Appendix F. Design Guidelines

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Bicyclists have legal access to all county streets. While this Plan identifies a specific subset of streets to be designated as bikeways, many bicyclists will need to use other streets to reach their destinations. Therefore, it is important that all roadways be designed to accommodate bicyclists.

The County of Los Angeles works 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. The County of Los Angeles features a mix of urban, suburban, and rural environments, and many future projects will involve retrofitting existing streets and intersections. The County has high demand for on-street parking in commercial corridors, an auto-oriented roadway system reliant on high-capacity arterials, and many other complex situations.

The Design Guidelines are intended to provide a range of design options for bicycle treatments. The Design Guidelines provide a toolbox of ideas that may be implemented by the County of Los Angeles, but is not inclusive of all treatments that may be used and does not identify treatments intended for any specific projects. The following key principles should guide the development of all future County bikeways and bicycle facilities:

- The bicycling environment should be safe. On-and off-road bikeways described in Chapter 3 (Table 3.1) 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 bicycle network should be accessible. Future bikeway design 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 bicycle network should connect to places people want to visit. The bikeway network should provide continuous direct routes and convenient connections between destinations, including homes, schools, offices, commercial districts, shopping areas, recreational opportunities and transit.
- The bikeway network should be clearly designated and easy to use. On-and off-road bikeways should be designed so people can easily find a direct route to a destination and delays are minimized.
- Bicyclists should be able to enjoy a positive environment. Good design should enhance the feel of the bicycling environment. A complete network of on-street bicycling facilities should connect seamlessly to the existing and proposed off-street pathways to complete recreational and commuting routes around the County.
- All roadway projects and improvements *should* accommodate bicyclists.
- Bicycle 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 should 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.

F.1 National, State, and Local Guidelines / Best Practices

The following is a list of references and sources utilized to develop design guidelines for the County of Los Angeles Bicycle Master Plan. Many of these documents are available online.

F.1.1 Federal Guidelines

- American Association of State Highway and Transportation Officials. (2004). *AASHTO Policy on Geometric Design of Streets and Highways*. Washington, DC. www.transportation.org
- American Association of State Highway and Transportation Officials. (1999). *AASHTO Guide for the Development of Bicycle Facilities*. Washington, DC. www.transportation.org
- Federal Highway Administration. (2009). *Manual on Uniform Traffic Control Devices (MUTCD)*.Washington, DC. http://mutcd.fhwa.dot.gov
- United States Access Board. (2007). *Public Rights-of-Way Accessibility Guidelines (PROWAG)*. Washington, D.C. http://www.access-board.gov/PROWAC/alterations/guide.htm

F.1.2 State and Local Guidelines

- California Department of Transportation. (2006). *Highway Design Manual* (HDM), *Chapter 1000: Bikeway Planning and Design.* http://www.dot.ca.gov/hq/oppd/hdm/pdf/chp1000.pdf
- California Department of Transportation. (2010). *California Manual of Uniform Traffic Control Devices for Streets and Highways, Part 9: Traffic Controls for Bicycle Facilities.* http://www.dot.ca.gov/hq/traffops/signtech/mutcdsupp/pdf/camutcd2010/Part9.pdf
- California Department of Transportation. (2005). Pedestrian and Bicycle Facilities in California: A Technical Reference and Technology Transfer Synthesis for Caltrans Planners and Engineers. http://www.dot.ca.gov/hq/traffops/survey/pedestrian/TR_MAY0405.pdf
- County of Los Angeles, Department of Public Works. (2004). *Los Angeles River Master Plan Landscaping Guidelines and Plant Palettes.* http://ladpw.org/wmd/watershed/LA/LAR_planting_guidelines_webversion.pdf

F.1.3 Best Practices Documents

- Alta Planning + Design and the Initiative for Bicycle & Pedestrian Innovation (IBPI). (2009). *Fundamentals of Bicycle Boulevard Planning & Design.* http://www.ibpi.usp.pdx.edu/media/BicycleBoulevardGuidebook.pdf
- Association of Pedestrian and Bicycle Professionals (APBP). (2010). *Bicycle Parking Design Guidelines, 2nd Edition.*
- City of Berkeley. (2000). *Bicycle Boulevard Design Tools and Guidelines.* http://www.ci.berkeley.ca.us/contentdisplay.aspx?id=6652
- City of Chicago and the Pedestrian and Bicycle Information Center (PBIC). (2002). Bik*e Lane Design Guide.*http://www.activelivingresources.org/assets/chicagosbikelanedesignguide.pdf
- City of Portland Bureau of Transportation. (2010). *Portland Bicycle Master Plan for 2030.*http://www.portlandonline.com/transportation/index.cfm?c=44597

- Federal Highway Administration. (2005). *Report HRT-04-100, Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations.* http://www.tfhrc.gov/safety/pubs/04100/
- Federal Highway Administration. (2001). *Designing Sidewalks and Trails for Access.*http://www.fhwa.dot.gov/environment/sidewalk2/contents.htm
- Institute of Transportation Engineers Pedestrian and Bicycle Council. (2003). *Innovative Bicycle Treatments.*
- King, Michael, for the Pedestrian and Bicycle Information Center. (2002). *Bicycle Facility Selection: A Comparison of Approaches.* Highway Safety Research Center, University of North Carolina – Chapel Hill. http://www.bicyclinginfo.org/pdf/bikeguide.pdf
- National Association of City Transportation Officials, NACTO Urban Bikeway Design Guide, (2011), http://nacto.org/cities-for-cycling/design-guide/
- Oregon Department of Transportation. (1995). *Oregon Bicycle and Pedestrian Plan.* http://www.oregon.gov/ODOT/HWY/BIKEPED/planproc.shtml
- Rosales, Jennifer. (2006). *Road Diet Handbook: Setting Trends for Livable Streets.* Institute of Transportation Engineers.

F.2 Experimental Projects

Most of the design concepts in **Section F.5** are based on uniform standards outlined in the *California Highway Design Manual*, *Chapter 1000 – Bikeway Planning and Design*; *Manual of Uniform Traffic Control Devices* (CA MUTCD) 2010, Part 9 Traffic Controls for Bicycle Facilities and the American Association of State Highway and Transportation Officials (AASHTO) *Guide for the Development of Bicycle Facilities*. The toolbox also includes treatments that as yet have not been approved by the State of California Department of Transportation and/or the Federal Highway Administration. California State law requires the State to adopt uniform standards, and for local agencies to conform to these standards. California allows approved experimental projects on a case by case basis as approved by the California Traffic Control Devices Committee (CTCDC) and FHWA. These approved experimental projects are studied by the CTCDC and FHWA as a means to consider changes to these uniform standards.

These Design Guidelines contain several innovative treatments, such as cycle tracks, for which other jurisdictions both in California and in other states are experimenting. The State of California may at some future time approve these treatments, or other treatments not provided in these Design Guidelines, for use by all local agencies. As additional designs and standards are adopted by the State of California, the County will include those innovative treatments in the Plan's toolbox of treatments. The County promotes the use of these innovative treatments and will apply for and implement experimental projects utilizing them where cost effective and where such projects enhance the safety of bicycles, pedestrians, and motorists.

The process and requirements related to requests for approval for an experimental project from FHWA and CTCDC is outlined in the CA MUTCD. Examples of the processes to request and conduct experimental projects from the CTCDC and FHWA are shown in **Chart F-1** and **Chart F-2**, respectively. Per State guidelines, "experimental projects shall terminate at the end of the approved period unless an extension is granted, and all experimental devices and applications shall be removed unless specific permission is given for continued operation."

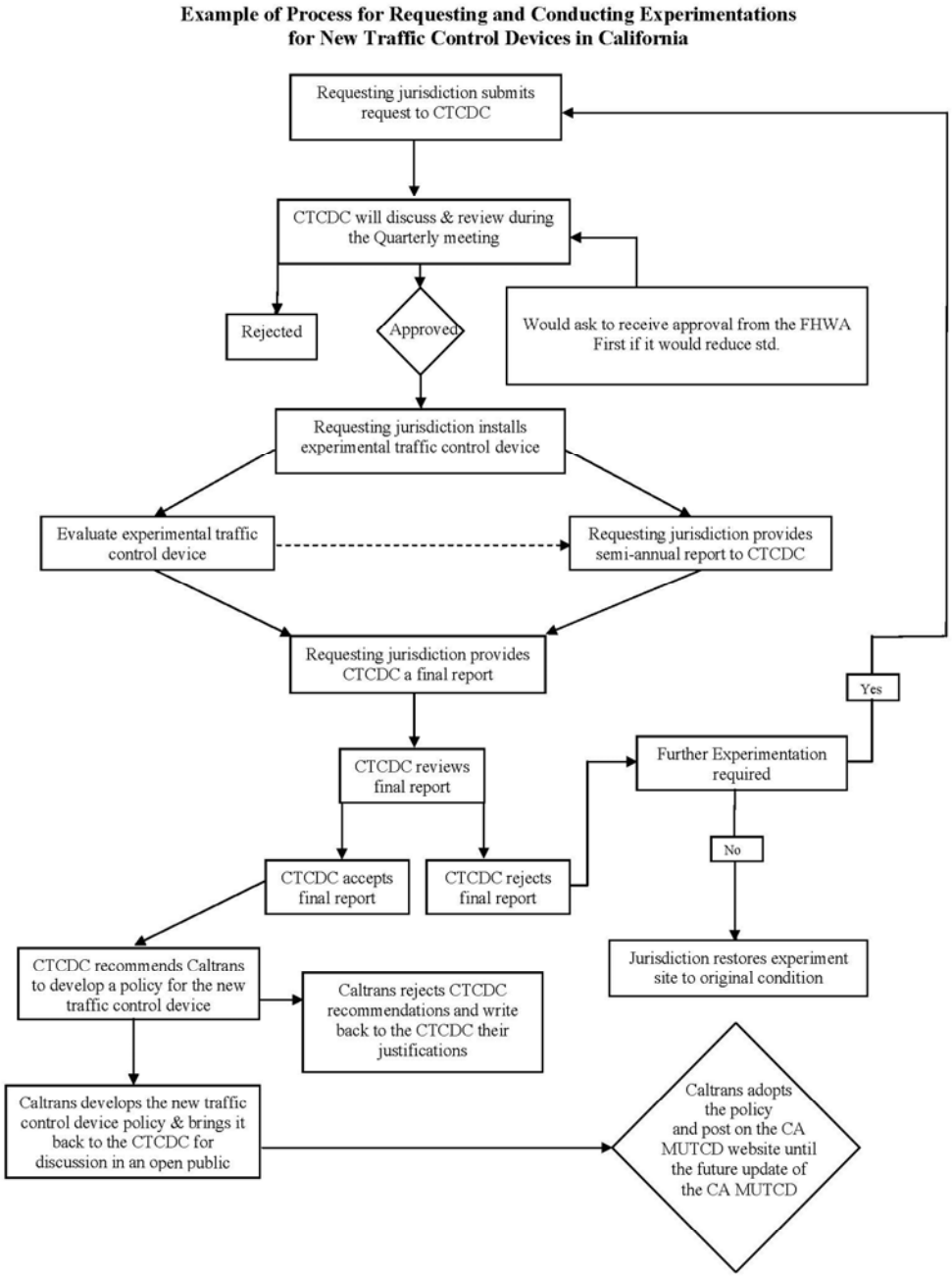


Chart F-1 – CTCDC Experimental Process

Reference: California Department of Transportation website

link: http://www.dot.ca.gov/hq/traffops/signtech/newtech/others/example-implementation.pdf

Example of Process for the Use of a Traffic Control Device in California Approved as on Interim Approval (IA) by the FHWA

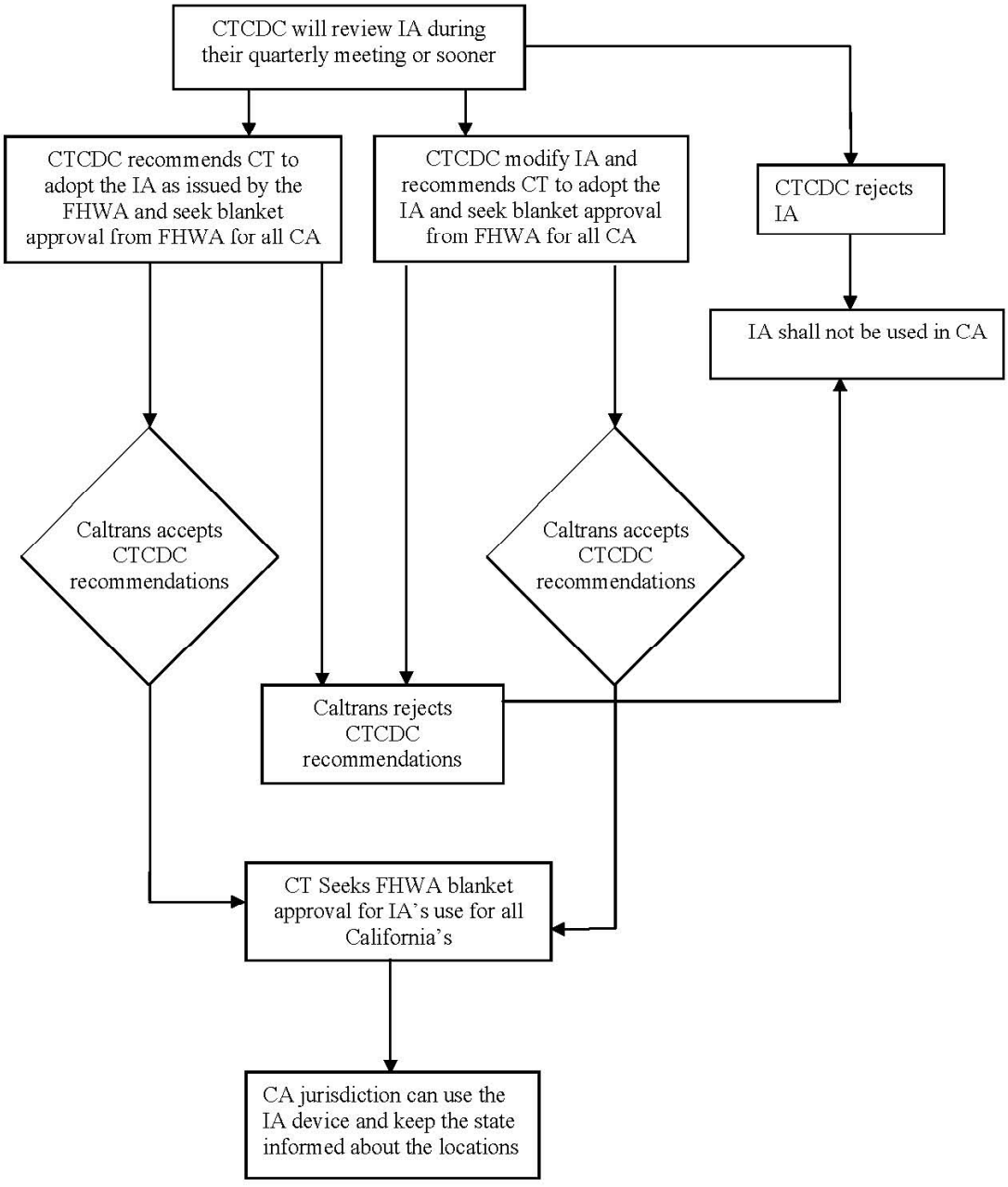


Chart F-2 – FHWA Experimental Process

Reference: California Department of Transportation website

link: http://www.dot.ca.gov/hq/traffops/signtech/newtech/others/example-experimentprocess.pdf

F.3 The Bicycle as a Design Vehicle

Similar to motor vehicles, bicyclists and their bicycles come in a variety of sizes and configurations. This variation can take the form of the variety in types of vehicle (such as a conventional bicycle, a recumbent bicycle, or a tricycle), or the behavioral characteristics and comfort level of the cyclist riding the vehicle. Any bicycle facility undergoing design should consider what types of design vehicles will be using the facility and design with that set of critical dimensions in mind.

F.3.1 Physical Dimensions

The operating space and physical dimensions of a typical adult bicyclist are shown in **Figure F-1**. Clear space is required for the bicyclist to be able to operate within a facility; this is why the minimum operating width is greater than the physical dimensions of the bicyclist. Although four feet is the minimum acceptable operating width, five feet or more is preferred.

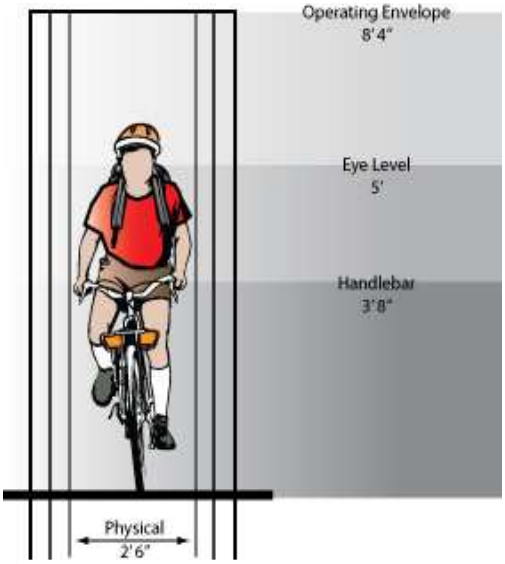


Figure F-1: Standard Bicycle Rider Dimensions

Outside of the design dimensions of a typical bicycle, there are many commonly used pedal driven cycles and accessories that should be considered when planning and designing bicycle facilities. The most common types of bicycles are depicted in **Figure F-2.**

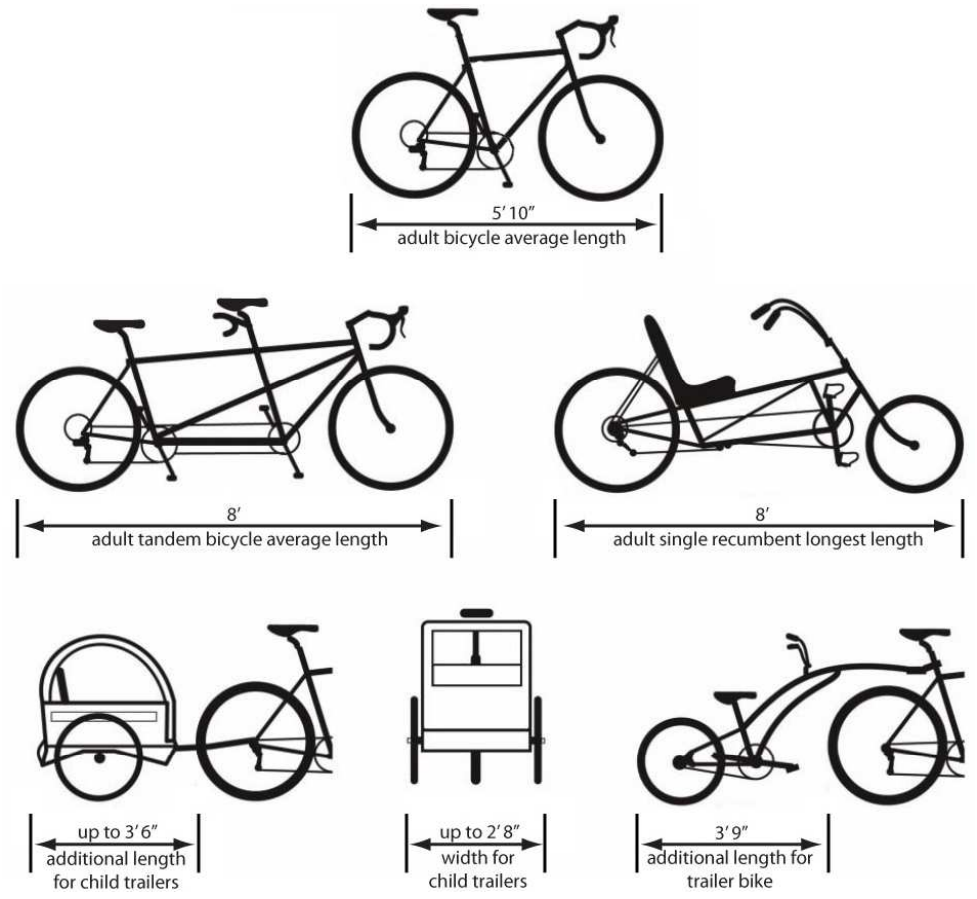


Figure F-2: Various Bicycle Dimensions

Table F-1 summarizes the typical dimensions for most commonly encountered bicycle design vehicles.

