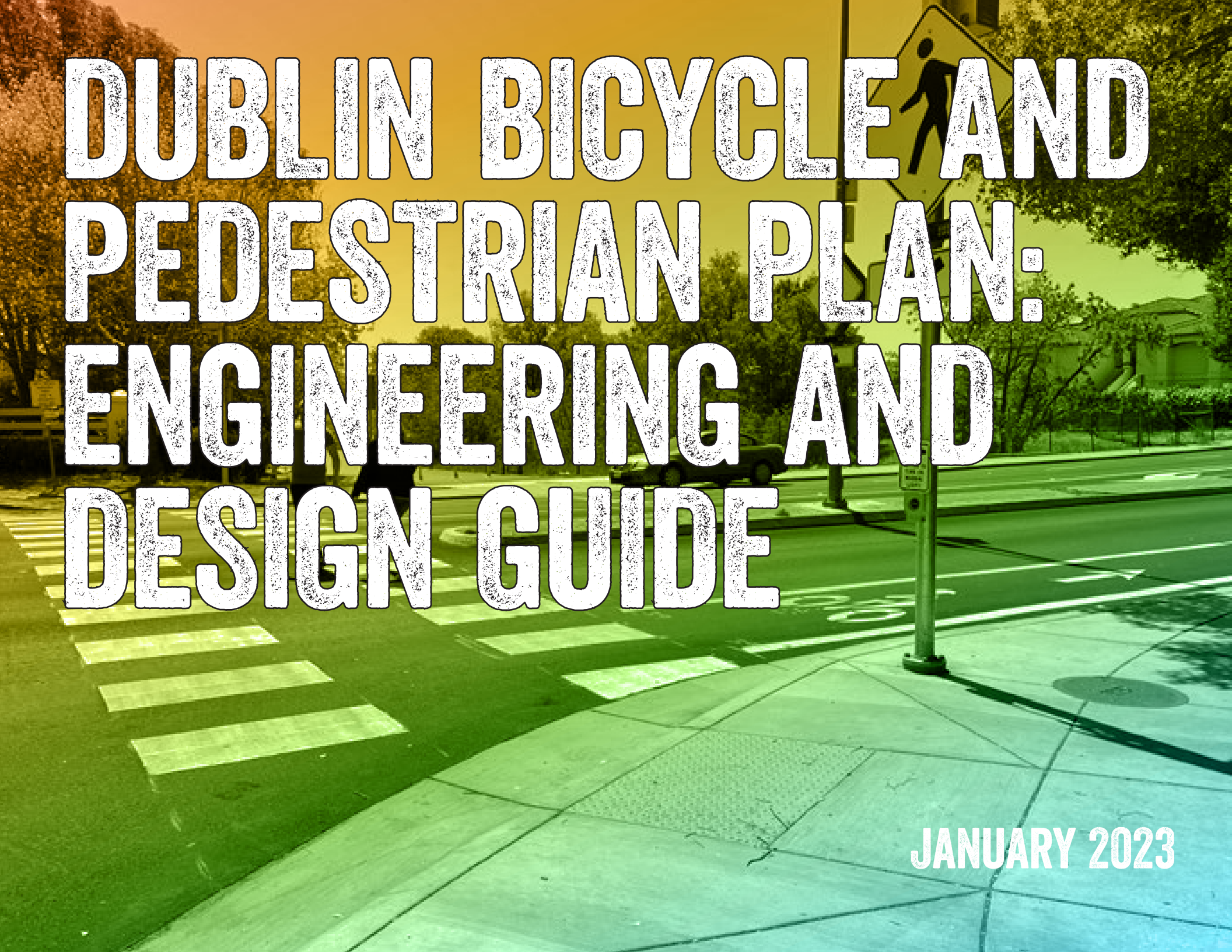


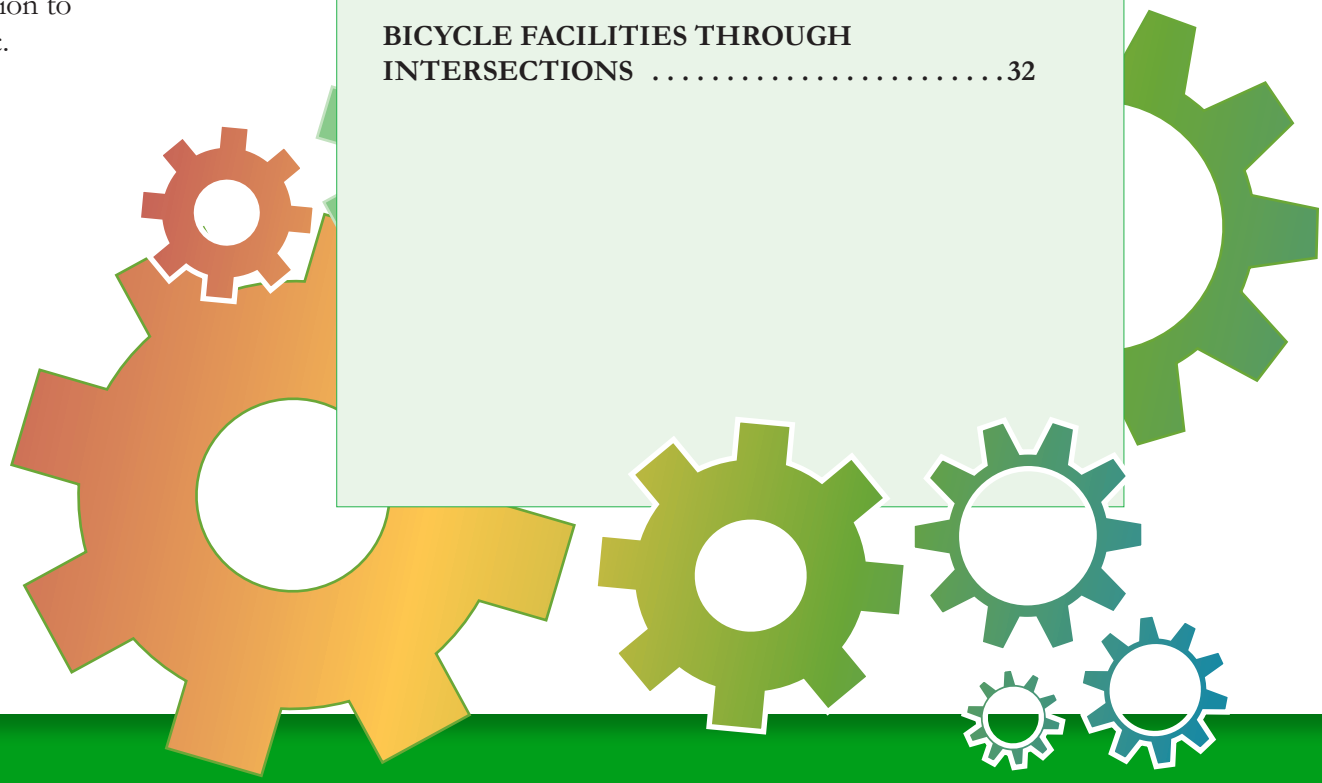
DUBLIN BICYCLE AND PEDESTRIAN PLAN: ENGINEERING AND DESIGN GUIDE

JANUARY 2023

INTRODUCTION

This guide was developed as a reference document for best practices in planning and designing bicycle and pedestrian facilities. It first provides resources relevant to planning and designing pedestrian and bicycle facilities, including a list of specific design topics and guidance document recommendations to consult. It then provides specific planning and design recommendations for several key topics relevant to developing Dublin's biking and walking infrastructure.

In applying this design guidance, the responsible engineer should use professional judgment and document design decisions. Decisions should be made based on location specific context and the obligation to protect the life, health, and property of the public.



RESOURCES

The following resources should be used as references for best practices in planning and design for pedestrian facilities.

KEY RESOURCES

- *AASHTO Guide for the Development of Bicycle Facilities, Fourth Edition (2012)* – likely to be replaced by the Fifth Edition in 2022
- *NACTO Urban Bikeway Design Guide, Second Edition (2014)*
- *NACTO Urban Street Design Guide (2013)*
- *FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (2018)*
- *CalTrans Highway Design Manual (2018)*
- *FHWA Separated Bike Lane Planning and Design Guide (2015)*
- *FHWA Manual on Uniform Traffic Control Devices (2009)*
- *California Manual on Uniform Traffic Control Devices, Revision 6 (2021)*

SUPPLEMENTAL RESOURCES

- TCRP Report 112/NCHRP Report 562: Improving Pedestrian Safety at Unsignalized Crossings. Washington D.C.: TCRP and NCHRP, 2006.
- *Routine Accommodations of Pedestrians and Bicyclists in the Bay Area,* Metropolitan Transportation Commission, Available: https://mtc.ca.gov/sites/default/files/A-08_RES-3765_complete_streets.pdf 2006.
- *Complete Streets Checklist Guidance Resolution 4493*, Metropolitan Transportation Commission, Available: https://mtc.ca.gov/sites/default/files/documents/2022-05/MTC-Administrative-Guidance-CS-Checklist.pdf (2022)

DESIGN TOPICS AND RELEVANT GUIDANCE

DESIGN TOPIC	DESIGN RESOURCE	RELEVANT PAGES/LOCATION
Sidewalks and Sidewalk Zones	NACTO Urban Street Design Guide (2013) https://nacto.org/publication/urban-street-design-guide/	Pages 37– 44; https://nacto.org/publication/urban-street-design-guide/street-design-elements/sidewalks/
	Guide for the Planning Design and Operation of Pedestrian Facilities (2004) https://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07(263)_FR.pdf	Chapter 3.2; Pages 54 - 70
Pedestrian Wayfinding	Seamless Seattle Pedestrian Wayfinding Strategy (2019)	Wayfinding Strategy_July2019_SDOT Edit.pdf (seattle.gov)
	Global Street Design Guide (2016) Global Street Design Guide | Global Designing Cities Initiative	6.3.9; Page 91; https://globaldesigningcities.org/wp-content/uploads/guides/global-street-design-guide-lowres.pdf
Street Furniture	Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-way (2013) https://www.access-board.gov/prowag/preamble-prowag/	Page 70; https://www.access-board.gov/prowag/preamble-prowag/#r212-street-furniture
Pedestrian Scale Lighting	FHWA Pedestrian Lighting Primer (2022) https://safety.fhwa.dot.gov/roadway_dept/night_visib/docs/Pedestrian_Lighting_Primer_Final.pdf	Entire document
	FHWA Lighting Handbook (2012) https://safety.fhwa.dot.gov/roadway_dept/night_visib/lighting_handbook/pdf/fhwa_handbook2012.pdf	Pages 75-78
	Street Design Manual: Lighting Update (2016) https://www.sandiego.gov/sites/default/files/street_design_manual_-_lighting_update_2016_2.pdf	Pages 2-3
	Guide for the Planning Design and Operation of Pedestrian Facilities https://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07(263)_FR.pdf	Chapter 3.2.11, Page 65

