

**THE UNIQUE CHARACTER  
AND NEEDS OF  
BICYCLING RELATING  
TO ROADWAY SAFETY  
REQUIRE QUALITY  
FACILITIES THAT  
MINIMIZE RISK.**





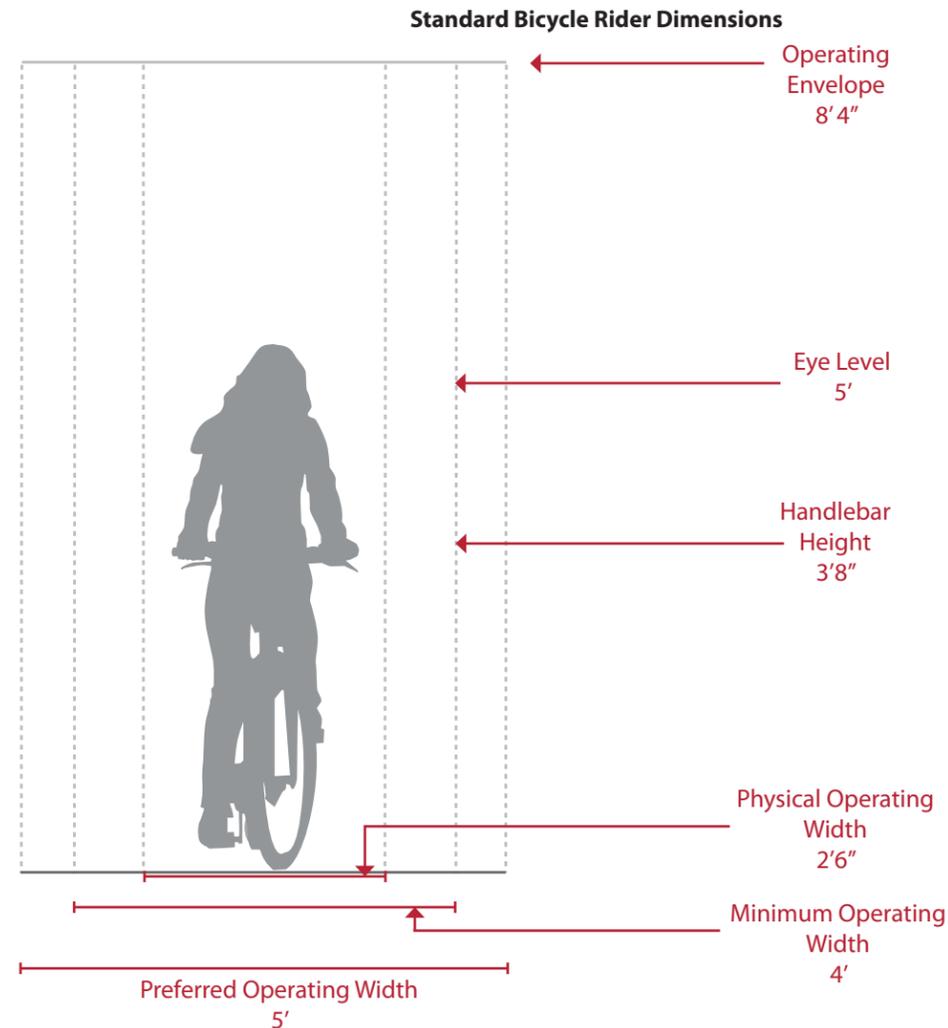
# DESIGN NEEDS OF BICYCLISTS

The purpose of this section is to provide the facility designer with an understanding of how bicyclists operate and how their bicycle influences that operation. Bicyclists, by nature, are much more affected by poor facility design, construction and maintenance practices than motor vehicle drivers. Bicyclists lack the protection from the elements and roadway hazards provided by an automobile's structure and safety features. By understanding the unique characteristics and needs of bicyclists, a facility designer can provide quality facilities and minimize user risk.

## Bicycle as a Design Vehicle

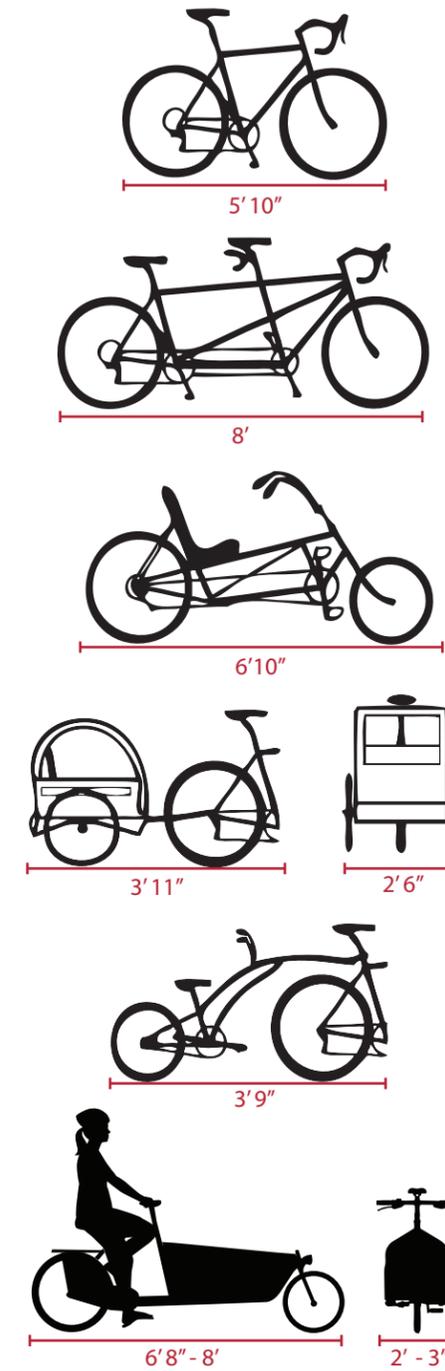
Similar to motor vehicles, bicyclists and their bicycles exist in a variety of sizes and configurations. These variations occur in the types of vehicle (such as a conventional bicycle, a recumbent bicycle or a tricycle), and behavioral characteristics (such as the comfort level of the bicyclist). The design of a bikeway should consider reasonably expected bicycle types on the facility and utilize the appropriate dimensions.

The figure below illustrates the operating space and physical dimensions of a typical adult bicyclist, which are the basis for typical facility design. Bicyclists require clear space to operate within a facility. This is why the minimum operating width is greater than the physical dimensions of the bicyclist. Bicyclists prefer five feet or more operating width, although four feet may be minimally acceptable.



Source: AASHTO Guide for the Development of Bicycle Facilities, 4th Edition. 2012.

In addition to the design dimensions of a typical bicycle, there are many other commonly used pedal-driven cycles and accessories to consider when planning and designing bicycle facilities. The most common types include tandem bicycles, recumbent bicycles, and trailer accessories. The figure and table below summarize the typical dimensions for bicycle types.



### Bicycle as Design Vehicle - Typical Dimensions

Source: AASHTO Guide for the Development of Bicycle Facilities, 4th Edition \*AASHTO does not provide typical dimensions for tricycles.

Bicycle Type	Feature	Typical Dimensions
Upright Adult Bicyclist	Physical width	2 ft 6 in
	Operating width (Minimum)	4 ft
	Operating width (Preferred)	5 ft
	Physical length	5 ft 10 in
	Physical height of handlebars	3 ft 8 in
	Operating height	8 ft 4 in
	Eye height	5 ft
Recumbent Bicyclist	Vertical clearance to obstructions (tunnel height, lighting, etc)	10 ft
	Approximate center of gravity	2 ft 9 in - 3 ft 4 in
	Physical length	8 ft
Tandem Bicyclist	Eye height	3 ft 10 in
	Physical length	8 ft
Bicyclist with child trailer	Physical length	10 ft
	Physical width	2 ft 6 in

### Bicycle as Design Vehicle - Design Speed Expectations

Bicycle Type	Feature	Typical Speed
Upright Adult Bicyclist	Paved level surfacing	15 mph
	Crossing Intersections	10 mph
	Downhill	30 mph
	Uphill	5 - 12 mph
Recumbent Bicyclist	Paved level surfacing	18 mph

\*Tandem bicycles and bicyclists with trailers have typical speeds equal to or less than upright adult bicyclists.

## Design Speed Expectations

The expected speed that different types of bicyclists can maintain under various conditions also influences the design of facilities such as shared use paths. The table to the right provides typical bicyclist speeds for a variety of conditions.

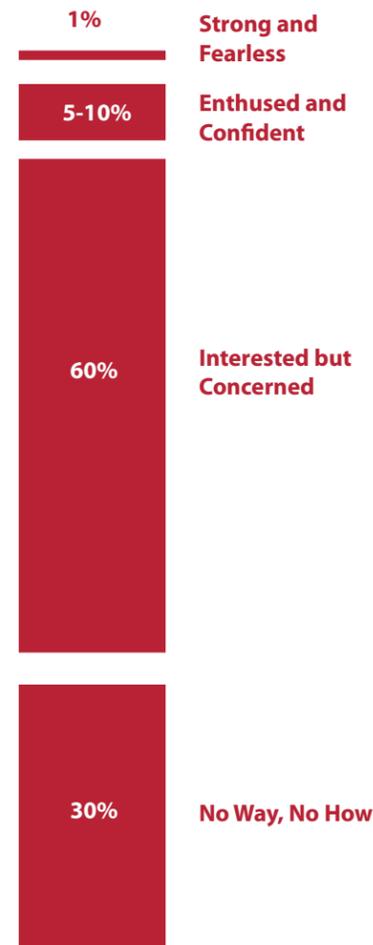


## Types of Bicyclists

It is important to consider bicyclists of all skill levels when creating a non-motorized plan or project. Bicyclist skill level greatly influences expected speeds and behavior, both in separated bikeways and on shared roadways. Bicycle infrastructure should accommodate as many user types as possible, with decisions for separate or parallel facilities based on providing a comfortable experience for the greatest number of people.

The bicycle planning and engineering professions currently use several systems to classify the population which can assist in understanding the characteristics and infrastructure preferences of different bicyclists. The current AASHTO Guide to the Development of Bicycle Facilities encourages designers to identify their rider type based on the trip purpose (Recreational vs Transportation) and on the level of comfort and skill of the rider (Causal vs Experienced). A more detailed framework for understanding of the US population's relationship to transportation focused bicycling is illustrated in the figure below. Developed by planners in Portland, OR<sup>1</sup> and supported by research<sup>2</sup>, this classification provides the following alternative categories to address varying attitudes towards bicycling in the US:

- **Strong and Fearless** (approximately 1% of population) – Characterized by bicyclists that will typically ride anywhere regardless of roadway conditions or weather. These bicyclists can ride faster than other user types, prefer direct routes and will typically choose roadway connections -- even if shared with vehicles -- over separate bicycle facilities such as shared use paths.
- **Enthusied and Confident** (5-10% of population) - This user group encompasses bicyclists who are fairly comfortable riding on all types of bikeways but usually choose low traffic streets or shared use paths when available. These bicyclists may deviate from a more direct route in favor of a preferred facility type. This group includes all kinds of bicyclists such as commuters, recreationalists, racers and utilitarian bicyclists.
- **Interested but Concerned** (approximately 60% of population) – This user type comprises the bulk of the cycling population and represents bicyclists who typically only ride a bicycle on low traffic streets or shared use paths under favorable weather conditions. These bicyclists perceive significant barriers to their increased use of cycling, specifically traffic and other safety issues. These people may become "Enthusied & Confident" with encouragement, education and experience.
- **No Way, No How** (approximately 30% of population) – Persons in this category are not bicyclists, and perceive severe safety issues with riding in traffic. Some people in this group may eventually become more regular cyclists with time and education. A significant portion of these people will not ride a bicycle under any circumstances.



Typical Distribution of Bicyclist Types

<sup>1</sup> Roger Geller, City of Portland Bureau of Transportation. *Four Types of Cyclists*. <http://www.portlandonline.com/transportation/index.cfm?a=237507>. 2009.

<sup>2</sup> Dill, J., McNeil, N. *Four Types of Cyclists? Testing a Typology to Better Understand Bicycling Behavior and Potential*. 2012.

# BICYCLE FACILITY SELECTION GUIDELINES

The specific bicycle facility type that should be provided depends on the surrounding environment (e.g. auto speed and volume, topography, and adjacent land use) and expected bicyclist needs (e.g. bicyclists commuting on a highway versus students riding to school on residential streets).



## Facility Selection Guidelines

There are no 'hard and fast' rules for determining the most appropriate type of bicycle facility for a particular location – roadway speeds, volumes, right-of-way width, presence of parking, adjacent land uses, and expected bicycle user types are all critical elements of this decision. Studies find that the most significant factors influencing bicycle use are motor vehicle traffic volumes and speeds. Additionally, most bicyclists prefer facilities separated from motor vehicle traffic or located on local roads with low motor vehicle traffic speeds and volumes. Because off-street pathways are physically separated from the roadway, they are perceived as safe and attractive routes for bicyclists who prefer to avoid motor vehicle traffic. Consistent use of treatments and application of bikeway facilities allow users to anticipate whether they would feel comfortable riding on a particular facility, and plan their trips accordingly. This section provides guidance on various factors that affect the type of facilities that should be provided.





# FACILITY CLASSIFICATION

## Description

Consistent with bicycle facility classifications throughout the nation, these Bicycle Facility Design Guidelines identify the following classes of facilities by degree of separation from motor vehicle traffic.

**Shared roadways** are bikeways where bicyclists and cars operate within the same travel lane, either side by side or in single file depending on roadway configuration. The most basic type of bikeway is a signed shared roadway. This facility provides continuity with other bicycle facilities (usually bike lanes), or designates preferred routes through high-demand corridors.



Shared roadways may also be designated by pavement markings, signage and other treatments including directional signage, traffic diverters, chicanes, chokers and /or other traffic calming devices to reduce vehicle speeds or volumes. Such treatments often are associated with Neighborhood Greenways.



**Separated Bikeways**, such as bike lanes, use signage and striping to delineate the right-of-way assigned to bicyclists and motorists. Bike lanes encourage predictable movements by both bicyclists and motorists.



**Cycle Tracks** are exclusive bike facilities that combine the user experience of a separated path with the on-street infrastructure of conventional bike lanes.



**Shared Use Paths** are facilities separated from roadways for use by bicyclists and pedestrians.



# FACILITY CONTINUA

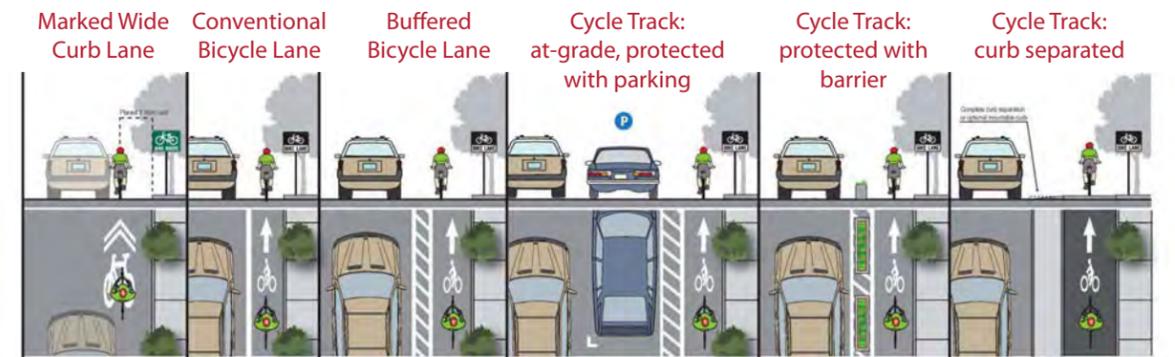
The following continua illustrate the range of bicycle facilities applicable to various roadway environments, based on the roadway type and desired degree of separation. Engineering judgment, traffic studies, previous municipal planning efforts, community input and local context should be used to refine criteria when developing bicycle facility recommendations for a particular street. In some corridors, it may be desirable to construct facilities to a higher level of treatment than those recommended in relevant planning documents in order to enhance user safety and comfort. In other cases, existing and/or future motor vehicle speeds and volumes may not justify the recommended level of separation, and a less intensive treatment may be acceptable.



## Arterial/Highway Bikeway Continuum (without curb and gutter)



## Arterial/Highway Bikeway Continuum (with curb and gutter)



## Collector Bikeway Continuum



# SHARED ROADWAYS





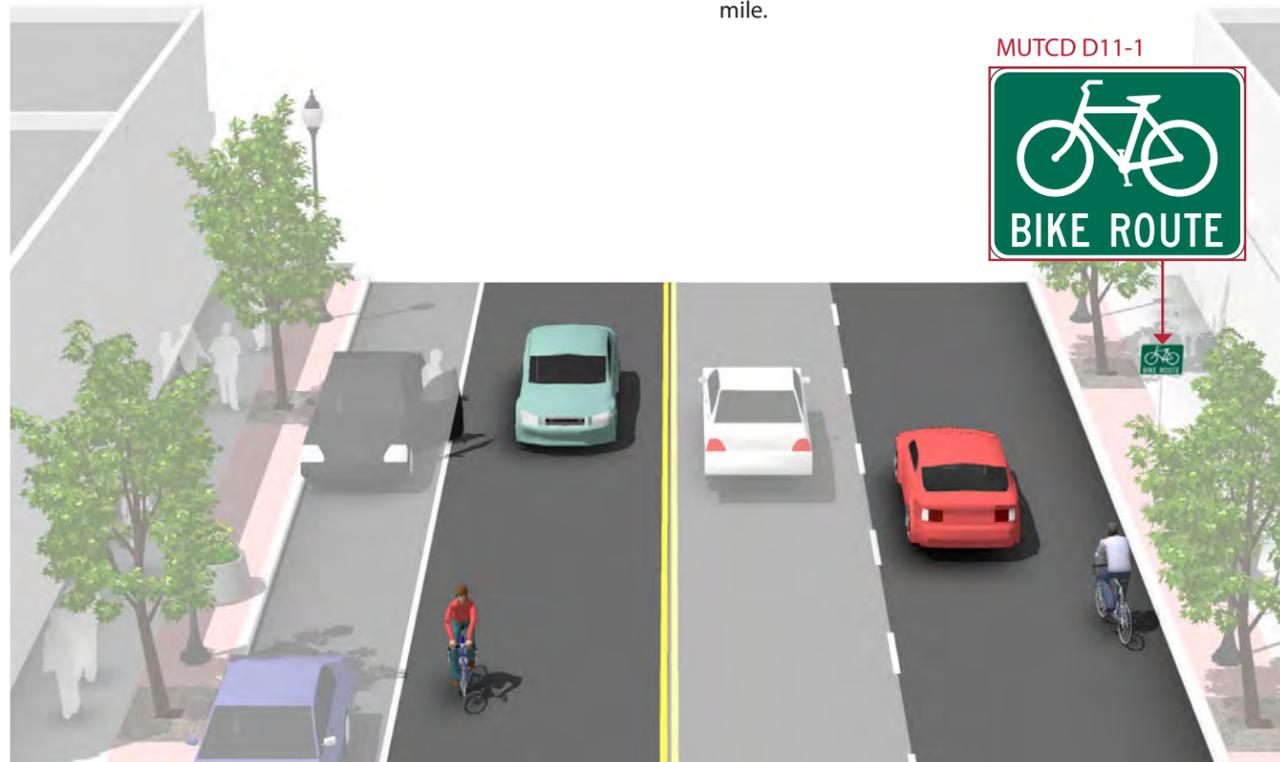
# SIGNED SHARED ROADWAYS

## Description

Signed shared roadways are facilities shared with motor vehicles. They are typically used on roads with low speeds and traffic volumes, however can be used on higher volume roads with wide outside lanes or shoulders. A motor vehicle driver will usually have to cross over into the adjacent travel lane to pass a bicyclist, unless a wide outside lane or shoulder is provided.

## Guidance

- Lane width varies depending on roadway configuration.
- Bike route signage (D11-1) should be applied at intervals frequent enough to keep bicyclists informed of changes in route direction and to remind motorists of the presence of bicyclists. Commonly, this includes placement at:
  - Beginning or end of Bicycle Route.
  - At major changes in direction or at intersections with other bicycle routes.
  - At intervals along bicycle routes not to exceed 1/2 mile.



## Discussion

Signed Shared Roadways serve either to provide continuity with other bicycle facilities (usually bike lanes) or to designate preferred routes through high-demand corridors.

This configuration differs from a neighborhood greenway due to a lack of traffic calming, wayfinding, pavement markings and other enhancements designed to provide a higher level of comfort for a broad spectrum of users.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
FHWA. *Manual on Uniform Traffic Control Devices*. 2009.

## Materials and Maintenance

Maintenance needs for bicycle wayfinding signs are similar to other signs, and will need periodic replacement due to wear.

# MARKED SHARED ROADWAYS

## Description

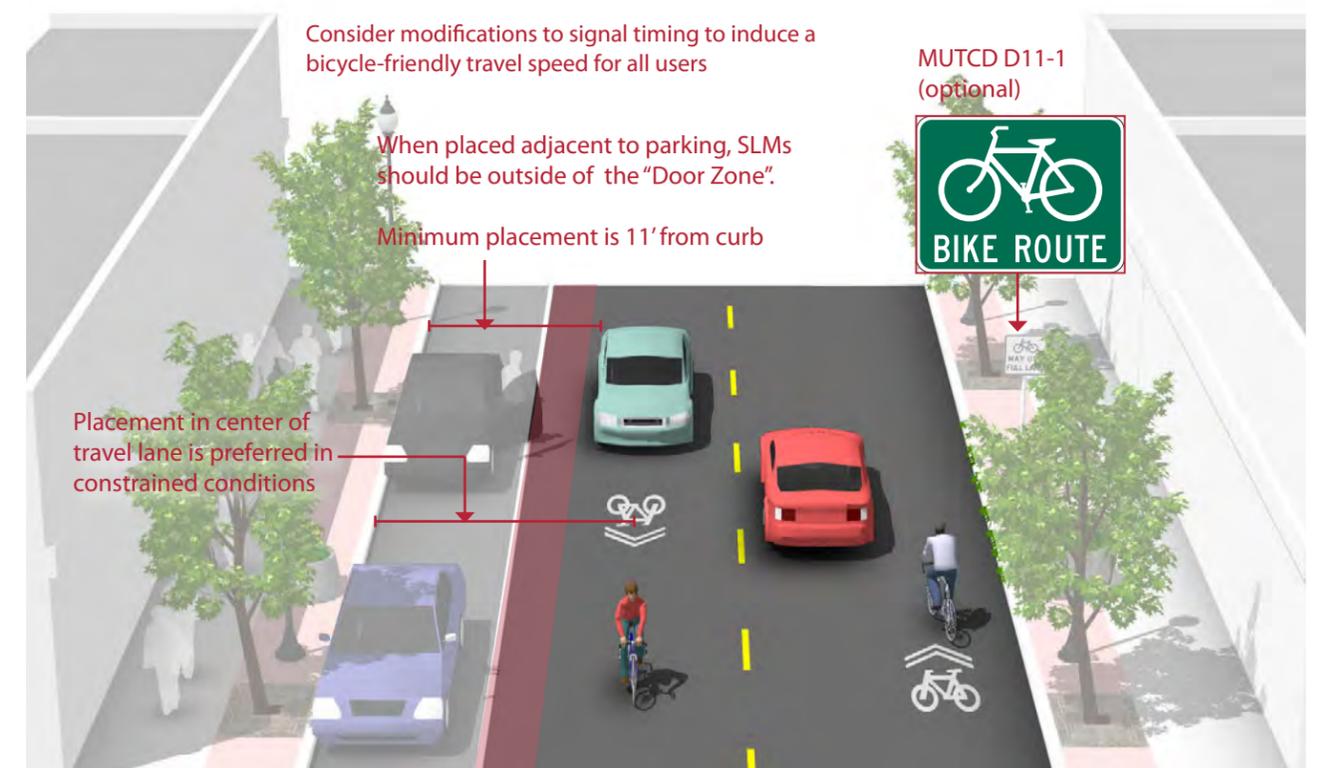
A marked shared roadway is a general purpose travel lane marked with shared lane markings (SLM) used to encourage bicycle travel and proper positioning within the lane.

In constrained conditions, the SLMs are placed in the middle of the lane. On a wide outside lane, the SLMs can be used to promote bicycle travel to the right of motor vehicles.

In all conditions, SLMs should be placed outside of the door zone of parked cars.

