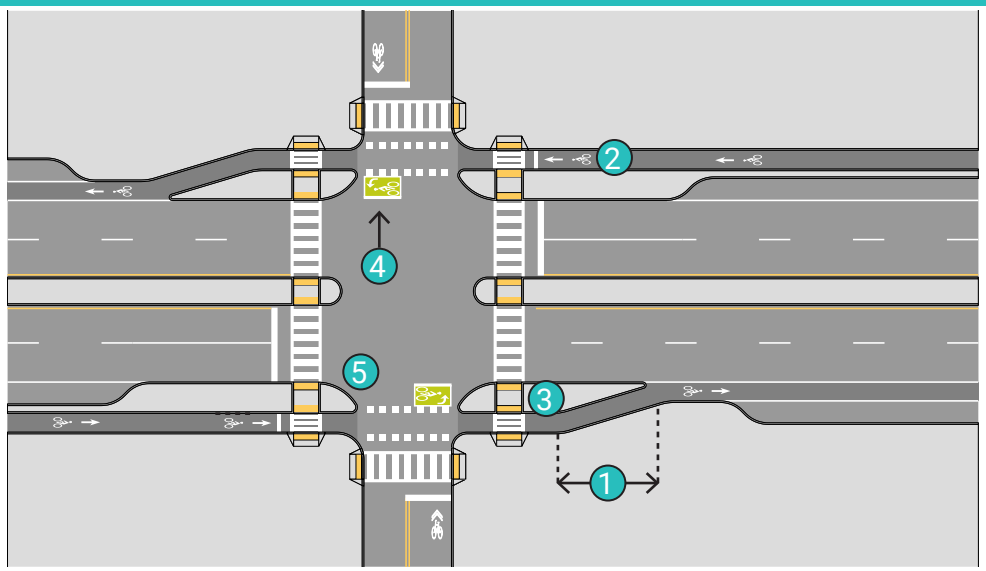
NACTO. Urban Bikeway Design Guide. 2nd Edition.

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Separated Bike Lane Planning and Design Guide. 2015.

Transition from One-Way Separated Bike Lane to Conventional Bike Lane on Same Street

This treatment provides an example of a preferred design of a separated bike lane transition to a conventional bike lane.



Typical Application

All one-way separated bike lane locations that require a transition to a conventional bike lane.

Guidance

1. Maximum 3:1 lateral taper.
2. For separated bike lane widths see page 4.
3. A protecting island should be provided to shadow the bike lane on the far side of the intersection and to create protection for queuing left turn bicyclists waiting in the turn box.
4. Provide a two-stage turn queue box at intersections with cross streets that have bike lanes or shared lanes. See page 24 for further design information.
5. A protected intersection should be provided on the near side of the intersection. See page 20 for more information.

Considerations

The transition should:

- Occur on the far side of the intersection to eliminate the stress of bicyclists attempting to merge into a near side bike lane or shared lane where motorists may be entering prior to the intersection.
- Maintain a vertical or visual separation between bicyclists and pedestrians where sidewalk buffers are eliminated.
- Clearly communicate how bicyclists should enter and exit the separated bike lane minimizing conflicts with other users.
- Preferably merge bicyclists into a bicycle lane rather than a shared lane.

REFERENCES

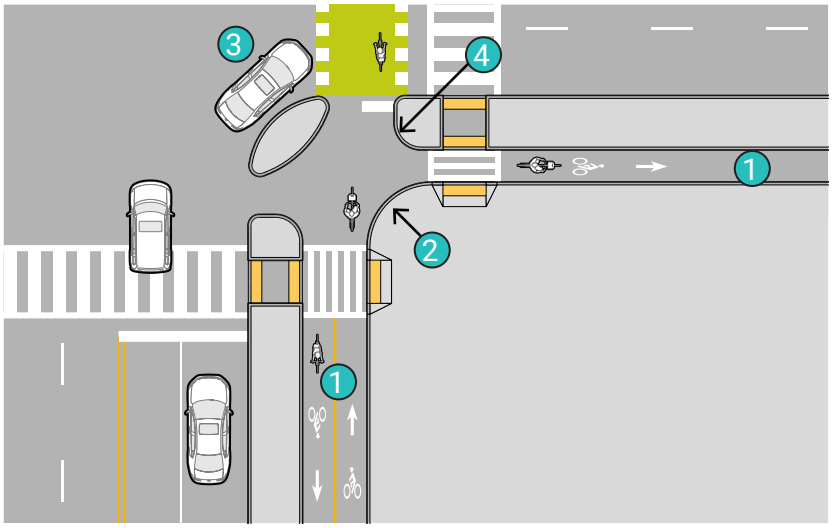
NACTO. Urban Bikeway Design Guide. 2nd Edition.