DESIGN TOPIC	DESIGN RESOURCE	RELEVANT PAGES/LOCATION
Crosswalk Markings	Manual on Uniform Traffic Control Devices (2009): https://mutcd.fhwa.dot.gov/	https://mutcd.fhwa.dot.gov/htm/2009r1r2/part3/part3b.htm#section3B18
Uncontrolled Crossing Enhancements	NACTO Urban Street Design Guide (2013):" https://nacto.org/publication/urban-street-design-guide/ FHWA Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations (2005) https://www.fhwa.dot.gov/publications/research/safety/04100/04100.pdf	https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings/midblock-crosswalks/ Pages 49 - 61
Special Paving Treatments	FHWA Pedestrian Safety Guide and Countermeasure Selection System (2013) http://www.pedbikesafe.org/pedsafe/index.cfm	http://www.pedbikesafe.org/pedsafe/countermeasures_detail.cfm?CM_NUM=39
Crossing Islands	NACTO Urban Street Design Guide (2013): https://nacto.org/publication/urban-street-design-guide/	Page 116; https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/crosswalks-and-crossings/pedestrian-safety-islands/
In-Street Pedestrian Crossings Signs	Manual on Uniform Traffic Control Devices (2009): https://mutcd.fhwa.dot.gov/	https://mutcd.fhwa.dot.gov/htm/2009r1r2/part2/part2b.htm#section2B12
Reduced Radii and Sidewalk Corners	NACTO Urban Street Design Guide (2013): https://nacto.org/publication/urban-street-design-guide/	Pages 117-118/ https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/corner-radii/
Curb Extensions, Including Chicanes	NACTO Urban Street Design Guide (2013): https://nacto.org/publication/urban-street-design-guide/ Guide for the Planning Design and Operation of Pedestrian Facilities https://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07(263)_FR.pdf	Pages 45- 50; https://nacto.org/publication/urban-street-design-guide/street-design-elements/curb-extensions/ Chapter 2.6.2 Page - 43

DESIGN TOPIC	DESIGN RESOURCE	RELEVANT PAGES/LOCATION
Curb Ramps	Proposed Accessibility Guidelines for Pedestrian Facilities in the Public Right-of-way https://www.access-board.gov/prowag/preamble-prowag/	Pages 36 – 37; https://www.access-board.gov/prowag/preamble-prowag/#r304-curb-ramps-and-blended-transitions
Right-Turn Slip Lane	FHWA Pedestrian Safety Guide and Countermeasure Selection System (2013) http://www.pedbikesafe.org/pedsafe/index.cfm	http://www.pedbikesafe.org/pedsafe/countermeasures_detail.cfm?CM_NUM=24
Advanced Yield Markings	Manual on Uniform Traffic Control Devices (2009): https://mutcd.fhwa.dot.gov/ California Manual on Uniform Traffic Control Devices (2014) https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/ca-mutcd/rev6/camutcd2014-rev6.pdf	https://mutcd.fhwa.dot.gov/htm/2009r1r2/part2/part2b.htm#section2B11 Section 2B.11
Advanced Warning Signs	Manual on Uniform Traffic Control Devices (2009): https://mutcd.fhwa.dot.gov/	Sign R1-5a
Crossing Types: RRFB, PHB, Grade Separated Crossings,	Manual on Uniform Traffic Control Devices (2009): https://mutcd.fhwa.dot.gov/	Sections 4C.05, 4C.06, 4F.01, 4L.03

DESIGN TOPIC	DESIGN RESOURCE	RELEVANT PAGES/LOCATION
Pedestrian Signal Timing	NACTO Urban Street Design Guide: https://nacto.org/publication/urban-street-design-guide/	NACTO pages 125 – 134; https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/traffic-signals/
	Guide for the Planning Design and Operation of Pedestrian Facilities https://onlinepubs.trb.org/onlinepubs/nchrp/docs/NCHRP20-07(263)_FR.pdf	Chapter 4.1.2 – Page 101
	Manual on Uniform Traffic Control Devices (2009): https://mutcd.fhwa.dot.gov/	4E.06; https://mutcd.fhwa.dot.gov/htm/2009/part4/part4e.htm
Leading Pedestrian Intervals	NACTO Urban Street Design Guide: https://nacto.org/publication/urban-street-design-guide/	Page 128; https://nacto.org/publication/urban-street-design-guide/intersection-design-elements/traffic-signals/leading-pedestrian-interval/
Signal Phasing-Protected Left Turns and Split Phasing	FHWA Pedestrian Safety Guide and Countermeasure Selection System (2013) http://www.pedbikesafe.org/pedsafe/index.cfm	http://www.pedbikesafe.org/pedsafe/countermeasures_detail.cfm?CM_NUM=51
Bus Stop Accessibility	Toolkit for the Assessment of Bus Stop Accessibility and Safety (2 https://www.nadtc.org/wp-content/uploads/NADTC-Toolkit-for-the-Assessment-of-Bus-Stop-Accessibility.pdf	Page 10
	ADA Accessibility Guidelines (2002): Adaag 1991 2002 (access-board.gov)	Section 10.2; https://www.access-board.gov/adaag-1991-2002.html#tranfac

DESIGN TOPIC	DESIGN RESOURCE	RELEVANT PAGES/LOCATION
Bikeway selection	FHWA Bikeway Selection Guide: https://safety.fhwa.dot.gov/ped_bike/tools_solve/docs/fhwasa18077.pdf Also see supplemental guidance pages XYZ	Pages 22-23
Class I Shared Use Path & Shared Use Path Features	Guide for the Planning Design and Operation of Pedestrian Facilities (2021)	Chapter 3.4
Grade Separation	Guide for the Planning Design and Operation of Pedestrian Facilities (2021)	Section 3.6.4.6
Curb Ramps	Public Right of Way Accessibility Guidelines (PROWAG) (2013) https://www.access-board.gov/files/prowag/PROW-SUP-SNPRM-2013.pdf Guide for the Planning Design and Operations of Pedestrian Facilities (2021)	R304; https://www.access-board.gov/prowag/chapter-r3-technical-requirements/#r304-curb-ramps-and-blended-transitions Section 3.6.4.5
Crossing Treatments	Guide for the Planning Design and Operation of Pedestrian Facilities (2021)	Chapter 3.6
Bicycle Signal Heads	NACTO Urban Bikeway Design Guide: https://nacto.org/publication/urban-bikeway-design-guide/	Page 91; https://nacto.org/publication/urban-bikeway-design-guide/bicycle-signals/
Unsignalized Intersections	NACTO Urban Bikeway Design Guide: https://nacto.org/publication/urban-bikeway-design-guide/	Page 105; https://nacto.org/publication/urban-bikeway-design-guide/bicycle-signals/

DESIGN TOPIC	DESIGN RESOURCE	RELEVANT PAGES/LOCATION
Sidepaths	AASHTO Guide for the Development of Bicycle Facilities (2012)	Chapter 5, Page 8
Sidepath Intersection Design Considerations	AASHTO Guide for the Development of Bicycle Facilities (2012)	Chapter 5, Page 42
Class IIA Bicycle Lanes	California Highway Design Manual https://dot.ca.gov/-/media/dot-media/programs/design/documents/hdm-complete-12312020a11y.pdf	Section 301.2
	AASHTO 2012 Guide for the Development of Bicycle Facilities https://nacto.org/references/aashto-guide-for-the-development-of-bicycle-facilities-2012/	Chapter 4, Pages 11 -22
	Urban Bicycle Design Guide https://nacto.org/publication/urban-bikeway-design-guide/	Pages 1 – 21/https://nacto.org/publication/urban-bikeway-design-guide/bike-lanes/
Bicycle Facility Design	California Highway Design Manual https://dot.ca.gov/-/media/dot-media/programs/design/documents/hdm-complete-12312020a11y.pdf	Sections 301 & 1000
	NACTO Urban Bikeway Design Guide: https://nacto.org/publication/urban-bikeway-design-guide/	Page 119/https://nacto.org/publication/urban-bikeway-design-guide/bikeway-signing-marking/
	Geometric Design of Highways and Streets	Chapter 4 Page 77; Chapter 5 Page 8; Chapter 6 Page 7; Chapter 9 Page 156

DESIGN TOPIC	DESIGN RESOURCE	RELEVANT PAGES/LOCATION
Bicycle Parking	AASHTO 2012 Guide for the Development of Bicycle Facilities https://nacto.org/references/aashto-guide-for-the-development-of-bicycle-facilities-2012/	Chapter 6
	Transit Street Design Guide https://nacto.org/publication/transit-street-design-guide/transit-streets/	Chapter 4 Page 105
Bicycle Facility Maintenance	AASHTO 2012 Guide for the Development of Bicycle Facilities https://nacto.org/references/aashto-guide-for-the-development-of-bicycle-facilities-2012/	Chapter 7
Bicycle Signals	AASHTO 2012 Guide for the Development of Bicycle Facilities: https://nacto.org/references/aashto-guide-for-the-development-of-bicycle-facilities-2012/	Chapter 4 Page 43
	Manual on Uniform Traffic Control Devices (2009): https://mutcd.fhwa.dot.gov/	MUTCD Figure 9C-7 (bicycle detector pavement markings); Section 4D.08 through 4D.16 (signal placement)
	NACTO Urban Bikeway Design Guide: https://nacto.org/publication/urban-bikeway-design-guide/	Pages 91 – 111; https://nacto.org/publication/urban-bikeway-design-guide/bicycle-signals/

