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Contents

1.0 Design Guidelines

This document presents best practice bicycle and multi-use trail network design from North America and elsewhere.

1.1 Guiding Documents

The City of Albuquerque has been working to implement on- and off-street projects to encourage walking and cycling, improve safety and accessibility and enhance the quality of the walkway and bikeway networks so that these activities become integral parts of daily life. While Albuquerque is growing, it has a predominantly built urban environment, and many future projects will involve retrofitting existing streets and intersections. The City has a moderate demand for on-street parking, an auto-oriented roadway system reliant on high-capacity arterials and many other complex situations. When looking to implement sidewalks and bike lanes or other improvements on City streets, most standard design manuals offer limited solutions.

The Albuquerque Bikeways and Trails Master Plan Update Design Guidelines are designed to provide an extensive range of design options for bikeways and trail treatments. These design concepts are based on current bikeway and trail design guidelines for typical situations provided in City documents, including:

- *City of Albuquerque Development Process Manual (DPM)*
- *City of Albuquerque Trail and Bikeways Facility Plan, 2000*
- *City of Albuquerque On-Street Bicycle Plan, 1993*

In addition, the Association of State Highway and Transportation Officials (AASHTO) 2000 *Guide for the Development of Bicycle Facilities*[1] and the *Manual of Uniform Traffic Control Devices* (*MUTCD*) 2003, Part 9 Traffic Controls for Bicycle Facilities and 2009 update were also used. The Albuquerque Bikeways and Trails Master Plan Update Design Guidelines use these documents as a baseline for minimum conditions. In addition to the current standards, an innovative design treatments section follows the design guidelines and provides creative solutions that have been used nationally and internationally to provide safe bikeways that are appealing to a wide range of users.

The following are key principles for these pedestrian and bicycle guidelines:

- The bicycling and trail environment should be safe. Bike routes, pathways and crossings and should be designed and built to be free of hazards and to minimize conflicts with external factors such as noise, vehicular traffic and protruding architectural elements.
- The bikeway and trail network should be accessible. Bike routes, pathways and crosswalks should ensure the mobility of all users by accommodating the needs of people regardless of age or ability. Bicyclists have a range of skill levels, and facilities should be designed for use by experienced cyclists at a minimum, with a goal of providing for inexperienced / recreational bicyclists (especially children and seniors) to the greatest extent possible. In areas where specific needs have been identified (e.g., near schools) the needs of appropriate types of bicyclists should be accommodated.
- The bikeway and trail network should connect to places people want to go. The bikeway and trail network should provide a continuous direct routes and convenient connections between destinations, including homes, schools, shopping areas, public services, recreational opportunities and transit.
- The bicycling and trail environment should be clear and easy to use. Bike routes, pathways and crossings should be designed so people can easily find a direct route to a destination and delays are minimized. Most roads in Albuquerque are legal for the use of bicyclists, meaning that most streets are bikeway facilities and should be designed, marked and maintained accordingly.
- The bikeway and trail environment should provide good places. Good design should enhance the feel of the bicycle and trail environment. A complete network of on-street bikeway facilities should connect seamlessly to the existing and proposed off-street pathways to complete recreational and commuting routes around the city.

1 An update to the 2000 *Guide for the Development of Bicycle Facilities* is currently available for public review, but cannot be used as a reference until the final version is approved. It is recommended that these design guidelines be updated at that time and the new AASHTO standards should be adopted if they meet or exceed the standards included in this document.

- Bikeway and trail improvements should be economical. Improvements should be designed to achieve the maximum benefit for their cost, including initial cost and maintenance cost as well as reduced reliance on more expensive modes of transportation. Where possible, improvements in the right-of-way should stimulate, reinforce and connect with adjacent private improvements.

Design guidelines are intended to be flexible and can be applied with professional judgment by designers. Specific national and state guidelines are identified in this document, as well as design treatments that may exceed these guidelines.

1.1.1 National and State Guidelines/Best Practices

The following is a list of references and sources used to develop design guidelines for the Albuquerque Bikeways and Trails Master Plan Update Design Guidelines. Many of these documents are available online and are a wealth of information and resources that are available to the public.

1.1.1.1 Federal Guidelines

- *AASHTO Guide for the Development of Bicycle Facilities*, 1999. American Association of State Highway and Transportation Officials, Washington, D.C. www.transportation.org
- *AASHTO Policy on Geometric Design of Streets and Highways*, 2001. American Association of State Highway and Transportation Officials, Washington, D.C. www.transportation.org
- *Manual on Uniform Traffic Control Devices (MUTCD)*, 2003. Federal Highway Administration, Washington, D.C. http://mutcd.fhwa.dot.gov
- *Public Rights-of-Way Accessibility Guidelines (PROWAG)*, 2007. United States Access Board, Washington, D.C. http://www.access-board.gov/PROWAC/alterations/guide.htm
- *Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Developed Areas Final Report*, 1999, U.S. Access Board. http://www.access-board.gov/outdoor/outdoor-rec-rpt.htm

1.1.1.2 State and Local Guidelines

- Albuquerque Public Works Department, *Neighborhood Traffic Management Standards*.
- City of *Albuquerque Development Process Manual*. http://www.cabq.gov/planning/dpm/dpm.html
- New Mexico Department of Transportation, *New Mexico Bicycle-Pedestrian-Equestrian Advisory Plan*, 2009.
- New Mexico *Comprehensive Transportation Safety Plan* (CTSP), 2009. http://nmshtd.state.nm.us/upload/images/Traffic_Safety/pdf/DR3_NMDOT_Safety%20Plan%20Strategie_COMPLETE.pdf
- New Mexico. (1978). *Night Sky Protection Act*. (Section 74-12-11 NMSA 1978) http://law.justia.com/new-mexico/codes/nmrc/jd_74-12-3-1b725.html
- Best Practices Documents
- FHWA Report HRT-04-100, *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations*. http://www.tfhrc.gov/safety/pubs/04100/
- FHWA. (2001). *Designing Sidewalks and Trails for Access* http://www.fhwa.dot.gov/environment/sidewalk2/contents.htm
- *Road Diet Handbook: Setting Trends for Livable Streets*. 2006. Jennifer Rosales.
- *Bicycle Facility Selection: A Comparison of Approaches*. Michael King, for the Pedestrian and Bicycle Information Center. Highway Safety Research Center, University of North Carolina – Chapel Hill, August 2002 http://www.bicyclinginfo.org/pdf/bikeguide.pdf
- *Bicycle Parking Design Guidelines*. http://www.bicyclinginfo.org/pdf/bikepark.pdf
- *City of Chicago Bike Lane Design Guide*. http://www.bicyclinginfo.org/pdf/bike_lane.pdf
- *The North Carolina Bicycle Facilities Planning and Design Guidelines*, 1994. NCDOT Division of Bicycle and Pedestrian Transportation. http://www.ncdot.org/transit/bicycle/projects/resources/projects_facilitydesign.html
- *Wisconsin Bicycle Facility Design Handbook*. 2004. Wisconsin Department of Transportation. http://www.dot.wisconsin.gov/projects/bike.htm
- *Florida Bicycle Facilities Planning and Design Handbook*. 1999. Florida Department of Transportation. http://www.dot.state.fl.us/safety/ped_bike/ped_bike_standards.htm#Florida%20Bike%20Handbook
- *Oregon Bicycle and Pedestrian Plan*. 1995 Oregon Department of Transportation. http://www.oregon.gov/ODOT/HWY/BIKEPED/planproc.shtml

- *City of Portland (OR) Bicycle Master Plan*. 1998. City of Portland (OR) Office of Transportation. http://www.portlandonline.com/shared/cfm/image.cfm?id=40414
- Vélo Québec. 2003. *Technical Handbook of Bikeway Design*.
- CROW. (2006). *Record 25: Design Manual for Bicycle Traffic. CROW, The Netherlands*.

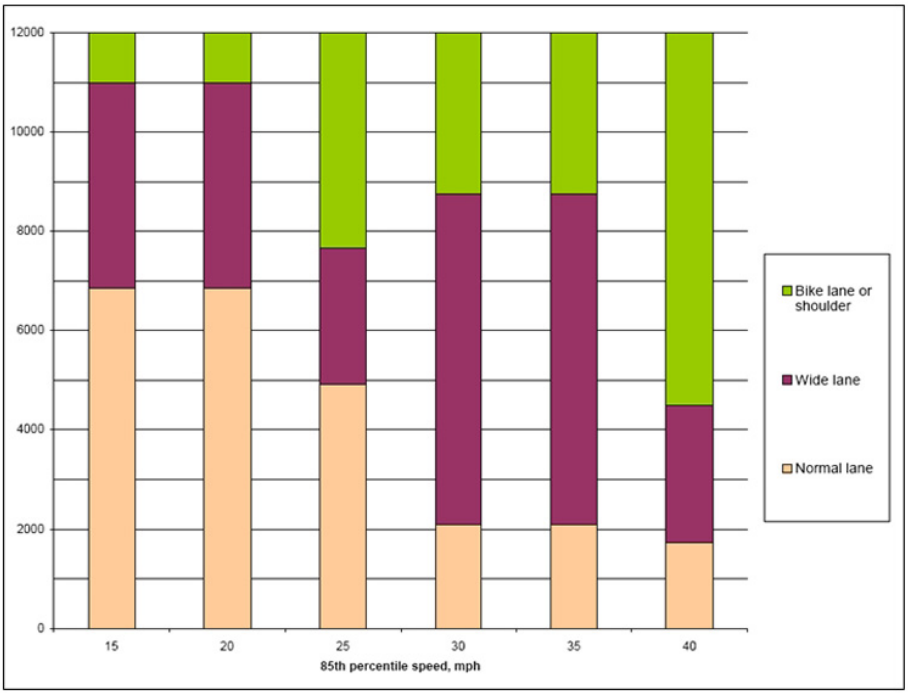
1.2 Facility Selection

There are a wide variety of techniques for selecting the type of facility for a given context. Roadway characteristics that are often used include:

- Motor vehicle speed and volume
- Presence of heavy vehicles/trucks
- Roadway width
- Demand for bikeway facilities
- User preference
- Land use/urban or rural context

There are no specific rules for determining the most appropriate type of facility for a particular location; engineering judgment and planning skills are critical elements of this decision.

A 2002 study combined bikeway dimension standards for ten different communities in North America. The goal of the study was to survey the varying requirements available and provide a best practices approach for providing bikeway facilities. The study included a comparison with European standards and found that, "North Americans rely much more on wide lanes for bicycle accommodation than their counterparts overseas." The table below shows the results of this analysis, which recommends use of bike lanes or shoulders, wide lanes or normal lanes.

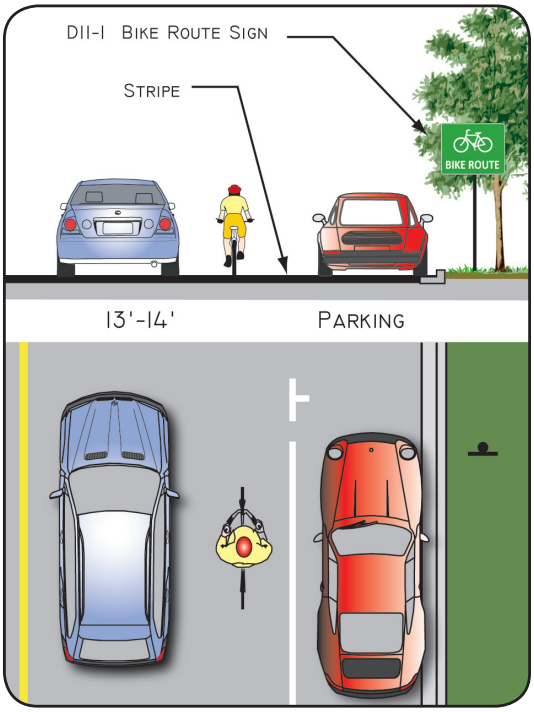


North American Bicycle Facility Selection Chart
(King,. Michael. (2002). Bicycle Facility Selection: A Comparison of Approaches. Pedestrian and Bicycle Information Center and Highway Safety Research Center, University of North Carolina – Chapel Hill.)

1.3 Shared Roadways

Design Summary

- Any street without specific bikeway facilities where bicycling is permitted.
- Can be signed connections, often to trails or other major destinations.
- Sign R4-11 BICYCLES MAY USE FULL LANE may be used on roadways where no bicycle lanes or adjacent shoulders usable by bicyclists are present and where travel lanes are too narrow for bicyclists and motor vehicles to operate side by side (*MUTCD* Section 9B.06).



Shared roadway recommended configuration.

Discussion

A treatment appropriate for commuter riders and those accessing a trail, shared roadways can provide a key connection. Shared roadways are indicated exclusively by signage, which provide key connections to destinations and trails where providing additional separation is not possible.

Roadways appropriate for shared roadways often have a centerline stripe only and no designated shoulders. Bicyclists are forced to share a travel lane with automobiles. This type of facility can be developed on a rural roadway without curbs and gutters. It can also be used on an urban road where traffic speeds and volumes are low, although shared lane markings in addition to signage may be more appropriate in these locations.

This bike route in Los Angeles provides a wide outside lane adjacent to on-street parking.

Guidance

The City of *Albuquerque Development Process Manual* (DPM) defines shared roadways as, "any roadway that may be legally used by both motor vehicles and bicycles and is not specifically designated as a bikeway."

The DPM states that, "where trails intersect with the street network, safe connections to the on-street bikeway system should be designed." Shared routes may be an appropriate treatment for such connections.

See also: *MUTCD* Section 9B. 20 Bicycle Guide Signs.

1.4 Shoulder Bikeways

Design Summary

DPM recommended widths (measured from painted edgeline to edge of pavement):

- 6 feet on roadways with posted speed limits of 40 mph or greater.
- 5 feet on roadways with posted speed limits of 35 mph or below.
- 4 feet may be considered on low-speed, low-volume streets where right-of-way constraints exist.
- Can include pavement markings and Share the Road signage.
- See bike lane section (Page 12) for additional guidance for determining if bike lanes are required.

Discussion

On streets without adequate space for bike lanes or on rural roads with a large shoulder, shoulder bikeways can accommodate bicycle travel. Shoulder bikeways are generally used by commuter and long-distance recreational riders, rather than families with children or more inexperienced riders.

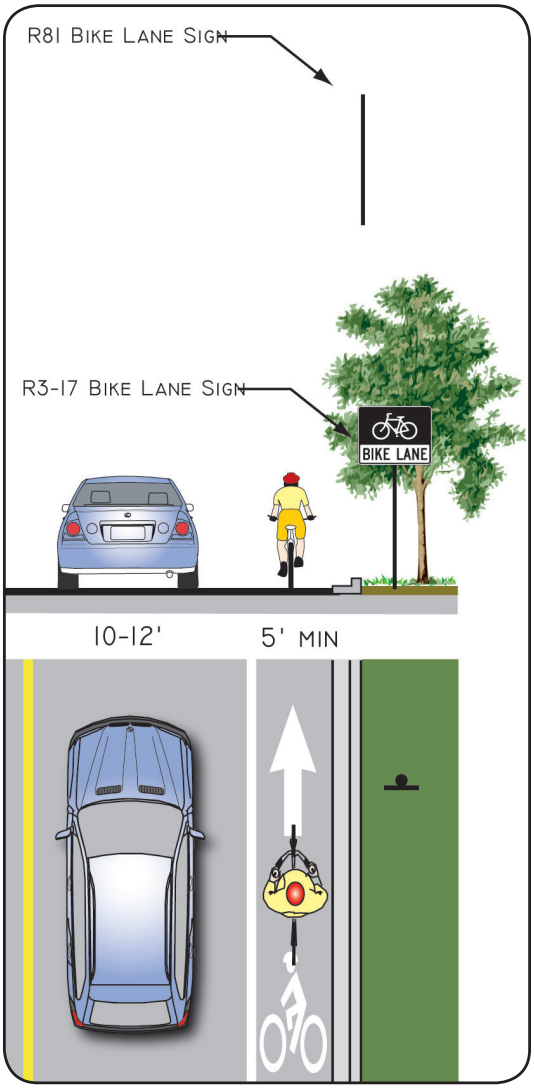
In many cases, the opportunity to develop a full standard bike lane on a street where it is desirable may be many years. It is possible to stripe the shoulder in lieu of bike lanes if the area is 50 percent of the desirable bike lane width and the outside lane width can be reduced to the American Association of State Highway and Transportation Officials (AASHTO) minimum. If the available bike lane width is two-thirds of the desirable bike lane width, the full bike lane treatment of signs, legends and an 8-foot bike lane line would be provided. Where feasible, extra width should be provided with pavement resurfacing jobs, but not exceeding desirable bike lane widths.

Guidance

The DPM states that, "paved shoulder bikeways are located on uncurbed arterials and collectors and consist of a smooth paved surface that covers all or part of the roadway shoulder." The DPM also specifies that bike lanes and paved shoulders are the standard treatments for use on arterial or collector streets.

The New Mexico Bicycle-Pedestrian-Equestrian Advisory Plan provides guidance on the use of rumble strips to provide a buffer on roadway shoulders. It also has information about guard rails, pavement edges and shoulder continuity.

See also: *MUTCD* Section 9B. 20 Bicycle Guide Signs.



Recommended shoulder bikeway configuration.

Shoulder bikeways are appropriate along wide rural roads where vehicles can avoid passing close to bicyclists.

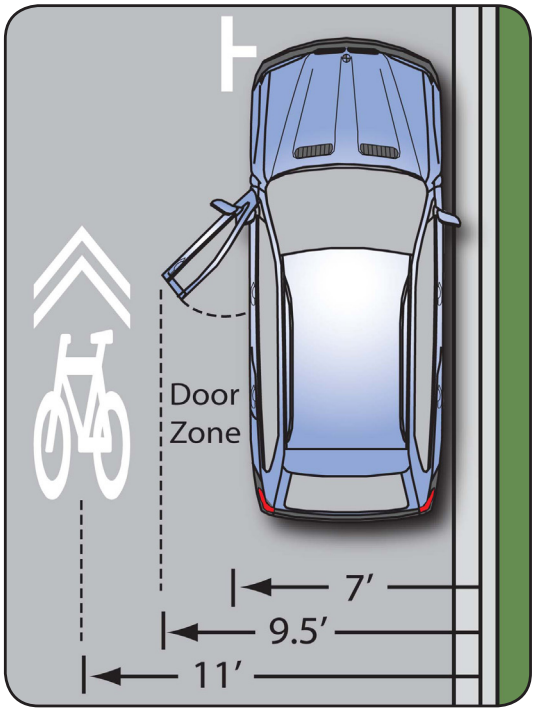
1.5 Wide Curb Lane

Design Summary

- Outside lane widths of 14-16 feet (DPM) or 14-15 feet (NM BPE Plan).
- The width of the door zone is generally assumed to be 2.5 feet from the edge of the parking lane.
- Place in a linear pattern along a corridor (typically every 100-200 feet).

Recommended Placement:

- At least 11 feet from face of curb (or shoulder edge) on streets with on-street parking.
- At least 4 feet from face of curb (or shoulder edge) on streets without on-street parking.



Shared lane marking placement guidance for streets with on-street parking.

Discussion

On wide curb lane bikeways, high-visibility pavement markings, called shared lane markings (also known as sharrows), are used to position bicyclists within the travel lane. These markings are often used on streets where dedicated bike lanes are desirable but are not possible due to physical or other constraints. Shared lane markings are placed strategically in the travel lane to alert motorists of bicycle traffic, while also encouraging cyclists to ride at an appropriate distance from the "door zone" of adjacent parked cars. Shared lane markings also encourage cyclists to ride in a straight line so their movements are predictable to motorists. Shared lane markings made of thermoplastic tend to last longer than painted ones.

Shared lane markings are currently used in Albuquerque.

Guidance

The 2009 *MUTCD* notes that shared lane markings should not be placed on roadways with a speed limit over 35 mph, and that when used the marking should be placed immediately after an intersection and spaced at intervals no greater than 250 feet thereafter. Placing shared lane markings between vehicle tire tracks (if possible) will increase the life of the markings. (See *MUTCD* Section 9C.07).

1.6 Bike Lanes

Design Summary

Designated exclusively for bicycle travel, bike lanes are separated from vehicle travel lanes with striping and also include pavement stencils. Bike lanes are most appropriate on arterial and collector streets where higher traffic volumes and speeds warrant greater separation.

Bike lanes are a popular accommodation for commuter and recreational cyclists.

The DPM recommends minimum bike lane widths of:

- 5 feet, measured from painted edgeline to edge of gutter, on roadways with posted speed limits of 40 mph or greater.
- 4 feet, measured from painted edgeline to edge of gutter, on roadways with posted speed limits of 35 mph or less.

However, AASHTO and other guidance authorities recommends a 5-foot minimum for bike lanes, with 4 feet only in restricted corridors. This text should be considered for revision to specify that a 5-foot bike lane is recommended on streets with posted speed limits of 35 mph or less. In addition, the DPM should specify that bike lanes are measured to the inside edge of the gutter pan, ensuring smooth pavement rather than a gutter edge in the bike lane.

Bike lane pavement markings in Portland, Oregon provide character to the roadway.

Discussion

Many bicyclists, particularly less experienced riders, are more comfortable riding on a busy street if it has a striped and signed bike lane than if they are expected to share a wide lane. Providing marked facilities such as bike lanes is one way of helping to persuade more tentative riders to try bicycling.

Bike lanes can increase safety and promote proper riding by:

- Defining road space for bicyclists and motorists, reducing the possibility that motorists will stray into the cyclists' path
- Discouraging bicyclists from riding on the sidewalk
- Reminding motorists that cyclists have a right to the road.

In an urban setting, it is crucial to ensure that bike lanes and adjacent parking lanes have sufficient width, so that cyclists have enough room to avoid opened vehicle doors.

Additional Guidance

The DPM defines a bike lane as, "a lane on the roadway that has been designated by striping, signing and pavement markings for preferential or exclusive use by bicyclists." The DPM recommends the provision of bike lanes on all new or reconstructed arterial and collector roadways.

The DPM also specifies that high-speed traffic (posted speed of 40 mph or greater) and the presence of large vehicles (truck, bus or recreational vehicle) are significant factors affecting the acceptability of potential bikeway locations. In locations where these conditions exist, bike lane widths of 5-feet or greater are recommended.

The AASHTO *Guide for the Development of Bicycle Facilities* guideline states that, "If used, the bicycle lane symbol marking shall be placed immediately after an intersection and other locations as needed… If the

word or symbol pavement markings are used, Bicycle Lane signs shall also be used, but the signs need not be adjacent to every symbol to avoid overuse of the signs."

The *New Mexico Bicycle and Pedestrian Plan* specifies that, "A vertical edge of pavement should not be left in the useable shoulder area or bicycle lane after construction or maintenance," stating that 4 feet (minimum) of clear space should be provided and noting that partial overlays create undue hazards for cyclists.

See also *MUTCD* Section 9C.04 Markings for Bicycle Lanes.

1.6.1 Guidelines for Bike Lanes

1.6.1.1 Bike Lane Adjacent to On-Street Parallel Parking

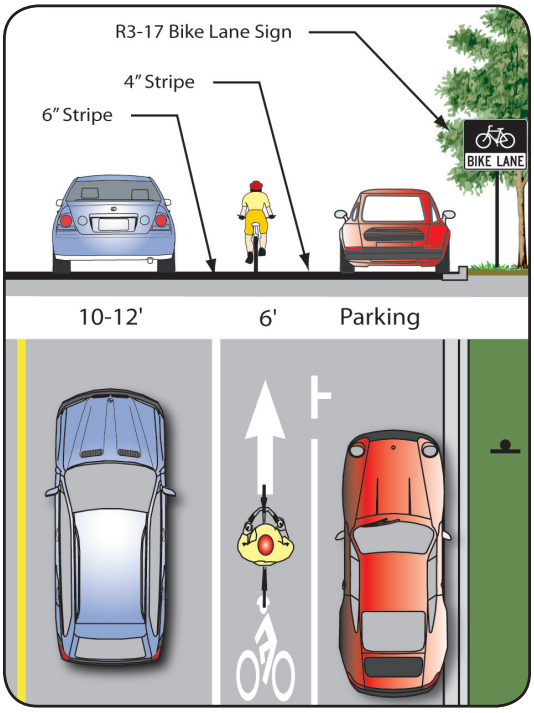
Design Summary

Bike Lane Width

- 6 feet recommended when parking stalls are marked.
- 4 feet minimum in constrained locations.
- 5 feet acceptable if parking not marked (drivers tend to park closer to the curb where parking is unmarked).
- 7 feet maximum (greater widths may encourage vehicle loading in bike lane).

