LIVERMORE BICYCLE, PEDESTRIAN, & TRAILS ACTIVE TRANSPORTATION PLAN

DESIGN GUIDELINES

LIVERMORE
CALIFORNIA

ADOPTED JUNE 11 2018

alta
PLANNING + DESIGN

People enjoying Lizzie Fountain Park in Livermore.

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These Design Guidelines do not constitute a standard, specification, or regulation. They do not create or confer any rights for or on any person or operate to bind the public. Images are intended to serve as examples of the range of real world existing conditions; they are not limited to best practices or approved designs.

Livermore provides places for people to walk, bike, and enjoy nature.

CONTEXT

SECTION 1

GUIDANCE BASIS

The sections that follow serve as an inventory of pedestrian, bicycle, and trail design treatments and provide guidelines for their development. These treatments and design guidelines are important because they are the tools for creating a safe and accessible community.

CONTEXT

This document presents design guidelines and best practices recommended for the City of Livermore to use for pedestrian, bicycle, and equestrian facilities, to be used in conjunction with the City's Standard Details and Standard Specifications. These guidelines describe the ideal conditions which cannot always be provided. Nor, do the descriptions obligate the City, these are references for design and implementation.

This document follows the design standards and guidelines of national best practice documents, as well as California-specific guidance.

The guidelines are not, however, a substitute for a more thorough evaluation of site-specific conditions by a landscape architect or engineer, in detailed design and implementation of facility improvements.

NATIONAL GUIDANCE

The following standards and guidelines are referred to in this guide:

- ***American Association of State Highway and Transportation Officials (AASHTO) Guide for the Development of Bicycle Facilities*** (2013), updated in June 2012 provides guidance on dimensions, use, and layout of specific bicycle facilities.
- The ***National Association of City Transportation Officials' (NACTO) Urban Bikeway Design Guide*** (2012) is the newest publication of nationally recognized bikeway design standards, and offers guidance on the current state of the practice designs.
- The ***AASHTO A Policy on Geometric Design of Highways and Streets*** (2011) commonly referred to as the "Green Book," contains the current design research and practices for highway and street geometric design.
- The ***National Association of City Transportation Officials' (NACTO) Designing for All Ages and Abilities*** (2017) offers guidance on combining traffic calming tools and roadway design to create high-comfort bicycle facilities.

The following national guidelines provide information on complying with the Americans with Disability Act (ADA) and designing for users of all abilities:

- United States Access Board. Accessibility Guidelines for Buildings and Facilities. 2002
- United States Access Board. Proposed Accessibility Guidelines for Pedestrian Facilities in the Public-Right-of-Way. 2013
- USDOJ. ADA Standards for Accessible Design. 2010.

STATE GUIDANCE

The following California-specific standards and guidelines are referred to in this guide:

- The ***California Manual on Uniform Traffic Control Devices (CaMUTCD)*** (2014) is an amended version of the FHWA MUTCD 2009 edition modified for use in California. While standards presented in the CA MUTCD substantially conform to the FHWA MUTCD, the state of California follows local practices, laws and requirements with regards to signing, striping and other traffic control devices.
- ***The California Highway Design Manual (HDM)*** (2014) establishes uniform policies and procedures to carry out highway design functions for the California Department of Transportation. The 2012 edition incorporated Complete Streets focused revisions to address the Department Directive 64 R-1.
- ***Complete Intersections: A Guide to Reconstructing Intersections and Interchanges for Bicyclists and Pedestrians*** (2010) is a reference guide presents information and concepts related to improving conditions for bicyclists and pedestrians at major intersections and interchanges. The guide can be used to inform minor signage and striping changes to intersections, as well as major changes and designs for new intersections.
- ***Main Street, California: A Guide for Improving Community and Transportation Vitality*** (2013) reflects California's current manuals and policies that improve multimodal access, livability and sustainability within the transportation system. The guide recognizes the overlapping and sometimes competing needs of main streets.
- The ***Caltrans Memo: Design Flexibility in Multimodal Design*** (2014) encourages flexibility in highway design. The memo states, "Publications such as the National Association of City Transportation Officials (NACTO) "Urban Street Design Guide" and "Urban Bikeway Design Guide," ... are resources that Caltrans and local entities can reference when making planning and design decisions on the State highway system and local streets and roads."
- The ***Caltrans Design Information Bulletin 89-01: Class IV Bikeway Guidance (DIB 89-01)*** (2018) provides design criteria and guidance on best practices related to separated bikeways to establish uniform guidance. The bulletin is flexible to allow designers to exercise sound judgment in applying the design criteria, taking into consideration the context of the project location and specific circumstances while maintaining safety.

USER DESIGN NEEDS

Active transportation facility needs are specific to the different user groups. The pages that follow provide an overview of pedestrian, cyclist, and equestrian users, their design needs, and operating space requirements.

DESIGN NEEDS OF PEDESTRIANS

The CaMUTCD recommends a normal walking speed of 3.5 ft per second when calculating the pedestrian clearance interval at traffic signals. The walking speed can drop to 3 ft per second for areas with older populations and persons with mobility impairments. While the type and degree of mobility impairment varies greatly across the population, the transportation system should accommodate these users to the greatest reasonable extent.

TYPES OF PEDESTRIANS

Pedestrians have a variety of characteristics and the network should accommodate a variety of needs, abilities, and possible impairments.

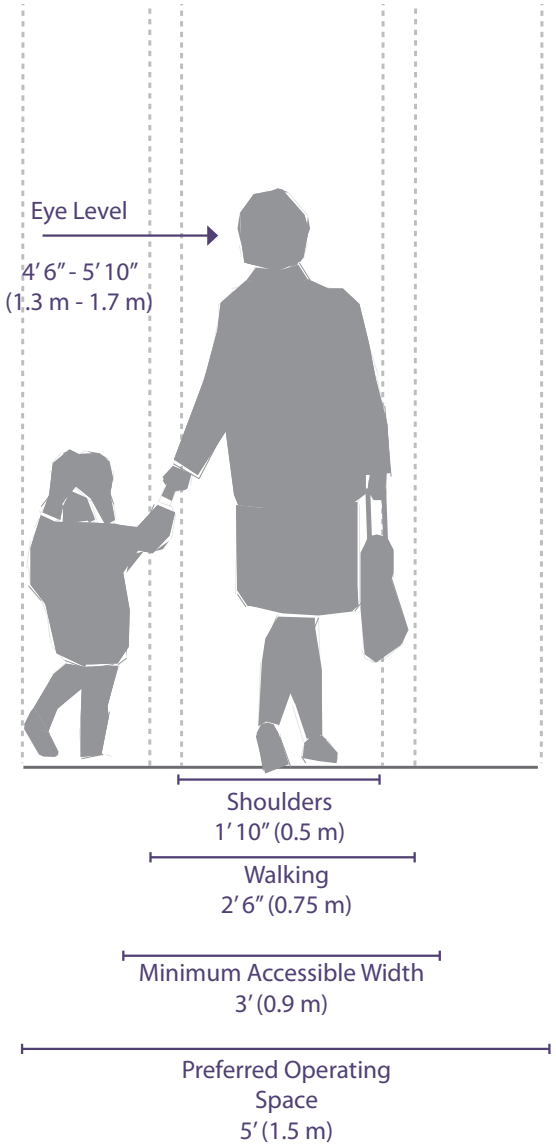
Age is one major factor that affects pedestrians' physical characteristics, walking speed, and environmental perception. Children have low eye height and walk at slower speeds than adults. They also perceive the environment differently at various stages of their cognitive development. Older adults walk more slowly and may require assistive devices for walking stability, sight, and hearing.

Pedestrian Characteristics by Age

Age	Characteristics
0-4	Learning to walk
	Requires constant adult supervision
	Developing peripheral vision and depth perception
5-8	Increasing independence, but still requires supervision
	Poor depth perception
9-13	Susceptible to "darting out" in roadways
	Insufficient judgment
	Sense of invulnerability
14-18	Improved awareness of traffic environment
	Insufficient judgment
19-40	Active, aware of traffic environment
41-65	Slowing of reflexes
65+	Difficulty crossing street
	Vision loss
	Difficulty hearing vehicles approaching from behind

Source: AASHTO. ***Guide for the Planning, Design, and Operation of Pedestrian Facilities***, Exhibit 2-1. 2004.

Pedestrian Dimensions



DISABLED PEDESTRIAN DESIGN CONSIDERATIONS

The table below summarizes common physical and cognitive impairments, how they affect personal mobility, and recommendations for improved pedestrian-friendly design.

Disabled Pedestrian Design Considerations (AASHTO Pedestrian Guide 2004)

Impairment	Effect on Mobility	Design Solution
Physical Impairment Necessitating Wheelchair and Scooter Use	Difficulty propelling over uneven or soft surfaces.	Firm, stable surfaces and structures, including ramps or beveled edges.
	Cross-slopes cause wheelchairs to veer downhill or tip sideways.	Cross-slopes of less than two percent.
	Require wider path of travel.	Sufficient width and maneuvering space.
Physical Impairment Necessitating Walking Aid Use	Difficulty negotiating steep grades and cross slopes; decreased stability and tripping hazard.	Cross-slopes of less than two percent. Smooth, non-slippery travel surface.
	Slower walking speed and reduced endurance; reduced ability to react.	At trail crossings, longer pedestrian signal cycles, shorter crossing distances, median refuges, and street furniture.
Hearing Impairment	Less able to detect oncoming hazards at locations with limited sight lines.	At trail crossings, longer pedestrian signal cycles, clear sight distances, highly visible pedestrian signals and markings.
Vision Impairment	Limited perception of path ahead and obstacles; reliance on memory; reliance on non-visual indicators (e.g. sound and texture).	Accessible text (larger print and raised text), accessible pedestrian signals (APS), guide strips and detectable warning surfaces, safety barriers, and lighting.
Cognitive Impairment	Varies greatly. Can affect ability to perceive, recognize, understand, interpret, and respond to information.	Signs with pictures, universal symbols, and colors, rather than text.

