Appendix B. Resources for the Design of Bicycle Facilities

Emeryville Pedestrian and Bicycle Plan

May 2012

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Introduction

This appendix presents an overview of bicycle facility designs, based on appropriate Manual on Uniform Traffic Control Devices (MUTCD) and Highway Design Manual (HDM), and as supplemented by American Association of State Highway and Transportation Officials (AASHTO) best practices and Emeryville-specific design guidelines. The purpose is to provide readers and project designers with an understanding of the facility types that are proposed in the Pedestrian and Bicycle Master Plan.

The design concepts presented in this document are based on bikeway and bike path design guidelines provided in federal, state, and local design and standards documents, as well as best practices from communities throughout the world. The bicycle design guidelines are intended to provide solutions to the problem of providing high-quality bicycle facilities in a wide variety of conditions.

In California, roadway design, including bikeway design, is governed by the California MUTCD, which is based on the Federal Highway Administration's MUTCD. As of April 2011, the California Department of Transportation (Caltrans) is using CA MUTCD 2009 Edition, and has issued a draft CA MUTDC 2011 Edition, which incorporates the Federal Highway Administration's MUTCD 2009 Edition.

Not all of the design treatments described in these appendices are compliant with the CA MUTCD. In the event that a specific treatment is not in the California MUTCD, it may be necessary to go through experimental testing procedures. Experimental testing is overseen by the California Traffic Control Devices Committee.

Key Principles

The following are key principles for these bicycle guidelines:

- **The bicycling environment should be safe.** Bicycle routes and bike paths should be designed and built to be free of hazards and to minimize conflicts with external factors such as vehicles and buildings.
- **The bicycle network should be accessible.** Bicycle routes and bike paths should permit the mobility of community members and visitors of all ages and abilities. Bicyclists have a range of skill levels, and facilities should be designed with a goal of providing for inexperienced/recreational bicyclists (especially children and seniors) to the greatest extent possible.
- **The bicycling environment should be clear and easy to use.** Bicycle routes and bike paths should be designed so bicyclists can easily find a direct route to a destination and so delays are minimized.
- **The bicycling environment should enhance community livability.** Good design should integrate with, and support the development of, complementary uses and should encourage preservation and construction of art, landscaping and other items that add value to public ways. 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 city.
- **Bicycle improvements should be economical.** Bicycle improvements should be designed to achieve the maximum benefit for their cost, including initial cost and maintenance costs as well as reduced reliance on more expensive modes of transportation. Where possible, public improvements in the right-of-way should stimulate, reinforce and connect with adjacent private improvements.
- **Design guidelines are intended to be flexible and to be applied with professional judgment.** Specific national and state guidelines are identified in this document, as well as design treatments

that may exceed these guidelines. It is recognized that statutory and regulatory guidance may change. For this reason, among others, it is noted that the guidance and recommendations in this document are meant to complement the other resources considered during the design process.

References

The following is a list of references and sources utilized to develop these design guidelines. Many of these documents are available online and are a wealth of information and resources available to the public.

Federal Guidelines

- 2010 Americans with Disabilities Act (ADA) Standards for Accessible Design, 2010. Department of Justice. http://www.ada.gov/regs2010/2010ADAStandards/2010ADAstandards.htm#curbramps
- AASHTO Guide for the Development of Bicycle Facilities,[1] 1999. American Association of State Highway and Transportation Officials, Washington, DC. www.transportation.org
- AASHTO Policy on Geometric Design of Streets and Highways, 2001. American Association of State Highway and Transportation Officials, Washington, DC. www.transportation.org
- Accessibility Guidelines for Buildings and Facilities, 2002. United States Access Board, Washington, D.C. http://www.access-board.gov/adaag/html/adaag.htm
- Manual on Uniform Traffic Control Devices (MUTCD), 2009. Federal Highway Administration, Washington, DC. http://mutcd.fhwa.dot.gov
- Public Rights-of-Way Accessibility Guidelines (PROWAG), 2007. United States Access Board, Washington, D.C. http://www.access-board.gov/PROWAC/alterations/guide.htm

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/english/chp1000.pdf
- California Department of Transportation. (2009). *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

Best Practices Documents

- Bicycle Parking Guidelines, 2nd Edition. (2010). Association of Pedestrian and Bicycle Professionals (APBP). http://www.apbp.org/resource/resmgr/webinars/bpg_exec_summary_4-21-10.pdf
- Designing Sidewalks and Trails for Access. (2001). FHWA. http://www.fhwa.dot.gov/environment/sidewalk2/contents.htm
- National Association of City Transportation Officials (NACTO). (2011). Urban Bikeway Design Guide. http://nacto.org/cities-for-cycling/design-guide/
- Portland Bicycle Master Plan for 2030. (2010). City of Portland, Oregon Department of Transportation. http://www.portlandonline.com/transportation/index.cfm?c=44597&a=289122

[1] The Guide for the Development of Bicycle Facilities is currently being updated, and the new document cannot be quoted at the time of this writing. However, many of the facilities under consideration for the update are included in these design guidelines.

- Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations. (2005). FHWA Report HRT-04-100 http://www.tfhrc.gov/safety/pubs/04100/

Bicycle Facilities

The following sheets detail guidance for the design of bicycle facilities.

Bikeway Classification Overview

Discussion

Caltrans has defined three types of bikeways in Chapter 1000 of the Highway Design Manual: Class I/shared use path, Class II/Bike Lane, and Class III/Bike Route. This document uses the generic terms "shared use path", "bike lane" and "bike route".

Design Summary

Class I Path Width:

8 feet is the minimum allowed for a two-way bicycle path and is only recommended for low traffic situations.

10 feet is recommended in most situations and will be adequate for moderate to heavy use.

12 feet is recommended for heavy use situations with high concentrations of multiple users such as joggers, bicyclists, rollerbladers and pedestrians. A separate track (5' minimum) can be provided for pedestrian use.

Class II Bike Lane Width with Adjacent On-Street Parking:

5' minimum recommended when parking stalls are marked

Bike Lane Width without Adjacent Parking:

4' minimum when no gutter is present (rural road sections)

5' minimum when adjacent to curb and gutter (3' more than the gutter pan width if the gutter pan is greater than 2')

Recommended Width: 6' where right-of-way allows

Class III Lane Width for Bicycle Route With Wide Outside Lane:

Fourteen feet (14') minimum is preferred. Fifteen feet (15') should be considered if heavy truck or bus traffic is present. Bike lanes should be considered on roadways with outside lanes wider than 15 feet. This treatment is found on all residential streets, collectors, and minor arterials.

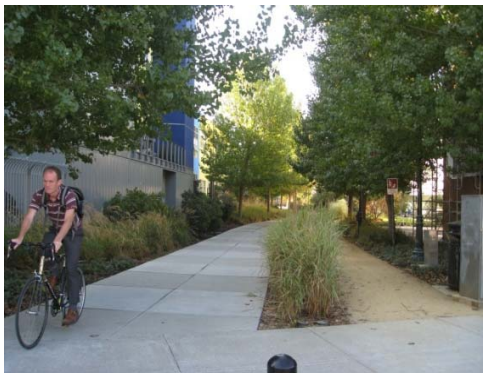
Emeryville Greenway

The off-street portion of the Emeryville Greenway is a multi-use path consisting of a 10-foot concrete bikeway and 6-foot wide decomposed granite walking path. These are separated by a 4-foot wide planting strip

Guidance

- Caltrans *Highway Design Manual* (Chapter 1000: Sections 1003.1(1) and (2), 1003.2(1), 1003.3(1), and 1003.5)
- California MUTCD Chapter 9
- AASHTO Guide for the Development of Bicycle Facilities, Chapter 2

Design Example



Class I Shared Use Bike Path

Class II Bike Lane

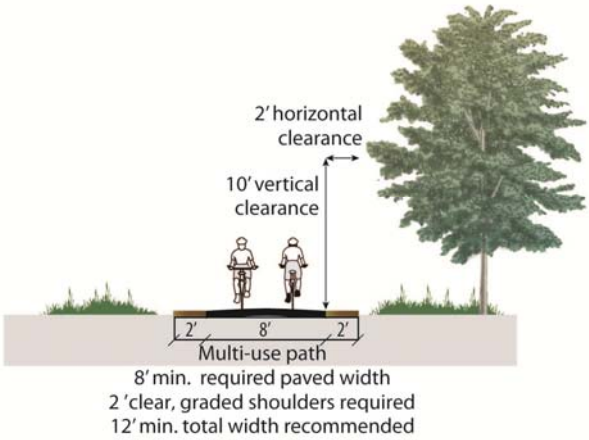
Class III Bike Route

Bikeway Classification Overview

Recommended Design

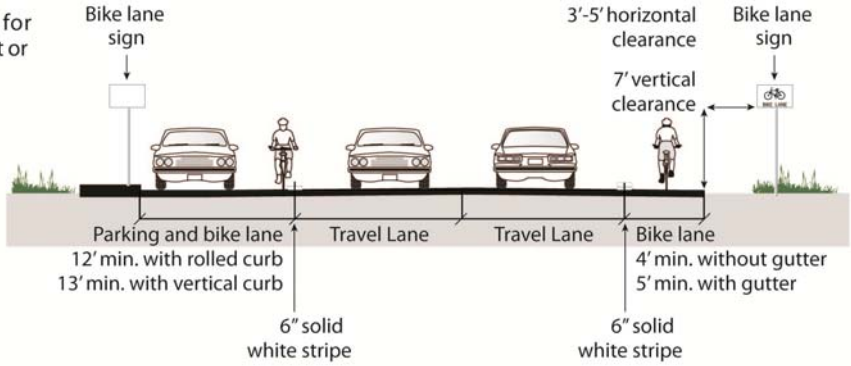
CLASS I
Multi-Use Path

Provides a completely separated right of way for the exclusive use of bicycles and pedestrians with crossflow minimized.



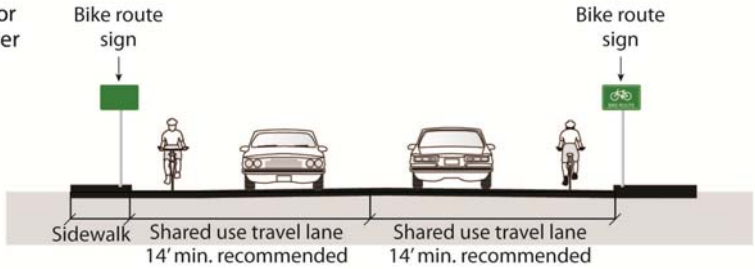
CLASS II
Bike Lane

Provides a striped lane for one-way bike travel on a street or highway.