Travel Lane Width

- 12 feet for a shared lane adjacent to a curb face.
- 11 feet minimum for a shared bike/parking lane where parking is permitted but not marked on streets without curbs.



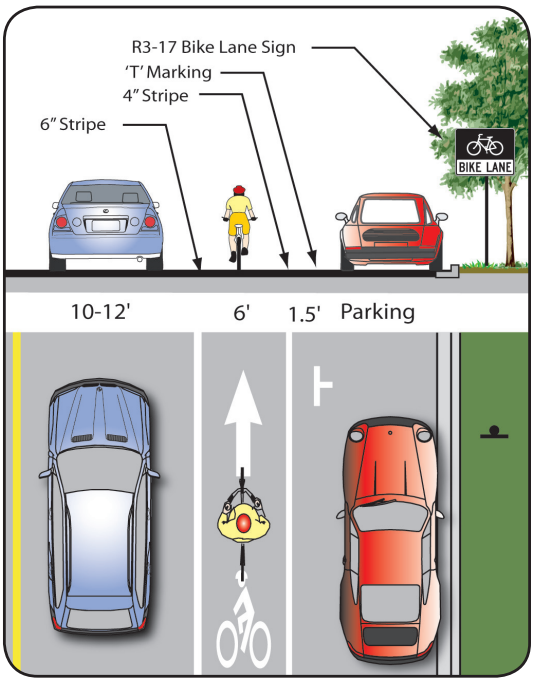
Parking 'T' bike lane design.

Discussion

Bike lanes adjacent to on-street parallel parking are common in the U.S. and can be dangerous for bicyclists if not designed properly. Crashes caused by a suddenly opened vehicle door are a common hazard for bicyclists using this type of facility. On the other hand, wide bike lanes may encourage the cyclist to ride farther to the right (door zone) to maximize distance from passing traffic. Wide bike lanes may also cause confusion with unloading vehicles in busy areas where parking is typically full.

Some treatments to encourage bicyclists to ride away from the door zone include:

- Installing parking "T's" and smaller bike lane stencils placed to the left (see graphic at top).
- Provide a buffer zone (preferred design; shown bottom). Bicyclists traveling in the center of the bike lane will be less likely to encounter open car doors. Motorists have space to stand outside the bike lane when loading and unloading.



Parking buffer bike lane design.

Guidance

From AASHTO *Guide for the Development of Bicycle Facilities*:

> *"If parking is permitted, the bike lane should be placed between the parking area and the travel lane and have a minimum width of 5 feet. Where parking is permitted but a parking stripe or stalls are not utilized, the shared area should be a minimum of*

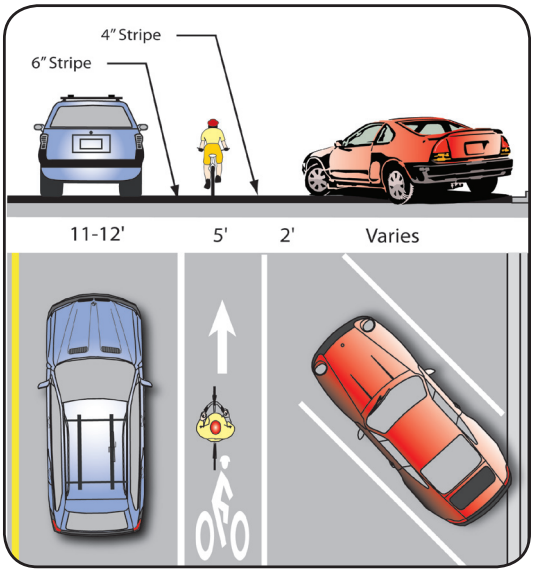
11 feet without a curb face and adjacent to a curb face. If the parking volume is substantial or turnover is high, an additional 1-2 feet of width is desirable."

1.6.1.2 Bike Lane Adjacent to On-Street Diagonal Parking

Design Summary

Bike Lane Width

- 5 feet minimum.
- White 4 inch stripe separates bike lane from parking bays.
- White 6 inch stripes separate bike lane from motor vehicle travel lanes.
- Parking bays are sufficiently long to accommodate most vehicles (vehicles do not block bike lane).



Recommended bike lane adjacent to on-street diagonal parking design.

Discussion

In areas with high parking demand such as urban commercial areas, diagonal parking can be used to increase parking supply. Conventional "head-in" diagonal parking is not recommended in conjunction with high levels of bicycle traffic or with the provision of bike lanes as drivers backing out of conventional diagonal parking spaces have poor visibility of approaching bicyclists.

The use of back-in diagonal parking or reverse angled parking is recommended over head-in diagonal parking. This design addresses issues with diagonal parking and bicycle travel by improving sight distance between drivers and bicyclists and has other benefits to vehicles including: loading and unloading of the trunk occurs at the curb rather than in the street, passengers (including children) are directed by open doors towards the curb and no door conflict with bicyclists. While there may be a learning curve for some drivers, using back-in diagonal parking is typically an easier maneuver than conventional parallel parking.

'Back-in' diagonal parking is safer for cyclists than 'head-in' diagonal parking due to drivers' visibility as they exit the parking spot.

Guidance

This treatment is currently slated for inclusion in the upcoming update of the AASHTO *Guide for the Development of Bicycle Facilities*.

1.6.1.3 Bike Lane Without On-Street Parking

Design Summary

Bike Lane Width

- 4 feet minimum when no curb & gutter is present.
- 5 feet minimum when adjacent to curb and gutter.

Recommended Width

- 6 feet where right-of-way allows.

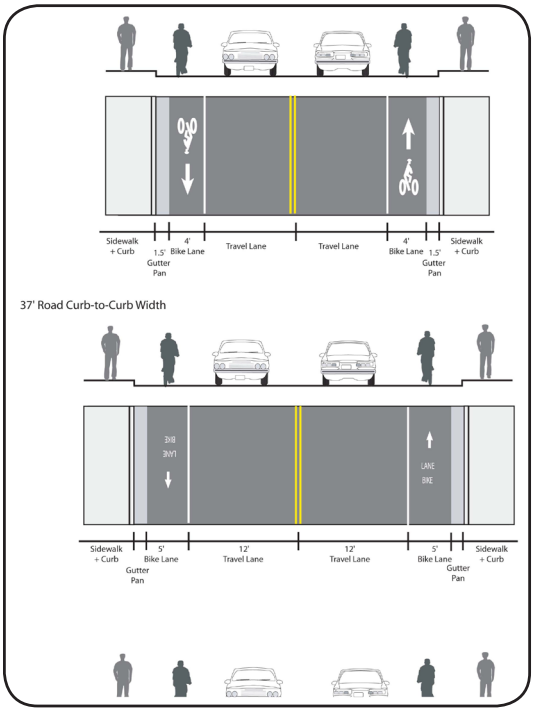
Maximum Width

- 8 feet adjacent to arterials with high travel speeds (45 mph or more).

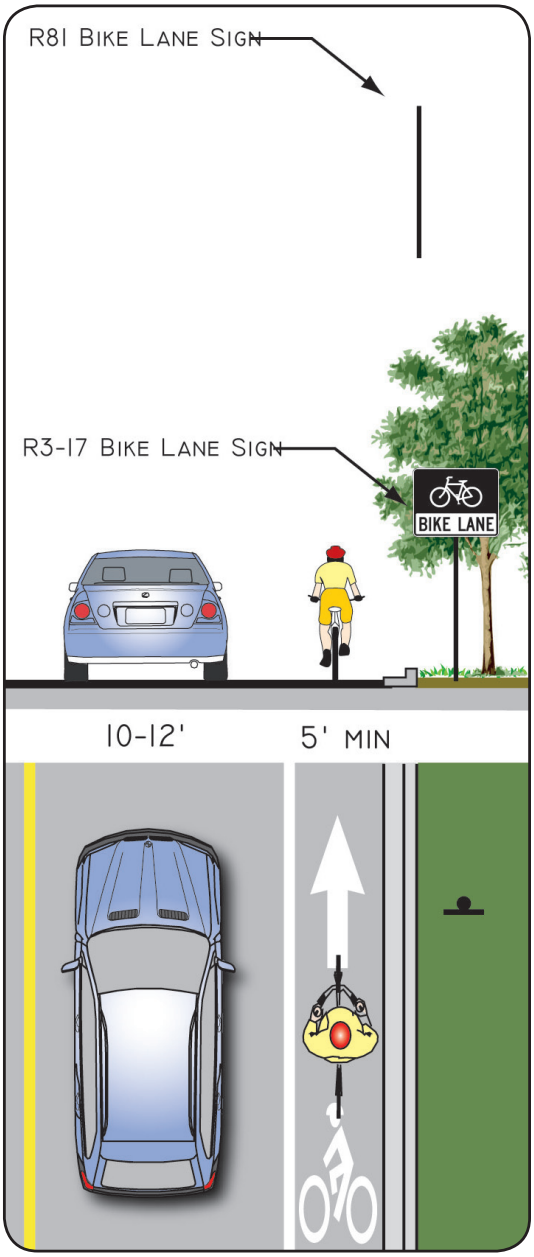
Discussion

Wider bike lanes are desirable in certain circumstances such as on higher speed arterials (45 mph or more) where a wider bike lane can increase separation between passing vehicles and cyclists. Wide bike lanes are also appropriate in areas with high bicycle use. A bike lane width of 6-8 feet makes it possible for bicyclists to ride side-by-side or pass each other without leaving the bike lane, increasing the capacity of the lane. Appropriate signing and stenciling is important with wide bike lanes to ensure motorists do not mistake the lane for a vehicle lane or parking lane.

Guidance



Two Lane Cross-Section with No Parking.*
**Bike lanes may be 4' in width under constrained circumstances.*

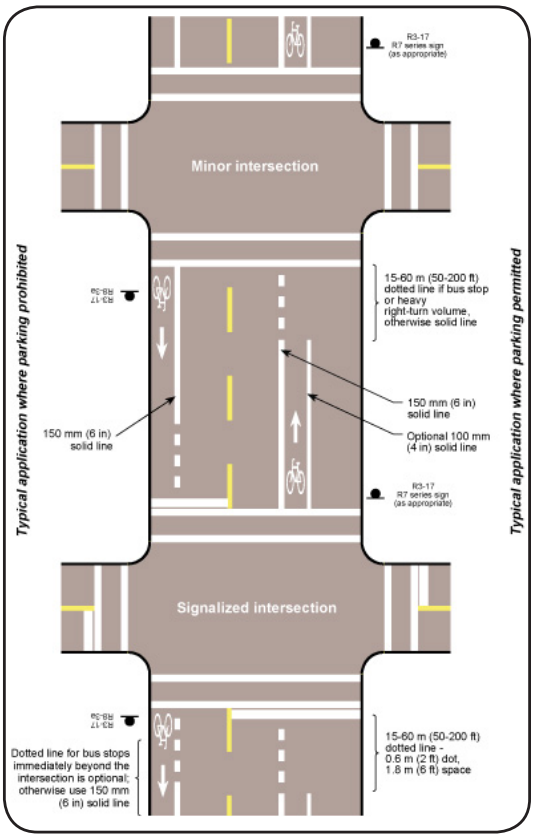


Recommend bike lane without on-street parking design.

1.6.1.4 Bike Lane Striping at Intersections

Design Summary

- Stop striping bike lanes at painted crosswalks or the near side cross street property line
- At complex intersections, bike lanes may be dotted.
- At signalized or stop-controlled intersections with right-turning motor vehicles or at bus stops on the near side of the intersection, replace the solid striping to the approach should be with a broken line with 2-foot dots and 6-foot spaces for 50 to 200 feet.
- If a bus stop is located on a far side of the intersection, replace the solid white line with a broken line for at least 80 feet from the crosswalk on the far side of the intersection.
- At T-intersections with no painted crosswalks, continue the bike lane striping on the side across from the T-intersection through the intersection area with no break.



Typical pavement markings for bike lane on two-way street (AASHTO)

Discussion

Bike lane striping should be brought to the crosswalk or property line on the near side of an intersection. Bike lane striping is not continued through intersections, except where high volumes of motor vehicles are turning right, a bus stop is located in advance of or on the far side of the intersection or at a complex intersection. In the example photo from Portland, Ore., bicyclists are directed on the right hand side of a light rail stop, while the road continues to the left. This diversion sets cyclists up to cross the light rail tracks at a 90 degree angle.

Some jurisdictions are experimenting with using shared lane markings or other high-visibility pavement markings through intersections. At high-speed intersections, such as where a highway on- or off-ramp crosses a bike lane, colored pavement can be used to highlight the conflict area (see innovative design guidelines).

Consistency of intersection design and visibility of cyclists travelling in a bike lane should be a priority to accommodate bicyclists through intersections.

Bike lane dashed through complex intersection.

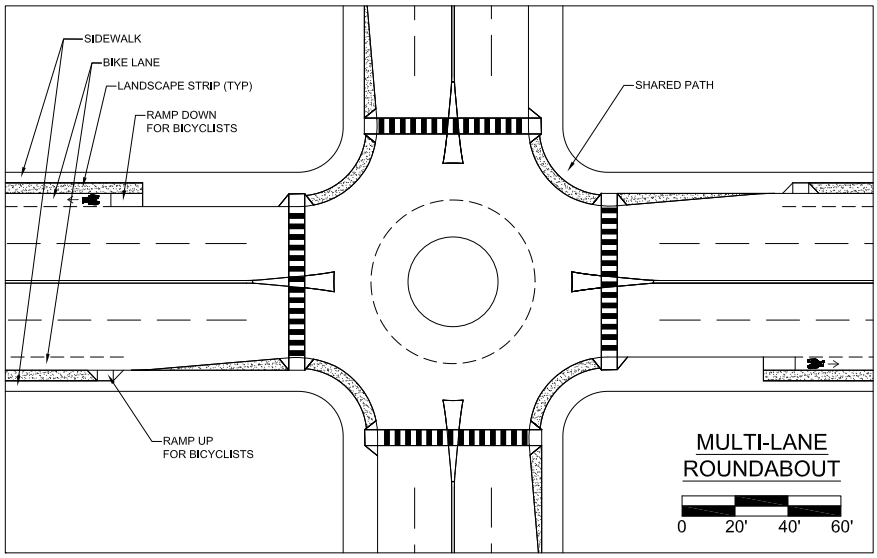
Guidance

AASHTO *Guide for the Development of Bicycle Facilities* (1999).

1.6.1.5 Bike Lanes at Roundabouts

Design Summary

- Reduce the speed differential between circulating motorists and bicyclists (25 mph maximum circulating design speed).
- Design approaches/exits to the lowest speeds possible to reduce the severity of potential collisions with pedestrians.
- 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.
- Indicate to drivers and bicyclists the correct way for them to circulate through the roundabout through appropriately designed signage, pavement markings and geometric design elements.
- Indicate to drivers, bicyclists and pedestrians the right-of-way rules through appropriately designed signage, pavement markings and geometric design elements.



Recommended bike lane at roundabout design.
(Source: UC Berkeley Traffic Safety Center for Caltrans, Identifying Factors that Determine Bicyclist and Pedestrian-Involved Collision Rates and Bicyclist and Pedestrian Demand at Multi-Lane Roundabouts, 2009).

Discussion

Research indicates that while single-lane roundabouts may benefit bicyclists and pedestrians by slowing traffic, multi-lane roundabouts may significantly increase safety problems for these users. Multi-lane roundabouts pose the following challenges to bicyclists riding in a bike lane:

- Bicyclists must take the lane before they enter the roundabout to avoid becoming caught in a "right hook," a situation in which a motorist turns right, across the path of a bicyclist traveling straight. Entry leg speeds must be slow enough for bicyclists to be able to take the lane safely.
- Theoretically, once motor vehicle volumes reach a certain magnitude, there are no gaps in traffic large enough to accommodate a bicyclist.
- Bicyclists must be able to correctly judge the speed of circulating motorists to find a gap that is large enough for them to safely enter the roundabout. This task is particularly difficult if the circulating motorists are traveling at a much higher speed than the bicyclists. In addition, if circulating speeds in a roundabout are much higher than 20 mph, drivers behind a bicyclist may become impatient and may pass the bicyclist and turn in front of him, creating more risks for the bicyclist.
- As a circulating bicyclist approaches an entry lane, a driver waiting to enter must notice the bicyclist, properly judge the bicyclist's speed and yield to him/her if necessary. In a location where there are few bicyclists, motorists may not even register that there is a bicyclist approaching. If a bicyclist is hugging the curb, s/he may be outside the motorist's cone of vision.

Guidance

The *New Mexico Bicycle-Pedestrian-Equestrian Advisory Plan* state provides additional guidance for providing bicycle travel around roundabouts.

1.6.2 Retrofitting Existing Streets with Bike Lanes

Most major streets in Albuquerque are characterized by conditions (e.g., high vehicle speeds and/or volumes) for which dedicated bike lanes are appropriate to accommodate safe and comfortable riding. Although opportunities to add bike lanes through roadway widening may exist in some locations, most major streets in Albuquerque pose physical and other constraints requiring street retrofit measures within existing curb-to-curb widths. As a result, many of the recommended measures effectively reallocate existing street width through striping modifications to accommodate dedicated bike lanes.

The DPM notes that, "the addition of bike lanes as part of arterial and collector rehabilitation is recommended where feasible." While largely intended for major streets, these measures may be appropriate on some lower-order streets where bike lanes would best accommodate cyclists.

1.6.2.1 Roadway Widening

Design Summary

- 6 feet preferred.
- 4 feet minimum (see bike lane guidance).

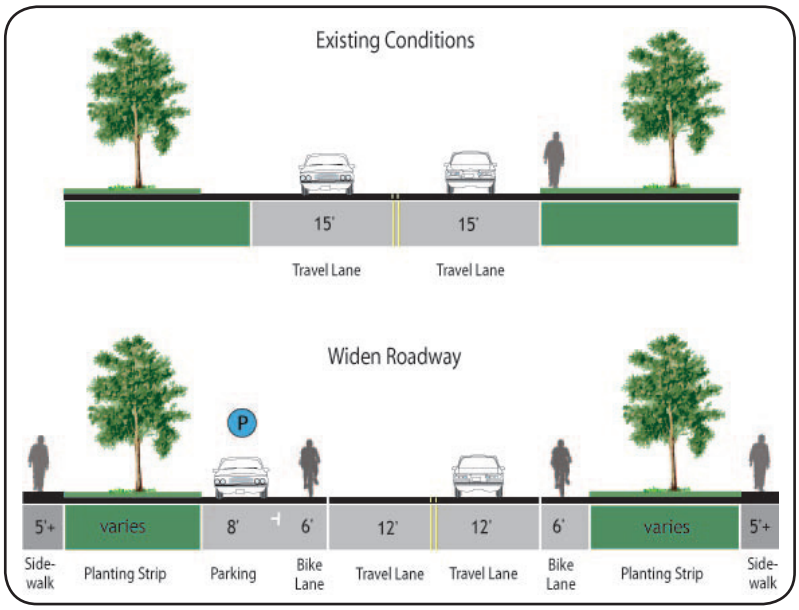
Roadway widening is preferred on roads lacking curbs, gutters and sidewalks.

Discussion

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

As a long-term measure, the City should find opportunities to add bike lanes to other major streets where they are needed. Opportunities include adding bike lanes as streets and bridges are widened for additional auto capacity or as property development necessitates street reconstruction.

Guidance



Example of roadway widening to accommodate bike lanes and sidewalks.

1.6.2.2 Lane Narrowing (Road Diet 1)

Design Summary

Vehicle Lane Widths

- Before: 12-15 feet; after: 10-11 feet.

Bike Lane Width

- See bike lane design guidance.

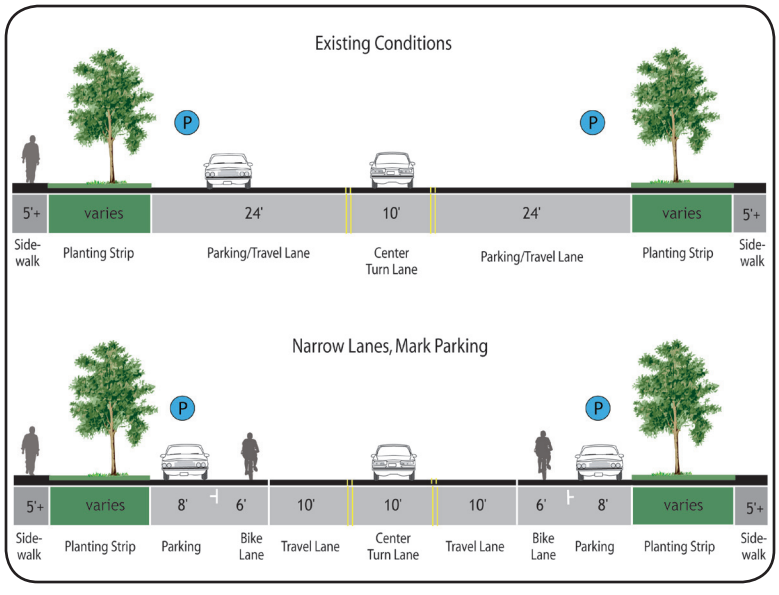
This street in Portland, Oregon previously had 13' lanes, which were narrowed to accommodate bike lanes without removing a lane.

Discussion

Also called a 'Road Diet,' lane narrowing utilizes roadway space that exceeds minimum standards to create the needed space to provide bike lanes. Many roadways in Albuquerque have existing 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 wide and sometimes 10-foot wide travel lanes to create space for bike lanes.

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.

Guidance



Example of vehicle travel lane narrowing to accommodate bike lanes.

1.6.2.3 Lane Reconfiguration (Road Diet 2)

Design Summary

Vehicle Lane Widths

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

Bike Lane Width

- See bike lane design guidance.

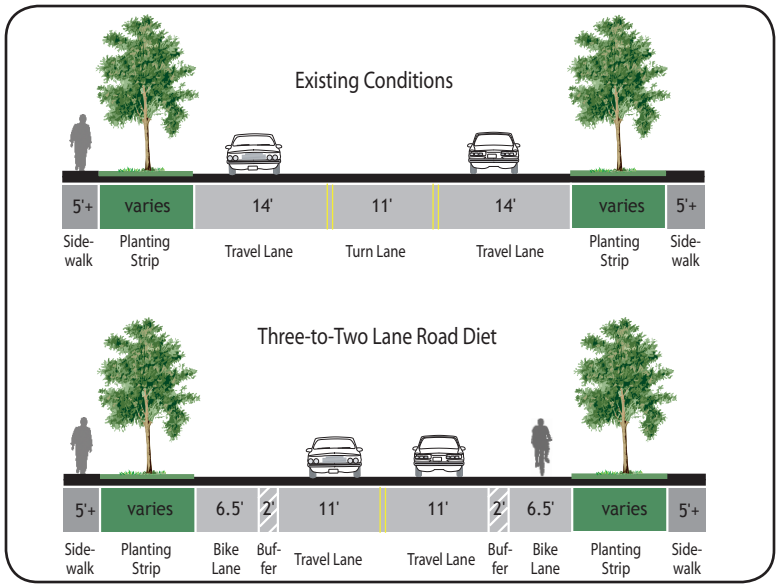
This road was re-striped to convert four vehicle travel lanes into three travel lanes with bike lanes.

Discussion

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

This treatment is slated for inclusion in the update to the AASHTO *Guide for the Development of Bicycle Facilities*.

Guidance



Example of vehicle travel lane reconfiguration to accommodate bike lanes.

1.6.2.4 Parking Reduction (Road Diet 3)

Design Summary

Vehicle Lane Widths

- Width depends on project. No narrowing may be needed depending on the width of the parking lane to be removed.