DESIGN TOPIC	DESIGN RESOURCE	RELEVANT PAGES/LOCATION
Restriping to Add Bicycle Facilities	FHWA: Incorporating On-Road Bicycle Networks into Resurfacing Projects, 2016 https://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/resurfacing/resurfacing_workbook.pdf	Entire document
Stormwater Management	NACTO Urban Bikeway Design Guide: https://nacto.org/publication/urban-bikeway-design-guide/ LA Model for Living Streets Design Manual (2011) https://www.cleanwaterprogram.org/resources/resources/la-living-streets-design-manual/download.htmlChapter 11	Pages 65 – 70; https://nacto.org/publication/urban-street-design-guide/street-design-elements/stormwater-management/

SUPPLEMENTAL GUIDANCE

SIDEWALK WIDTH RECOMMENDATIONS

Streets and sidewalks should support the activities and pedestrian levels along the street. Sidewalks should be wide enough to support the expected pedestrian volumes. This Plan recommends a minimum width of six feet for the pedestrian pathway section of a sidewalk, which is wide enough for two people to walk side by side, can be navigated by persons with mobility impairments, and meets current ADA requirements. See Table 1 for recommended sidewalk widths by context. In addition to Table 1, if a specific area plan with recommended cross section widths exists for a project location, refer to the specific area plan guidance.

ADA sidewalk regulations specify that routes with less than 60 inches, or five feet of clear width must provide passing spaces, or wider areas that can accommodate two wheelchairs passing, at least 60 inches wide at reasonable intervals not exceeding 200 feet, and a five feet by five feet turning space should be provided where turning or maneuvering is necessary. If a sidewalk is directly adjacent to moving traffic, 2 feet should be added to the absolute minimum clear path width to provide buffer and space for street furniture and utilities. Based on the Caltrans Highway Design Manual, the minimum width of a sidewalk should be 8 feet between a curb and building when in urban and rural main street place types, 6 feet in all other locations when continuous to a curb, or 5 feet when separated by a planting strip.

In addition to the typical sidewalk widths, the context should dictate other design feature as well, identified below:

- **Edge/ Curb Zone -** At a minimum, such as in areas with lower pedestrian activity, there should be a 6-inch-wide curb. Other areas, such as downtowns, should have at least an extra foot to accommodate car doors to not conflict with the sidewalk.
- **Furnishing/Landscape Zone -** This area acts as a buffer between the curb and throughway zone. This is the areas where trees should be planted, and benches should be located. Any sidewalk amenities should be located within this area and should not interfere with the throughway zone. A furnishing zone must be a minimum of 3 feet to have the opportunity to include street trees or landscaping. The landscape buffer should increase in width as speeds increase: four feet is the recommended minimum buffer for areas that are 25 mph and the buffer should increase 1 foot for every 5 mph increase in speed.
- **Throughway zone – This area acts as the sidewalk clear zone.** See Table 1 for recommended sidewalk widths for the throughway zones.
- **Frontage Zone -** This area borders the building façade or fence. The primary purpose of this zone is to create a buffer between pedestrians walking in the throughway zone from people entering and exiting buildings. It provides opportunities for shops to place signs, planters, or chairs that do not encroach into the throughway zone.

Table 1: Recommended Sidewalk Widths by Context

LAND USE CONTEXT	RECOMMENDED SIDEWALK WIDTH	RECOMMENDED GREENSCAPE/ FURNISHING ZONE WIDTH
Residential and industrial areas	8 feet – 5 feet	6 feet – 3 feet
Downtown or commercial areas	12 feet – 8 feet	8 feet – 3 feet
Schools	10 feet – 8 feet	8 feet – 3 feet

BIKEWAY SELECTION

CLASS IA: BIKE PATHS OR SHARED USE PATHS

DESCRIPTION:

Bike paths provide a completely separated facility designed for the exclusive use of bicyclists and pedestrians with minimal or no conflicting motor vehicle traffic. Generally, these corridors are not served by streets, and the path may be along a river, converted rail right-of-way, or powerline, or other car-free corridors.

TYPICAL APPLICATION:

Class IA paths may provide connectivity between neighborhoods or communities, to parks or recreational areas, along or to rivers or streams, or to other destinations without travelling along a roadway corridor.

COST ESTIMATE:

$2.2M per mile, including design and construction for the path, assuming the inclusion of two high visibility actuated crossings

DESIGN CONSIDERATIONS:

- The width of a shared-use path may vary based on expected bicyclist and pedestrian volume and right-of-way constraints. For accessibility purposes, trails should be limited to 5% grade.
- Where right-of-way or other physical constraints exist, sidepaths may be provided adjacent to the roadway. Information about these facilities, Class IB facilities, are provided on the next page.

Iron Horse Regional Trail, Dublin, California Source: Kittelson & Associates, Inc.

PREFERRED DESIGN AND ELEMENTS:

- A 10 ft wide path with 2 ft shoulders on each side is preferable (14 ft total). The higher the anticipated volumes of users, the greater the width should be to accommodate these users comfortably.
- Pedestrian-scale lighting improves visibility, particularly at intersection crossings, tunnels, underpasses, trail heads, and rest areas.
- A shy distance of at least one foot allows adequate lateral clearance for the placement of signs or other vertical objects. If objects are shorter than 3 feet tall, they may not present an obstruction for cyclists.

REQUIRED ELEMENTS:

- While the width may vary along a path, a path should be at least 10 feet wide except in rare cases and for short distances.
- Path must include at least 2 feet (3 feet preferred) horizontal clearance between the paved edge of path and obstructions.
- Path crossings may be designed with yield, signal, or stop control for either motorists or path users depending on path volume and traffic volume on the crossing street.

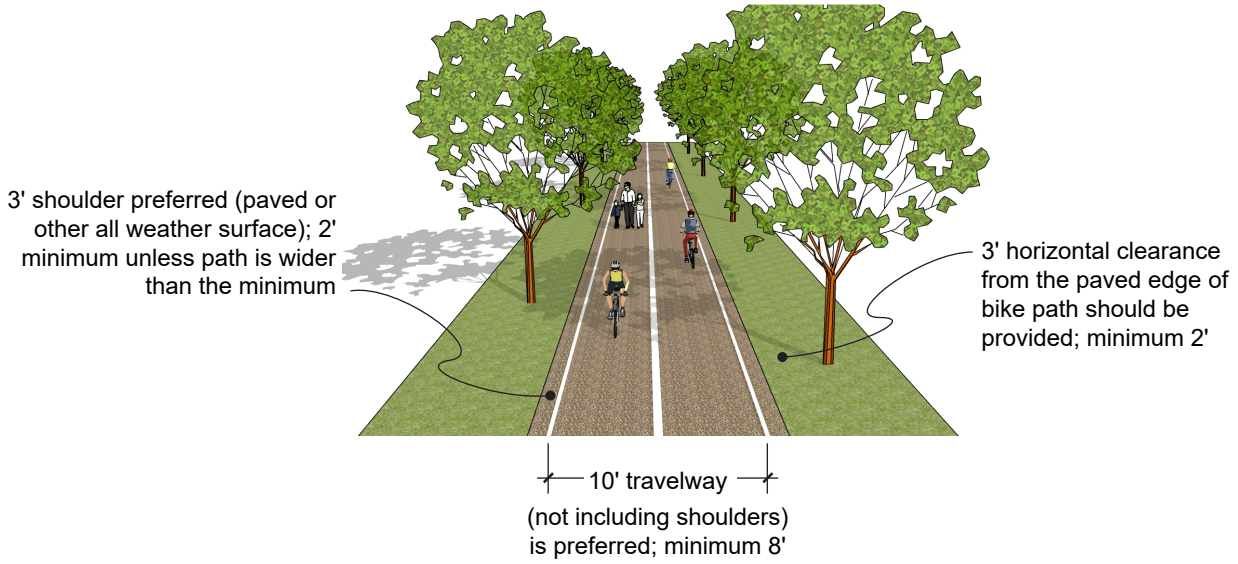


Exhibit 1: Class 1A–Shared Use Path

CLASS IB: SIDEPATHS

DESCRIPTION:

Sidepaths are shared use paths that exist within a roadway corridor. They provide dedicated space for bidirectional travel for people walking, biking, using mobility devices, or using scooters or other micromobility devices.

TYPICAL APPLICATION:

Sidepaths are applicable in areas with few motor vehicle driveways or access points on roadways with operating speeds above 35 miles per hour and serving above 6,500 vehicles per day, but other treatments (generally sidewalks and Class IV facilities) are typically preferred for safety and comfort. Sidepaths can be used along high speed and/or volume roadways to provide a completely separated space outside of the roadway for people walking and biking.

COST ESTIMATE:

$2.6M per mile , including design and construction for the path and a planted buffer

DESIGN CONSIDERATIONS:

- In many situations, especially urban areas or denser or destination focused suburban areas, providing dedicated walking and biking facilities that are separate from each other is preferred to combining these modes on a sidepath.
- As motor vehicle speeds and volumes increase, providing more separation between the roadway and the path will provide higher comfort for those using the path.

Dougherty Road, Dublin, California Source: Kittelson and Associates, Inc

- One key concern with providing sidepaths instead of directional bicycle facilities is the lack of driver awareness about contraflow bicycle traffic (higher speed traffic than pedestrians, which are expected to travel bidirectionally) at intersections and access points. If a motor vehicle is turning left, they are more likely to be aware of or look for traffic traveling toward them. Skip striping and signs that indicate two-way bicycle travel through crossings at intersections is key to creating awareness of the birdirectional

traffic. Exhibit 2 shows a sign used by Colorado DOT to increase awareness of sidepath users. At signalized intersections, consider detection that activates No Right Turn On Red signs and/or Yield To Pedestrians In Crosswalk signs when sidepath users are present.