Table F-1: Bicycle as Design Vehicle – Typical Dimensions

Bicycle Type	Feature	Typical Dimensions
Upright Adult Bicyclist	Physical width	2 ft 6 in
	Operating width (Minimum)	4 ft
	Operating width (Preferred)	5 ft
	Physical length	5 ft 10 in
	Physical height of handlebars	3 ft 8 in
	Operating height	8 ft 4 in
	Eye height	5 ft
	Vertical clearance to obstructions (tunnel height, lighting, etc.).	10 ft
	Approximate center of gravity	2 ft 9 in to 3 ft 4 in
Recumbent Bicyclist	Physical length	7 ft
	Eye height	3 ft 10 in
Tandem Bicyclist	Physical length	8 ft
Bicyclist with child trailer	Physical length	10 ft
	Physical width	2 ft 6 in
Hand Bicyclist	Eye height	2 ft 10 in
Inline Skater	Operating width (sweep width)	5 ft

F.3.2 Design Speed

The speed that various types of bicyclists can be expected to maintain under various conditions can also have influence over the design of facilities such as shared use paths. **Table F-2** provides typical speeds of various types of bicyclists for a variety of conditions.

Table F-2: Bicycle as Design Vehicle – Design Speed Expectations

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

F.3.3 Types of Cyclists

The skill level of the cyclist also provides a dramatic variance on expected speeds and expected behavior. There are several systems of classification currently in use within the bicycle planning and engineering professions. These classifications can be helpful in understanding the characteristics and infrastructure preferences of different cyclists. However, it should be noted that these classifications may change in type or proportion over time as infrastructure and culture evolve. Often times an instructional course can instantly change a less confident cyclist to one that can comfortably and safely share the roadway with vehicular traffic. Bicycle infrastructure should be planned and designed to accommodate as many user types as possible with separate or parallel facilities considered to provide a comfortable experience for the greatest number of cyclists.

A classification system that is currently in use in the Pacific Northwest and also under consideration for the Draft 2009 AASHTO *Guide for the Development of Bicycle Facilities* provides the following bicycle user types:

- **Strong and Fearless** (Very low percentage of population) – Characterized by bicyclists that will typically ride anywhere regardless of roadway conditions or weather. These bicyclists can ride faster than other user types, prefer direct routes and will typically choose roadway connections, even if shared with vehicles, over separate bicycle facilities such as class I pathways.
- **Enthused & Confident** (5-10% of population) – This user group encompasses the 'intermediate' cyclists who are mostly comfortable riding on all types of bicycle facilities but will usually prefer low traffic streets or class I pathways when available. These cyclists may deviate from a more direct route in favor of a preferred facility type. This group includes all kinds of cyclists including commuters, recreationalists, racers, and utilitarian cyclists.
- **Interested But Concerned** (approximately 60% of population) – This user type makes up the bulk of the cycling population and represents cyclists who typically only ride a bicycle on low traffic streets or class I pathways under favorable conditions and weather. These cyclists perceive significant barriers towards increased use of cycling with regards to traffic and safety. These cyclists may become "Enthused & Confident" with encouragement, education and experience.
- **No Way, No How** (approximately 30% of population) – Persons in this category are not cyclists, and perceive severe safety issues with riding in traffic. Some people in this group may eventually give

cycling a second look and may progress to the user types above. A significant portion of these people will never ride a bicycle under any circumstances.

F.4 Routine Accommodation of Bicyclists (Complete Streets)

Bicyclists have legal access to all County streets. While this Plan identifies a specific subset of streets to be designated as bikeways, many bicyclists will need to use other streets to reach their destinations. Therefore, it is important that all roadways be designed to accommodate bicyclists. The California Complete Streets Act of 2008 (AB 1358) mandates that cities and counties plan for all users of roadways.

> *"Commencing January 1, 2011, upon any substantive revision of the circulation element, the legislative body shall modify the circulation element to plan for a balanced, multimodal transportation network that meets the needs of all users of streets, roads, and highways for safe and convenient travel in a manner that is suitable to the rural, suburban, or urban context of the general plan....*
>
> *For purposes of this paragraph, "users of streets, roads, and highways" means bicyclists, children, persons with disabilities, motorists, movers of commercial goods, pedestrians, users of public transportation, and seniors."*

An engineering study, accounting for various site-specific factors including traffic speeds, parking turnover, bus and truck volumes, will determine whether it is safe to use "absolute minimum" travel and turn lane widths in order to accommodate bike lanes.

Figure F-3 through **Figure F-8** illustrate potential ways to configure roadways in order to enhance bicycle access. For roads without curb and gutter, the minimum bike lane width allowed in the Caltrans Highway Design Manual is four feet. The cross-sections shown below are not intended to be standards; they are merely illustrations how bikeways may be included on County roadways.

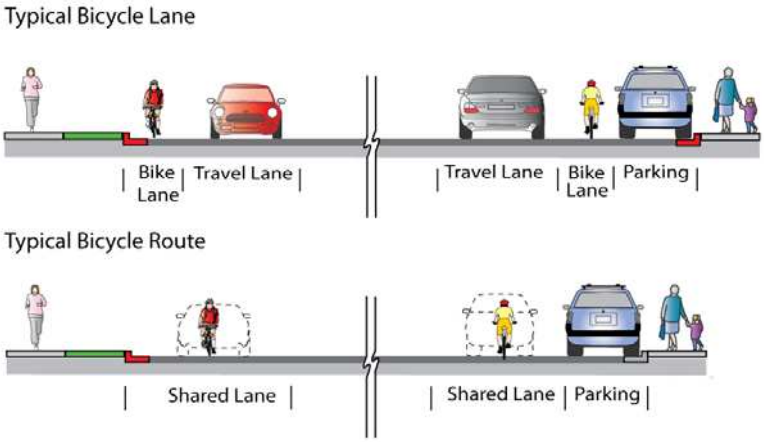
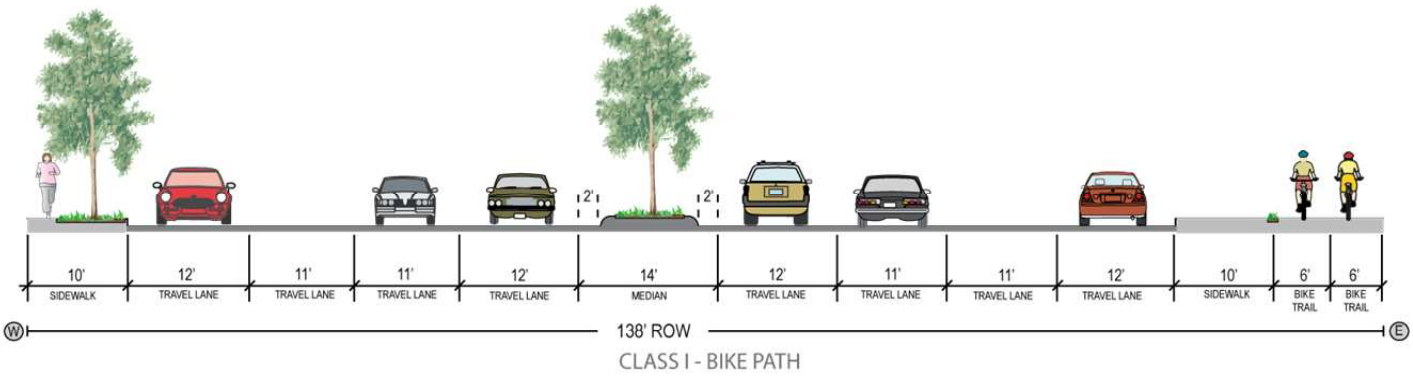


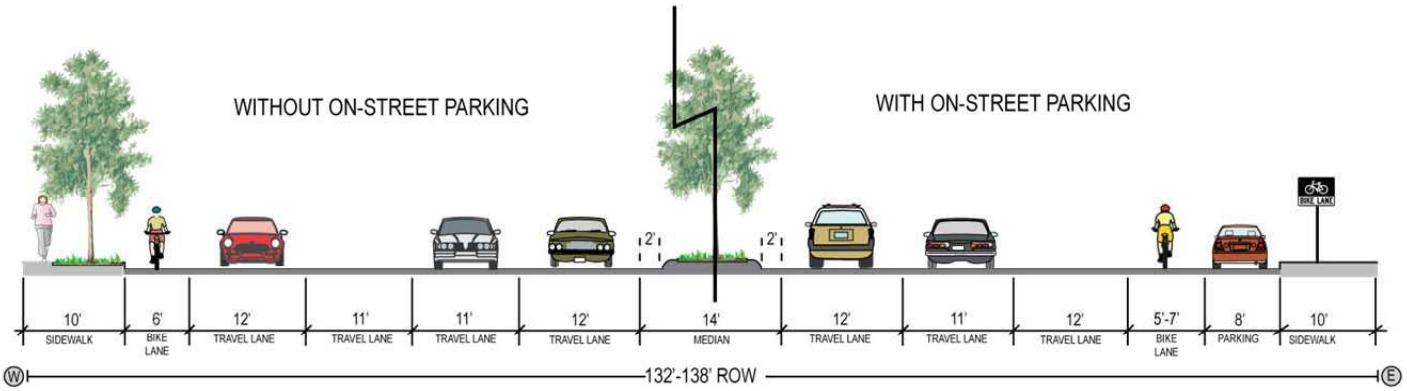
Figure F-3: Typical bicycle lane and bicycle route accommodation with and without on street parking

1 MAJOR HIGHWAY

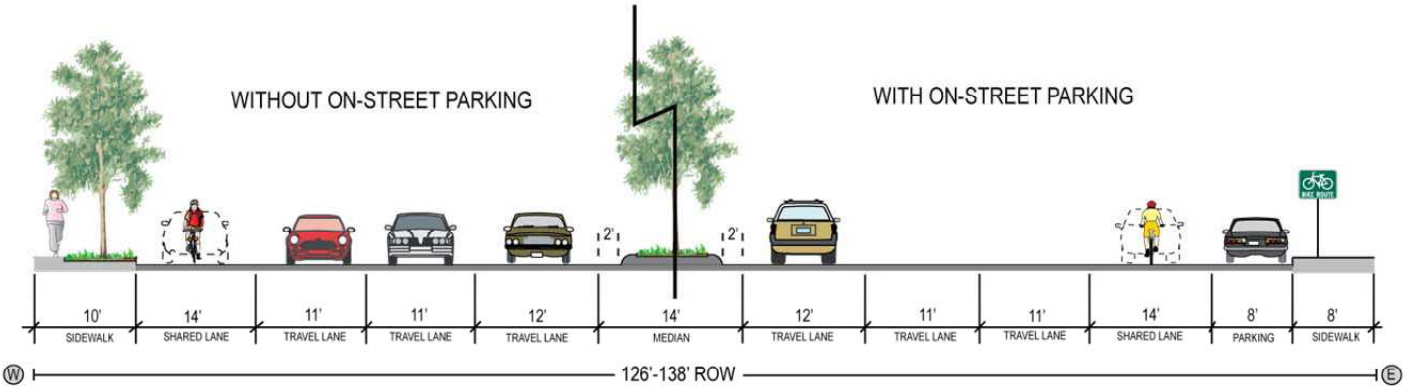
FOUR LANES IN EACH DIRECTION WITH RAISED LANDSCAPE MEDIAN



CLASS I - BIKE PATH



CLASS iI - BIKE LANE



CLASS III - BIKE ROUTE

Figure F-4: Major Highway with four traffic lanes, ROW ≥100'

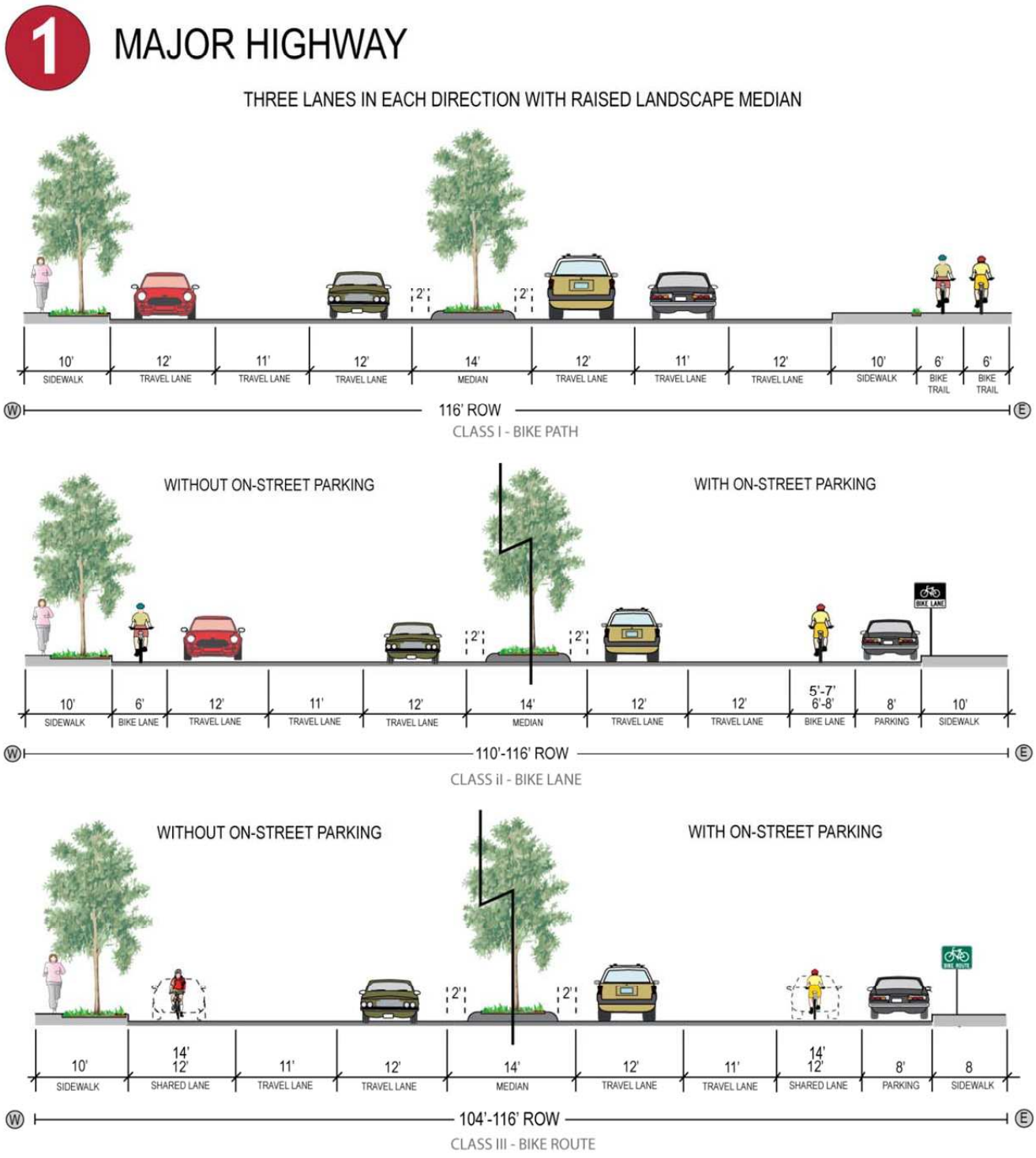


Figure F-5: Major Highway with three traffic lanes, ROW ≥100'

2 SECONDARY HIGHWAYS

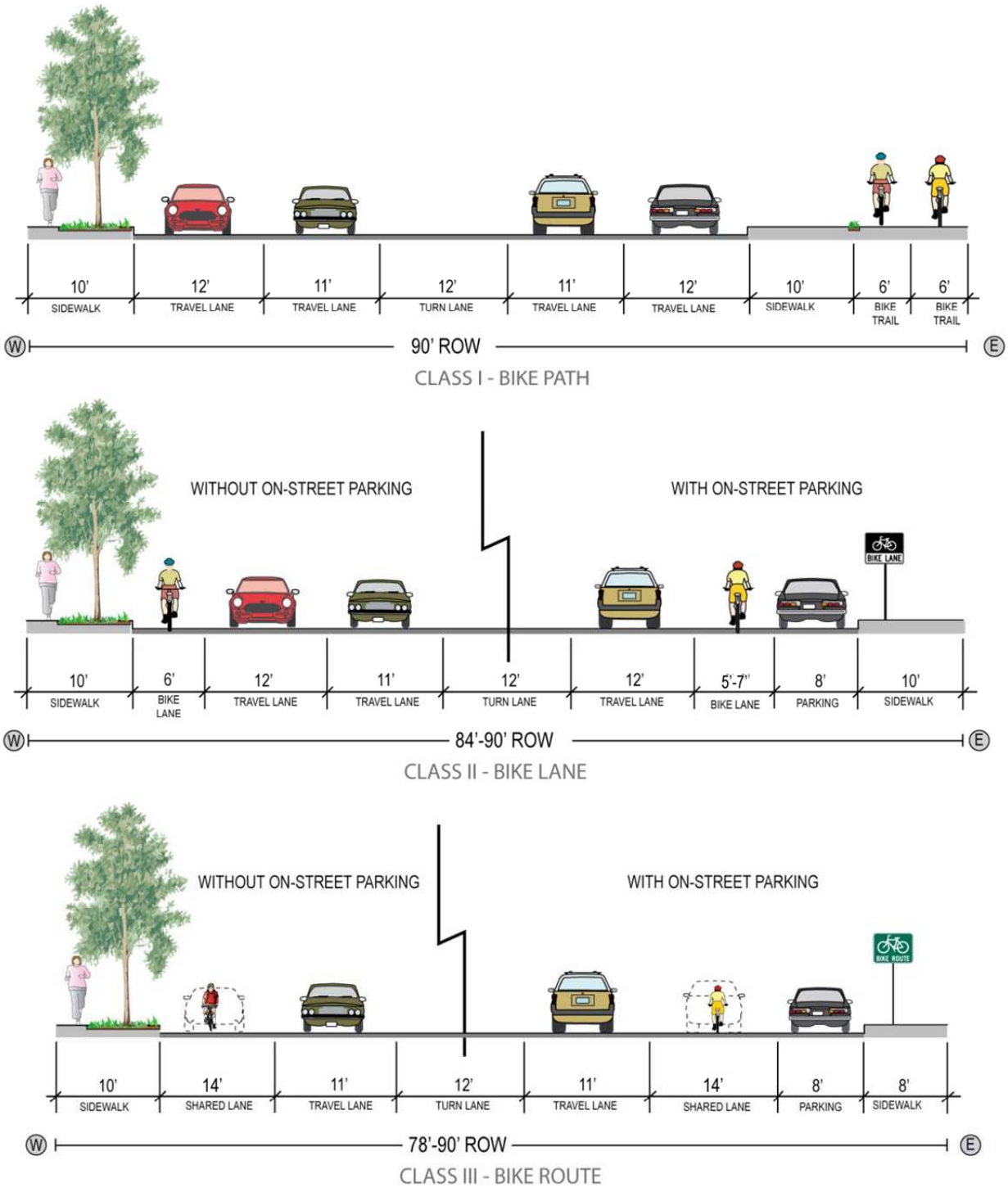


Figure F-6: Secondary Highway ROW 80'-90'

3 LIMITED SECONDARY HIGHWAY

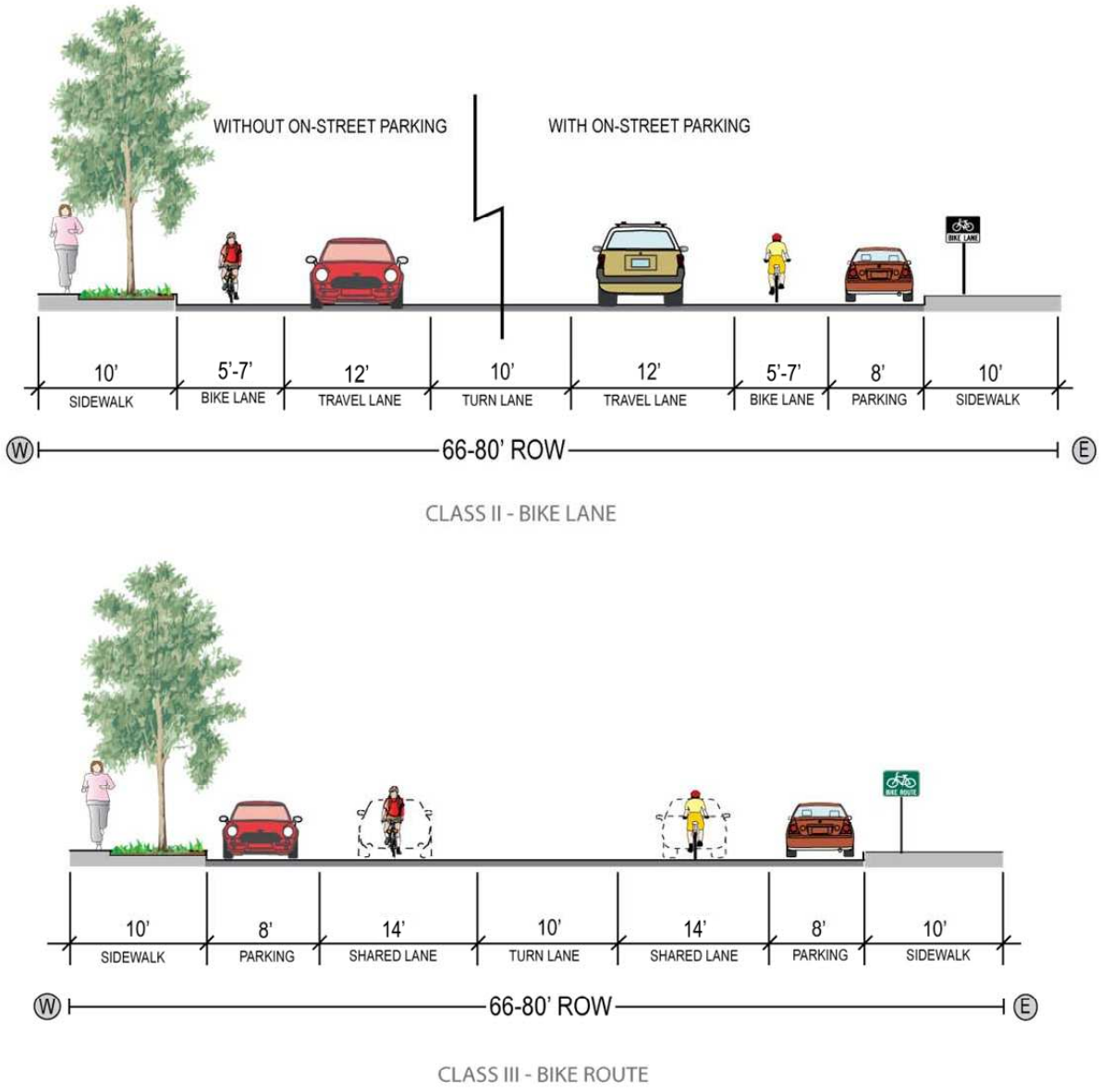


Figure F-7: Limited Secondary Highway ROW 66'-79'