Bike Lane Width

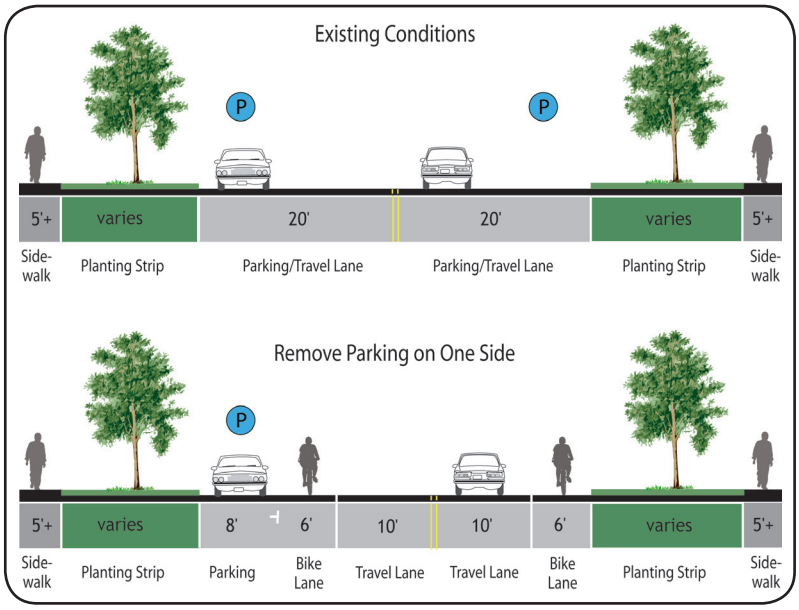
- See bike lane design guidance.

Some streets may not require parking on both sides.

Discussion

Bike lanes could 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 instance, parking may be needed on only one side of a street (as shown below and at right). Eliminating or reducing on-street parking also improves sight distance for cyclists in bike lanes and for motorists on approaching side streets and driveways. 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.

Guidance



Example of parking removal to accommodate bike lanes.

1.6.3 Bike Lane Maintenance Considerations

Like all roadways, bike lanes require regular maintenance. This includes sweeping, maintaining a smooth roadway, ensuring that the gutter-to-pavement transition remains relatively flat and installing bicycle-friendly drainage grates. These considerations are particularly relevant to bike lanes, as cyclists have a narrow corridor to traverse.

1.6.3.1 Drainage Grates

Design Summary

- Require all new drainage grates be bicycle-friendly, including grates that have horizontal slats on them so that bicycle tires do not fall through the vertical slats.
- Consider a program to inventory all existing drainage grates and replace hazardous grates as necessary.

Examples of bicycle-safe drainage grates.

Discussion

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

Guidance

- BIKESAFE Repetitive/Short-Term Maintenance: http://www.bicyclinginfo.org/bikesafe/countermeasure.cfm?CM_NUM=-4

1.6.3.2 Surface

Design Summary

- Ensure that on new roadway construction, the finished surface on bikeways does not vary more than 1/4 of an inch.
- Maintain a smooth surface of all bikeways that is free of potholes.
- Maintain pavement so ridge buildup does not occur at the gutter-to-pavement transition.

Discussion

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.

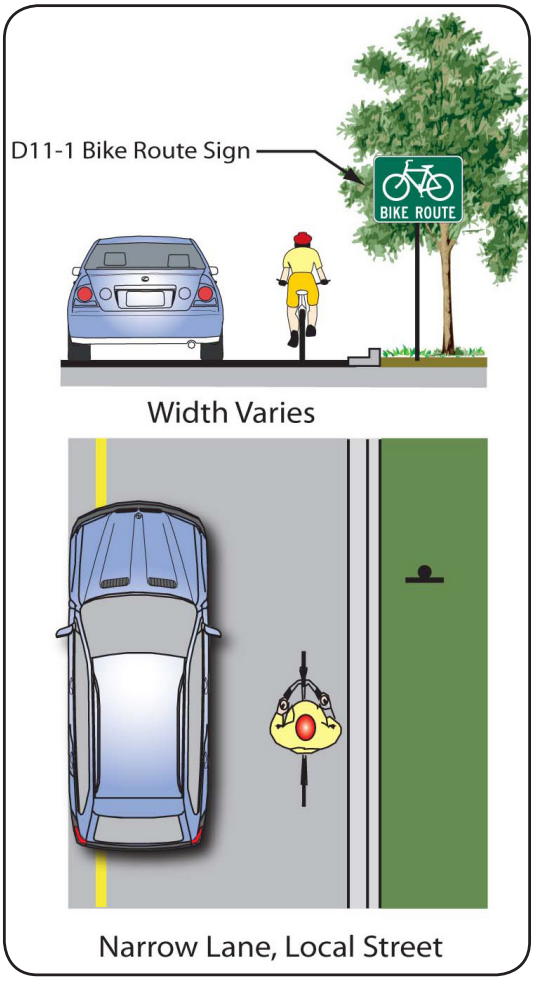
Guidance

- BIKESAFE Repetitive/Short-Term Maintenance: http://www.bicyclinginfo.org/bikesafe/countermeasure.cfm?CM_NUM=-4

1.7 Bicycle Boulevards

Design Summary

- Roadway width varies depending on roadway configuration.
- Use D11-1 "Bike Route" sign as specified for shared roadways.
- Shared lane markings may be applied.
- Intersection treatments, traffic calming and traffic diversions can be utilized to improve the cycling environment, as recommended in the following pages.



Recommended design for bike routes/ bicycle boulevards.

Discussion

Treatments for bicycle boulevards include five application levels, which are rated based on their level of physical intensity. This helps identify the appropriate application level for individual bicyclists. Level one represents the least physically intensive treatments that could be implemented at a relatively low cost.

Traffic calming and other treatments along the corridor reduce vehicle speeds so that motorists and bicyclists generally travel at the same speed, creating a more-comfortable environment for all users. Bicycle boulevards incorporate treatments to facilitate convenient crossings where the route crosses a major street. They work best in well-connected street grids where riders can follow reasonably direct and logical routes and when higher-order parallel streets exist to serve through vehicle traffic.

Bicycle boulevards/bike routes can be treated with shared lane markings, directional signage, traffic diverters, chicanes, chokers and /or other traffic calming devices to reduce vehicle speeds or volumes.

Bicycle boulevards can employ a variety of treatments from signage to traffic calming and pavement stencils. The level of treatment provided at a specific location depends on several factors, discussed below.

Bicycle boulevards are low-speed streets that provide a comfortable and pleasant experience for cyclists.

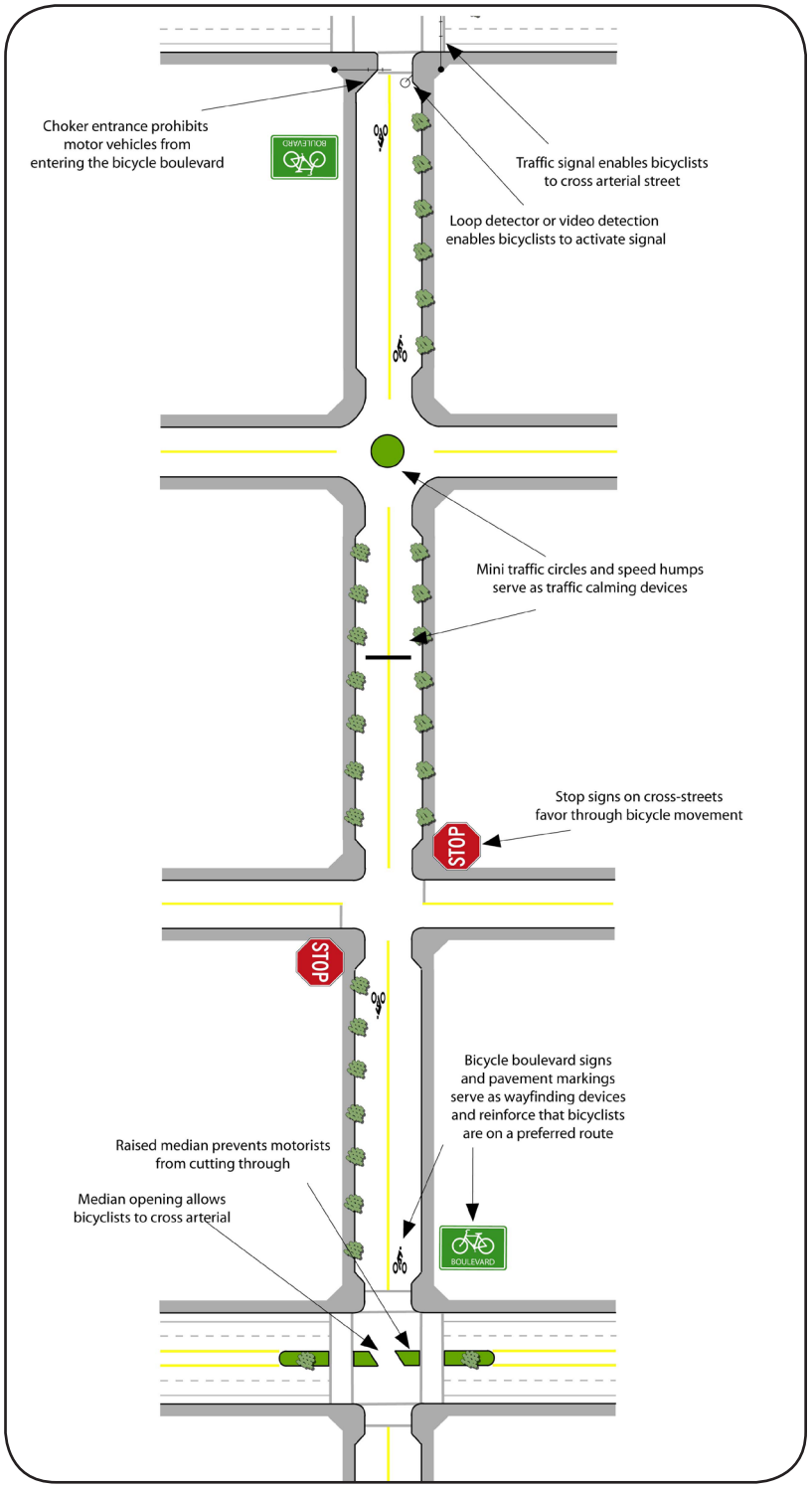
Guidance

- The DPM defines a bicycle boulevard as, "a bike route designed to encourage the through movement of bicycles while maintaining local access for motor vehicle travel."
- Bicycle boulevards have been implemented in California in Berkeley, Emeryville, Palo Alto, San Luis Obispo and Pasadena; in Oregon in Portland and Eugene; in Madison, Wis.; in Vancouver, B.C.; in Tucson, Ariz.; in Minneapolis, Minn.; in Ocean City, Md.; and in Syracuse, N.Y.
- Alta Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook*. www.ibpi.usp.pdx.edu/guidebook.php
- City of Berkeley. (2000). *Bicycle Boulevard Design Tools and Guidelines*. http://www.ci.berkeley.ca.us/contentdisplay.aspx?id=6652
- AASHTO *Guide for the Development of Bicycle Facilities*.

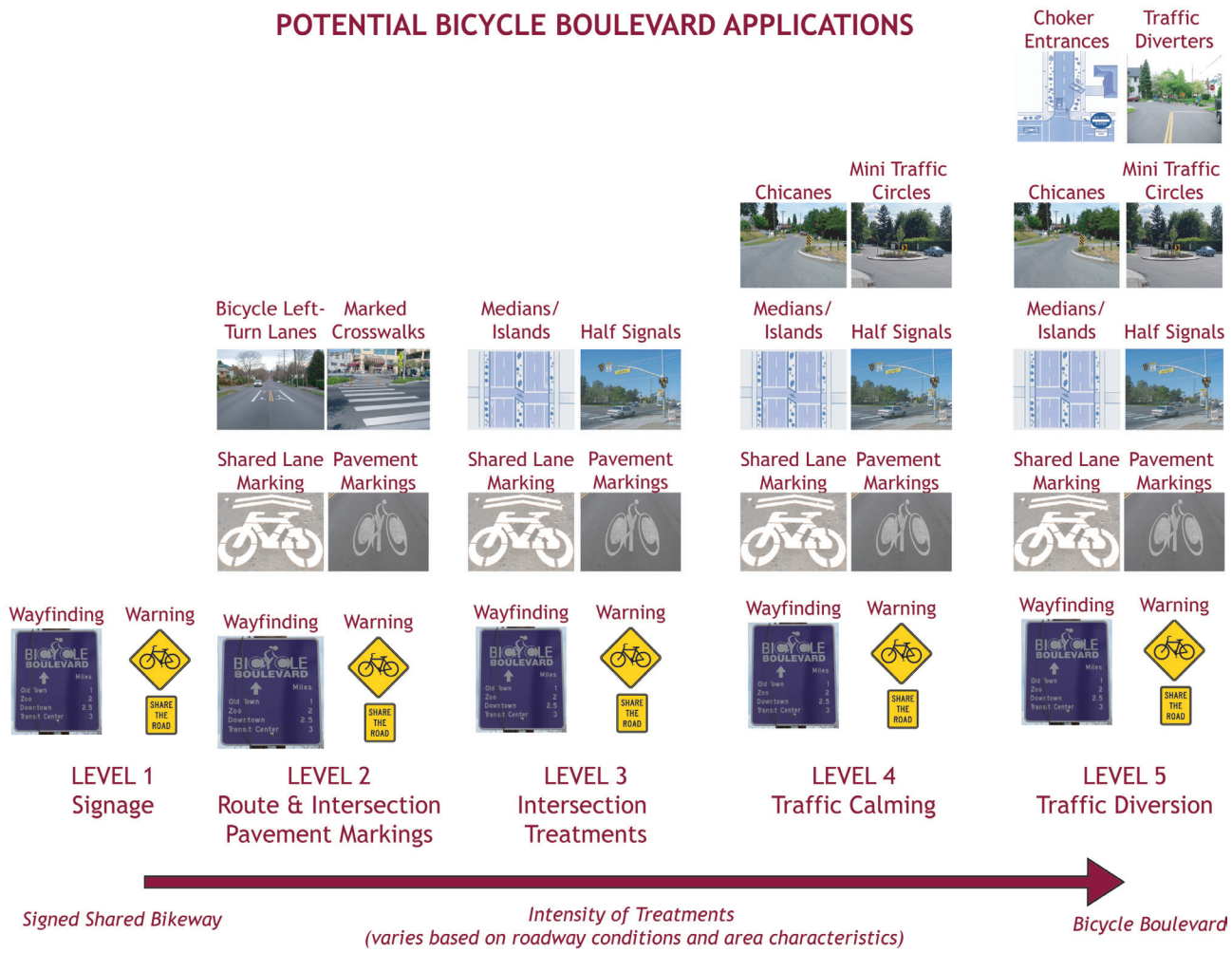
Discussion (continued)

Bicycle boulevards serve a variety of purposes:

- Parallel major streets lacking dedicated bicycle facilities: Higher-order streets typically include major bicyclist destinations (e.g., commercial and employment areas). However, these corridors often lack bike lanes or other dedicated facilities creating an uncomfortable, unattractive and potentially unsafe riding environment. Bicycle boulevards serve as alternate parallel facilities that allow cyclists to avoid major streets for longer trips.
- Parallel major streets with bicycle facilities that are uncomfortable for some users: Some users may not feel comfortable using bike lanes on major streets due to high traffic volumes and vehicle speeds, conflicts with motorists entering and leaving driveways and/or conflicts with buses loading and unloading passengers. Children and less-experienced riders might find these environments especially challenging. Utilizing lower-order streets, bicycle boulevards provide alternate route choices for these bicyclists. It should be noted that bike lanes on major streets provide important access to key land uses, and the major street network often provides the most direct routes between major destinations. For these reasons, bicycle boulevards should complement a bike lane network and not serve as a substitute.
- Ease of implementation on most local streets: bicycle boulevards incorporate cost-effective and less physically-intrusive treatments than bike lanes and cycle tracks. Most streets could be provided relatively inexpensive treatments like new signage, pavement markings, striping and signal improvements to facilitate bicyclists' mobility and safety. Other potential treatments include curb extensions, medians and other features that can be implemented at reasonable cost and are compatible with emergency vehicle accessibility.
- Benefits beyond an improved bicycling environment: Residents living on bicycle boulevards benefit from reduced vehicle speeds and through traffic, creating a safer and more-attractive environment. Pedestrians and other users can also benefit from boulevard treatments (e.g., by improving the crossing environment where boulevards meet major streets).



Sample bicycle boulevard treatments.



Bicycle Boulevard Application Levels.

It should be noted that corridors targeted for higher-level applications would also receive relevant lower-level treatments. For instance, a street targeted for Level 3 applications should also include Level 1 and 2 applications as necessary. It should also be noted that some applications may be appropriate on some streets while inappropriate on others. In other words, it may not be appropriate or necessary to implement all Level 2 applications on a Level 2 street. Furthermore, several treatments could fall within multiple categories as they achieve multiple goals. To identify and develop specific treatments for each bicycle boulevard, the City should involve the bicycling community and neighborhood groups. Further analysis and engineering work may also be necessary to determine the feasibility of some applications.

The City should strive to implement bicycle boulevards of Level 3 or higher, with additional traffic calming or diversion as needed.

1.7.1 Level 1: Bicycle Boulevard Signing

Design Summary

- Signing is a cost-effective and highly visible treatment that can improve the riding environment on a bicycle boulevard.
- The City should adopt consistent signage and paint markings throughout the region.

Sample bicycle boulevard signage.

Discussion

Wayfinding Signs (Can be non-standard treatment)
Wayfinding signs are typically placed at key locations leading to and along bicycle boulevards, including where multiple routes intersect and at key bicyclist "decision points." Wayfinding signs displaying destinations, distances and "riding time" can dispel common misperceptions about time and distance while increasing users' comfort and accessibility to the boulevard network.

Wayfinding signs also visually cue motorists that they are driving along a bike route and should correspondingly use caution. Note that too many signs tend to clutter the right-of-way, and it is recommended that these signs be posted at a level most visible to bicyclists and pedestrians, rather than per vehicle signage standards.

Wayfinding signs help bicyclists stay on designated bike routes.

Warning signs
Warning signs advising motorists to "share the road" and "watch for bicyclists" may also improve bicycling conditions on shared streets. These signs are especially useful near major bicycle trip generators such as schools, parks and other activity centers. Warning signs should also be placed on major streets approaching bicycle boulevards to alert motorists of bicyclist crossings.

Guidance

- Alta Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook*. www.ibpi.usp.pdx.edu/guidebook.php
- City of Berkeley. (2000). *Bicycle Boulevard Design Tools and Guidelines*.
- AASHTO *Guide for the Development of Bicycle Facilities*.
- *MUTCD*.

1.7.2 Level 2: Bicycle Boulevard Pavement Markings

Design Summary

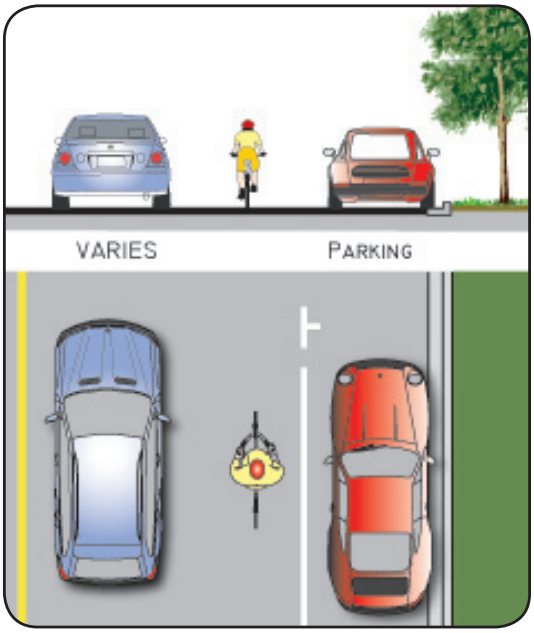
Use pavement markings to designate bicycle boulevards and provide directional/wayfinding information

Shared lane markings also provide directional support for bicyclists.

Discussion

On-Street Parking Delineation
Delineating on-street parking spaces with paint or other materials clearly indicates where a vehicle should be parked and can discourage motorists from parking their vehicles too far into the adjacent travel lane. This helps cyclists by maintaining a wide enough space to safely share a travel lane with moving vehicles while minimizing the need to swerve farther into the travel lane to maneuver around parked cars.

In addition to benefiting cyclists, delineated parking spaces also promote the efficient use of on-street parking by maximizing the number of spaces in high-demand areas.



Example of on-street parking delineation.

Centerline Striping Removal
Automobiles have an easier time passing cyclists on roads without centerline stripes for the majority of the block length. If vehicles cannot easily pass each other using the full width of the street, it is likely that there is too much traffic for the subject street to be a successful bicycle boulevard. In addition, not striping the centerline reduces maintenance costs. Berkeley paints a double yellow centerline from 40-50 feet at uncontrolled or stop-controlled intersections, as well as pavement reflectors to identify the center of the street.

Directional Pavement Markings (Non-standard treatment)
Directional pavement markings (also known as bicycle boulevard markings) lead cyclists along a boulevard and reinforce that they are on a designated route. Markings can take a variety of forms, such as small bicycle symbols placed every 600-800 feet along a linear corridor, as previously used on Portland, Ore.,'s boulevard network.

Recently, jurisdictions have been using larger, more visible pavement markings. Shared lane markings could be used as bicycle boulevard markings, as Portland, Ore., has moved towards using. See shared lane marking guidelines for additional information on this treatment.

In Berkeley, Calif., non-standard pavement markings include larger-scale lettering and stencils to clearly inform motorists and bicyclists of a street's function as a bicycle boulevard.

Bicycle boulevard directional marker.

Guidance

- Alta Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook*. www.ibpi.usp.pdx.edu/guidebook.php
- City of Berkeley. (2000). *Bicycle Boulevard Design Tools and Guidelines*.
- AASHTO *Guide for the Development of Bicycle Facilities*.

- *MUTCD*.

1.7.3 Level 3: Bicycle Boulevards at Minor Unsignalized Intersections

Design Summary

- To encourage use of the boulevard and improve cyclists' safety, reduce bicycle travel time by eliminating unnecessary stops and improving intersection crossings.

Discussion

Stop Sign on Cross-Street
Unmarked intersections are dangerous for bicyclists because cross-traffic may not be watching for cyclists. Stop signs on cross streets require crossing motorists to stop and proceed when safe. Stop signs are a relatively inexpensive treatment that is quite effective at minimizing bicycle and cross-vehicle conflicts. However, placing stop signs at all intersections along bicycle boulevards may be unwarranted as a traffic control device.

Stop signs effectively minimize conflicts along bicycle boulevards.

The DPM specifies that, "Potential on-street bikeway locations should include no more than one stop sign or traffic signal per 1/4 mile. Local street stop control should be reassigned to facilitate through bicycle traffic on designated bikeways. Stop control reassignment requires an engineering study to determine additional measures necessary to minimize neighborhood impacts."


Curb extensions can be a good location for pedestrian amenities, including street trees.

Curb Extensions and High-Visibility Crosswalks
This treatment is appropriate near activity centers with large amounts of pedestrian activity, such as schools or commercial areas. Curb extensions should only extend across the parking lane and not obstruct bicyclists' path of travel or the travel lane. Curb extensions and high-visibility crosswalks both calm traffic and also increase the visibility of pedestrians waiting to cross the street, although they may impact on-street parking.

Bicycle Forward Stop Bar (Non-standard treatment)
A second stop bar for cyclists placed closer to the centerline of the cross street than the first stop bar increases the visibility of cyclists waiting to cross a street. This treatment is typically used with other crossing treatments (i.e., curb extension) to encourage cyclists to take full advantage of crossing design. They are appropriate at unsignalized crossings where fewer than 25 percent of motorists make a right turn movement.

Bicycle forward stop bars encourage cyclists to wait where they are more visible.

Guidance
- Alta Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook*.
- City of Berkeley. (2000). *Bicycle Boulevard Design Tools and Guidelines*.
- AASHTO *Guide for the Development of Bicycle Facilities*.
- *MUTCD*.

1.7.4 Level 3: Bicycle Boulevards at Major Unsignalized Intersections

Design Summary

- Increase crossing opportunities with medians and refuge islands.

Medians on bicycle boulevards can provide space for a bicyclist to wait.