## Guidance

- May be used on streets with a speed limit of 35 mph or under. Lower than 30 mph speed limit preferred.
- In constrained conditions, preferred placement is in the center of the travel lane to minimize wear and promote single file travel.
- Minimum placement of SLM marking centerline is 11 feet from edge of curb where on-street parking is present, 4 feet from edge of curb with no parking. If parking lane is wider than 7.5 feet, the SLM should be moved further out accordingly.



## Discussion

If collector or arterial, this should not be a substitute for dedicated bicycle facilities if space is available.

Bike Lanes should be considered on roadways with outside travel lanes wider than 15 feet, or where other lane narrowing or removal strategies may provide adequate road space. SLMs shall not be used on shoulders, in designated bike lanes, or to designate bicycle detection at signalized intersections. (MUTCD 9C.07)

## Additional References and Guidelines

SCDOT. *TG-24: Use of Shared Lane Marking Symbols*.  
AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
FHWA. *Manual on Uniform Traffic Control Devices*. 2009.  
NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

Placing SLMs between vehicle tire tracks will increase the life of the markings and minimize the long-term cost of the treatment.



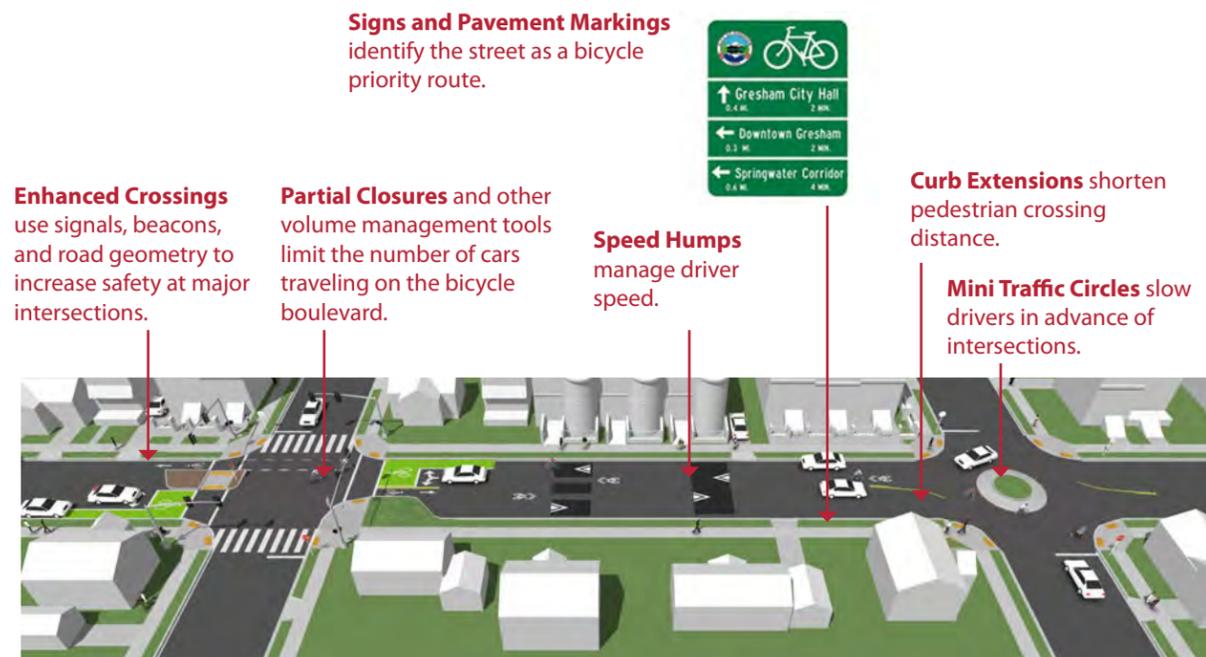
# BICYCLE BOULEVARDS

## Description

Bicycle boulevards are low-volume, low-speed streets modified to enhance bicyclist comfort by using treatments such as signage, pavement markings, traffic calming and/or traffic reduction, and intersection modifications. These treatments allow through movements of bicyclists while discouraging similar through-trips by non-local motorized traffic.

## Guidance

- Signs and pavement markings are the minimum treatments necessary to designate a street as a bicycle boulevard.
- Bicycle boulevards should have a maximum posted speed of 25 mph. Use traffic calming to maintain an 85th percentile speed below 22 mph.
- Implement volume control treatments based on the context of the bicycle boulevard, using engineering judgment. Target motor vehicle volumes range from 1,000 to 3,000 vehicles per day.
- Intersection crossings should be designed to enhance safety and minimize delay for bicyclists.



## Discussion

Bicycle boulevard retrofits to local streets are typically located on streets without existing signalized accommodation at crossings of collector and arterial roadways. Without treatments for bicyclists, these intersections can become major barriers along the bicycle boulevard and compromise safety.

Traffic calming can deter motorists from driving on a street. Anticipate and monitor vehicle volumes on adjacent streets to determine whether traffic calming results in inappropriate volumes. Traffic calming can be implemented on a trial basis.

## Additional References and Guidelines

Alta Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook*. 2009.  
 BikeSafe. *Bicycle countermeasure selection system*.  
 Ewing, Reid. *Traffic Calming: State of the Practice*. 1999.  
 Ewing, Reid and Brown, Steven. *U.S. Traffic Calming Manual*. 2009.

## Materials and Maintenance

Vegetation should be regularly trimmed to maintain visibility and attractiveness.

# ADVISORY BIKE LANE

## Description

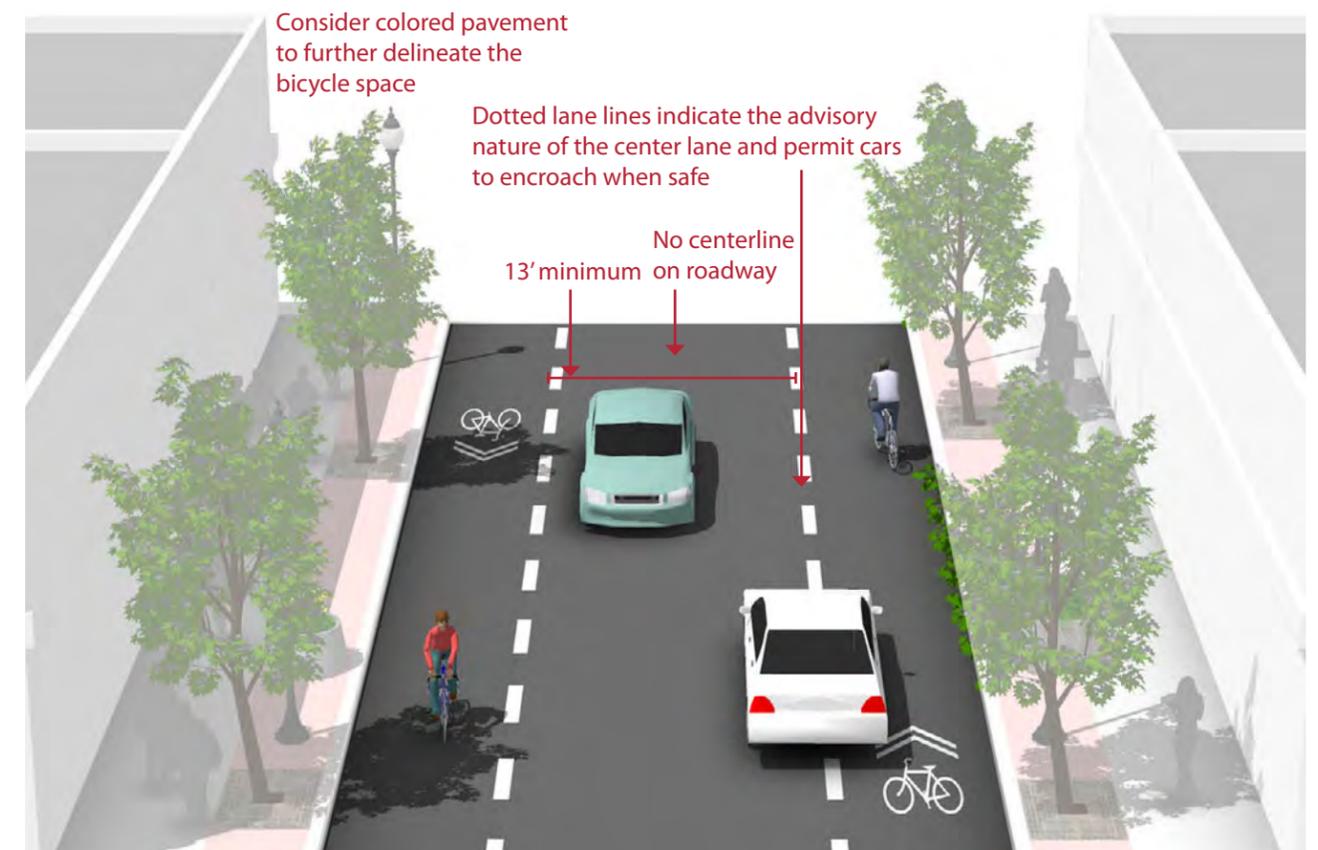
Advisory bike lanes are bicycle priority areas delineated by dotted white lines, separated from a narrow automobile travel area. The automobile zone should be configured narrowly enough so that two cars cannot pass each other in both directions without crossing the advisory lane line.

Motorists may only enter the bicycle zone when no bicycles are present. Motorists must overtake with caution due to potential oncoming traffic.

## Guidance

Advisory bike lanes can be used on roadways where the following conditions exist:

- Motor vehicle traffic is <4000 motor vehicles per day (<2000 preferred).
- Advisory bike lane width of 5 to 7 ft.
- Minimum 2-way motor vehicle travel lane width of 13-18 feet.
- No centerline on roadway.



## Discussion

Most appropriate when roadways are straight with few bends, inclines or sightline obstructions. Consider the use of colored pavement within the bicycle priority area to discourage unnecessary encroachment by motorists or parked vehicles. This treatment requires a request to experiment to be implemented on roadways funded with federal transportation dollars.

## Additional References and Guidelines

City of Minneapolis. Request To Experiment. July 2010.

## Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

# SEPARATED BIKEWAYS





# SHOULDER BIKEWAYS

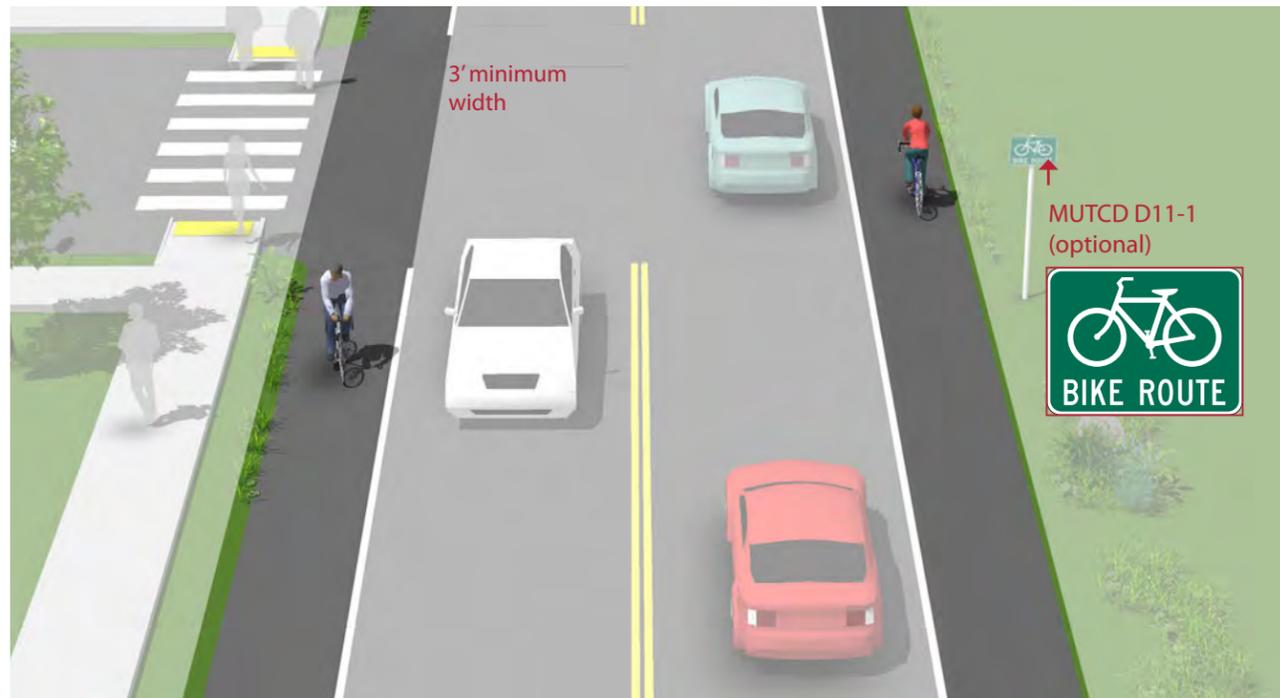
## Description

Typically found in less-dense areas, shoulder bikeways are paved roadways with striped shoulders (4'+) wide enough for bicycle travel. Shoulder bikeways often, but not always, include signage alerting motorists to expect bicycle travel along the roadway. Shoulder bikeways should be considered a temporary treatment, with full bike lanes planned for construction when the roadway is widened or completed with curb and gutter. This type of treatment is not typical in urban areas and should only be used where constraints exist.

## Guidance

If 4 feet or more is available for bicycle travel, the full bike lane treatment of signs, legends, and an 8" bike lane line would be provided.

- If it is not possible to meet minimum bicycle lane dimensions, a reduced width paved shoulder can still improve conditions for bicyclists on constrained roadways. In these situations, a minimum of 3 feet of operating space should be provided.
- Rumble strips are not recommended on shoulders used by bicyclists unless there is a minimum 4 foot clear path. 12 foot gaps every 40-60 feet should be provided to allow access as needed.



## Discussion

A wide outside lane may be sufficient accommodation for bicyclists on streets with insufficient width for bike lanes but which do have space available to provide a wider (14'-16') outside travel lane. Consider configuring as a marked shared roadway in these locations.

## Additional References and Guidelines

SCDOT. *EDM 53: Installation of Rumble Strips*.  
AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
FHWA. *Manual on Uniform Traffic Control Devices*. 2009.

## Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Shoulder bikeways should be cleared of snow through routine snow removal operations.

# CONVENTIONAL BIKE LANE

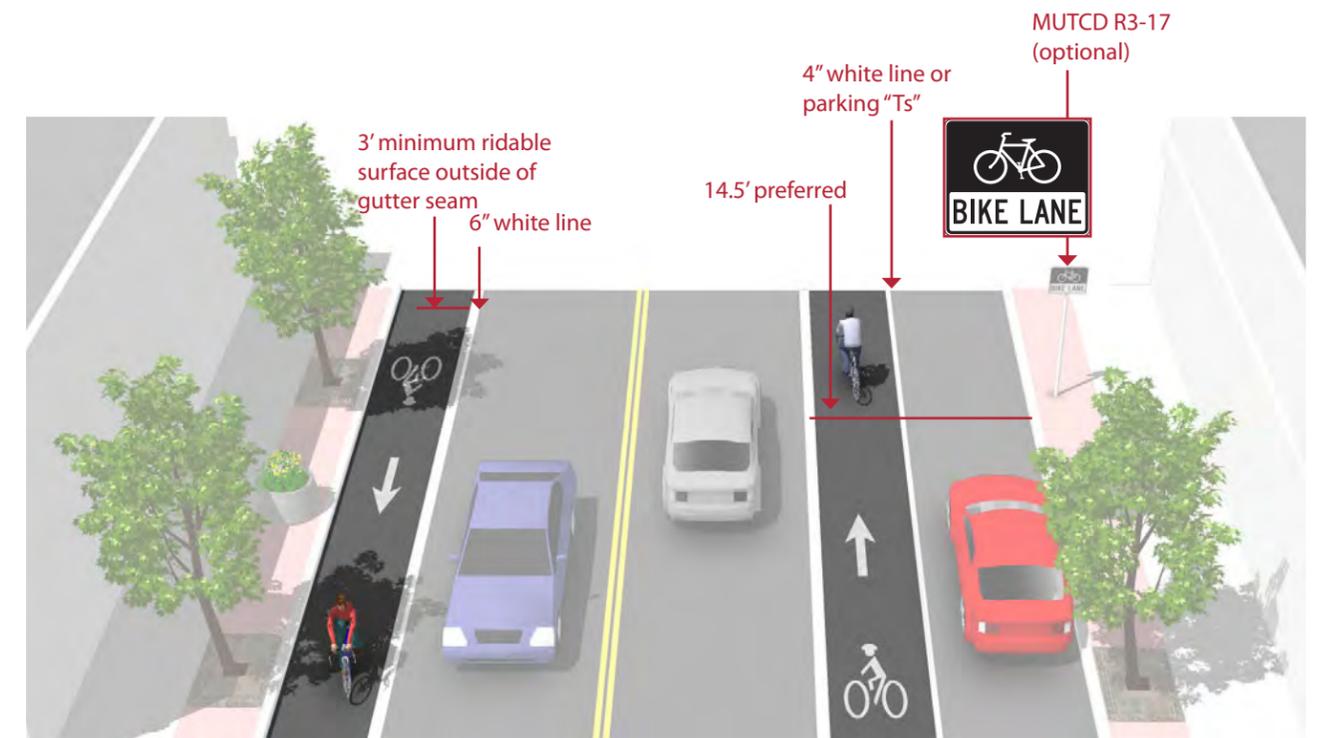
## Description

Bike lanes designate an exclusive space for bicyclists through the use of pavement markings and signage. The bike lane is located adjacent to motor vehicle travel lanes and is used in the same direction as motor vehicle traffic. Bike lanes are typically on the right side of the street, between the adjacent travel lane and curb, road edge or parking lane.

Many bicyclists, particularly less experienced riders, are more comfortable riding on a busy street if it has a striped and signed bikeway than if they are expected to share a lane with vehicles.

## Guidance

- 4 foot minimum when no curb and gutter is present.
- 5 foot minimum when adjacent to curb and gutter or 3 feet more than the gutter pan width if the gutter pan is wider than 2 feet.
- 14.5 foot preferred from curb face to edge of bike lane. (12 foot minimum).
- 7 foot maximum width for use adjacent to arterials with high travel speeds. Greater widths may encourage motor vehicle use of bike lane.



## Discussion

Wider bicycle lanes are desirable in certain situations such as on higher speed arterials (45 mph+) where use of a wider bicycle lane would increase separation between passing vehicles and bicyclists. Appropriate signing and stenciling is important with wide bicycle lanes to ensure motorists do not mistake the lane for a vehicle lane or parking lane. Consider buffered bike lanes when further separation is desired.

## Additional References and Guidelines

SCDOT. *EDM 22: Considerations for Bicycle Facilities*.  
AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
FHWA. *Manual on Uniform Traffic Control Devices*. 2009.  
NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

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# BIKE LANE ADJACENT TO ON-STREET PARKING

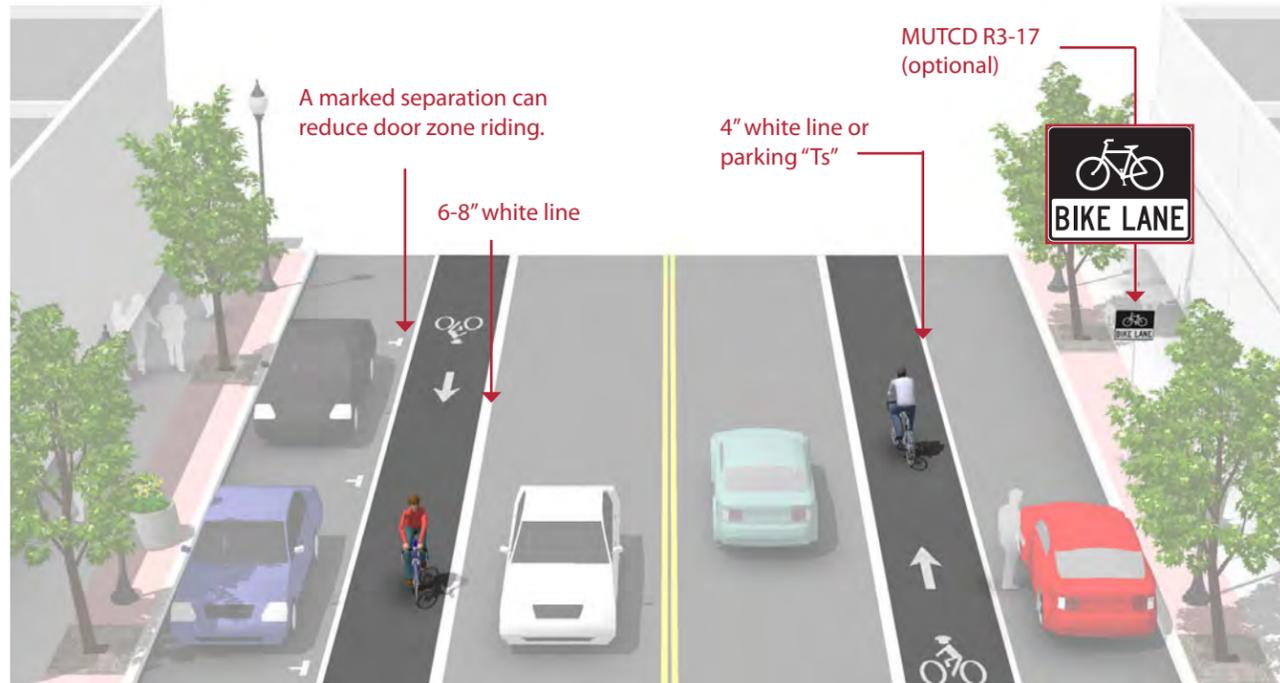
## Description

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Many bicyclists, particularly less experienced riders, are more comfortable riding on a busy street if it has a striped and signed bikeway than if they are expected to share a lane with vehicles.

## Guidance

- 12 foot minimum from curb face to edge of bike lane.
- 14.5 foot preferred from curb face to edge of bike lane.
- 7 foot maximum for marked width of bike lane. Greater widths may encourage vehicle loading in bike lane. Configure as buffered bicycle lanes when a wider facility is desired.



## Discussion

Bike lanes adjacent to on-street parallel parking require special treatment in order to avoid crashes caused by an open vehicle door. The bike lane should have sufficient width to allow bicyclists to stay out of the door zone while not encroaching into the adjacent vehicular lane. Parking stall markings, such as parking "Ts" and double white lines create a parking side buffer that encourages bicyclists to ride farther away from the door zone.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
 FHWA. *Manual on Uniform Traffic Control Devices*. 2009.  
 NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

# BIKEWAYS AND DIAGONAL PARKING

## Description

In certain areas with high parking demand such as urban commercial areas, diagonal parking can be used to increase parking supply.

Back-in diagonal parking improves sight distances between drivers and bicyclists when compared to conventional head-in diagonal parking. Back-in parking is best paired with a dedicated bicycle lane.

Conventional front-in diagonal parking is not compatible or recommended with the provision of bike lanes, as drivers backing out of conventional diagonal parking have limited visibility of approaching bicyclists. Under these conditions, shared lane markings should be used to guide bicyclists away from reversing automobiles.