CLASS III
Bike Route
Signed Shared Roadway

Provides for shared use with pedestrian or motor vehicle traffic, typically on lower volume roadways.



Bike Routes

Discussion

The Caltrans Highway Design Manual (HDM) Chapter 1000 defines Class III bicycle facilities as bikeways shared with motor vehicles. They are typically located on roads with low speeds and traffic volumes; however, they can be used on higher volume roads with wide outside lanes or with shoulders.

Shared roadways are indicated exclusively by signs that identify the street as a bike route (see right). Wayfinding signs can also be used to indicate connections to destinations and paths (see Section 0), and shared lane markings or bicycle boulevard treatments can be used to enhance shared roadways.

Design Summary

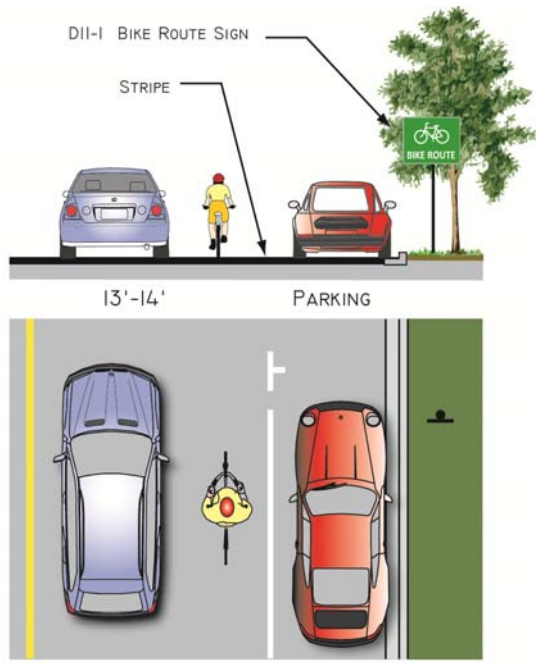
- Use D11-1 Bike Route Sign at:
  - Beginning or end of bike route
  - Entrance to bike path (Class I) – optional.
  - At major changes in direction or at intersections with other bike routes (with applicable arrow or directional sign).

At intervals along bike routes not to exceed ½ mile.

Guidance

- Caltrans Highway Design Manual Chapter 1000
- AASHTO Guide for the Development of Bicycle Facilities
- *MUTCD* – California Supplement 2011 Draft Edition

Design Example



Shared roadway recommended configuration.

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

Additional Bike Route Signage

Discussion

'Share the Road' signs are intended to reduce motor vehicle/bicyclist conflict and are appropriate to be placed on routes that lack paved shoulders or other bicycle facilities. They typically work best when placed near activity centers such as schools, shopping centers and other destinations that attract bicycle traffic.

Many cities around the country have been experimenting with a new type of signage that encourages bicyclists to take the lane when the lane is too narrow. This type of sign is becoming known as BAUFL (Bikes Allowed Use of Full Lane). This can be quantified to lanes being less than 14 feet wide with no parking and less than 22 feet wide with adjacent parallel parking. The 2009 update to the MUTCD recognizes the need for such signage and has designated the white and black sign at right (R4-11). The 2010 CA MUTCD states that Shared Lane Markings (which serve a similar function as Bikes May Use Full Lane signage) should not be placed on roadways that have a speed limit above 40 mph. Dedicated bicycle facilities are recommended for roadways with speed limits above 40 mph where the need for bicycle access exists.

Design Summary

Placement:

- At the beginning of the bikeway
- When a bikeway turns (particularly in advance of left turns to allow a bicyclist time to merge for the turn)
- When bikeways intersect
- At intervals of ½ to one mile (based on density of streets) along routes with no designated bicycle facilities.

Guidance

- MUTCD – California Supplement 2011 Draft Edition
- City of Oakland. 2009. Guidelines for Bicycle Wayfinding Signage

Design Example

R4-11

Share The Road Signs (CA MUTCD 2011 Draft)

Shared Lane Markings

Discussion

Shared lane markings are high-visibility pavement markings that help position bicyclists within the travel lane. These markings are often used on streets where dedicated bike lanes are desirable but are not possible due to physical or other constraints. Shared lane markings are placed strategically in the travel lane to alert motorists of bicycle traffic, while also encouraging cyclists to ride at an appropriate distance from the "door zone" of adjacent parked cars. Placed in a linear pattern along a corridor, shared lane markings also encourage cyclists to ride in a straight line so their movements are predictable to motorists.

Shared lane marking stencils (also called "sharrows") have been introduced for use in California as an additional treatment for Class III facilities. 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.

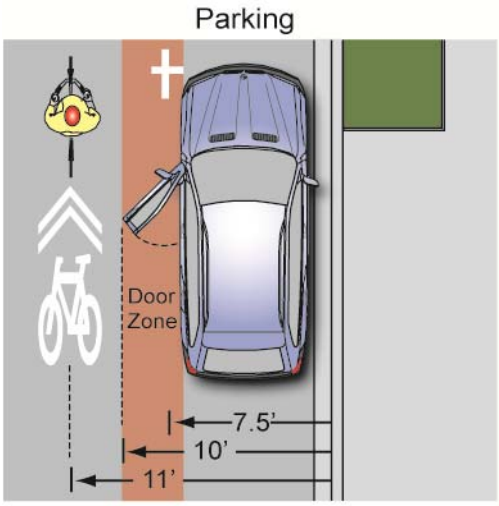
Design Summary

- Use D11-1 "Bike Route" Sign as specified for shared roadways.
- Place shared lane markings in a linear pattern along a corridor (typically every 100-200').
- Centered at least 11' from face of curb (or shoulder edge) on streets with on-street parking.
- At least 4' from face of curb (or shoulder edge) on streets without on-street parking.
- Shared lane markings should not be placed on roadways with a speed limit over 40 mph (CA MUTCD 2011 Draft).
- Marking should be placed immediately after an intersection and spaced at intervals no greater than 250' thereafter (CA MUTCD 2011 Draft).

Guidance

- 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.
- Caltrans *Highway Design Manual* (Chapter 1000).
- NACTO Urban Bikeway Design Guide.

Design Example



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

Shared lane markings were first tested in San Francisco

Bike Lanes

Discussion

Bike lanes or Class II bicycle facilities (Caltrans designation) are 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 connector or transit streets 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 Example

Approved R81(CA) Sign.

Approved California bike lane stencils

Design Summary

- Width: 5-8′ measured from edge of gutter pan. Varies depending on roadway configuration; see following pages for design examples.
- Use dashed white stripe in the following locations:
  - Vehicle merging area (optional)
  - Approach to intersections: 100-200′
  - Delineate conflict area in intersections (optional): Length of conflict area.
- Signing: use R81(CA) Bike Lane Sign at:
  - Beginning of bike lane
  - At approaches and at far side of all arterial crossings
  - At major changes in direction
  - At intervals not to exceed ½ mile
- Use the bike lane stencil with directional arrow to be used at:
  - Beginning of bike lane
  - 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

Guidance

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

Bike Lane Adjacent to On-Street Parallel Parking

Discussion

Bike lanes adjacent to parallel parking should be designed to be wide enough to allow bicyclists to ride outside of the "door zone" (i.e., five feet minimum).

Treatments to encourage bicyclists to ride away from the "door zone" include:

- Installing parking "T's" and smaller bike lane stencils placed to the left (see graphic at top).
- Using diagonal stripes to encourage cyclists to ride on the left side of the bike lane (shown middle; this treatment is not standard and should be studied before use).
- Provide a buffer zone (preferred design; shown bottom). Bicyclists traveling in the center of the bike lane will be less likely to encounter open car doors. Motorists have space to stand outside the bike lane when loading and unloading.

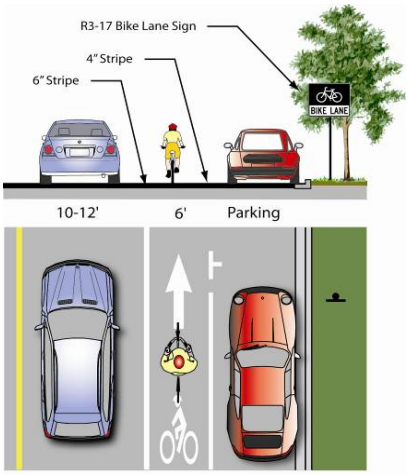
Design Summary

- Width:
  - 6" recommended when parking stalls are marked (5' minimum)
  - 7' maximum (greater widths may encourage vehicle loading in bike lane).
- Shared bike and parking lane width:
- 12 feet for a shared lane adjacent to a curb face (13 feet is preferred where parking is substantial or turnover is high), or 11' minimum for a shared bike/parking lane on streets without curbs where parking is permitted.

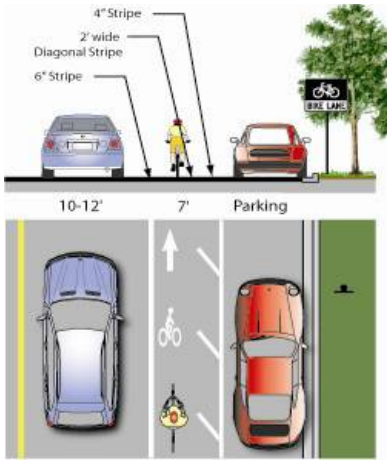
Guidance

- AASHTO Guide for the Development of Bicycle Facilities
- Caltrans *Highway Design Manual* (Chapter 1000)
- MUTCD – California Supplement 2011 Draft Edition

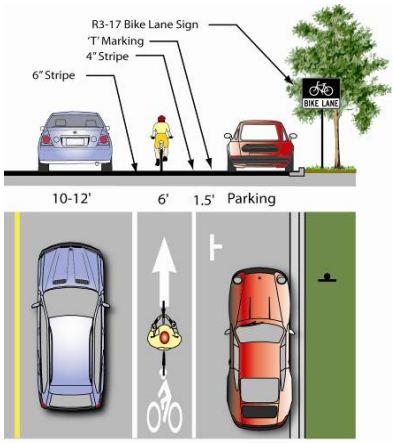
Design Example



Parking 'T' bike lane design.



Diagonal stripe bike lane design (maximum width).



Parking buffer bike lane design.

Bike Lane Adjacent to On-Street Diagonal Parking

Discussion

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

"Back-in diagonal parking" or "reverse angled parking" improves sightlines between drivers and bicyclists and provides benefits to motorists including: loading and unloading of the trunk occurs at the curb rather than in the street, passengers (including children) are directed by open doors towards the curb. While there may be a learning curve for some drivers, using back-in diagonal parking is typically an easier maneuver than conventional parallel parking.