Discussion

Medians/Refuge Islands
A crossing island can be provided to allow cyclists to cross one direction of traffic at a time when gaps in traffic allow. The crossing island should be at least 8 feet wide; narrower medians can accommodate bikes if the holding area is at an acute angle to the major roadway. Crossing islands can be placed in the middle of the intersection, prohibiting left and through vehicle movements.

Guidance

- Alta Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook*.
- City of Berkeley. (2000). *Bicycle Boulevard Design Tools and Guidelines*.
- AASHTO *Guide for the Development of Bicycle Facilities*.

1.7.5 Level 3: Bike Routes/Boulevards at Offset Intersections

Design Summary

- Provide turning lanes or pockets at offset intersection , providing cyclists with a refuge to make a two-step turn.
- Bike turn pockets - 5 feet wide, with a total of 11 feet required for both turn pockets and center striping.

Example of a bicycle left-turn pocket.

Discussion

Offset intersection can be challenging for cyclists, who need to transition onto the busier cross-street in order to continue along the boulevard.

Bicycle Left-Turn Lane (Non-standard treatment)
Bicycle left-turn lanes allow the crossing to be completed in two phases. The bicyclist executes a right-hand turn onto the cross-street and then waits in a delineated left-turn lane if necessary. The bike turn pockets should be at least 5 feet wide, total of 11 feet for turn pockets and center striping.

Bicycle Left Turn Pocket (Non-standard treatment)
A bike-only left-turn pocket permits bicyclists to make left turns while restricting vehicle left turns. Signs should prohibit motorists from turning. Because of the restriction on vehicle left-turning movements, this treatment also acts as traffic diversion.

This bike-only left-turn pocket guides cyclists along a popular bike route.

Guidance

- Alta and IBPI. *Bicycle Boulevard Planning and Design Handbook*.
- AASHTO *Guide for the Development of Bicycle Facilities*.

1.7.6 Level 4: Bicycle Boulevard Traffic Calming

Design Summary

- Traffic calming treatments reduce vehicle speeds to the point where they generally match cyclists' operating speeds, enabling motorists and cyclists to safely co-exist on the same facility.

Discussion

Chicanes (Non-standard treatment)
Chicanes are a series of raised or delineated curb extensions on alternating sides of a street forming an S-shaped curb, which reduce vehicle speeds through narrowed travel lanes. Chicanes can also be achieved by establishing on-street parking on alternate sides of the street. These treatments are most effective on streets with narrower cross-sections.

Mini Traffic Circles
Mini traffic circles are raised or delineated islands placed at intersections, reducing vehicle speeds through tighter turning radii and narrowed vehicle travel lanes (see right). These devices can effectively slow vehicle traffic while facilitating all turning movements at an intersection. Mini traffic circles can also include a paved apron to accommodate the turning radii of larger vehicles like fire trucks or school buses.

Speed Humps
Shown right, speed humps are rounded raised areas of the pavement requiring approaching motor vehicles to reduce speed. These devices also discourage through vehicle travel on a street when a parallel route exists.

Speed humps should never be constructed so steep that they may cause a bicyclist to lose control of the bicycle or be distracted from traffic. In some cases, a gap could be provided, whereby a bicyclist could continue on the level roadway surface, while vehicles would slow down to cross the barrier.

Guidance

- Alta Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook*. www.ibpi.usp.pdx.edu/guidebook.php
- City of Berkeley. (2000). *Bicycle Boulevard Design Tools and Guidelines*.
- AASHTO *Guide for the Development of Bicycle Facilities*.

Chicanes require all vehicles to reduce their speeds.


Traffic circles provide an opportunity for landscaping, but visibility should be maintained.


Speed humps are a common traffic calming treatment, which should not be used on emergency routes.

1.7.7 Level 5: Bicycle Boulevard Traffic Diversion

Design Summary

- Traffic diversion treatments maintain through-bicycle travel on a street while physically restricting through vehicle traffic.
- Traffic diversion is most effective when higher-order streets can sufficiently accommodate the diverted traffic associated with these treatments.

Choker entrances prevent vehicular traffic from turning from a main street onto a traffic-calmed bicycle boulevard.

Discussion

Choker Entrances (Non-standard treatment)
Choker entrances are intersection curb extensions, or raised islands, allowing full bicycle passage while restricting vehicle access to and from a bicycle boulevard. When they approach a choker entrance at a cross-street, motorists on the bicycle boulevard must turn onto the cross-street while cyclists may continue forward. These devices can be designed to permit some vehicle turning movements from a cross-street onto the bicycle boulevard while restricting other movements.

Traffic Diverters (Non-standard treatment)
Similar to choker entrances, traffic diverters are raised features directing vehicle traffic off the bicycle boulevard while permitting through travel.

Traffic diverters prevent access to both directions of motor vehicle traffic.

Advantages:

- Provides safe refuge in the median of the major street so that bicyclists only have to cross one direction of traffic at a time. Works well with signal-controlled traffic platoons coming from opposite directions.
- Provides traffic calming and safety benefits by preventing left turns and/or through traffic from using the intersection.

Disadvantages:

- Potential motor vehicle impacts to major roadways, including lane narrowing, loss of some on-street parking and restricted turning movements.
- Crossing island may be difficult to maintain and may collect debris.

Guidance

- Alta Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook*. www.ibpi.usp.pdx.edu/guidebook.php
- City of Berkeley. (2000). *Bicycle Boulevard Design Tools and Guidelines*.
- AASHTO *Guide for the Development of Bicycle Facilities*.

1.8 General Intersection Design Guidelines

A wide variety of intersection treatments exist, which provide safe crossing for bicyclists and pedestrians. Treatments specific to particular facility types were previously discussed. This section addresses general guidelines for crossings.

1.8.1 High-Visibility Crosswalk Techniques

Design Summary

- Additional treatments can be used to increase visibility of the crosswalk at high-use locations and in locations with high use from school children, elderly pedestrians or pedestrians with disabilities.

Flashing warning sign.

Discussion

Flasher Warning Sign
Flashing warning signs increase the visibility of a crossing by calling attention to the pedestrian crossing location. They can be continuous, timed for rush hours or activated by a pedestrian push-button. *MUTCD* Chapter 4L provides information about flashing beacons.

Raised Median (Non-standard treatment)
A median can eliminate grade changes from the pedestrian path and give pedestrians greater prominence as they cross the street. Raised crosswalks should be used only in limited cases where a special emphasis on pedestrians is desired such as at a mid-block crossing. Review on case-by-case basis.

Raised medians require drivers to slow down.

Additional guidelines include:

- Use detectable warnings at the curb edges to alert vision-impaired pedestrians that they are entering the roadway.
- Approaches to the raised crosswalk may be designed to be similar to speed humps, or they may be designed so they do not have a slowing effect (such as on emergency response routes).
- Use post mounted pedestrian crosswalk signs placed on the median and on the right side of the roadway for each approach.

In-Street "Yield to Pedestrians" Signs and Flashers
In-street "Yield to Pedestrian" signs are flexible plastic paddle signs installed in the center of a roadway to enhance a crosswalk at uncontrolled crossing locations. In-pavement flashers may be appropriate on undivided roadways in densely developed areas that do not offer median refuges for crossing pedestrians. See *MUTCD* Section 2B.12 In-Street and Overhead Pedestrian Crossing Signs.

In-street yield to pedestrian signage.

In-Roadway Lights
In-roadway lights may be used at marked crosswalks to provide additional warning. They are actuated by the pedestrian and flash for a designated amount of time before turning off. See *MUTCD* Section 4N.02 In-Roadway Warning Lights at Crosswalks for additional information.

Guidance

- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines* (PROWAG).
- *MUTCD*

1.8.2 Marked Crosswalks

1.8.2.1 Minimizing Conflict with Automobiles

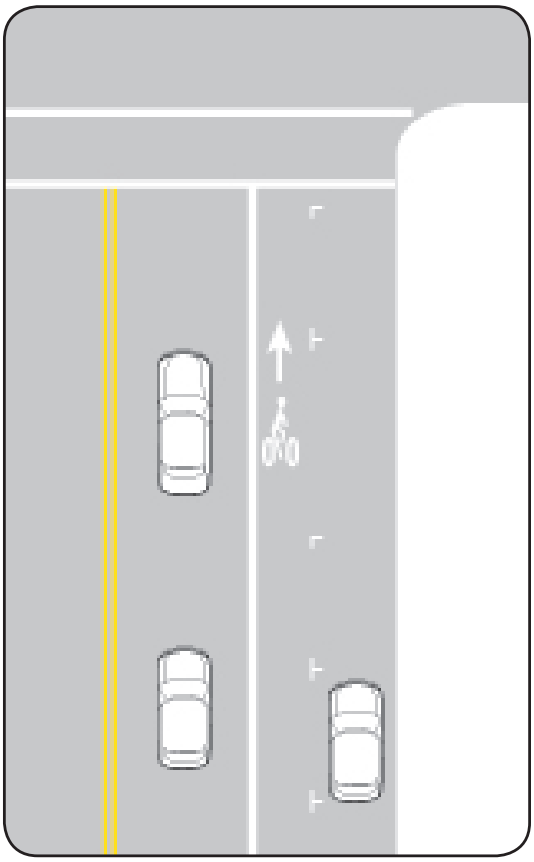
Design Summary

- Separating pedestrians and motor vehicles at intersections improves safety and visibility.

Discussion

Parking Control

- Parking control improves visibility in the vicinity of the crosswalk. Parking is prohibited within all intersections and crosswalks unless otherwise signed. At "T" and offset intersections, where the boundaries of the intersection may not be obvious, this prohibition should be made clear with signage.
- In areas where there is high parking demand (as determined by a Traffic Engineer), parking for compact vehicles may be allowed within "T" or offset intersections and on either side of the crosswalk. At these locations, signs will be placed to prohibit parking within the designated crosswalk areas and additional enforcement should be provided, particularly when the treatment is new.
- Parking shall not be allowed within any type of intersection adjacent to schools, school crosswalks and parks. This includes "T" and offset intersections.
- Installation of parking signage to allow and/or prohibit parking within any given intersection will occur at the time that the parking control section is undertaking work at the intersection.



Crosswalks should always be kept clear of on-street parking.

Advance Stop Bars

Advance stop bars increase pedestrian comfort and safety by stopping motor vehicles well in advance of marked crosswalks, allowing vehicle operators a better line of sight of pedestrians and giving inner lane motor vehicle traffic time to stop for pedestrians. Pedestrians feel more comfortable since motor vehicles are not stopped adjacent to the crosswalk. The multiple threat of motor vehicles is reduced, since vehicles in the inner travel lane have a clearer line of sight to pedestrians entering the sidewalk. Without an advance stop bar, the vehicle in the outer lane may stop for the pedestrian, but the vehicle in the inner lane proceeds, increasing the possibility of a vehicle-pedestrian conflict.

Advance stop bars alert motorists of pedestrians.

Advanced stop bars should be used:

- On streets with at least two travel lanes in each direction.
- Prior to a marked crosswalk
- In one or both directions of motor vehicle travel

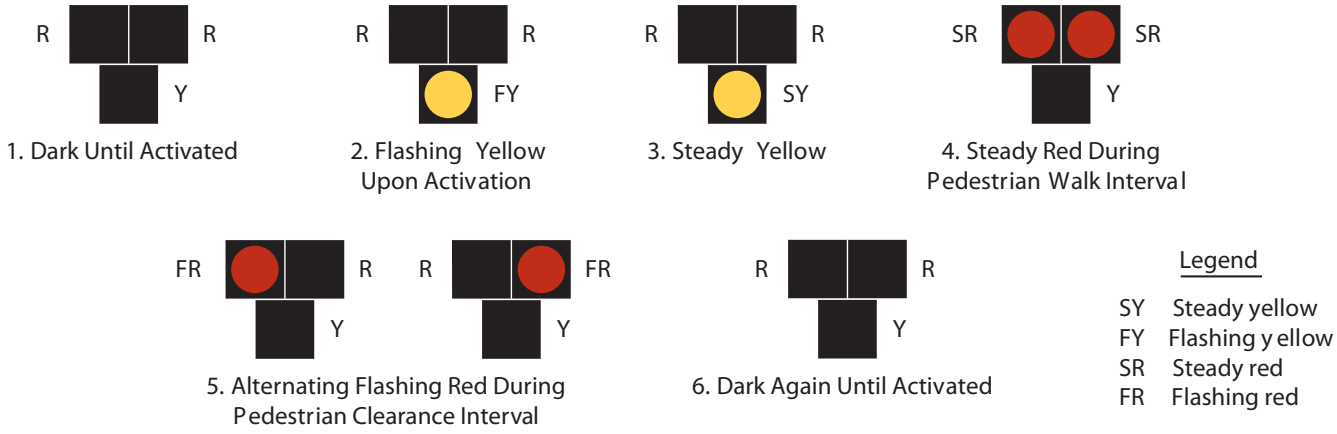
- Recommended 30 feet in advance of the crosswalk.
- A "Stop Here for Pedestrians" sign must accompany the advance stop bar.

Guidance

- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines* (PROWAG).

1.8.3 Pedestrian Hybrid Beacon

Design Summary



Sequence for a pedestrian hybrid beacon (MUTCD Figure 4F-3).

Guidance from the *MUTCD* Section 4F. Pedestrian Hybrid Beacons:

- The pedestrian hybrid beacon should be installed at least 100 feet from side streets or driveways that are controlled by a STOP or YIELD sign.
- 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, or site accommodations should be made through curb extensions or other techniques to provide adequate sight distance.
- The installation should include suitable standard signs and pavement markings.
- If installed within a signal system, the pedestrian hybrid beacon should be coordinated.

Pedestrian hybrid signal; also called HAWK signals (High-Intensity Activated Crosswalk).

Discussion

A pedestrian hybrid beacon may be considered for installation to facilitate pedestrian crossings at a location that does not meet traffic signal warrants (see *MUTCD* Chapter 4C) or at a location that meets traffic signal warrants but where a decision is made to not install a traffic control signal.

The beacon signal consists of a traffic signal head with a red-yellow-red lens. The unit is off until activated, then the signal phasing is:

Scramble signals allow cyclists to cross a intersection diagonally.

- The signal flashes yellow to warn approaching drivers.
- A solid yellow advises drivers to prepare to stop.
- The signal changes to a solid red and a WALK indicator is shown.

The beacon signal converts to an alternating flashing red, allowing the drivers to proceed after stopping at the crosswalk, while the bicyclist or pedestrian is shown the flashing DON'T WALK signal.

Scramble Signals (Non-standard treatment)
Scramble signals can be used at intersections with frequent vehicle/bicycle conflicts and/or at intersections experiencing high bicycle turning movements (especially left turns that force bicyclists to cross vehicle traffic). Scramble signals provide a simultaneous "All Red" phase for motorists and a green phase dedicated for bicycle/pedestrian movements that enables non-motorized users to cross an intersection using their desired travel path (straight or diagonal).

Scramble signals have been used successfully in Davis, Calif.; Honolulu, Hawaii; and Portland, Ore.

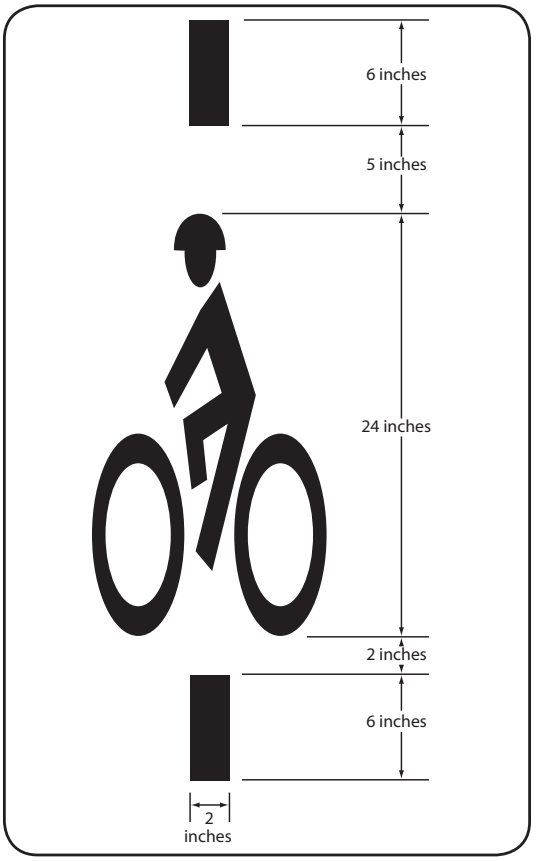
Guidance

- *MUTCD* Section 4F. Pedestrian Hybrid Beacons
- Bureau of Highway Operations (2010) *HAWK Pedestrian Signals: A Survey of National Guidance, State Practice and Related Research* http://on.dot.wi.gov/wisdotresearch/database/tsrs/tsrhawksignals.pdf
- National Cooperative Highway Research Program (2006). *Improving Pedestrian Safety at Unsignalized Crossings*, Report 562, 2006. http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_562.pdf

1.8.4 Accommodating Bicyclists at Intersections

Design Summary

At signalized intersections, cyclists should be able to trigger signals when cars are not present. Requiring cyclists to dismount to press a pedestrian button is inconvenient and requires the cyclist to merge in into traffic at an intersection. It is particularly important to provide bicycle actuation in a left-turn-only lane where cyclists regularly make left turn movements.



Recommended loop detector marking design.

Discussion

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 cyclist to stay within the lane of travel and avoid manoeuvring to the side of the road to trigger a push button.
- Most demand-actuated signals in Albuquerque currently use loop detectors, which can be attuned to be sensitive enough to detect any type of metal, including steel and aluminum.
- Current and future loops that are sensitive enough to detect bicycles should have pavement markings to instruct cyclists how to trip them, as well as signage (see right).

Detection Cameras

Video detection cameras can also be used to determine when a vehicle is waiting for a signal. These systems use digital image processing to detect a change in the image at the location. Cameras can detect bicycles, although cyclists should wait in the center of the lane, where an automobile would usually wait, in order to be detected. Video camera system costs range from $20,000 to $25,000 per intersection.

Detection cameras are currently used for cyclists in the City of San Luis Obisbo, Calif., where the system has proven to detect pedestrians as well.

Instructional Sign (MUTCD Sign R10-15).

Remote Traffic Microwave Sensor Detection (RTMS) (Non-standard treatment)

RTMS is a system developed in China that uses frequency modulated continuous wave radio signals to detect objects in the roadway. This method is marked with a time code which gives information on how far away the object is. The RTMS system is unaffected by temperature and lighting, which can affect standard detection cameras.

Push Buttons

A pushbutton is a four-foot pedestal pole next to the curb for a cyclist to actuate the signal. Push buttons should only be used in locations without right turn bays and can be used with or without bike lanes.

Guidance

- Additional technical information is available at: www.humantransport.org/bicycledriving/library/signals/detection.htm
- ITE Guidance for Bicycle—Sensitive Detection and Counters: http://www.ite.org/councils/Bike-Report-Ch4.pdf

1.9 Off-Street Facility Design Guidelines

Design Summary

Shared-use paths, or multi-use trails, provide a desirable facility for bicyclists (particularly novice riders), pedestrians and other trail users. They allow for travel and recreational use that is separated from traffic. Multi-use trails should generally provide new travel opportunities while accommodating all types of trail users.

The *Albuquerque Development Process Manual* defines a shared-use path/trail as, "A shared use path is a bikeway physically separated from motorized vehicle traffic by an open space or barrier and constructed within the street right-of-way or within an independent right-of-way including shared-use rights-of-way or utility or drainage easements."

Discussion

Shared-use paths serve bicyclists and pedestrians and provide additional width over a standard sidewalk. Facilities may be constructed adjacent to roads, through parks or along linear corridors such as active or abandoned railroad lines or waterways. Regardless of the type, paths constructed next to the road must have some type of vertical (e.g., curb or barrier) or horizontal (e.g., landscaped strip) buffer separating the path area from adjacent vehicle travel lanes.

Elements that enhance shared-use path design include:

- Providing frequent access points from the local road network. If access points are spaced too far apart, users will have to travel out of direction to enter or exit the path, which will discourage use.
- Placing directional signs to direct users to and from the path.
- Building to a standard high enough to allow heavy maintenance equipment to use the path without causing it to deteriorate.
- Limiting the number of at-grade crossings with streets or driveways.
- Terminating the path where it is easily accessible to and from the street system, preferably at a controlled intersection or at the beginning of a dead-end street. If poorly designed, the point where the path joins the street system can put pedestrians and cyclists in a position where motor vehicle drivers do not expect them.
- Identifying and addressing potential safety and security issues up front.
- Whenever possible, and especially where heavy use can be expected, separate bicycle and pedestrian ways should be provided to reduce conflicts.
- Providing accessible parking space(s) at trailheads and access points.
- Providing a soft surface shoulder adjacent to paved surfaces for use by joggers and equestrians.

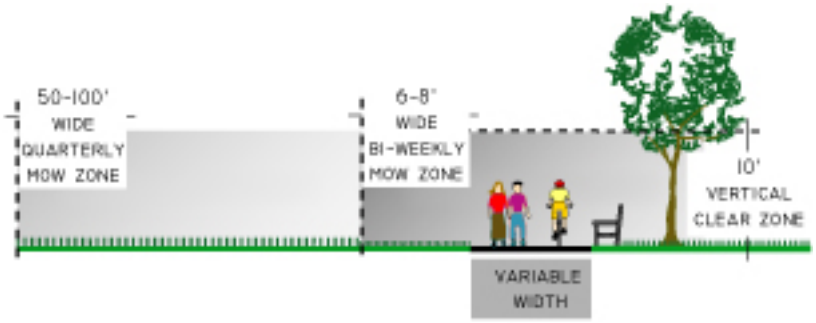
Shared-use paths (also referred to as "trails" and "multi-use paths") are often viewed as recreational facilities, but they are also important corridors for utilitarian trips.

Additional Guidance

Shared-use paths should be constructed according to the AASHTO *Guide for the Development of Bicycle Facilities*. Where possible, shared-use paths should be designed according to American with Disabilities Act (ADA) standards. Constructing trails may have limitations that make meeting ADA standards difficult and sometimes prohibitive. Prohibitive impacts include harm to significant cultural or natural resources, a significant change in the intended purpose of the trail, requirements of construction methods that are against federal, state or local regulations or presence of terrain characteristics that prevent compliance.

1.9.1 Shared-Use Path Design

Design Summary



Recommended shared-use path design.

Width (DPM standards)

- 10 feet is the minimum allowed for a two-way shared-use path and is only recommended for low traffic situations.
- 12 feet or greater is recommended for high-use areas, as identified in the Long Range Bikeway System, or in heavy use situations with high concentrations of multiple users, such as joggers, bicyclists, in-line skaters and pedestrians.

Lateral Clearance

- A 2 feet or greater shoulder on both sides.

Overhead Clearance

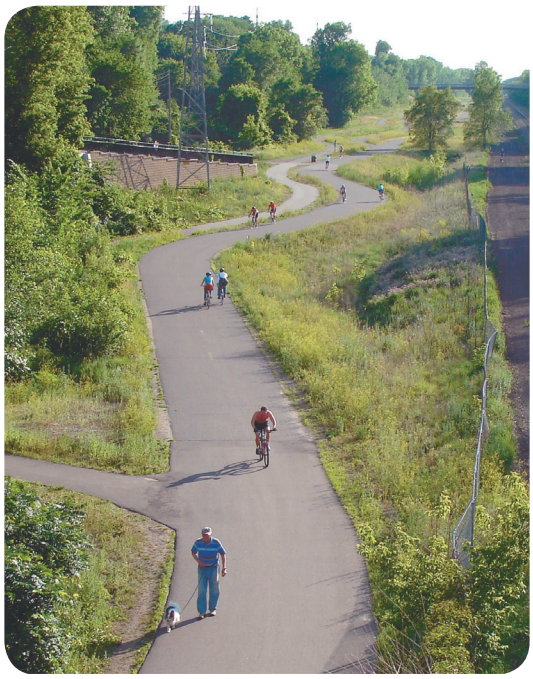
- Clearance to overhead obstructions should be 8' minimum, with 10 feet recommended.

Design Speed

- The maximum design speed for bike paths is 20 mph. Speed bumps or other surface irregularities should never be used to slow bicycles.