DESIGN NEEDS OF RUNNERS

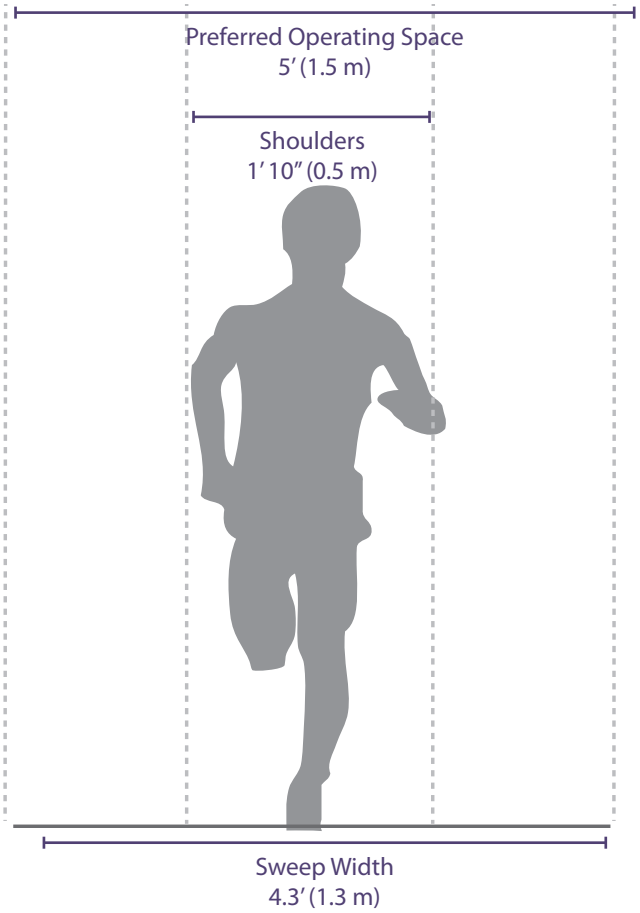
Running is an important recreation and fitness activity commonly performed on trails. Many runners prefer softer surfaces (such as rubber, bare earth or crushed rock) to reduce impact. Runners can change their speed and direction frequently. If high volumes are expected, controlled interaction or separation of different types of users should be considered.

DESIGN NEEDS OF STROLLERS

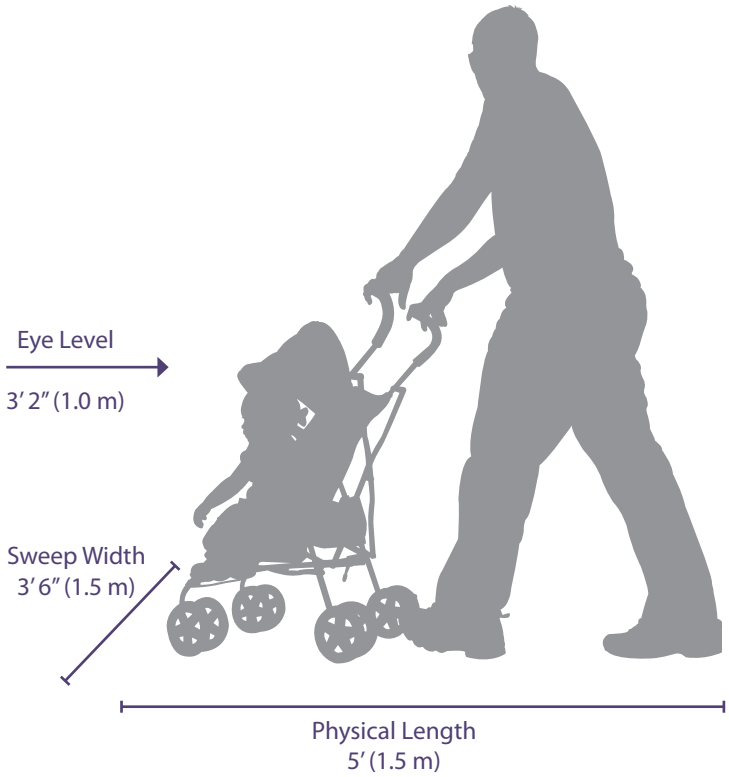
Strollers are wheeled devices pushed by pedestrians to transport babies or small children. Stroller models vary greatly in their design and capacity. Some strollers are designed to accommodate a single child, others can carry 3 or more. Design needs of strollers depend on the wheel size, geometry and ability of the adult who is pushing the stroller.

Strollers commonly have small pivoting front wheels for easy maneuverability, but these wheels may limit their use on unpaved surfaces or rough pavement. Curb ramps are valuable to these users. Lateral overturning is one main safety concern for stroller users.

Runner Dimensions



Stroller Dimensions



DESIGN NEEDS OF WHEELCHAIR USERS

As the American population ages, the number of people using mobility assistive devices (such as manual wheelchairs, powered wheelchairs) increases.

Manual wheelchairs are self-propelled devices. Users propel themselves using push rims attached to the rear wheels. Braking is done through resisting wheel movement with the hands or arm. Alternatively, a second individual can control the wheelchair using handles attached to the back of the chair.

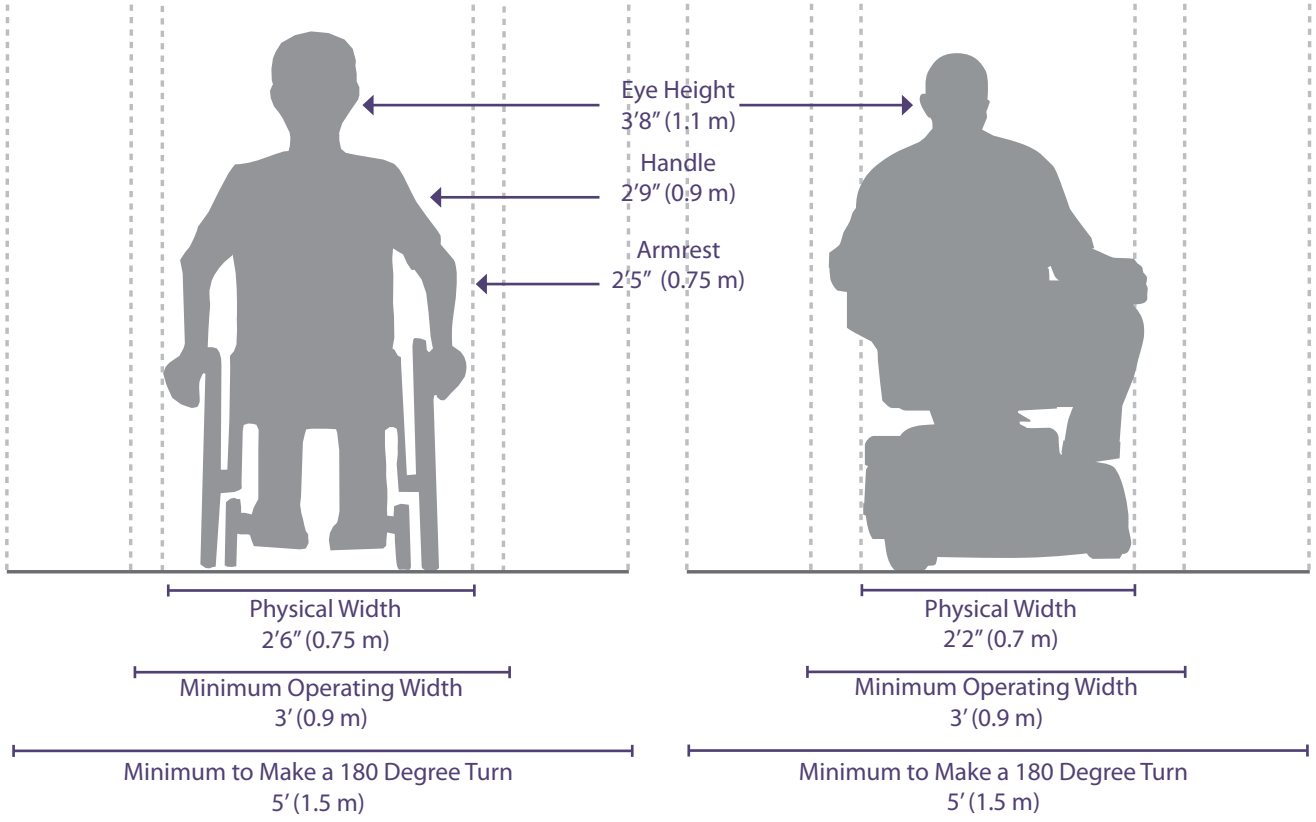
Power wheelchairs use battery power to move the wheelchair. The size and weight of power wheelchairs limit their ability to negotiate obstacles without a ramp. Various control units are available that enable users to control the wheelchair movement, based on their ability (e.g., joystick control, breath controlled, etc).

Maneuvering around a turn requires additional space for wheelchair devices. Providing adequate space for 180 degree turns at appropriate locations is an important element of accessible design.

Wheelchair User Design Considerations

Effect on Mobility	Design Solution
Difficulty propelling over uneven or soft surfaces.	Firm, stable surfaces and structures, including ramps or beveled edges.
Cross-slopes cause wheelchairs to veer downhill.	Cross-slopes of less than two percent.
Require wider path of travel.	Sufficient width and maneuvering space.