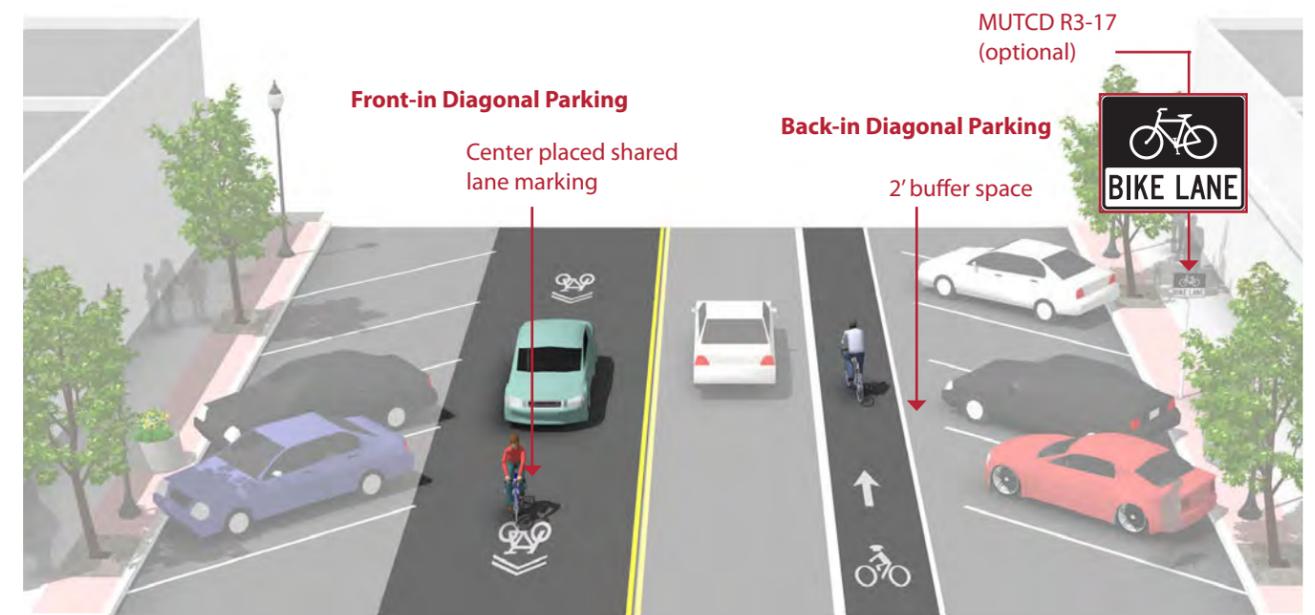
## Guidance

Front-in Diagonal Parking

- Shared lane markings are the preferred facility with front-in diagonal parking

Back-in Diagonal Parking

- 5 foot minimum marked width of bike lane
- Parking bays are sufficiently long to accommodate most vehicles (so vehicles do not block bike lane)



## Discussion

Back-in diagonal parking provides other benefits including loading and unloading of the trunk at the curb rather than in the street, passengers (including children) are directed by open doors towards the curb and there is no door conflict with bicyclists. While there may be a learning curve for some drivers, back-in diagonal parking is typically an easier maneuver than conventional parallel parking.

## Additional References and Guidelines

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

## Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.



# LEFT SIDE BIKE LANE

## Description

Left-side bike lanes are conventional bike lanes placed on the left side of one-way streets or two-way median divided streets.

Left-side bike lanes offer advantages on streets with heavy delivery or transit use, frequent parking turnover on the right side or other potential conflicts that could be associated with right-side bicycle lanes.

## Guidance

Follow guidance for conventional bike lanes.

Signage should accompany left-side bicycle lanes to clarify proper use by bicyclists to reduce wrong-way riding.

Bicycle through lanes should be provided to the right of vehicle left turn pockets to reduce conflicts at intersections.



## Discussion

Intersection treatments such as bike boxes and bike signals should be considered to assist in the transition from left-side bike lanes to right-side bike lanes.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
FHWA. *Manual on Uniform Traffic Control Devices*. 2009.  
NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

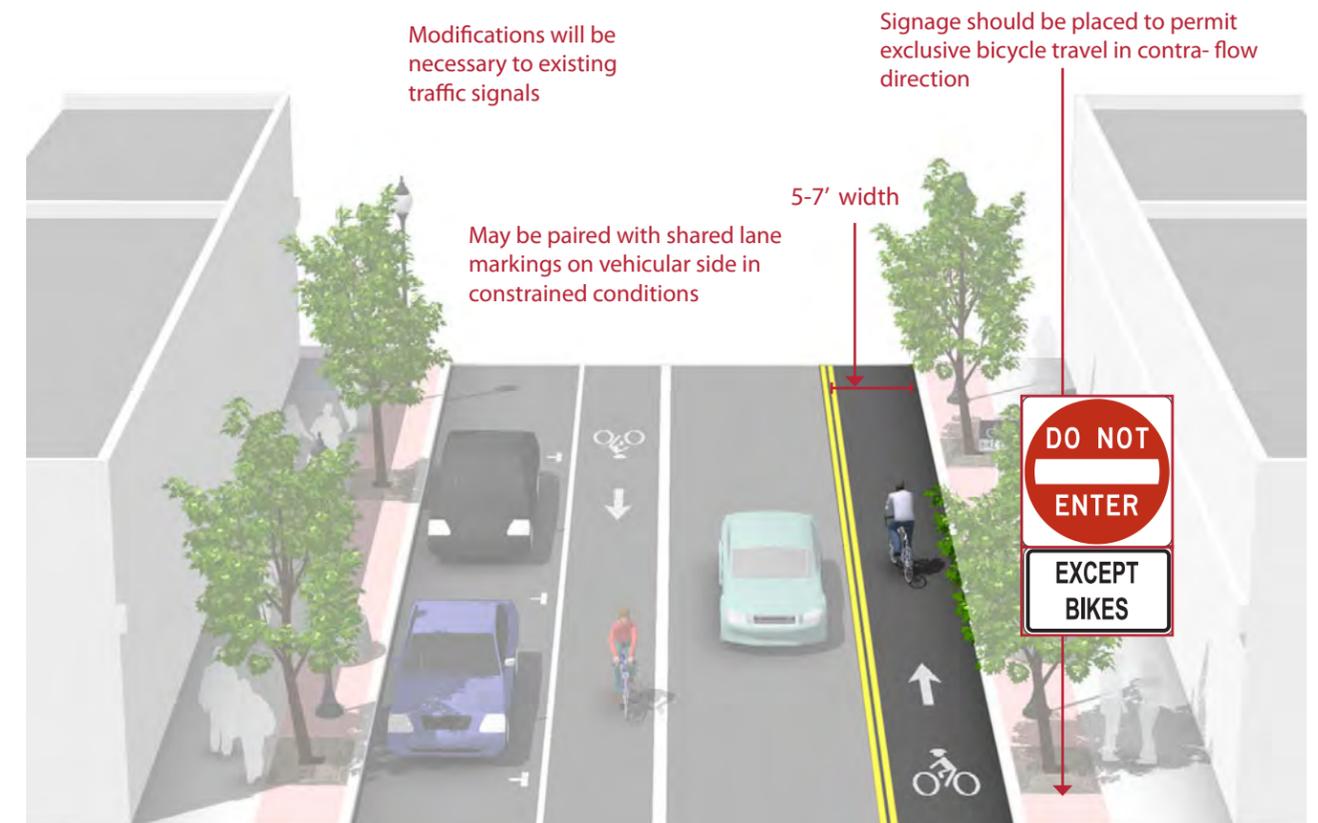
# CONTRA FLOW BIKE LANE

## Description

Contra-flow bike lanes provide bidirectional bicycle access on a roadway that is one-way for motor vehicle traffic. This treatment can provide direct access and connectivity for bicyclists and reducing travel distances. Contra-flow bike lanes can also be used to convert two-way motor vehicle traffic to one-way to reduce traffic volumes where desired.

## Guidance

- The contra-flow bike lane should be 5-7 feet wide and marked with a solid double yellow line and appropriate signage. Bike lane markings should be clearly visible to ensure that the contra-flow lane is exclusively for bicycles. Coloration should be considered in the bike lane.
- Signage specifically allowing bicycles at the entrance of the contra flow lane is recommended.



## Discussion

Because of the opposing direction of travel, contra-flow bike lanes increase the speed differential between bicyclists and motor vehicles in the adjacent travel lane. If space permits consider a buffered bike lane or cycle track configuration to provide additional separation.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
FHWA. *Manual on Uniform Traffic Control Devices*. 2009.  
NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

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# BUFFERED BIKE LANE

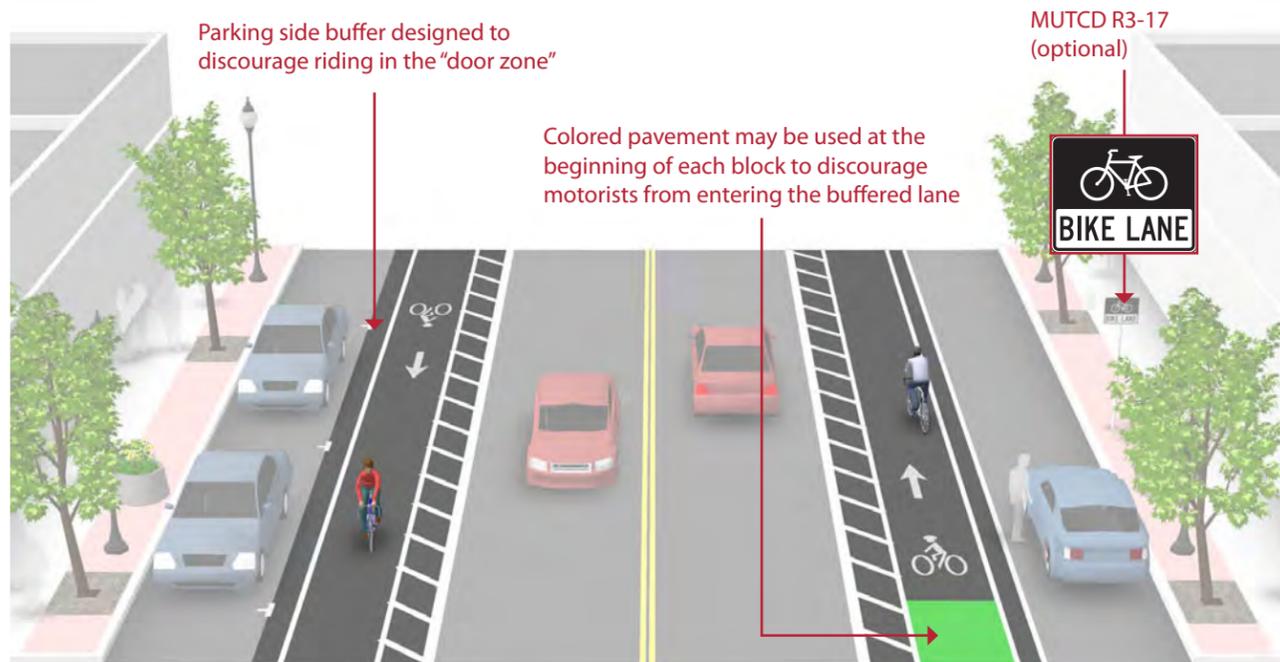
## Description

Buffered bike lanes are conventional bicycle lanes paired with a designated buffer space, separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane. Buffered bike lanes follow general guidance for buffered preferential vehicle lanes as per MUTCD guidelines (section 3D-01).

Buffered bike lanes are designed to increase the space between the bike lane and the travel lane and/or parked cars. This treatment is appropriate for bike lanes on roadways with high motor vehicle traffic volumes and speed, adjacent to parking lanes, or a high volume of truck or oversized vehicle traffic.

## Guidance

- The minimum bicycle travel area (not including buffer) is 5 feet wide.
- Buffers should be at least 2 feet wide. If 3 feet or wider, mark with diagonal or chevron hatching. For clarity at driveways or minor street crossings, consider a dotted line for the inside buffer boundary where cars are expected to cross.
- Buffered bike lanes can buffer the travel lane only, or parking lane only depending on available space and the objectives of the design.



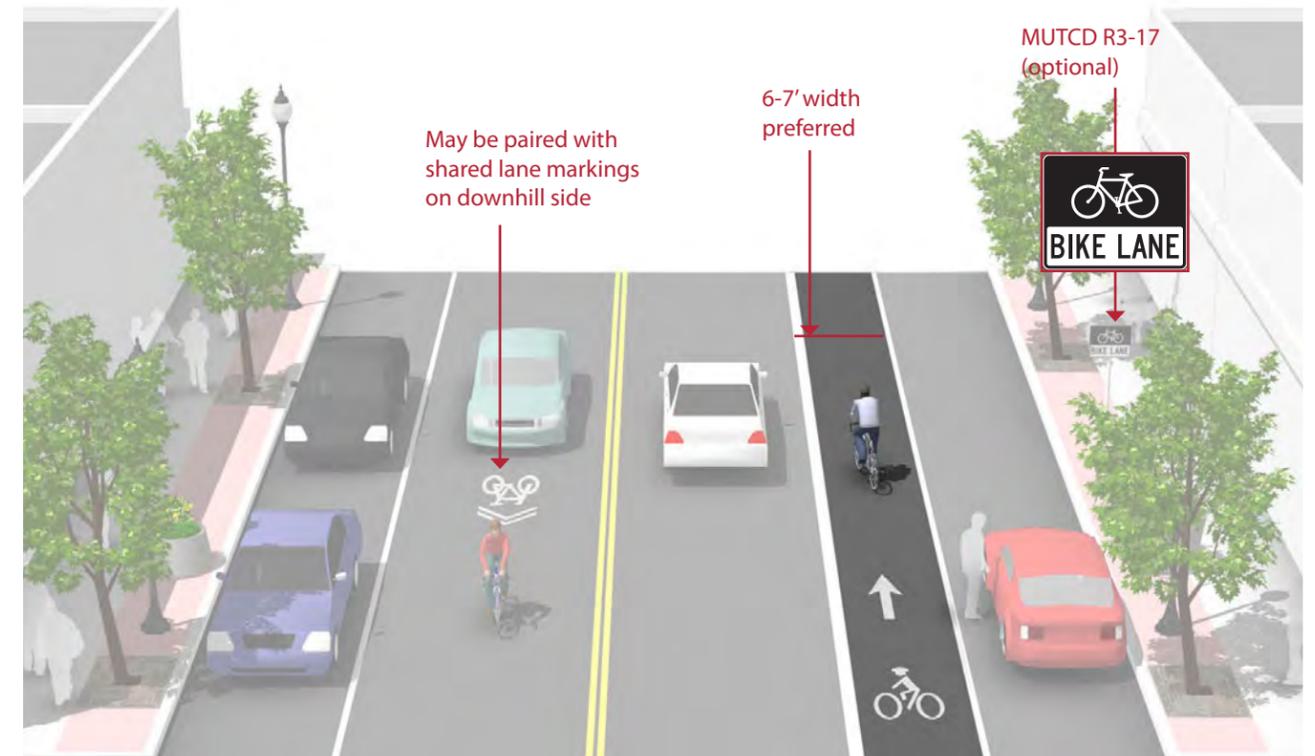
# UPHILL BICYCLE CLIMBING LANE

## Description

Uphill bike lanes (also known as "climbing lanes") enable motorists to safely pass slower-speed bicyclists, thereby improving conditions for both travel modes.

## Guidance

- Uphill bike lanes should be 6-7 feet wide (wider lanes are preferred because extra maneuvering room on steep grades can benefit bicyclists).
- Can be combined with shared lane markings for downhill bicyclists who can more closely match prevailing traffic speeds.



## Discussion

Frequency of right turns by motor vehicles at major intersections should determine whether continuous or truncated buffer striping should be used approaching the intersection. Commonly configured as a buffer between the bicycle lane and motor vehicle travel lane, a parking side buffer may also be provided to help bicyclists avoid the 'door zone' of parked cars.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
 FHWA. *Manual on Uniform Traffic Control Devices*. (3D-01). 2009.  
 NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

## Discussion

This treatment is typically found on retrofit projects as newly constructed roads should provide adequate space for bicycle lanes in both directions of travel. Accommodating an uphill bicycle lane often includes delineating on-street parking (if provided), narrowing travel lanes and/or shifting the centerline if necessary.

## Additional References and Guidelines

NACTO. *Urban Bikeway Design Guide*. 2012.  
 AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
 FHWA. *Manual on Uniform Traffic Control Devices*. 2009.

## Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates. Bicycle lanes should be cleared of snow through routine snow removal operations.

# PROTECTED BIKE LANES





# CYCLE TRACK SEPARATION AND PLACEMENT

## Description

Protection is provided through physical barriers and can include bollards, parking, a planter strip, an extruded curb, or on-street parking. Cycle tracks using these protection elements typically share the same elevation as adjacent travel lanes.

Raised cycle tracks may be at the level of the adjacent sidewalk or set at an intermediate level between the roadway and sidewalk to separate the cycle track from the pedestrian area.

## Guidance

- Cycle tracks should ideally be placed along streets with long blocks and few driveways or mid-block access points for motor vehicles. Cycle tracks located on one-way streets have fewer potential conflict areas than those on two-way streets.
- In situations where on-street parking is allowed, cycle tracks shall be located between the parking lane and the sidewalk (in contrast to bike lanes).



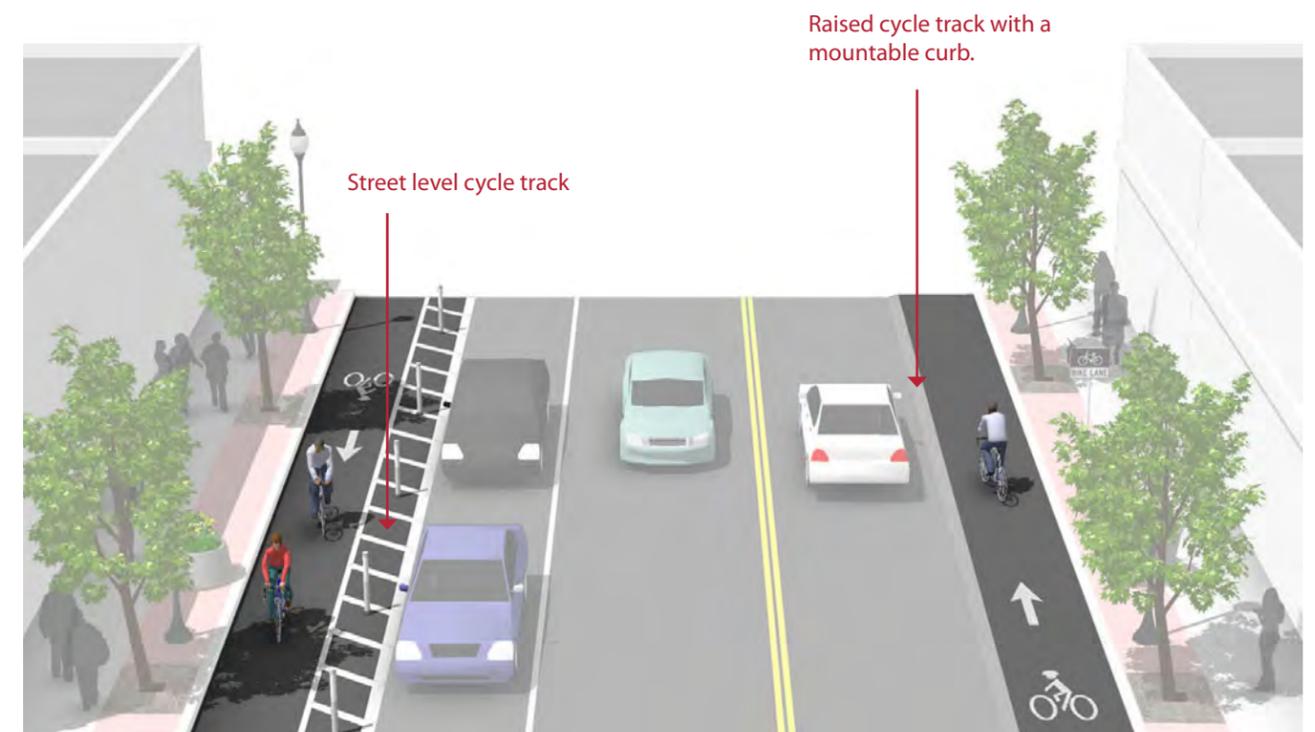
# ONE-WAY CYCLE TRACKS

## Description

One-way cycle tracks are physically separated from motor traffic and distinct from the sidewalk. Cycle tracks are either raised or at street level and use a variety of elements for physical protection from passing traffic.

## Guidance

- 7 foot recommended minimum to allow passing.
- 5 foot minimum width in constrained locations.
- When placed adjacent to parking, the parking buffer should be three feet wide to allow for passenger loading and to prevent door collisions.
- When placed adjacent to a travel lane, one-way raised cycle tracks may be configured with a mountable curb to allow entry and exit from the bicycle lane for passing other bicyclists or to access vehicular turn lanes.



## Discussion

Sidewalks or other pedestrian facilities should not be narrowed to accommodate the cycle track as pedestrians will likely walk on the cycle track if sidewalk capacity is reduced. Visual and physical cues (e.g., pavement markings & signage) should be used to make it clear where bicyclists and pedestrians should be travelling. If possible, separate the cycle track and pedestrian zone with a furnishing zone.

## Additional References and Guidelines

NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

In cities with winter climates, barrier separated and raised cycle tracks may require special equipment for snow removal.

## Discussion

Special consideration should be given at transit stops to manage bicycle and pedestrian interactions. Driveways and minor street crossings are unique challenges to cycle track design. Parking should be prohibited within 30 feet of the intersection to improve visibility. Color, yield markings and "Yield to Bikes" signage should be used to identify the conflict area and make it clear that the cycle track has priority over entering and exiting traffic. If configured as a raised cycle track, the crossing should be raised so that the sidewalk and cycle track maintain their elevation through the crossing.

## Additional References and Guidelines

NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

In cities with winter climates, barrier separated and raised cycle tracks may require special equipment for snow removal.



# TWO-WAY CYCLE TRACKS

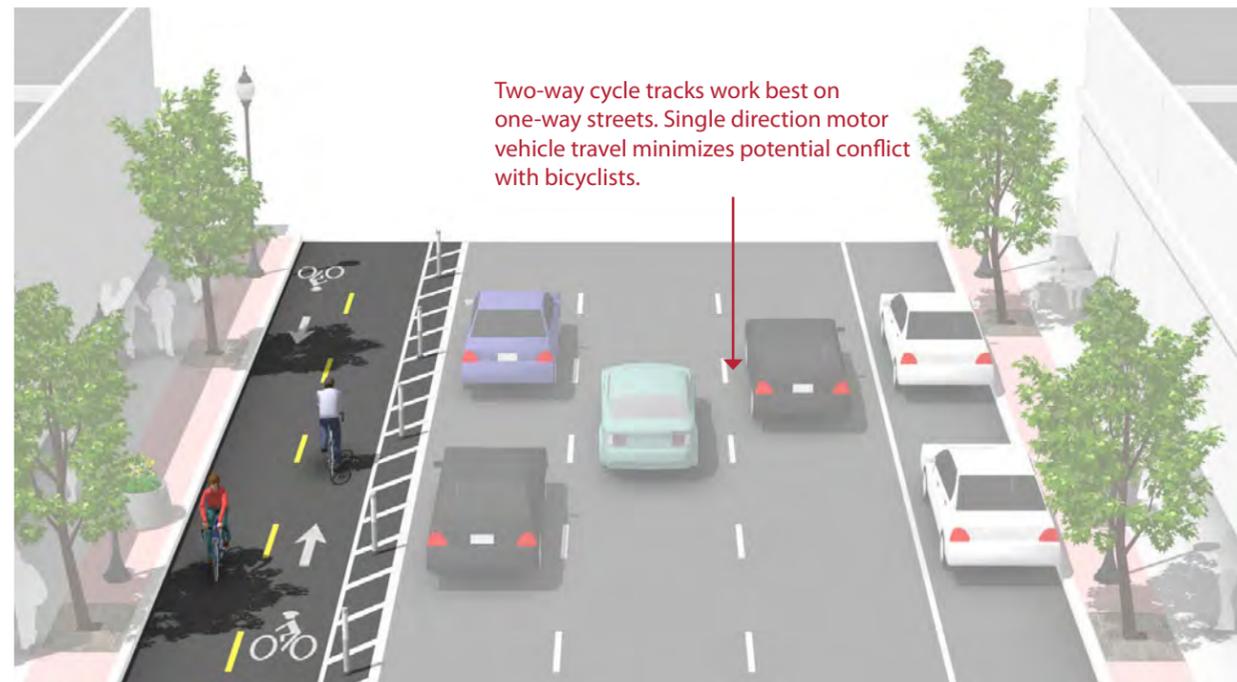
## Description

Two-way cycle tracks are physically separated cycle tracks that allow bicycle movement in both directions on one side of the road. Two-way cycle tracks share some of the same design characteristics as one-way cycle tracks, but may require additional considerations at driveway and side-street crossings.

A two-way cycle track may be configured as a protected cycle track at street level with a parking lane or other barrier between the cycle track and the motor vehicle travel lane and/or as a raised cycle track to provide vertical separation from the adjacent motor vehicle lane.

## Guidance

- 12 foot recommended minimum for two-way facility
- 8 foot minimum in constrained locations
- When placed adjacent to parking, the parking buffer should be three feet wide to allow for passenger loading and to prevent door collisions.



## Discussion

Cycle tracks will require careful assessment of intersection traffic operation, including traffic signal control, to ensure safe and efficient travel is maintained. Turning movements should be guided by separated signals for bicycles and conflicting motor vehicles. Transitions into and out of two-way cycle tracks should be simple and easy to use to deter bicyclists from continuing to ride against the flow of traffic.

At driveways and minor intersections, bicyclists riding against roadway traffic in two-way cycle tracks may surprise pedestrians and drivers not expecting bidirectional travel. Appropriate signage is recommended.