4 LOCAL STREET

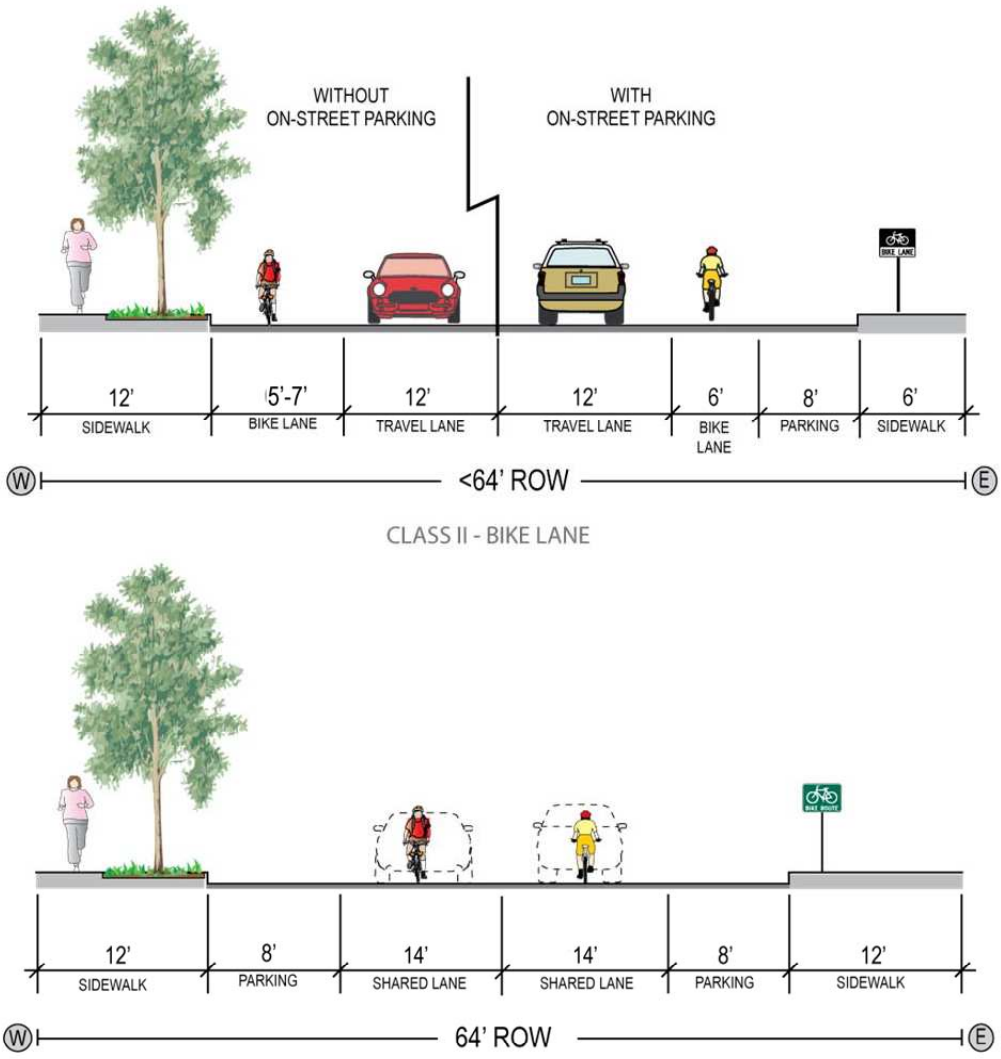


Figure F-8: Local street ROW <64'

F.5 Design Toolbox

F.5.1 Class I Bikeway

Bike Path (Class I Bikeway) Design Guidelines

A Class I facility allows for two-way, off-street bicycle and pedestrian traffic and also may be used by pedestrians, skaters, wheelchair users, and other non-motorized users. These facilities are frequently found in parks, along rivers, and in greenbelts or utility corridors where there are few conflicts with motorized vehicles. Class I facilities can also include amenities such as lighting, signage, and fencing (where appropriate). In California, design of Class I facilities is dictated by Chapter 1000 of the Highway Design Manual. Class I facilities can provide a desirable facility particularly for novice riders, recreational trips, and cyclists of all skill levels preferring separation from traffic. Class I bikeways should generally provide new travel opportunities.

Class I facilities 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.

Class I Bikeways (also referred to as "bike trails" or "paths") are often viewed as recreational facilities, but they are also important corridors for utilitarian trips.

Elements that enhance Class I bikeway design include:

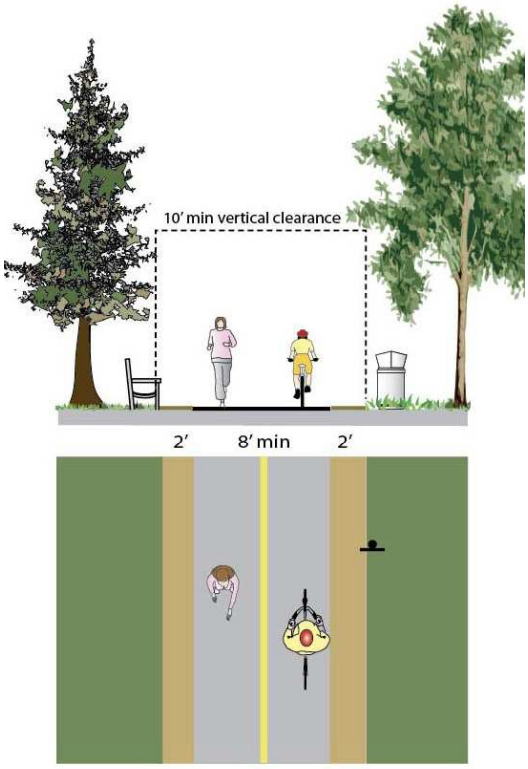
- Providing frequent access points from the local road network; if access points are spaced too far apart, users will have to travel out of direction to enter or exit the path, which will discourage use
- Placing directional signs to direct users to and from the path
- Building to a standard high enough to allow heavy maintenance equipment to use the path without damage
- 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 paths and pedestrian walkways should be provided to reduce conflicts
- Providing accessible parking space(s) at trailheads and access points
- Limiting the number of at-grade crossings with streets or driveways

Bike Path (Class I Bikeway) Design Guidelines (continued)

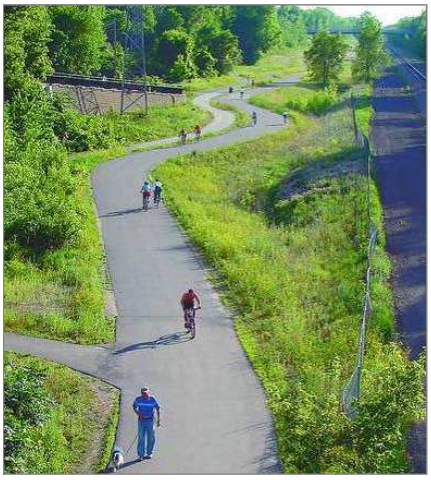
A hard surface should be used for Class I bikeways. Concrete, while more expensive than asphalt, is the hardest of all surfaces and lasts the longest. Dyes, such as reddish pigments, can be added to concrete to increase the aesthetic value of the facility itself. When concrete is used the Class I bikeway should be designed and installed using the narrowest possible expansion joints to minimize the amount of 'bumping' cyclists experience on the facility.
Where possible, Class I bikeways should be designed according to ADA standards. Topographic, environmental, or space constraints may 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.

Design Considerations

- Width standards:
  - 8′ is the minimum allowed for a two-way bikeway and is only recommended for low traffic situations
  - 10′ is recommended in most situations and will be adequate for moderate to heavy use
  - 12′ is recommended for heavy use situations with high concentrations of multiple users such as joggers, bicyclists, rollerbladers, and pedestrians
- Lateral Clearance: 2′ minimum or 3′ preferred shoulder on both sides (required by Caltrans' HDM, Chapter 1000)
- Overhead Clearance: 8′ minimum, 10′ recommended to accommodate first responders such as fire trucks or ambulance
- Minimum design speed: 25 mph. Speed bumps or other surface irregularities should never be used to slow bicycles
- Recommended maximum grade: 5%. Steeper grades can be tolerated for short distances (see guidelines following)
- Loading: AASHTO H-20. Heavy duty traffic load requirement



Recommended Class I Bikeway design.



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

Reference

California Highway Design Manual Chapter 1000
AASHTO Guide for the Development of Bicycle Facilities
U.S. Access Board, Public Rights-of-Way Accessibility Guidelines (PROWAG).
FHWA. Designing Sidewalks and Trails for Access.

Class I Bikeway: Along Utility Corridors/Waterway Corridors

Several utility and waterway corridors in Los Angeles offer excellent Class I bikeway and bikeway gap closure opportunities. Utility corridors typically include power line and sewer corridors, while waterway corridors include canals, drainage ditches, rivers, and beaches. Class I bikeway development along these corridors already exists in the Los Angeles area (e.g., along the Los Angeles and San Gabriel rivers). The LARMP Landscape Guidelines (2004) require service road access on both sides of the river and wash, which is compatible with bicycle path use.

Access Points

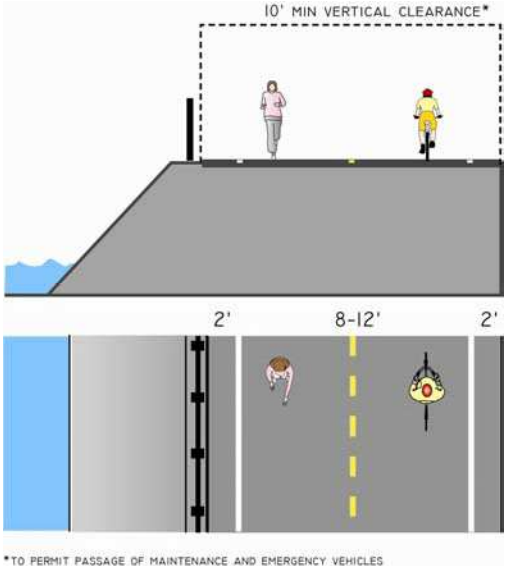
Any access point to the bikeway should be well-defined with appropriate signage designating the pathway as a bicycle facility and prohibiting motor vehicles. Removable bollards can prevent motorized access while preserving maintenance access to authorized vehicles (see bollards section for additional guidance). A gate that can prevent any access to the facility should also be present in case of path closure, to prevent public access to the bike path during maintenance activities or flooding. Advanced warning signs with detour information for path closures should be posted 14 days prior to planned closure. Signs should be posted at the closed access point and at the two adjacent access points in either direction.

Fencing

Public access to flood control channels or canals is undesirable for public safety. Hazardous materials, deep water or swift current, steep, slippery slopes, and debris are all potential hazards. Fencing can help keep path users within the designated travel way. The County of Los Angeles requires a 5′ minimum height fences or railings to retain bicyclists. Fencing on the channel side should be constructed out of metal such as chain link or wrought iron, and allow a view down to the channel. Fencing on the non-channel side can take several forms. Bike path owners should consider constructing a masonry wall if the path is adjacent to high-security land-uses. Visually permeable fencing is acceptable for non-sensitive areas, with fence types including chain link or wrought iron in urban areas, to picket, split rail, or post and cable fencing in rural areas.

Landscaping

The Los Angeles and San Gabriel River Watershed Councils provide guidelines for sustainable re-vegetation of public right-of-way. Landscaping along bikeways within river corridors will conform to the Los Angeles River Master Plan Landscaping Guidelines and Plant Palettes and standards established by relevant Los Angeles County River Master Plans.



Recommended design for bikeways in flood control channels.

Flood control channels are a good opportunity to develop a continuous off-street pathway.

Gate at access point to San Gabriel River Bikeway.

Class I Bikeway: Along Utility Corridors/Waterway Corridors (continued)

Ownership and Liability

Owners of Bike Paths shall fund landscaping and landscaping maintenance at their cost. Bike paths and landscaping shall be non-invasive and compatible with existing and future flood control and maintenance uses. Operators of bike paths shall indemnify the Los Angeles County Flood Control District (LACFCD) for liability associated with bike paths within LACFCD right-of-way. Operators of bike paths shall assume all responsibility for opening and closing access points.

Design Considerations

- Meet or exceed Caltrans standards
- Use permeable surfacing where possible; where asphalt is required, grade towards infiltration strips
- Meet ADA standards to the maximum extent feasible
- 12' minimum vertical clearance to permit passage of maintenance and emergency vehicles
- Operators of bike paths shall indemnify the Los Angeles County Flood Control District (LACFCD) for liability associated with Bike Paths usage within LACFCD right-of-way
- Operators of bike paths are to fund landscaping and landscaping maintenance at their cost.
- Bike path landscaping is to be non-invasive. The plant palette in the LA River Master Plan is a good source for selecting low maintenance California Native Plants that are well suited to the environment
- Bike paths and landscaping along rivers and channels are to be compatible with existing and future flood control and maintenance uses
- Operators of Bike paths are to assume all responsibility for opening and closing access points

Reference

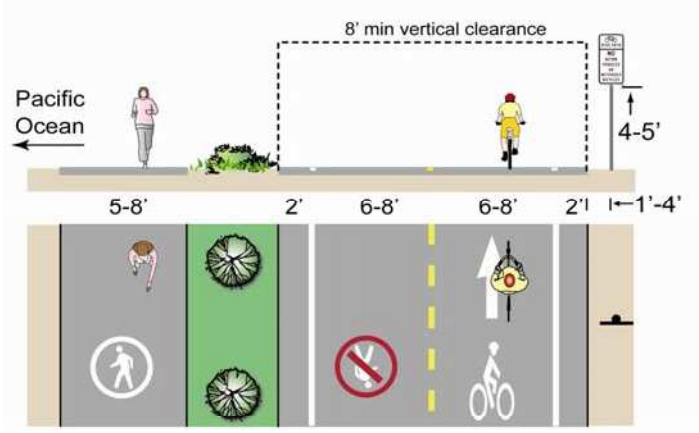
- AASHTO Guide for the Development of Bicycle Facilities
- California Highway Design Manual Chapter 1000
- LARMP Landscape Guidelines (2004)

Class I Bikeway: Coastal Paths

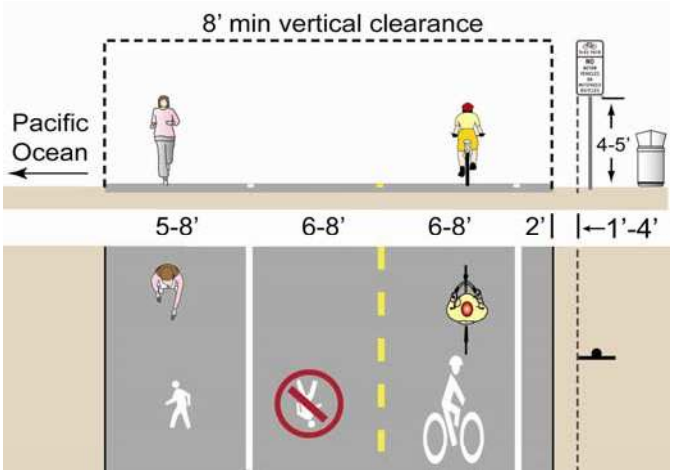
Coastal Paths attract many types of pathway users and conveyances. Bicyclists, pedestrians, rollerbladers, strollers, and pedal cabs typically compete for space. To provide an adequate and pleasant facility, adequate widths and separation are needed to maintain a good pathway environment.

Offsetting of the pedestrian path should be provided if possible. Otherwise, physical separation should be provided in the form of striping or landscaping.

The multi-use path should be located on whichever side of the path will result in the fewest number of anticipated pedestrian crossings. For example, the multi-use path should not be placed adjacent to large numbers of destinations. Site analysis of each project is required to determine expected pedestrian behavior.



Preferred design, with separation.



Preferred design, no separation.

Design Considerations

- Preferred Width: 17 feet
- Multi-use path: 12 feet minimum; 17 feet with parallel 5 foot pedestrian path, with 1 foot clearance for signage
- Pavement Markings: Facility should have graphic markings for non-English speakers
- Striping: Dashed centerline and shoulder striping should be used
- Surfacing: Paved surface adequate to support maintenance vehicles. Required thickness dependent upon paving material and subgrade

Reference

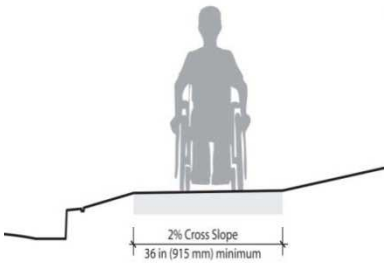
- California MUTCD
- Caltrans Highway Design Manual (Chapter 1000)
- AASHTO Guide for the Development of Bicycle Facilities

Class I Bikeway: Accessibility

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

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

The surface shall be firm and stable. The Forest Service Accessibility Guidelines defines a firm surface as one 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, Class I bikeways can be made more accessible by creating side paths that meander away from a roadway that exceeds a 5% slope.



ADA clearance requirement.

Class I bikeways surfacing materials affects which types of users can benefit from the facility.

Design Considerations

3 foot minimum clear width where clear width of facility is less than 5 feet; passing space (5 foot section or wider) should be provided at least every 100 feet

Cross slope should not exceed 5%

Signs shall be provided indicating the length of the accessible trail segment

Ramps should be provided at roadway crossings. Tactile warning strips and auditory crossing signals are recommended.

FHWA recommends that when trails intersect roads, the design of trail curb ramps should, as a minimum, follow the recommendations provided in Chapter 7: Curb Ramps (FHWA *Designing Sidewalks and Trails for Access;*
www.fhwa.dot.gov/environment/sidewalk2/sidewalks207.htm

Reference

- American with Disabilities Act (ADA) for accessible trails
- See also FHWA. (2001).Designing Sidewalks and Trails for Access, Chapter 14: Shared Use Path Design, Section 14.5.1: Gradewww.fhwa.dot.gov/environment/sidewalk2/sidewalks212.htm#tra2

Class I Bikeway: Managing Multiple Users

On Class I bikeways that have high bicycle and pedestrian use, conflicts can arise between faster-moving bicyclists and slower bicyclists, as well as pedestrians and other users. As this is a common problem in more urban areas, a variety of treatments have been designed to alleviate congestion and minimize conflicts.

Centerline Striping

On trails of standards widths, striping the centerline identifies which side of the trail users should be on.

Trail Etiquette Signage

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.

Centerline striping and directional arrows encourage trail users to provide space for other users to pass.

Design Considerations

- Barrier separation – vegetated buffers or barriers, elevation changes, walls, fences, railings and bollards
- Distance separation – differing surfaces
- User behavior guidance signage

Reference

- The 2009 CA-MUTCD Section 9C.03 contains additional information about centerline striping on a trail

Class I Bikeway: Roadway Crossings

While at-grade crossings create a potentially high level of conflict between Class I bikeway 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 crossings involves analysis of vehicular and anticipated path user traffic patterns, including

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

Consideration must be given for adequate warning distance based on vehicle speeds and line of sight. Visibility of any signing used to mark the crossing is 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 Class I bikeway users must include a standard "STOP" sign and pavement marking, sometimes combined with other features such as a kink in the pathway to slow bicyclists.

Design Considerations

At-grade Class I bikeway/roadway crossings that provide assistance for cyclists and pedestrians crossing the roadway generally will fit into one of four basic categories:

- Type 1: Marked/Unsignalized - Uncontrolled 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.