- At intersections, treatments like leading pedestrian and bicycle intervals can also help increase the visibility of crossings bicyclists. Sidepaths must be appropriately designed at access points or intersections.
- At intersections, divert the sidepath away from the parallel roadway at conflict points so that it functions as a mid-block crossing and there is enough space (25 feet) for at least one vehicle to queue between the crossing and roadway intersection.
- When providing sidepaths, a critical consideration is the connection to other biking facilities. If a sidepath connects to a uni-directional bike lane at an intersection, the design of the intersection should consider the efficiency and safety of connecting bicyclists to the infrastructure they will need to use to continue on their path. Diagonal crossings can reduce the need for two-stage crossings, which can slow bicyclists and increase crossing exposure. Pavement markings and signs can also be effective in guiding bicyclists for how to make the connection and provide continuity and clarity to these transitions, which can otherwise be uncomfortable or unclear, and may encourage crossing in ways or locations that increase exposure or the number of potential conflict points. Striping on the ground to encourage separation between people walking and biking in different directions, especially at intersections or areas with higher volumes can create clarity and decrease conflicts between these modes. The maximum grade of a side path should be 5%, but the grade should generally match the grade of the roadway. Where the roadway grade exceeds 5%, the sidepath grade may as well but it must be less than or equal to the roadway grade.

Exhibit 2: CDOT Sidepath Sign

Note: This sign is not included in the CA MUTCD but may be considered as a candidate to apply for a request for experimentation.

PREFERRED DESIGN AND ELEMENTS:

- A 10 ft wide path with 2 ft shoulders on each side is preferable (14 ft total). The higher the anticipated volumes of users, the greater the width should be to accommodate these users comfortably. Curb ramps should be as wide as the path travelway to allow people walking and biking to use the ramps simultaneously.
- Pedestrian-scale lighting improves visibility for and of the users, and is particularly important at intersection crossings and in areas with access points or driveways.
- A 2 ft or greater shoulder on both sides of the path should be provided. An additional foot of lateral clearance is required by the CAMUTCD for the installation of signage or other furnishings. If objects are shorter than 3 feet tall, they may not present an obstruction for cyclists.
- Biking and walking facilities should be provided on both sides of the street to provide access to destinations along both sides of

a street. Walking facilities should be bi-directional on each side of the street. Bike lanes may be one-way, but a one-way bike path should only be provided in rare situations where there is only need for one direction of travel. If a one-way bike path is provided, adequate signage and striping is necessary to ensure it is used appropriately. A one-way bike path should be at least 5 feet in width and has the same shoulder requirements as a bi-directional path.

REQUIRED ELEMENTS:

- While the width may vary along a path, a path should have at least an 8 feet paved travelway with 2 feet paved or all weather surface shoulders on each side except in rare cases and for short distances.
- A wide separation should be provided between a two-way sidepath and the adjacent roadway to demonstrate to both the bicyclist and the motorist that the path functions as an independent facility for bicyclists and other users. The minimum recommended distance between a path and the roadway curb (i.e., face of curb) or edge of traveled way (where there is no curb) is 5 feet.
- Path crossings may be designed with yield, signal, or stop control for either motorists or path users depending on path volume and traffic volume on the crossing street.

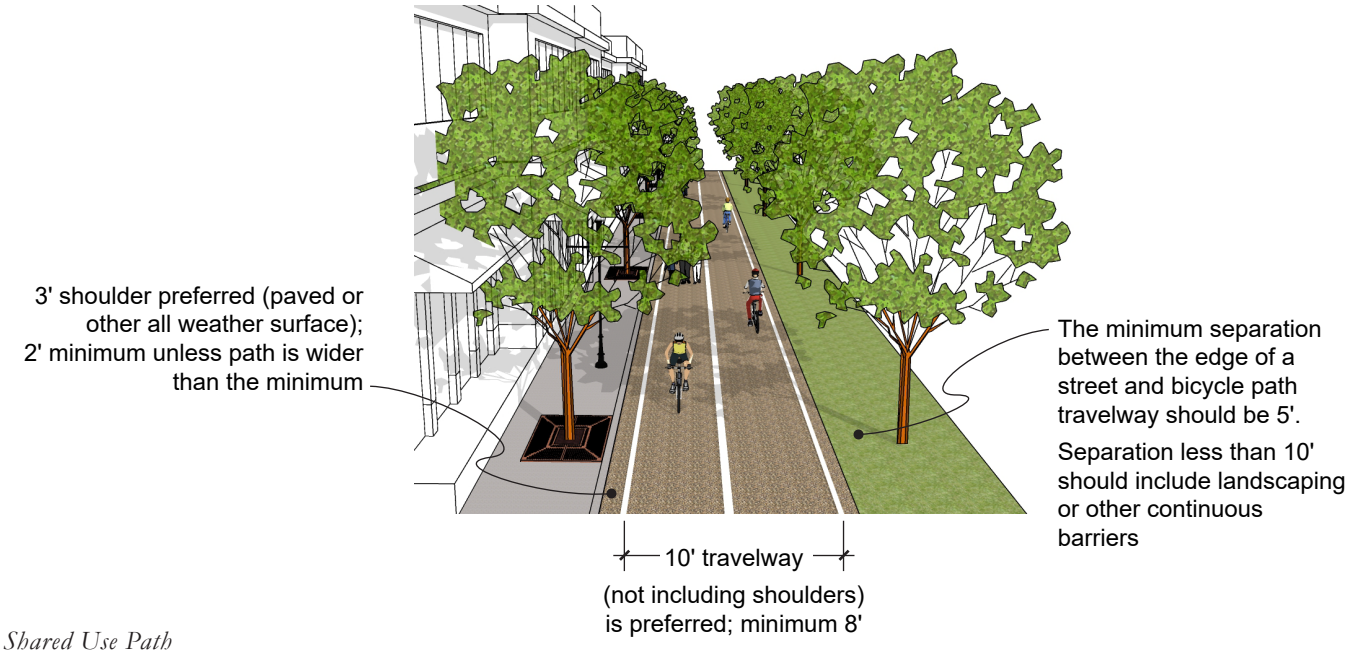


Exhibit 3: Class IB – Shared Use Path

CLASS IIA AND CLASS IIB FACILITIES: BIKE LANES AND BUFFERED BIKE LANES

DESCRIPTION:

Bike lanes are on-street bikeways that provide a designated right-of-way for the exclusive use of bicycles. Through travel by motor vehicles or pedestrians is prohibited, but vehicle parking may be allowed on either side of the bikeway, and drivers may cross through for turning movements. Class IIA facilities are bike lanes without a buffer, while Class IIB facilities include a buffer between motor vehicle traffic and the dedicated bike lane.

TYPICAL APPLICATION:

Bike lanes are appropriate on streets with moderate traffic volumes and speeds: typically between 25-35 mph and 3,000 to 6,500 vehicles per day. Class IIB facilities are preferred for these conditions, but if constraints do not allow for a buffer to be added, Class IIA facilities can be provided.

COST ESTIMATE:

$225,000 – $5,500,000 per mile including design and construction; the lower end of the estimate is based on the ability to restripe existing roadway to add bicycle lanes, while the high end of the estimate is based on the need to widen the roadway to add facilities, including a full reconstruction of a planter strip and sidewalk.

DESIGN CONSIDERATIONS:

A buffer provides a more comfortable facility, so if space is available, a buffer should be provided. A buffer becomes more necessary when speeds and volumes are at the high end of the ranges provided in the "typical application" above.

San Ramon Road, Dublin, California Source: Kittelson and Associates, Inc

PREFERRED DESIGN AND ELEMENTS:

When a bike lane is placed next to active street parking, a parking-side buffer is preferred.

When steep grades are present, consider providing the next level of separation uphill (i.e., add a buffer, or physically separate the bike lane). It may be appropriate to mix facilities for opposite directions along a steep grade.

The desired minimum width of a bike lane is 6 feet. When adjacent to parking, the recommended width from curb face to the far edge of the bike lane is 14.5 feet (12 feet minimum). With high bike volumes, a 7-foot travel area width is recommended.

Storm drain catch basin grates along a Class II facility can cause a hazards for people biking. Inlets at the curb instead of on the street-surface are preferred. Grates should have rails perpendicular to the movement of bicycle traffic to keep tires from being caught in the grates. In addition, the slope of the roadway leading to the inlet must not be too severe, and the inlet and accompanying concrete box must not extend far into the bicycle lane.

At intersections with right-turn vehicle lanes, it is recommended that the bike lane transitioned to the left of the lane using dotted white lines, appropriate signage, and colored pavement.

REQUIRED ELEMENTS:

When buffers are used, they shall be marked with 2 solid parallel white lines, at least 18 inches apart. If the buffer is at least 3 feet wide, use diagonal or chevron hatching inside. See CAMUTCD Section 9C.04 for more information.