## Additional References and Guidelines

NACTO. *Urban Bikeway Design Guide*. 2012.  
ITE. *Separated Bikeways*. 2013.

## Materials and Maintenance

*In cities with winter climates barrier, separated and raised cycle tracks may require special equipment for snow removal.*

# DRIVEWAYS AND MINOR STREET CROSSINGS

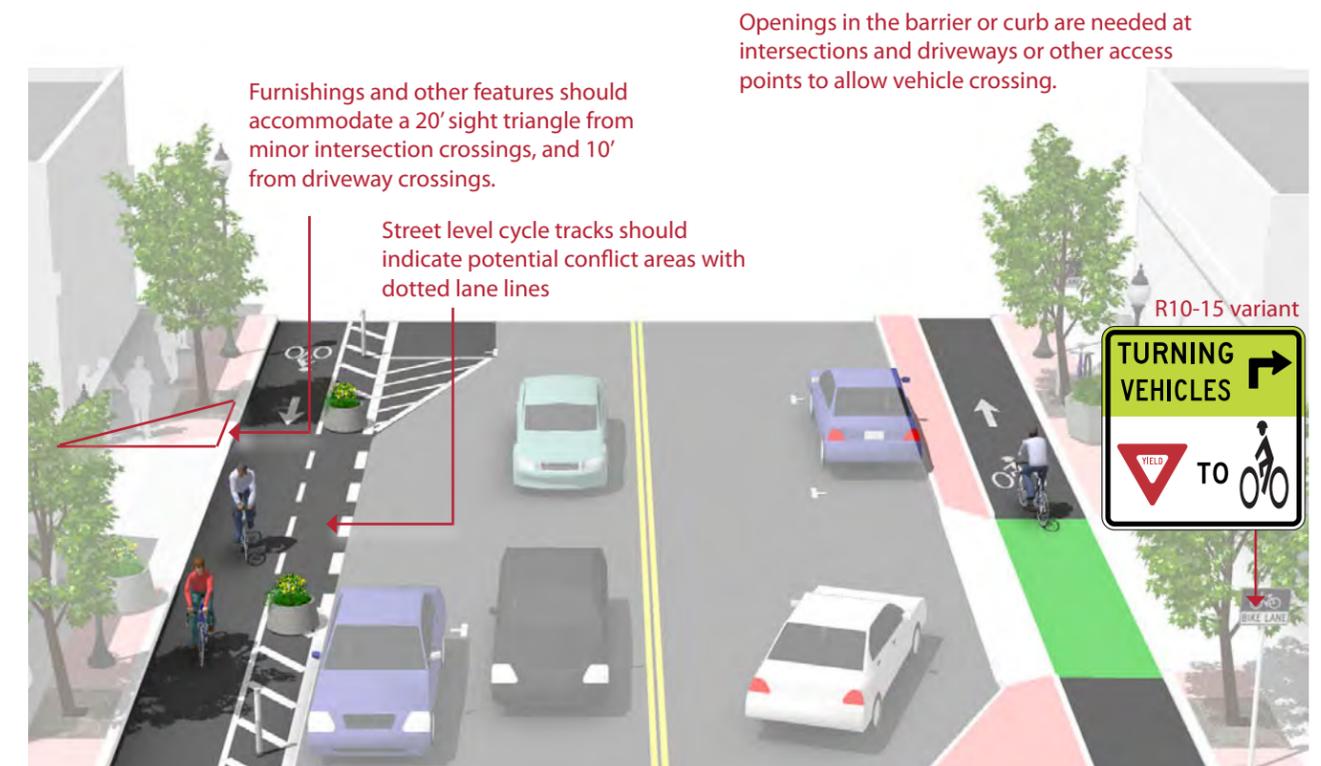
## Description

The added separation provided by cycle tracks creates additional considerations at intersections that should be addressed.

At driveways and crossings of minor streets a smaller fraction of automobiles will cross the cycle track. Bicyclists should not be expected to stop at these minor intersections if the major street does not stop.

## Guidance

- If raised, maintain the height of the cycle track through the crossing, requiring automobiles to cross over.
- Remove parking 30 feet prior the intersection.
- Use colored pavement markings and/or shared lane markings through the conflict area.
- Place warning signage to identify the crossing.



Openings in the barrier or curb are needed at intersections and driveways or other access points to allow vehicle crossing.

## Discussion

At these locations, bicyclist visibility is important, as a buffer of parked cars or vegetation can reduce the visibility of a bicyclist traveling in the cycle track. Markings and signage should be present that make it easy to understand where bicyclists and pedestrians should be travelling. Access management should be used to reduce the number of crossings of driveways on a cycle track. Driveway consolidations and restrictions on motorized traffic movements reduce the potential for conflict.

## Additional References and Guidelines

NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

In cities with winter climates, barrier separated and raised cycle tracks may require special equipment for snow removal.



# MAJOR STREET CROSSINGS

## Description

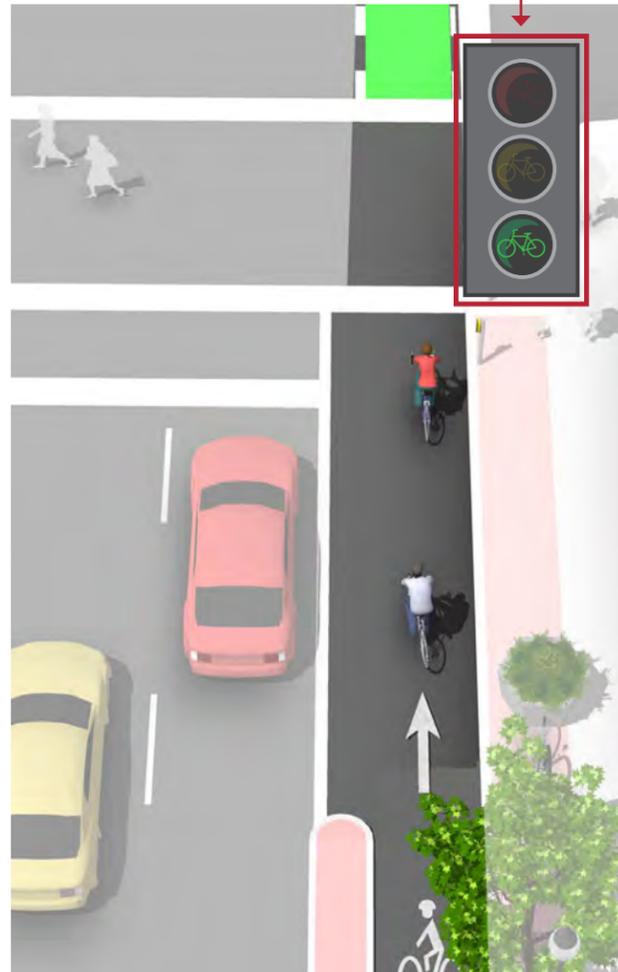
Cycle tracks approaching major intersections must minimize and mitigate potential conflicts and provide connections to intersecting facility types.

Cycle track crossings of signalized intersections can also be accomplished through the use of a bicycle signal phase which reduces conflicts with motor vehicles by separating bicycle movements from any conflicting motor vehicle movements.

## Guidance

- Drop cycle track buffer and transition to bike lane 16' in advance of the intersection.
- Remove parking 16' -50' in advance of the buffer termination.
- Use a bike box or advanced stop line treatment to place bicyclists in front of traffic.
- Use colored pavement markings through the conflict area.
- Provide for left-turning movements with two-stage turn boxes.
- Consider using a protected phase bicycle signal to isolate conflicts between bicyclists and motor vehicle traffic.
- In constrained conditions with right turn only lanes, consider transitioning to a shared bike lane/turn lane.

Demand-only bicycle signals can be implemented to reduce vehicle delay and to prevent an empty signal phase from regularly occurring.



## Discussion

Signalization utilizing a bicycle signal head can also be set to provide cycle track users a green phase in advance of vehicle phases. The length of the signal phase will depend on the width of the intersection.

The same conflicts exist at non-signalized intersections. Warning signs, special markings and the removal of on-street parking in advance of the intersection can raise visibility and awareness of bicyclists.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
 FHWA. *Manual on Uniform Traffic Control Devices*. 2009.  
 NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

In cities with winter climates, barrier separated and raised cycle tracks may require special equipment for snow removal.

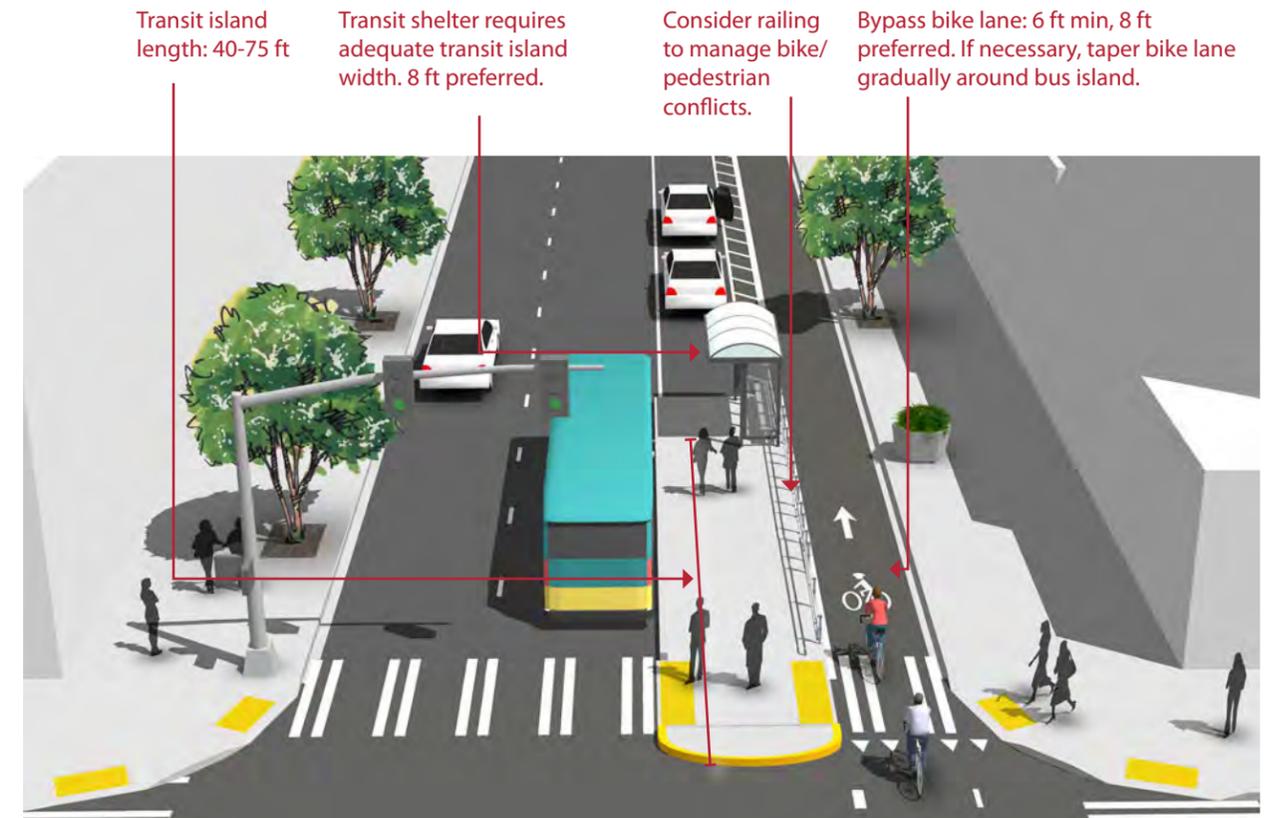
# BICYCLE TRANSIT BYPASS

## Description

The bicycle lane transit bypass is a channelized lane for bicycles designed to allow bicyclists to pass stopped buses, and prevent conflicts with buses pulling to the curb. This is particularly helpful on corridors with high volumes of transit vehicles and bicyclists, where "leapfrogging" may occur.

## Guidance

- Appropriate in areas with high volumes of buses and bicyclists.
- 6 foot minimum width bypass lane.
- Transit island should be wide enough to hold all waiting transit riders.



## Discussion

Ensure an adequate width bicycle lane where the bypass lane rejoins the roadway so that bicyclists do not encroach into adjacent lanes.

Conflicts with pedestrians may be increased over conventional bus stop designs. Consider railings to direct pedestrians to a single location where they may cross to the sidewalk.

## Additional References and Guidelines

NACTO. *Urban Bikeway Design Guide*. 2012.  
 NACTO. *Urban Street Design Guide*. 2013.

## Materials and Maintenance

*The channelized bicycle lane may require additional sweeping to maintain free of debris.*

# BIKEWAYS AT INTERSECTIONS





# BIKE BOX

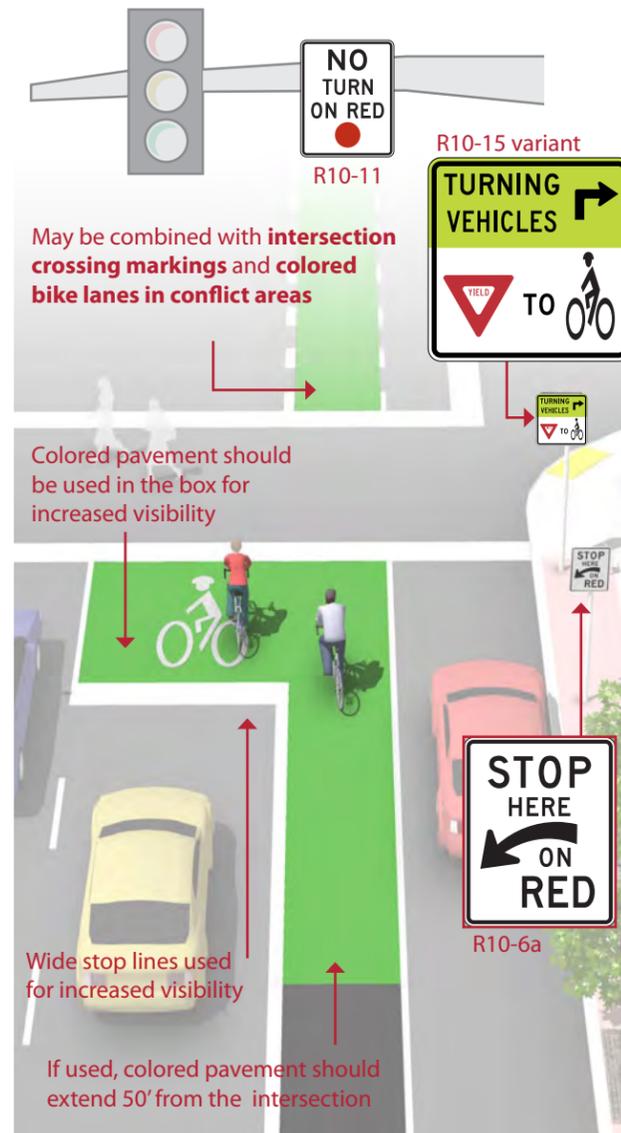
## Description

A bike box is a designated area located at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible space to get in front of queuing motorized traffic during the red signal phase. Motor vehicles must queue behind the white stop line at the rear of the bike box.

At locations with downhill grades or high speed bicycle travel, intersections will require additional safety measures to prevent conflicts between bicyclists proceeding straight and motorists turning right. Potential enhancements include designing the intersection to include a separate right turn lane, prohibiting all vehicle right turns, and/or providing an exclusive signal phase for bicycles.

## Guidance

- 14' minimum depth
- A "No Turn on Red" (MUTCD R10-11) sign shall be installed overhead to prevent vehicles from entering the Bike Box.
- A "Stop Here on Red" sign should be post-mounted at the stop line to reinforce observance of the stop line.
- A "Yield to Bikes" sign should be post-mounted in advance of and in conjunction with an egress lane to reinforce that bicyclists have the right-of-way going through the intersection.
- An ingress lane should be used to provide access to the box.
- A supplemental "Wait Here" legend can be provided in advance of the stop bar to increase clarity to motorists.



## Discussion

Bike boxes are considered experimental by the FHWA. Bike boxes should be placed only at signalized intersections, and right turns on red shall be prohibited for motor vehicles. Bike boxes should be used in locations that have a large volume of bicyclists and are best utilized in central areas where traffic is usually moving more slowly. Prohibiting right turns on red improves safety for bicyclists yet does not significantly impede motor vehicle travel.

## Additional References and Guidelines

NACTO. *Urban Bikeway Design Guide*. 2012.  
FHWA. Interim Approval (IA-14) has been granted. Requests to use green colored pavement need to comply with the provisions of Paragraphs 14 through 22 of Section 1A.10. 2011.

## Materials and Maintenance

Because the effectiveness of markings depends entirely on their visibility, maintaining markings should be a high priority.

# BIKE LANES AT RIGHT TURN ONLY LANES

## Description

The appropriate treatment at right-turn lanes is to place the bike lane between the right-turn lane and the right-most through lane or, where right-of-way is insufficient, to use a shared bike lane/turn lane.

The design (right) illustrates a bike lane pocket, with signage indicating that motorists should yield to bicyclists through the conflict area.

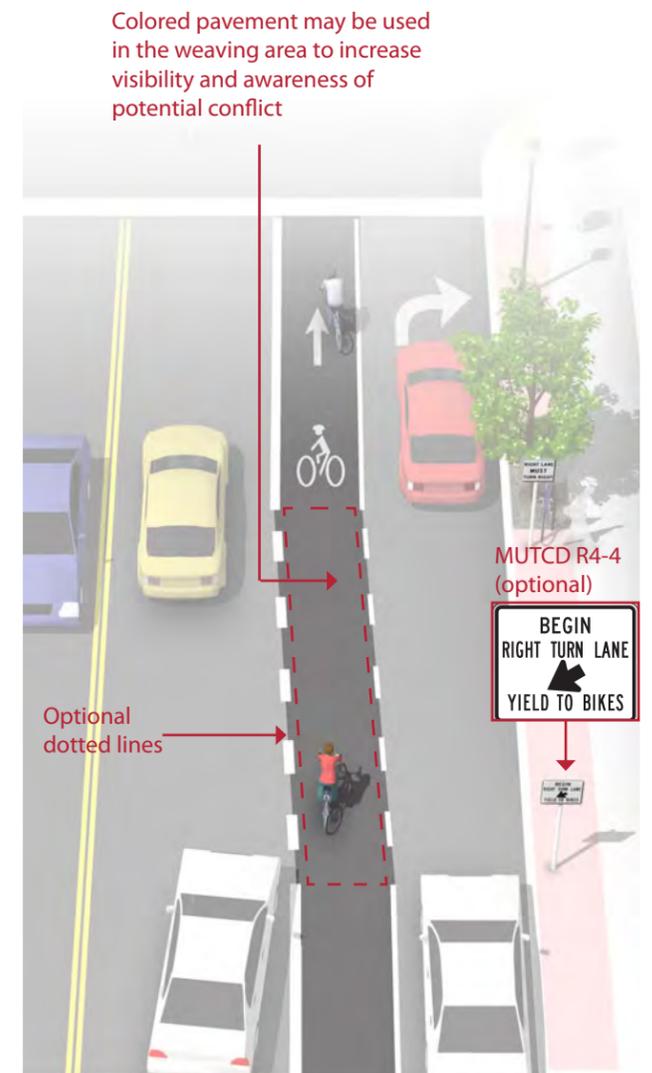
## Guidance

### At auxiliary right turn only lanes (add lane):

- Continue existing bike lane width; standard width of 5 to 6 feet or 4 feet in constrained locations.
- Use signage to indicate that motorists should yield to bicyclists through the conflict area.
- Consider using colored conflict areas to promote visibility of the mixing zone.

### Where a through lane becomes a right turn only lane:

- Do not define a dotted line merging path for bicyclists.
- Drop the bicycle lane in advance of the merge area.
- Use shared lane markings to indicate shared use of the lane in the merging zone.



## Discussion

For other potential approaches to providing accommodations for bicyclists at intersections with turn lanes, please see guidance on shared bike lane/turn lane, bicycle signals, and colored bike facilities.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
FHWA. *Manual on Uniform Traffic Control Devices*. 2009.  
NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

Because the effectiveness of markings depends entirely on their visibility, maintaining markings should be a high priority.



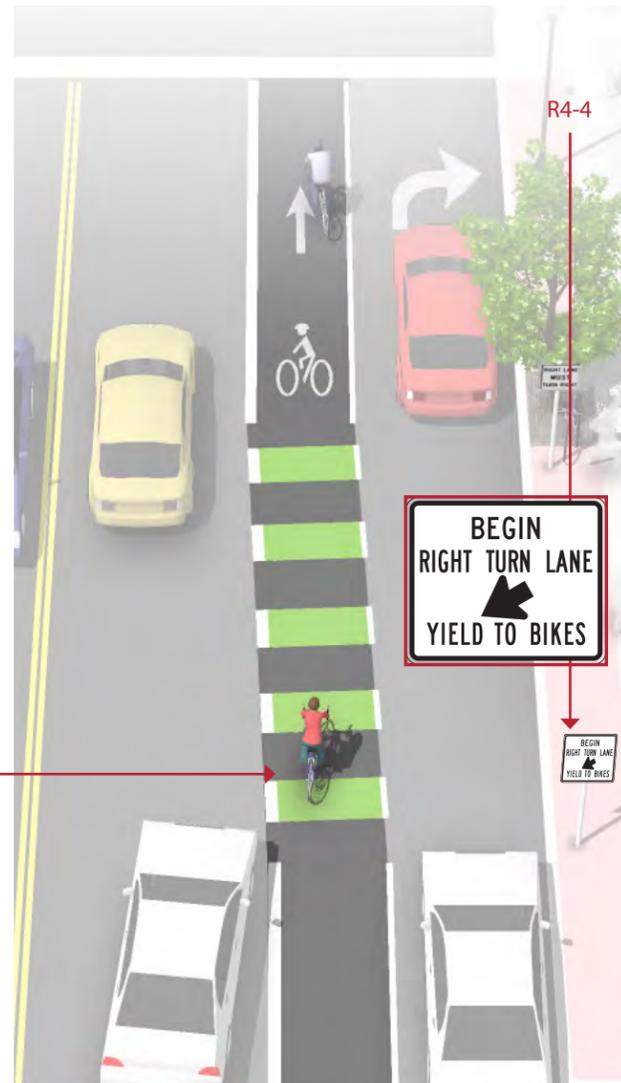
# COLORED BIKE LANES IN CONFLICT AREAS

## Description

Colored pavement within a bicycle lane increases the visibility of the facility and reinforces priority of bicyclists in conflict areas.

## Guidance

- Green colored pavement was given interim approval by the Federal Highways Administration in March 2011. See interim approval for specific colored pavement standards.
- The colored surface should be skid resistant and retro-reflective.
- A "Yield to Bikes" sign should be used at intersections or driveway crossings to reinforce that bicyclists have the right-of-way in colored bike lane areas.



Normal white dotted edge lines should define colored space

## Discussion

Evaluations performed in Portland, OR, St. Petersburg, FL and Austin, TX found that significantly more motorists yielded to bicyclists and slowed or stopped before entering the conflict area after the application of the colored pavement when compared with an uncolored treatment.

## Additional References and Guidelines

FHWA. Interim Approval (IA-14) has been granted. Requests to use green colored pavement need to comply with the provisions of Paragraphs 14 through 22 of Section 1A.10. 2011.  
NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

Because the effectiveness of markings depends entirely on their visibility, maintaining markings should be a high priority.