Wheelchair User Dimensions



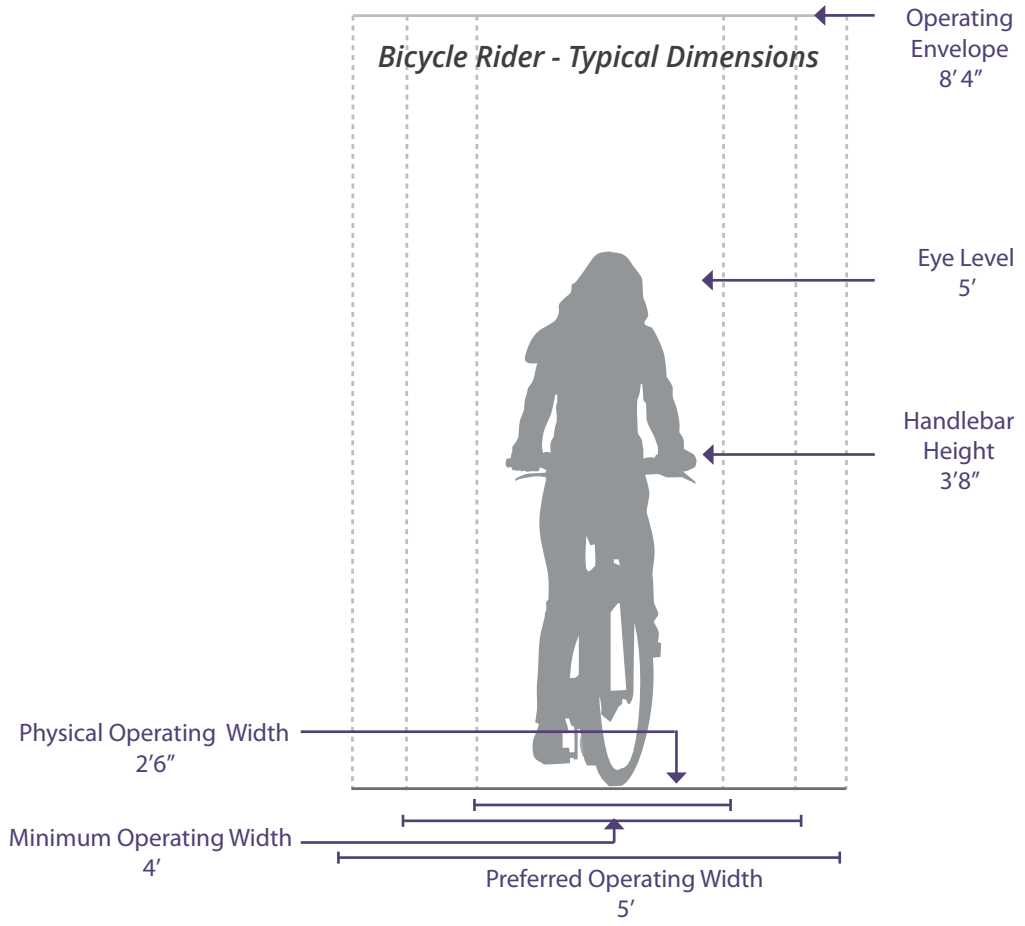
DESIGN NEEDS OF CYCLISTS

Bicyclists and their bicycles exist in a variety of sizes and configurations. These variations occur in the types of bicycle (such as a conventional bicycle, a recumbent bicycle or a tricycle), and behavioral characteristics (such as the comfort level of the cyclist). The facility design should consider reasonably expected bicycle types and utilize the appropriate dimensions.

CYCLIST OPERATING SPACES

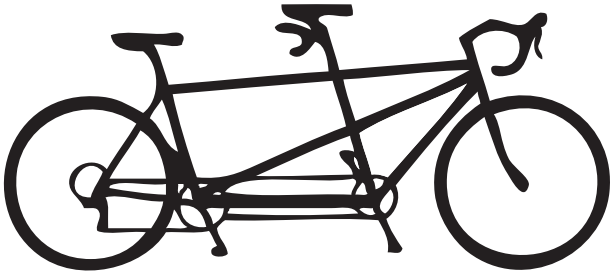
The figure to the right illustrates the operating space and physical dimensions of a typical adult bicyclist, which are the basis for typical facility design. Bicyclists require clear space to operate within a facility. This is why the minimum operating width is greater than the physical dimensions of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

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



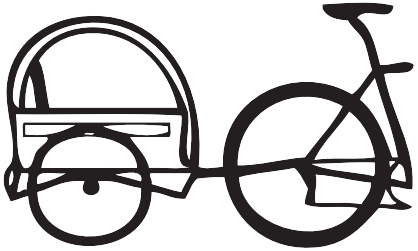
Cycles and Accessories Dimensions

5′ 10″

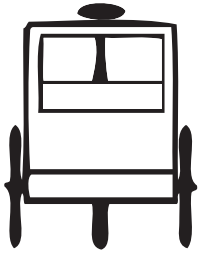


8′

6′10″



3′ 6″



2′ 6″

3′ 9″

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

DESIGN NEEDS OF EQUESTRIANS

Trail design guidelines refer to the characteristics of the trail which provide different levels of access, traffic loads, maintenance requirements, and costs.

Suggested Widths and Clearance For Equestrians on Trails

Trail Element	Low Development	Medium Development	High Development
Tread Width	1.5 - 2 ft	3 - 6 ft	8 - 10 ft
Clearing Width (horizontal)	5.5 - 8 ft (Tread plus 2' to 3' each side)	9 - 12 ft (Tread plus 3' each side)	14 - 18 ft (Tread plus 3' each side)
Vertical Clearance	10	10 - 12 ft	10 - 12 ft

Source: USDA/FHWA Equestrian Design Guidebook for Trails, Trailheads, and Campgrounds

In order to select the appropriate trail design for a particular trail or trail system, a number of factors should be considered, such as:

- Setting
- Trail user types
- Anticipated trail use volumes and seasonal demands
- Trail grades
- Drainage needs
- Maintenance needs
- Maintenance costs and schedules

Trails in urban settings often accommodate multiple user groups including pedestrians, cyclists, and equestrians. While the above safety considerations apply to trails in urban areas, trails in developed areas are also more likely to interact with roadways and motorized vehicles.

Less developed or rural trail settings include rivers, open spaces, and drainages among others. Safety concerns for riders in rural settings involve: visibility, interactions with other trail users and natural hazards. Urban settings include developed or congested areas.

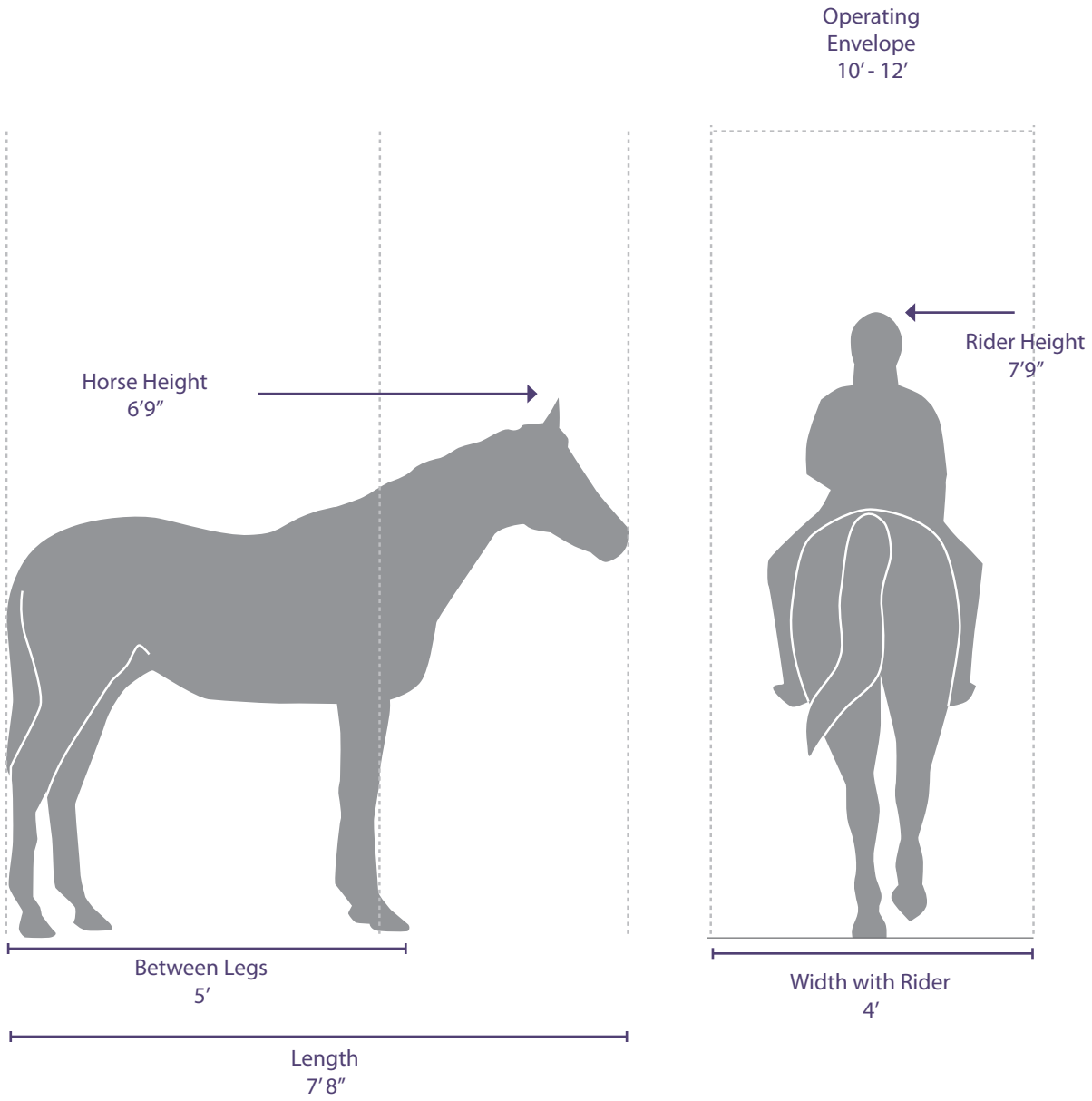
Trails can serve both pedestrians and equestrians, as they both travel easily on unpaved surfaces and move at relatively slow speeds. However, equestrians and bicyclists are not typically compatible on the same tread. For instance, quiet, fast-moving cyclist can startle a horse. In areas where trail user conflicts seem likely, efforts should be made to physically separate non-compatible user groups. Adequate passing distance is especially important in shared use scenarios to allow users to pass and avoid conflict.