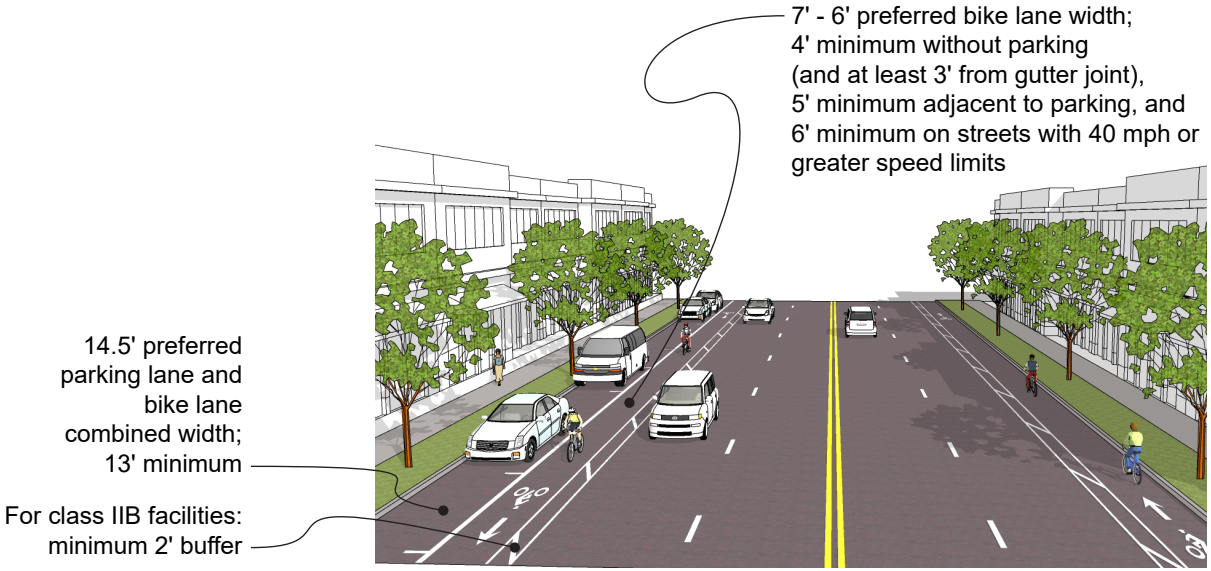


Exhibit 4: Class II Bike Lanes

CLASS III BIKE ROUTES/BICYCLE BOULEVARDS

DESCRIPTION:

Bike routes or bicycle boulevards provide a shared travel lane with motorists. They are designated by signs or permanent markings, which may include shared-lane markings ("sharrows") to alert drivers of the shared roadway environment. Because the right-of-way is shared, vehicle speeds on Class III bikeways should be managed through the use of traffic calming or traffic diversion.

TYPICAL APPLICATION:

Bike routes are appropriate only in the presence of low speeds and low traffic volumes: typically below 25 miles per hour and 3,000 vehicles per day. They are most applicable on streets where no striped centerline is present. Outside of these circumstances, a designated lane or other facility is appropriate.

COST ESTIMATE:

$40,000 – $135,000 per mile including design and construction, depending on the need to add traffic calming elements.

BENEFITS:

On streets that are already low speed and volume, bike routes can provide bike connectivity for people of all ages and abilities at a relatively low cost. Sharrow pavement markings should be placed every 250 feet and after each intersection.

DESIGN CONSIDERATIONS:

To ensure the selected facility retains its low speed and low-volume character, bicycle boulevards should be supported with traffic calming measures and volume management measures (e.g., restricting vehicle access).

Shafter Avenue, Oakland, California Source: Kittelson and Associates, Inc.

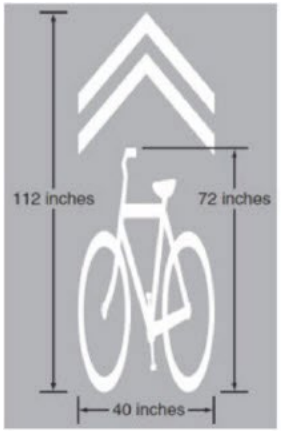


Exhibit 5: California MUTCD (Figure 9C-9)

The level of stress of bicycle boulevards are typically determined by major street crossings, which should be designed to promote the desired level of traffic stress (i.e., controlled).

PREFERRED DESIGN AND ELEMENTS:

Bike routes should be direct, as bicyclists are unlikely to adhere to a path that requires significant out-of-direction travel. Ideally a bicycle boulevard would be parallel and proximate to a major vehicle route.

Signs and pavement markings should be used to identify the bike route. Wayfinding signs are recommended to guide bicyclists to destinations and through any turns in the route (refer to CAMUTCD 9B.20). Chevron pavement markings can guide bicyclists with lateral positioning in lanes that are too narrow for a motor vehicle and bicycle to travel side-by-side within the same traffic lane, and alert road users of their presence.

To create a shared street environment, it is most appropriate to use roadways that do not have a striped centerline as neighborhood bikeways.

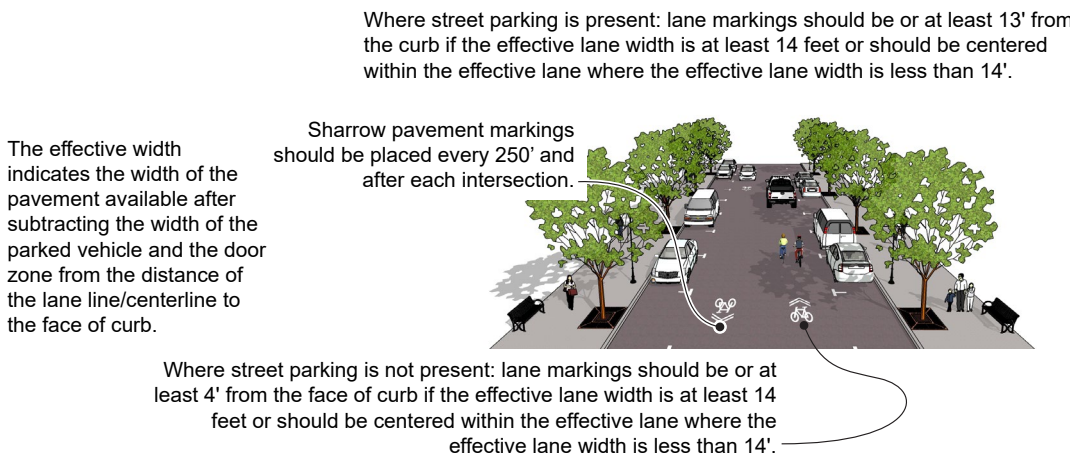


Exhibit 6: Class III Bike Routes

Typically, minor streets along the bicycle boulevard should be controlled to minimize delay for bicyclists and encourage use of the bicycle boulevard.

REQUIRED ELEMENTS:

Place sharrow pavement markings at least every 250 feet and after each intersection.

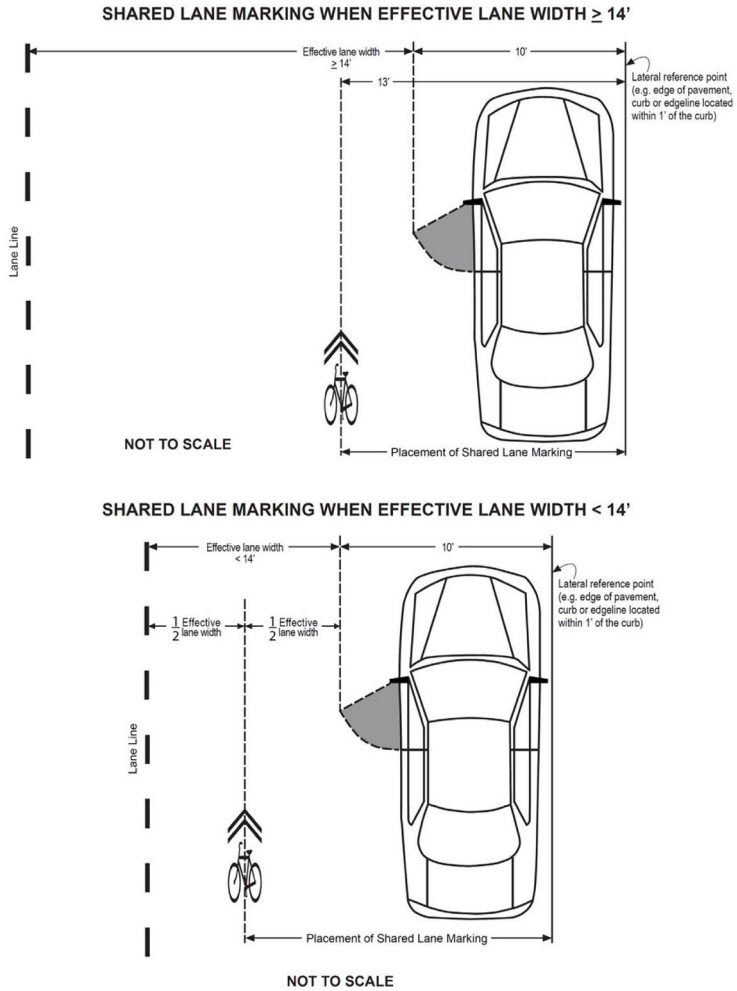


Exhibit 7: California MUTCD 9C-108(CA)

CLASS IV: SEPARATED BIKEWAY/CYCLE TRACK

DESCRIPTION:

Separated bikeways provide physical separation from vehicular traffic. This separation may include grade separation, flexible posts, planters or other inflexible physical barriers, or on-street parking. These bikeways provide bicyclists a greater sense of comfort and security, especially in the context of high-speed roadways. Separated facilities can provide one-way or two-way travel and may be located on either side of a one-way roadway.

TYPICAL APPLICATION:

Separated bikeways are appropriate for higher volume and speed settings including above 35 miles per hour and serving 6,500 or more vehicles per day.

COST ESTIMATE:

$1,100,000 – $5,700,000 per mile including design and construction; the lower end of the estimate is based on the ability to reorganize existing roadway to add separated bike lanes, while the high end of the estimate is based on the need to widen the roadway to add facilities, including a full reconstruction of a planter strip and sidewalk.

San Diego, California Source: Kittelson and Associates, Inc.

Village Parkway, Dublin, California Source: City of Dublin

DESIGN CONSIDERATIONS:

Separated bikeways are appropriate at speeds and volumes where bike lanes or buffered bike lanes do not adequately address the comfort needs of the Interested but Concerned biking population per the FHWA Bikeway Selection Guide. These facilities are more appropriate than shared-use paths if pedestrian and bicyclist volumes are expected to be relatively high or there are significant access points or driveways along a road.

Two-way separated bikeways are appropriate along routes with many destinations on only one-side of the road, incidences of wrong-way riding, along one-way streets, or in locations where they facilitate connection to a shared-use path.

PREFERRED DESIGN AND ELEMENTS:

The type of separator can impact the comfort of bicyclists along a separated bikeway. Elements with higher mass and height can provide higher comfort. Planted separators can also improve the aesthetics along a corridor.

Along separated bikeways, intersections may provide the most exposure to cyclists. Including protected intersection treatments can improve the comfort along the entire route and make the facility more appropriate for people of all ages and abilities.