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

Reference

- California Highway Design Manual Chapter 1000
- AASHTO Guide for the Development of Bicycle Facilities
- Federal Highway Administration (FHWA) Report, Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations

Class I Bikeway: Roadway Crossings (continued)

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

Roadway Type	Vehicle ADT ≤ 9,00			Vehicle ADT > 9,000 to 12,000			Vehicle ADT >12,000 to 15,000			Vehicle ADT > 15,000		
	Speed Limit (mph)**											
	30	35	40	30	35	40	30	35	40	30	35	40
2 Lanes	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+/3	1	1+	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 mph 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. Los Angeles County prefers a 14 ft wide raised median, although a 12 ft wide median without a median nose could be used.*

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 2 or 5 (depending on school presence) and EAU factoring. 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.

[iv] *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.*

Class I Bikeway: Marked/Unsignalized Crossings

If well-designed, multi-lane crossings of higher-volume arterials of 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 75 millimeters 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.

Design Considerations

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.

Maximum traffic 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

Type 1 crossings include signage and pavement markings.

Reference

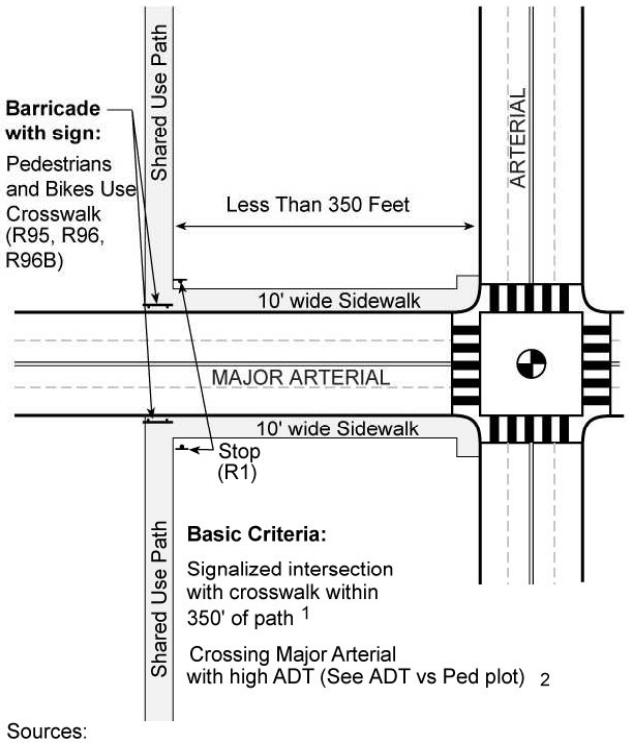
- California *Highway Design Manual* Chapter 1000
- AASHTO Guide for the Development of Bicycle Facilities
- Federal Highway Administration (FHWA) Report, Safety Effects of Marked vs. Unmarked Crosswalks at Uncontrolled Locations

Class I Bikeway: Route Users to Existing Signalized Intersection

Crossings within 350 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.

Design Considerations

- A Class I bikeway should cross at a signalized intersection if there is a signalized intersection within 350 feet of the path and the crossroad is crossing a major arterial with a high ADT.
- Intersection Warning (W2-1 through W2-5) signs may be used on a path in advance of the intersection to indicate the presence of the crossing and the possibility of turning or entering traffic. A trail-sized stop sign (R1-1) should be placed about 5 feet before the intersection.



Sources:
1. California MUTCD, 2006
2. Investigation of Exposure Based Accident Areas: Crosswalks, Local Street, and Arterials, Knoblauch, 1987

Recommended at-grade crossing of a major arterial at an intersection where trail is within 350′ of a roadway intersection

Reference

- Caltrans *Highway Design Manual* (Chapter 1000)
- *California MUTCD*, Part 9
- AASHTO *Guide for the Development of Bicycle Facilities*
- AASHTO *Policy on the Geometric Design of Highways and Streets*
- FHWA-RD-87-038 *Investigation of Exposure-Based Pedestrian Accident Areas: Crosswalks, Sidewalks, Local Streets, and Major Arterials*

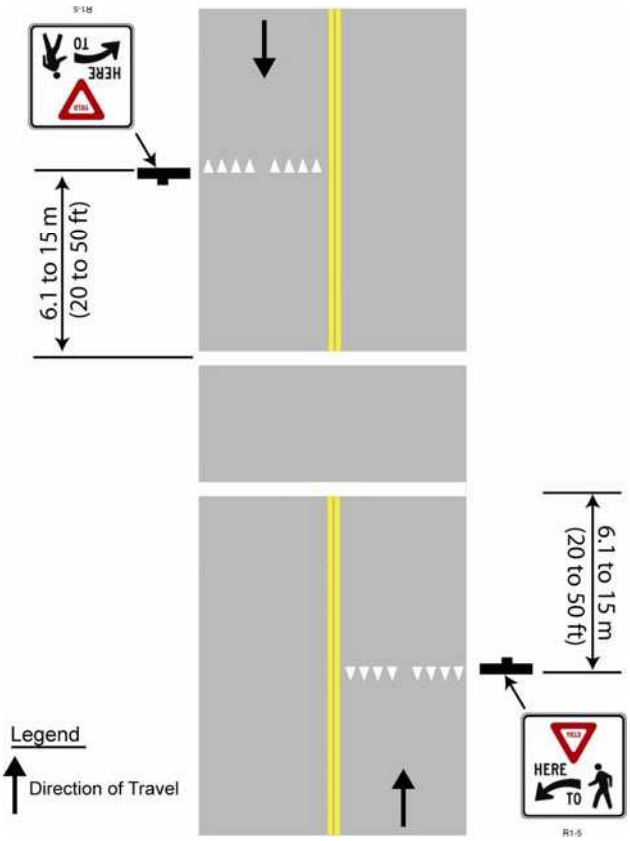
Class I Bikeway: Uncontrolled Mid-Block Crossing

The National MUTCD requires yield lines and "Yield Here to Pedestrians" signs at all uncontrolled crossings of a multi-lane roadway. Yield lines are not required by the CA MUTCD. The National MUTCD includes a trail crossing sign, shown to the right on the next page (W11-15 and W11-15P), which may be used where both bicyclists and pedestrians might be crossing the roadway, such as at an intersection with a shared-use path.

Design Considerations

- Installed where there is a significant demand for crossing and no nearby existing crosswalks
- If yield lines are used for vehicles, they shall be placed 20–50 feet in advance of the nearest crosswalk line to indicate the point at which the yield is intended or required to be made and "Yield Here to Pedestrians" signs shall be placed adjacent to the yield line. Where traffic is not heavy, stop or yield signs for pedestrians and bicyclists may suffice.
- The Bicycle Warning (W11-1) sign alerts the road user to unexpected entries into the roadway by bicyclists, and other crossing activities that might cause conflicts

A ladder crosswalk should be used. Warning markings on the path and roadway should be installed.



Recommended design from CA-MUTCD, Figure 3B-15.

Reference

- California MUTCD, Part 9
- AASHTO Guide for the Development of Bicycle Facilities

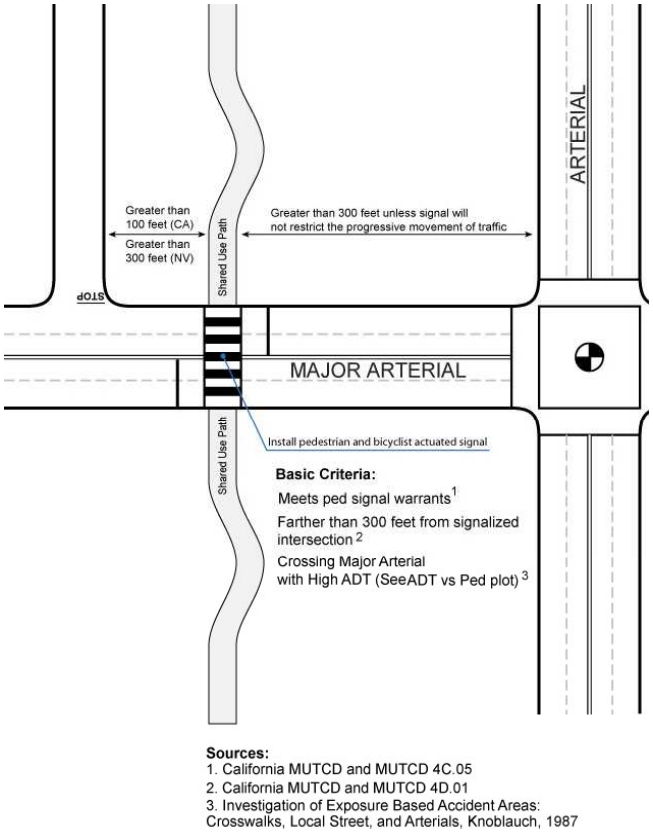
Recommended signage.

Class I Bikeway: Signalized Mid-Block Crossing

Warrants from the MUTCD combined with sound engineering judgment should be considered when determining the type of traffic control device to be installed at path-roadway intersections. Traffic signals for path-roadway intersections are appropriate under certain circumstances. The MUTCD lists 11 warrants for traffic signals, and although path crossings are not addressed, bicycle traffic on the path may be functionally classified as vehicular traffic and the warrants applied accordingly. Pedestrian volumes can also be used for warrants.

Design Considerations

- Section 4C.05 in the CAMUTCD describes pedestrian volume minimum requirements (referred to as warrants) for a mid-block pedestrian-actuated signal
- Stop lines at midblock signalized locations should be placed at least 40 feet in advance of the nearest signal indication



CA-MUTCD guidance for a signalized mid-block crossing.

Reference

- MUTCD, Sections 4C.05 and 4D
- California MUTCD, Chapters 3 and 9 and Section 4C.05 and 4D
- AASHTO Guide for the Development of Bicycle Facilities, Chapter 2

Class I Bikeway: Grade Separated Undercrossing

Undercrossings should be considered when high volumes of bicycles and pedestrians are expected along a corridor and:

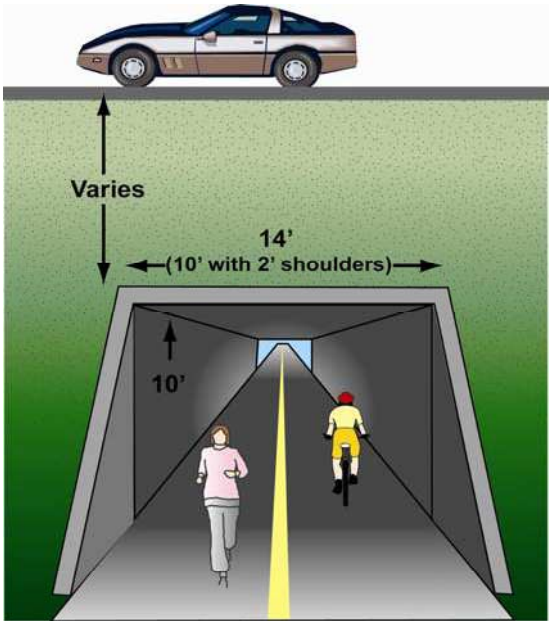
- Vehicle volumes/speeds are high
- The roadway is wide
- A signal is not feasible
- Crossing is needed under another grade-separated facility such as a freeway or rail line

Advantages of grade separated undercrossings include:

- Improves bicycle and pedestrian safety while reducing delay for all users
- Eliminates barriers to bicyclists and pedestrians
- Undercrossings require 10 feet of overhead clearance from the path surface. Undercrossings often require less ramping and elevation change for the user versus an overcrossing, particularly for railroad crossings.

Disadvantages or potential hazards include:

- If crossing is not convenient or does not serve a direct connection it may not be well utilized
- Potential issues with vandalism and maintenance
- Security may be an issue if sight lines through undercrossing and approaches are inadequate. Lighting or openings for sunlight may be desirable for longer crossings to enhance users' sense of security, especially at tunnels and underpasses under freeways and major highways. Lighting should follow Caltrans-accepted lighting design guidelines.
- High cost



Recommended undercrossing design.

Undercrossings provide key connections and allow path users to avoid a potentially dangerous at-grade crossing of a major street.

Design Considerations

- 14' minimum width to allow for access by maintenance vehicles if necessary
- 10' minimum overhead height (AASHTO)
- The undercrossing should have a centerline stripe even if the rest of the path does not have one

Reference

- Caltrans *Highway Design Manual* (Chapter 1000)
- ASHTO *Guide for the Development of Bicycle Facilities*

Class I Bikeway: Grade Separated Overcrossing

Overcrossings require a minimum of 17' of vertical clearance to the roadway below versus a minimum elevation differential of around 12' for an undercrossing. This results in potentially greater elevation differences and much longer ramps for bicycles and pedestrians to negotiate.

Overcrossings should be considered when high volumes of bicycles and pedestrians are expected along a corridor and:

- Vehicle volumes/speeds are high
- The roadway is wide
- A signal is not feasible
- Crossing is needed over a grade-separated facility such as a freeway or rail line

Advantages of grade separated overcrossings include:

- Improves bicycle and pedestrian safety while reducing delay for all users
- Eliminates barriers to bicyclists and pedestrians

Disadvantages and potential hazards include:

- If crossing is not convenient or does not serve a direct connection it may not be well utilized
- Overcrossings require at least 17 feet of clearance to the roadway below involving up to 400 feet or greater of approach ramps at each end. Long ramps can sometimes be difficult for the disabled
- Potential issues with vandalism, maintenance
- High cost

Design Considerations

- 12 foot minimum width
- If overcrossing has any scenic vistas additional width should be provided to allow for stopped path users
- A separate 6 foot pedestrian area may be provided in locations with high bicycle and pedestrian use
- Minimum of 17 feet of vertical clearance to the roadway below
- 10 foot headroom on overcrossing
- Clearance below will vary depending on feature being crossed
- The overcrossing should have a centerline stripe even if the rest of the path does not have one.
- Ramp slopes should be ADA-accessible: 5% (1:20) grade with landings at 400-foot intervals, or 8.33% (1:12) with landings every 30 feet

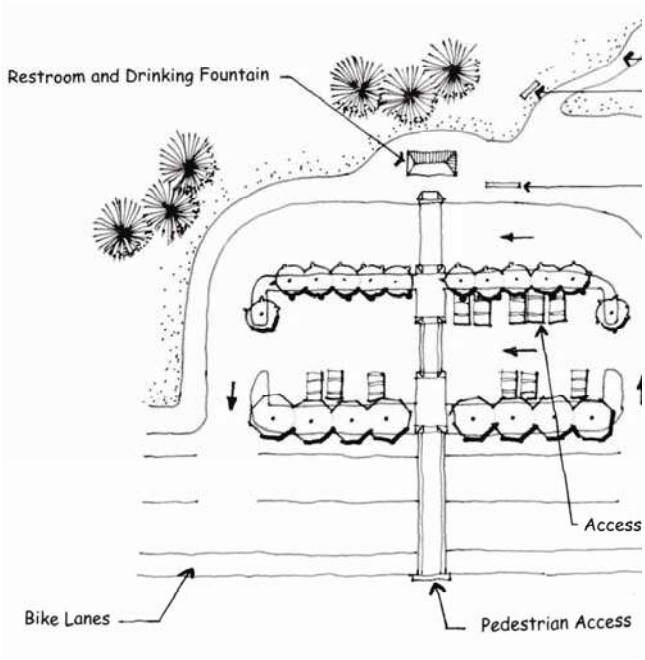
Overcrossings are frequently used over a major roadway.

Reference

- Caltrans *Highway Design Manual* (Chapter 1000)
- AASHTO *Guide for the Development of Bicycle Facilities*

Class I Bike Paths: Trailheads

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. Trailheads with a small parking area should additionally include bicycle parking and accessible parking. Neighborhood access should be achieved from all local streets crossing the trail. In some situations "No Parking" signs on the adjacent streets are desirable to minimize impact on the neighborhood.



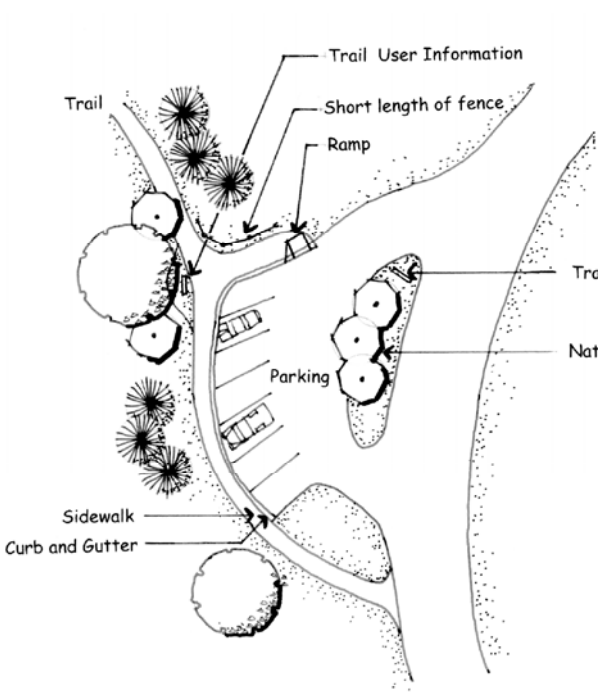
Example major trailhead.

Design Considerations

- 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
- Any trailhead improvements installed within Los Angeles County Flood Control District (LACFCD) right-of-way needs to be operated and maintained by the project sponsor

Reference

- AASHTO Guide for the Development of Bicycle Facilities



Example minor trailhead.

F.5.2 Class II Bikeway

On-Street Facility Design Guidelines

There are a range of different types of bicycle facilities that can be applied in various contexts, which provide varying levels of protection or separation from automobile traffic. This section summarizes best practice on-street bicycle facility design from North America and elsewhere.

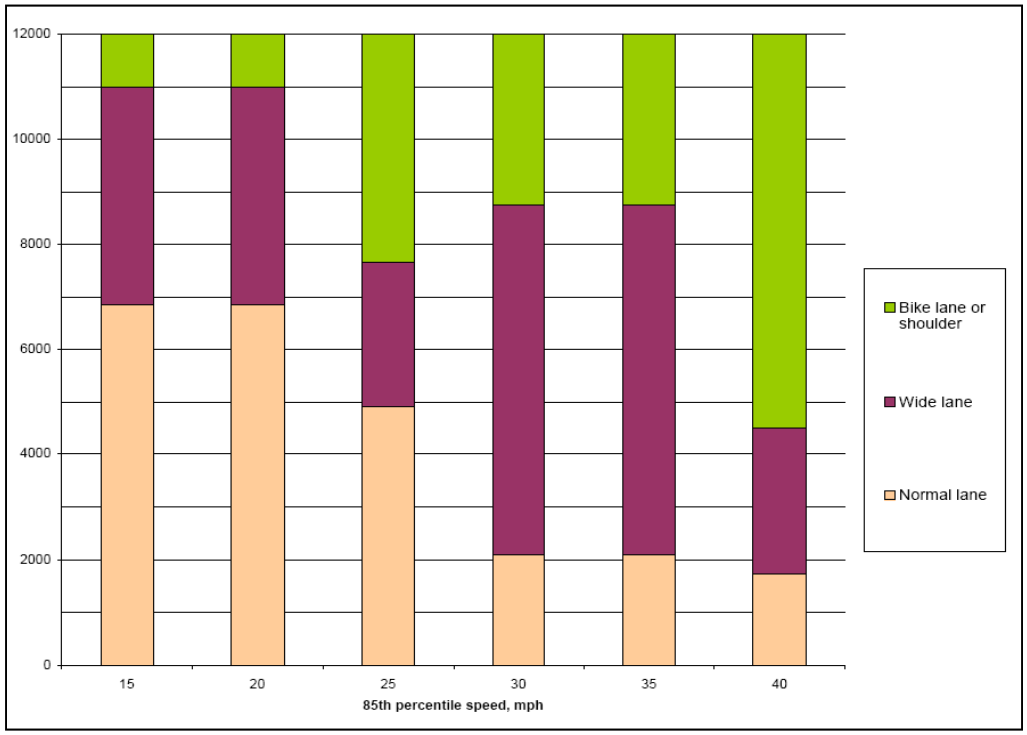
Facility Selection

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 bicycle facilities
- User preference
- Land use/urban or rural context

There are no 'hard and fast' 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 bicycle 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.)

Class II Bikeway

Bike lanes or Class II bicycle facilities (Caltrans designation) are defined as a portion of the roadway that has been designated by striping, signage, and pavement markings for the preferential or exclusive use of bicyclists. Bike lanes are generally found on major arterial and collector roadways and are 5-8 feet wide. Bike lanes can be found in a large variety of configurations, and can have special characteristics including coloring and placement if beneficial.
Bike lanes enable bicyclists to ride at their preferred speed without interference from prevailing traffic conditions and facilitate predictable behavior and movements between bicyclists and motorists. Bicyclists may leave the bike lane to pass other cyclists, make left turns, avoid obstacles or debris, and to avoid other conflicts with other roadway users.

Design Considerations

Width varies depending on roadway configuration, see following pages for design examples. 4-8 feet is standard, measured from edge of gutter pan, although a maximum of 7 feet is recommended to prevent parking or driving in the bike lane.