Equestrians include: youth, elders, leisure riders, professional riders, organized groups, novices, and people with disabilities. Riders may recreate individually or in groups for pleasure, exercise or challenge. While some equestrians prefer wide, gentle trails, others seek a technically challenging route.

Equestrian trail definitions:

- Tread: the part of the trail that feet, bicycle tires, or hooves travel on
- Stock: animals using the trail, primarily equine animals such as horses

Equestrian Dimensions



TRAIL WIDTHS

Horizontal trail clearance will vary based on the trail setting. Trail facilities should provide enough space so that a horse feels at ease. Horses prefer to travel away from walls or barriers that they cannot see through or over and are most comfortable traveling in the tread that other stock have traveled. USDA/FHWA suggested widths for a standard single-track horse trails are listed on the previous page.

A horse on a single-track requires a minimum of 1.5 feet of tread width with two feet horizontal clear width on each side to accommodate horse and rider. Horses will often travel eighteen inches from a trail edge or tread surface. Single track treads vary from 1.5 feet in wild areas to eight feet in urban areas. Many double-tracked equestrian trails are designed to be five to six feet wide with a two foot clear or shy distance on each side of the tread.

In developed areas like Livermore, a double-track tread allows for equestrians to ride side by side while also providing a comfortable passing distance. This is a common configuration for moderately developed trails in rural settings. In developed areas, double-track treads are often eight to twelve feet wide.

PEDESTRIAN CROSSING LOCATION AND FACILITY SELECTION

The specific type of treatment at a crossing may range from a simple marked crosswalk to full traffic signals or grade separated crossings. Crosswalk lines should not be used indiscriminately, and appropriate selection of crossing treatments should be evaluated in an engineering study should be performed before a marked crosswalk is installed.

The engineering study should consider the number of lanes, the presence or lack of a median, the distance from adjacent signalized intersections, the pedestrian volumes and delays, the average daily traffic (ADT), the posted or statutory speed limit or 85th-percentile speed, the geometry of the location, the possible consolidation of multiple crossing points, the availability of street lighting, and other appropriate factors.

MID-BLOCK CROSSINGS

Midblock crossings are an important street design element for pedestrians. They can provide a legal crossing at locations where pedestrians want to travel, and can be safer than crossings at intersections because traffic is only moving in two directions. Locations where midblock crossings should be considered include:

- Long blocks (longer than 600 ft) with destinations on both sides of the street.
- Locations with heavy pedestrian traffic, such as schools, shopping centers.
- Midblock transit stops, where transit riders must cross the street on one leg of their journey.

CROSSING TREATMENT SELECTION

PEDESTRIAN CROSSING CONTEXTUAL GUIDANCE At unsignalized locations		Local Streets 15-25 mph		Collector Streets 25-30 mph			Arterial Streets 30-45 mph							
FACILITY TYPE		2 lane	3 lane	2 lane	2 lane with median refuge	3 lane	2 lane	2 lane with median refuge	3 lane	4 lane	4 lane with median refuge	5 lane	6 lane	6 lane with median refuge
1	Crosswalk Only (high visibility)	✓	✓	EJ	EJ	X	EJ	EJ	X	X	X	X	X	X
2	Crosswalk with warning signage and yield lines	EJ	✓	✓	✓	✓	EJ	EJ	EJ	X	X	X	X	X
3	Stop Sign Controlled	✓	✓	EJ	EJ	EJ	EJ	EJ	EJ	X	X	X	X	X
4	Active Warning Beacon (RRFB)	X	EJ	✓	✓	✓	✓	✓	✓	X	✓	X	X	X
5	Hybrid Beacon	X	X	EJ	EJ	EJ	EJ	✓	✓	✓	✓	✓	✓	✓
6	Full Traffic Signal	X	X	EJ	EJ	EJ	EJ	EJ	EJ	✓	✓	✓	✓	✓
7	Grade separation	X	X	EJ	EJ	EJ	X	EJ	EJ	✓	✓	✓	✓	✓

LEGEND	
Most Desirable	✓
Engineering Judgement	EJ
Not Recommended	X


1 Marked Crosswalks


2 Crosswalk with Warning Signage

3 Stop Sign Controlled


4 Active Warning Beacon (RRFB)

4 Pedestrian Hybrid Beacon


5 Full Traffic Signal

6 Grade Separation

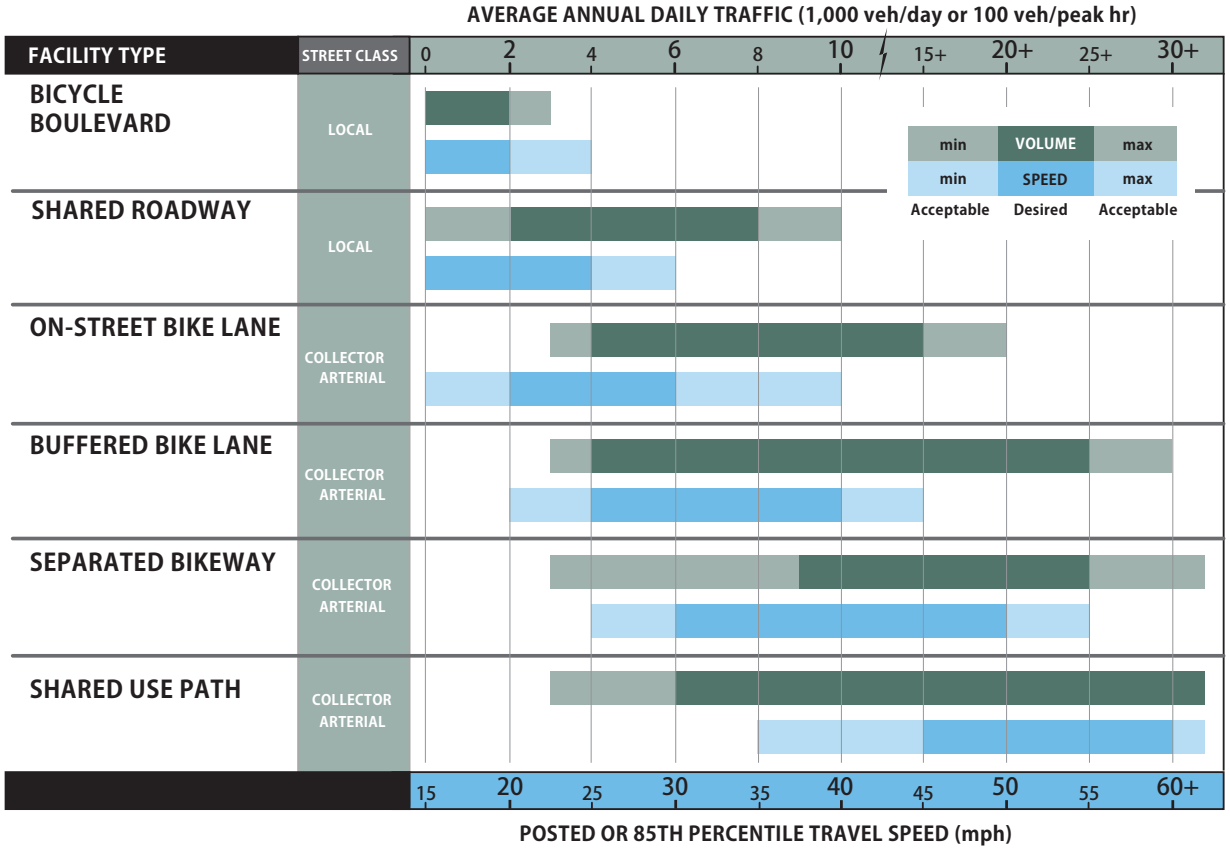
BIKEWAY FACILITY SELECTION

Selecting the best bikeway facility type for a given roadway can be challenging, due to the range of factors that influence bicycle users' comfort and safety. There is a significant impact on cycling comfort when the speed differential between bicyclists and motor vehicle traffic is high and motor vehicle traffic volumes are high.

FACILITY SELECTION TABLE

As a starting point to identify a preferred facility, the chart below can be used to determine the recommended type of bikeway to be provided in particular roadway speed and volume situations. To use this chart, identify the appropriate daily traffic volume and travel speed on or the existing or proposed roadway, and locate the facility types indicated by those key variables.

Other factors beyond speed and volume which affect facility selection include traffic mix of automobiles and heavy vehicles, mix and volume of pedestrians, the presence of on-street parking, intersection density, surrounding land use, and roadway sight distance. These factors are not included in the facility selection chart below, but should always be considered in the facility selection and design process.



BICYCLE USER TYPES

The current AASHTO Guide to the Development of Bicycle Facilities encourages designers to identify their rider type based on the trip purpose (Recreational vs Transportation) and on the level of comfort and skill of the rider (Causal vs Experienced). An alternate research based[1] classification system identifies four categories to address varying attitudes towards bicycling in the US. This system is illustrated in the figure below.

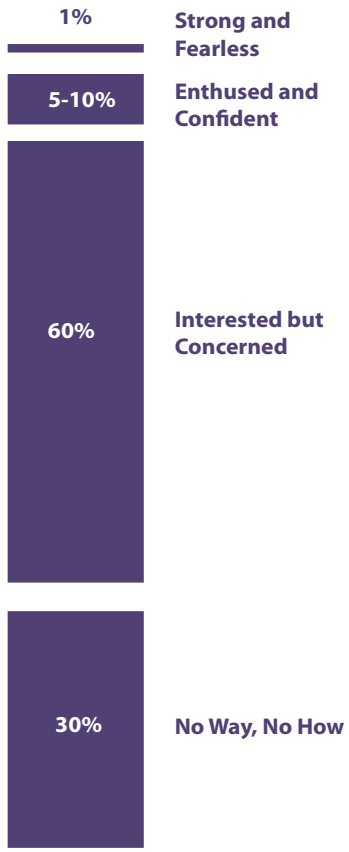
FOUR TYPES OF CYCLISTS

Strong and Fearless (approximately 1% of population) – Characterized by bicyclists that will typically ride anywhere regardless of roadway conditions or weather. These bicyclists can ride faster than other user types, prefer direct routes and will typically choose roadway connections -- even if shared with vehicles -- over separate bicycle facilities such as shared-use paths.