REQUIRED ELEMENTS:

Physical separation may be provided by flexible delineators, parked cars, bollards, planters, or parking stops. When parked cars provide separation, a buffer width of at least 3 feet should be provided for bicyclists to avoid the "door zone." Delineation should be intentional to discourage people driving from entering the bikeway and to indicate the location of the parking lane.

The riding area for one-way lanes should be at least 5 feet wide (7 feet if along an uphill grade). For two-way bikeways, the preferred width is 12 feet (10 feet minimum).

In constrained environments, consider removing a travel lane, reducing the bike lane width, or reducing the sidewalk buffer width. Sidewalk accessibility requirements must be maintained, and adequate street buffer is essential for the safety of bicyclists.

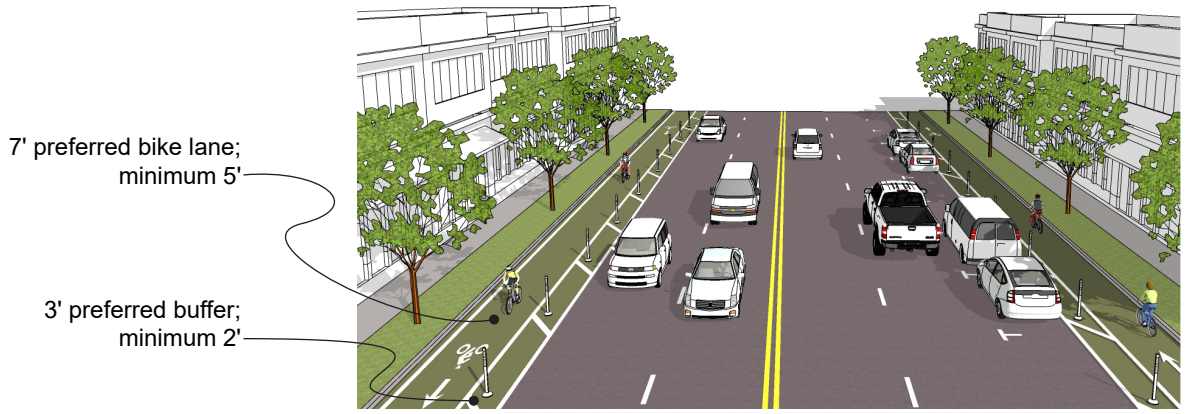


Exhibit 8: Class IV Cycle Track

ACCESSIBLE PEDESTRIAN SIGNALS

DESCRIPTION:

An accessible pedestrian signal (APS) is a pedestrian signal that uses audible tones or messages and/or vibrotactile surfaces to communicate crossing information (e.g., WALK and DON'T WALK intervals) to those walking who are vision impaired or blind. Section 504 of the Rehabilitation Act requires newly constructed and reconstructed public facilities to be accessible to all members of the public. APS should be installed wherever pedestrian signals are installed.

TYPICAL APPLICATION:

The factors that make crossing at a signalized location difficult for pedestrians who have visual disabilities include: quiet car technology including through electric vehicles, high right turn on red or continuous right-turn movements, complex signal operations, traffic circles, wide streets, or low traffic volumes that make it difficult to discern signal phase changes.

APS should be provided everywhere a signalized crossing opportunity is provided, but should be provided in particular at signalized intersections that may present difficulties for pedestrians who have visual disabilities, including those listed above. Greater consistency can provide more expectations.

COST ESTIMATE:

Costs range from $550 to $1,150 per signal in locations where pedestrian signal poles already exist; up to eight APS units are needed per intersection.

BENEFITS:

Without APS, those with visual disabilities generally determine if they're able to cross a street by initiating a crossing when they hear traffic stop and traffic perpendicular to them move, but this does not always provide sufficient information needed to safely or efficiently cross. When it does provide accurate information, it may require the pedestrian to need to wait an additional signal cycle. APS has been shown to reduce the number of crossings during a DON'T WALK phase, provide more accurate judgements of the WALK phase, and reduce delay of crossing. It can also reduce delay and reduce conflicts due to a misunderstanding of crossing opportunities.

DESIGN CONSIDERATIONS:

When APS cannot be implemented everywhere, it should be prioritized in areas with the following characteristics:

- Very wide crossings,
- Crossings of major streets where minor streets have minimal or intermittent traffic,
- Complex or uncommon intersection types,
- Low volumes of through vehicles,
- High volumes of turning vehicles,
- Split phase signal timing,
- Exclusive pedestrian phasing, Leading pedestrian intervals, and
- Proximity to major pedestrian destinations like BART stations, parks, downtown, etc.

PREFERRED DESIGN AND ELEMENTS:

An alert tone may be used to alert pedestrians to the beginning of the walk interval.

Locator tones should help those with visual impairment find pushbuttons, and APS should be clear to which crossing leg the audible signal is associated. It is preferred for APS pushbutton poles to be at least 10 feet apart to improve clarity for which crossing leg is associated with each audible signal. Including the name of the street to be crossed in an accessible format, such as Braille or raised print on the pushbutton, can help provide clarity for which crossing the APS is associated.

Pushbuttons for accessible pedestrian signals should be located as close as possible to the crosswalk line furthest from the center of the intersection and as close as possible to the curb ramp. In addition to being more useful, the closer to the crossing that it is located, the quieter it can be. It should be within 5 feet of the crosswalk extended or 10 feet of the edge of curb, shoulder, or pavement.

REQUIRED ELEMENTS*:

- Where two accessible pedestrian signals are separated by a distance of at least 10 feet, the audible walk indication shall be a percussive tone. Where two accessible pedestrian signals on one corner are not separated by a distance of at least 10 feet, the audible walk indication shall be a speech walk message.
- If speech walk messages are used to communicate the walk interval, they shall provide a clear message that the walk interval is in effect, as well as to which crossing it applies. Speech walk messages shall be used only at intersections where it is technically infeasible to install two accessible pedestrian signals at one corner separated by a distance of at least 10 feet.
- If two accessible pedestrian pushbuttons are placed less than 10 feet apart or on the same pole, each accessible pedestrian pushbutton shall be provided with the following features: Pushbutton locator tone, tactile arrow, speech walk message, speech pushbutton information message
- If the pedestrian clearance time is sufficient only to cross from the curb or shoulder to a median of sufficient width for pedestrians to wait and accessible pedestrian detectors are used, an additional accessible pedestrian detector shall be provided in the median.

FOR MORE INFORMATION:

NCHRP Web-Only Document 150:
Accessible Pedestrian Signals: A Guide to Best Practices
https://www.trb.org/Publications/Blurbs/164696.aspx

California Manual on Uniform Traffic Control Devices Section 4E.09 https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/ca-mutcd/rev6/camutcd2014-rev6.pdf

* Check the California MUTCD Part 4 for current guidance

CROSSING SELECTION

DESCRIPTION:

Providing visible pedestrian crossings is critical to allowing those who travel by foot or mobility device to have access to their destinations. Uncontrolled pedestrian crossing locations generally correspond to higher pedestrian crash rates than controlled locations, often due to inadequate pedestrian crossing accommodations (FHWA, 2018). The type of crossing provided should be appropriate for the context of the roadway that is being crossed. The higher the speeds, volumes, and number of lanes on the roadway, the greater the need for higher visibility crossing elements. Providing regular crossings with the correct crossing features based on the roadway context supports a safe, convenient, and comfortable walking environment, leading to more people walking to meet everyday needs and thus contributing to the health, sustainability, and vibrancy of a community.

In addition to the crossing countermeasures provided, curb ramps should be provided at all crossings. At intersections, directional curb ramps should be provided, which means providing dual curb ramps at most intersections.

TYPICAL APPLICATION:

Mid-block and unsignalized intersections; crossings should be provided with regular spacing and should especially be provided to access key destinations like transit stops, schools, trailheads, parks, and grocery stores. Different crossing types and countermeasures are appropriate based on the roadway context. Exhibit 9 provides the appropriate crash countermeasures by roadway feature.

Exhibit 9: Application of pedestrian crash countermeasures by roadway feature

Roadway Configuration	Posted Speed Limit and AADT								
	Vehicle AADT <9,000			Vehicle AADT 9,000–15,000			Vehicle AADT >15,000		
	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph	≤30 mph	35 mph	≥40 mph
2 lanes (1 lane in each direction)	● 2 4 5 6	● 5 6 7 9	○ 5 6 ● 9	● 4 5 6	● 5 6 7 9	○ 5 6 ● 9	● 4 5 6 7 9	○ 5 6 7 9	○ 5 6 9
3 lanes with raised median (1 lane in each direction)	● 2 3 4 5	● 3 5 7 9	○ 3 5 ● 9	○ 3 4 5 7 9	○ 3 5 ● 9	○ 3 5 ● 9	○ 3 4 5 7 9	○ 3 5 7 9	○ 3 5 9
3 lanes w/o raised median (1 lane in each direction with a two-way left-turn lane)	● 2 3 4 5 6 7 9	● 3 5 6 7 9	○ 3 5 6 9	○ 3 4 5 6 7 9	○ 3 5 6 ● 9	○ 3 5 6 9	○ 3 4 5 6 7 9	○ 3 5 6 9	○ 3 5 6 9
4+ lanes with raised median (2 or more lanes in each direction)	● 3 5 7 8 9	● 3 5 7 8 9	○ 3 5 8 ● 9	○ 3 5 7 8 9	○ 3 5 ● 8 9	○ 3 5 8 ● 9	○ 3 5 ● 7 8 9	○ 3 5 8 9	○ 3 5 8 9
4+ lanes w/o raised median (2 or more lanes in each direction)	● 3 5 6 7 8 9	○ 3 5 ● 6 7 8 9	○ 3 5 6 8 ● 9	○ 3 5 ● 6 7 8 9	○ 3 5 6 8 ● 9	○ 3 5 6 8 ● 9	○ 3 5 ● 6 7 8 9	○ 3 5 6 8 9	○ 3 5 6 8 9

Given the set of conditions in a cell,

- # Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location.
- ● Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location.
- ○ Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures.*

The absence of a number signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

1. High-visibility crosswalk markings, parking restrictions on crosswalk approach, adequate nighttime lighting levels, and crossing warning signs
2. Raised crosswalk
3. Advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line
4. In-Street Pedestrian Crossing sign
5. Curb extension
6. Pedestrian refuge island
7. Rectangular Rapid-Flashing Beacon (RRFB)**
8. Road Diet
9. Pedestrian Hybrid Beacon (PHB)**

*Refer to Chapter 4, 'Using Table 1 and Table 2 to Select Countermeasures,' for more information about using multiple countermeasures.