Striping

- Separating vehicle lane from bike lane (typically left sideline): 6 inches
- Delineate conflict area in intersections (optional): Length of conflict area
- Separating bike lane from parking lane (if applicable): 4 inches
- Dashed white stripe when:
  - Vehicle merging area (optional): Varies
  - Approach to intersections: 100-200 feet
  - Delineate conflict area in intersections (optional): Length of conflict area

Approved R-81 Sign.

Signing: use R81 Bike Lane Sign at:

- Beginning of bike lane
- Far side of all bike path (class I) crossings
- At approaches and at far side of all arterial crossings
- At major changes in direction
- At intervals not to exceed ½ mile

Pavement markings: the preferred pavement marking for bike lanes is the bike lane stencil with directional arrow to be used at:

- Beginning of bike lane
- Far side of all bike path (class I) crossings
- At approaches and at far side of all arterial crossings
- At major changes in direction
- At intervals not to exceed ½ mile
- At beginning and end of bike lane pockets at approach to intersection

Approved California bike lane stencils (either is optional, as is arrow).

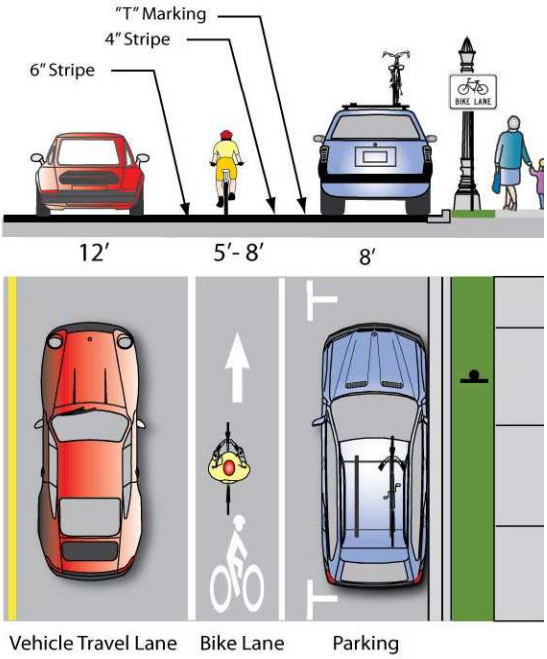
Reference

- Caltrans *Highway Design Manual* (Chapter 1000)
- *California MUTCD*
- AASHTO *Guide for the Development of Bicycle Facilities*
- Additional standards and treatments for bike lanes are provided in the following pages

Class II Bikeway: Bike Lane Adjacent to On-Street Parallel Parking

Bike lanes adjacent to on-street parallel parking are common in the U.S. and can be dangerous for bicyclists if they do not provide adequate separation from parked cars. 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. Treatments to encourage bicyclists to ride away from the 'door zone' include:

- Provide a buffer zone (preferred design). 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.
- Installing parking "T's" and smaller bike lane stencils placed to the left.



Parking 'T' bike lane design.

Design Considerations

Bike Lane Width:

- 6 feet recommended when parking stalls are marked
- 5 feet minimum in constrained locations
- 8 feet maximum (greater widths may encourage vehicle loading in bike lane)

Shared bike and parking lane width:

- 13-14 feet for a shared bike/parking lane where parking is permitted but not marked on streets without curbs
- If the parking volume is substantial or turnover is high, an additional 1-2 feet of width is desirable

Reference

- Caltrans *Highway Design Manual* (Chapter 1000)
- California *MUTCD*
- AASHTO *Guide for the Development of Bicycle Facilities*

Class II Bikeway: Bike Lanes on Streets Without Parking

Wider bike lanes are desirable in certain circumstances such as on higher speed arterials (45 mph+) 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 6-7 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.

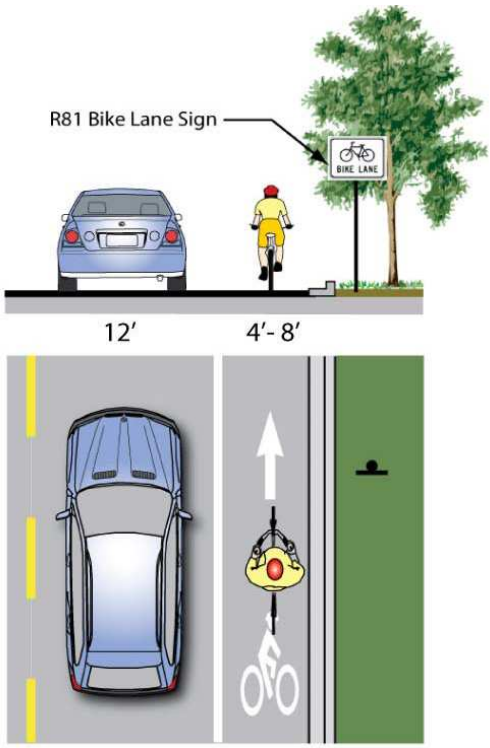
Design Considerations

Bike lane width:

- 4 foot minimum when no curb & gutter is present, 6 foot preferred (rural road sections). Parking may be allowed on the adjacent shoulder.
- 7 feet preferred when adjacent to curb and gutter (5′ more than the gutter pan width if the gutter pan is wider than 2′).
- 6 feet recommended where right-of-way allows.

Maximum width:

- 7 feet Adjacent to arterials with high travel speeds (45 mph+) and widen curb lanes by 2 feet.



Where on-street parking is not allowed adjacent to a bike lane, bicyclists do not require additional space to avoid opened car doors.

Reference

- Caltrans *Highway Design Manual* (Chapter 1000)
- *California MUTCD*
- *AASHTO Guide for the Development of Bicycle Facilities*

Class II Bikeway: Retrofitting Existing Streets, Roadway Widening

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.

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

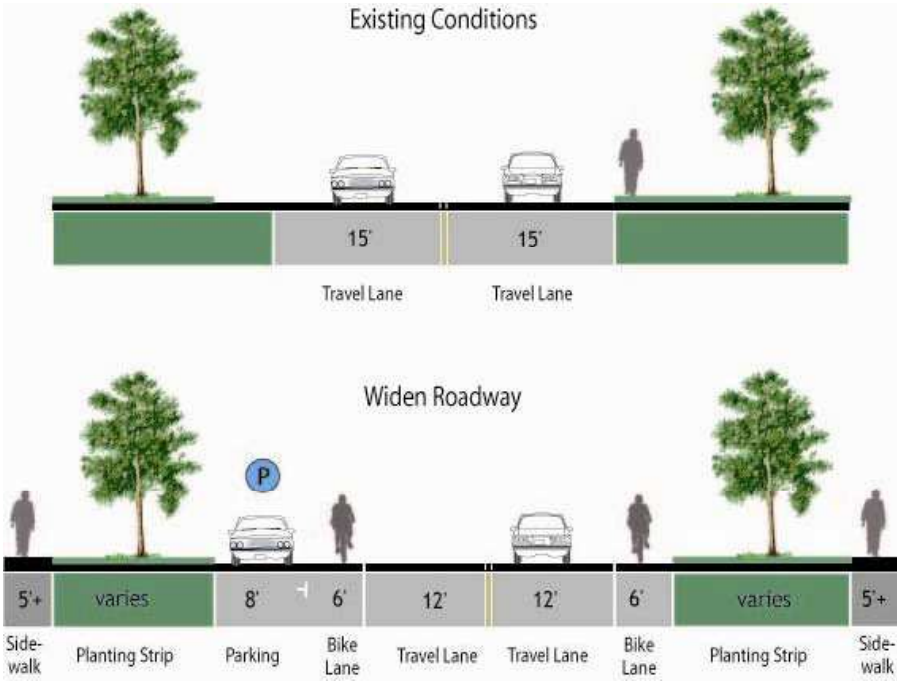
Design Considerations

Bike lane width:

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

Reference

- Caltrans *Highway Design Manual* (Chapter 1000)
- AASHTO *Guide for the Development of Bicycle Facilities*
- Rosales, Jennifer. (2006). *Road Diet Handbook: Setting Trends for Livable Streets*



Example of roadway widening to accommodate bike lanes and sidewalks.

Class II Bikeway: Retrofitting Existing Streets, Lane Narrowing

Lane narrowing utilizes roadway space that exceeds minimum standards to create the needed space to provide bicycle lanes. Many roadways have lanes that are wider than currently established minimums contained in the AASHTO *Policy on the Geometric Design of Highways and Streets* and the Caltrans HCM. Most standards allow for the use of 11' and sometimes 10' travel lanes. Lane widths can be narrowed on a case by case basis to connect to bikeways in neighboring jurisdictions.

Special considerations 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 bicycle lanes.

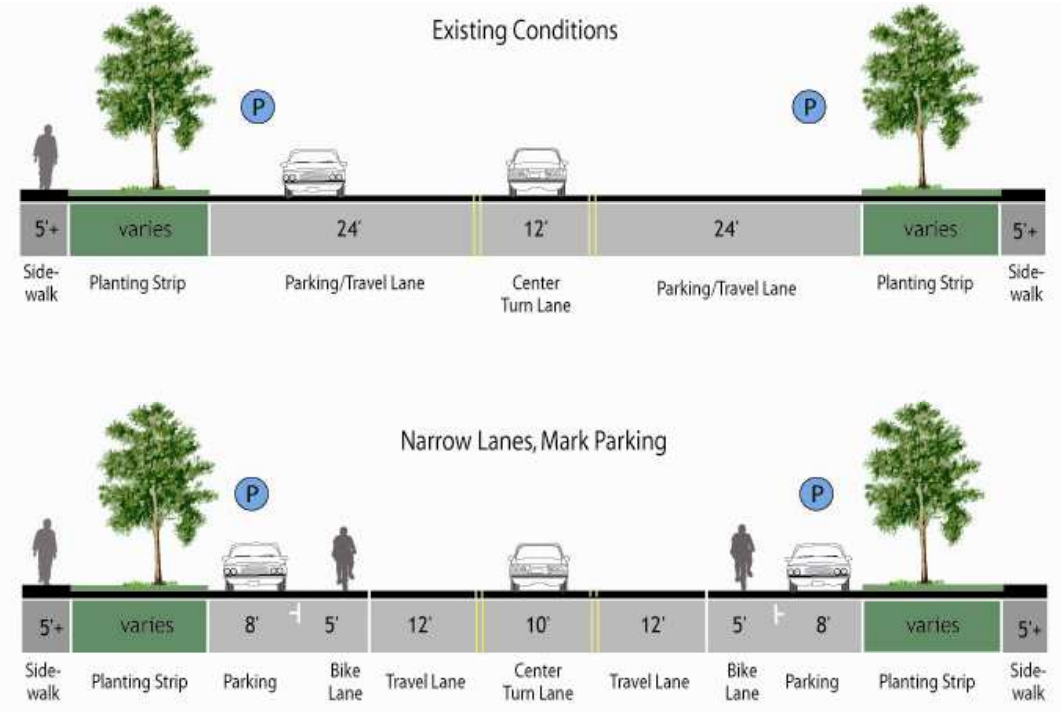
This street in Portland, Oregon previously had 13' lanes, which were narrowed to accommodate bike lanes without removing a lane.

Design Considerations

- Vehicle lane: before 12 feet to 15 feet; after: 10 feet to 11 feet
- Bike lane width: see bike lane design guidance

Reference

- Caltrans Highway Design Manual (Chapter 1000)
- AASHTO *Guide for the Development of Bicycle Facilities*
- Rosales, Jennifer. (2006). *Road Diet Handbook: Setting Trends for Livable Streets*



Example of vehicle travel lane narrowing to accommodate bike lanes.

Class II Bikeway: Retrofitting Existing Streets, Lane Reconfiguration

The removal of a single travel lane, also called a "Road Diet", 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.

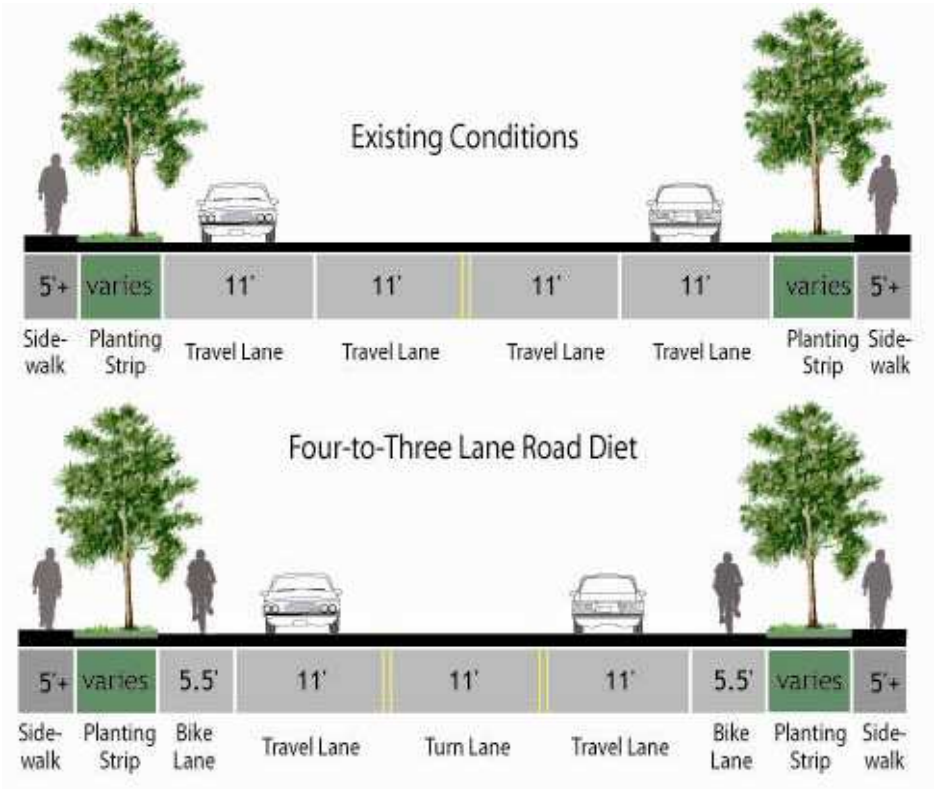
This road was re-striped to convert four vehicle travel lanes into three travel lanes with bike lanes.

Design Considerations

- Vehicle lane width depends on project. No narrowing may be needed if a lane is removed.
- Bike lane width: see bike lane design guidance

Reference

- Slated for inclusion in the update to the AASHTO *Guide for the Development of Bicycle Facilities*
- Rosales, Jennifer. (2006). *Road Diet Handbook: Setting Trends for Livable Streets*



Example of bikeway lane reconfiguration to accommodate bike lanes.

Class II Bikeway: Retrofitting Existing Streets, Parking Reduction

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. On streets where parking is at a premium and the roadway width constrains bicycle lane implementation, a Class III Bike Route can be considered.

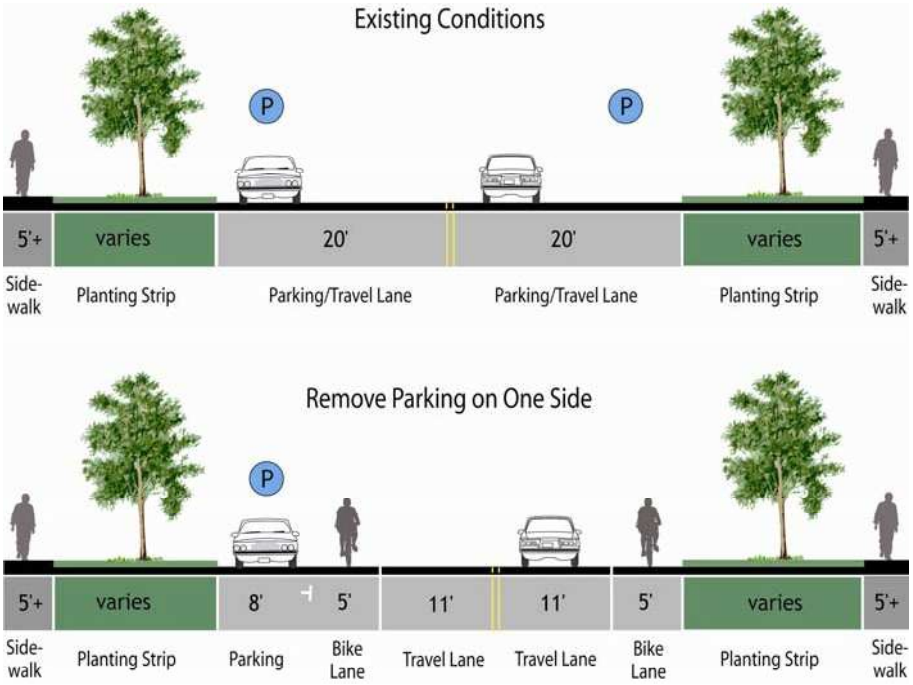
Some streets may not require parking on both sides.

Design Considerations

- Vehicle lane 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

Reference

- Rosales, Jennifer. (2006). Road Diet Handbook: Setting Trends for Livable Streets



Example of parking removal to accommodate bike lanes.

Class II Bike Lane: Intersection Treatments, Bicycle Signal Actuation

Loop Detectors

Bicycle-activated loop detectors are installed within the roadway to allow a bicycle to trigger a change in the traffic signal. This allows the cyclist to stay within the lane of travel rather than maneuvering to the side of the road to trigger a push button.

All new loop detectors installed will be capable of detecting bicycles. Identify loops that detect bicycles with the "Bicycle Detector Symbol" shown in Figure 9C-7(CA) in the CA- MUTCD.

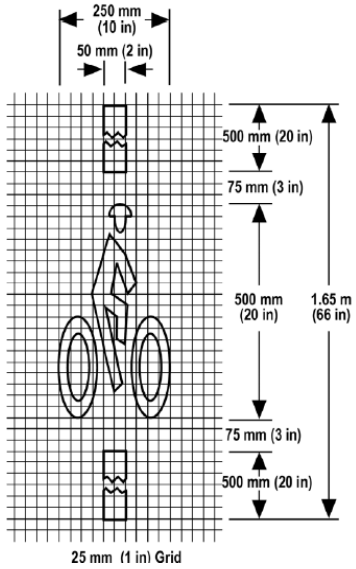
Detection Cameras

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 Obispo, CA, where the system has proven to detect pedestrians as well.

Remote Traffic Microwave Sensor Detection (RTMS)

RTMS is a system developed in China, which 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.



Recommended loop detector marking (MUTCD-CA Supplement Figure 9C-7).

Example bicycle actuator marking.

Instructional Sign (MUTCD-CA Supplement Sign R62C).

Design Considerations

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.

Reference

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

Class II Bikeway: Intersection Treatments, Channelized Right Turn Pocket

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 positioning within the lane.

According to the CA MUTCD and Chapter 1000, the appropriate treatment for right-turn only lanes is to place a bike lane pocket between the right-turn lane and the right-most through lane or, where right-of-way is insufficient, to drop the bike lane entirely approaching the right-turn lane. Dropping the bike lane is not recommended, and should only be done when a bike lane pocket cannot be accommodated.

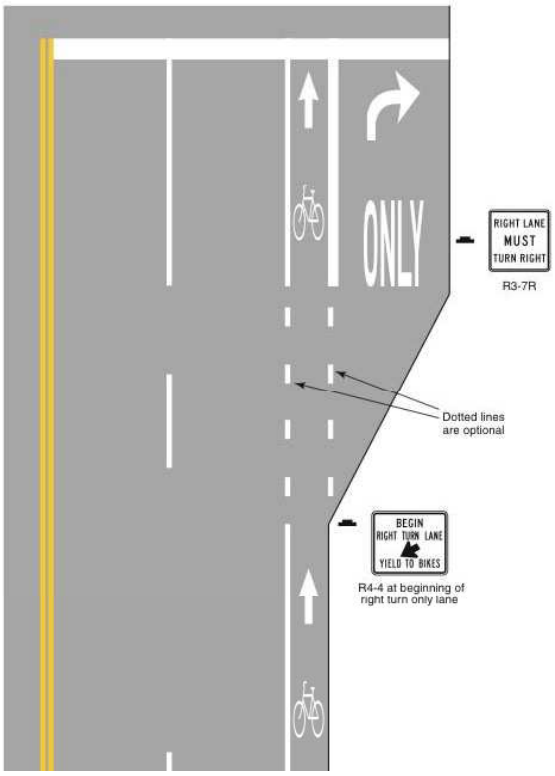
An optional through-right-turn lane next to a right-turn only lane should not be used where there is a through bicycle lane. If a capacity analysis indicates the need for an optional through-right turn lane, the bicycle lane should be discontinued at the intersection approach.

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



Recommended bike/right turn lane design (MUTCD-CA Supplement Figure 9C-3).

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

Design Considerations

- Right-turn lane width – minimum 12-foot width.
- Bike lane pocket width – minimum 4-5 feet preferred.
- Works best on streets with lower posted speeds (30 MPH or less) and with low traffic volumes (10,000 ADT or less)

Reference

- Caltrans Highway Design Manual (Chapter 1000)
- California MUTCD, Section 9C.04
- AASHTO Guide for the Development of Bicycle Facilities

Class II Bike Lane: Intersection Treatments, Interchanges

At highway interchanges, motor vehicles often make turns at higher speeds than on surface roads. Bike lanes through interchange areas should clearly warn motorists to expect bicyclists, and signage should alert bicyclists that they should not turn to enter the highway.