Emeryville's past experiments with back-in diagonal parking have been discontinued due to motorist confusion over the proper way to use the parking. Any future treatments should include significant public outreach and education.

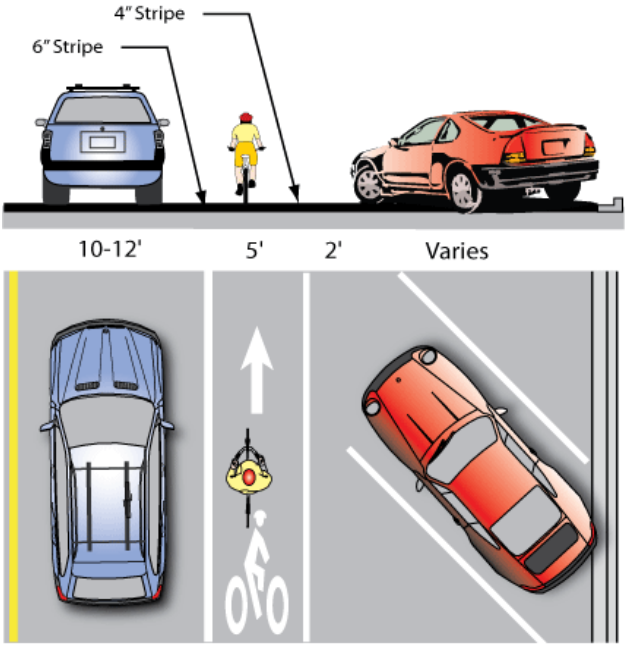
Design Summary

- Width:
  - 5' minimum.
  - White 4" stripe separates bike lane from parking bays.
  - Parking bays are sufficiently long to accommodate most vehicles (vehicles do not block bike lane).

Guidance

- Slated for inclusion in the upcoming update of the AASHTO *Guide for the Development of Bicycle Facilities.*

Design Example



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

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

Bike Lane Without On-Street Parking

Discussion

Recommended bicycle lane width is 5 feet minimum when adjacent to curb and gutter. Wider bicycle lanes are desirable in certain circumstances such as on higher speed or volume streets (30 mph+) where a wider bicycle lane can increase separation between passing vehicles and bicyclists. Appropriate signing and stenciling is important with wide bicycle lanes to ensure motorists do not mistake the lane for a vehicle lane or parking lane. Bicycle lanes wider than seven feet are not recommended.

Design Summary

- Width:
  - 4′ minimum when no curb & gutter is present
  - 5′ minimum when adjacent to curb and gutter (3′ more than the gutter pan width if the gutter pan is wider than 2′).
  - 6′ recommended where right-of-way allows.

7′ maximum adjacent to high speed streets

Guidance

- AASHTO Guide for the Development of Bicycle Facilities
- Caltrans *Highway Design Manual* (Chapter 1000)
- MUTCD – California Supplement 2011 Draft Edition

Design Example

Recommend bike lane without on-street parking design.

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

Buffered Bike Lanes

Discussion

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

This treatment is appropriate on roads with high automobile traffic volumes and speed or high volumes of truck or oversized vehicles, and on bike lanes adjacent to parked cars. If there is a high frequency of right turns by motor vehicles at major intersections, buffer striping should be truncated approaching the intersection.

Advantages of buffered bike lanes:

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

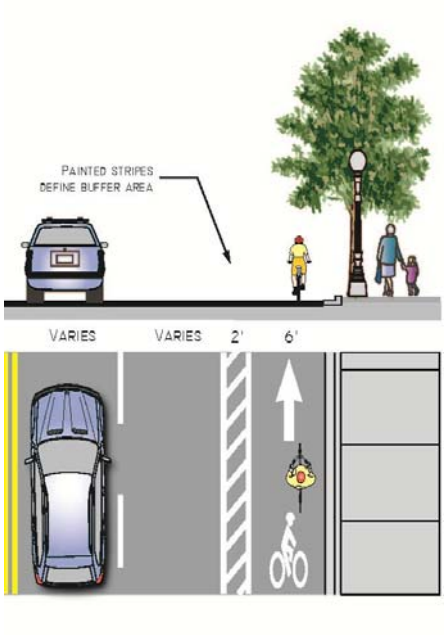
Disadvantages / potential hazards:

- Requires additional roadway space.
- Requires additional maintenance for the buffer striping.
- Frequency of parking turnover should be considered prior to installing buffered bike lanes.

Design Summary

- Width: 6' recommended
- Minimum of 2' buffer area

Design Example



Recommended buffered bike lane design.

Buffered bike lanes in San Rafael, CA

Guidance

- City of Portland, OR Bikeway Design Best Practices for the 2030 Bicycle Master Plan
- NACTO. Urban Bikeway Design Guide

Contraflow Bike Lane

Discussion

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

Advantages of contraflow bike lanes:

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

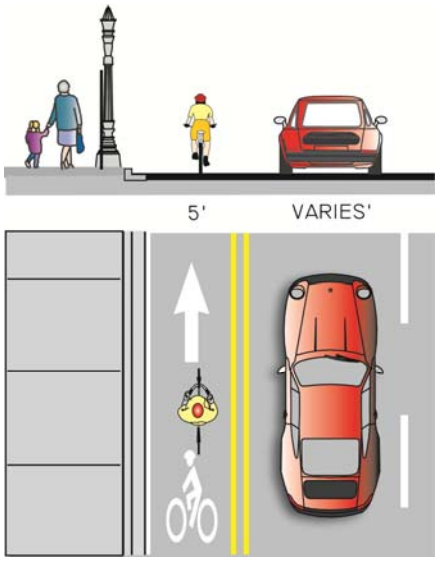
Disadvantages / potential hazards

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

Design Summary

- Width: 5-7
- Mark with a solid double yellow line and bike lane markings that are clearly visible.
- Consider coloration on the bike lane.

Design Example



Recommended contraflow bike lane design.

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

Guidance

- Wisconsin Bicycle Facility Design Handbook.
- City of Portland, OR Bikeway Design Best Practices for the 2030 Bicycle Master Plan.
- Currently used in Berkeley, CA, Olympia and Seattle, WA; Madison, WI, Cambridge, MA, San Francisco, CA, and Portland, OR.
- NACTO. Urban Bikeway Design Guide.

Shared Bicycle/Bus Lane

Discussion

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

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

On auto-congested streets, or with moderate or long bus headways.

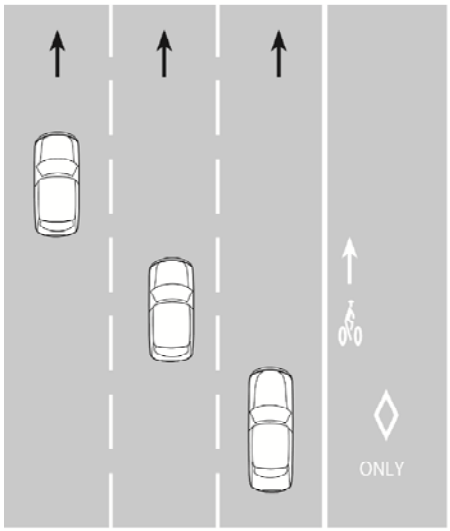
Moderate bus headways during peak hour.

No reasonable alternative route.

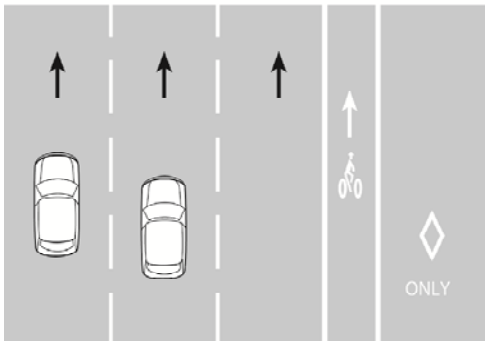
Design Summary

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

Design Example



Minimum design: shared bicycle/bus lane.



Preferred design: separated bike lane and bus lane.

Bicycle Detection at Signalized Intersections

Discussion

Traffic Operations Policy Directive 09-06, issued August 27, 2009 by Caltrans modified CA MUTCD 4D.105 to require bicyclists to be detected at all traffic-actuated signals on public and private roads and driveways. If more than 50 percent of the limit line detectors need to be replaced at a signalized intersection, then the entire intersection should be upgraded so that every line has a limit line detection zone. Bicycle detection must be confirmed when a new detection system has been installed or when the detection system has been modified.

The California Policy Directive does not state which type of bicycle detection technology should be used. Two common types of detection are video and in pavement loop detectors. Where loop detectors exist, they can be calibrated to detect bicycles without significant cost. Video detection has a higher initial cost.

Design Summary

Caltrans Policy Directive 09-06 requires bicycle detection or fixed recall at all new and modified signals.

Provide bicycle detectors in a left-turn only lane where cyclists regularly make left turn movements.

Clearance Interval

The sum of the minimum green, yellow change interval, and red clearance interval should allow clearance for a 6' bicycle traveling at 14.7 ft/sec, with a start-up time of 6 seconds (see CA policy directive)

Limit Lines

The Reference Bicycle Rider must be detected with 95% accuracy within a 6 foot by 6 foot Limit Line Detection Zone.

Loop Detector

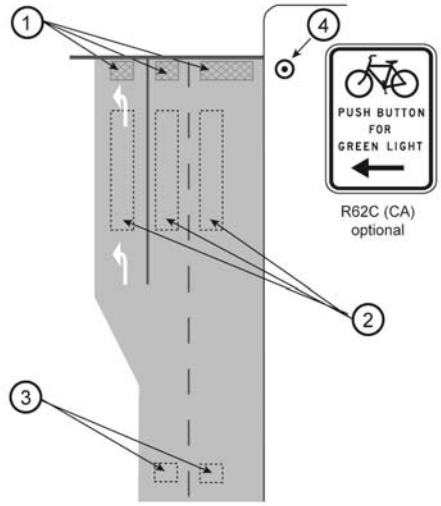
In order to minimize delay to bicyclists, it is recommended to install one loop about 100 feet from the stop bar within the bike lane, with a second loop located at the stop bar.

Details of saw cuts and winding patterns for inductive detector loop types appear on Caltrans Standard Detail ES-5B.

- NOTE: In California, Caltrans "Type C" and "Type D" quadruple loop detectors have been proven to be the most effective at detecting bicycles at signalized intersections.