Enthused and Confident (5-10% of population) - This user group encompasses bicyclists who are fairly comfortable riding on all types of bikeways but usually choose low traffic streets or shared-use paths when available. These bicyclists may deviate from a more direct route in favor of a preferred facility type. This group includes all kinds of bicyclists such as commuters, recreationalists, racers and utilitarian bicyclists.

Interested but Concerned (approximately 60% of population) – This user type comprises the bulk of the cycling population and represents bicyclists who typically only ride a bicycle on low traffic streets or shared-use paths under favorable weather conditions. These bicyclists perceive significant barriers to their increased use of cycling, specifically traffic and other safety issues. These people may become "Enthused & Confident" with encouragement, education and experience.

No Way, No How (approximately 30% of population) – Persons in this category are not bicyclists, and perceive severe safety issues with riding in traffic. Some people in this group may eventually become more regular cyclists with time and education. A significant portion of these people will not ride a bicycle under any circumstances.



Typical Distribution of Bicyclist Types

1 Dill, J., McNeil, N. Four Types of Cyclists? Testing a Typology to Better Understand Bicycling Behavior and Potential. 2012.

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Pedestrian facilities in Livermore include sidewalks with well landscaped buffers.

PEDESTRIAN FACILITIES

SECTION 2

SIDEWALKS & SIDEWALK ZONES

Sidewalks are the most fundamental element of the walking network, as they provide an area for pedestrian travel separated from vehicle traffic. Providing adequate and accessible facilities can lead to increased numbers of people walking, improved safety, and the creation of social space.

TYPICAL APPLICATION

- Sidewalks should be provided on both sides of urban commercial streets, and should be required in areas of moderate residential density. (1-4 dwelling units per acre). Per state code, sidewalks are the responsibility of property owners.
- When retrofitting gaps in the sidewalk network, locations near transit stops, schools, parks, public buildings, and other areas with high concentrations of pedestrians should be the highest priority.
- In rural areas, no curb and gutter is necessary to establish a sidewalk. Instead, the sidewalk should feature a wide furnishing zone, which may be configured as an open ditch for stormwater catchment and infiltration. Ditches can be retrofitted into bioswales or raingardens for filtration and water purification.

DESIGN FEATURES

- It is important to provide adequate width along a sidewalk corridor. A minimum pedestrian through zone width of 5 ft enables two pedestrians (including wheelchair users) to walk side-by-side, or to pass each other comfortably.
- In areas of high demand, sidewalks should contain adequate width to accommodate the high volumes and different walking speeds of pedestrians.
- Appropriate placement of street trees in the furnishing zone (minimum width 4 ft) helps buffer pedestrians from the travel lane and increases facility comfort.

STREET CLASSIFICATION	PARKING LANE/ ENHANCEMENT ZONE	FURNISHING ZONE	PEDESTRIAN THROUGH ZONE	FRONTAGE ZONE
Local Streets	Varies	2 - 5 ft	5 ft	N/A
Downtown and Pedestrian Priority Areas	Varies	4 - 6 ft	5-12 ft	2.5 - 10 ft
Arterials and Collectors	Varies	2 - 6 ft	5 - 8 ft	2.5 - 5 ft

Curbside Lane

The curbside lane can act as a flexible space to further buffer the sidewalk from moving traffic and may be used for a bike lane. Curb extensions and bike corrals may occupy this space where appropriate.

EDGE ZONE

In the edge zone there should be a 6 inch wide curb.

Furnishing Zone

The furnishing zone buffers pedestrians from the adjacent roadway, and is also the area where elements such as street trees, signal poles, signs, and other street furniture are properly located.

Pedestrian Thru Zone

The through zone is the area intended for pedestrian travel. This zone should be entirely free of permanent and temporary objects.

Wide through zones are needed in downtown areas or where pedestrian flows are high.

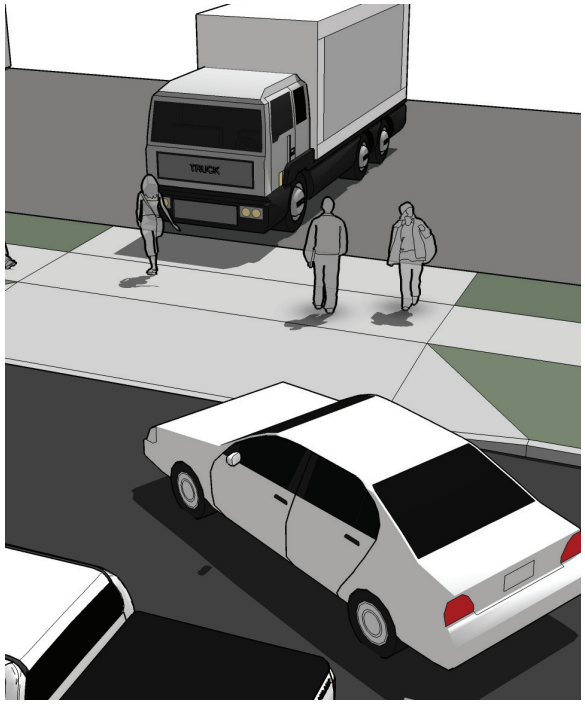
Frontage Zone

The frontage zone allows pedestrians a comfortable "shy" (or space between) distance from the building fronts. It provides opportunities for window shopping, to place signs, planters, or chairs.

COMMERICAL-TYPE DRIVEWAYS

Driveways provide automobile access to private property but can also cause conflicts with pedestrians using the sidewalk at that location. There are generally two types of driveway designs: commercial-type and intersection-type. Commercial-type driveways are preferred, as they maintain the sidewalk grade across the driveway which compels motorists to slow down before crossing. Intersection-type crossings can compromise pedestrian safety and comfort due to the ability for motorists to negotiate turns at higher speeds and the lack of defined pedestrian right-of-way.

COMMERCIAL-TYPE DRIVEWAY



TYPICAL APPLICATION

- Commercial-type driveways are appropriate for all private accessways and driveways that cross sidewalks.
- Ideal for commercial business districts with high pedestrian activity and slower travel lanes.
- Right-in/right-out restrictions reduce points of conflict between modes.
- Traffic signals may be considered where turning movements are very high.

DESIGN FEATURES

- Commercial-type driveway access is preferred, as the sidewalk maintains grade and material across the driveway to reinforce pedestrian right-of-way. Cross slope (driveway grade) should be no greater than 2 percent.
- Decrease curb radius to reduce vehicle speeds and pedestrian crossing distance (10-25' recommended based on site activity and street context).
- Minimize driveway widths to reduce crossing distance and accommodate entering and exiting vehicles.
- Where turning volumes are high, right-turn channelization removes slower turning vehicles from main flow of traffic, improving motorist yield compliance.

CURB EXTENSIONS

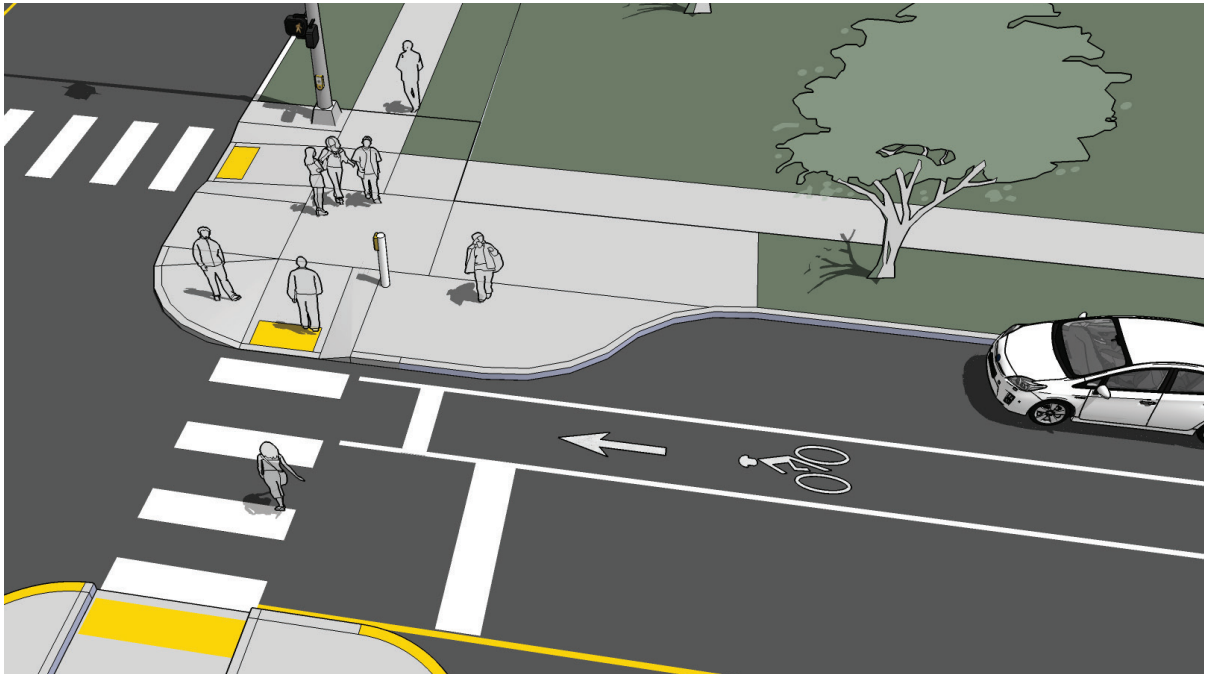
Curb extensions minimize pedestrian exposure during crossing by shortening crossing distance and giving pedestrians a better chance to see and be seen before committing to crossing.