Figure 9C-104 (right) depicts the current guidance provided by the California MUTCD. On high traffic bicycle corridors, non-standard treatments may be desirable. Dashed bicycle lane lines with or without colored bike lanes may be applied to provide increased visibility for bicycles in the merging area. The use of double-turn lanes should be discouraged because of the difficulties they present for pedestrians and bicyclists (see previous treatment). Existing double-turn lanes should be studied and converted to single-turn lanes, unless found to be absolutely necessary for traffic operations.

Design Considerations

Bike lane width:

- 4-foot minimum when no curb & gutter is present (rural road sections).
- 5-foot minimum when adjacent to curb and gutter (5 feet more than the gutter pan width if the gutter pan is wider than 2 feet).
- 6 feet recommended where right-of-way allows

Maximum Width:

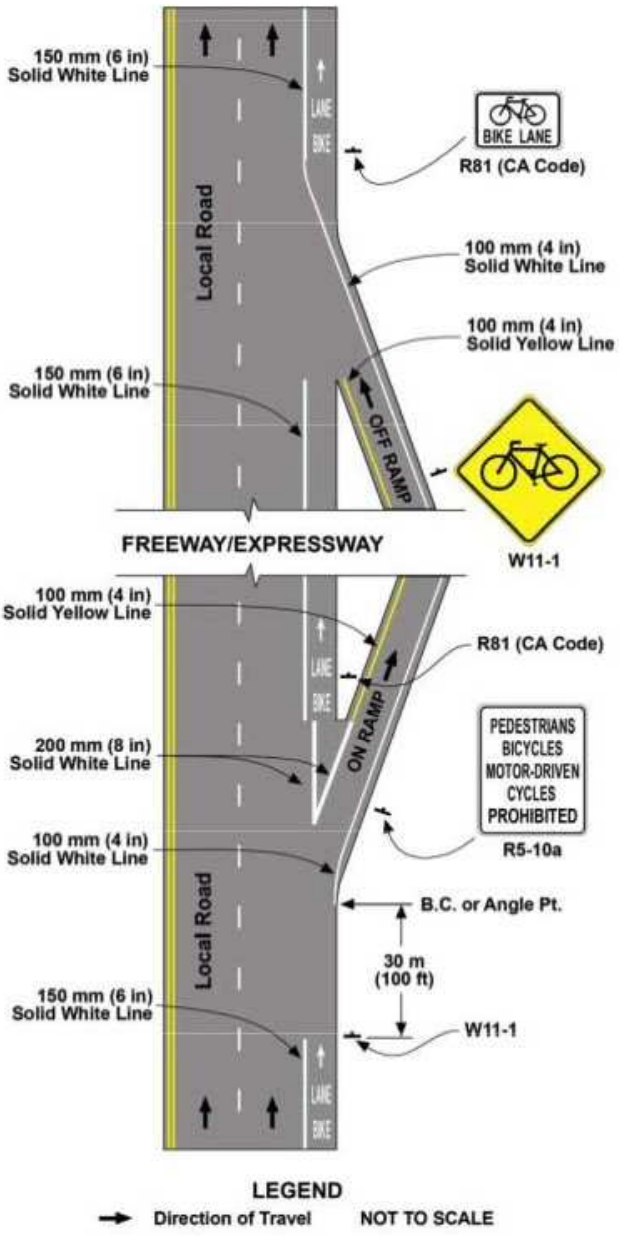
- 8 feet adjacent to arterials with high travel speeds (45 mph+)

Treatment for Interchange Ramp Ingress / Egress:

- Design intersections and ramps to limit the conflict areas or eliminate unnecessary uncontrolled ramp connections to urban roadways
- Follow AASHTO guidance (pp. 62 and 63) on methods for delineating or not delineating a bike lane through an interchange

Reference

- Caltrans *Highway Design Manual* (Chapter 1000)
- *California MUTCD*
- AASHTO *Guide for the Development of Bicycle Facilities*



California MUTCD Figure 9C-104 provides guidance for continuing bike lanes through intersection areas.

F.5.3 Class III Bike Routes

Class III Bikeway: Bike Route

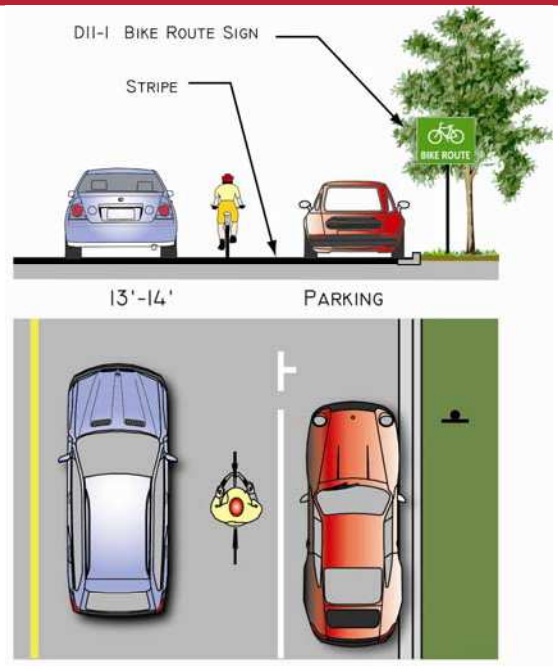
Class III bicycle facilities – (Caltrans designation) are defined as facilities shared with motor vehicles. They are typically used on roads with low speeds and traffic volumes; however, they can be used on higher volume roads with wide outside lanes or with shoulders. Roadways appropriate as shared roadways often have a centerline stripe only, and no designated shoulders.

Bike routes are indicated exclusively by signage, which provide key connections to destinations and trails where providing additional separation is not possible.

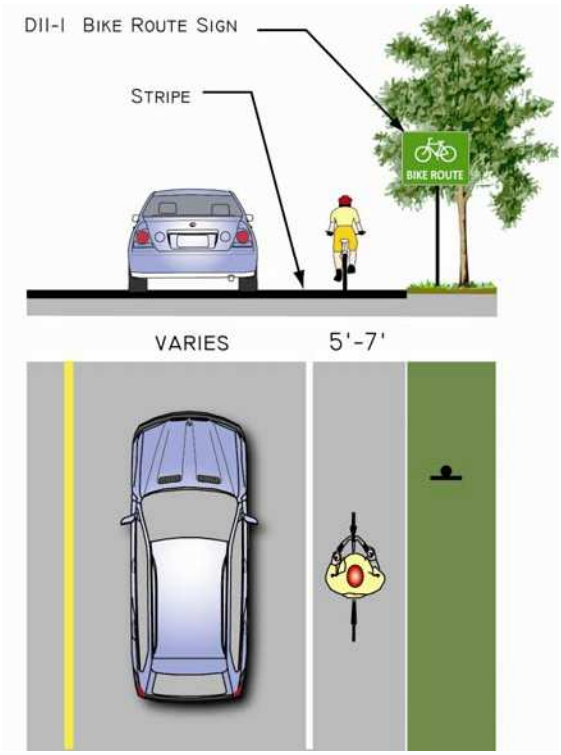
Rural roads with a large shoulder may already accommodate bicycle travel. Reclassifying these large shoulders as "shoulder bikeways" may encourage additional cyclist use. This type of facility can be developed on a rural roadway without curb and gutter. Bike routes along shoulders are appropriate and preferable to bike lanes in rural areas. The separation between the shoulder and the travel lane should be marked with an edge line, and the shoulder should be paved and maintained. A shoulder bikeway could 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.

When a roadway with a shoulder bikeway is reconstructed, widened, or overlaid, open drainage grates should be oriented with openings perpendicular to the direction of bicycle travel, so that bicycle wheels are not caught in the openings.

Rumble strips are placed along the sides of high-speed and rural roads, in order to alert drivers when their vehicles have left the roadway. Rumble strips can be dangerous for bicyclists, as a cyclist who runs over a strip could lose control of the bicycle. Conversely, rumble strips can help bicyclists feel more comfortable, knowing that drivers will be alerted if they are near the edge of the roadway. The bike-able area should have sufficient width (5-foot minimum) to accommodate bicycle travel. Rumble strips along shoulder bikeways should also include gaps to allow bicyclists to cross the rumble strip area.



Shared roadway recommended configuration.



Recommended shoulder bikeway configuration.

Class III Bikeway: Bike Route (continued)

Design Considerations

Shared Roadway Considerations:
Use D11-1 Bike Route sign at:

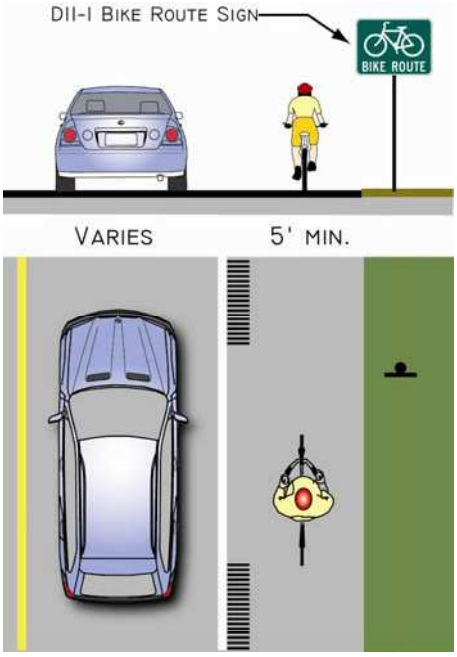
- Beginning or end of bike route (with applicable M4 series sign below)
- Entrance to bike path (class I) – optional
- At major changes in direction or at intersections with other bike routes (with applicable M7 series arrow sign)
- At intervals along bike routes not to exceed ½ mile

Shoulder Bikeway Considerations:
Widths (measured from painted edge line to edge of pavement or gutter pan):

- The shoulder should be a minimum of 4 feet and preferably, 6 feet wide
- On steep hills, additional width should be provided in the uphill direction, both for cyclists to pass each other and to allow cyclists to 'traverse' the hill by weaving slightly back and forth
- For shoulder bikeways along high-speed roadways, a buffer between the shoulder and vehicle lane using paint or bike-friendly rumble strips (see right) may be considered.

Additional considerations:

- Locate 5 feet from the face of the guardrail, curb, or other roadside barrier
- Use D11-1 "Bike Route" sign as specified for shared roadways



Shoulder bikeway with bike-friendly rumble strip

D11-1 "Bike Route" sign should be used along designated shared roadways.

Reference

- From Caltrans Highway Design Manual (HDM) Chapter 1000: "Class III bikeways (bike routes) are intended to provide continuity to the bikeway system. Bike routes are established along through routes not served by Class I or II bikeways, or to connect discontinuous segments of bikeway (normally bike lanes). Class III facilities are shared facilities, either with motor vehicles on the street, or with pedestrians on sidewalks, and in either case bicycle usage is secondary. Class III facilities are established by placing Bike Route signs along roadways."
- 2010 California MUTCD states," provide a right-of-way designated by signs or permanent markings and shared with pedestrians or motorists. Refer California Streets and Highways Code Section 890.4."
- 2010 California MUTCD Section 9C.04 states, "Class III Bikeways (Bike Route) are shared routes and do not require pavement markings. In some instances, a 100 mm (4 in) white edge stripe separating the traffic lanes from the shoulder can be helpful in providing for safer shared use. This practice is particularly applicable on rural highways and on major arterials in urban areas where there is no vehicle parking."
- AASHTO Guide for the Development of Bicycle Facilities
- Caltrans Standard Plan (2006 Edition).

Class III Bikeway: Shared Roadway Bicycle Marking (Sharrow)

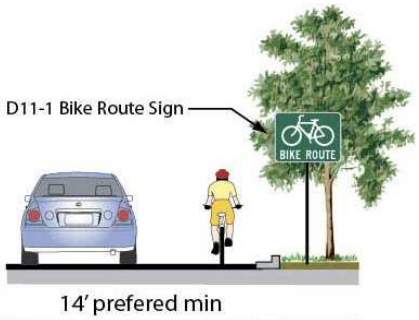
Shared lane marking stencils (also called "sharrows") have been introduced for use in California as an additional treatment for Class III facilities. The California MUTCD states that the shared roadway bicycle marking is intended to:

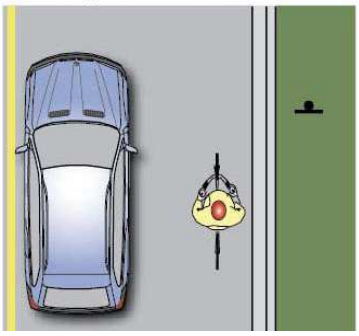
- Reduce the chance of collisions between open doors of parked vehicles and bicyclists on a roadway with on-street parallel parking
- Alert road users within a narrow traveled way of the lateral location where bicyclists ride
- Be used only on roadways without marked bicycle lanes or shoulders

The stencil can serve a number of purposes, such as making motorists aware of bicycles potentially in their lane, showing bicyclists the direction of travel, and, with proper placement, reminding bicyclists to bike further from parked cars to prevent "dooring" collisions.

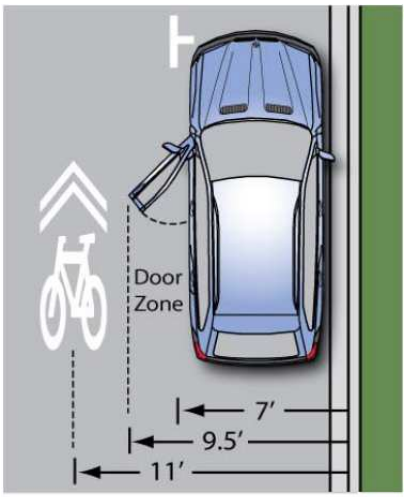
A wide outside lane can be used on roadways where bike lanes might otherwise be used, but the existing road width does not allow for restriping. The wide lane allows motor vehicles to pass bicycles while providing the recommended 3 feet of clearance.

When a roadway with a shoulder bikeway is reconstructed, widened, or overlaid, open drainage grates should be oriented with openings perpendicular to the direction of bicycle travel, so that bicycle wheels are not caught in the openings.





Wide curb lanes can include shared lane pavement markings to increase visibility.



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

Design Considerations

- Use D11-1 "Bike Route" sign as specified for shared roadways
- Place in a linear pattern along a corridor at least 11' from face of curb (or shoulder edge) on streets with on-street parking. The longitudinal spacing of the markings may be increased or reduced as needed for roadway and traffic conditions.
- Shared lane markings should not be placed on roadways with a speed limit at or above 40 MPH (CA MUTCD)
- Marking should be placed immediately after an intersection and spaced at intervals no greater than 250 feet hereafter
- Use only on a roadway Class III Bikeway (bike route) or shared roadway (no bikeway designation) which has on-street parallel parking

Reference

- Caltrans *Highway Design Manual* (Chapter 1000)
- Use of shared lane markings was adopted by Caltrans in 2005 as California MUTCD Section 9C.103 and Figure 9C-107
- AASHTO *Guide for the Development of Bicycle Facilities*

F.5.4 Bicycle Boulevards

Bicycle Routes/Bicycle Boulevards

Design Summary

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

Discussion

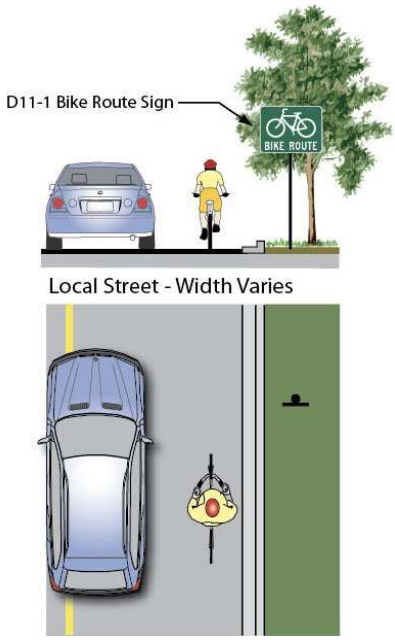
Bicycle boulevards are low-volume streets where motorists and bicyclists share the same space. Treatments for bicycle boulevards include five "application levels" based on their level of physical intensity, with Level 1 representing the least physically-intensive treatments that could be implemented at relatively low cost. Identifying appropriate application levels for individual bicycle 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 thru 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 following.

Guidance

- Bicycle boulevards have been implemented in Berkeley, Emeryville, Palo Alto, San Luis Obispo, and Pasadena, CA; Portland and Eugene, OR; Vancouver, BC; Tucson, AZ; Minneapolis, MN; Ocean City, MD; and Syracuse, NY.
- 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.*
- *MUTCD* – California Supplement.



Recommended design for bike routes/ bicycle boulevards.

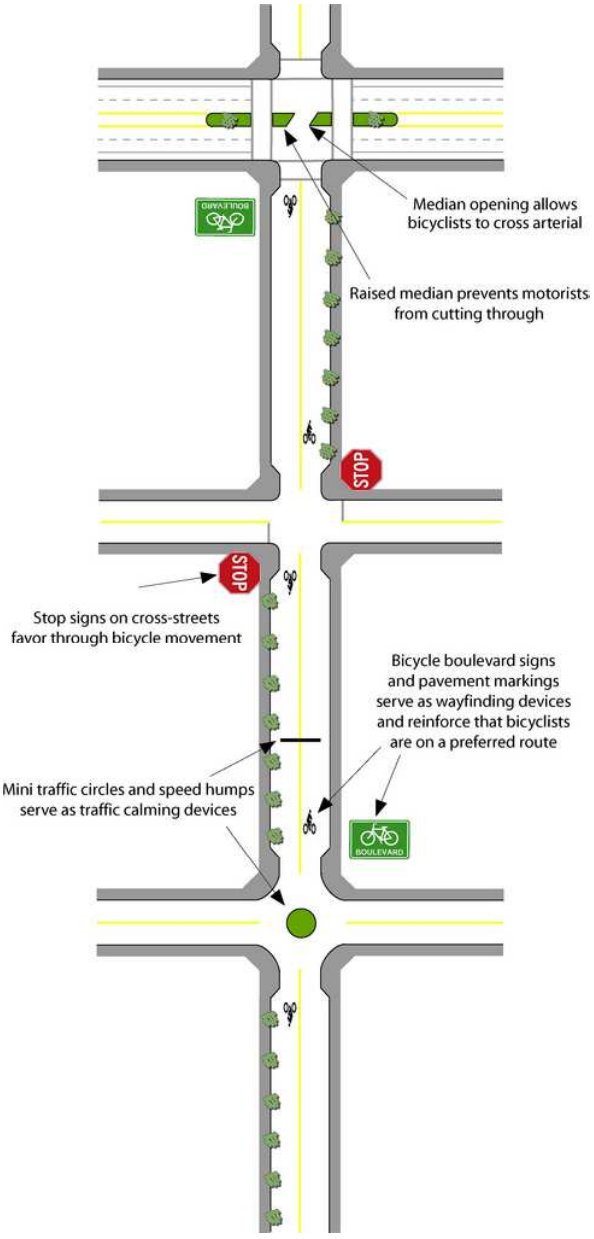
Bicycle boulevards are low-speed streets that provide a comfortable and pleasant experience for cyclists.