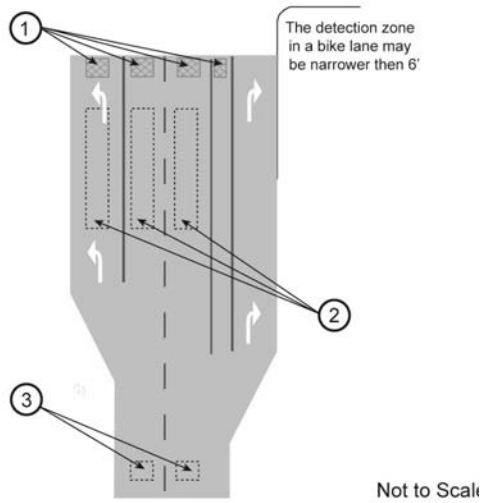
Design Example

A. Intersection with a wide right/through lane



1. Typical technology-neutral limit line detection locations. See Section 4D.105(CA).
2. Typical presence detection locations. See Section 4D.103(CA).
3. Typical advance detection locations.
4. A bicyclist pushbuttion may be used to activate a traffic signal to supplement the required limit line detection. A pushbutton should be located so it is convenient to use by bicyclists. See Section 9B.1 for bicycle regulatory signs.

B. Intersection with a Bike Lane and right-turn lane



Source: Caltrans Traffic Operations Policy Directive 09-06Video Detection – Designs not available

Bicycle Detection at Signalized Intersections

Guidance

- Caltrans Policy Directive 09-06. Provide Bicycle and Motorcycle Detection on all new and modified approaches to traffic-actuated signals in the state of California. http://www.dot.ca.gov/hq/traffops/signtech/signdel/policy/09-06.pdf
- ITE Guidance for Bicycle—Sensitive Detection and Counters: http://www.ite.org/councils/Bike-Report-Ch4.pdf

Type "C" loop detector in use in California.

Bike Lanes at Channelized Intersection With Right Turn Pocket

Discussion

The channelized intersection with right-turn pocket places a standard-width bike lane on the left side of a dedicated right turn lane. A dashed strip delineates the merging zone where automobiles cross the bike lane. This treatment includes signage advising motorists and bicyclists of proper positing 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. See the sheet following for applications, where right-of-way is insufficient.

Colored bike lanes can help distinguish the bike lane in the merging area (see colored bike lane guidelines).

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 numbers of right-turning heavy vehicles.

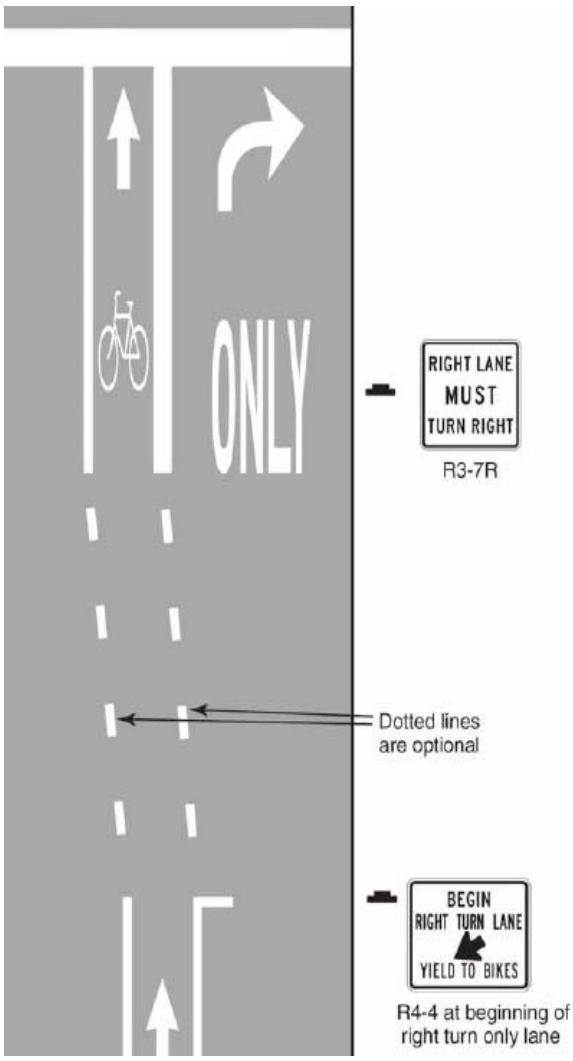
Design Summary

- Shared turn lane width – min. 12' width.
- Bike lane pocket width – min. 4'-5' preferred.
- Works best on streets with lower posted speeds (30 mph or less) and with low traffic volumes (10,000 ADT or less).

Guidance

- AASHTO Guide for the Development of Bicycle Facilities.
- Caltrans *Highway Design Manual* (Chapter 1000).
- *MUTCD* – California Supplement.
- NACTO. Urban Bikeway Design Guide.

Design Example



Recommended shared bike/right turn lane design.

Source: MUTCD-CA Figure 9C-4.

Continuing a bike lane straight while providing a right-turn pocket reduces bicycle/motor vehicle conflicts.

Shared Bicycle/Right Turn Lane

Discussion

This treatment is recommended at intersections lacking sufficient space to accommodate a standard bike lane and right turn lane. The shared bicycle/right turn lane places a standard-width bike lane on the left side of a dedicated right turn lane. A dashed strip delineates the space for bicyclists and motorists within the shared lane. This treatment includes signage advising motorists and bicyclists of proper positioning within the lane. Case studies cited by the Pedestrian and Bicycle Information Center indicate that this treatment works best on streets with lower posted speeds (30 MPH or less) and with lower traffic volumes (10,000 ADT or less).

Advantages of Shared Bicycle/Right Turn Lanes

- Aids in correct bicycle positioning at intersections with a dedicated right turn lane without adequate space for a dedicated bike lane.
- Encourages motorists using the right turn lane to yield to bicyclists.
- 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.

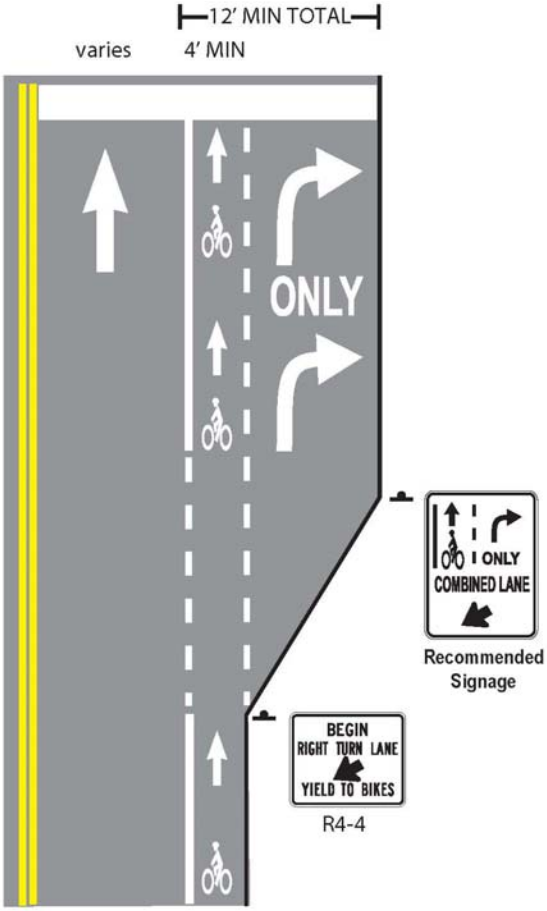
Design Summary

- Width
  - Shared turn lane – min. 12′ width
  - Bike Lane pocket – min. 4′ width. 6′preferred

Guidance

- This has been implemented in Oakland, CA.
- AASHTO Guide for the Development of Bicycle Facilities.
- NACTO. Urban Bikeway Design Guide.

Design Example



Recommended design.

Shared bicycle/right turn lanes require warning signage as well as pavement markings.

Bike Box

Discussion

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

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

Bike boxes should be located at signalized intersections only, and right turns on red should be prohibited. Bike boxes should be used at locations that have a relatively large volume of cyclists.

On roadways without left turn pockets, the bike box also facilitates left turning movements for cyclists.

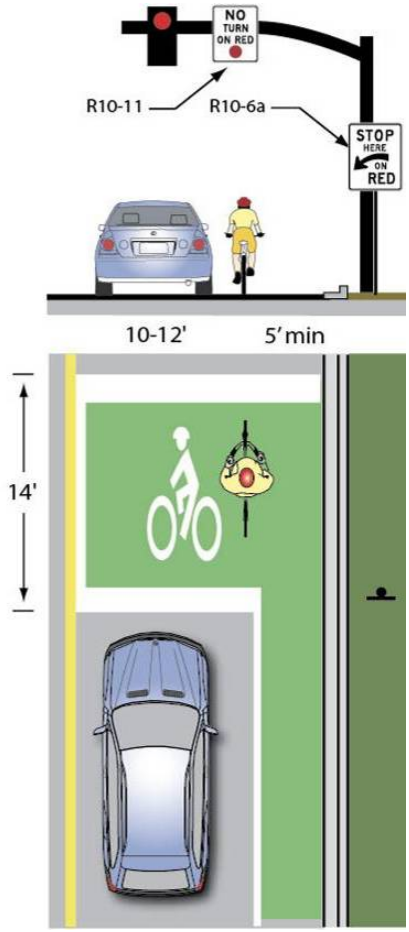
Design Summary

- Bike box dimensions: 14' deep to allow for bicycle positioning.
- Use appropriate signs as recommended by the MUTCD. Signs should prohibit 'right turn on red' and indicate where the motorist must stop.

Guidance

- FHWA has granted interim approval for use of green markings for bike lanes and cycle tracks within intersections, at conflicting points, and behind bike lane symbols and arrows (IA Memo #14).
- Evaluation of Innovative Bike-Box Application in Eugene, Oregon, Author: Hunter, W.W., 2000.
- NACTO. Urban Bikeway Design Guide.
- San Francisco, CA and Portland, OR have implemented bike boxes.

Design Example



Recommended design of a bike box.

Bike boxes have been installed at several intersections in Portland, OR

Colored Bike Lanes

Discussion

Color applied to bike lanes helps alert roadway users to the presence of bicyclists and clearly assigns right-of-way to cyclists. Motorists are expected to yield to cyclists in these areas. Some cities apply color selectively to highlight potential conflict zones, while others use it to mark all non-shared bicycle facilities in high volume traffic situations.

Color Considerations:

There are three colors commonly used in bicycle lanes: blue, green, and red. All help the bike lane stand out in merging areas. The City of Portland began using green lanes in 2008, as blue, the color used previously, is associated with ADA related signage on roadways. Green is the color recommended for use in Emeryville.