# COMBINED BIKE LANE/TURN LANE

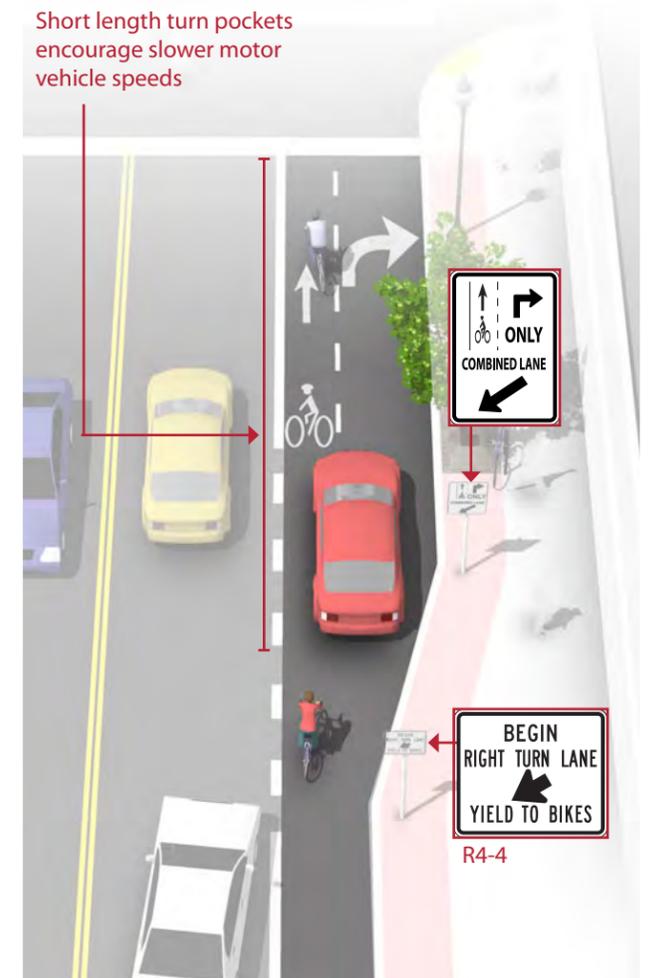
## Description

The combined bike lane/turn lane places a standard-width bike lane on the left side of a dedicated right turn lane. A dotted line delineates the space for bicyclists and motorists within the shared lane. This treatment includes signage advising motorists and bicyclists of proper positioning within the lane.

This treatment is recommended at intersections lacking sufficient space to accommodate both a standard through bike lane and right turn lane.

## Guidance

- Maximum shared turn lane width is 13 feet; narrower is preferable.
- Bike Lane pocket should have a minimum width of 4 feet with 5 feet preferred.
- A dotted 4 inch line and bicycle lane marking should be used to clarify bicyclist positioning within the combined lane, without excluding cars from the suggested bicycle area.
- A "Right Turn Only" sign with an "Except Bicycles" plaque may be needed to make it legal for through bicyclists to use a right turn lane.



Short length turn pockets encourage slower motor vehicle speeds

## Discussion

Case studies cited by the Pedestrian and Bicycle Information Center indicate that this treatment works best on streets with lower posted speeds (30 MPH or less) and with lower traffic volumes (10,000 ADT or less). May not be appropriate for high-speed arterials or intersections with long right turn lanes. May not be appropriate for intersections with large percentages of right-turning heavy vehicles.

## Additional References and Guidelines

NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

Locate markings out of tire tread to minimize wear. Because the effectiveness of markings depends on their visibility, maintaining markings should be a high priority.



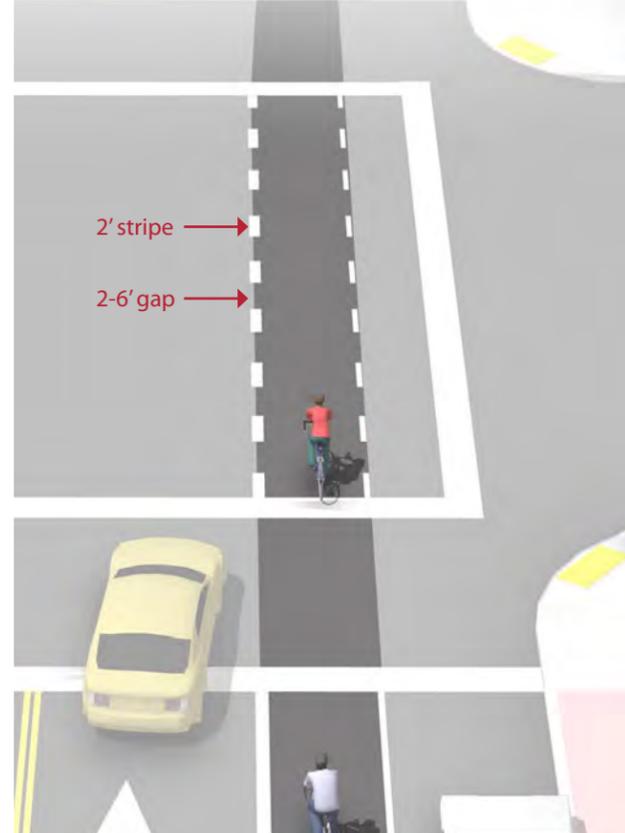
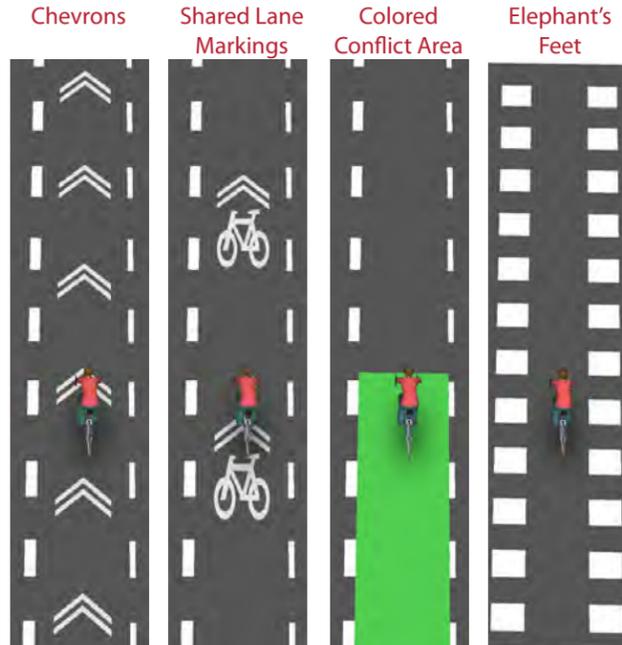
# INTERSECTION CROSSING MARKINGS

## Description

Bicycle pavement markings through intersections indicate the intended path of bicyclists through an intersection or across a driveway or ramp. They guide bicyclists on a safe and direct path through the intersection and provide a clear boundary between the paths of through bicyclists and either through or crossing motor vehicles in the adjacent lane.

## Guidance

- See MUTCD Section 3B.08: "dotted line extensions"
- Crossing striping shall be at least six inches wide when adjacent to motor vehicle travel lanes. Dotted lines should be two-foot lines spaced two to six feet apart.
- Chevrons, shared lane markings, or colored bike lanes in conflict areas may be used to increase visibility within conflict areas or across entire intersections. Elephant's Feet markings are common in Europe and Canada.



## Discussion

Additional markings such as chevrons, shared lane markings, or colored bike lanes in conflict areas are strategies currently in use in the United States and Canada. Cities considering the implementation of markings through intersections should standardize future designs to avoid confusion.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
 FHWA. *Manual on Uniform Traffic Control Devices*. (3A.06). 2009.  
 NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

Because the effectiveness of marked crossings depends entirely on their visibility, maintaining marked crossings should be a high priority.

# TWO-STAGE TURN BOX

## Description

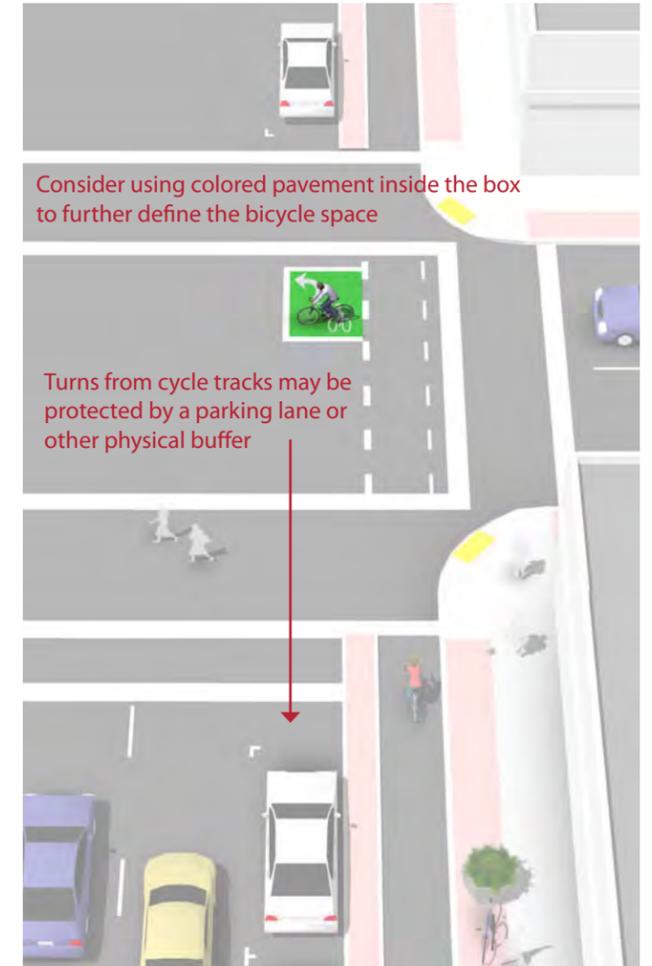
Two-stage turn queue boxes offer bicyclists a safe way to make left turns at multi-lane signalized intersections from a right side cycle track or bike lane.

On right side cycle tracks, bicyclists are often unable to merge into traffic to turn left due to physical separation, making the provision of two-stage left turn boxes critical. Design guidance for two-stage turns apply to both bike lanes and cycle tracks.

## Guidance

- The queue box shall be placed in a protected area. Typically this is within an on-street parking lane or cycle track buffer area.
- 6' minimum depth of bicycle storage area
- Bicycle stencil and turn arrow pavement markings shall be used to indicate proper bicycle direction and positioning.
- A "No Turn on Red" (MUTCD R10-11) sign shall be installed on the cross street to prevent vehicles from entering the turn box.

Turns from a bicycle lane may be protected by an adjacent parking lane or crosswalk setback space



Consider using colored pavement inside the box to further define the bicycle space

Turns from cycle tracks may be protected by a parking lane or other physical buffer

Cycle track turn box protected by physical buffer:

Bike lane turn box protected by parking lane:



## Discussion

Two-Stage Turn boxes are considered experimental by FHWA.

While two stage turns may increase bicyclist comfort in many locations, this configuration will typically result in higher average signal delay for bicyclists due to the need to receive two separate green signal indications (one for the through street, followed by one for the cross street) before proceeding.

## Additional References and Guidelines

NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

Paint can wear more quickly in high traffic areas or in winter climates.



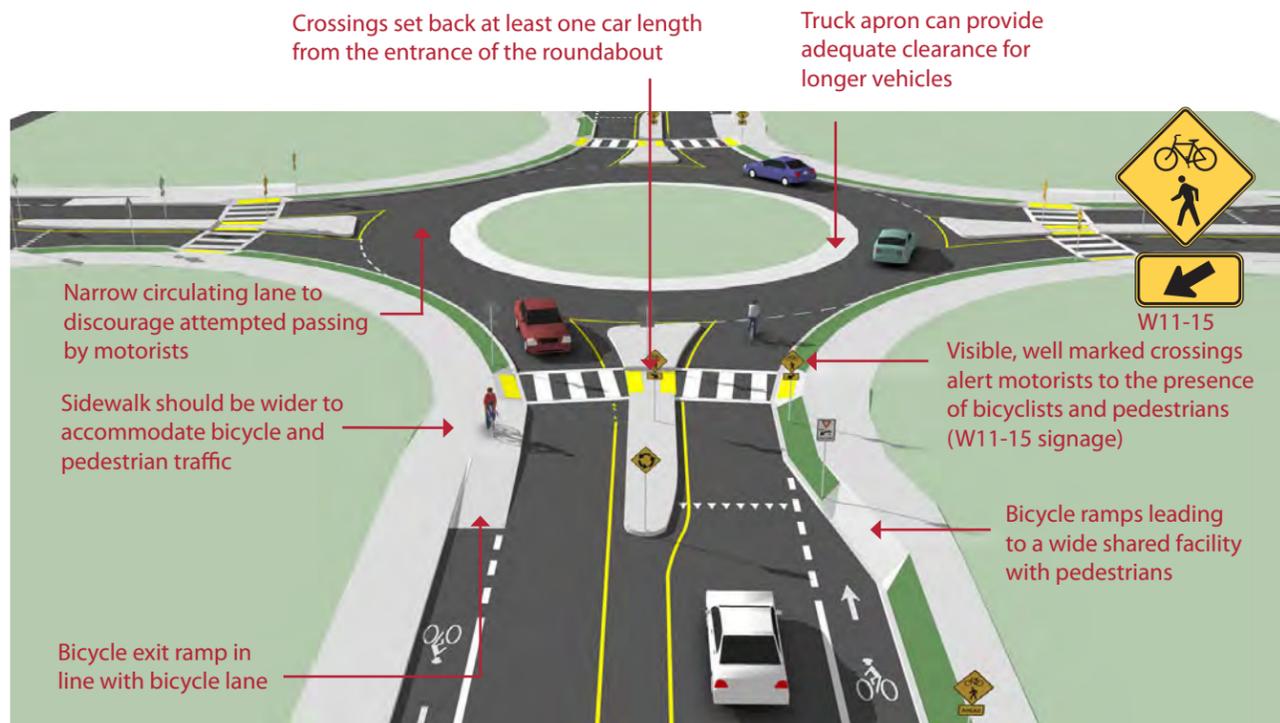
# BICYCLISTS AT SINGLE LANE ROUNDABOUTS

## Description

In single lane roundabouts it is important to indicate to motorists, bicyclists and pedestrians the right-of-way rules and correct way for them to circulate, using appropriately designed signage, pavement markings, and geometric design elements.

## Guidelines

- 25 mph maximum circulating design speed.
- Design approaches/exits to the lowest speeds possible.
- Encourage bicyclists navigating the roundabout like motor vehicles to “take the lane.”
- Maximize yielding rate of motorists to pedestrians and bicyclists at crosswalks.
- Provide separated facilities for bicyclists who prefer not to navigate the roundabout on the roadway.



## Discussion

Research indicates that while single-lane roundabouts may benefit bicyclists and pedestrians by slowing traffic, multi-lane roundabouts may present greater challenges and significantly increase safety problems for these users.

## Additional References and Guidelines

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

FHWA. *Roundabouts: An Informational Guide*. 2000.

TRB. *Roundabouts: An Informational Guide, Second Edition*. NCHRP 672. 2010.

## Materials and Maintenance

Signage and striping require routine maintenance.

# BIKE LANES AT HIGH SPEED INTERCHANGES

## Description

Some arterials may contain high speed freeway-style designs such as merge lanes and exit ramps, which can create difficulties for bicyclists. The entrance and exit lanes typically have intrinsic visibility problems because of low approach angles and feature high speed differentials between bicyclists and motor vehicles.

Strategies to improve safety focus on increasing sight distances, creating formal crossings, and minimizing crossing distances.

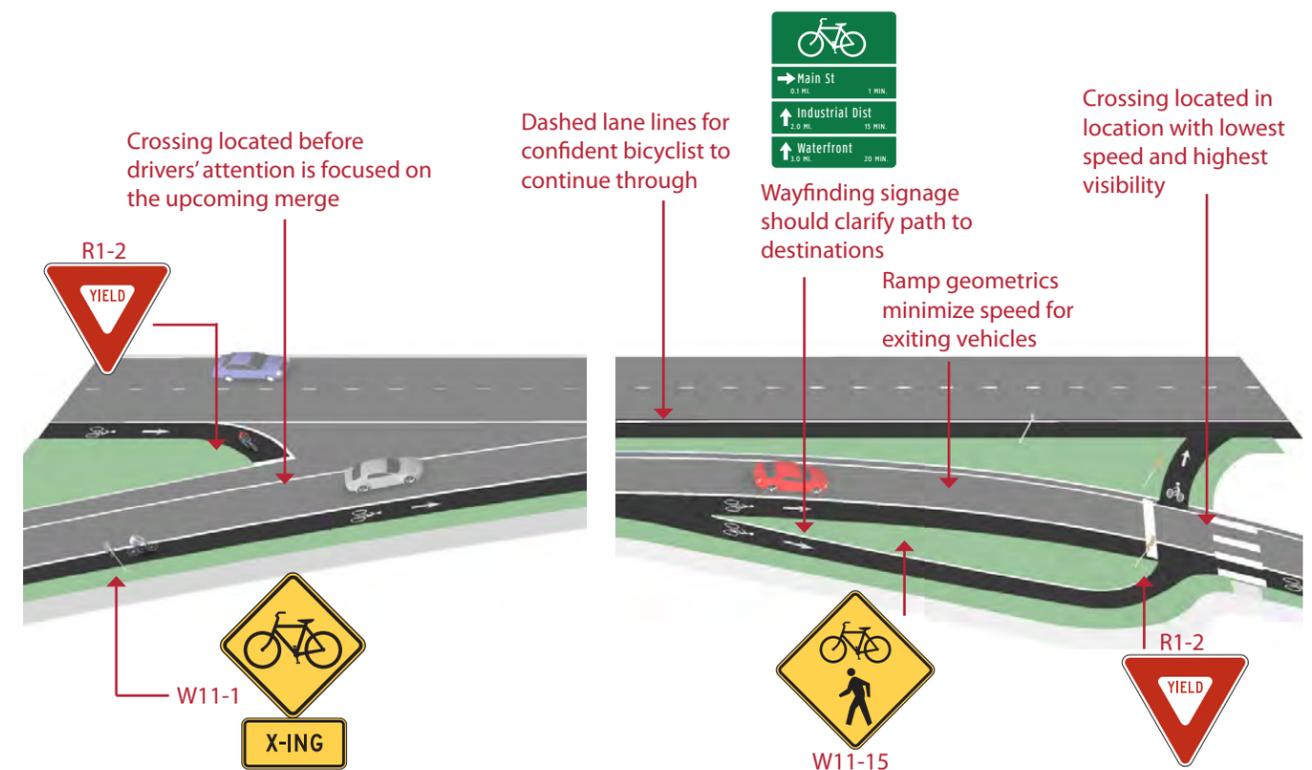
## Guidance

### Entrance Ramps:

Angle the bike lane to increase the approach angle with entering traffic. Position crossing before drivers' attention is focused on the upcoming merge.

### Exit Ramps:

Use a jug handle turn to bring bicyclists to increase the approach angle with exiting traffic, and add yield striping and signage to the bicycle approach.



## Discussion

While the jug-handle approach is the preferred configuration at exit ramps, provide the option for through bicyclists to perform a vehicular merge and proceed straight through under safe conditions.

## Additional References and Guidelines

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

FHWA. *Manual on Uniform Traffic Control Devices*. 2009.

FHWA. *Bicycle and Pedestrian Transportation. Lesson 15: Bicycle Lanes*. 2006.

## Materials and Maintenance

Locate crossing markings out of wheel tread when possible to minimize wear and maintenance costs.



# BIKE/PED FACILITIES AT DIVERGING DIAMOND INTERCHANGES

## Description

The Diverging Diamond Interchange (DDI) is a modern interchange configuration designed to reduce conflict points and improve safety and performance for automobile users.

Highway interchanges are not typically comfortable for bicyclists or pedestrians due to the high speed and volume of motor vehicle traffic. Key design features at conflict areas in DDIs should be included to improve the experience for vulnerable road users such as bicyclists and pedestrians.

## Guidance

- A buffered bike lane or cycle track approaching the interchange offers a lower stress approach for bicyclists.
- Through bike lane striping provides clear priority for bicyclists at right turn 'add lane' on-ramps.
- Raised crosswalks increase yielding compliance at the channelized right turn on- and off- ramps.
- A raised bike lane provides separation from moving traffic, and provides an added buffer for pedestrians.
- Median island offers a safe refuge from moving traffic.



Low Stress Bikeway



Raised Crosswalk



Raised Cycle Track



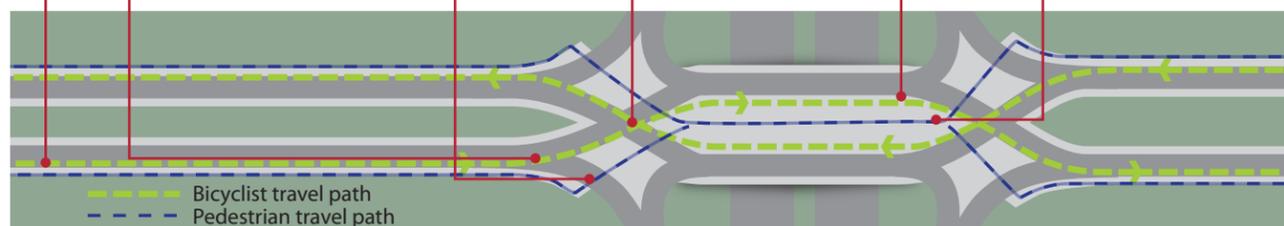
Through Bike Lane with 'Add Lane'



Intersection Crossing Markings



Pedestrian Refuge



## Discussion

The on-ramps should be configured as a right-turn-only "add lane" to assert through bicyclist priority. The center running island may provide a physical barrier between the auto lanes and the cycle track or pedestrian way to provide additional protection. Elephant's feet markings (shown) offer more visibility through the intersection than conventional dotted line extensions.

## Additional References and Guidelines

TRB. *NCHRP 674: Crossing Solutions at Roundabouts and Channelized Turn Lanes for Pedestrians with Vision Disabilities*. 2011.  
 Missouri DOT. *Engineering Policy Guide. 234.6 Diverging Diamond Interchanges*. 2012.

## Materials and Maintenance

Maintenance issues of DDIs are very similar to other types of interchanges.

# BIKEWAYS AT RAILROAD GRADE CROSSINGS

## Description

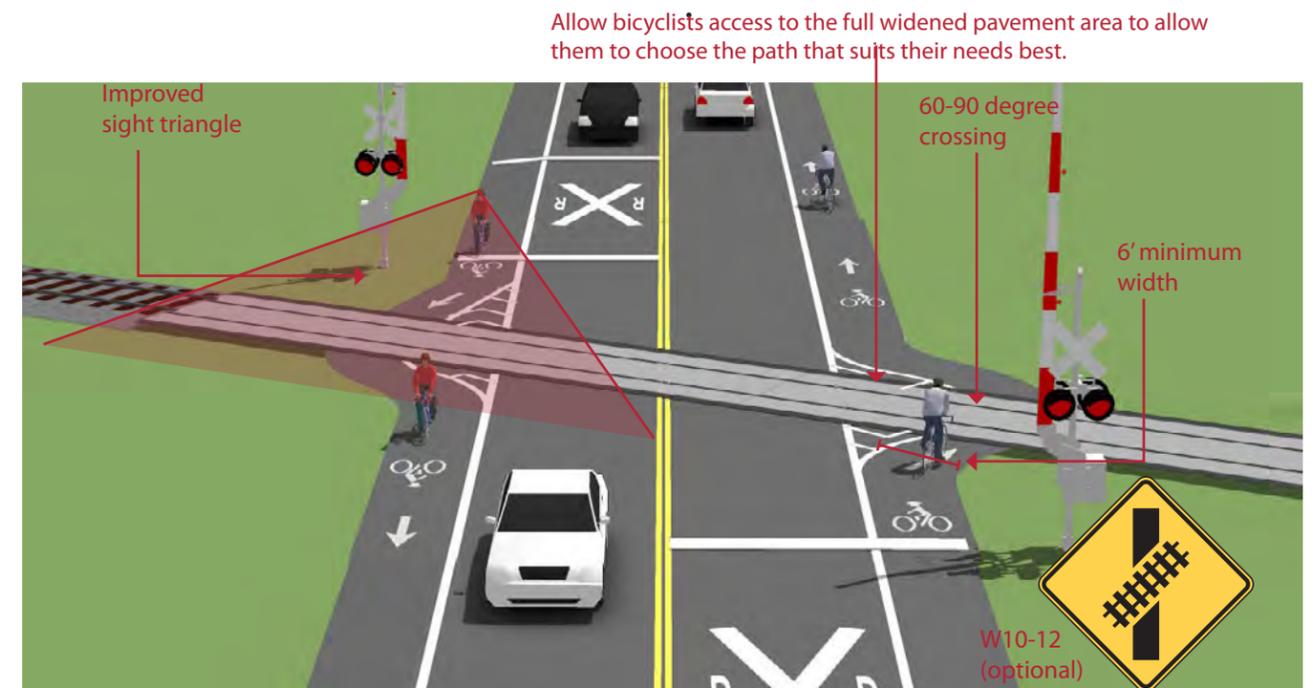
Bikeways that cross railroad tracks at a diagonal may cause steering difficulties or loss of control for bicyclists due to slippery surfaces, degraded rough materials, and the size of the flangeway gaps.

Angled track crossings also limit sight triangles, impacting the ability to see oncoming trains.

Bicyclist crashes at railroad tracks are often sudden and unexpected. Improvements to track placement, surface quality, flangeway opening width and crossing angle can minimize risks to people riding.