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Separated Bike Lane Planning and Design Guide. 2015.

Transition from Two-Way Separated Bike Lane to One-Way Separated Bike Lane on Intersecting Street

This treatment provides an example of a typical design of a two-way separated bike lane transition to a one-way separated bike lane on an intersecting street.



Typical Application

All two-way separated bike lane locations that require a transition to a cross street one-way separated bike lane.

Guidance

1. For separated bike lane widths see page 4.
2. A 15-foot corner radius is recommended for turns from the two-way bike lane onto the one-way bike lane.
3. A protected intersection should be provided on the near side of the intersection. See page 20 for more information.
4. Provide a minimum 10 foot curb radius to allow left turning bicyclists to enter the one-way bike lane.

Considerations

The transition design should:

- Allow right turning bicyclists to slowly turn at all times, yielding to pedestrians in crosswalks.
- Maintain a vertical or visual separation between bicyclists and pedestrians where sidewalk buffers are eliminated.
- Provide bicycle lane markings to reduce wrong-way riding.

REFERENCES

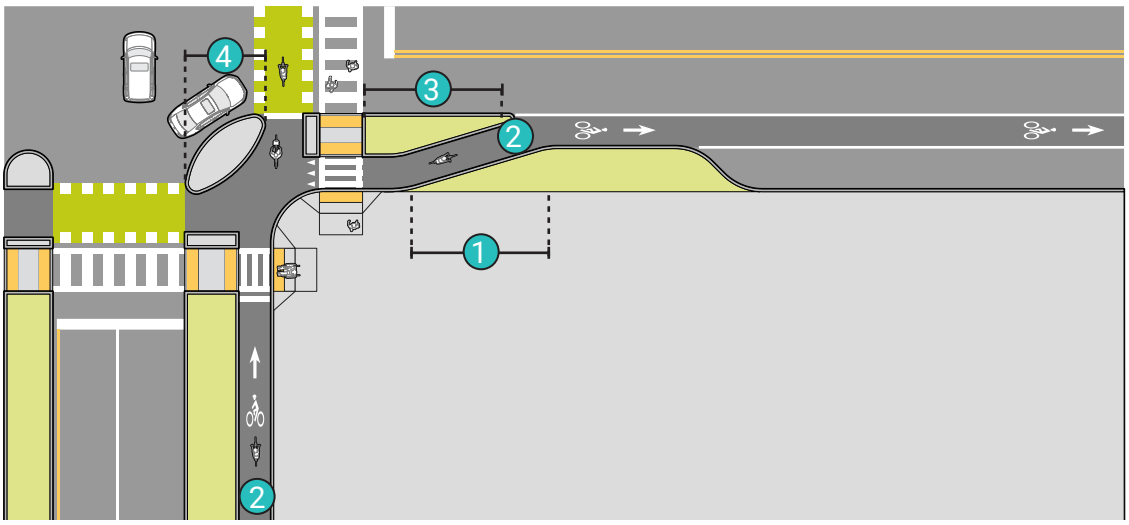
NACTO. Urban Bikeway Design Guide. 2nd Edition.

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Separated Bike Lane Planning and Design Guide. 2015.

Transition from One-Way Separated Bike Lane to Conventional Bike Lane on Intersecting Street

This treatment provides an example of a typical design of a one-way separated bike lane transition to a one-way separated bike lane on an intersecting street.