Bicycle Routes/Bicycle Boulevards

Discussion (continued)

Bicycle boulevards serve a variety of purposes:

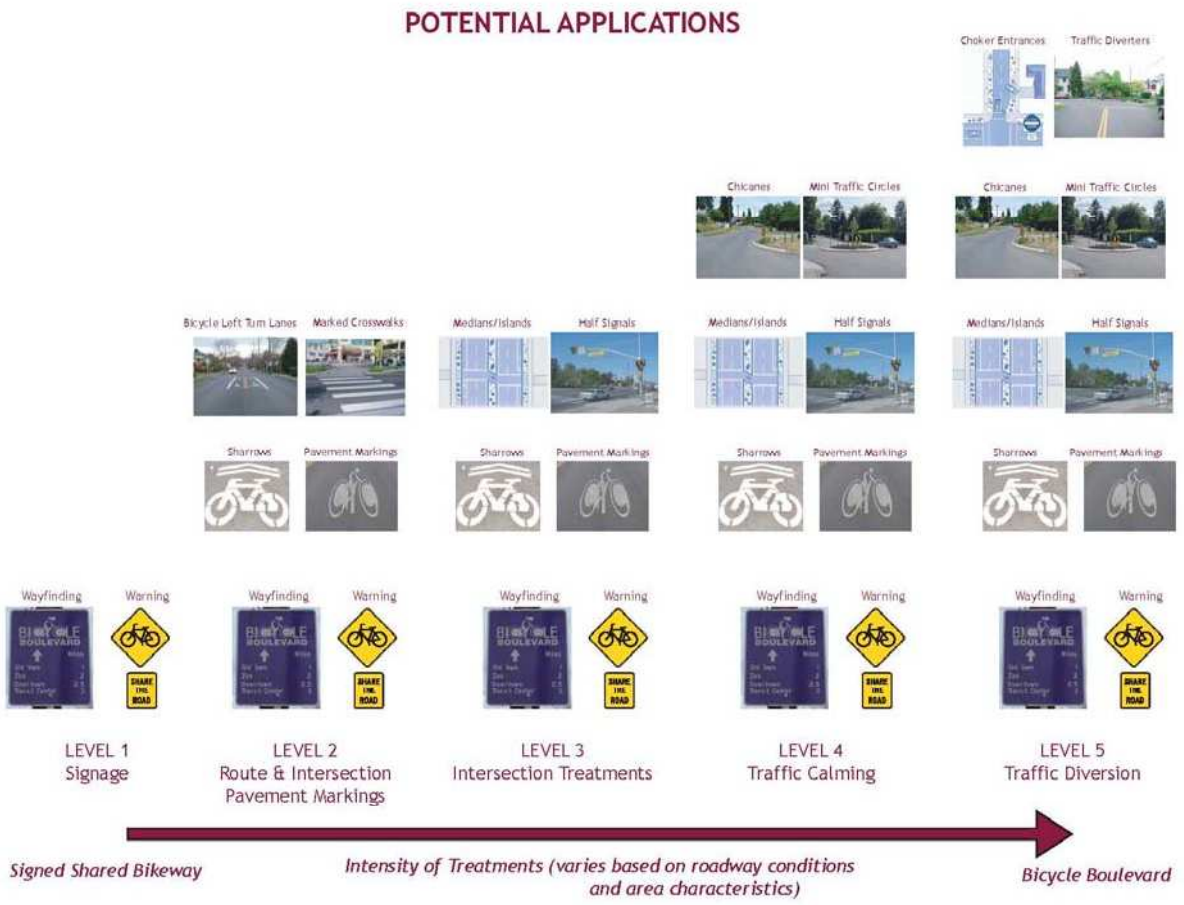
- Parallel major streets lacking dedicated bicycle facilities: Higher-order streets typically include major bicyclist destinations (e.g., commercial and employment areas). However, these corridors often lack bike lanes or other dedicated facilities creating an uncomfortable, unattractive and potentially 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 thru 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 Routes/Bicycle Boulevards

Bicycle Boulevard Application Levels



This section describes various treatments commonly used for developing Bicycle Boulevards. The treatments fall within five main "application levels" based on their level of physical intensity, with Level 1 representing the least physically-intensive treatments that could be implemented at relatively low cost. Identifying appropriate application levels for individual Bicycle Boulevard corridors provides a starting point for selecting appropriate site-specific improvements. The five Bicycle Boulevard application levels include the following:

Level 1: Signage	See Section 5.4.1
Level 2: Pavement markings	See Section 5.4.2
Level 3: Intersection treatments	See Sections 5.4.3-5.4.5
Level 4: Traffic calming	See Sections 5.4.6.
Level 5: Traffic diversion	See Sections 5.4.7.

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, Los Angeles County should involve the bicycling community and neighborhood groups. Further analysis and engineering work may also be necessary to determine the feasibility of some applications.

F.5.4.1 Bike Route/Boulevard Signing

Level 1: Bike Route/Boulevard Signing

Design Summary

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

Discussion

Wayfinding Signs

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 bicycle 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.

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* – California Supplement.

F.5.4.2 Bike Route/Boulevard Pavement Markings

Level 2: Bike Route/Boulevard Pavement Markings

Design Summary

- The shared lane marking is the only approved wayfinding/ bicycle boulevard pavement marking by the California MUTCD.

Discussion

Directional Pavement Markings

Directional pavement markings (also known as "bicycle boulevard markings" or "breadcrumbs") 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, Oregon's boulevard network.

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

In Berkeley, California, 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.

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.

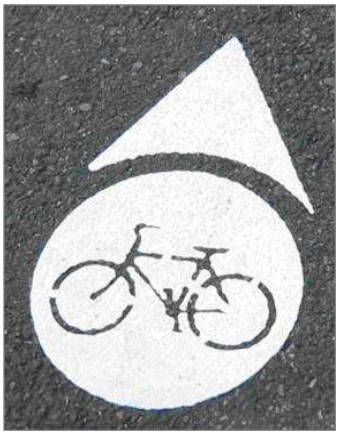
In addition to benefiting cyclists, delineated parking spaces also promote the efficient use of on-street parking by maximizing the number of spaces in high-demand areas.

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' at uncontrolled or stop-controlled intersections, as well as pavement reflectors to identify the center of the street.

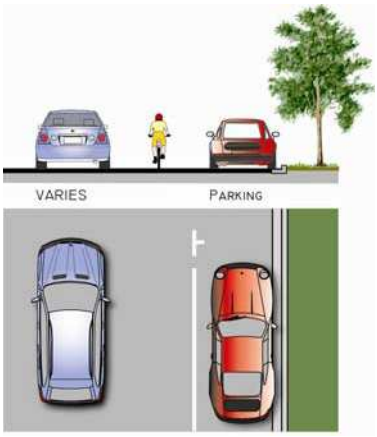
Guidance

- 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* – California Supplement.



Bicycle boulevard directional marker.

Shared lane markings also provide directional support for bicyclists.



Example of on-street parking delineation.

F.5.4.3 Bike Routes/Boulevards at Minor Unsignalized Intersections

Level 3: Bike Routes/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 can be 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, stop signs at intersections along bicycle boulevards may be unwarranted as a traffic control device.

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

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.

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* – California Supplement.

Stop signs effectively minimize conflicts along bicycle boulevards.

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

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

F.5.4.4 Bike Routes/Boulevards at Major Unsignalized Intersections

Level 3: Bike Routes/Boulevards at Major Unsignalized Intersections

Design Summary

- Increase crossing opportunities with medians and refuge islands.
- Instructional and regulatory signage should be included with installation of a bicycle signal. This signage is not standard and will have to be created for the application. Part 4 of the California MUTCD covers bicycle signals.

Discussion

Medians/Refuge Islands

At uncontrolled intersections at major streets, a crossing island can be provided to allow cyclists to cross one direction of traffic at a time when gaps in traffic allow. The bicycle crossing island should be at least 8' wide to be used as the bike refuge area. 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 thru vehicle movements.

Half-Signals

Bicycle signals are an approved traffic control device in the state of California after the technology was studied and approved after years of service in the City of Davis. A bicycle signal provides an exclusive signal phase for bicyclists traveling through an intersection. This takes the form of a new signal head installed with red, amber, and green bicycle indications. Bicycle signals can be actuated with bicycle sensitive loop detectors, video detection, or push buttons.

Where cyclists have few crossable gaps and where vehicles on the major street do not stop for pedestrians and cyclists waiting to cross, "half signals" could be installed to improve the crossing environment. Half signals include pedestrian and bicycle activation buttons and may also include loop detectors on the bicycle boulevard approach. Many of these models have been used successfully for years overseas, and their use in the U.S. has increased dramatically over the last decade.

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

Half-signals for bicyclists should be clearly marked to minimize confusion.

Guidance

Note: While bicycle signals are approved for use in California, local municipal code should be checked or modified to clarify that at intersections with bicycle signals, bicycles should only obey the bicycle signal heads.

- 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* – California Supplement.

F.5.4.5 Bike Routes/Boulevards at Offset Intersections

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' wide, with a total of 11' 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

Similar to medians/refuge islands, bicycle left-turn lanes allow the crossing to be completed in two phases. A bicyclist on the boulevard could execute a right-hand turn onto the cross-street, and then wait in a delineated left-turn lane (if necessary to wait for a gap in oncoming traffic). The bike turn pockets should be at least 5 feet wide, with a total of 11 feet for both turn pockets and center striping.

Bicycle Left Turn Pocket

A bike-only left-turn pocket permits bicyclists to make left turns while restricting vehicle left turns. If the intersection is signal-controlled, a left arrow signal may be appropriate, depending on bicycle and vehicle volumes. Signs should be provided prohibiting motorists from turning. Ideally, the left turn pocket should be protected by a raised curb, but the pocket may also be defined by striping if necessary. 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 Planning + Design and IBPI. *Bicycle Boulevard Planning and Design Handbook.* www.ibpi.usp.pdx.edu/guidebook.php
- AASHTO *Guide for the Development of Bicycle Facilities.*

F.5.4.6 Bicycle Boulevard Traffic Calming

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: 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 thru 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.

Other: The Count also has a Neighborhood Traffic Management Program toolbox, providing information on numerous traffic calming devices that be considered on any bicycle boulevard. The toolbox provides explanations of the pros and cons of these devices, as well as their level of effectiveness. Additional information is available at www.ladpw.org/TNL/NTMP.

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 slow down.

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

Speed humps are a common traffic calming treatment.

F.5.4.7 Bicycle Boulevard Traffic Diversion

Level 5: Bicycle Boulevard Traffic Diversion

Design Summary

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

Discussion

Choker Entrances

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.

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

Traffic Diverters

Similar to choker entrances, traffic diverters are raised features directing vehicle traffic off the bicycle boulevard while permitting thru travel.

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 thru 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.

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

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.*

F.5.4.8 Bike Signage and Wayfinding

Signing Standards and Guidelines

Bikeways have unique signage requirements and are included in a separate chapter in the Manual of Uniform Traffic Control Devices (MUTCD). In the MUTCD there are three types of signs:

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

In addition to MUTCD signs, Los Angeles County uses regulatory signs to alert trail users to the rules and regulations in effect within river path corridors. Under the California Public Resources Code, rules must be posted in order to be enforced by patrolling police officers.

MUTCD Sign R5-1b and R9-3c are regulatory sign. The bicycle path exclusion sign (R44A) is specific to the CA MUTCD.

Warning signs are yellow, such as this combination of W11-15 and W11-15P from the MUTCD

Bicycle guide signs are green, and can include destination, direction and distance information. (MUTCD sign D1-3C).

Los Angeles County Department of Public Works regulatory signs post rules and provide contact information.

Design Considerations

- Bicycle signs shall be standard in shape, legend, and color
- All signs shall be retroreflective for use on bikeways, including shared-use paths and bicycle lane facilities
- Signs for the exclusive use of bicyclists should be located so that other road users are not confused by them
- Where signs serve bicyclists as well as other road users, vertical mounting height and lateral placement shall be as specified in Part 2 (Signs)

Reference

- Caltrans *Highway Design Manual* (Chapter 1000)
- California MUTCD
- AASHTO *Guide for the Development of Bicycle Facilities*
- Los Angeles River Master Plan Sign Guidelines

Wayfinding Guidelines

The ability to navigate through a region is informed by landmarks, natural features, and other visual cues. Wayfinding is a cost-effective and highly visible treatment that can improve the bicycling environment through:

- Helping to familiarize users with the pedestrian and bicycle network
- Helping users identify the best routes to destinations
- Helping to address misperceptions about time and distance
- Helping overcome a "barrier to entry" for infrequent cyclists or pedestrians (e.g., "interested but concerned" cyclists)

A bikeway wayfinding system is composed of three elements:

- Signs: Wayfinding signs throughout Los Angeles County can indicate to pedestrians and bicyclists their direction of travel, location of destinations, and travel time/distance to those destinations.
- Pavement Markings: Pavement markings indicate to cyclists the traffic regulations which apply at a specific time or place on a bikeway. Markings also reinforce to bicyclists that they are on a designated route and remind motorists to drive courteously.
- Maps and Kiosks: Provides users with valuable information regarding bicycle facilities and route options throughout Los Angeles County. Maps and kiosks provide bicyclists with key information such as the rules of the road, tips on safe cycling practices, and other bicycle safety information.

Design Considerations

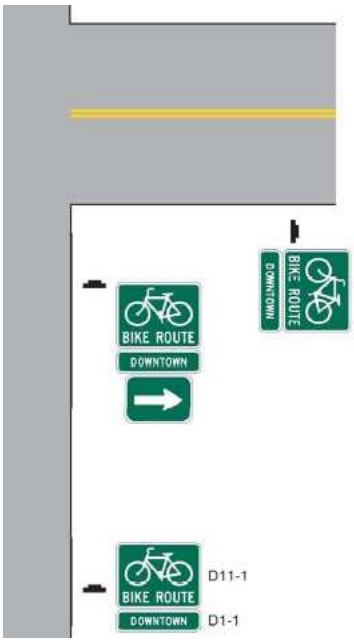
Destinations for on-street signage can include: On-street bikeways, commercial centers, regional parks and trails, public transit sites, civic/community destinations, local parks and trails, hospitals, and schools.

Recommended uses for on-street signage include:

- Confirmation signs confirm that a cyclist is on a designated bikeway. Confirmation signs can include destinations and their associated distances, but not directional arrows.
- Turn signs indicate where a bikeway turns from one street onto another street. Turn signs are located on the near-side of intersections.

Custom bike route guide sign for the Los Angeles River Bikeway.

Pavement markings along the San Gabriel River Bikeway indicate mileage at quarter mile intervals.



Example of signing for an on-roadway bicycle route (MUTCD-CA Figure 9B-6).

Wayfinding Guidelines (continued)

- Decision signs mark the junction of two or more bikeways. Decision signs are located on the near-side of intersections. They can include destinations and their associated directional arrows, but not distances.

Signs are typically placed at key locations leading to and along bicycle routes, including the intersection of multiple routes. Too many road signs tend to clutter the right-of-way, and it is recommended that these signs be posted at a level that is most visible to bicyclists and pedestrians, rather than per vehicle signage standards. Additional recommended guidelines include:

- Place the closest destination to each sign in the top slot. Destinations that are further away can be placed in slots two and three. This allows the nearest destination to 'fall off' the sign and subsequent destinations to move up the sign as the bicyclist approaches.
- Use pavement markings to help reinforce routes and directional signage. Markings, such as bicycle boulevard symbols, may be used in addition to or in place of directional signs along bike routes. Pavement markings can help cyclists navigate difficult turns and provide route reinforcement.

Reference

- Caltrans *Highway Design Manual* (Chapter 1000)
- California MUTCD 9B.19
- AASHTO *Guide for the Development of Bicycle Facilities*
- Los Angeles River Master Plan Sign Guidelines
- City of Oakland. (2009). *Design Guidelines for Bicycle Wayfinding Signage*
- City of Portland (2002). *Bicycle Network Signing Project*

F.5.5 Innovative Bicycle Treatments

Class II - Colored Bike Lanes

Design Summary

Bicycle Lane Width:
5' minimum and 7' maximum.

Colored bike lanes are a common treatment in many European Cities and are starting to garner acceptance in US cities.

Discuss ion

A contrasting color for the paving of bicycle lanes can also be applied to continuous sections of roadways. These situations help to better define road space dedicated to bicyclists and make the roadway appear narrower to drivers resulting in beneficial speed reductions.
Colored bicycle lanes require additional cost to install and maintain. Techniques include:

- Paint – less durable and can be slippery when wet
- Colored asphalt – colored medium in asphalt during construction – most durable.
- Colored and textured sheets of acrylic epoxy coating.
- Thermoplastic – Expensive, durable but slippery when worn.

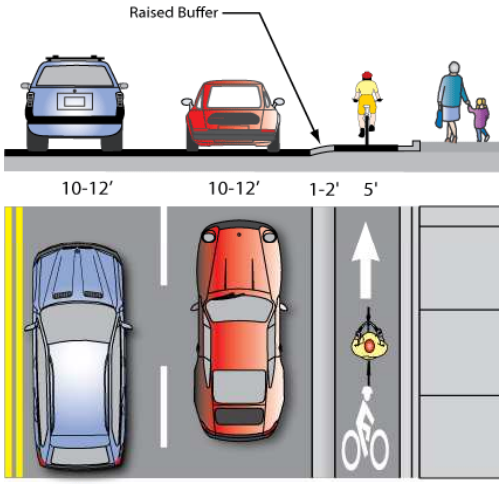
Guidance

Currently this treatment has been granted interim approval per FHWA.
National Association of City Transportation Officials (NACTO) *Urban Bikeway Design Guide (2011).*

Class II - Raised Bicycle Lanes

Design Summary

Bicycle Lane Width:
5 feet minimum. Bicycle lane should drain to street. Drainage grates should be in travel lane.
Mountable Curb Design:
Mountable curb should have a 4:1 or flatter slope and have no lip that could catch bicycle tires.
Signage & Striping:
Same as traditional Class II bicycle lanes



Discussion

Raised bicycle lanes are bicycle lanes that have a mountable curb separating them from the adjacent travel lanes. Raised bicycle lanes provide an element of physical separation from faster moving vehicle traffic. For drivers, the mountable curb provides a visual and tactile reminder of where the bicycle lane is. For bicyclists the mountable curb makes it easy to leave the bicycle lane if necessary, when passing another bicyclist, or to merge to the left for turning movements. The raised bicycle lane should return to level grade at intersections.
Raised bicycle lanes cost more than traditional bicycle lanes and typically require a separate paving operation. Maintenance costs are lower as the bicycle lane receives no vehicle wear and resists debris accumulation.
Raised bicycle lanes work well adjacent to higher speed roadways with few driveways.

Guidance

Currently this treatment is not present in any State or Federal design standards
National Association of City Transportation Officials (NACTO) *Urban Bikeway Design Guide (2011).*
Crow Design Manual for Bicycle Traffic - Chapter 5

Class II - Buffered Bicycle Lanes

Design Summary

Bicycle Lane Width:
Signage & Striping:
Same as traditional Class II bicycle lanes

Discussion

Provides cushion of space to mitigate friction with motor vehicles on streets with frequent or fast motor vehicle traffic. Buffered Bike lanes allow bicyclists to pass one another or avoid obstacles without encroaching into the travel lane.
These facilities increase motorist shy distance from bicyclist in the bike lane and reduce the risk of "dooring" compared to a conventional bike lane.
Buffered bike lanes require additional roadway space and maintenance.

Guidance

Currently this treatment is not present in any State or Federal design standards
National Association of City Transportation Officials (NACTO) *Urban Bikeway Design Guide (2011)*.
Crow Design Manual for Bicycle Traffic - Chapter 5

Class II - Cycletrack

Design Summary

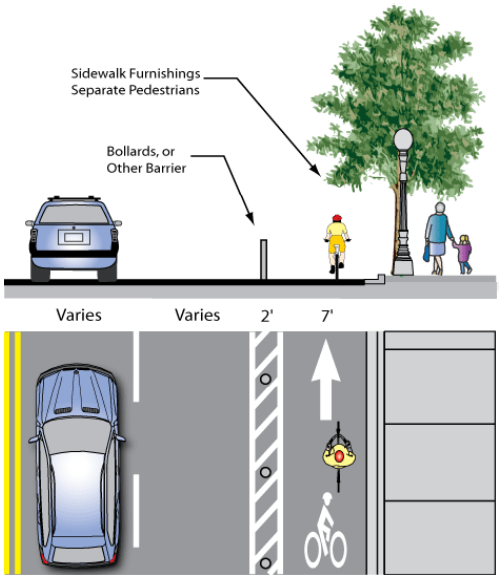
Cycle Track Width:
7 feet preferred to allow passing and obstacle avoidance
12 feet minimum for two-way facility

Discussion

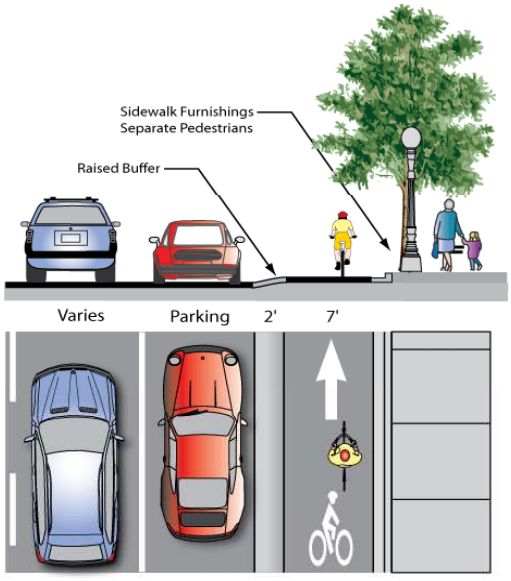
A cycle track is a hybrid type bicycle facility that combines the experience of a separated path with the on-street infrastructure of a conventional bicycle lane. Cycle tracks have different forms, but all share common elements. Cycle tracks provide space that is intended to be exclusively or primarily for bicycles, and is 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. They are separated from vehicles and pedestrians by either striping, colored pavement, bollards, curbs/medians or a combination of these elements.