## Guidance

- 6 ft minimum shoulder/bike lane width.
- If the skew angle is less than 45 degrees, special attention should be given to the sidewalk and bicycle alignment to improve the approach angle to at least 60 degrees (90 degrees preferred where possible).
- Consider posting W-10 or W-12 signs to alert bicyclists.
- Sight triangles of 50 feet by 100 feet will be provided at the railroad and street right of way. (Sight triangles are measured from the centerline of the railroad track).



## Discussion

Crossing design and implementation is a collaboration between the railroad company and highway agency. The railroad company is responsible for the crossbucks, flashing lights and gate mechanisms, and the highway agency is responsible for advance warning markings and signs. Warning devices should be recommended for each specific situation by a qualified engineer based on various factors including train frequency and speed, path and trail usage and sight distances.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
 FHWA. *Manual on Uniform Traffic Control Devices*. 2009.  
 TRB. *TCRP 17: Integration of Light Rail Transit into City Streets*. 1996.  
 FHWA. *Railroad-Highway Grade Crossing Handbook*. 2007.  
 Rails-to-Trails Conservancy. *Rails-with-Trails: A Preliminary Assessment of Safety and Grade Crossings*. 2005.

## Materials and Maintenance

Concrete is the preferred material for use at bikeway railroad crossings. Rubber crossings are rideable when new and dry, but become slippery when wet and degrade over time. (AASHTO 2012)

# CROSSING BEACONS AND SIGNALS FOR BICYCLES





# ACTIVE WARNING BEACONS

## Description

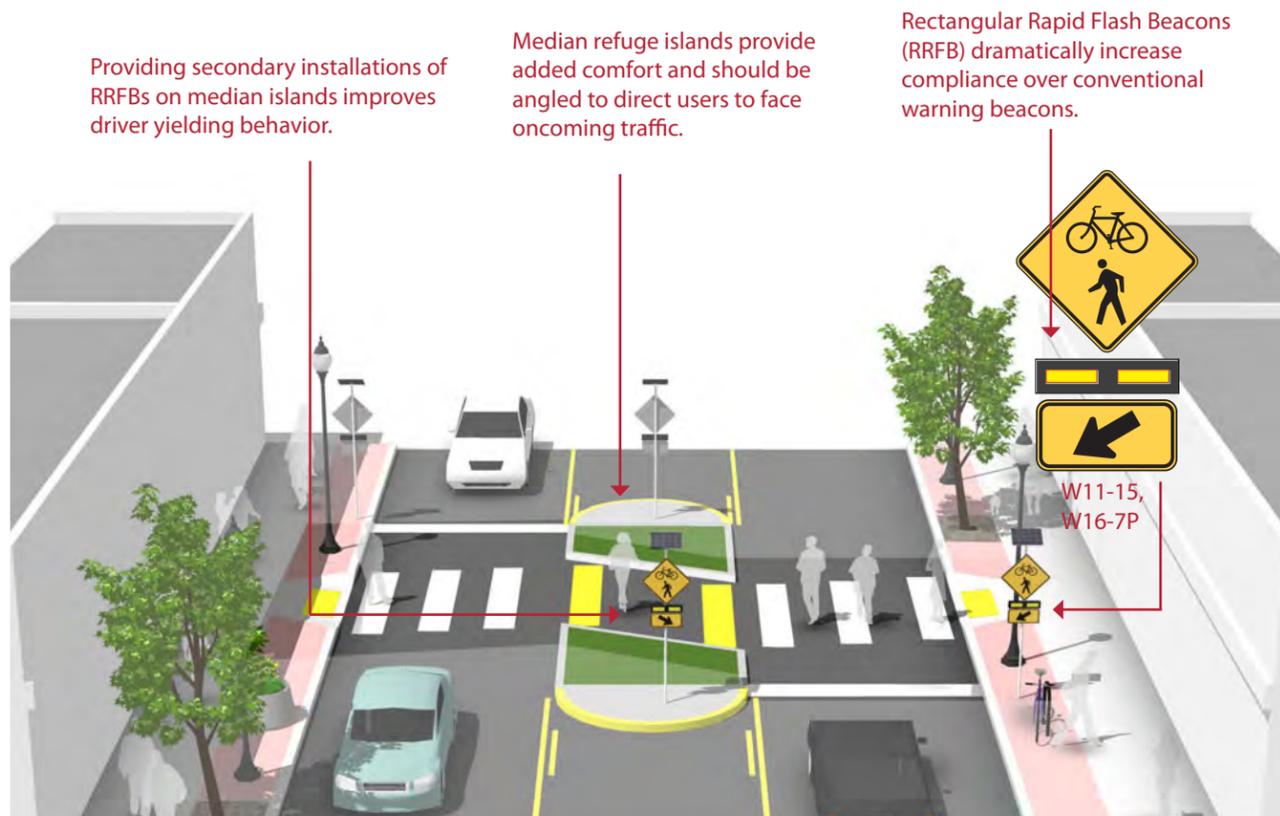
Active warning beacons are user actuated illuminated devices designed to increase motor vehicle yielding compliance at crossings of multi lane or high volume roadways.

Types of active warning beacons include conventional circular yellow flashing beacons, in-roadway warning lights, or Rectangular Rapid Flash Beacons (RRFB).

## Guidance

Warning beacons shall not be used at crosswalks controlled by YIELD signs, STOP signs or traffic signals.

- Warning beacons shall initiate operation based on pedestrian or bicyclist actuation and shall cease operation at a predetermined time after actuation or, with passive detection, after the pedestrian or bicyclist clears the crosswalk.



# HYBRID WARNING BEACON (HAWK) FOR BICYCLE ROUTE CROSSING

## Description

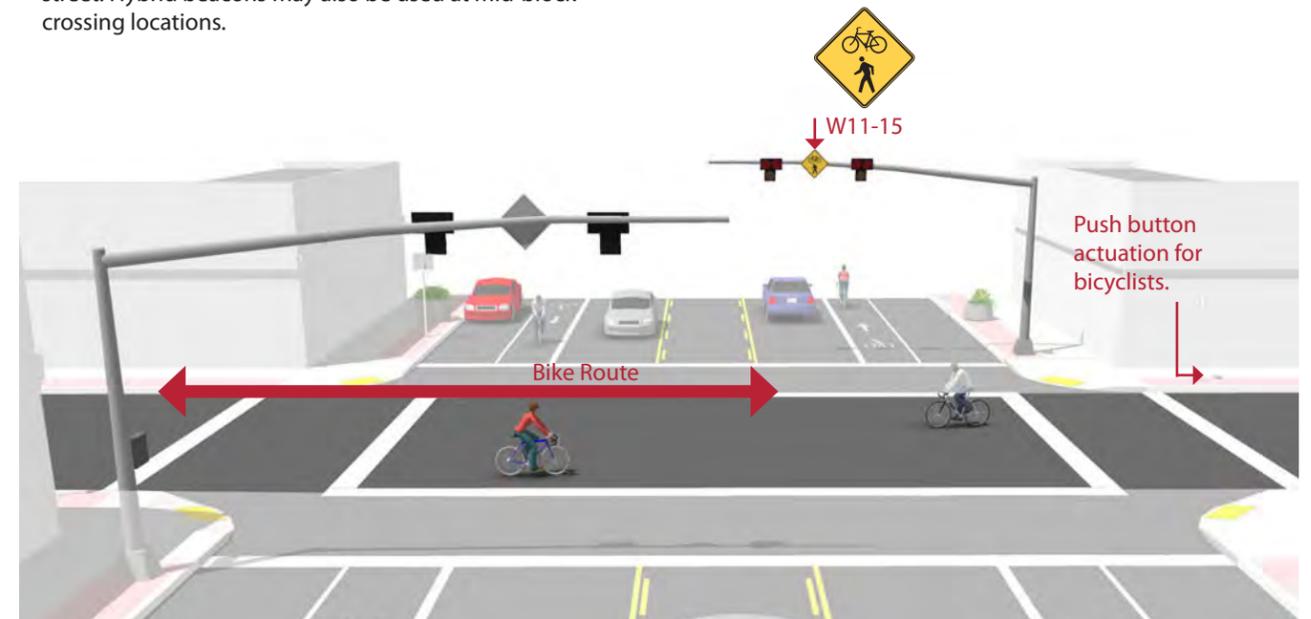
A hybrid beacon, formerly known as a High-intensity Activated Crosswalk (HAWK), consists of a signal-head with two red lenses over a single yellow lens on the major street, and pedestrian and/or bicycle signal heads for the minor street. There are no signal indications for motor vehicles on the minor street approaches.

Hybrid beacons are used to improve non-motorized crossings of major streets in locations where side-street volumes do not support installation of a conventional traffic signal or where there are concerns that a conventional signal will encourage additional motor vehicle traffic on the minor street. Hybrid beacons may also be used at mid-block crossing locations.

## Guidance

Hybrid beacons may be installed without meeting traffic control signal warrants if roadway speed and volumes are excessive for comfortable user crossing.

- If installed within a signal system, signal engineers should evaluate the need for the hybrid signal to be coordinated with other signals.
- Parking and other sight obstructions should be prohibited for at least 100 feet in advance of and at least 20 feet beyond the marked crosswalk to provide adequate sight distance.



## Discussion

Rectangular rapid flash beacons have the highest compliance of all the warning beacon enhancement options.

A study of the effectiveness of going from a no-beacon arrangement to a two-beacon RRFB installation increased yielding from 18 percent to 81 percent. A four-beacon arrangement raised compliance to 88 percent. Additional studies over long term installations show little to no decrease in yielding behavior over time.

## Additional References and Guidelines

- NACTO. *Urban Bikeway Design Guide*. 2012.
- FHWA. *Manual on Uniform Traffic Control Devices*. 2009.
- FHWA. *MUTCD - Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons (IA-11)*. 2008.
- SCDOT. *Traffic Engineering Guideline TG-33: Rectangular Rapid Flash Beacons*.

## Materials and Maintenance

Depending on power supply, maintenance can be minimal. If solar power is used, RRFBs can run for years without issue.

## Discussion

The hybrid beacon can significantly improve the operation of a bicycle route, particularly along neighborhood greenway corridors. Because of the low traffic volumes on these facilities, intersections with major roadways are often unsignalized, creating difficult and potentially unsafe crossing conditions for bicyclists.

Each crossing, regardless of traffic speed or volume, requires additional review by a registered engineer to identify sight lines, potential impacts on traffic progression, timing with adjacent signals, capacity and safety.

## Additional References and Guidelines

- FHWA. *Pedestrian Hybrid Beacon Guide*. 2014.
- SCDOT. *TG-26: Pedestrian Hybrid Beacon Guideline*.
- NACTO. *Urban Bikeway Design Guide*. 2012.
- FHWA. *Manual on Uniform Traffic Control Devices*. 2009.

## Materials and Maintenance

Hybrid beacons are subject to the same maintenance needs and requirements as standard traffic signals. Signing and striping need to be maintained to help users understand any unfamiliar traffic control.



# BICYCLE DETECTION AND ACTUATION

## Description

### Push Button Actuation

User-activated button mounted on a pole facing the street.

### Loop Detectors

Bicycle-activated loop detectors are installed within the roadway to allow the presence of a bicycle to trigger a change in the traffic signal. This allows the bicyclist to stay within the lane of travel without having to maneuver to the side of the road to trip a push button.

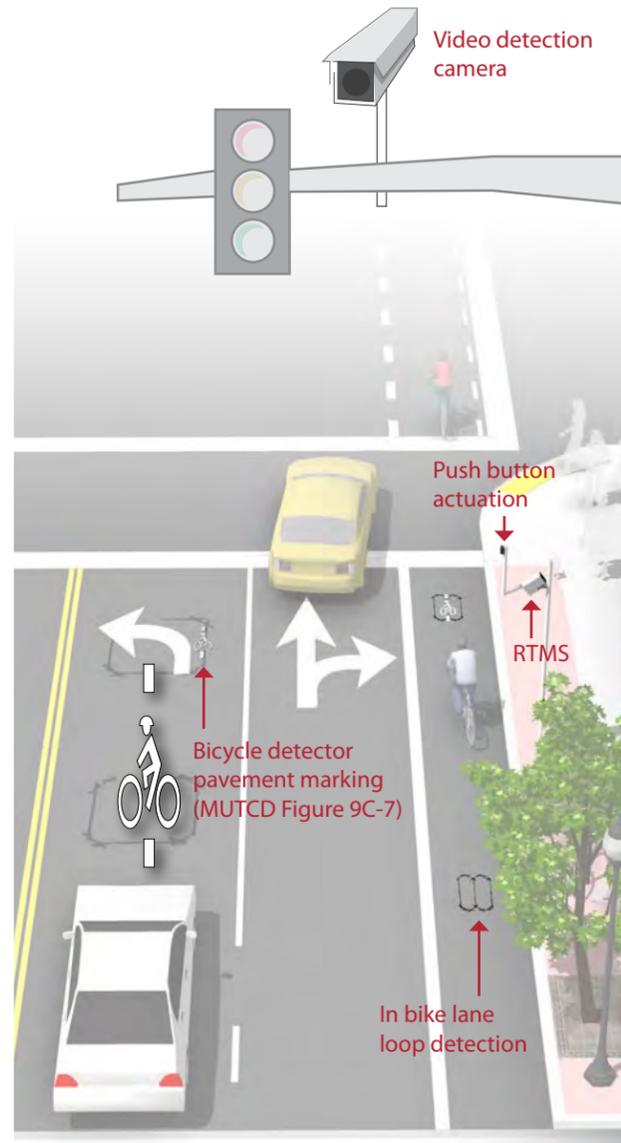
Loops that are sensitive enough to detect bicycles should be supplemented with pavement markings to instruct bicyclists how to trip them.

### Video Detection Cameras

Video detection systems use digital image processing to detect a change in the image at a location. These systems can be calibrated to detect bicycles. Video camera system costs range from \$20,000 to \$25,000 per intersection.

### Remote Traffic Microwave Sensor Detection (RTMS)

RTMS is a system which uses frequency modulated continuous wave radio signals to detect objects in the roadway. This method marks the detected object with a time code to determine its distance from the sensor. The RTMS system is unaffected by temperature and lighting, which can affect standard video detection.



# BICYCLE SIGNAL HEADS

## Description

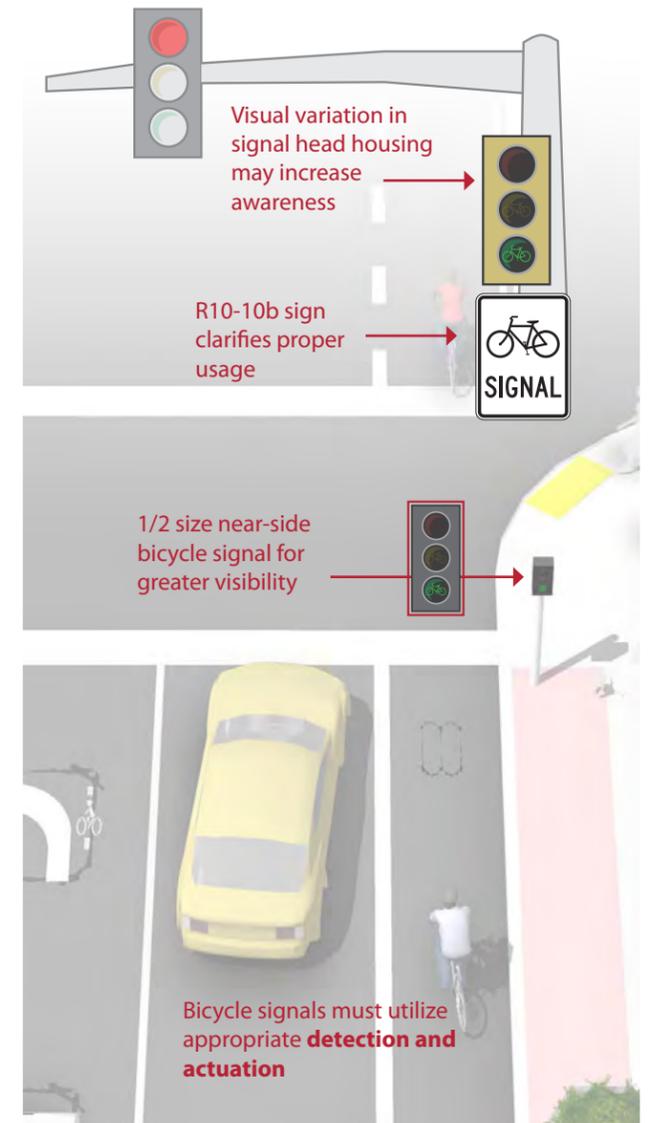
A bicycle signal is an electrically powered traffic control device that should only be used in combination with an existing traffic signal. Bicycle signals are typically used to improve identified safety or operational problems involving bicycle facilities. Bicycle signal heads may be installed at signalized intersections to indicate bicycle signal phases and other bicycle-specific timing strategies. Bicycle signals can be actuated with bicycle sensitive loop detectors, video detection, or push buttons.

Bicycle signals are typically used to provide guidance for bicyclists at intersections where they may have different needs from other road users (e.g., bicycle-only movements).

## Guidance

Specific locations where bicycle signals have had a demonstrated positive effect include:

- Those with high volume of bicyclists at peak hours
- Those with high numbers of bicycle/motor vehicle crashes, especially those caused by turning vehicle movements
- At T-intersections with major bicycle movement along the top of the "T."
- At the confluence of an off-street bike path and a roadway intersection
- Where separated bike paths run parallel to arterial streets



## Discussion

Proper bicycle detection should meet two primary criteria: 1) accurately detects bicyclists and 2) provides clear guidance to bicyclists on how to actuate detection (e.g., what button to push, where to stand).

Bicycle loops and other detection mechanisms can also provide bicyclists with an extended green time before the light turns yellow so that bicyclists of all abilities can reach the far side of the intersection.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
FHWA. *Manual on Uniform Traffic Control Devices*. 2009.  
NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

Signal detection and actuation for bicyclists should be maintained with other traffic signal detection and roadway pavement markings.

## Discussion

Local municipal code should be checked or modified to clarify that at intersections with bicycle signals, bicyclists should only obey the bicycle signal heads. For improved visibility, smaller (4 inch lens) near-sided bicycle signals should be considered to supplement far-side signals.

## Additional References and Guidelines

FHWA. *MUTCD - Interim Approval for Optional Use of a Bicycle Signal Face (IA-16)*. 2013.  
NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

Bicycle signal heads require the same maintenance as standard traffic signal heads, such as replacing bulbs and responding to power outages.

# RETROFITTING STREETS TO ADD BIKEWAYS





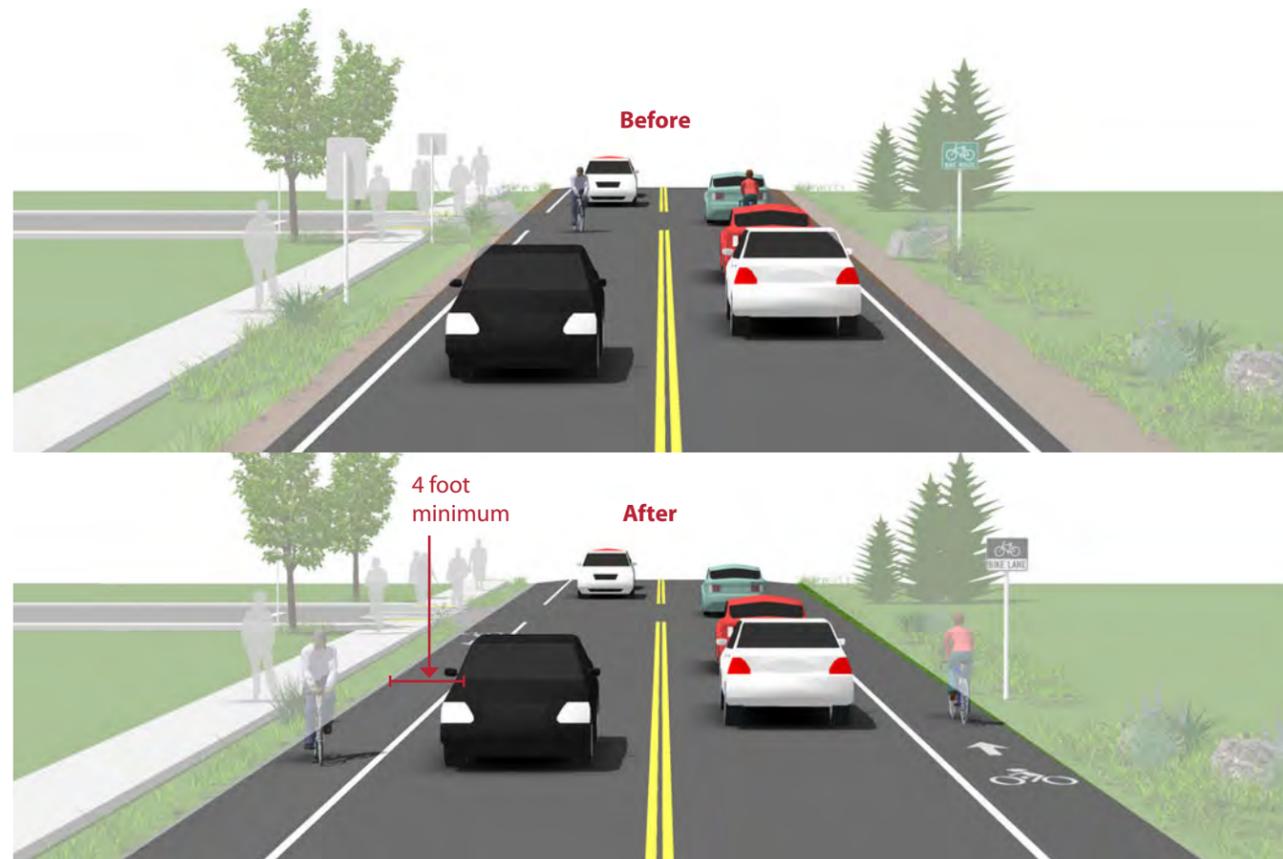
# ROADWAY WIDENING

## Description

Bike lanes can be accommodated on streets with excess right-of-way through shoulder widening. Although roadway widening incurs higher expenses compared with re-striping projects, bike lanes can be added to streets currently lacking curbs, gutters and sidewalks without the high costs of major infrastructure reconstruction.

## Guidance

- Guidance on bicycle lanes applies to this treatment.
- 4 foot minimum width when no curb and gutter is present.
- 6 foot width preferred.



## Discussion

Roadway widening is most appropriate on roads lacking curbs, gutters and sidewalks.

If it is not possible to meet minimum bicycle lane dimensions, a reduced width paved shoulder can still improve conditions for bicyclists on constrained roadways. In these situations, a minimum of 3 feet of operating space should be provided.

## Additional References and Guidelines

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

## Materials and Maintenance

The extended bicycle area should not contain any rough joints where bicyclists ride. Saw or grind a clean cut at the edge of the travel lane, or feather with a fine mix in a non-ridable area of the roadway.

# LANE NARROWING

## Description

Lane narrowing utilizes roadway space that exceeds minimum standards to provide the needed space for bike lanes. Many roadways have existing travel lanes that are wider than those prescribed in local and national roadway design standards, or which are not marked. Most standards allow for the use of 11 foot and sometimes 10 foot wide travel lanes to create space for bike lanes.