Grade

- The recommended maximum gradient is 5 percent. Steeper grades can be tolerated for short distances (500 feet max).



The Cedar Lake Regional Trail in Minneapolis, MN has sufficient width to accommodate a variety of users.

Discussion

A hard surface should be used for multi-use trails. Concrete, while more expensive than asphalt, is the hardest of all trail surfaces and lasts the longest. However, joggers and runners prefer surfaces such as asphalt or decomposed granite due to its softness relative to concrete. While most asphalt is black, dyes (such as reddish pigments) can be added to increase the aesthetic value of the trail itself.

When concrete is used the trail should be designed and installed using the narrowest possible expansion joints to minimize the amount of bumping cyclists experience on the trail. A soft surface shoulder can be added adjacent to the hard surface trail to provide alternatives for joggers and equestrians.

Guidance

- U.S. Access Board, *Public Rights-of-Way Accessibility Guidelines* (PROWAG).
- FHWA. *Designing Sidewalks and Trails for Access*.

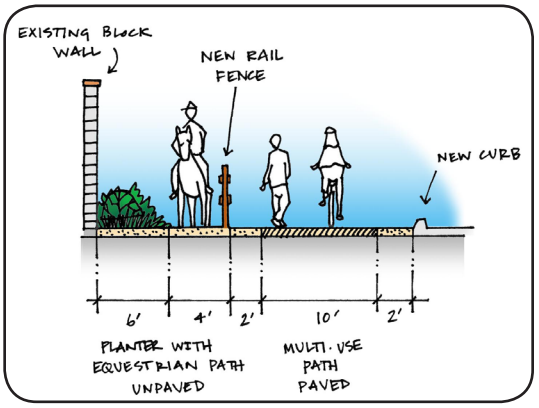
1.9.1.1 Shared-Use Equestrian Trail Design

Design Summary

Width
- 5-6 feet in low (rural) development
- 8-12 feet in moderate to high development

Lateral Clearance
- A 3 foot or greater shoulder on both sides.

Overhead Clearance
- Clearance to overhead obstructions should be 10 foot minimum, with 12 feet recommended.



Recommended design for a multi-use path that accommodates equestrians.

Discussion

Walkers, hikers and cyclists often share trail corridors with equestrians. Pedestrians and riders are often compatible on the same tread as they both accept unpaved surfaces and move at relatively slow speeds. However, fast moving and quiet cyclists approaching a horse from behind are a valid concern for riders. In areas where conflicts seem likely, efforts are made to physically separate the different user groups.

For equestrian routes, trail tread or surface should be relatively stable. The trail surface should be solid, obstacle-free and should stay in place. Appropriate trail surfaces include: compacted native soil, crusherfines and decomposed granite. Hard surfaces, such as asphalt and concrete are not amenable to equestrians.

Example multi-use equestrian trail.

Trails that are comfortable for equestrians are ones that accommodate most trail users. While horses can easily negotiate grades up to 20 percent for short distances (up to 200 feet), steeper running grades result in faster water run-off and erosion problems. Following contours helps reduce erosion problems, minimize maintenance needs and increase comfort levels. A 2 percent cross slope or crowned tread and periodic grade reversals along running slopes will minimize standing surface water and will resolve most drainage issues on a multi-use path. An exception is to cut sections where uphill water must be collected in a ditch and directed to a catch basin, where the water can be directed under the trail in a drainage pipe of suitable dimensions. Additionally, on running grades steeper than 5 percent, add 6-12 inches of extra tread width as a safety margin where possible.

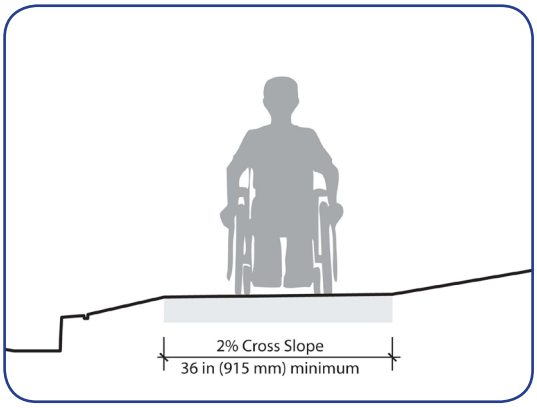
Guidance

USDA/FHWA *Equestrian Design Guidebook for Trails, Trailheads, and Campgrounds*.

1.9.1.2 Trail Accessibility

Design Summary

- 3 feet minimum clear width, where less than 5 feet, passing space should be provided at least every 100 feet.
- Cross slope should not exceed 5 percent.
- Signs shall be provided indicating the length of the accessible trail segment.
- Curb ramps shall be provided at roadway crossings and curbs. Tactile warning strips and auditory crossing signals are recommended.



ADA clearance requirement.

Discussion

Slopes typically should not exceed 2 percent. However, certain conditions may require the use of steeper slope. For conditions exceeding a 5 percent slope, the recommendations are as follows:

- Up to an 8.33 percent slope for a 200 feet max run, landings or resting intervals must be provided at minimum of 20 feet.
- Up to a 10 percent slope for a 30 feet maximum run, resting intervals spaced at 30 feet minimum.
- Up to 12.5 percent slope for 10 feet maximum run, with resting intervals spaced at 10 feet minimum.

Shared-use paths surfacing materials affects which types of users can benefit from the facility.

The trail surface shall be firm and stable. The *Forest Service Accessibility Guidelines* defines a firm surface as a trail surface that is not noticeably distorted or compressed by the passage of a device that simulates a person who uses a wheelchair. Where rights-of-way are available, paths can be made more accessible by creating side paths that meander away from a roadway that exceeds a 5 percent slope.

Accessibility guidelines note that the natural environment may prohibit ADA compliance. In addition, the standards may be waived where compliance would cause "substantial harm to cultural, historic, religious or significant natural features or characteristics."

Guidance

General guidelines have been created in response to the ADA for accessible trails.

- FHWA. (2001). *Designing Sidewalks and Trails for Access*, Chapter 14: Shared Use Path Design, Section 14.5.1: Grade. www.fhwa.dot.gov/environment/sidewalk2/sidewalks212.htm#tra2
- *Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Developed Areas Final Report*, (1999). http://www.access-board.gov/outdoor/outdoor-rec-rpt.htm

1.9.1.3 Managing Multiple Users

Design Summary

- Stripe a centerline.
- Separate bicycle and pedestrian areas.
  - Barrier separation – vegetated buffers or barriers, elevation changes, walls, fences, railings and bollards.
  - Distance separation – differing surfaces.
- User behavior guidance signs.

Discussion

Trails that experience high levels of use, particularly by a variety of user types, may become overcrowded and unsafe for users. The City should consider widening a high-use trail where feasible; otherwise, treatments such as separating bicycle and pedestrian areas, pavement markings and etiquette signs can improve sharing the trail.

Centerline striping can be used to encourage users to stay on a particular side of the trail. AASHTO recommends a 4-foot wide yellow stripe, which can be dashed where passing sight distance exists and solid in other directions. This may be particularly beneficial in the following circumstances:

- For heavy volumes of bicycles and/or other users,
- On curves with restricted sight distance, and
- On unlighted paths where nighttime riding is expected.

Differing surfaces suitable to each user group foster visual separation and clarity of where each user group should be. A dirt track can draw runners and walkers to reduce conflicts with cyclists as a more joint-friendly option. When trail corridors are constrained, the approach is often to locate the two different trail surfaces side by side with no separation.

Informing trail users of acceptable trail etiquette is a common issue when multiple user types are anticipated. Yielding the right-of-way is a courtesy and yet a necessary part of a safe trail experience involving multiple trail users. Trail right-of-way information should be posted at trail access points and along the trail. The message must be clear and easy to understand. Where appropriate, trail etiquette systems should instruct trail users to the yielding of cyclists to pedestrians and equestrians and the yielding of pedestrians to equestrians.

Guidance

The 2009 *MUTCD* contains additional information about centerline striping on a trail.

Centerline striping encourages trail users to provide space for other users to pass.

Albuquerque uses guidance signage to encourage multiple users to share trail facilities.

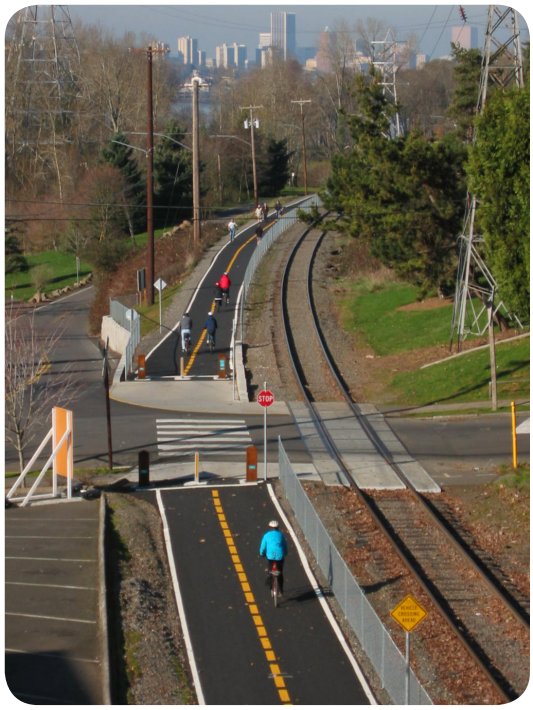
A commonly used multi-use trail etiquette sign.

1.9.1.4 Trail Opportunities

1.9.1.4.1 Rails-with-Trails

Rails-with-Trails projects typically consist of paths adjacent to active railroads. Offering the same benefits as rail-to-trail projects, these facilities could be developed within active rail corridors in Albuquerque.

It should be noted that some constraints could impact the feasibility of rail-with-trail projects. In some cases, space needs to be preserved for future planned freight, transit or commuter rail service. In other cases, limited right-of-way width, inadequate setbacks, concerns about trespassing and numerous mid-block crossings may affect a project's feasibility.



The Springwater Corridor in Portland, Oregon runs next to an active rail line.

1.9.1.4.2 Utility and Arroyo Corridor Trails

Several utility and arroyo corridors in Albuquerque offer excellent trail development and bikeway gap closure opportunities. Utility corridors typically include powerlines, sewer corridors and irrigation ditches while waterway corridors include canals, drainage ditches, rivers and beaches. These corridors offer excellent transportation and recreation opportunities for cyclists of all ages and skills.

Trails along waterways such as drainage ditches should consider design to minimize access to the water. Fences can deter trail users from attempting to access to the water or from inadvertently falling.

Albuquerque has significant opportunities to develop trails along drainage ditches.

1.9.1.5 Trails Along Roadways

Design Summary

Trails directly adjacent to roadways can be challenging for users at roadway intersections.

Where a shared-use path must be adjacent to a roadway, a five-foot minimum buffer should separate the path from the edge of the roadway or a physical barrier of sufficient height should be installed.

Shared use paths may be considered along roadways under the following conditions:

- The path will generally be separated from all motor vehicle traffic.
- Bicycle and pedestrian use is anticipated to be high.
- To provide continuity with an existing path through a roadway corridor.
- The path can be terminated at each end onto streets or trails with good bicycle and pedestrian facilities.
- There is adequate access to local cross-streets and other facilities along the route.
- Any needed grade separation structures do not add substantial out-of-direction travel.

Discussion

Concerns about shared use paths directly adjacent to roadways (e.g., with minimal or no separation) are:

- Half of bicycle traffic may ride against the flow of vehicle traffic, contrary to the rules of the road.
- When the path ends, cyclists riding against traffic tend to continue to travel on the wrong side of the street, as do cyclists who are accessing the path. Wrong-way bicycle travel is a major cause of crashes.
- At intersections, motorists crossing the path often do not notice bicyclists approaching from certain directions, especially where sight distances are poor.
- Bicyclists are required to stop or yield at cross-streets and driveways, unless otherwise posted.
- Stopped vehicles on a cross-street or driveway may block the path.
- Because of the closeness of vehicle traffic to opposing bicycle traffic, barriers are often necessary to separate motorists from cyclists. These barriers serve as obstructions, complicate facility maintenance and waste available right-of-way.
- Paths directly adjacent to high-volume roadways diminish users' experience by placing them in an uncomfortable environment.

As bicyclists gain experience and realize some of the advantages of riding on the roadway, some riders stop using paths adjacent to roadways. Bicyclists may also tend to prefer the roadway as pedestrian traffic on the shared use path increases due to its location next to an urban roadway. When designing a bikeway network, the presence of a nearby or parallel path should not be used as a reason to not provide adequate shoulder or bike lane width on the roadway, as the on-street bicycle facility will generally be superior to the "sidepath" for experienced cyclists and those who are cycling for transportation purposes. Bike lanes should be provided as an alternate (more transportation-oriented) facility whenever possible.

Guidance

The AASHTO *Guide for the Development of Bicycle Facilities* generally recommends against the development of trails adjacent to roadways. The DPM similarly states that, "Bike Trails should be located to serve corridors not served by streets and highways or where wide rights-of-way exist, permitting such facilities to be constructed away from the influence of parallel streets." The DPM also states, "The sidewalk may be designated as a legal trail for short distances of up to one-quarter mile to serve as a linkage within the bikeway network. Two-way bicycle traffic as well as pedestrian traffic should be expected on sidewalks under these conditions."

1.9.2 Path/Roadway Crossings

Design Summary

An offset crossing forces pedestrians to turn and face the traffic they are about to cross.

At-grade path/roadway crossings generally will fit into one of four basic categories:

- Type 1: Marked/Unsignalized-Unprotected crossings include trail crossings of residential, collector and sometimes major arterial streets or railroad tracks.
- Type 1+: Marked/Enhanced - Unsignalized intersections can provide additional visibility with flashing beacons and other treatments.
- Type 2: Route Users to Existing Signalized Intersection - Trails that emerge near existing intersections may be routed to these locations, provided that sufficient protection is provided at the existing intersection.
- Type 3: Signalized/Controlled - Trail crossings that require signals or other control measures due to traffic volumes, speeds and trail usage.
- Type 4: Grade-Separated Crossings - Bridges or under-crossings provide the maximum level of safety but also generally are the most expensive and have right-of-way, maintenance and other public safety considerations.

Discussion

While at-grade crossings create a potentially high level of conflict between path users and motorists, well-designed crossings have not historically posed a safety problem for path users. This is evidenced by the thousands of successful paths around the United States with at-grade crossings. In most cases, at-grade path crossings can be properly designed to a reasonable degree of safety and can meet existing traffic and safety standards.

Evaluation of path crossings involves analysis of vehicular and anticipated path user traffic patterns, including:

- Vehicle speeds
- Street width
- Sight distance
- Traffic volumes (average daily traffic, peak hour traffic).
- Path user profile (age distribution, destinations served)

Crossing features for all roadways include warning signs both for vehicles and path users.

Consideration must be given for adequate warning distance based on vehicle speeds and line of sight, with visibility of any signing absolutely critical. Catching the attention of motorists jaded to roadway signs may require additional alerting devices such as a flashing light, roadway striping or changes in pavement texture. Signing for path users must include a "STOP" sign and pavement marking, sometimes combined with other features such as bollards.

Guidance

The proposed intersection approach that follows is based on established standards, published technical reports[2] and experiences from cities around the country.

2 Federal Highway Administration (FHWA) Report, "Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations."

Guidance (continued)

Summary of Path/Roadway At-Grade Crossing Recommendations [3]

	Vehicle ADT ≤ 9,000			Vehicle ADT > 9,000 to 12,000			Vehicle ADT > 12,000 to 15,000			Vehicle ADT >>15,000		
	Speed Limit (mph)**											
Roadway Type	30	35	40	30	35	40	30	35	40	30	35	40
2 Lanes	1	1	1/1+	1	1	1/1+	1	1	1+/3	1	1/1+	+/3
3 Lanes	1	1	1/1+	1	1/1+	1/1+	1/1+	1/1+	1+/3	1/1+	1+/3	1/3
Multi-Lane (4 +) w/ raised median***	1	1	1/1+	1	1/1+	1+/3	1/1+	1/1+	1+/3	1+/3	1+/3	1+/3
Multi-Lane (4 +) w/o raised median	1	1/1+	1+/3	1/1+	1/1+	1+/3	1+/3	1+/3	1+/3	1+/3	1+/3	1+/3

***General Notes**: Crosswalks should not be installed at locations that could present an increased risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone **will not** make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. **These are general recommendations; good engineering judgment should be used in individual cases for deciding which treatment to use.**

For each pathway-roadway crossing, an engineering study is needed to determine the proper location. For each engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc. may be needed at other sites.

** Where the speed limit exceeds 40 mi/h marked crosswalks alone should not be used at unsignalized locations.

*** The raised median or crossing island must be at least 4 ft (1.2 m) wide and 6 ft (1.8 m) long to adequately serve as a refuge area for pedestrians in accordance with *MUTCD* and AASHTO guidelines. A two-way center turn lane is not considered a median.

1= Type 1 Crossings. Ladder-style crosswalks with appropriate signage should be used.

1/1+ = With the higher volumes and speeds, enhanced treatments should be used, including marked ladder style crosswalks, median refuge, flashing beacons and/or in-pavement flashers. Ensure there are sufficient gaps through signal timing, as well as sight distance.

1+/3 = Carefully analyze signal warrants using a combination of Warrant 4, Pedestrian Volume or 5, School Crossing (depending on school presence) and Equivalent Adult Unit (EAU) factoring (see *MUTCD*, Chapter 4). Make sure to project pathway usage based on future potential demand. Consider Pelican, Puffin, or Hawk signals in lieu of full signals. For those intersections not meeting warrants or where engineering judgment or cost recommends against signalization, implement Type 1 enhanced crosswalk markings with marked ladder style crosswalks, median refuge, flashing beacons and/or in-pavement flashers. Ensure there are sufficient gaps through signal timing, as well as sight distance.

1.9.2.1 Type 1: Marked/Unsignalized Crossings

A marked/unsignalized crossing (Type 1) consists of a crosswalk, signage and often no other devices to slow or stop traffic. The approach to designing crossings at mid-block locations depends on an evaluation of vehicular traffic, line of sight, path traffic, use patterns, vehicle speed, road type and width and other safety issues such as proximity to schools. The following thresholds recommend where unsignalized crossings may be acceptable:

Maximum traffic volumes:

- ≤9,000-12,000 Average Daily Traffic (ADT) volumes.
- Up to 15,000 ADT on two-lane roads, preferably with a median.
- Up to 12,000 ADT on four-lane roads with median.

Maximum travel speed:

- 35 mph.

Minimum line of sight:

- 25 mph zone: 155 feet.
- 35 mph zone: 250 feet.
- 45 mph zone: 360 feet.

3 This table is based on information contained in the U.S. Department of Transportation Federal Highway Administration Study, "Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations," February 2002.

Discussion

Type 1 Crossing

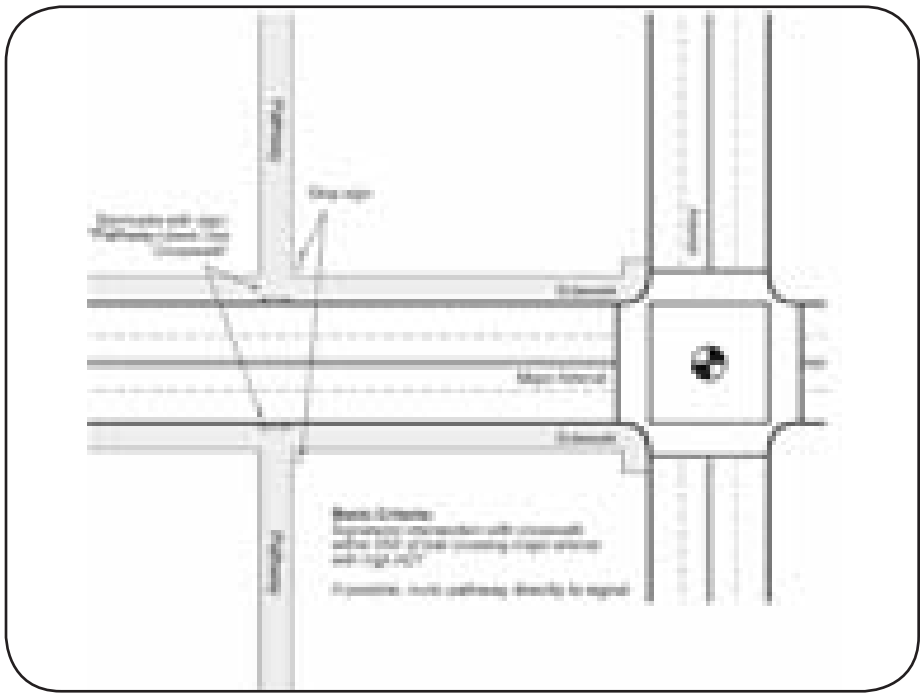
If well-designed crossings of multi-lane higher-volume arterials over 15,000 ADT may be unsignalized with features such as a combination of some or all of the following: excellent sight distance, sufficient crossing gaps (more than 60 per hour), median refuges and/or active warning devices like flashing beacons or in-pavement flashers. These are referred to as "Type 1 Enhanced" (Type 1+). Such crossings would not be appropriate; however, if a significant number of schoolchildren used the path. Furthermore, both existing and potential future path usage volume should be taken into consideration.

On two-lane residential and collector roads below 15,000 ADT with average vehicle speeds of 35 mph or less, crosswalks and warning signs ("Path Xing") should be provided to warn motorists, and stop signs and slowing techniques (bollards/geometry) should be used on the path approach. Curves in paths that orient the path user toward oncoming traffic are helpful in slowing path users and making them aware of oncoming vehicles. Care should be taken to keep vegetation and other obstacles out of the sight line for motorists and path users. Engineering judgment should be used to determine the appropriate level of traffic control and design.

On roadways with low to moderate traffic volumes (<12,000 ADT) and a need to control traffic speeds, a raised crosswalk may be the most appropriate crossing design to improve pedestrian visibility and safety. These crosswalks are raised 3 inches above the roadway pavement (similar to speed humps) to an elevation that matches the adjacent sidewalk. The top of the crosswalk is flat and typically made of asphalt, patterned concrete or brick pavers. Brick or unit pavers should be discouraged because of potential problems related to pedestrians, bicycles and ADA requirements for a continuous, smooth, vibration-free surface. Detectable warning strips are needed at the sidewalk/street boundary so that visually impaired pedestrians can identify the edge of the street.

1.10.2.2 Type 2: Route Users to Existing Signalized Intersection

Crossings within 250 feet of an existing signalized intersection with pedestrian crosswalks are typically diverted to the signalized intersection for safety purposes. For this option to be effective, barriers and signing may be needed to direct shared-use path users to the signalized crossings. In most cases, signal modifications would be made to add pedestrian detection and to comply with ADA.



Type 2 Crossing Treatment.

1.9.2.3 Type 3: Signalized/Controlled Crossings

New signalized crossings may be recommended for crossings that meet pedestrian, school or modified warrants, are located more than 250 feet from an existing signalized intersection and where 85th percentile travel speeds are 40 mph and above and/or ADT exceeds 15,000 vehicles. 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.

Type 3 Crossing.

1.9.2.3.1 Mid-block Crosswalk

Mid-block crossings provide a crossing opportunity where there is no intersection. At controlled mid-block crossing locations, crosswalks are marked where there is a demand for crossing and there are no nearby marked crosswalks. At uncontrolled crossing use FHWA report HRT-04-100 as guidance of when to mark a crosswalk. Mid-block crosswalks should always be accompanied with pavement markings and warning signs to inform drivers of the approaching crosswalk.

Mid-block crosswalk.

1.9.2.4 Type 4: Grade-separated Crossings

Grade-separated crossings may be needed where existing bicycle/pedestrian crossings do not exist, where ADT exceeds 25,000 vehicles and where 85th percentile speeds exceed 45 mph. Safety is a major concern with both overcrossings and undercrossings. In both cases, shared-use path users may be temporarily out of sight from public view and may have poor visibility themselves. Undercrossings, like parking garages, have the reputation of being places where crimes occur. Most crime on shared-use paths, however, appears to have more in common with the general crime rate of the community and the overall usage of the shared-use path than any specific design feature.

Type 4 Grade-Separated Undercrossing.