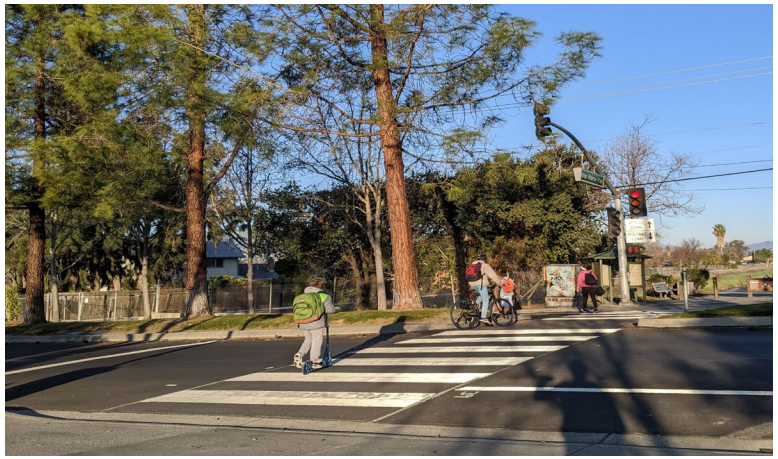
**It should be noted that the PHB and RRFB are not both installed at the same crossing location.

This table was developed using information from: Zegeer, C.V., J.R. Stewart, H.H. Huang, P.A. Lagerwey, J. Feaganes, and B.J. Campbell. (2005). Safety effects of marked versus unmarked crosswalks at uncontrolled locations: Final report and recommended guidelines. FHWA, No. FHWA-HRT-04-100, Washington, D.C.; FHWA. Manual on Uniform Traffic Control Devices, 2009 Edition. (revised 2012). Chapter 4F, Pedestrian Hybrid Beacons. FHWA, Washington, D.C.; FHWA. Crash Modification Factors (CMF) Clearinghouse. http://www.cmfclearinghouse.org/; FHWA. Pedestrian Safety Guide and Countermeasure Selection System (PEDSAFE). http://www.pedbikesafe.org/PEDSAFE/; Zegeer, C., R. Srinivasan, B. Lan, D. Carter, S. Smith, C. Sundstrom, N.J. Thirsk, J. Zegeer, C. Lyon, E. Ferguson, and R. Van Houten. (2017). NCHRP Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments. Transportation Research Board, Washington, D.C.; Thomas, Thirsk, and Zegeer. (2016). NCHRP Synthesis 498: Application of Pedestrian Crossing Treatments for Streets and Highways. Transportation Research Board, Washington, D.C.; and personal interviews with selected pedestrian safety practitioners.

Source: FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations

HIGH VISIBILITY CROSSWALK MARKINGS, PARKING RESTRICTIONS ON THE CROSSWALK APPROACH, ADEQUATE NIGHTTIME LIGHTING LEVELS, AND CROSSING WARNING SIGNS

HIGH VISIBILITY CROSSWALK



Iron Horse Trail and Amador Valley Boulevard, Dublin, California
Source: Kittelson and Associates, Inc

PEDESTRIAN REFUGE ISLAND

Amador Valley Boulevard and San Ramon Road Dublin, California.
Source: Kittelson and Associates, Inc

RAISED CROSSWALK

Source: Federal Highway Administration

RECTANGULAR RAPID-FLASHING BEACON

Amador Valley Boulevard and Wildwood Road, Dublin, California
Source: City of Dublin

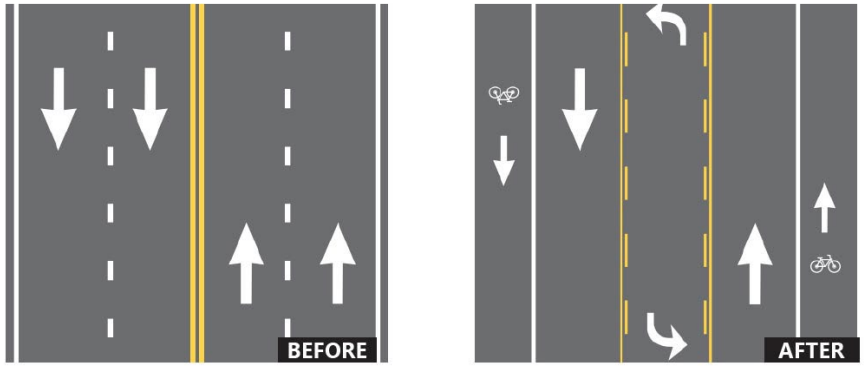
ADVANCE YIELD HERE TO (STOP HERE FOR) PEDESTRIANS SIGN AND YIELD/STOP

Source: MUTCD

IN STREET PEDESTRIAN CROSSING SIGN

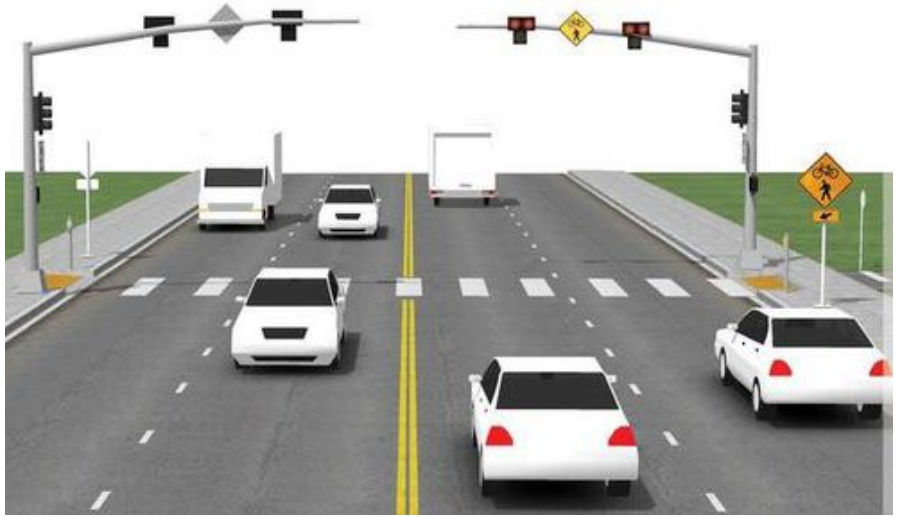
Alcosta Boulevard, San Ramon, California
Source: Google Streetview

ROAD DIET (REALLOCATING SPACE WITHIN THE ROADWAY FOR OTHER USES)



Source: Federal Highway Administration

PEDESTRIAN HYBRID BEACON



Source: NACTO

CURB EXTENSION

Amador Valley Boulevard and Wildwood Road, Dublin, California.
Source: City of Dublin

BICYCLE FACILITIES THROUGH INTERSECTIONS

In locations where there is dedicated space for bicyclists along a roadway, it is important to maintain the bicycle facility through the intersection to clearly provide the intended use of the space, enhance bicyclist comfort, increase motorist yielding behavior, and highlight conflict zones. There are several elements that can support bicyclist movements through intersections including bicycle lane markings, skip striping, green paint, bike boxes, two-stage left turn boxes, protected intersection elements , intersection approach considerations, and traffic control considerations.

2nd Avenue, Seattle, Washington. Source: Kittelson & Associates, Inc.

INTERSECTION CROSSINGS MARKINGS

DESCRIPTION:

Intersection crossing markings indicate where a bicyclist will be travelling through an intersection to clearly mark the intended use, enhance cyclist comfort, increase motorist yielding behavior, and highlight conflict zones. They are generally made up of green "skip striping" paint, green bike lane paint, and/or bicycle lane markings.

TYPICAL APPLICATION:

Through intersections or across driveways

COST ESTIMATE:

$1,500 - $4,000 per approach

DESIGN RECOMMENDATIONS:

When colored paint is used for bicycle facilities, it should be green to avoid confusion with other traffic control markings. For more information, see CA MUTCD Section 9C.04 Figure 9C-103(A). , MUTCD Section 3B.08, or https://nacto.org/publication/urban-bikeway-design-guide/intersection-treatments/intersection-crossing-markings/.

Green pavement is not currently allowed in the extension area through the intersection by MUTCD.

https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/ctcdc/ctcdc-agenda-item-21-22-a11y.pdf

Dublin Boulevard, Dublin, California. Source: Kittelson and Associates, Inc.

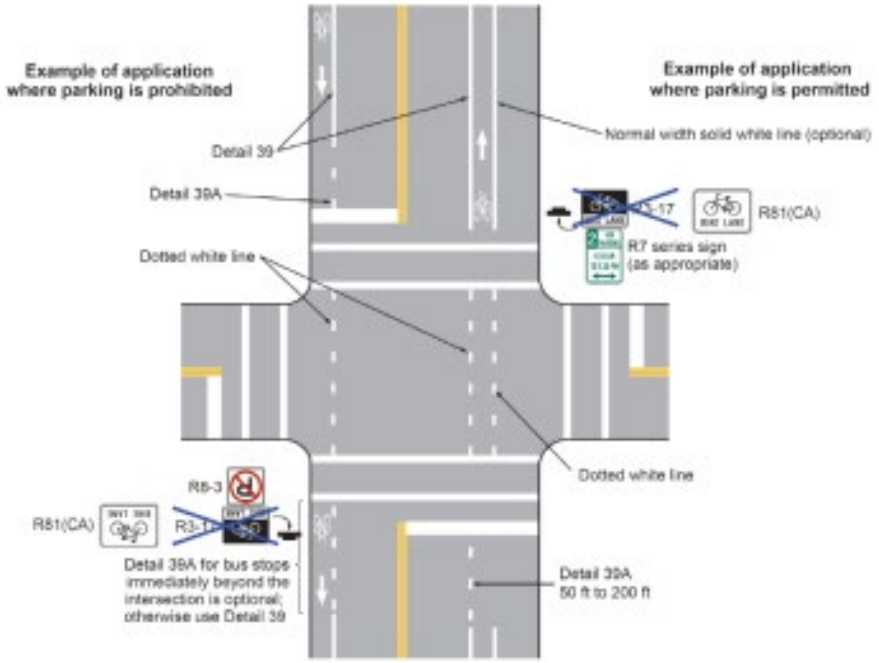


Exhibit 10: CA Traffic Control Devices Committee Editorial Changes to the CA MUTCD

Source: NACTO

BIKE BOXES

DESCRIPTION:

A bike box is a dedicated area at the head of a traffic lane at a signalized intersection that provides bicyclists with a safe and visible way to get ahead of queuing traffic during the red signal phase.