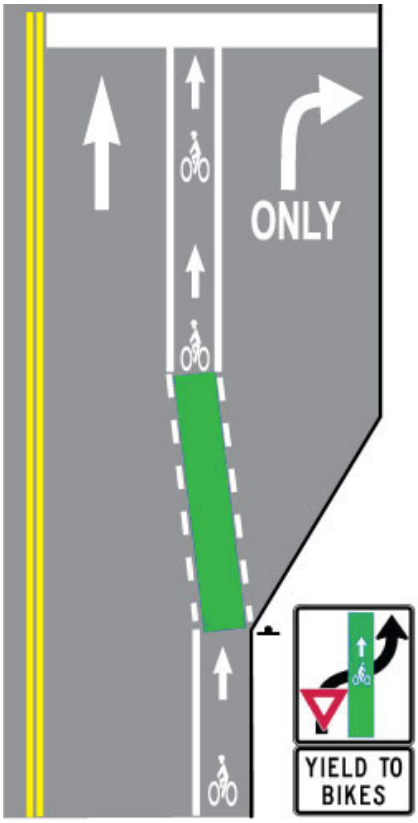
Material Options:

Colored bike 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.



Recommended colored bike lane design.

Design Summary

Appropriate for heavy auto traffic streets with bike lanes; at transition points where cyclists, motorists and/or pedestrians must weave with one another; conflict areas or intersections with a record of crashes; and to emphasize bicycle space in unfamiliar or unique design treatments.

Guidance

- FHWA has granted interim approval for use of green markings for bike lanes and cycle tracks within intersections, at conflicting points, and behind bike lane symbols and arrows (IA Memo #14).
- Portland Office of Transportation (1999). Portland's Blue Bike Lanes: Improved Safety through Enhanced Visibility. Available: www.portlandonline.com/shared/cfm/image.cfm?id=58842
- NACTO. Urban Bikeway Design Guide.

Portland, OR has used colored pavement in potential bicycle/auto conflict zones for over 10 years.

Cycletracks

Discussion

Cycletracks combine the user experience of a separated path with the on-street infrastructure of a conventional bike lane. Cycletracks have different forms, but all share common elements. They are separated from vehicle traffic lanes, parking lanes and sidewalks and provide space exclusively for bicyclists. When on-street parking is available, cycletracks are located on the outside of the parking lane. Cycletracks can be either one-way or two-way, on one or both sides of a street, and are separated from vehicles and pedestrians by pavement markings or coloring, bollards, curbs/medians or a combination of these elements. See following page for additional discussion.

Design Summary

Bikeways separated from adjacent motor vehicles by a physical barrier or line of parked cars.

Separation can be achieved in multiple ways, including grade separation, mountable curb, bollards, planters and markings.

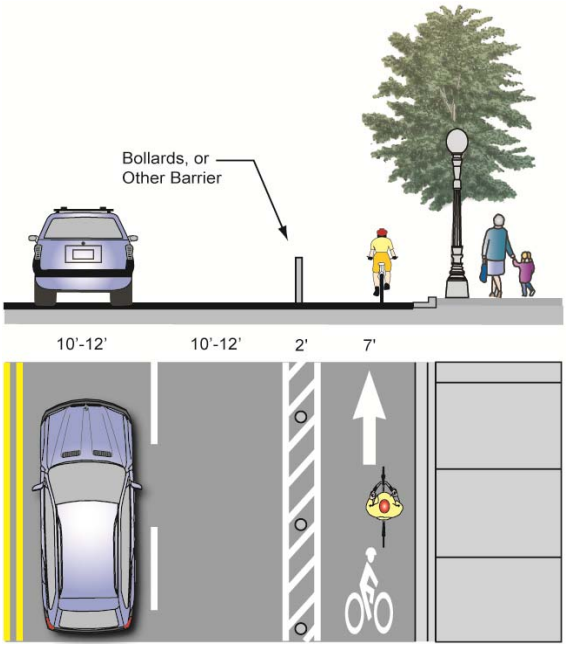
Most appropriate on wide, high-volume, high-speed roadways that are on major bike routes; and roadways with infrequent cross streets, curb cuts and long blocks.

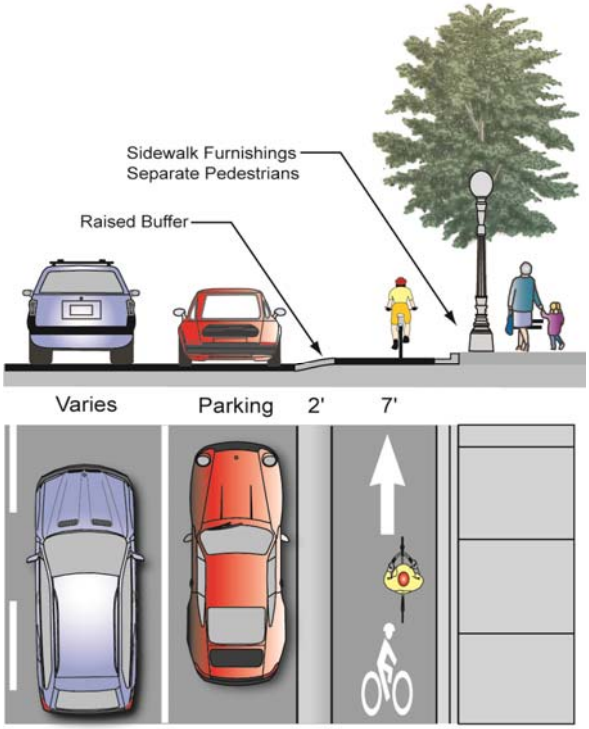
Cycletrack Width:

- 7 feet minimum for passing/obstacle avoidance
- 12 feet minimum for two-way facility

Design Example

Design Example (continued)





Guidance

This treatment is not currently present in any State or Federal design standards

Cycletracks

Additional Discussion – Cycletracks

Separation

Cycletracks can be separated by a barrier or by on-street parking. Cycletracks using barrier separation are typically at-grade. Openings in the barrier or curb are needed at driveways or other access points. The barrier should be dropped at intersections to allow vehicle crossing.

When on-street parking is present, it should separate the cycletrack from the roadway, the cycletrack should be placed with a 2-foot buffer between parking and the cycletrack to minimize the hazard of opening car doors to passing bicyclists.

Placement

Cycletracks should be placed along slower speed urban/suburban streets with long blocks and few driveway or midblock access points for vehicles. Cycletracks located on one-way streets will have fewer potential conflicts than those on two-way streets. A two-way cycletrack is desirable when there are more destinations on one side of a street or if the cycletrack will be connecting to a shared use path or other bicycle facility on one side of the street.

Cycletracks should only be constructed along corridors with adequate right-of-way. Sidewalks or other pedestrian facilities should not be narrowed to accommodate the cycletrack as pedestrians will likely walk on the cycletrack if sidewalk capacity is reduced. Visual and physical cues should be present that make it easy to understand where bicyclists and pedestrians should be moving.

Intersections

Cycletracks separate bicyclists and motor vehicles to a greater degree than bicycle lanes. This produces added comfort for bicyclists on the cycletrack, but it creates additional considerations at intersections that must be addressed. Right turning motorists conflicting with cycletrack users is the most common conflict. Both roadway users have to expand their visual scanning to see potential conflicts. To mitigate for this issue, several treatments can be applied at intersections:

Protected Phases at Signals. This treatment must have separate signal phases for bicyclists and will potentially increase delay. With this treatment, left and right turning movements are separated from conflicting through movements. The use of a bicycle signal head is required in this treatment to ensure all users know which signals to follow. Demand only bicycle signals can be implemented to reduce vehicle delay to prevent an empty signal phase from regularly occurring. With this scenario, a push button or imbedded loop within the cycletrack should be available to actuate the signal. If heavy bicyclist left turns are expected, these movements should be given its own signal phase and push button.

Advanced Signal Phases. Signalization utilizing a bicycle signal head can also be set to provide cycletrack users a green phase in advance of vehicle phases. The amount of time will depend on the width of the intersection.

Unsignalized Treatments. At non-signalized intersections the same conflicts exist. Warning signs, special markings and the removal of on-street parking (if present) in advance of the intersection can all raise visibility and awareness for bicyclists.

Access Management. The reduction in the number of potential conflict points can also benefit a cycletrack corridor. Medians, driveway consolidations, or restricted movements reduce the potential for conflict.

Bike Path Design

Discussion

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

When concrete is used the bike path should be designed and installed using the narrowest possible expansion joints to minimize the amount of 'bumping' cyclists experience on the path.

Where possible, bike paths should be designed according to ADA standards. ADA accessibility requirements for trails are exclusive to trails designed and constructed primarily for pedestrians; mountain bike and equestrian trails that also allow pedestrians, but where hiking is not the primary use, are exempt from accessibility requirements. Constructing soft surface paths may have limitations that make meeting ADA standards difficult and sometimes prohibitive. Prohibitive impacts include harm to significant cultural or natural resources, a significant change in the intended purpose of the path, requirements of construction methods that are against federal, state or local regulations, or presence of terrain characteristics that prevent compliance.

Design Summary

Width

8 feet minimum paved path width (Caltrans). AASHTO recommends a paved width of 10 feet.

A 3 to 4-foot wide native surface path may be considered alongside shared-use paths for runners.

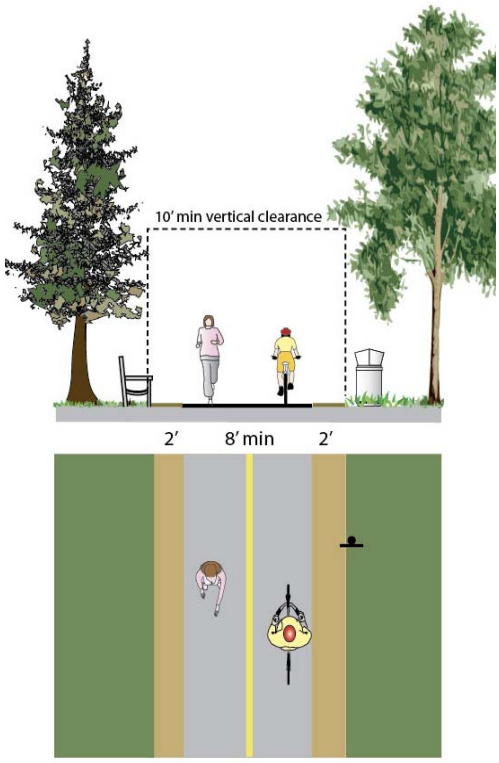
Paving

Hard, all-weather pavement surfaces are usually preferred over those of crushed aggregate, sand, clay or stabilized earth (AASHTO).