Design and operation measures are available which can address shared-use path user concerns. For example, an undercrossing can be designed to be spacious, well-lit, equipped with emergency cell phones at each end and completely visible for its entire length prior to entering. Undercrossings should include lighting, particularly where nighttime security is a potential issue. AASHTO recommends average maintained horizontal illumination levels of 5 lux to 22 lux, depending on the location.

Other potential problems with undercrossings include conflicts with utilities, drainage, flood control and maintenance requirements. Overcrossings pose potential concerns about visual impact and functional appeal, as well as space requirements necessary to meet ADA guidelines for slope.

Type 4 Grade-Separated Overcrossing.

1.9.3 Amenities

A variety of amenities can make a path inviting to the user. The following table highlights some common items that make path systems complete facilities. Costs vary depending on the design and materials selected for each amenity. Amenities shall be designed and located so as not to impede accessibility.

1.9.3.1 Pedestrian-Scale Lighting

Pedestrian-scale lighting improves safety and enables the facility to be used year-round, particularly on winter afternoons. Minimizing glare, not lighting the night sky and protecting the light from vandalism are the three main issues neighborhood trail lighting design should consider.

Recommended pedestrian-scale lighting.

Albuquerque has a Night Sky Protection Act, which limits the use of lights in the area. The Act requires all outdoor lighting fixtures to be shielded. The Act also states that, "No outdoor recreational facility, whether public or private, shall be illuminated after 11:00 p.m." The New Mexico Heritage Preservation Alliance has provided a comprehensive guide to acceptable lighting under this Act. http://www.wetmtndarkskies.org/images/Lighting_Guide_NMHeritage.pdf

Some neighborhood-scale lighting options include:

- In-ground lighting – dim lights which indicate the extent of the path.
- Bollards – low-level lighting, susceptible to vandalism.
- Solar lighting – best used in situations where running power to the trail would be costly or undesirable.

Pedestrian scale lighting can have screens to deter the glare from affecting neighbors. In addition, lights can be programmed to dim or turn off later in the night.

A guideline for a pedestrian way is illumination of between 0.5 foot-candle to 1 foot-candle.

1.9.3.2 Bollards

Bollards are posts that can be used to block vehicle access to the path and that can provide information such as mile markings, wayfinding for key destinations or small area maps.

Bollards deter motorists from driving on the trail, but they can be dangerous for cyclists, particularly on a busy trail.

Where used, bollards should be high-visibility with reflective tape or paint and should not be low enough to be unnoticed. Cyclists using the shared-use path can collide with a bollard, particularly in low light conditions. Bollards should be placed on either side of the trail entrance to discourage use by motor vehicles. Where bollards are placed in the middle of the path, sufficient space should be provided for path users of all abilities, using a variety of mobility devices, as well as tricycles, trailers and other types of bicycles. Bollards can create bottlenecks with path users at intersections and should be used with caution.

Bollards can also include small signs, mile markers and path logos. This can reduce sign clutter and branding to the trail.

Guidelines for bollards can be found in *MUTCD* Figure 9C-8.

1.9.3.3 Edge Treatments

1.9.3.3.1 Fencing

Fencing is a means of assuring safety for both trail users and neighboring residents by preventing unwanted access onto or off of the trail. However, fencing both sides of the trail right of way can result in a "tunnel" effect with the perception of being trapped, resulting in a detrimental effect on the trail user experience. The narrow width of many corridors in compounds this tunnel effect. Additionally, fencing could inhibit community surveillance of the trail. Solid fencing that does not allow any visual access to the trail should therefore be discouraged.

Post and wire fence.

Fencing should not be a barrier to wildlife passage across the corridor. For example, a small 6-inch gap between the bottom of the fence and the ground can allow wildlife passage while not allowing trail users to trespass on private property.

Fencing that allows a balance between the need for privacy, while simultaneously allowing informal surveillance of the trail, should be encouraged. If fencing is requested purely for privacy reasons, vegetative buffers should be considered.

Open boundaries can be used where users may be entering or existing the trail.

1.9.3.3.2 Dense Vegetation

Dense vegetation can be used to define the trail corridor and increase privacy, particularly in locations with preexisting plants. The major expense of this option is maintenance and upkeep, which includes watering and trimming vegetation semi-regularly to maintain adequate path clearance.

1.9.3.3.3 Open Boundary

In locations without significant vegetation, it is an option to maintain an open boundary around the trail. Users will tend to walk through an open area, so this option is not practical for areas where privacy or trespassing is a concern of landowners.

1.9.3.4 Landscaping

Landscape features, including street trees or trees along paths, can enhance the visual environment and improve the path user experience. Trees can also provide shade from heat and also provide protection from rain.

Landscaping improves the walking and bicycling experience, and can deter vandalism.

1.9.4 Path Amenities

Design Summary

A variety of amenities can make a path inviting to the user. Costs vary depending on the design and materials selected for each amenity. Amenities shall be designed and located so as not to impede accessibility.

Discussion

Benches
Providing benches at key rest areas and viewpoints encourages people of all ages to use the trail by ensuring that they have a place to rest along the way. Benches can be simple (e.g., wood slates) or more ornate (e.g., stone, wrought iron, concrete).

Restrooms
Restrooms benefit path users, especially in more remote areas where other facilities do not exist. Restrooms can be sited at trailheads along the path system.

Water Fountains
Water fountains provide water for people (and pets, in some cases) and bicycle racks allow recreational users to safely park their bikes if they wish to stop along the way, particularly at parks and other desirable destinations.

Bicycle Parking
Bicycle parking allows trail users to store their bicycles safely for a short time. Bicycle parking should be provided if a trail transitions to an unpaved pedestrian-only area.

Trash Receptacles
Litter receptacles should be placed at access points. Litter should be picked up once a week and after any special events held on the trail, except where specially designed trash cans have been installed. If maintenance funds are not available to meet trash removal needs, it is best to remove trash receptacles.

Signage
Informational kiosks with maps at trailheads and signage for other destinations can provide information trail users. They are beneficial for areas with high out-of-area visitation rates as well as the local citizens.

Art
Local artists can be commissioned to provide art for the pathway system, making it uniquely distinct. Many pathway art installations are functional as well as aesthetic, as they may provide places to sit and play on.

Benches and rest areas encourage trail use by seniors and families with children.

Bathrooms are recommended for longer trails and in more remote areas.

Art installations can provide a sense of place for the trail.

Guidance

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

1.9.5 Trail Safety and Security

1.9.5.1 Crime Prevention Through Environmental Design (CPTED)

Safety and security concerns on a trail can be addressed through Crime Prevention Through Environmental Design (CPTED) guidelines. The four principles of CPTED are:

- Natural surveillance – maintaining sight lines and visibility to deter criminal activities.
- Natural access control utilizes fences, lighting, signage and landscape to clearly define where people and vehicles are expected to be.
- Territorial reinforcement – use physical designs such as pavement treatments, landscaping and signage to develop a sense of proprietorship over the trail.
- Maintenance - if graffiti or vandalism occurs and is not repaired replaced right away, it can send the message that no one is watching or that no one cares.

It is also recommended that law enforcement conduct a site visit of the proposed trail alignment during the planning and design phase to determine areas of concern, so that those areas can be addressed through the proposed design.

1.9.5.2 Trail Safety and Security Concerns

1.9.5.2.1 Privacy of adjacent property owners

- Encourage the use of neighborhood friendly fencing and also planting of landscape buffers.
- Clearly mark path access points.
- Post path rules that encourage respect for private property.
- Strategically placed lighting.

Neighborhood-friendly fencing deters trail users from disturbing private property.

1.9.5.2.2 Unwanted vehicle access

- Utilize landscaping to define the corridor edge and path, including earth berms or boulders.
- Use bollards at intersections (see guidelines above).
- Pass a motorized vehicle prohibited ordinance and sign the path.
- Create a Path Watch Program and encourage citizens to photograph and report illegal vehicle use of the corridor.
- Lay the shared-use path out with curves that allow bike/pedestrian passage but are uncomfortably tight for automobile passage

Bollards and pavement change prevent motor vehicles from using the trail.

1.9.5.2.3 Litter and dumping

- Post rules encouraging pack-it-out practices.
- Place garbage receptacles at trailheads.
- Strategically placed lighting, utilizing light shields to minimize unwanted light in adjacent homes.
- Manage vegetation to allow visual surveillance of the path from adjacent properties and from roadway/path intersections.
- Encourage local residents to report incidents as soon as they occur.
- Remove dumpsites as soon as possible.

1.9.5.2.4 Trespassing

- Clearly distinguish public path right-of-way from private property through the use of vegetative buffers and the use of good neighbor type fencing.
- Post rules encouraging respect for property.

1.9.5.2.5 Local on-street parking

- Designate residential streets as parking for local residents only to discourage user parking.
- Place "no outlet" and "no parking" signs prior to path access points.
- Accessible parking should be provided when feasible.

1.9.5.2.6 Crime

- Manage vegetation to ensure visibility from adjacent streets and residences.
- Place lights strategically and as necessary.
- Place benches and other amenities at locations with good visual surveillance and high activity.
- Provide mileage markers every 1/4 mile and clear directional signage for orientation.
- Create a "Path Watch Program" involving local residents.
- Encourage proactive law enforcement on the trail, with regular bicycle patrols.

1.9.5.2.7 Vandalism

- Select benches, bollards, signage and other site amenities that are durable, low maintenance and vandal resistant.
- Respond through removal or replacement in rapid manner.
- Keep a photo record of all vandalism and turn it over to local law enforcement.
- Encourage local residents to report vandalism.
- Create a Trail Watch Program and maintain good surveillance of the corridor.
- Involve neighbors in path projects to build a sense of ownership.
- Place amenities in well used and visible areas.

Rest stops should provide garbage receptacles to minimize littering.

Emergency call boxes improve users' feelings of safety.

Surveillance from nearby buildings and pedestrian-scale lighting can increase shared-use path safety.

1.9.5.3 Community Involvement with Safety on the Trail

Creating a safe trail environment goes beyond design and law enforcement and should involve the entire community. The most effective and most visible deterrent to illegal activity on Albuquerque's trail system will be the presence of legitimate path users. Getting as many "eyes on the corridor" as possible is a key deterrent to undesirable activity.

Trails should provide frequent access points into neighborhoods.

1.9.5.3.1 Good access to the path

Access ranges from providing conveniently located trailheads along the trail to encouraging the construction of sidewalks to accommodate access from private developments adjacent to the trail. Access points should be inviting and signed so as to welcome the public onto the trail.

1.9.5.3.2 Good visibility from neighbors

Neighbors adjacent to the trail can potentially provide 24-hour surveillance of the trail and can become Albuquerque's biggest ally. Though some screening and setback of the path is needed for privacy of adjacent neighbors; complete blocking out of the trail from neighborhood view should be discouraged. This eliminates the potential of neighbors' "eyes on the trail" and could result in a "tunnel effect" on the trail.

'Share the Path' and other community programs raise awareness of safety and other shared-use path issues.

1.9.5.3.3 High level of maintenance

A well-maintained trail sends a message that the community cares about the public space. This message alone will discourage undesirable activity along the trail.

1.9.5.3.4 Programmed events

Community events along the trail will help increase public awareness and thereby attract more people to use the trail. Neighbors and residents can help organize numerous public events along the path which will increase support for the path. Events might include a day-long path clean up or a series of short interpretive walks led by long time residents or a park naturalist.

1.9.5.3.5 Adopt-a-Path Program

Nearby businesses, community institutions and residential neighbors often see the benefit of their involvement in trail path development and maintenance. Businesses and developers may view the trail as an integral piece of their site planning and be willing to take on some level of responsibility for the trail.

Vancouver, B.C. has a program where neighbors adopt a traffic circle, and an annual reward is given to the most beautiful one.

1.9.5.3.6 Path Watch Program

Partnering with local and county law enforcement, a path watch program would provide an opportunity for local residents to become actively involved in crime prevention along Albuquerque's path system. Similar to Neighborhood Watch

programs, residents are brought together to get to know their neighbors and are educated on how to recognize and report suspicious activity.

1.9.5.4 Trailheads

Design Summary

- Major trailheads should include automobile and bicycle parking, trail information (maps, user guidelines, wildlife information, etc.), garbage receptacles and restrooms.
- Minor trailheads can provide a subset of these amenities.

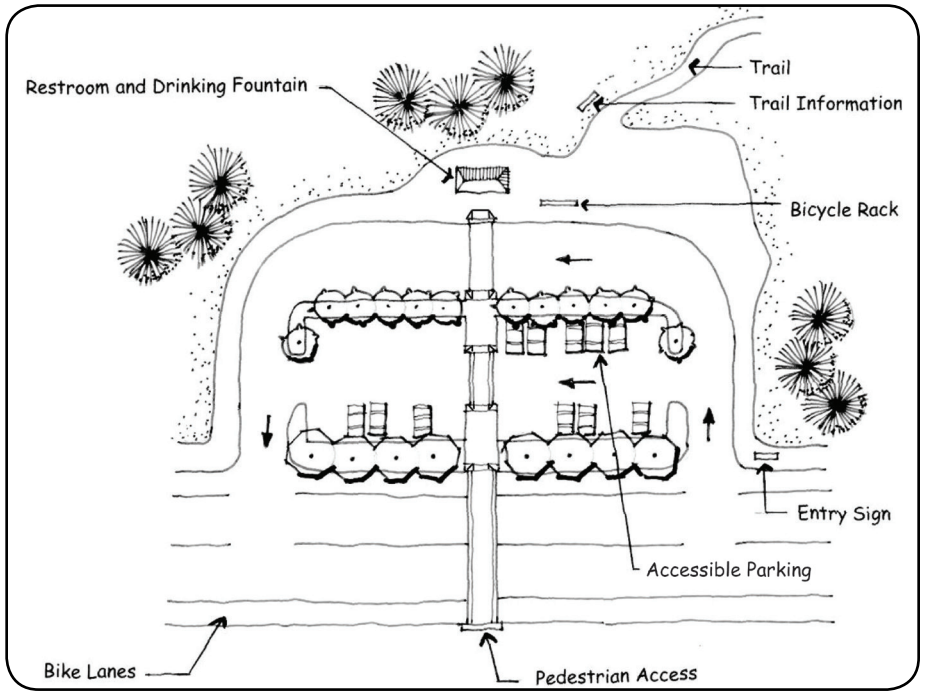
Discussion

Good access to a path system is a key element for its success. Trailheads (formalized parking areas) serve the local and regional population arriving to the path system by car, transit, bicycle or other modes. Trailheads provide essential access to the shared-use path system and include amenities like parking for vehicles and bicycles, restrooms (at major trailheads) and posted maps.

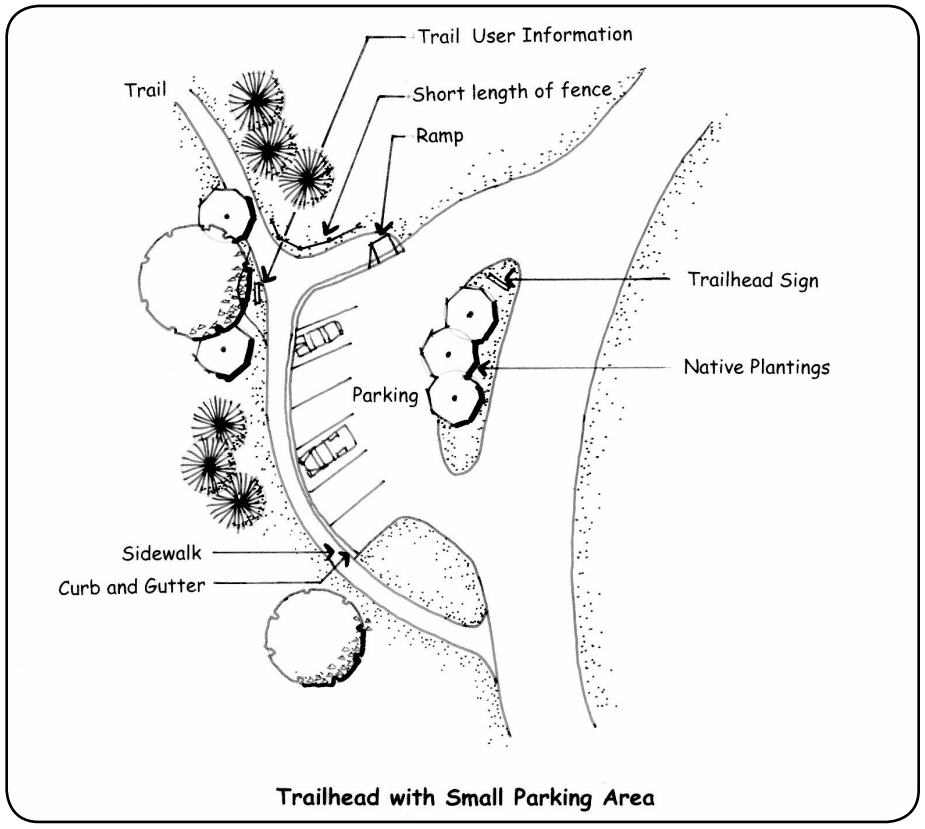
All areas of newly designed or newly constructed and altered portions of existing trails connecting to designated trailheads or accessible trails to comply with Section 16.1 of the accessibility standards. However, the guidelines do recognize that often the natural environment will prevent full compliance with certain technical provisions.

Guidance

- AASHTO *Guide for the Development of Bicycle Facilities*.
- *Regulatory Negotiation Committee on Accessibility Guidelines for Outdoor Developed Areas*.



Example major trailhead.



Example minor trailhead.

1.10 Wayfinding

Wayfinding needs of on-street and multi-use trail users are similar but the location identification infrastructure differs. On-street bikeways benefit from an existing street name, address and signing system. This type of system currently does not exist for the multi-use trail network. The City's multi-use trails are named but a mile marker system means of location identification and signing needs to be established. This section will address the improvements for a wayfinding of the on-street and multi-use trail facilities.

The ability to navigate through a city is informed by landmarks, natural features and other visual cues. Signs throughout the city can indicate to pedestrians and bicyclists their direction of travel, location of destinations and travel time/distance to those destinations. Types of signage include:

- Regulatory signs indicate to cyclists the traffic regulations which apply at a specific time or place on a bikeway.
- Warning signs indicate in advance conditions on or adjacent to a road or bikeway that will normally require caution and may require a reduction in vehicle speed.

Figure 1

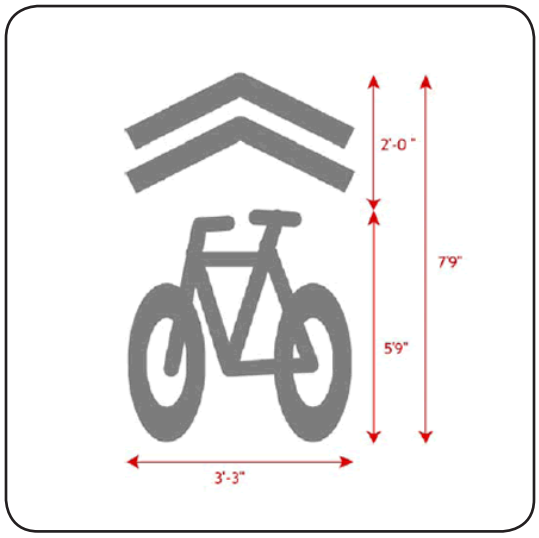


Figure 4

Figure 2

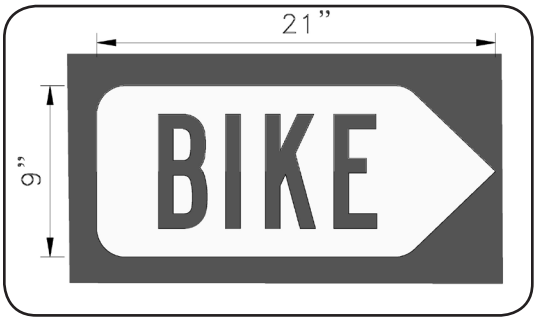


Figure 5

Figure 3

- Guide and information signs indicate information for route selection, for locating off-road facilities or for identifying geographical features or points of interest.

Regulatory and warning signs are dictated by the *MUTCD*. The *MUTCD* also provides guidance for way-finding signs for trails and on-street bikeways, but allows for more leeway in design and information.

1.10.1 On-Street

1.10.1.1 Bike Routes

Bike routes should be identified using the bike route sign D11-1. Placement should be at the beginning and end of the bike routes, using the M4-14 and M4-6 plaques (Figure 1). Where routes split or shift to an intersecting street, advanced turn arrows (M4 series) and directional arrows (M5 series) shall be used to indicate the change in direction. The D11-1 sign can be placed occasionally along the bike route to help in wayfinding. Other signs that provide addition route identity are the bicycle warning sign W11-1 with the Share-the-road plaque W16-1P (Figure 2) and bicycle may use full lane R4-11 (Figure 3). These signs can help remind motorists and cyclists of the presents of a bicycle facility.

Pavement markings can be used to provide awareness of the presence of the bicycle facility as well as wayfinding guidance.

Pavement markings Sharrows (Figure 4) and bike route "pavement direction indicators" or bike blazes (Figure 5) can be effective and durable additions to help guide the cyclist along their route. The bike blaze can be used to indicate changes in direction of the bike route.

1.10.1.2 Bike Lanes

Bike lanes are separate travel lanes for use by bicycles. The bike lanes are marked using a lane edge stripe between the motor vehicle lane and the bike lane and include bike lane symbols and bike lane signs (R3-17). Where bike lanes change direction or at the junction with another bike lane, directions arrow sign plaques (M4 and M5 series) should be included. These simple additions to the built environment can provide adequate guidance for the cyclist to aid in route identification.

Figure 9B-4 in chapter 9 of the *MUTCD* shows a selection of guide signs and plaques that can be used to inform bicyclists of bike route direction changes and to confirm route direction, distance and destination.

1.10.1.3 Bicycle Boulevards

Bike boulevards are roadways in which bicyclists share the pavement with motor vehicles, but the facility is optimized in favor of the bicycle. Bicycle boulevards are characteristically slower than residential streets to the extent that posted speed limits are non-typical (18 mph vs. 25 mph). The non-typical speed limit is intended to call attention to the bike boulevard's posted speed being different from a normal roadway.

Figure 6a

Figure 6b

The City recently developed a series of signs and pavement markings to provide identification for the bicycle boulevards. The color and logo of these signs are unique to the Bicycle Boulevard and provide identification, guidance

and wayfinding for the cyclist alerting the motorist to the unique character and operations of the bicycle boulevard (Figure 6).

1.10.1.4 On-Street Signage Guidelines

Signage for on-street bikeways can serve both wayfinding and safety purposes including:

- Helping to familiarize users with the bicycle network.
- Helping users identify the best routes to destinations (Figure 7).
- Helping overcome a "barrier to entry" for people who are not frequent cyclists or pedestrians.
- Visually cue motorists that they are driving along a bike route and should use caution.
- Including mileage and travel time estimates minimize the tendency to overestimate the amount of time it takes to travel by bicycle (Figure 8).

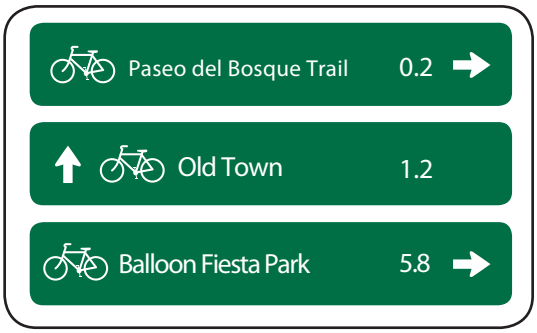


Figure 7 - Wayfinding signage concept.