Typical Application

All one-way separated bike lane locations that require a transition to a cross street conventional bike lane.

Guidance

1. Maximum 3:1 lateral taper.
2. For separated bike lane widths see page 4.
3. A protecting island should be provided to shadow the bike lane on the far side of the intersection and to create protection for queuing left turn bicyclists waiting in the turn box.
4. A protected intersection should be provided on the near side of the intersection. See page 20 for more information.

Considerations

The transition should:

- Occur on the far side of the intersection to eliminate the stress of bicyclists attempting to merge into a near side bike lane or shared lane where motorists may be entering prior to the intersection.
- Maintain a vertical or visual separation between bicyclists and pedestrians where sidewalk buffers are eliminated.
- Clearly communicate how bicyclists should enter and exit the separated bike lane minimizing conflicts with other users.
- Preferably merge bicyclists into a bicycle lane rather than a shared lane.

REFERENCES

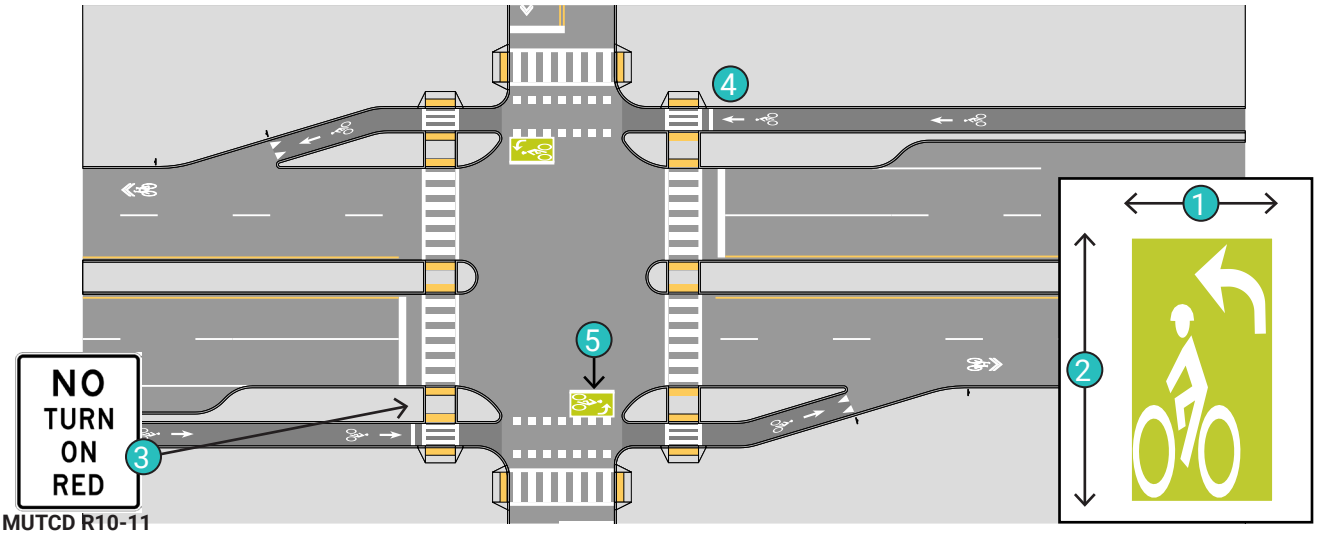
NACTO. Urban Bikeway Design Guide. 2nd Edition.

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Separated Bike Lane Planning and Design Guide. 2015.

Transition from One-Way Separated Bike Lane to Intersecting Street with Two-Stage Turn Queue Box

This treatment provides an example of a typical design of a one-way separated bike lane transition to a conventional bike lane or shared lane on a cross street using a two-stage turn queue box.



Typical Application

All separated bike lane locations that require a transition to a cross street conventional bike lane or shared lane.

Guidance

1. A minimum width of 6.5 feet is recommended.
2. A desirable length of 10 feet is recommended. A minimum length of 6.5 feet is recommended.
3. NO TURN ON RED (R10-11) restrictions should be used to prevent vehicles from entering the queuing area at signalized intersections.
4. The use of a supplemental sign instructing bicyclists how to use the box is optional.
5. The bike box should consist of a green box outlined with solid white lines supplemented with a bicycle symbol and a turn arrow to emphasize the crossing direction.