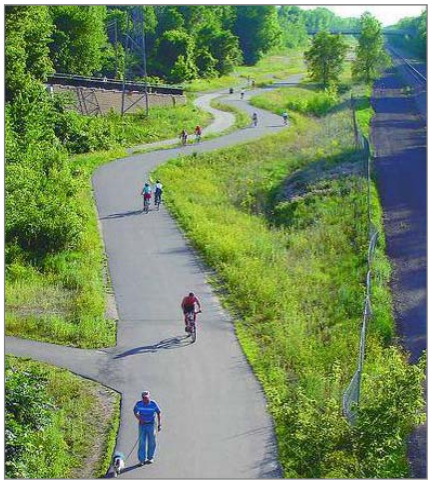
Guidance

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

Design Example



Recommended bike path design.



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

Managing Multiple Users on Bike Paths

Discussion

On paths 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 and Separation

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

Physical Separation

Differing surfaces suitable to each user group foster visual separation and clarity of where each user group should be. When path corridors are constrained, the approach is often to locate the two different path surfaces side by side with no separation.

The pedestrian path should be separated from the bike path if possible. Otherwise, physical separation should be provided in the form of a small hump or other crossable barrier.

The bicycle path should be located on whichever side of the path will result in the fewest number of anticipated pedestrian crossings. For example, the bike path should not be placed adjacent to large numbers of destinations.

Bike Path Etiquette Signage

Informing path users of acceptable path 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 path experience involving multiple path users. Path right-of-way information should be posted at path access points and along the path. 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.

Design Summary

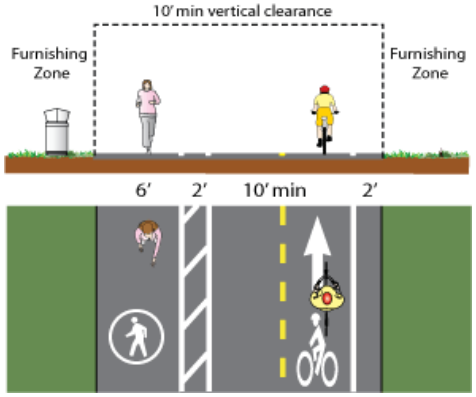
- Barrier separation – vegetated buffers or barriers, elevation changes, walls, fences, railings and bollards.
- Distance separation – differing surfaces.
- User behavior guidance signage.

Guidance

- The 2010 CA-MUTCD contains additional information about centerline striping on a path.

Design Example

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



Recommended design for a separated bike path.

A commonly used bike path etiquette sign.

Path/Roadway Crossings

Discussion

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

Evaluation of path crossings involves analysis of vehicular and anticipated path user traffic patterns, including vehicle speeds, street width, sight distance, traffic volumes (average daily traffic and peak hour traffic), path user profile (age distribution, destinations served). 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.

An engineering study should determine whether to give pathway users or motorists the right of way at a pathway crossing. In some instances, it may be appropriate to require motorists to yield or stop for pathway users and give pathway users the right-of-way.

Design Example

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

Design Summary

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

- Type 1: Marked/Unsignalized Unprotected crossings include path 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 - Paths 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 - Path crossings that require signals or other control measures due to traffic volumes, speeds, and path 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.

Guidance

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

Path/Roadway Crossings

Guidance (continued)

Summary of Path/Roadway At-Grade Crossing Recommendations[2]

	Vehicle ADT < 9,000			Vehicle ADT > 9,000 to 2,000			Vehicle ADT > 12,000 to 15,000			Vehicle ADT > 15,00		
	Speed Limit(mph)**											
Roadway Type	**30**	**35**	**40**	**30**	**35**	**40**	**30**	**35**	**40**	**30**	**35**	**40**
2 Lanes	1	1	1/1+	1	1	1/1+	1	1	1+/3	1	1/1+	1+/3
3Lanes	1	1	1/1+	1	1/1+	1/1+	1/1+	1/1+	1+/3	1/1	1+/3	1+/3
Multi-Lane (4+) w/ raised median***	1	1	1/1+	1	1/1+	1+/3	1/1+	1/1+	1+/3	1+/3	1+/3	1+/3
Multi-Lane (4 +) w/o raised median	1	1/1+	1+/3	1/1+	1/1+	1+/3	1+/3	1+/3	1+/3	1+/3	1+/3	1+/3

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

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

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

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

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

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

1+/3 = Carefully analyze signal warrants using a combination of Warrant 2 or 5 (depending on school presence) and Equivalent Adult Unit (EAU) factoring. Make sure to project pathway usage based on future potential demand. Consider half-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.

[2] 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.

Type 1 Path Crossings: Marked/Unsignalized

Discussion

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 (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.

Currently, the crossings of the Greenway at 65th, 66th, and 67th Streets use this design.

Design Summary

Maximum traffic volumes:

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

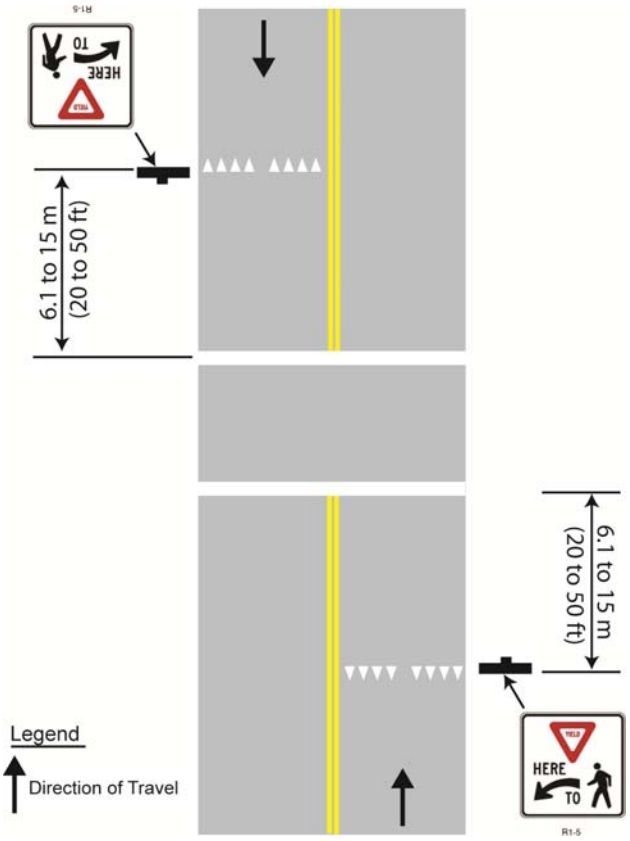
Maximum travel speed:

- 35 MPH.
- Minimum line of sight:
- 25 MPH zone: 155 feet.
- 35 MPH zone: 250 feet.
- 45 MPH zone: 360 feet.

Guidance

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

Design Example



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

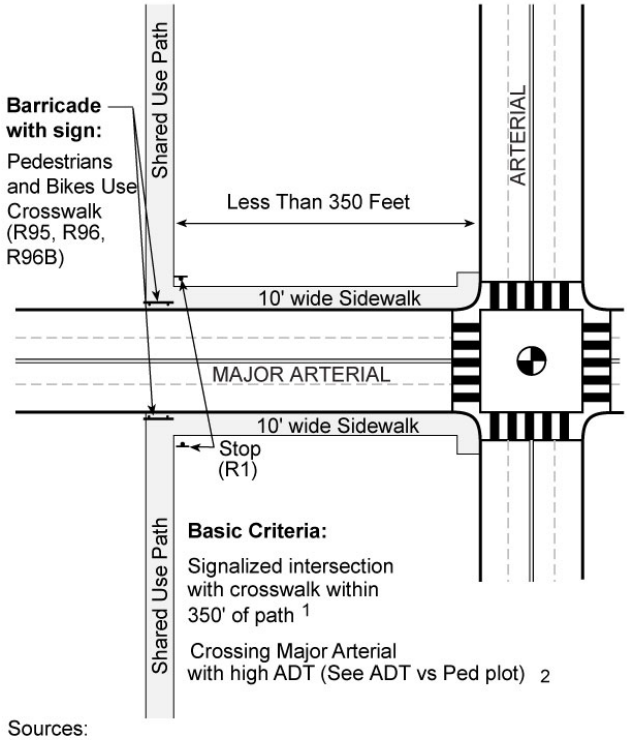
Recommended signage.

Type 2 Path Crossings: Route Users to Existing Signalized Intersection

Discussion

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 Example



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 feet of a roadway intersection

Design Summary

- A path 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 street with high average daily traffic (ADT) volumes.
- Intersection Warning (W2-1 through W2-5) signs may be used on a roadway, street, or shared-use path in advance of an intersection to indicate the presence of an intersection and the possibility of turning or entering traffic. A trail-sized stop sign (R1-1) may be placed about 5 feet before the intersection.
- Reducing the speed of the conflicting motor vehicle traffic should be considered. Options may include: transverse rumble strips approaching the trail crossing; sinusoidal speed humps[3] (compatible with slow speed snow removal operations.

Guidance

- Caltrans *Highway Design Manual* (Chapter 1000).
- *MUTCD* – California Supplement, 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.*

[3] Humps with a sinusoidal profile are similar to round-top humps but have a shallower initial rise (similar to a sine wave).

Type 3 Path Crossings: Signalized/Controlled Crossings

Discussion

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.

Experimental Treatment

A Toucan crossing (derived from: "two can cross") is used in higher traffic areas where pedestrians and bicyclists are crossing together.

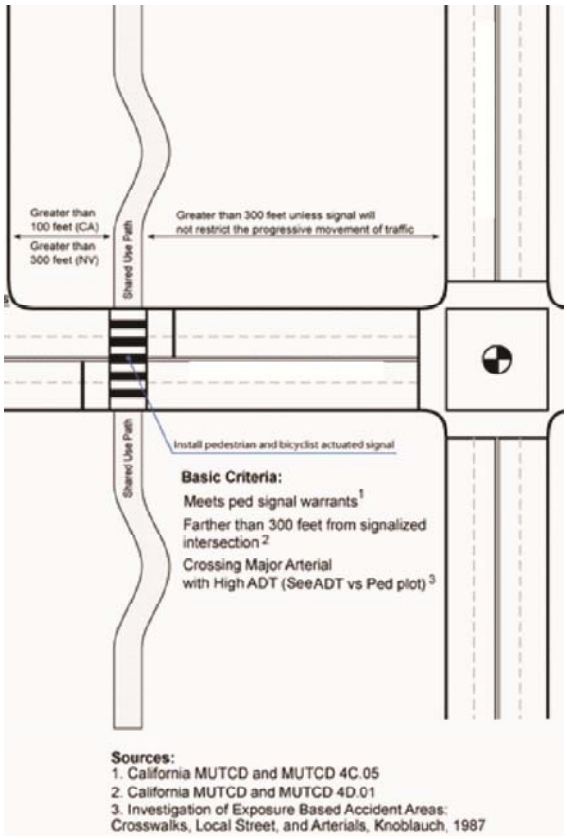
Design Summary

- 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' in advance of the nearest signal indication.