Identifying Destinations for Signage

Destinations for on-street signage can include:

- On-street bikeways (regional or local)
- Commercial centers
- Regional or local parks and trails
- Public transit sites
- Civic or community destinations, such as hospitals and schools
- Area destinations (e.g., cities, downtowns or neighborhoods)

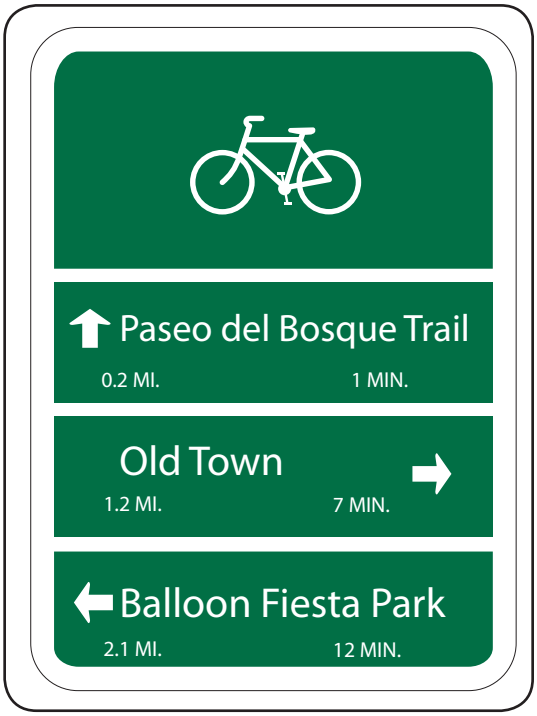


Figure 8 - Wayfinding that includes distance and time can address misperceptions about time and distance.

Placement Standards and Techniques

Too many road signs clutter the right-of-way. Signs should be placed at key locations to and along bike routes, including:

- Confirmation signs designate bikeways to bicyclists and drivers.
- Turn signs indicate where a bikeway turns from one street onto another street.
- Decision signs mark the junction of two or more bikeways and include destinations and associated directional arrows.

Additional recommended guidelines include:

- Place the closest destination to each sign in the top slot, allowing the nearest destination to fall off the sign and subsequent destinations to move up as the bicyclist approaches.
- Use pavement markings to help reinforce routes and directional signage. Markings, such as bicycle boulevard symbols (Figure 9), bike blaze and sharrow may be used in addition to signs along bike routes and can help cyclists navigate difficult turns in route.

Figure 9 - Bicycle Boulevard pavement marking.

1.10.2 Multi-use Trails

There are 175 miles of formalized multi-use trail in the city. Wayfinding can be a challenge for most trail users. A system needs to be established to provide effective wayfinding for the trail users and location identification for emergency responders.

1.10.2.1 Trail identification

Multi-use trails are typically identified by name, usually coinciding with the major feature which they parallel such as an arroyo, highway or geographical location. Examples of these are the Bear Canyon, I-40 trail and Paseo del Bosque multi-use trails. Knowing where you are on these trails can be difficult due to lack of an addressing system. A logical system needs to be established that provides the trail user with their location and direction of travel. Multi-use trails shall follow the following conventions with regards to direction and location.

1. **Trail direction and mile marker**
   a. Multi-use trails that have a predominantly south/north alignment shall have a mile marker designation that begins at mile zero at the southern terminus of the trail. If there are plans to extend the trail towards the south the mile marker shall begin at the future southerner terminus of the planned extension. The mile markers shall increase along the trails alignment in the northerly direction.
   b. Multi-use trail that have a predominantly west/east alignment shall have a mile marker designation that begins at mile zero the existing western terminus of the trail. If there are plans to extend the trail to the west the mile marker shall being at the future western terminus of the planned extension. The mile markers shall increase along the trails alignment in the easterly direction.
   c. When posting mile marking information shall be shown to the nearest 1/10th of a mile in decimal format. Whole number mile marks shall use a decimal point followed by a zero.

2. **Trail location**
   a. Locations on a trail shall be identified by the distance from the beginning terminus of the trail expressed in miles and tenths of miles.

It would be beneficial to the trail users to include on the City's bike map multi-use trail mile markers at major locations such as trail heads, trail/trail intersections and trail/street intersections. Emergency responders should be aware of the multi-use trail identification system and incorporate it into their dispatching protocol.

1.10.2.2 Trail marking

Trail identification/location marking and wayfinding can be comprised of signs, trail heads, kiosks, maps and pavement markings. The type of location marking is dependent on the location and anticipated needs of the trail users.

Trail head

Trail head identification should be used to indicate the terminus of the trail, thus informing users approaching the trail from an intersecting trail and when users are leaving a specific trail to use another trail. The trail head can be as simple as a sign identifying the trail by name or more informative by including additional information, such as the City's Bike Map, or a map emphasizing the trail and showing the trail length, major destinations and distances and 911 emergency reporting instructions. A kiosk can provide a good location to display this information in addition to trail etiquette educational information and pet waste cleanup stations. Trail appurtenances near the kiosk may also improve user satisfaction and aid in alerting quick moving commuters to the congested quality, which maybe present near the kiosk as shown in the figure at the right.

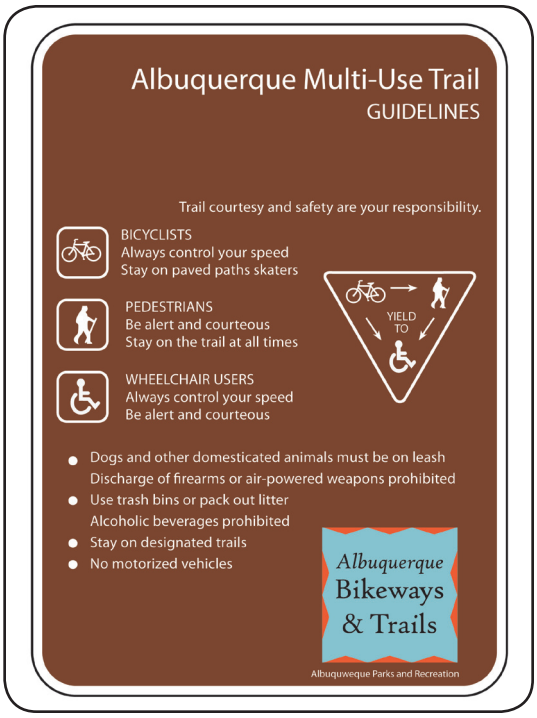


Figure 10b - Example informational signage from Albuquerque.

Figure 10 b - Bike Facilities map

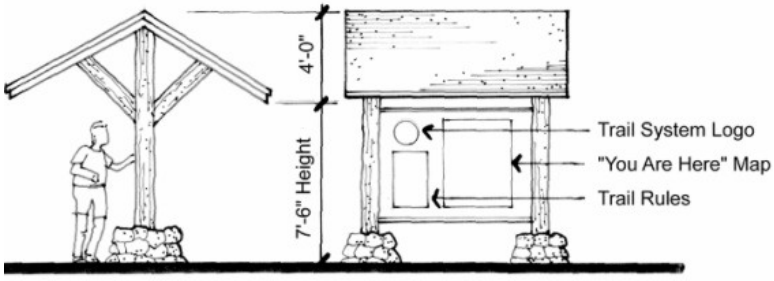


Figure 10 c- Example of a trail information kiosk

Mid-trail marking

Mid-trail markings should be placed at 0.5 mile intervals starting at the southern or western trail terminus and shall include the trail name and mile marker. A combination of a pavement marking and sign can be used or pavement marking solely. Pavement markings showing the trail name and mile marker shall be placed on and parallel to the trail centerline using retroreflective pavement marking utilizing a 4-inch high white letters and numbers. When a sign is used, a single, double-sided sign shall be placed on the right side of the trail in the direction of increasing mileage. The sign shall be a flexible fiberglass

Figure 11

composite extending 3 feet above ground displaying the mile marker and optionally the trail name. An example of the mid-trail pavement marking and sign is shown in Figure 11.

Trail/street intersections

Where a multi-use trail intersects a street the trail name, trail mile marker and street name shall be displayed. In addition destination guide signs may be appropriate.

Figure 12

Intersection sign
A post mounted street name sign, similar to a D3-1 with 4-inch initial upper-case letters with 3-inch lower-case letters, shall be located on the right side of the trail near as particle to the edge of the street right-of-way. These signs shall display the trail name and street name. For trails with long names appropriate abbreviations can be used.

Intersection pavement marking
The street name shall be shown using retroreflective pavement marking in 6-inch high white letters placed perpendicular to the trails centerline approximately 10 feet from the intersection. The trail name and mile marker retroreflective pavement marking shall be placed on and parallel to the trail centerline using retroreflective pavement marking using 4-inch high white letters and numbers and should be placed approximately 25 feet before the intersection. Figure 12 shows the preferred layout for trail identification markings.

Trail/trail intersections

Where multi-use trails intersect the trail names and mile markers shall be shown using signs ans pavement markings.

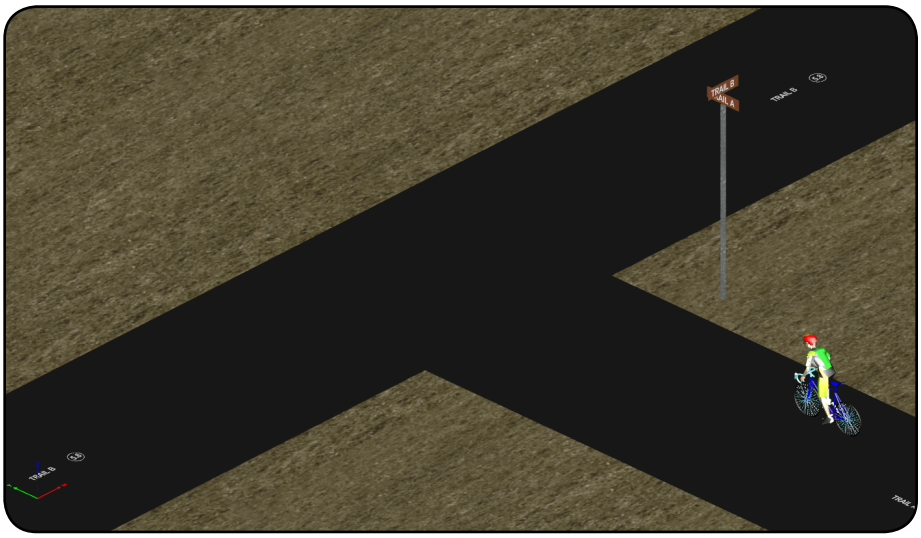


Figure 13

Intersection sign
Post mounted signs displaying both trail names, similar to a D3-1 sign with 4-inch initial upper-case letters with 3-inch lower-case letters, shall be located at the intersection. For trail with long names appropriate abbreviations can be used.

Intersection pavement marking
The trail name, for each trail, shall be shown using retroreflective pavement marking in 4-inch high white letters and numbers. The multi-use trail name and mile marker shall be placed on and parallel to the center line of the trail approximately 25 feet before the intersection. Figure 13 shows the preferred layout for trail identification markings.

1.11 Pedestrian and Cycling Supportive Site Design

The DPM requires that, "All new roadways which are legal for bicycle use should be designed and constructed under the assumption that they will be used by bicyclists."

The DPM provides the following guidance for accommodating bicycles on new streets:

a) Development of Bike Lanes on New or Reconstructed Roadways

Bike lanes should be provided on all new or reconstructed arterial and collector roadways. Recommended minimum widths for bicycle lanes are as follows:

- 5 feet, measured from painted edgeline to edge of gutter, on roadways with posted speed limits of 40 mph or greater.
- 4 feet, measured from painted edgeline to edge of gutter, on roadways with posted speed limits of 35 mph or less.

Bike lanes shall be flush with roadside gutters and should be marked in accordance with the *MUTCD* and AASHTO guidelines.

Future roadway improvements should retain existing bike lanes, including intersection approaches where additional turn-lanes may be constructed.

The DPM also states that, "In new residential or commercial developments adjacent to bikeways, contiguous walls or fences should provide breaks for paved bicycle access which link the development to the bikeway system. Access(es) should be delineated on the sketch plat, preliminary plat and/or site development plan as appropriate."

1.11.1 Bike Routes to Transit

Safe and easy access to bicycle parking facilities is necessary to encourage commuters to access transit via bicycle. Bicycling to transit reduces the need to provide expensive car parking spaces, mitigates peak-hour congestion and promotes active, healthy lifestyles.

Providing bicycle routes to transit helps combine the long-distance coverage of bus travel with the door-to-door service of bicycle riding. Transit use can overcome large obstacles to bicycling, including distance, hills, riding on busy streets, night riding, inclement weather and breakdowns. Providing bicycle access to transit and space for bicycles on buses can increase the feasibility of transit in lower-density suburban areas where transit stops are beyond walking distance of many residences. People are often willing to walk only a quarter-mile to half-a-mile to a bus stop, while they might bike as much as two or more miles to reach the bus station. As the majority of bus stops do not provide long-term, secure parking options for bicycles, most people who ride to a bus stop will want to bring their bicycle with them on the transit portion of their trip.

The local bicycle network should connect to transit stations, particularly higher-volume hubs that provide bicycle parking. The TCRP report, Bicycle and Transit Integration also recommends bicycle paths from neighboring communities that are shorter in length than roadways, which is particularly important in areas with a disconnected street pattern. Signage on these routes should be clearly visible, using the bicycle symbol for bike routes and parking facilities.

High-visibility crosswalks and mid-block crossings are often appropriate treatments to provide safer bicycle and pedestrian access to bus stops, particularly at high-usage transit stops. If a bus stop is located mid-block, adequate crossing treatments should be provided based on the level of traffic on the roadway. All transit riders will need to cross the street to access or leave the bus stop.

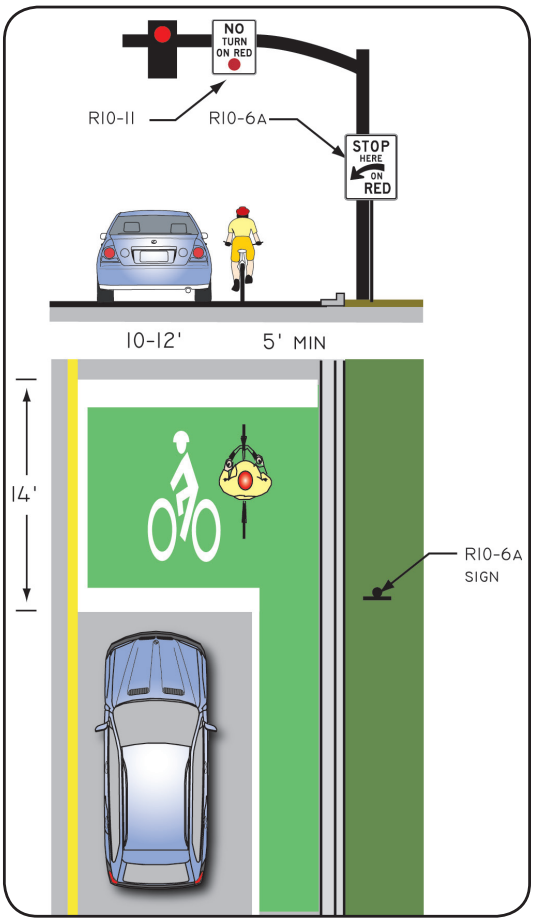
1.12 Innovative Bike Lane Treatments

1.12.1 Bike Box

Design Summary

Bike Box Dimensions:

- 14 feet deep to allow for bicycle positioning.
- Signage: Appropriate signage as recommended by the *MUTCD* applies. Signage should be present to prohibit right turn on red and to indicate where the motorist must stop.



Recommended bike box design.

Discussion

A bike box is generally a right angle extension of a bike lane at the head of a signalized intersection. The bike box allows bicyclists to move to the front of the traffic queue on a red light and proceed first when that signal turns green. Motor vehicles must stop behind the white stop line at the rear of the bike box.

Bike boxes can be combined with dashed lines through the intersection for green light situations to remind right-turning motorists to be aware of bicyclists traveling straight, similar to the colored bike lane treatment described earlier. Bike boxes can be installed with striping only or with colored treatments to increase visibility. Use of coloration substantially increases costs of maintenance over uncolored (striping, bicycle symbol and text only) treatments.

Bike boxes should be located at signalized intersections only and right turns on red should be prohibited. Bike boxes should be used locations that have a large volume of cyclists and are often utilized in central areas where traffic is usually moving slowly. Reducing right turns on red improves safety for cyclists and does not significantly impede motor vehicle travel.

On roadways with one travel lane in each direction, the bike box also facilitates left turning movements for cyclists.

Bike boxes have been installed at several intersections in Portland, OR where right-turning motorists conflict with through bicyclists.

Guidance

Evaluation of Innovative Bike-Box Application in Eugene, Oregon, Author: Hunter, W.W., 2000

1.12.2 Shared Bicycle/Bus Lane

Design Summary

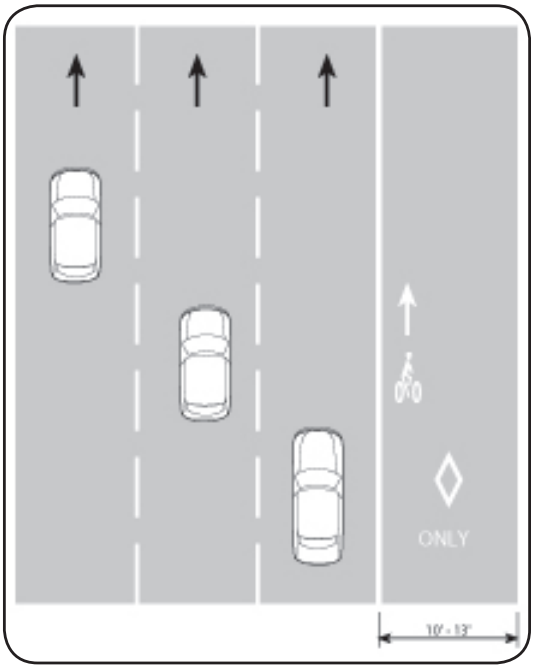
- Provide a standard width bike lane (minimum 4 feet) where possible.
- Paint bicycle symbol or shared lane marking symbol to the left side of the bus lane to allow bicyclist to pass a bus that has turned in at a stop.

Discussion

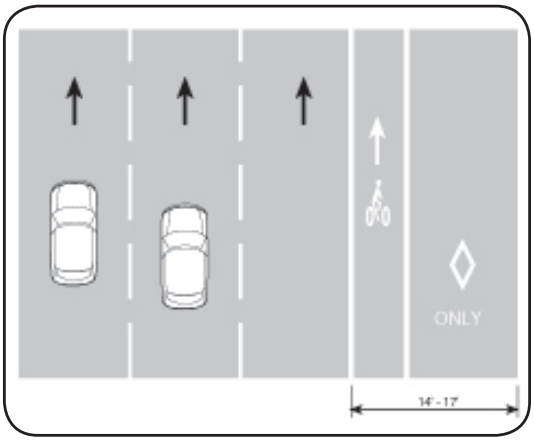
The shared bus/bicycle lane should be used where width is available for a bus lane, but not a bus and bike lane. The dedicated lane attempts to reduce conflicts between bicyclists, buses and automobiles. Various cities have experimented with different designs and there is currently no evidence of one design being more effective than the others.

Shared bike/bus lanes can be appropriate in the following applications:

- On auto-congested streets and moderate or long bus headways.
- Moderate bus headways during peak hours.
- No reasonable alternative route.



Minimum design: shared bicycle/bus lane.



Preferred design: separated bike lane and bus lane.

1.12.3 Shared Bike/Right Turn Lane

Design Summary

Width:

- Shared turn lane – minimum 12 feet width.
- Bike lane pocket – minimum 4-5 feet preferred.

Discussion

This treatment is recommended at intersections lacking sufficient space to accommodate a standard bike lane and right turn lane. The shared bicycle/right turn lane places a standard-width bike lane on the left side of a dedicated right turn lane. A dashed strip delineates the space for bicyclists and motorists within the shared lane. This treatment includes signage advising motorists and bicyclists of proper positing within the lane.

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).

Advantages:

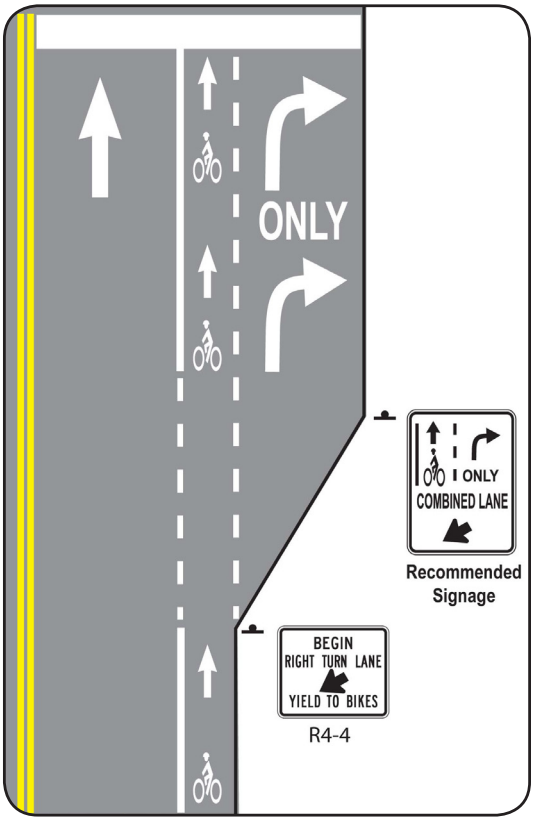
- Aids in correct positioning of cyclists at intersections with a dedicated right turn lane without adequate space for a dedicated bike lane.
- Encourages motorists to yield to bicyclists when using the right turn lane.
- Reduces motor vehicle speed within the right turn lane.

Disadvantages/potential hazards:

- 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.

Guidance

This treatment has coverage in the draft 2009 AASHTO *Guide For the Development of Bicycle Facilities*. It has been previously implemented in San Francisco, Calif., and Eugene, Ore.



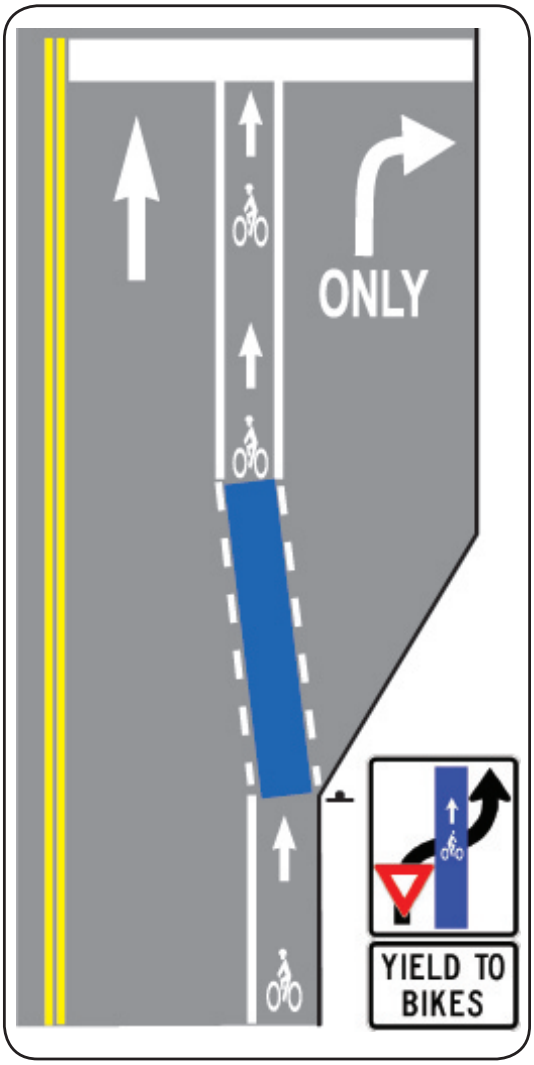
Recommended shared bike/right turn lane design.

Shared bike-right turn lanes require warning signage as well as pavement markings.

1.12.4 Colored Bike Lanes

Design Summary

- Bike lane pocket – minimum 4-5 feet preferred.
- Use colored pavement through entire merge area.
- Dashed lines can be used to indicate that automobiles are crossing the bike lane.
- Signage reminds drivers to yield to cyclists in the bike lane.



Recommended colored bike lane design.

Discussion

Cyclists are especially vulnerable at locations where the volume of conflicting vehicle traffic is high and where the vehicle/bicycle conflict area is long. Some cities are using colored bike lanes to guide cyclists through major vehicle/bicycle conflict points. These conflict areas are locations where motorists and cyclists must cross each other's path (e.g., at intersections or merge areas). Colored bike lanes typically extend through the entire bicycle/vehicle conflict zone (e.g., through the entire intersection) or through the transition zone where motorists cross a bike lane to enter a dedicated right turn lane.