TYPICAL APPLICATION:

Signalized intersections with higher volumes of bicyclists and right-turning vehicles, typically along Class II or Class III facilities.

COST ESTIMATE:

$1,000 each

DESIGN RECOMMENDATIONS:

- "Wait Here" pavement markings can be placed in advance of the bike box as reinforcement for drivers not to impede the bike box
- A STOP HERE ON RED (MUTCD R10-6 or R10-6a) sign can be used at the advance stop bar, with an EXCEPT BICYCLES (MUTCD R3-7bp) plaque below.
- Green paint highlights bike boxes for visibility.
- Right turn on red and bike boxes are not compatible. Use approved MUTCD "NO RIGHT TURN ON RED" signs shall be used (R10-11).
- A bike box shall include an advance stop line at least 10 feet in advance of the intersection stop line, with at least one bicycle pavement marking in the box.

Flanders Street, Portland, Oregon. Source: Kittelson and Associates, Inc.

FOR MORE INFORMATION:

FHWA's Interim Approval for Optional Use of an Intersection Bicycle Box (IA-18)

TWO STAGE BICYCLE TURN BOXES

DESCRIPTION:

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

TYPICAL APPLICATION:

Two-stage bicycle turn boxes are commonly used to facilitate a left turn across multiple lanes of traffic at a signalized intersection. They may also be used for turns at midblock crossing locations, for right turns from a left-side bike lane, or to facilitate a proper angle across tracks (streetcar, train, etc.)

COST ESTIMATE:

$1,000 each

DESIGN RECOMMENDATIONS:

The turn box should be sized to provide room for waiting cyclists, up to 10 feet wide and 6.5 feet deep but not less than 3 feet deep. Appropriate signage may be used to indicate the two-stage turn is provided (MUTCD D11-20L or D11-20R).

The bicycle symbol and left-turn arrow marking shall be provided within the box, which shall be bounded by solid white lines on all sides.

FOR MORE INFORMATION:

FWHA's Interim Approval for Option Use of Two-Stage Bicycle Turn Boxes (IA-20)

Meade Avenue, San Diego, California Source: Kittelson and Associates, Inc.

PROTECTED INTERSECTION TREATMENTS

DESCRIPTION:

A protected intersection provides physical separation for bicyclists and pedestrians up to and through an intersection and provides bicyclists and pedestrians with the right of way over turning vehicles. The physical separation between people driving and people biking or walking creates a setback, which is intended to control speeds, promote visibility, and reduce conflicts among motorists, cyclists, and pedestrians. Protected intersections generally also provide shorter crossing distances for people walking and biking.

TYPICAL APPLICATION:

Intersections with higher speeds and volumes, especially at intersections where Class IV bikeways are present, or a high incidence of bicycle or pedestrian crashes.

COST ESTIMATE:

$1,000,000 per intersection

DESIGN RECOMMENDATIONS:

- Intersection crossing markings for bicyclists and pedestrians provide directional guidance for where each should cross. Green cross bike or skip striping and/or bike markings can provide clear guidance to people biking and allow drivers to anticipate bicyclists in this space.
- Tighter curb return radii (10 feet to 15 feet) should be used to discourage fast turning movements.

Meade Avenue, San Diego, California. Source: Kittelson and Associates, Inc.

- Wider pedestrian islands support higher volumes of people walking and biking. Pedestrian crossing islands should be at least 6 feet wide to provide an accessible waiting area.
- A modified "Turning Vehicles Yield to Bikes and Pedestrians" sign (R10-15) is recommended where a signalized intersection allows right turns with bicycle and pedestrian movements.

FOR MORE INFORMATION:

Reference the following NACTO guidance: https://nacto.org/publication/dont-give-up-at-the-intersection/protected-intersections

INTERSECTION APPROACH CONSIDERATIONS

DESCRIPTION:

A bicycle lane approach to intersections can take different forms depending on the type of lane, existence of turn lanes, and other roadway features. In locations where a right turn lane is added, the roadway can include a mixing zone in the approach to keep bicyclists to the left of the right-turning vehicles. Depending on the geometry of the roadway, the bicycle lane may maintain as a straight line or may transition with a diagonal at the beginning of the turn lane.

TYPICAL APPLICATION:

Intersections with right turn lanes adjacent to a bike lane.

COST ESTIMATE:

$1,500 - $4,000 per approach

DESIGN RECOMMENDATIONS:

- The merge/conflict area can be highlighted with markings, including green paint and skip striping.
- The right turn lane should be as short as practical to encourage slow vehicle speeds when merging across the bike lane. The merge area should also be no more than 100 feet long for the same reasons.
- A through bicycle lane shall not be positioned to the right of a right-turn lane (MUTCD 9C.04) unless the movements are separated by different traffic signal phases.
- Use "BEGIN RIGHT TURN LANE YIELD TO BIKES" (MUTCD R4-4) at the beginning of the right turn lane and merge area.

Source: NACTO

- In cases where space is especially constrained (13 feet is not available for both a right turn lane and bike lane), a shared right turn/through bike lane may be provided.

FOR MORE INFORMATION:

AASHTO Guide for the Development of Bicycle Facilities, 2012, pgs 422 - 427

TRAFFIC SIGNAL CONSIDERATIONS

DESCRIPTION:

Bicycle signals offer a bicycle-exclusive phase at signalized intersections. Bicycle signals can improve safety and operations at intersections by removing bicycle and vehicle time conflicts in time or defining different needs from other road users.

TYPICAL APPLICATION:

Bicycle signals are most appropriate at locations with high bicycle and right-turning vehicle volumes, and often is used to provide a through phase for bicyclists separate from the right-turn phase for motorists. A bicycle signal can be triggered by loop detection, push-buttons, or video detection. Automatic bike detection discourages red-light running.

COST ESTIMATE:

$27,000 - $78,000

DESIGN RECOMMENDATIONS:

- At intersections with right-turning vehicles, right-turns on red should also be prohibited to prevent conflict with the bicycle movement.
- MUTCD Figure 9C-7 provides guidance on bicycle detector pavement markings.
- Some existing bicycle signal designs shields the bicycle signal from drivers' line of sight to avoid potential confusion.
- A bicycle signal face should be separated vertically or horizontally from the nearest motor vehicle traffic signal face for the same approach by at least 3 feet. (IA-16)
- Section 4D.105(CA) Bicycle/Motorcycle Detection Standard: 01 All new limit line detector installations and modifications to the existing limit line detection on a public or private road or driveway intersecting a public road shall either provide a Limit Line Detection Zone in which the Reference Bicycle Rider is detected or be placed on permanent recall or fixed time operation. Refer to CVC 21450.5.

Source: NACTO

FOR MORE INFORMATION:

- FHWA's Interim Approval for Optional Use of Bicycle Signal Faces (IA-16)

BICYCLE PARKING

DESCRIPTION:

Short-term and long-term bicycle parking is an essential part of a successful bicycle system. A lack of secure and convenient bicycle storage can discourage cycling.

CONTEXT:

Short-term bicycle parking is intended to be used for a few hours at most and is provided in public space. Often this is provided along the curb or furniture zone of a street. -

Long-term bicycle parking is intended to be used for longer than several hours. It should be sheltered or indoors to provide greater security.- A bike corral, or multiple bike parking spaces on the street along the curb, can be an efficient use of space. Bike corrals can store up to 12 bicycles in a single vehicle parking space.

TYPICAL APPLICATION:

Bicycle parking should be provided at or near all destinations to allow people to bike to access those destinations. The amount and type of bicycle parking should be dependent upon the type of destination.

COST ESTIMATE:

$27,000 - $78,000

Bike Parking at Dublin Library, Dublin, California. Source: City of Dublin

DESIGN RECOMMENDATIONS:

- Bike racks should be securely fastened to the ground to prevent a bike from being stolen by removing the rack. Adding a crossbar below where the bike would likely be fastened to reduce the ability to remove the bike rack from the ground to slip a lock off and including internal cabling to make it more challenging to cut through can further reduce theft and increase the security of the bike parking system.
- Bike racks should accommodate U-shaped locks and support the bicycle at two points above its center of gravity to allow the frame and both wheels to be locked.
- Long-term parking should be included as a requirement in all buildings where people travel to spend more than several hours, including multi-family housing, places of work, schools, hospitals, and other destinations.
- Long-term parking requirements should be based on household units, trip generation, employees per square footage, and visitation rates. It should be easy to find, direct, and accessible without stairs. It is preferred that it can also be accessed by use of automatic doorways and entryways to limit the need for someone to open a door and hold their bike, which may not be possible.

Long term bicycle parking (BikeLink bike lockers) at the West Dublin BART Station, Dublin, California. Source: City of Dublin

- Long-term parking should consider accommodating e-bike charging by locating electrical outlets near the parking spots and should include spaces for longer bicycles, including cargo bikes or bike trailers. If mounted bicycle parking is provided, there should also be horizontal floor parking available for larger bikes or those that can not lift their bike. For double-decker bicycle racks, a lift-assisted mechanism should be provided to access the upper tier.