Guidance

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

Design Example



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

Toucan Crossing (This experimental treatment has not been approved for use in California).

Bicycle and Pedestrian Overcrossing Design

Discussion

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

See following page for additional discussion.

Design Summary

Width

8 feet minimum, 14 feet preferred. If overcrossing has any scenic vistas additional width should be provided to allow for stopped path users. A separate 5 foot pedestrian area may be provided for facilities with high bicycle and pedestrian use.

Height

10 feet headroom on overcrossing; clearance below will vary depending on feature being crossed.

Signage & Striping

The overcrossing should have a centerline stripe even if the rest of the path does not have one.

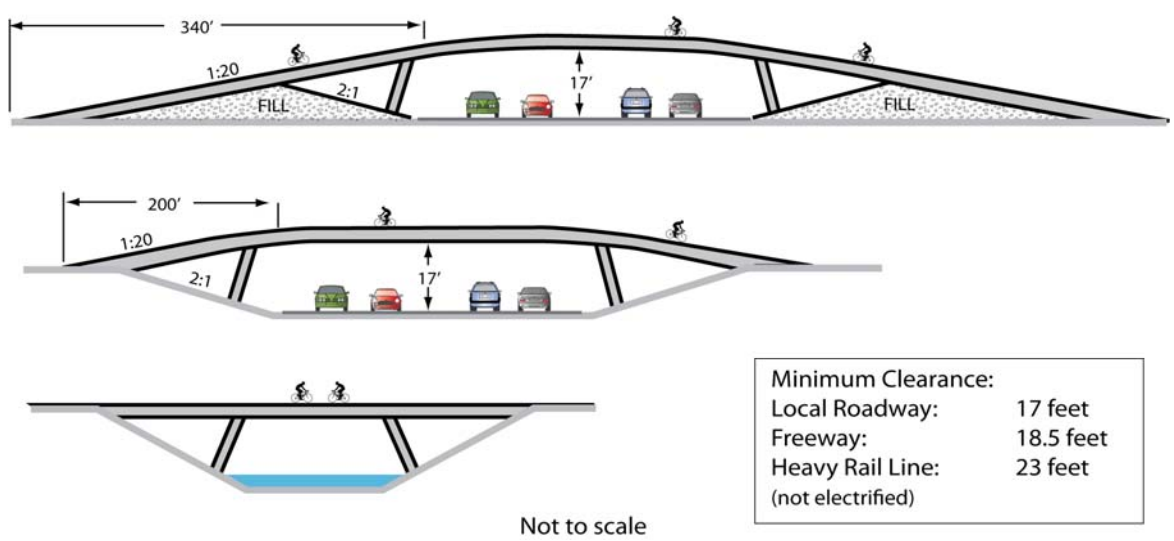
ADA Compliance

Either ramp slopes to 5% (1:20) with landings at 400 foot intervals or ramp slopes of 8.33% (1:12) with landings every 30 feet.

Guidance

- Caltrans Highway Design Manual (Chapters 200 & 1000)
- Caltrans Bridge Design Specifications
- MUTCD – California Supplement
- AASHTO Guide for the Development of Bicycle Facilities
- AASHTO Guide Specifications for Design of Pedestrian Bridges

Design Example



Additional Discussion – Grade Separated Overcrossing

Ramp Considerations:

Overcrossings for bicycles and pedestrians typically fall under the Americans with Disabilities Act (ADA), which strictly limits ramp slopes to 5% (1:20) with landings at 400 foot intervals, or 8.33% (1:12) with landings every 30 feet.

Overcrossing Use:

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.
- An at-grade crossing is not feasible.
- Crossing is needed over a grade-separated facility such as a freeway or rail line.

Advantages of Grade Separated Overcrossing

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

Disadvantages / Potential Hazards

- 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.

On-Street Bikeway Wayfinding Signage

Discussion

Wayfinding signs should be used in addition to white regulatory signs such as "Bike Lane" signs and yellow warning signs. Guide or wayfinding signs are generally green per the MUTCD-CA guidance, although purple is widely used in the Bay Area, and is the color recommended for continued use in Emeryville. Signage can serve both wayfinding and safety purposes including:

- 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).

Signs are typically placed at key locations leading to and along bicycle routes, including the intersection of multiple routes. Signs are typically placed at key locations leading to and along bicycle routes, including the intersection of multiple routes. 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.

Design Example

D11-1

D1-1b (L)

D1-1b (R)

D1-1c

Wayfinding signage from the MUTCD

Wayfinding that includes distance and time can aid cyclists in routefinding.

Design Summary

Destinations for on-street signage can include:

- On-street bikeways
- Commercial centers
- Parks and paths
- Public transit sites
- Civic/community destinations
- Hospitals
- 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.
- **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.

Guidance

- City of Oakland. (2009). Design Guidelines for Bicycle Wayfinding Signage.
- City of Portland (2002). Bicycle Network Signing Project.

Bicycle Parking General Guidelines

Design Summary

- 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.

Discussion

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 directly visible and obvious from the right-of-way, 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, at a garage or a school.
Lighting	Lighting of not less than one foot-candle illumination at ground level should be provided in all 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 feet 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.
Retrofit Program	In established locations, such as schools, employment centers, and shopping areas, the City should conduct bicycle audits to assess bicycle parking availability and access, and add additional bicycle racks where necessary.

Guidance

- See Emeryville Ordinance No. 08-009 (Article 68) related to bicycle parking.
- AASHTO Guide for the Development of Bicycle Facilities.
- Caltrans *Highway Design Manual (*Chapter 1000).
- *MUTCD* - California Supplement.

Bike Racks

Discussion

Bicycle racks should be a design that is intuitive and easy to use.

A standard inverted-U style rack is recommended for San Mateo County.

Bicycle racks should be securely anchored to a surface or structure.

The rack element (part of the rack that supports the bicycle) should keep the bicycle upright by supporting the frame in two places without the bicycle frame touching the rack. The rack should allow one or both wheels to be secured.

Avoid use of multiple-capacity "wave" style racks. Users commonly misunderstand how to correctly park at wave racks, placing their bikes parallel to the rack and limiting capacity to 1 or 2 bikes.

Position racks so there is enough room between parked bicycles. Racks should be situated on 36" recommended centers (15" is the current minimum, or narrower if the space is wedge-shaped).

A five-foot aisle for bicycle maneuvering should be provided and maintained beside or between each row of bicycle racks.

Empty racks should not pose a tripping hazard for visually impaired pedestrians. Position racks out of the walkway's clear zone.

For sidewalks with heavy pedestrian traffic, at least seven feet of unobstructed right-of-way is required.

Racks should be located close to a main building entrance, in a lighted, high-visibility area protected from the elements.

Design Summary

Emeryville Ordinance No. 08-009 requires that a "bicycle parking space" be a "paved. Level, drained, lighted area for the parking of one bicycle, having a minimum width of 15 inches, a minimum length of six feet, and a minimum overhead clearance of seven feet, with access to a right of way without use of stairs.

Bicycle Parking Manufactures:

- Palmer: www.bikeparking.com
- Park-a-Bike: www.parkabike.com
- Dero: www.dero.com
- Creative Pipe: www.creativepipe.com
- Cycle Safe: www.cyclesafe.com

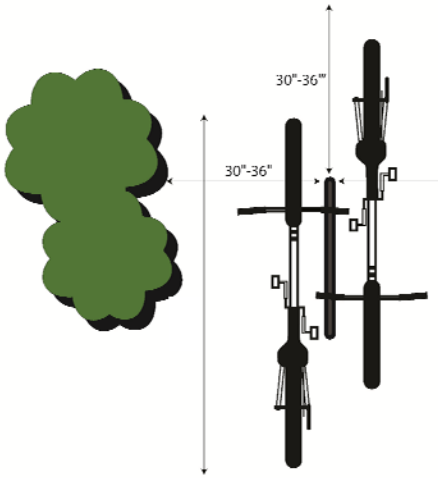
Guidance

- Association of Bicycle and Pedestrian Professionals Bicycle Parking Guidelines (2nd edition 2010)
- City of Oakland, CA Bicycle Parking Ordinance (2008)

Design Example

Standard bicycle 'staple' rack.

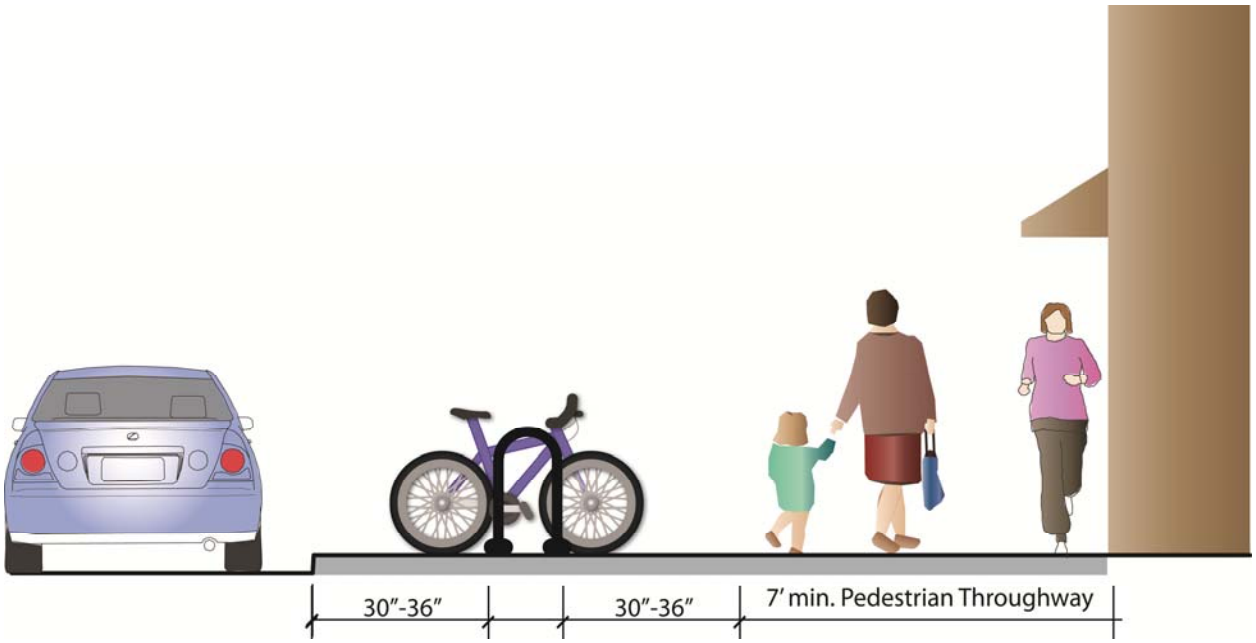
Art racks can be an attractive way of marketing the bicycle parking.