Guidance

Currently this treatment is not present in any State or Federal design standards
National Association of City Transportation Officials (NACTO) *Urban Bikeway Design Guide (2011)*
Crow Design Manual for Bicycle Traffic - Chapter 5



Recommended Design – No Parking

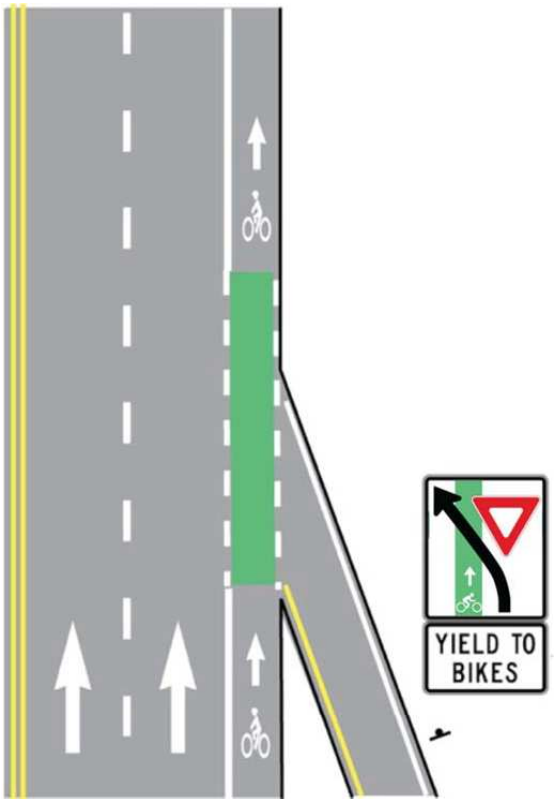


Recommended Design – On-Street Parking

Class II - Colored Bike Lanes at Interchanges

Design Summary

Bicycle Lane Width:
The bicycle lane width through the interchange should be the same width as the approaching bicycle lane (minimum five feet).



Discussion

On high traffic bicycle corridors non-standard treatments may be desirable over current practices outlined in the MUTCD. Dashed bicycle lane lines with or without colored bicycle lanes may be applied to provide increased visibility for bicycles in the merging area.

Guidance

Currently this treatment is not present in any State or Federal design standards
National Association of City Transportation Officials (NACTO) *Urban Bikeway Design Guide (2011).*
City of Chicago - Green Pavement Markings for Bicycle Lanes (Ongoing) - FHWA Experiment No. 9-77(E)
Portland's Blue Bicycle Lanes
http://www.portlandonline.com/shared/cfm/image.cfm?id=58842

Class II - Bicycle Box
Single Lane – No Vehicle Right Turns On Red

Design Summary

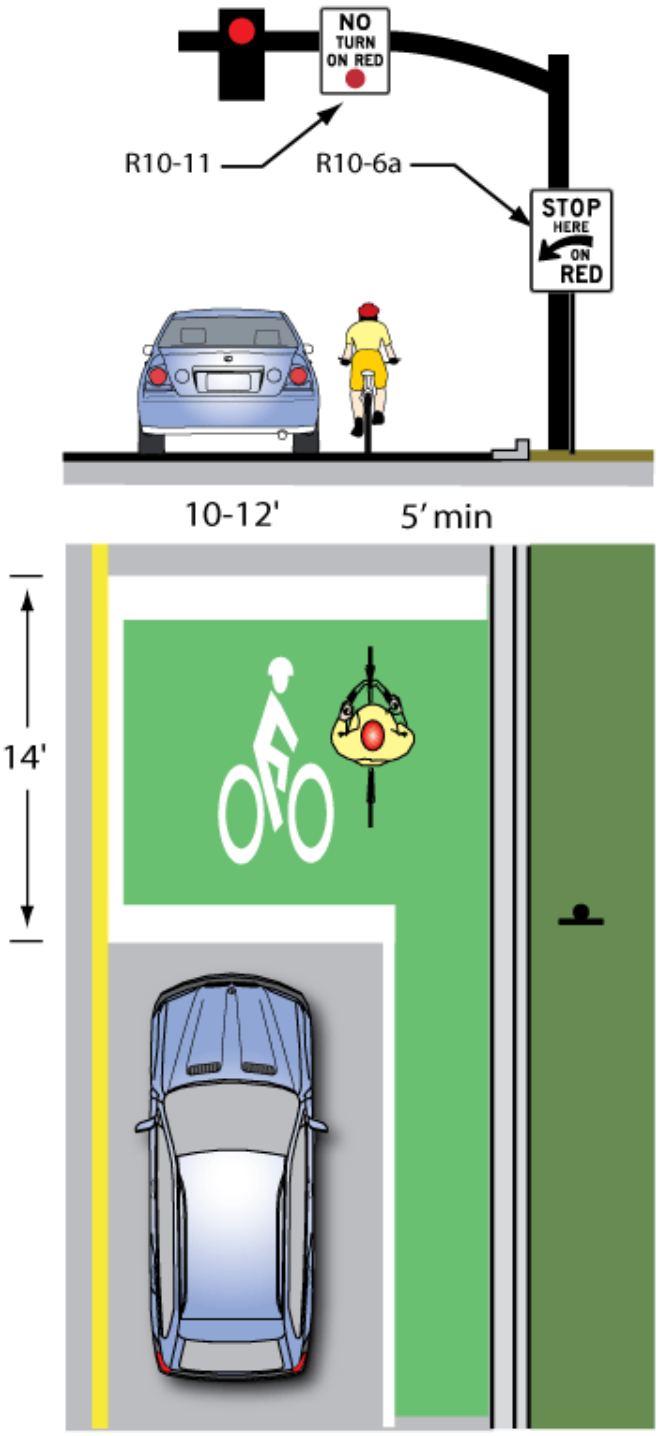
Bicycle Box Dimensions:
The Bicycle Box should be 14' deep to allow for bicycle positioning.
Signage:
Appropriate signage as recommended by the MUTCD applies. Signage should be present to prevent 'right turn on red' and to indicate where the motorist must stop.

Discussion

Bicycle boxes provide additional space for bicyclists to move to the front of the vehicular queue while waiting for a green light. On a two-lane roadway, the bicycle box can also facilitate left turning movements for bicyclists as well as through bicycle traffic. Motor vehicles must stop behind the white stop line at the rear of the bicycle box and may not turn right on red.

Guidance

Currently this treatment is not present in any U.S. State or Federal design manuals.
National Association of City Transportation Officials (NACTO) *Urban Bikeway Design Guide (2011)*.
Examples of this treatment can be found in Cambridge, Portland and Vancouver



Class II - Bicycle Box
Multi Lane – No Vehicle Right Turns On Red

Design Summary

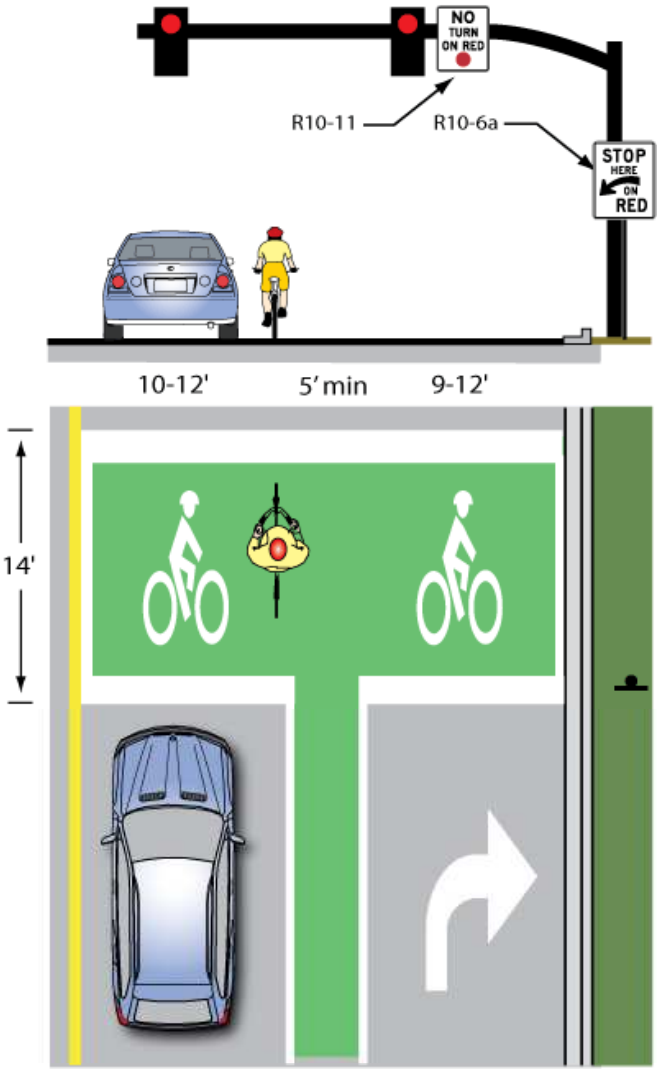
Bicycle Box Dimensions:
The Bicycle Box should be 14' deep to allow for bicycle positioning.
Signage:
Appropriate signage as recommended by the MUTCD applies. Signage should be present to prevent 'right turn on red' and to indicate where the motorist must stop.

Discussion

On wider roadways, the Bicycle Box can allow for movements in all directions for bicyclists providing for right turning, through, and left turning movements ahead of traffic. This treatment can be combined with a bicycle signal or an advanced signal phase to clear queuing bicyclists before vehicles are given a green phase.
At multi-lane bicycle boxes there can be a safety issue if a bicyclist is using the bicycle box to maneuver for a left turn just as the signal turns green. This would put the bicyclist possibly in the path of an approaching vehicle. It is recommended that installations wider than one lane across from the access point to the bicycle box be studied carefully before installation.

Guidance

Currently this treatment is not present in any State or Federal design standards



Class II - Bicycle Box
Multi Lane – Vehicle Right Turns On Red Allowed

Design Summary

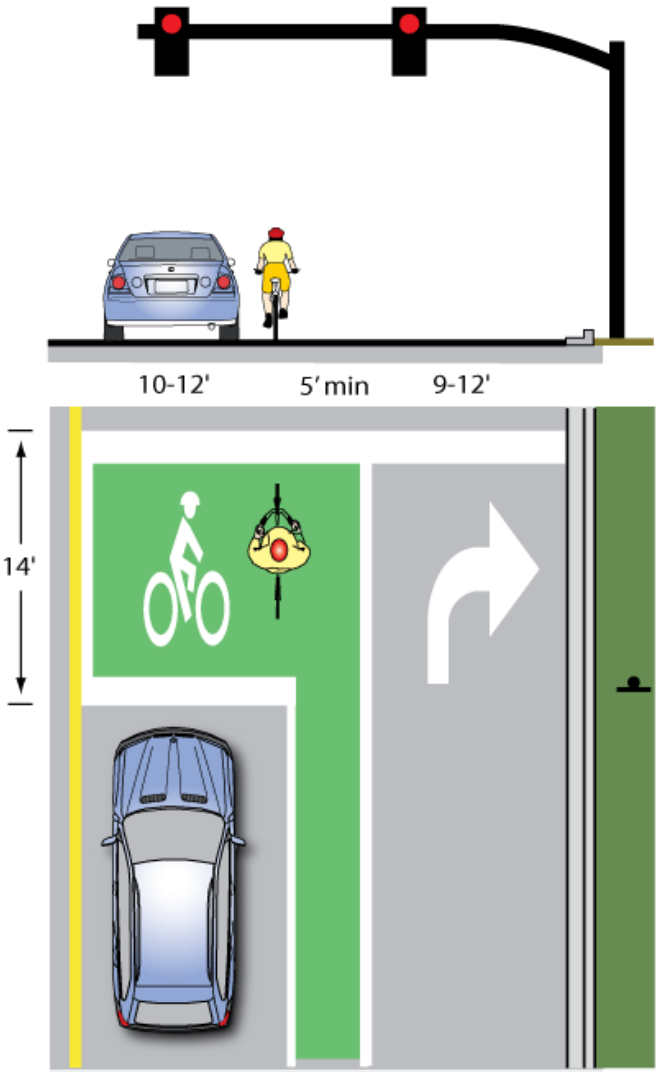
Bicycle Box Dimensions:
The Bicycle Box should be 14' deep to allow for bicycle positioning.
Signage:
Appropriate signage as recommended by the MUTCD applies.

Discussion

In some areas there may be a situation where a freeway ramp exists where bicycles are prohibited or areas where bicycles may not need to access such as parking garages. In these limited cases a vehicle right turn only lane may be provided to the outside of the bicycle box. Right turns on red are permitted in these instances.

Guidance

Currently this treatment is not present in any State or Federal design standards



F.5.6 Bicycle Parking

Bicycle Parking

- Short-term parking accommodates visitors, customers, messengers and others expected to depart within two hours; requires approved standard rack, appropriate location and placement, and weather protection.
- Long-term parking accommodates employees, students, residents, commuters, and others expected to park more than two hours. This parking is to be provided in a secure, weather-protected manner and location.

Design Considerations

Design Issue	Recommended Guidance
Minimum Rack Height	To increase visibility to pedestrians, racks should have a minimum height of 33 inches or be indicated or cordoned off by visible markers.
Signing	Where bicycle parking areas are not clearly visible to approaching cyclists, signs at least 12 inches square should direct them to the facility. The sign should include the name, phone number, and location of the person in charge of the facility, where applicable.
Lighting	A minimum of one foot-candle illumination at ground level should be provided in all high capacity bicycle parking areas.
Frequency of Racks on Streets	In popular retail areas, two or more racks should be installed on each side of each block. This does not eliminate the inclusion of requests from the public which do not fall in these areas. Areas officially designated or used as bicycle routes may warrant the consideration of more racks.
Location and Access	Access to facilities should be convenient; where access is by sidewalk or walkway, ADA-compliant curb ramps should be provided where appropriate. Parking facilities intended for employees should be located near the employee entrance, and those for customers or visitors near main public entrances. (Convenience should be balanced against the need for security if the employee entrance is not in a well traveled area). Bicycle parking should be clustered in lots not to exceed 16 spaces each. Large expanses of bicycle parking make it easier for thieves to be undetected.
Locations within Buildings	Provide bike racks within 50' of the entrance. Where a security guard is present, provide racks behind or within view of a security guard. The location should be outside the normal flow of pedestrian traffic.
Locations near Transit Stops	To prevent bicyclists from locking bikes to bus stop poles - which can create access problems for transit users, particularly those who are disabled - racks should be placed in close proximity to transit stops where there is a demand for short-term bike parking.

Bicycle Parking (continued)

Locations within a Campus-Type Setting	Racks are useful in a campus-type setting at locations where the user is likely to spend less than two hours, such as classroom buildings. Racks should be located near the entrance to each building. Where racks are clustered in a single location, they should be surrounded by a fence and watched by an attendant. The attendant can often share this duty with other duties to reduce or eliminate the cost of labor being applied to bike parking duties; a cheaper alternative to an attendant may be to site the fenced bicycle compound in a highly visible location on the campus. For long-term parking needs of employees and students, attendant parking and/or bike lockers are recommended.
Retrofit Program	In established locations, such as schools, employment centers, and shopping centers, the County should conduct bicycle audits to assess bicycle parking availability and access, and add additional bicycle racks where necessary.

The County could require bicycle parking as part of new developments. Quantities should be linked to land uses; the Association of Pedestrian and Bicycle Professionals (APBP) provides recommended quantities (see APBP reference).

Reference

- Caltrans Highway Design Manual (Chapter 1000)
- California MUTCD
- AASHTO Guide for the Development of Bicycle Facilities
- APBP Bicycle Parking Guidelines (2010.)www.apbp.org/?page=Publications

Short-Term Bicycle Parking

Short-term bicycle parking facilities include racks which permit the locking of the bicycle frame and at least one wheel to the rack and support the bicycle in a stable position without damage to wheels, frame or components. Short-term bicycle parking is currently provided at no charge at various locations in The County of Los Angeles. Such facilities should continue to be free, as they provide minimal security, but encourage cycling and promote proper bicycle parking.

The majority of short-term bicycle parking is provided via a 'staple' on the sidewalk, located within the buffer zone.

Art racks can be an attractive way of providing bicycle parking facilities. Costs can be subsidized by businesses sponsoring racks that are appropriate to their business (e.g., a pair of glasses for an optician).

Bollard-type bicycle racks can also accommodate short-term bicycle parking.

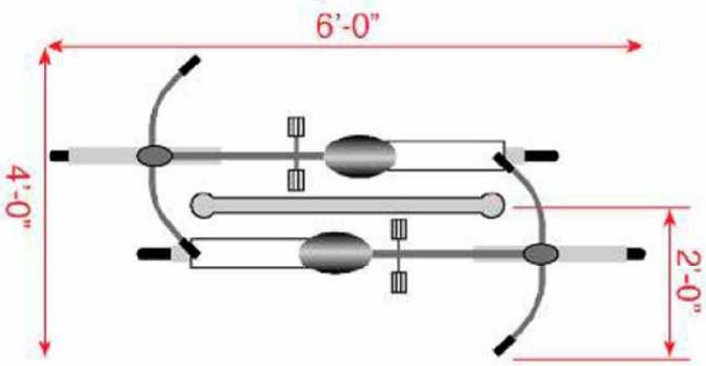
Bike corrals are high capacity bicycle racks installed in areas previously designated for automobile parking. The County shall evaluate requests for bike corrals if property owners and local stakeholders approve removing automobile parking spots.

Design Considerations

- See dimensions below

Reference

- Caltrans Highway Design Manual (Chapter 1000)
- California MUTCD
- AASHTO Guide for the Development of Bicycle Facilities



Staple rack parking configuration.

Standard bicycle 'staple' rack.

Art racks can be an attractive way of marketing the bicycle parking.

Bicycle parking can also be on a single post to minimize sidewalk obstructions.

Long-Term Bicycle Parking

Long-term bicycle parking facilities are intended to provide secure long-term bicycle storage. Long-term facilities protect the entire bicycle, its components and accessories against theft and against inclement weather, including snow and wind-driven rain. Examples include lockers, check-in facilities, monitored parking, restricted access parking, and personal storage. Check-in facilities are typically secured facilities that require an access code or key to access. Monitored parking facilities provide some form of supervision, e.g., an attendant.

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

Bike lockers at a transit station.

Design Considerations

- Dimensions and configuration depends on type of parking

Reference

- Caltrans *Highway Design Manual* (Chapter 1000)
- California MUTCD
- AASHTO *Guide for the Development of Bicycle Facilities*

F.5.7 Bikeway Maintenance

Bikeway Maintenance

Guidelines for regularly maintaining bicycle facilities are provided below.

Sweeping

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

Action items involving sweeping activities include:

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

Roadway Surface

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

Recommended action items involving maintaining the roadway surface include:

- On all bikeways, use the smallest possible chip for chip sealing bike lanes and shoulders
- Use sealants with the same color as the pavement. This avoids sealing cracks in concrete segments with asphalt
- During chip seal maintenance projects, if the pavement condition of the bike lane is satisfactory, it may be appropriate to chip seal the travel lanes only
- Ensure that on new roadway construction, the finished surface on bikeways does not vary more than ¼ inch
- Maintain a smooth surface on all bikeways that is free of potholes
- Maintain pavement so ridge build-up does not occur at the gutter-to-pavement transition or adjacent to railway crossings
- Inspect the pavement two to four months after trenching construction activities are completed to ensure that excessive settlement has not occurred
- Remove existing markings before reapplying new markings
- When applying thermoplastic stencils for signalizing bikeways, ensure that maximum thickness is 90 millimeters.

Gutter-to-Pavement Transition

On streets with concrete curbs and gutters, 10-20 inches of the curbside area is typically devoted to the gutter pan, where water collects and drains into catch basins. On many streets, the bikeway is situated near the transition between the gutter pan and the pavement edge. It is at this location that water can erode the transition, creating potholes and a rough surface for travel.

The pavement on many streets is not flush with the gutter, creating a vertical transition between these segments. This area can buckle over time, creating a hazardous environment for bicyclists. Since it is the most likely place for bicyclists to ride, this issue is significant for bike travel.

Bikeway Maintenance (continued)

Action items related to maintaining a smooth gutter-to-pavement transition include:

- Ensure that gutter-to-pavement transitions have no more than a ¼ inch vertical transition
- Examine pavement transitions during every roadway project for new construction, maintenance activities, and construction project activities that occur in streets

Drainage Grates

Drainage grates are typically located in the gutter area near the curb of a roadway. Drainage grates typically have slots through which water drains into the municipal wastewater system. Many grates are designed with linear parallel bars spread wide enough for a tire to get caught so that if a bicycle were to ride over them, the front tire would get caught and fall through the slot. This would cause the cyclist to tumble over the handlebars and sustain potentially serious injuries. The County should consider the following:

- Continue to require all new drainage grates be bicycle-friendly, including grates that have horizontal slats on them so that bicycle tires and assistive devices do not fall through the vertical slats
- Create a program to inventory all existing drainage grates and replace hazardous grates as necessary – temporary modifications such as installing rebar horizontally across the grate is no alternative to replacement

Pavement Overlays

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

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

Signage

Signage is crucial for safe and comfortable use of the bicycle and pedestrian network. Such signage is vulnerable to vandalism or wear, and requires regular maintenance and replacement as needed. The County should consider:

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

Landscaping

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

- Ensure that shoulder plants do not hang into or impede passage along bikeways

After major damage incidents, remove fallen trees or other debris from bikeways as quickly as possible.

Reference

- Caltrans *Highway Design Manual* (Chapter 1000)
- California MUTCD