TYPICAL APPLICATION

- Within parking lanes appropriate for any crosswalk where it is desirable to shorten the crossing distance and there is a parking lane adjacent to the curb.
- May be possible within non-travel areas on roadways with excess space.
- Particularly helpful at midblock crossing locations.
- Curb extensions should not impede bicycle travel in the absence of a bike lane.

DESIGN FEATURES

- For purposes of efficient street sweeping, the minimum radius for the reverse curves of the transition is 10 ft and the two radii should be balanced to be nearly equal.
- When a bike lane is present, the curb extensions should terminate one ft short of the parking lane to maximize bicyclist safety.
- Reduces pedestrian crossing distance by 6-8 ft.
- Planted curb extensions may be designed as a bioswale for stormwater management.



GREEN INFRASTRUCTURE

Green infrastructure treats and slows runoff from impervious surface areas, such as roadways, sidewalks, and buildings. Sustainable stormwater strategies may include bioretention swales, rain gardens, tree box filters, and pervious pavements (pervious concrete, asphalt and pavers). Bioswales are natural landscape elements that manage water runoff from a paved surface, reducing the risks of erosion or flooding of local streams and creeks, which can threaten natural habitats. Plants in the swale trap pollutants and silt from entering a river system.

TYPICAL APPLICATION

- Install in areas without conventional stormwater systems that are prone to flooding to improve drainage and reduce costs compared to installing traditional gutter and drainage systems.
- Use green infrastructure to provide an ecological and aesthetic enhancement of traditional traffic speed and volume control measures, such as along a bicycle boulevard corridor.

(A) Bioswales and rain gardens are appropriate at curb extensions and along planting strips.

(B) Street trees and plantings can be placed in medians, chicanes, and other locations.

(C) Pervious pavers can be used along sidewalks, street furniture zones, parking lanes, gutter strips, or entire roadways.

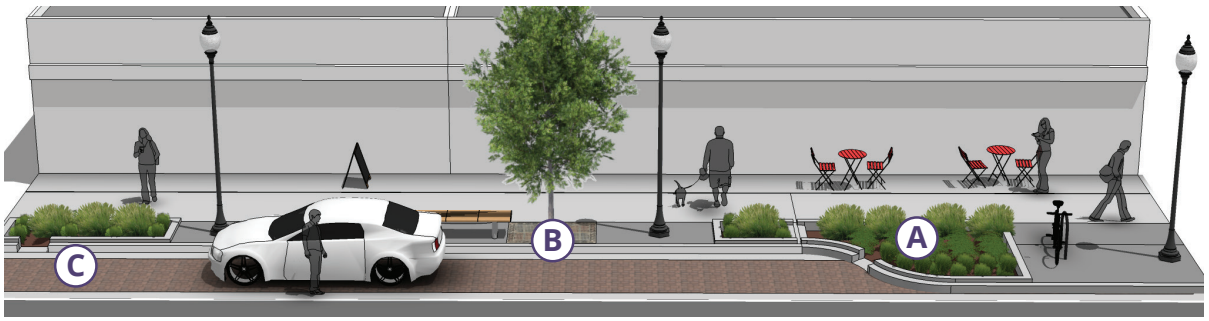
DESIGN FEATURES

BIOSWALES

The edge of the swale should be flush with the grade to accommodate sheetflow runoff, with a minimum 2-inch drop between the street grade and the finished grade of the facility. Where there are curbs, cut-outs at least 18 inches wide should be provided intermittently (3-15 ft apart) to allow runoff to enter and be treated. Hardy vegetative ground covers can be used to discourage pedestrian trampling.

PERVIOUS PAVEMENT

Engineering judgment and surrounding street context should be used when selecting the permeable surface, whether it is pavers, concrete or asphalt. Some decorative pavers may be more appropriate for bicycle and/or pedestrians areas due to the potential for shifting under heavy loads.



ACCESSIBLE CURB RAMPS

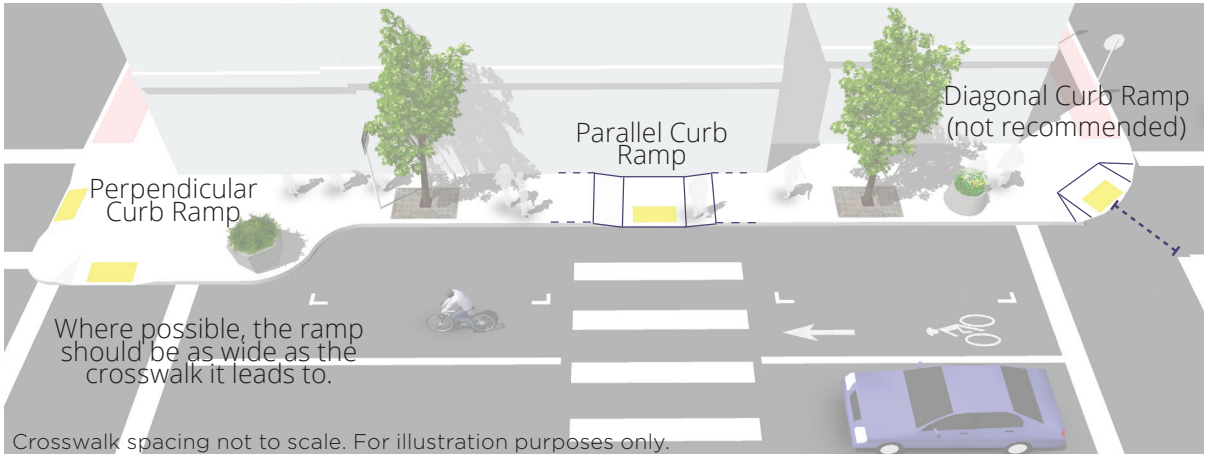
Infrastructure within the public right of way must be accessible and comply with the Americans with Disabilities Act (ADA) requirements. Sidewalk and curb design must accommodate users of all abilities, including blind pedestrians and those using a mobility device.

TYPICAL APPLICATION

- At all crossing locations, including mid-block crossings.
- Refer to the following documents for more information on ADA accessibility:
  - United States Access Board. Accessibility Guidelines for Buildings and Facilities. 2002.
  - United States Access Board. Proposed Accessibility Guidelines for Pedestrian Facilities in the Public-Right-of-Way. 2013.
  - USDOJ. ADA Standards for Accessible Design. 2010.

DESIGN FEATURES

- The level landing at the top of a ramp shall be at least 4 feet long and at least the same width as the ramp itself.
- The ramp shall slope no more than 1:12, with a maximum cross slope of 2.0%.
- If the ramp lands on a dropped landing within the sidewalk or corner area where someone in a wheelchair may have to change direction, the landing must be a minimum of 5'-0" long and at least as wide as the ramp, although a width of 5'-0" is preferred.
- Curb ramps shall be located so that they do not project into vehicular traffic lanes, parking spaces, or parking access aisles. Three configurations are illustrated below.
- Diagonal ramps shall include a clear space of at least 48" within the crosswalk for user maneuverability.



Crosswalk spacing not to scale. For illustration purposes only.

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Safe and convenient locations for pedestrians to cross the street are important facilities.

PEDESTRIAN FACILITIES AT INTERSECTIONS

SECTION 3

MARKED CROSSWALKS

A marked crosswalk signals to motorists that they must stop for pedestrians and encourages pedestrians to cross at designated locations. Installing crosswalks alone will not necessarily make crossings safer especially on multi-lane roadways. At mid-block locations, crosswalks can be marked where there is a demand for crossing and there are no nearby marked crosswalks.

TYPICAL APPLICATION

All crosswalks should be marked at signalized intersections. At unsignalized intersections, crosswalks may be marked under the following conditions:

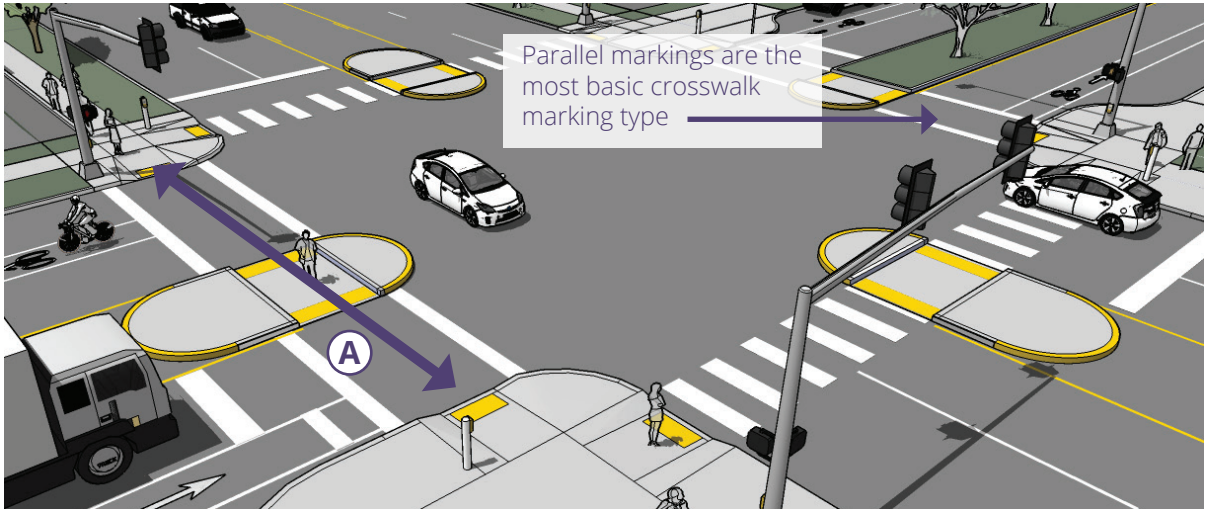
- At a complex intersection, to orient pedestrians in finding their way across.
- At an offset intersection, to show pedestrians the shortest route across traffic with the least exposure to vehicular traffic and traffic conflicts.
- At an intersection with visibility constraints, to position pedestrians where they can best be seen by oncoming traffic.
- At an intersection within a school zone on a walking route.