There are three colors commonly used in bike lanes: blue, green and red. Several cities initially used blue; however, this color is associated with amenities for handicapped drivers or pedestrians. Green is the color recommended for use in Albuquerque.

Advantages of colored bike lanes at conflict points:

- Draws attention to conflict areas
- Increases motorist yielding behavior
- Emphasizes expectation of bicyclists on the road.

Guidance

Although colored bike lanes are not an official standard at this time, they continue to be successfully used in cities, including Portland, Ore.; Philadelphia, Pa.; Cambridge, Mass.; Toronto, Ontario; Vancouver, B.C.; and Tempe, Ariz. This treatment typically includes signage alerting motorists of vehicle/ bicycle conflict points. Portland's *Blue Bike Lane* report found that significantly more motorists yielded to bicyclists and slowed or stopped before entering the conflict area after the application of the colored pavement.

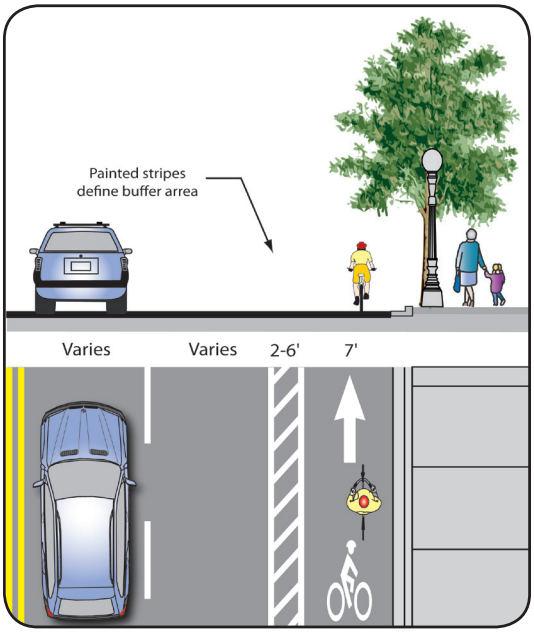
Additional information in Portland Office of Transportation (1999). *Portland's Blue Bike Lanes: Improved Safety through Enhanced Visibility*. Available: www.portlandonline.com/shared/cfm/image.cfm?id=58842

Portland, OR has implemented colored bike lanes.

1.12.5 Buffered Bike Lanes

Design Summary

Guidelines for buffer width varies:
- 2.6 feet/80 centimeters (London and Brussels)
- 1.6-2.5 feet/50-75 centimeters (CROW Guide)
- 6 feet (Portland, Ore.)



Recommended buffered bike lane design.

Discussion

Bike lanes on high-volume or high-speed roadways can be dangerous or uncomfortable for cyclists, as automobiles pass or are parked too close to bicyclists. Buffered bike lanes are designed to increase the space between the bike lanes and the travel lane or parked cars.

This treatment is appropriate on bike lanes with high automobile traffic volumes and speed, bike lanes adjacent to parked cars and bike lanes with a high volume of truck or oversized vehicle traffic. Frequency of right turns by motor vehicles at major intersections should determine whether continuous or truncated buffer striping should be used approaching the intersection.

Advantages of buffered bike lanes:
- Provides cushion of space to mitigate friction with motor vehicles on streets with narrow bike lanes.
- Provides space for cyclists to pass one another without encroaching into the travel lane.
- Provides space for cyclists to avoid potential obstacles in the bike lanes, including drainage inlets, manholes, trash cans or debris.
- Parking side buffer provides cyclists with space to avoid the door zone of parked cars.
- Provides motorists greater shy distances from cyclists in the bike lane.


Buffered bike lanes protect cyclists from fast-moving traffic.

Disadvantages/potential hazards
- Requires additional roadway space.
- Requires additional maintenance for the buffer striping.
- Frequency of parking turnover should be considered prior to installing buffered bike lanes.
- Increases the debris collection in the bike lane.

Guidance

This treatment is not currently present in any state or federal design standards.

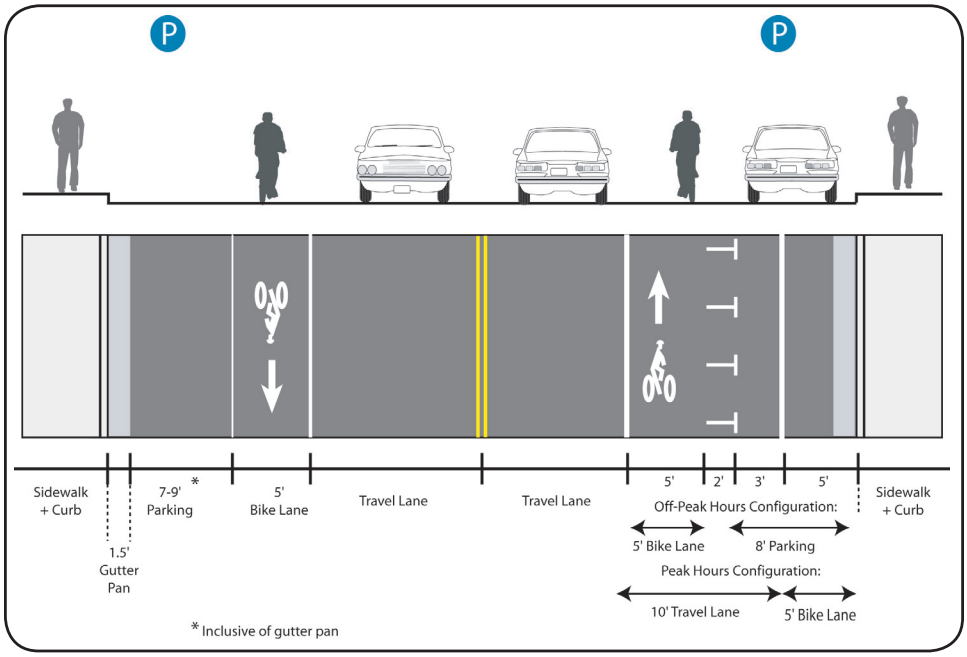
The City of Portland, Ore., included this treatment in the *Bikeway Design Best Practices* for the *2030 Bicycle Master Plan*. Buffered bike lanes are currently also used in Brussels & Bruges, Belgium, Budapest, Hungary, London, U.K., Seattle, Wash., San Francisco, Calif., and New York, N.Y.

1.12.6 Floating Bike Lanes

Design Summary

It is important to provide adequate space to minimize the risk of "doorings" when parking is permitted. The bicycle symbol may be used curbside or sharrow markings in lieu of bike lane striping.

In San Francisco, parking is permitted during off-peak times: 9 a.m.-3 p.m. and 7 p.m. to 7 a.m.



Recommended floating bike lane design.

Discussion

This treatment maintains the bicycle facility when an extra travel lane (for automobiles) is added during peak hours. A single lane can function as a parking lane or an exclusive bike lane. During peak hours, parking is not allowed and cyclists use a curbside bike lane. During off-peak hours, cyclists travel in the space between the motorized traffic lane and parked cars.

This treatment can be used on primary bike routes during peak hours or on streets warranting bike lanes with high parking demand where there is insufficient space to provide both standard bike lane and parking.

Floating bike lane when parking is allowed on The Embaradero, San Francisco.
Source: sfmta.org

Advantages of buffered bike lanes:

- Can accommodate bicycles at all times, even when parking is permitted.
- Provides bicycle facilities on streets with constrained rights-of-way.

Disadvantages/potential hazards

- Unorthodox design can be confusing to both cyclists and motorists.
- Enforcement is required.

Guidance

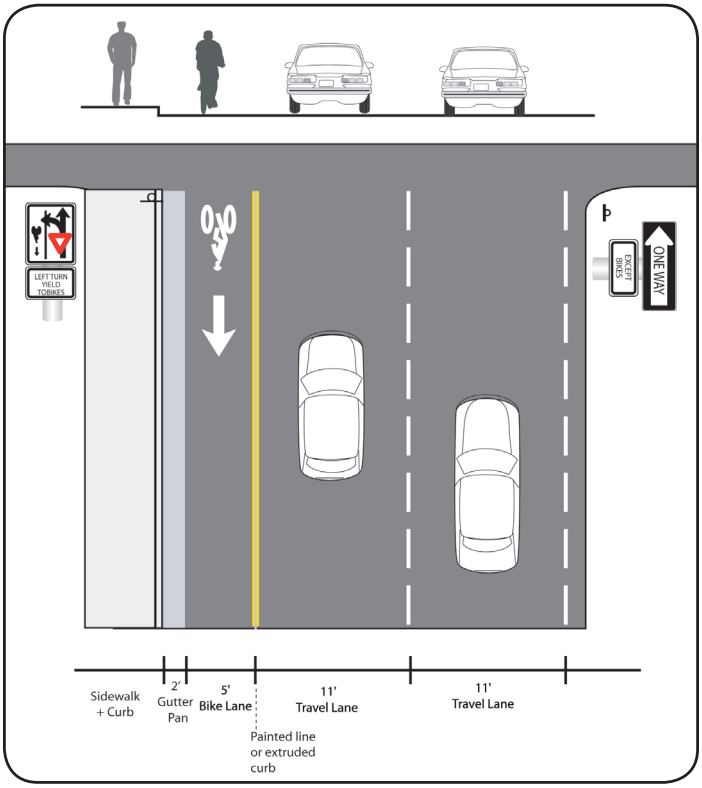
This treatment is not currently present in any state or federal design standards.

The City of Portland, Ore., included this treatment in the *Bikeway Design Best Practices* for the *2030 Bicycle Master Plan*. Floating bike lanes are currently used in San Francisco, Calif.

1.12.7 Contraflow Bike Lane

Design Summary

- The contraflow lane should be 5-6.5 feet and marked with a solid double yellow line and appropriate signage.
- Bike lane markings should be clearly visible to ensure that contraflow lane is exclusively for bicycles.
- Coloration should be considered on the bike lane.



Recommended contraflow bike lane design.

Discussion

Contraflow bike lanes provide bi-directional bicycle access along a roadway that is one-way for automobile traffic. This treatment can provide direct access and connectivity for bicyclists, avoiding detours and reducing travel distances for cyclists.

Advantages of contraflow bike lanes:

- Provides direct access and connectivity for bicycles traveling in both directions.
- Influences motorist choice of routes without limiting bicycle traffic.
- Cyclists do not have to make detours as a result of one-way traffic.

Disadvantages/potential hazards

- Parking should not be provided on the far side of the contraflow bike lane.
- Space requirements may require reallocation of roadway space from parking or travel lanes.
- The lane could be illegally used by motorists for loading or parking.
- Conversion from a two-way street requires elimination of one direction of automobile traffic
- Public outreach should be conducted prior to implementation of this treatment.

This contraflow bike lane in Portland, OR (left) provides a key connection along a narrow one-way street.

Guidance

This treatment is a federally-recognized design standard and present in some state Department of Transportation manuals, such as the *Wisconsin Bicycle Facility Design Handbook*.

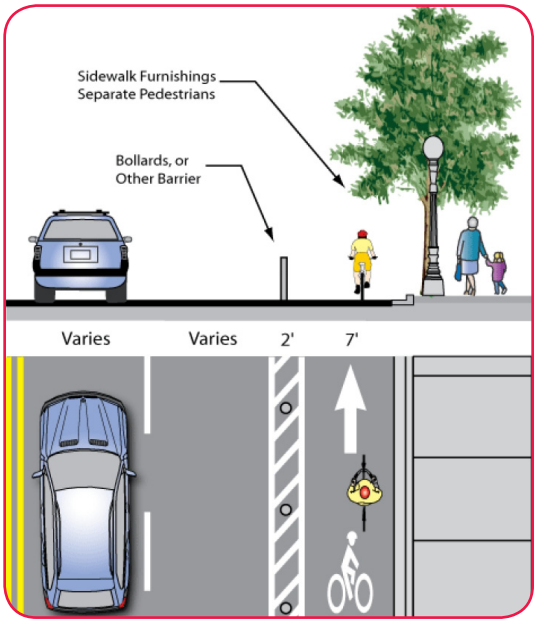
The City of Portland, Ore., included this treatment in the *Bikeway Design Best Practices for the 2030 Bicycle Master Plan*. Contraflow bike lanes are currently used in Olympia, Wash.; Seattle, Wash.; Madison, Wis.; Cambridge, Mass.; San Francisco, Calif.; and Portland, Ore.

1.13 Cycle Tracks

Design Summary

A cycle track is an exclusive bicycle facility that combines the user experience of a separated path with the on-street infrastructure of a conventional bike lane. Recommended cycle track width:

- 7 foot minimum to allow passing.



Recommended cycle track design without parking, using striping and flexible bollard separation.

Discussion

Cycle tracks provide space that is intended to be exclusively or primarily for bicycles and are separated from vehicle travel lanes, parking lanes and sidewalks. Cycle tracks can be either one-way or two-way, on one or both sides of a street and are separated from vehicles and pedestrians by pavement markings or coloring, bollards, curbs/medians or a combination of these elements.

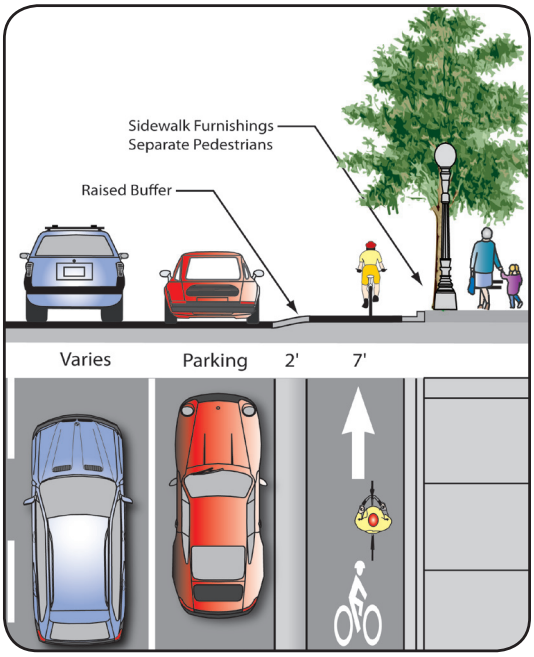
Cycle tracks provide:

- Increased comfort for bicyclists.
- Greater clarity about expected behaviour.
- Fewer conflicts between bicycles and parked cars as cyclists ride inside the parking lane.
- Space to reduce the danger of car dooring.

Danish research has shown that cycle tracks can increase bicycle ridership 18-20 percent, compared with the 5-7 percent increase associated with bike lanes.

However, disadvantages of cycle tracks include:

- Increased vulnerability at intersections.
- Regular street sweeping trucks cannot maintain the cycle track. Requires smaller sweepers.
- Conflicts with pedestrians and bus passengers can occur, particularly on cycle tracks that are undifferentiated from the sidewalk or that are between the sidewalk and a transit stop.



Recommended cycle track design with on-street parking.

Cycle tracks should be placed along slower speed urban/suburban streets with long blocks and few driveways or mid-block access points for vehicles. Cycle tracks located on one-way streets will have fewer potential conflicts than those on two-way streets. A two-way cycle track is desirable when there are more destinations on one side of a street or if the cycle track will connect to a shared-use path or bicycle facility on one side of the street.

Guidance

While only recently implemented in U.S. and Canadian cities, cycle tracks have been used in European countries for several decades. The cycle track design guidance was developed using best practices from European experience, as well as New York City, Montreal and Portland, Ore. Additional guidance: *Cycle Tracks: Lessons Learned*, Alta Planning + Design (2009). www.altaplanning.com/App_Content/files/pres_stud_docs/Cycle%20Track%20lessons%20learned.pdf

1.13.1 Cycle Track Separation

Design Summary

Cycle tracks can be separated from vehicle traffic by a barrier or through grade-separation. Physical barriers can include bollards, parking, a planter strip, an extruded curb or parking. Cycle tracks using barrier separation typically share the same elevation as adjacent travel lanes. Pavement markings or other minimal separation should designate pedestrian space and discourage pedestrians from walking in the cycle track.

Openings in the barrier or curb are needed at driveways or other access points. Grade-separated cycle tracks should incorporate a rolled curb, which allows cyclists to enter or leave the cycle track at will and enables motorists to cross the cycle track at intersections and crossings.

Cycle track with a parking buffer, Copenhagen.

Cycle track with curb separation, Amsterdam.

Discussion

Parking Placement
Where on-street parking exists, the cycle track should be placed between the parking and the sidewalk. The cycle track should be placed with a 2-foot buffer between parking and the sidewalk to minimize the hazard of dooring cyclists. Drainage inlets should be provided adjacent to the sidewalk curb to facilitate run-off. This technique is common in Copenhagen, as pictured right.

Channelization
Cycle tracks can be at street-level, provided that there is a physical separation. The curb creates the separated space, as well as preventing passengers from opening doors into the cycle track and discouraging pedestrians from walking on the facility.

Mountable Curb
Cycle tracks can be grade-separated from the roadway. The cycle track should be 2 or 3 inches above street-level, and the sidewalk should be an additional 2 to 3 inches above that. Where cyclists may enter or leave the cycle track or where motorists cross at a driveway, the curb should be mountable with a small ramp, allowing cyclist turning movements.

Mountable curb, Copenhagen.

Bollards and Pavement Markings
In addition to grade separation or channelization, the cycle track should have signage, pavement markings and/or different coloration or texture to indicate that the facility is provided for bicycle use. Signage, in addition to flexible bollards, can add to the physical separation of the facility, shown in this example from Melbourne, Australia.

Guidance
A buffer is not required of a cycle track wider than 7 feet, but is recommended where possible. The *CROW Design Manual for Bicycle Traffic* recommends that the buffer area inside built-up areas should be a minimum of 1.1 feet. If the buffer is a fence or other taller obstacle, a minimum of 2 feet shy distance is recommended on either side.

Cycle track with bollard separation, New York City.

1.13.2 Cycle Track Intersection Treatments

Cycle tracks separate cyclists and motor vehicles to a greater degree than bike lanes. This leads to added comfort for cyclists on the cycle track, but it creates additional considerations at intersections that must be addressed. A right-turning motorist conflicting with cycle track users represents the most common conflict. Both roadway users have to expand their visual scanning to see potential conflicts.

1.13.2.1 Cycle Track Treatments at Driveways and Minor Street Crossings

Design Summary

Recommendations for increasing bicyclist visibility at driveways and minor street crossings:

- Maintain height level of cycle track, requiring automobiles to cross over.
- Remove parking 16 feet prior to the intersection.
- Use colored pavement markings through the conflict area.
- Place warning signage to identify the crossing (see page 5).

Discussion

At driveways and crossings of minor streets, the majority of traffic will continue through intersections, while a small number of automobiles will cross the cycle track. At these locations, cyclist visibility is important, as a buffer of parked cars or vegetation can hide a cyclist traveling in the cycle track. Cyclists should not be expected to stop at these minor intersections if the major street does not stop, and markings and signage should be used to indicate that drivers should watch for cyclists.

Access management should be used to reduce the number of crossings of driveways on a cycle track.

Guidance

See the *CROW Design Manual for Bicycle Traffic* or *Cycle Tracks: Lessons Learned*, Alta Planning + Design (2009) for additional guidance.

www.altaplanning.com/App_Content/files/pres_stud_docs/Cycle%20Track%20lessons%20learned.pdf

Cycle tracks should be continued through driveway crossings, improving visibility.

Colored pavement informs bicyclists and drivers of a potential conflict area.

Bicycle markings at a driveway crossing.

1.13.2.2 Cycle Track Treatments at Major Street Crossings

Design Summary

Recommendations for increasing bicyclist visibility at major street crossings:

- Stripe stop line 16 feet back from the intersection.
- Remove parking 16 feet prior to the intersection.
- Drop cycle track to bike lane 16 feet back from intersection.
- Use bike box treatments to move cyclists in front of traffic (see page 2).
- Use colored pavement markings through the conflict area.

Cycle track dropping to bike lane before an intersection.

Discussion

Protected phases at signals or scramble signals separate automobile turning movements from conflicting through-bicycle movements. Bicycle signal heads ensure that all users know which signals to follow. Demand-only bicycle signals can require user actuation and reduce vehicle delay by preventing an empty signal phase from regularly occurring.

Advanced signal phases can be set to provide cycle track users an advanced green phase. This places cyclists in front of traffic and allows them to make their turning movements without merging into traffic.

An advanced warning allows bicyclists to prepare to move forward through the intersection. This warning can be accomplished through a pre-green interval, a yellow warning display two seconds before the green or a bicycle countdown signal.

Crossings should separate space for bicyclists and pedestrians.

Guidance

The CROW guide states that if the speed of the main street is 45 mph or less, the cycle track should turn inwards prior to crossing a side street. This is to improve visibility of cyclists to motorists in the main road turning right. If the speed is greater, the cycle track should bend away from the main road at intersections so that vehicles leaving the main road can stack up on the cross street between the cycle track and the main road. Signage should also warn motorists of the crossing.

At this unsignallized right turn, the cycle track has dropped to a bike lane with blue coloration and pavement markings through the conflict area.

Bike-specific signals are small and placed on the near-side of traffic.

1.13.2.3 Left Turn Movements

Design Summary

Left turn opportunities for cyclists can be provided in the following ways:

- Copenhagen lefts are a two-stage crossing, which include a turning and waiting area at the far side of the first intersection.
- Box lefts are pockets where bicyclists can move to the right hand side of the cycle track and wait for a crossing signal. This treatment can result in the cyclist being on the wrong side of the street in a standard four-way intersection.
- Scramble signals.

Discussion

Bicyclists are often not allowed to make left-turn movements from the cycle track can be physically barred from moving into the roadway by the cycle track barrier.

The "Copenhagen Left" (also known as the "Melbourne Left," the "jug-handle turn" and the "two-stage left") is a way of enabling a safe left-turn movement by bicyclists in a cycle track. Bicyclists approaching an intersection can make a right into the intersecting street from the cycle track to position themselves in front of cars. Bicyclists can go straight across the road they were on during next signal phase. All movements in this process are guided by separate traffic signals. Motorists are not allowed to make right turns on red signals. In addition, motorists have an exclusive left-turn phase in order to make their movements distinct from the bicyclists'.

Guidance

See the *CROW Design Manual for Bicycle Traffic* or *Cycle Tracks: Lessons Learned*, Alta Planning + Design (2009) for additional guidance.

www.altaplanning.com/App_Content/files/pres_stud_docs/Cycle%20Track%20lessons%20learned.pdf

Left-turn from a cycle track on the right via bicycle-signal phase in Stockholm, Sweden.

"Copenhagen Left" application.

"Box left" turn in Troisdorf, Germany.

1.13.3 Two-Way Cycle Tracks

Design Summary

- 12 foot minimum to allow passing. Fourteen-foot recommended (New York City).
- Striped center line to separate traffic.
- Pavement markings should indicate direction.

Discussion

A two-way cycle track is desirable when more destinations are on one side of a street (therefore preventing additional crossings) if the facility connects to a path or other bicycle facility on one side of the street or if there is not enough room for a cycle track on both sides of the road.

Two-way cycle track with dividing line.

Bidirectional cycle tracks are acceptable in the following situations:

- On a street with few intersections or without access on one side (e.g., along a waterway or rail line).
- On a one-way street with fewer than one intersection every 100 feet.
- On two-way streets where left-hand turns are prohibited and with a limited number of intersections and driveway entrances.

Parking should be banned along the street with the bike path to ensure adequate stopping sight distances for motorists crossing the path.

Directional markings on cycle track.

Two-way cycle tracks have many similar design characteristics as one-way tracks: they are physically divided from cars and pedestrians and require similar amenities at driveway and side-street crossings.

Two-way cycle tracks require a higher level of control at intersections to allow for a variety of turning movements. These movements should be guided by a separated signal for bicycles and for motor vehicles. Transitions onto bidirectional cycle tracks should be simple and easy to use to deter bicyclists from continuing to ride against the flow of traffic.

In addition, bicyclists riding against roadway traffic in two-way cycle tracks may surprise pedestrians and drivers at intersections.

Pavement markings indicate travel direction at a minor roadway crossing on this cycle track in Paris, France.

Guidance

Vélo Québec Technical Handbook of Bikeway Design. (2003), *CROW Design Manual for Bicycle Traffic* and *Alta Planning + Design Cycle Tracks: Lessons Learned*, (2009).