Recommended spacing for racks..

Bike Racks

Guidance (continued)



Staple rack parking configuration.

On-Street Bike Corrals

Discussion

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

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

Bicycle corrals can be considered instead of bicycle parking on the sidewalk where:

- High pedestrian activity or narrow sidewalk width limits available space for sidewalk bike racks.
- There is a moderate to high demand for short-term bicycle parking.
- The business community is interested in sponsoring the bicycle corral.

In many communities, the installation of bicycle corrals is driven by requests from adjacent businesses, and is not a City-driven initiative. In such cases, the City does not remove motor vehicle parking unless it is explicitly requested. In other areas, the City provides the facility and business associations take responsibility for the maintenance of the facility, including sweeping. Communities can establish maintenance agreements with the requesting business.

The bicycle corral can be visually enhanced through the use of attractive planters and vegetation to act as buffers from the motor vehicle parking area as well as the use of creative demarcation elements to separate the corral for motor vehicle traffic.

Design Example

On-street bicycle parking may be installed at intersection corners or at mid-block locations.

A variety of barriers have been used to delineate on-street parking, from flexible bollards to paint.

Design Summary

- Can be used with parallel or angled automobile parking.
- Each motor vehicle parking space can be replaced with approximately 6-10 bicycle parking spaces.
- Protect bicycles from motor vehicles with physical barriers such as curbs, bollards, or fences or through the application of other unique surface treatments as needed.
- Establish maintenance responsibility when facility is built, particularly regarding street sweeping.
- Parking stalls adjacent to curb extensions are good candidates for bicycle corrals since the concrete extension serves as delimitation on one side.
- Bicyclists should be able to access the corral from both the sidewalk and the roadway.
- Bicyclists should have an entrance width from the roadway of 5' – 6'.

Guidance

- Association of Bicycle and Pedestrian Professionals (APBP) Bicycle Parking Guide 2nd Edition

Bike Lockers

Discussion

Although bicycle lockers may be more expensive than bike racks to install, they can make the difference for commuters who are deciding whether or not to cycle. Bicycle lockers are large metal or plastic stand-alone boxes and offer the highest level of bicycle parking security available.

Some lockers allow access to two users - a partition separating the two bicycles can help ensure users feel their bike is secure. Lockers can also be stacked, reducing the footprint of the area, although that makes them more difficult to use.

Security requirements may require that locker contents be visible. Providing visibility into the locker also reduces unintended uses, such as use as homeless shelters, trash receptacles, or storage areas. Requiring that users procure a key or code to use the locker also reduces these unintended uses.

Design Example

Bike lockers at a transit station.

Traditionally, bicycle lockers have been available on a sign-up basis, whereby cyclists are given a key or a code to access a particular locker. Computerized on-demand systems allow users to check for available lockers or sign up online. Models from eLocker and CycleSafe allow keyless access to the locker with the use of a SmartCard or cell phone. With an internet connection, centralized computerized administration allows the transit agency to monitor and respond to demand for one-time use as well as reserved lockers.

Lockers available for one-time use have the advantage of serving multiple users a week. Monthly rentals, by contrast, ensure renters that their own personal locker will always be available. Bicycle lockers are most appropriate:

- Where demand is generally oriented towards long-term parking.
- At park-and-rides to help encourage multi-modal travel.
- Medium-high density employment and commercial areas and schools and colleges.
- Where additional security is required and other forms of covered storage are not possible.

Design Summary

- Place in close proximity to building entrances, or on the first level of a parking garage.
- Provide door locking mechanisms and systems.
- A flat, level site is needed; concrete surfaces preferred.
- Enclosure must be rigid.
- Transparent panels are available on some models to allow surveillance of locker contents.
- Integrated solar panels have been added to certain models for recharging electric bicycles.
- Minimum dimensions: width (opening) 2.5′; height 6′; depth 4′.
- Stackable models can double bicycle parking capacity.
- Wedge-shaped lockers are space-efficient where there is access from both sides.

Bicycle Compounds/Cages

Discussion

Bicycle compounds are fully enclosed, stand-alone bicycle parking structures. Compounds should not only have a locked gate but should also allow for the frame and both wheels to be locked to a rail, as other users also have access to the enclosure. Bicycle compounds are recommended for employment or residential bicycle parking areas, or for all-day parking at transit centers, workplaces and schools. They can be located at street level or in parking garages.

Bicycle Secure Parking Areas (SPAs) are a new concept implemented for TriMet (Portland, Oregon's transit agency). They provide high capacity, secure parking areas for 80-100 bicycles at light rail and bus transit centres. The Bicycle SPAs are semi-enclosed covered areas that are accessed by key cards and monitored by security cameras. The increased security measures provide an additional transportation option for those who may not be comfortable leaving their bicycle in an outdoor transit station exposed to weather and the threats of vandalism. They also include amenities that make the Bicycle SPA more attractive and inviting for users such as benches, bicycle repair stations, bicycle tube and maintenance item vending machines, as well as hitching posts which allow people to leave their locks at the SPA.

Design Example

Secure Parking Area (SPA) in Portland, OR use both inverted 'U' and racks that stack bicycles.

Design Summary

- See guidelines for bicycle rack placement and clear zones.
- A cage of 18' by 18' can accommodate up to 20 bicycles and uses the space of approximately two automobile parking spots.
- Improve surveillance through public lighting and video cameras.
- Bicycle compounds shall have an exterior structure consisting of metal mesh from floor to ceiling.
- In an attended parking facility, locate within 100' of an attendant or security guard or must be visible by other users of the parking facility.
- Entry doors must be steel and at least 2.5' in width, with "tamper proof" hinges. A window may be provided in the door to provide permanent visual access.
- Accommodate a maximum of 40 bicycles, or 120 if the room is compartmentalized with expanded metal mesh with lockable industrial-grade doors into enclosures containing a maximum of 40 bicycles.

Bicycle Rooms

Discussion

Bicycle rooms are locked rooms or cages which are accessible only to cyclists, and which may contain bicycle racks to provide extra security against theft. Bicycle rooms are used where there is a moderate to high demand for parking, and where cyclist who would use the bicycle parking are from a defined group, such as a group of employees. Bicycle rooms are also popular for apartment buildings, particularly smaller ones in which residents are familiar with one another.

The bicycle parking facilities shall be no further from the elevators or entrances than the closest motor vehicle parking space, and no more than 150' from an elevator or building entrance. Buildings with more than one entrance should consider providing bicycle parking close to each entrance, and particularly near entrances that are accessible through the bicycle network. Whenever possible, bicycle parking facilities should allow 24-hour secure access.

Dedicated bicycle-only secure access points shall be provided through the use of security cards, non-duplicable keys, or passcode access. The downside is that bicyclists must have a key or know a code prior to using the parking facilities, which is a barrier to incidental use.

Design Example

Bike rooms can be provided in office or apartment buildings.

Design Summary

- See guidelines for bicycle rack placement and clear zones.
- Improve surveillance through public lighting and video cameras.
- Walls should be solid and opaque from floor to ceiling.
- Install a panic button so as to provide a direct line of security in the event of an emergency.
- If the room is intended to store a large number of bicycles (more than 40 or so), it can be compartmentalized with metal mesh with lockable industrial-grade doors that form smaller enclosures, which reduces the number of people who have access to the room.

Bike Stations

Discussion

Bike depots generally refer to full-service parking facilities typically located at major transit locations that offer secure bicycle parking and other amenities. There is no universally accepted terminology to describe different types of full-service bicycle parking facilities.

The company BikeStation™, which runs several parking facilities in California and Washington, offers free parking during business hours and key-card access after-hours for members. Paying members enjoy a number of services. Services, which differ by location, may include bicycle repairs, bicycle rentals, sales and accessories, restrooms, changing rooms and showers, and access to vehicle-sharing. They can also incorporate restaurants or other services.

Design Summary

- While each depot is unique, they often provide:
  - Attended or restricted-access parking spots
  - Bicycle rentals
  - Access to public transportation
  - Commute trip-planning information

Design Example

Bike depot in Washington.

The downtown Berkeley BikeStation allows 24-hour access.

Design Review and Implementation Checklist

The purpose of a Design Review and Implementation Checklist is to ensure that bicycle needs are being considered in the planning, design, and construction of all transportation projects and new land use development. Also known as "Routine Accommodation" guidelines, these checklists can be used to ensure projects foster bicyclist safety and provide access in all roadways. Routine accommodation policies are included as part of the federal surface transportation act (SAFETEA-LU). Additionally, Caltrans Deputy Directive 64 (DD64-R1) requires the accommodation of bicyclists in all projects. In June 2006, the Metropolitan Transportation Commission (MTC) adopted regional policies to accommodate bicyclists through the Resolution No. 3765, which promotes the routine accommodation of all non-motorized travelers.

Documenting how well a project meets the City's goals to accommodate bicyclists within the transportation network is a valuable process, particularly in applying to future funding applications. The following section includes a resource to adequately consider bicycles as part of the project and land use planning process.

Design Summary for Bicyclist Accommodations

Streets

- Design "complete streets" which accommodate all bicyclists, paying special attention to vulnerable populations like children and older adults.
- Provide a continuous network of designated bikeways with appropriate facilities depending on the bicyclist demand and surrounding land uses.
- Provide bicyclist amenities, including bicycle parking and wayfinding signs where appropriate.

Uncontrolled Intersections

- Incorporate dashed lines or coloration to enhance crossings
- Consider using medians and/or traffic calming on residential streets or along bicycle boulevards

Controlled Intersections

- Provide bicycle-actuated signal detection and sufficient signal timing to accommodate bicyclists
- Design compact intersections with tight curb radii
- Place bike lanes on the right-hand side of a right turn lane
- Consider the use of bike boxes to increase the visibility of cyclists

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