DESIGN FEATURES

- The crosswalk should be located to align as closely as possible with the through pedestrian zone of the sidewalk corridor.
- Marked crosswalks should be provided on all legs of the intersection, when feasible.

CURB RAMPS

- The landing at the top of a ramp shall be at least 4 feet long and at least the same width as the ramp itself.
- The ramp shall slope no more than 8.33%, with a maximum cross slope of 2.0%.
- If the ramp runs directly into a crosswalk, the landing at the bottom will be in the roadway.
- If the ramp lands on a dropped landing within the sidewalk or corner area where someone in a wheelchair may have to change direction, the landing must be a minimum of 5'-0" long and at least as wide as the ramp itself.



MEDIAN REFUGE ISLANDS

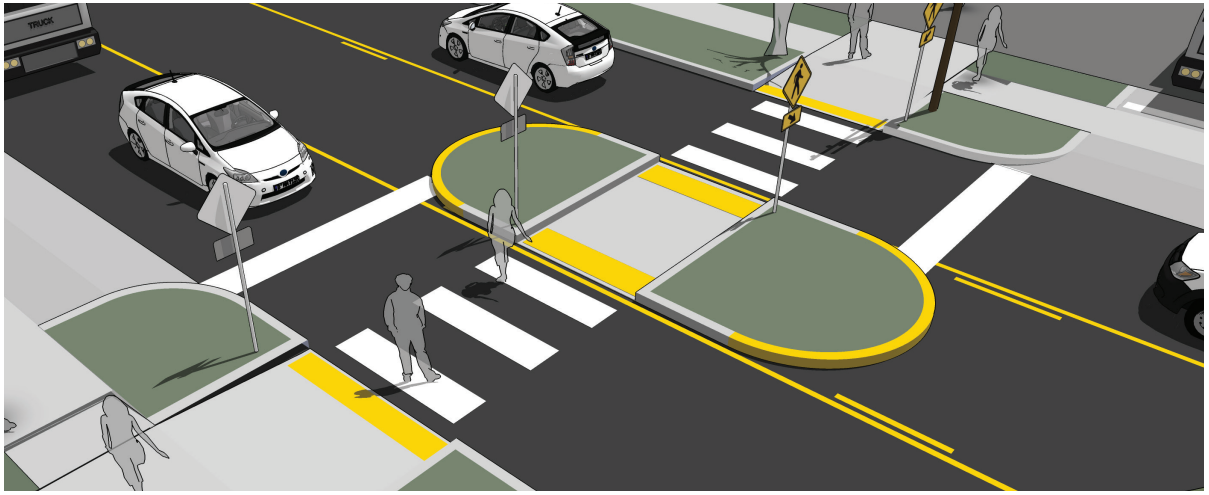
Median refuge islands are located at the mid-point of a marked crossing and help improve pedestrian safety by allowing pedestrians to cross one direction of traffic at a time. Refuge islands minimize pedestrian exposure by shortening crossing distance and increasing the number of available gaps for crossing.

TYPICAL APPLICATION

- Can be applied on any roadway with a center turn lane or median that is at least 6 ft wide.
- May be appropriate on multi-lane roadways depending on speeds and volumes. Consider configuration with active warning beacons for improved yielding compliance.
- Appropriate at signalized or unsignalized crosswalks.
- Where traffic calming is desired; median refuge islands calm traffic by physically narrowing the roadway and potentially restricting vehicle through movements.

DESIGN FEATURES

- The island must be accessible, preferably with at-grade passage through the island rather than ramps and landings. Detectable warning surfaces must be full-width and 2 ft deep to warn blind pedestrian.
- Requires 6 ft width between travel lanes (8-10 ft preferred to accommodate bikes with trailers and wheelchair users) and 20 ft length (40 ft preferred). Clear width of 4 ft required, but preferably same width as crosswalk.
- On streets with speeds higher than 25 mph, there should also be double centerline marking, reflectors, and "KEEP RIGHT" signage.



ACTIVE WARNING BEACONS (RRFB)

Active warning beacons are user actuated illuminated devices designed to increase motor vehicle yielding compliance at crossings of multi lane or high volume roadways. Types of active warning beacons include conventional circular yellow flashing beacons, in-roadway warning lights, or Rectangular Rapid Flashing Beacons (RRFB).

TYPICAL APPLICATION

- Warning beacons shall not be used at crosswalks controlled by YIELD signs, STOP signs, or traffic signals.
- Warning beacons shall initiate operation based on pedestrian or bicyclist actuation and shall cease operation at a predetermined time after actuation or, with passive detection, after the pedestrian or bicyclist clears the crosswalk.
- In-roadway warning lights are used by some communities to highlight the marked crossing, but RRFBs are increasingly favored for their effectiveness and lower maintenance costs.

DESIGN FEATURES

- Types of active warning beacons include conventional circular yellow flashing beacons, in-roadway warning lights, or RRFB.
- RRFBs have the most increased compliance of all the warning beacon enhancement options.
- Installations of RRFBs on median islands improves driver yielding behavior.

W11-15,
W16-7P

PEDESTRIANS AT SIGNALIZED INTERSECTIONS

A hybrid beacon, previously known as a High-intensity Activated CrosswalK (HAWK), consists of a signal-head with two red lenses over a single yellow lens on the major street, and pedestrian and/or bicycle signal heads for the minor street. There are no signal indications for motor vehicles on the minor street approaches. The signal is only activated when a pedestrian is present, resulting in minimal delay for motor vehicle traffic.

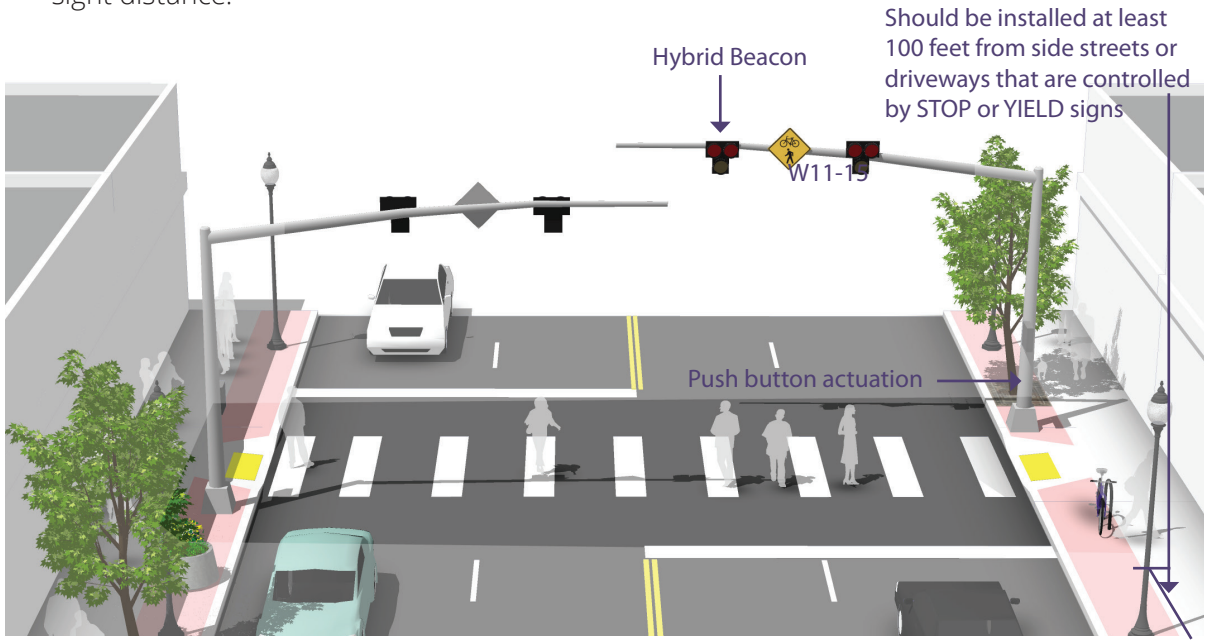
TYPICAL APPLICATION

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

DESIGN FEATURES

May be installed without meeting traffic signal control warrants if roadway speed and volumes are excessive for comfortable user crossing (at the discretion of Traffic Engineers).

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



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Bike facilities provided dedicated space for cyclists and increase safety and comfort.

BICYCLE FACILITIES

SECTION 4

SHARED ROADWAY BIKE ROUTES

Shared roadway bike routes are low volume, low speed streets that provide space for bicyclists and cars in the same travel space. Bike routes with Shared Lane Markings are a standard element in the development of bicycle boulevards.

TYPICAL APPLICATION

- Shared roadway bike routes are appropriate for low speed and low volume roadways.

SHARED LANE MARKINGS

- Shared lane markings are not appropriate on paved shoulders or in bike lanes, and should not be used on roadways that have a speed limit above 35 mph.
- Shared Lane Markings pair well with Bikes May Use Full Lane signs.