Considerations

The use of a two-stage turn queue box requires FHWA permission to experiment.

- Two-stage turn queue box dimensions will vary based on the street operating conditions, the presence or absence of a parking lane, traffic volumes and speeds, and available street space.
- The turn box may be placed in a variety of locations including in front of the pedestrian crossing (the crosswalk location may need to be adjusted), in a 'jug-handle' configuration within a sidewalk, or at the tail end of a parking lane or a median island.
- The turn box should be located outside the turning path of motor vehicle.
- Dashed bike lane extension markings may be used to indicate the path of travel across the intersection into the turn queue box.

REFERENCES

NACTO. Urban Bikeway Design Guide. 2nd Edition.

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

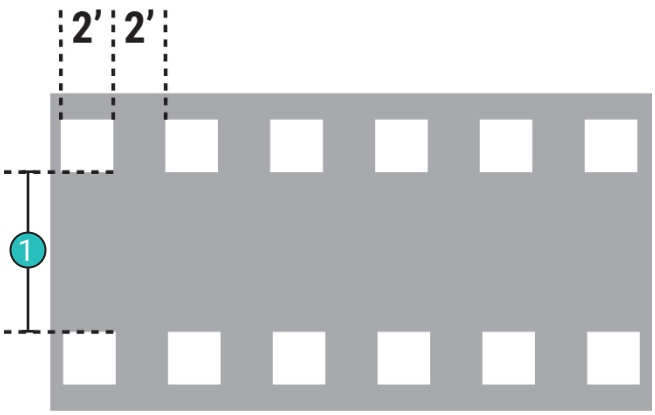
FHWA. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Bicycle Facilities and the Manual on Uniform Traffic Control Devices - Two-Stage Turn Box. 2015.

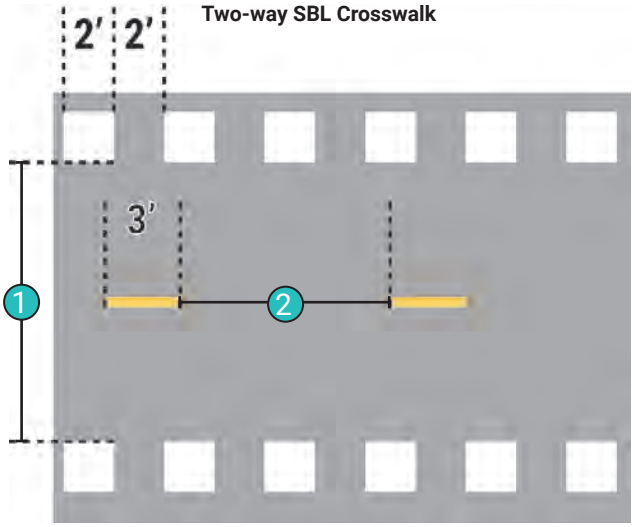
Separated Bike Lane: Crosswalk

A bicycle crosswalk is a marked crossing of an intersection with a street, driveway or alley which delineates a preferred path for people bicycling through the intersection.

One-way SBL Crosswalk



Two-way SBL Crosswalk



Typical Application

All separated bike lane crossings of streets, alleys, and driveways serving greater than 10 vehicles per day.

Considerations

- The bicycle crossing may be supplemented with a green colored surface to improve contrast with the surrounding roadway and adjacent pedestrian crossing, if present. Green surfacing may be desirable at crossings where concurrent vehicle turning movements are allowed.

Guidance

1. For separated bike lane widths see page 4.
2. A centerline is recommended for two-way separated bike lanes. It should be marked with a 3 foot solid yellow line, with a 9 foot gap.

REFERENCES

NACTO. Urban Bikeway Design Guide. 2nd Edition.

MassDOT. Separated Bike Lane Planning and Design Guide. 2015.

FHWA. Separated Bike Lane Planning and Design Guide. 2015.