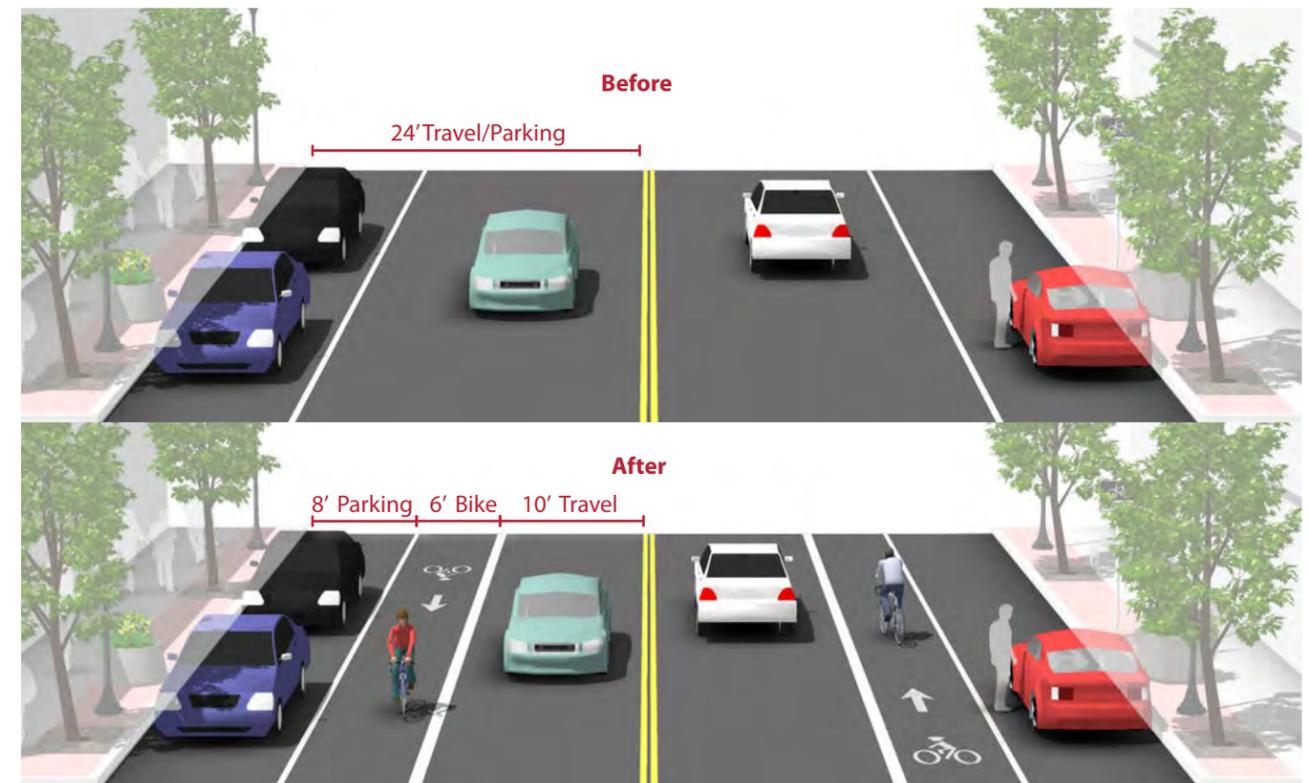
## Guidance

### Vehicle lane width:

- Before: 10-15 feet
- After: 10-11 feet

### Bicycle lane width:

- Guidance on bicycle lanes applies to this treatment.



## Discussion

Special consideration should be given to the amount of heavy vehicle traffic and horizontal curvature before the decision is made to narrow travel lanes. Center turn lanes can also be narrowed in some situations to free up pavement space for bike lanes.

AASHTO supports reduced width lanes in *A Policy on Geometric Design of Highways and Streets*: "On interrupted-flow operation conditions at low speeds (45 mph or less), narrow lane widths are normally adequate and have some advantages."

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
 SCDOT. *EDM 22: Considerations for Bicycle Facilities*.  
 NACTO. *Urban Street Design Guide*. 2013.  
 SCDOT. *Traffic Calming Guidelines*. 2006.

## Materials and Maintenance

Repair rough or uneven pavement surface. Use bicycle compatible drainage grates. Raise or lower existing grates and utility covers so they are flush with the pavement.



# LANE RECONFIGURATION

## Description

The removal of a single travel lane will generally provide sufficient space for bike lanes on both sides of a street. Streets with excess vehicle capacity provide opportunities for bike lane retrofit projects.

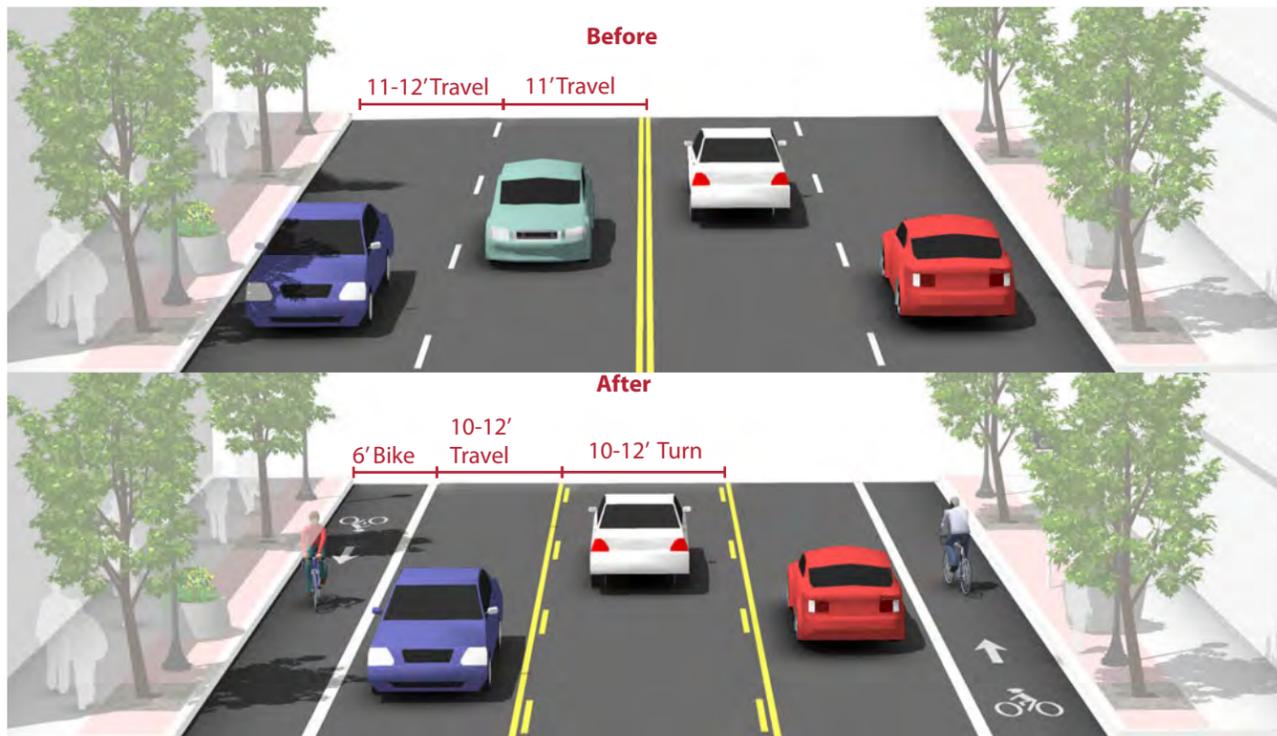
## Guidance

### Vehicle lane width:

- Width depends on project. No narrowing may be needed if a lane is removed.

### Bicycle lane width:

- Guidance on bicycle lanes applies to this treatment.



## Discussion

Depending on a street's existing configuration, traffic operations, user needs and safety concerns, various lane reduction configurations may apply. For instance, a four-lane street (with two travel lanes in each direction) could be modified to provide one travel lane in each direction, a center turn lane, and bike lanes. Prior to implementing this measure, a traffic analysis should identify potential impacts.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
 FHWA. *Evaluation of Lane Reduction "Road Diet" Measures on Crashes*.  
 Publication Number: FHWA-HRT-10-053. 2010.  
 NACTO. *Urban Street Design Guide*. 2013.

## Materials and Maintenance

Repair rough or uneven pavement surface. Use bicycle compatible drainage grates. Raise or lower existing grates and utility covers so they are flush with the pavement.

# PARKING REDUCTION

## Description

Bike lanes can replace one or more on-street parking lanes on streets where excess parking exists and/or the importance of bike lanes outweighs parking needs. For example, parking may be needed on only one side of a street. Eliminating or reducing on-street parking also improves sight distance for bicyclists in bike lanes and for motorists on approaching side streets and driveways.

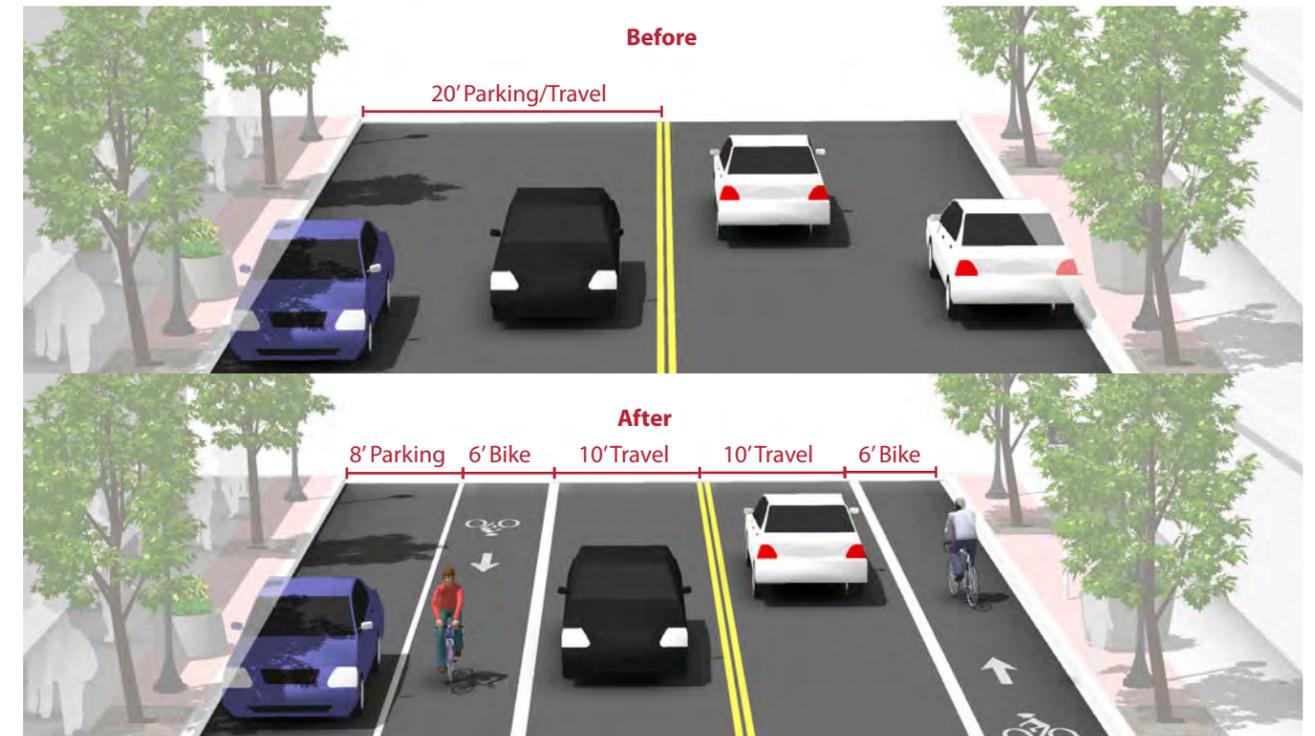
## Guidance

### Vehicle lane width:

- Parking lane width depends on project. No travel lane narrowing may be required depending on the width of the parking lanes.

### Bicycle lane width:

- Guidance on bicycle lanes applies to this treatment.



## Discussion

The City of Columbia has bonds issued against future parking revenue which requires any paid parking removed from the street be relocated elsewhere. Removing or reducing on-street parking to install bike lanes requires comprehensive outreach to the affected businesses and residents. Prior to reallocating on-street parking for other uses, a parking study should be performed to gauge demand and to evaluate impacts to people with disabilities.

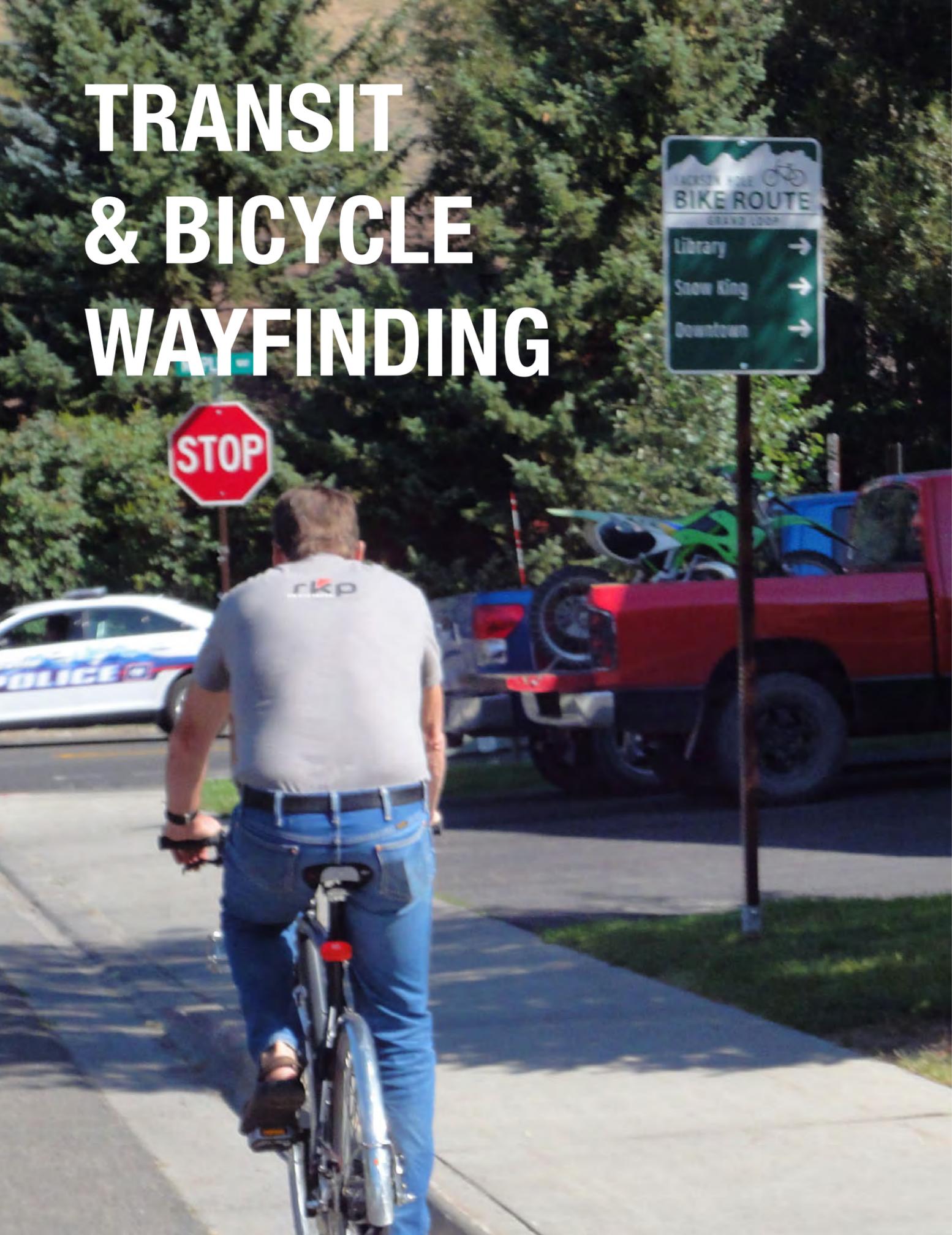
## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
 AASHTO. *A Policy on Geometric Design of Highways and Streets*. 2004.

## Materials and Maintenance

Repair rough or uneven pavement surface. Use bicycle compatible drainage grates. Raise or lower existing grates and utility covers so they are flush with the pavement.

# TRANSIT & BICYCLE WAYFINDING



## TRANSIT WAYFINDING

### Description

Transit wayfinding is important primarily for informing the public on where to access transit, and to assist users in making educated route plans to reach their destinations. Well planned and designed transit wayfinding can encourage people to use transit – likewise, poorly designed transit wayfinding can discourage transit use. Taking trips with transit involves several important steps that can be generalized into three phases:

**Trip planning** – locating a destination and deciding what mode or modes to utilize for the trip.

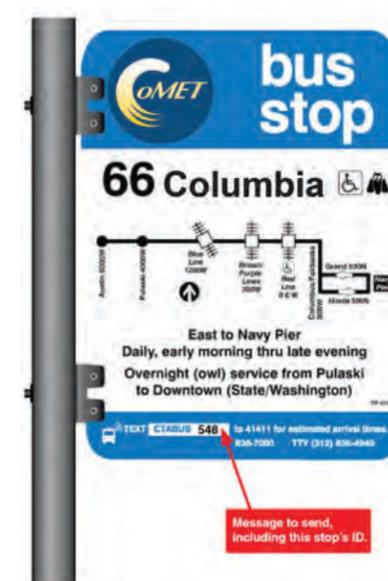
**Trip segment assessment** – understanding the necessary steps required to successfully reach a destination.

**En route decision points** – successfully judging options and navigating transfers between transit routes or modes within the trip.

### Guidance

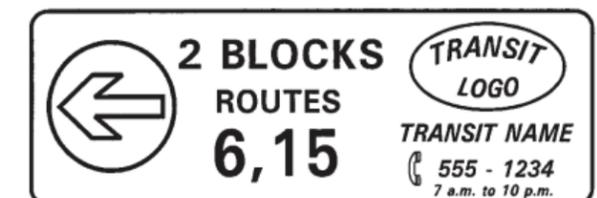
There are several media for providing wayfinding information to transit users - most often oral communication, signage (static and dynamic), pamphlets and digital communication are used. All can be effective means of conveying wayfinding information, and typically a combination of all should be considered. For the purposes of these Design Guidelines, we will be focusing on information conveyance through wayfinding signage.

- Signs should be mounted to be conspicuous against other signs, advertising, and other visual clutter. Consideration must also be given to local ordinances and protection against vandalism.
- Sign must be visible to bus passengers inside bus when bus is at stop.
- Consider use of duplicate sign with 3-in. raised letters/symbols in location suitable for approach to within 3 in., with Grade II Braille under each character.
- Bus stop signage should include the transit system logo/name, transit information telephone number, names of streets and landmarks where bus stop is located, and route number(s) serving the bus stop.



**Supplemental information can be included to assist in decision making and increase the convenience for passengers and may include:**

- Hours of operation
- Route frequency and/or timetables
- Diagrammatic route maps
- System maps
- Distances, directions and travel times to popular destinations



A "Trailblazer sign" can be used along or nearby routes to direct people to stops within close proximity. Such signage is also helpful guiding transit users between two nearby stops

### Discussion

Signage siting is an important aspect of transit wayfinding. In order to be noticed and effective, information must be perceived at or shortly before the decision point. Signage site characteristics to consider include light levels, density of people using the facility, ceiling heights and corridor widths. (from TCRP Report 12: Guidelines for Transit Facility Signage and Graphics)

### Additional References and Guidelines

OCTA. *Bus Stop Safety and Design Guidelines*. 2004.  
TCRP. *Report 12: Guidelines for Transit Facility Signage and Graphics*. 1996.

### Materials and Maintenance

Maintenance needs for transit wayfinding signs are similar to other signs and will need periodic replacement due to wear.



# BIKEWAY WAYFINDING SIGN TYPES

## Description

A bicycle wayfinding system consists of comprehensive signing and/or pavement markings to guide bicyclists to their destinations along preferred bicycle routes. There are three general types of wayfinding signs:

### Confirmation Signs

Indicate to bicyclists that they are on a designated bikeway. Make motorists aware of the bicycle route.

Can include destinations and distance/time. Do not include arrows.

### Turn Signs

Indicate where a bikeway turns from one street onto another street. Can be used with pavement markings.

Include destinations and arrows.

### Decisions Signs

Mark the junction of two or more bikeways.

Inform bicyclists of the designated bike route to access key destinations. Includes destinations and arrows and distances.

Travel times are optional but recommended.



## Discussion

There is no standard color for bicycle wayfinding signage. Section 1A.12 of the MUTCD establishes the general meaning for signage colors. Green is the color used for directional guidance and is the most common color of bicycle wayfinding signage in the US, including those in the MUTCD.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
FHWA. *Manual on Uniform Traffic Control Devices*. 2009.  
NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

Maintenance needs for bicycle wayfinding signs are similar to other signs and will need periodic replacement due to wear.

# BIKEWAY WAYFINDING SIGN PLACEMENT

## Confirmation Signs

Every ¼ to ½ mile on off-street facilities and every 2 to 3 blocks along on-street bicycle facilities, unless another type of sign is used (e.g., within 150 ft of a turn or decision sign). Should be placed soon after turns to confirm destination(s). Pavement markings can also act as confirmation that a bicyclist is on a preferred route.

## Turn Signs

Near-side of intersections where bike routes turn (e.g., where the street ceases to be a bicycle route or does not go through). Pavement markings can also indicate the need to turn to the bicyclist.

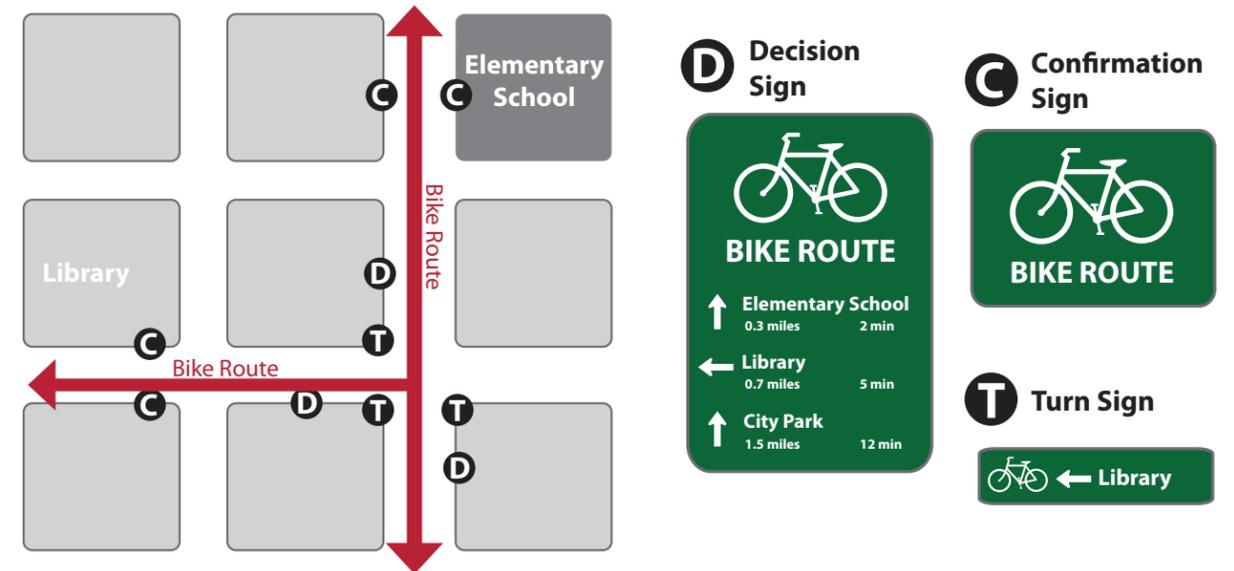
## Guidance

Signs are typically placed at decision points along bicycle routes – typically at the intersection of two or more bikeways and at other key locations leading to and along bicycle routes.

## Decisions Signs

Near-side of intersections in advance of a junction with another bicycle route.

Along a route to indicate a nearby destination.



## Discussion

It can be useful to classify a list of destinations for inclusion on the signs based on their relative importance to users throughout the area. A particular destination's ranking in the hierarchy can be used to determine the physical distance from which the locations are signed. For example, primary destinations (such as the downtown area) may be included on signage up to 5 miles away. Secondary destinations (such as a transit station) may be included on signage up to two miles away. Tertiary destinations (such as a park) may be included on signage up to one mile away.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
FHWA. *Manual on Uniform Traffic Control Devices*. 2009.  
NACTO. *Urban Bikeway Design Guide*. 2012.

## Materials and Maintenance

Maintenance needs for bicycle wayfinding signs are similar to other signs and will need periodic replacement due to wear.

# BICYCLE SUPPORT FACILITIES





# BICYCLE RACKS

## Description

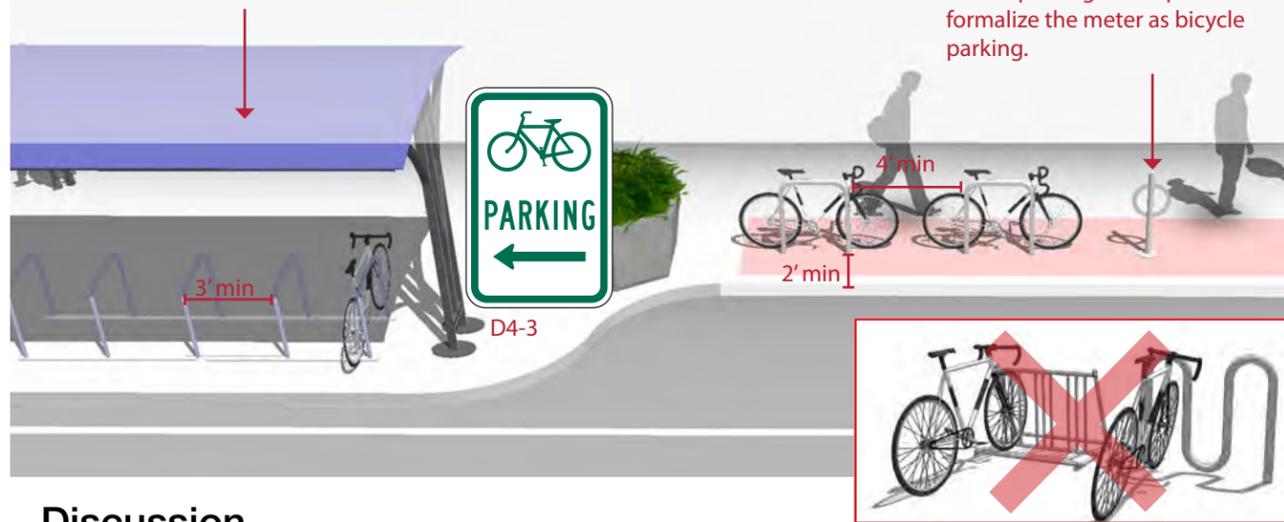
Short-term bicycle parking is meant to accommodate visitors, customers, and others expected to depart within two hours. It should have an approved standard rack, appropriate location and placement, and weather protection. The Association for Pedestrian and Bicycle Professionals (APBP) recommends selecting a bicycle rack that:

- Supports the bicycle in at least two places, preventing it from falling over.
- Allows locking of the frame and one or both wheels with a U-lock.
- Is securely anchored to ground.
- Resists cutting, rusting and bending or deformation.

## Guidance

- 2' minimum from the curb face to avoid 'dooring.'
- Close to destinations; 50' maximum distance from main building entrance.
- Minimum clear distance of 6' should be provided between the bicycle rack and the property line.
- Should be highly visible from adjacent bicycle routes and pedestrian traffic.
- Locate racks in areas that cyclists are most likely to travel.
- Post signage that clearly indicates mopeds and motorcycles are prohibited from parking at bike racks. Direct mopeds/motorcycles to designated moped/motorcycle parking areas.

Bicycle shelters consist of bicycle racks grouped together within structures with a roof that provides weather protection.



## Discussion

Some types of bicycle racks may meet design criteria, but are discouraged except in limited situations. This includes undulating "wave" racks, schoolyard "wheel bender" racks, and spiral racks. (See illustration above).

Decorative racks may enhance the aesthetic nature of a streetscape, but the custom design should not interfere with the functionality of the rack. Standard "U" racks are preferred over decorative racks in most regular installations, but decorative racks may be preferred in special districts or in areas with space constraints.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
APBP. *Bicycle Parking Guide 2nd Edition*. 2010.

## Materials and Maintenance

Use of proper anchors will prevent vandalism and theft. Racks and anchors should be regularly inspected for damage. Educate snow removal crews to avoid burying racks during winter months.

# ON-STREET BICYCLE CORRAL

## Description

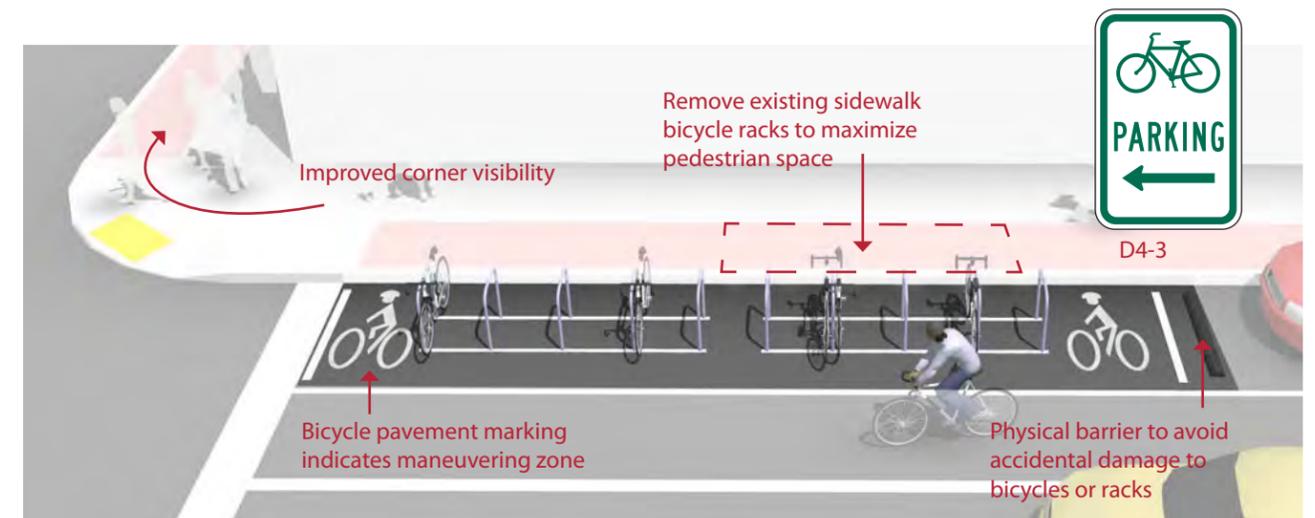
Bicycle corrals (also known as on-street bicycle parking) consist of bicycle racks grouped together in a common area within the street traditionally used for automobile parking. Bicycle corrals are reserved exclusively for bicycle parking and provide a relatively inexpensive solution to providing high-volume bicycle parking. Bicycle corrals can be implemented by converting one or two on-street motor vehicle parking spaces into on-street bicycle parking. Each motor vehicle parking space can be replaced with approximately 6-10 bicycle parking spaces.

Bicycle corrals move bicycles off the sidewalks, leaving more space for pedestrians, sidewalk café tables, etc. Because bicycle parking does not block sightlines (as large motor vehicles would do), it may be possible to locate bicycle parking in 'no-parking' zones near intersections and crosswalks.

## Guidance

See guidelines for sidewalk bicycle rack placement and clear zones.

- Bicyclists should have an entrance width from the roadway of 5' – 6'.
- Can be used with parallel or angled parking.
- Parking stalls adjacent to curb extensions are good candidates for bicycle corrals since the concrete extension serves as delimitation on one side.



## Discussion

In many communities, the installation of bicycle corrals is driven by requests from adjacent businesses, and is not a city-driven initiative. In such cases, the city does not remove motor vehicle parking unless it is explicitly requested. In other areas, the city provides the facility and business associations take responsibility for the maintenance of the facility. Communities can establish maintenance agreements with the requesting business. Bicycle corrals can be especially effective in areas with high bicycle parking demand or along street frontages with narrow sidewalks where parked bicycles would be detrimental to the pedestrian environment.

## Additional References and Guidelines

APBP. *Bicycle Parking Guide 2nd Edition*. 2010.

## Materials and Maintenance

Physical barriers may obstruct drainage and collect debris. Establish a maintenance agreement with neighboring businesses. In snowy climates the bicycle corral may need to be removed during the winter months.



# BICYCLE LOCKERS

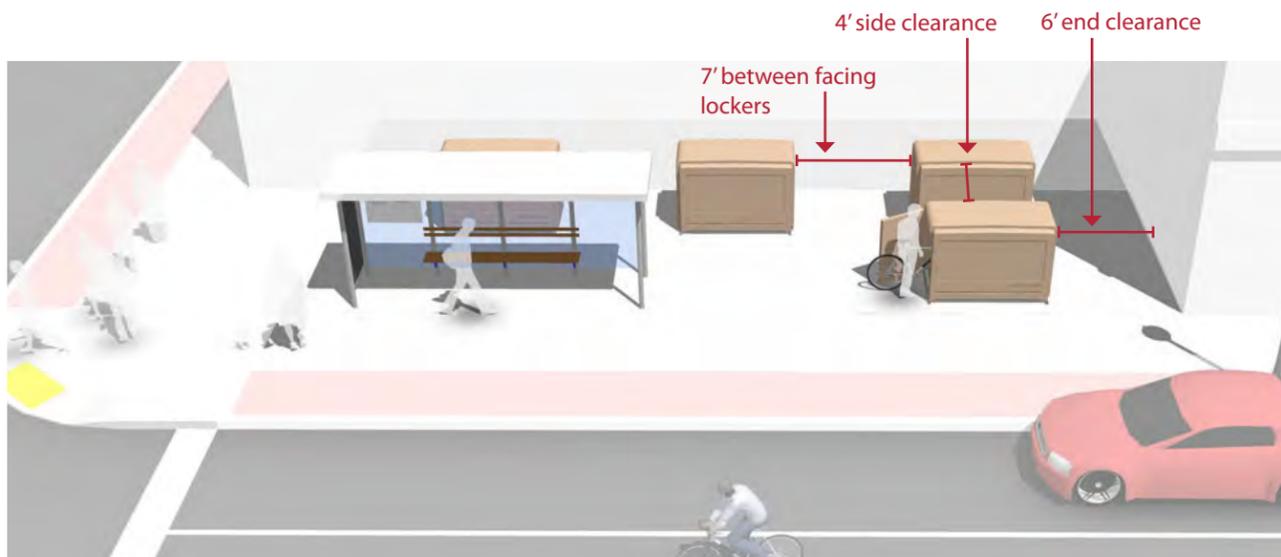
## Description

Bicycle lockers are intended to provide long-term bicycle storage for employees, students, residents, commuters, and others expected to park more than two hours. Long-term facilities protect the entire bicycle, its components and accessories against theft and against inclement weather, including snow and wind-driven rain.

Bicycle lockers provide space to store a few accessories or rain gear in addition to containing the bicycle. Some lockers allow access to two users - a partition separating the two bicycles can help users feel their bike is secure. Lockers can also be stacked, reducing the footprint of the area, although that makes them more difficult to use.

## Guidance

- Minimum dimensions: width (opening) 2.5'; height 4'; depth 6'.
- 4 foot side clearance and 6 foot end clearance.
- 7 foot minimum distance between facing lockers.
- Locker designs that allow visibility and inspection of contents are recommended for increased security.
- Access is controlled by a key or access code.



# SECURE PARKING AREA (SPA)

## Description

A Secure Parking Area for bicycles, also known as a Bike SPA or Bike & Ride (when located at transit stations), is a semi-enclosed space that offers a higher level of security than ordinary bike racks. Accessible via key-card, combination locks, or keys, Bike SPAs provide high-capacity parking for 10 to 100 or more bicycles. Increased security measures create an additional transportation option for those whose biggest concern is theft and vulnerability.

## Guidance

Bike SPAs may be stand alone or integrated into the ground floor of parking garage structure.

### Key features may include:

- Closed-circuit television monitoring.
- Double high racks & cargo bike spaces.
- Bike repair station with bench.
- Bike tube and maintenance item vending machine.
- Bike lock "hitching post" – allows people to leave bike locks.
- Secure access for users.



## Discussion

Long-term parking facilities are more expensive to provide than short-term facilities, but are also significantly more secure. Although many bicycle commuters would be willing to pay a nominal fee to guarantee the safety of their bicycle, long-term bicycle parking should be free wherever automobile parking is free. Potential locations for long-term bicycle parking include transit stations, large employers, and institutions where people use their bikes for commuting and not consistently throughout the day.

## Discussion

Long-term parking facilities are more expensive to provide than short-term facilities, but are also significantly more secure. Although many bicycle commuters would be willing to pay a nominal fee to guarantee the safety of their bicycle, long-term bicycle parking should be free wherever automobile parking is free. Bike SPAs are ideal for transit centers, airports, train stations, or wherever large numbers of people might arrive by bicycle and need a secure place to park while away.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
APBP. *Bicycle Parking Guide 2nd Edition*. 2010.

## Materials and Maintenance

Regularly inspect the functioning of moving parts and enclosures. Change keys and access codes periodically to prevent access to unapproved users.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
APBP. *Bicycle Parking Guide 2nd Edition*. 2010.

## Materials and Maintenance

Regularly inspect the functioning of moving parts and enclosures. Change keys and access codes periodically to prevent access to unapproved users.



# BICYCLE PARKING AT TRANSIT

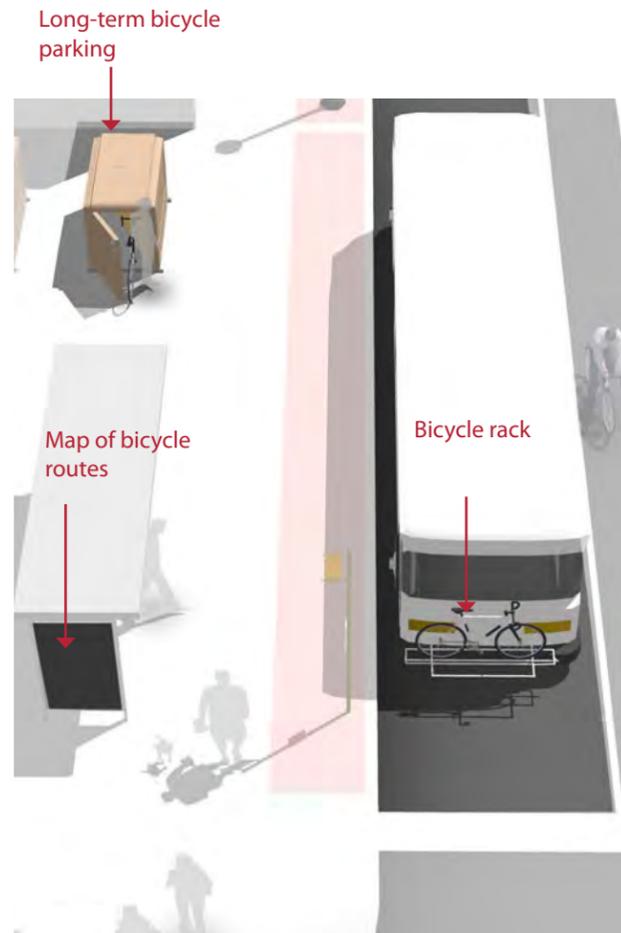
## Description

Bicycle parking facilities, such as securement devices (bike racks and storage lockers), may be provided at bus stops by local jurisdictions or adjacent property owners for the convenience of bicyclists using transit.

Bicycle parking facilities discourage the practice of locking bicycles onto bus facilities or onto adjacent property. By confining bicycles to one area, securement devices can reduce visual clutter and maintain appropriate pedestrian clearances. Below are guidelines for the placement of bicycle parking facilities.

## Guidance

- Locate securement devices or bicycle lockers away from other pedestrian or bus patron activities to improve safety and reduce congestion.
- Coordinate the location of bicycle parking facilities with existing on-site or street lighting.
- Ensure parked bikes are visible at all times. Do not locate bicycle parking where views are restricted by a bus shelter, landscaping, or existing site elements, such as walls.
- Design and placement of bicycle parking facilities should complement other transit furniture at bus stop.
- Covered or weather protected parking locations is an important bonus to bicyclists.



## Discussion

There are two bicycle locker facilities available for secure parking at transit stops. A key based locker is a long term rental, typically provided by the transit agency. A key based system allows access to only one individual. An alternative bicycle locker is a code or combo based system. These lockers allow users to rent the locker on a need-only basis.

## Additional References and Guidelines

AASHTO. *Guide for the Development of Bicycle Facilities*. 2012.  
 APBP. *Bicycle Parking Guide 2nd Edition*. 2010.  
 FHWA. *Federal Highway Administration University Course on Bicycle and Pedestrian Transportation. Lesson 18: Bicycle and Pedestrian Connections to Transit*. 2006.

## Materials and Maintenance

Regularly inspect the functioning of long-term parking moving parts and enclosures. Change keys and access codes periodically to prevent access to unapproved users.

# BIKE SHARE STATION PLACEMENT

## Description

Bike sharing is a nonmotorized transportation service, typically structured to provide users point-to-point transportation for short distance trips. Users pick up a bicycle at self-serve bike sharing stations and return it to the same or other station at the end of their trip.

Bike sharing stations holds the automated customer kiosk and bicycle docks.

## Guidance

Bike sharing station should be placed in safe, convenient and highly visible locations. If they are intended to support transit stations, they should be visible from the entrance/exit of the station.

### Placement:

**On-street stations** are placed within the parking lane of a street. On-street stations are accessible from within the street. These stations are typically located adjacent to on-street bicycle facilities such as bike lanes.

**Sidewalk stations** are located on the furnishing or frontage zone of a wide sidewalk.

**Public space stations** are located in plazas or parks. These locations may be privately owned.

An 11 dock bike sharing station will require an approximate space of 32 feet wide and 10-12 feet deep for infrastructure and access.



## Discussion

Two-sided stations may be provided in locations with adequate access from both sides, and offer the potential for increased station capacity given a certain footprint.

Solar powered stations should be placed in locations with access to sunlight for a portion of the day, and have 11 ft vertical clearance.

## Additional References and Guidelines

FHWA. *Bike Sharing in The United States: State of the Practice and Guide to Implementation*. 2012.

## Materials and Maintenance

Provide a 1 ft gap between on-street stations and the curb of the sidewalk to allow for water drainage and debris removal.

# BIKEWAY MAINTENANCE

Photo by VeloBusDriver via Flickr (CC BY-SA 2.0)



# SWEEPING

## Description

Bicyclists often avoid shoulders and bike lanes filled with gravel, broken glass and other debris; they will ride in the roadway to avoid these hazards, potentially causing conflicts with motorists. Debris from the roadway should not be swept onto sidewalks (pedestrians need a clean walking surface), nor should debris be swept from the sidewalk onto the roadway. A regularly scheduled inspection and maintenance program helps ensure that roadway debris is regularly picked up or swept.



## Guidance

- Establish a seasonal sweeping schedule that prioritizes roadways with major bicycle routes.
- Sweep walkways and bikeways whenever there is an accumulation of debris on the facility.
- In curbed sections, sweepers should pick up debris; on open shoulders, debris can be swept onto gravel shoulders.
- Pave gravel driveway approaches to minimize loose gravel on paved roadway shoulders.
- Perform additional sweeping in the Spring to remove debris from the Winter.
- Perform additional sweeping in the Fall in areas where leaves accumulate .

# ROADWAY SURFACE

## Description

Bicycles are much more sensitive to subtle changes in roadway surface than are motor vehicles. Various materials are used to pave roadways, and some are smoother than others. Compaction is also an important issue after trenches and other construction holes are filled. Uneven settlement after trenching can affect the roadway surface nearest the curb where bicycles travel. Sometimes compaction is not achieved to a satisfactory level, and an uneven pavement surface can result due to settling over the course of days or weeks. When resurfacing streets, use the smallest chip size and ensure that the surface is as smooth as possible to improve safety and comfort for bicyclists.



## Guidance

- Maintain a smooth pothole-free surface.
- Ensure that on new roadway construction, the finished surface on bikeways does not vary more than ¼".
- Maintain pavement so ridge buildup does not occur at the gutter-to-pavement transition or adjacent to railway crossings.
- Inspect the pavement 2 to 4 months after trenching construction activities are completed to ensure that excessive settlement has not occurred.
- If chip sealing is to be performed, use the smallest possible chip on bike lanes and shoulders. Sweep loose chips regularly following application.
- During chip seal maintenance projects, if the pavement condition of the bike lane is satisfactory, it may be appropriate to chip seal the travel lanes only. However, use caution when doing this so as not to create an unacceptable ridge between the bike lane and travel lane.

# SIGNAGE

## Description

Bike lanes, shared shoulders, Bicycle Boulevards and paths all have different signage types for wayfinding and regulations. Such signage is vulnerable to vandalism or wear, and requires periodic maintenance and replacement as needed.



## Guidance

- Check regulatory and wayfinding signage along bikeways for signs of vandalism, graffiti, or normal wear.
- Replace signage along the bikeway network as-needed.
- Perform a regularly-scheduled check on the status of signage with follow-up as necessary.
- Create a Maintenance Management Plan.

# PAVEMENT OVERLAYS

## Description

Pavement overlays represent good opportunities to improve conditions for bicyclists if done carefully. A ridge should not be left in the area where bicyclists ride (this occurs where an overlay extends part-way into a shoulder bikeway or bike lane). Overlay projects also offer opportunities to widen a roadway, or to re-stripe a roadway with bike lanes.



## Guidance

- Extend the overlay over the entire roadway surface to avoid leaving an abrupt edge.
- If the shoulder or bike lane pavement is of good quality, it may be appropriate to end the overlay at the shoulder or bike lane stripe provided no abrupt ridge remains.
- Ensure that inlet grates, manhole and valve covers are within ¼ inch of the finished pavement surface and are made or treated with slip resistant materials.
- Pave gravel driveways to property lines to prevent gravel from being tracked onto shoulders or bike lanes.



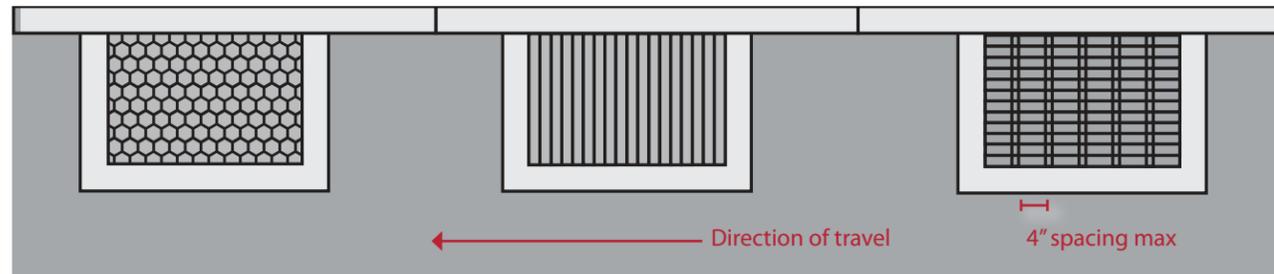
# DRAINAGE GRATES

## Description

Drainage grates are typically located in the gutter area near the curb of a roadway. Drainage grates typically have slots through which water drains into the municipal storm sewer system. Many older grates were designed with linear parallel bars spread wide enough for a tire to become caught so that if a bicyclist were to ride on them, the front tire could become caught in the slot. This would cause the bicyclist to tumble over the handlebars and sustain potentially serious injuries.

## Guidance

- Require all new drainage grates be bicycle-friendly, including grates that have horizontal slats on them so that bicycle tires and assistive devices do not fall through the vertical slats.
- Create a program to inventory all existing drainage grates, and replace hazardous grates as necessary – temporary modifications such as installing rebar horizontally across the grate should not be an acceptable alternative to replacement.



# GUTTER TO PAVEMENT TRANSITION

## Description

On streets with concrete curbs and gutters, 1 to 2 feet of the curbside area is typically devoted to the gutter pan, where water collects and drains into catch basins. On many streets, the bikeway is situated near the transition between the gutter pan and the pavement edge. This transition can be susceptible to erosion, creating potholes and a rough surface for travel.

The pavement on many streets is not flush with the gutter, creating a vertical transition between these segments. This area can buckle over time, creating a hazardous condition for bicyclists.



## Guidance

- Ensure that gutter-to-pavement transitions have no more than a 1/4" vertical transition.
- Examine pavement transitions during every roadway project for new construction, maintenance activities, and construction project activities that occur in streets.
- Inspect the pavement 2 to 4 months after trenching construction activities are completed to ensure that excessive settlement has not occurred.
- Provide at least 3 feet of pavement outside of the gutter seam.

# LANDSCAPING

## Description

Bikeways can become inaccessible due to overgrown vegetation. All landscaping needs to be designed and maintained to ensure compatibility with the use of the bikeways. After a flood or major storm, bikeways should be checked along with other roads, and fallen trees or other debris should be removed promptly.

## Guidance

- Ensure that shoulder plants do not hang into or impede passage along bikeways
- After major damage incidents, remove fallen trees or other debris from bikeways as quickly as possible



# MAINTENANCE MANAGEMENT PLAN

## Description

Bikeway users need accommodation during construction and maintenance activities when bikeways may be closed or unavailable. Users must be warned of bikeway closures and given adequate detour information to bypass the closed section. Users should be warned through the use of standard signing approaching each affected section (e.g., "Bike Lane Closed," "Trail Closed"), including information on alternate routes and dates of closure. Alternate routes should provide reasonable directness, equivalent traffic characteristics, and be signed.

## Guidance

- Provide fire and police departments with map of system, along with access points to gates/bollards
- Enforce speed limits and other rules of the road
- Enforce all trespassing laws for people attempting to enter adjacent private properties