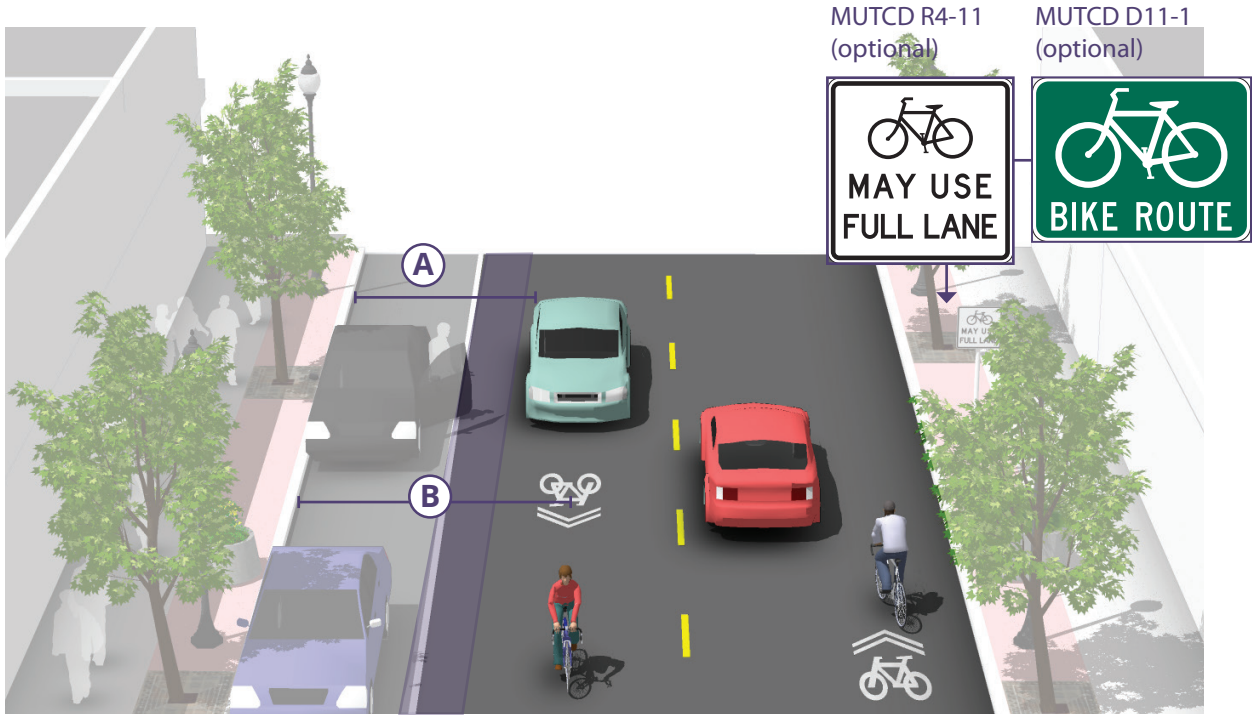
DESIGN FEATURES

- Shared Lane Marking stencils are used in California as an additional treatment for Bike Route facilities and are currently approved in conjunction with on-street parking. The stencil can serve a number of purposes, such as making motorists aware of the need to share the road with bicyclists, showing bicyclists the direction of travel, and, with proper placement, reminding bicyclists to bike further from parked cars to prevent "dooring" collisions.

(A) When placed adjacent to parking, sharrows should be outside of the "door zone". Minimum placement is 11' from curb.

(B) Placement in center of the travel lane is preferred in constrained conditions.

- Markings should be placed immediately after intersections and spaced at 250 ft intervals thereafter.



ADDITIONAL INFORMATION

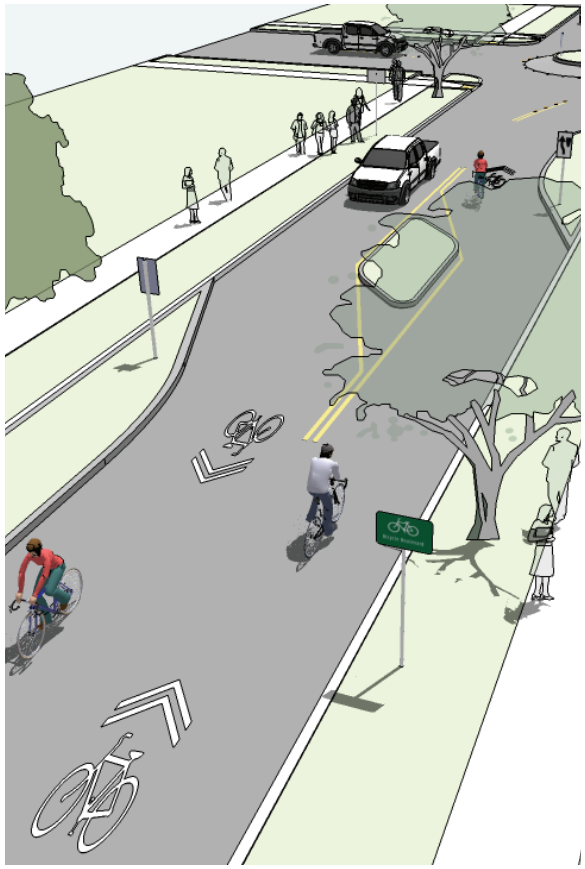
- Consider modifications to signal timing to induce a bicycle-friendly travel speed for all users.
- Though not always possible, placing the markings outside of vehicle tire tracks will increase the life of the markings and decrease the long-term cost of the treatment.

Shared Lane Markings

Sharrows can be used on higher-traffic streets as positional guidance and raise bicycle awareness where there isn't space to accommodate a full-width bike lane.

BIKE BOULEVARDS

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



TYPICAL APPLICATION

- Parallel with and in close proximity to major thoroughfares (1/4 mile or less).
- Follow a desire line for bicycle travel that is ideally long and relatively continuous (2-5 miles).
- Avoid alignments with excessive zigzag or circuitous routing. The bikeway should have less than 10 percent out of direction travel compared to shortest path of primary corridor.
- Streets with travel speeds at 25 mph or less and with traffic volumes of fewer than 3,000 vehicles per day. These conditions should either exist or be established with traffic calming measures.
- Bike boulevards can be considered a specific type of bikeway designation relative to Class III Bike Routes. While many Class III Bike Routes may utilize shared lane markings and are designated bike routes, bike boulevards are a special designation reserved for enhanced bikeways featuring a number of traffic calming and intersection crossing improvements.

DESIGN FEATURES

- Signs and pavement markings are the minimum treatments necessary to designate a street as a bicycle boulevard. Place signs and pavement markings every 500 ft (minimum).
- Bicycle boulevards should have a maximum posted speed of 25 mph.
- Implement treatments to maintain low volumes, based on the context of the bicycle boulevard, using engineering judgement
- Intersection crossings should be designed to enhance safety and minimize delay for bicyclists.

SPEED REDUCTION

(A) Median islands create pinchpoints for traffic in the center of the roadway and offers shorter crossing distances for pedestrians when used in tandem with a marked crossing.

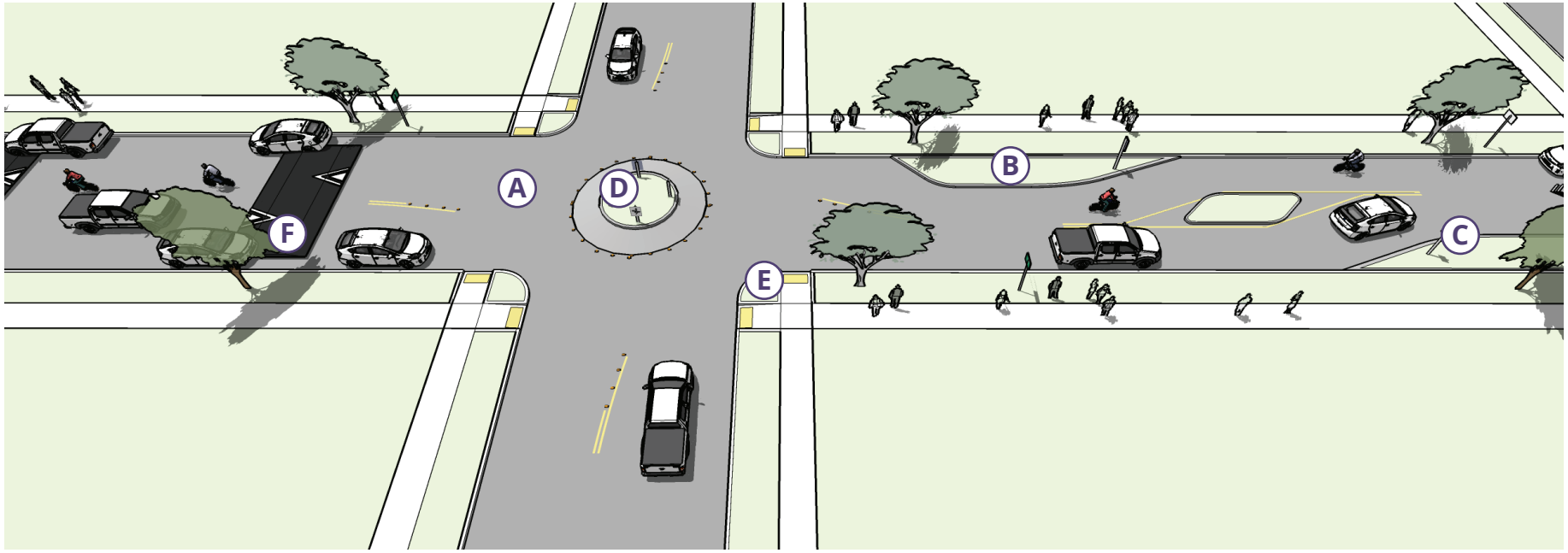
(B) Chicanes slow drivers by requiring vehicles to shift laterally through narrowed lanes and which avoids uninterrupted sightlines.

(C) Pinchpoints, chokers, or curb extensions restrict motorists from operating at high speeds on local streets by visually narrowing the roadway.

(D) Neighborhood traffic circles reduce speed of traffic at intersections by requiring motorists to move cautiously through conflict points.

(E) Street trees narrow a driver's visual field and creates a consistent rhythm and canopy along the street, which provides a unified character and facilitates place recognition.

(F) Speed humps slow drivers through vertical deflection. To minimize impacts to bicycles, use a wave profile and leave a gap along curb so that bicyclists may bypass the hump when appropriate. Speed cushions operate in a similar fashion to speed humps, but allow for unimpeded travel by emergency vehicles.



ON-STREET BIKE LANES

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

TYPICAL APPLICATION

- Bike lanes may be used on any street with adequate space, but are most effective on streets with moderate traffic volumes of less than 6,000 ADT (less than 3,000 preferred).
- Bike lanes are most appropriate on streets with moderate speeds of 25 mph.
- Appropriate for skilled adult riders on most streets.
- May be appropriate for children when configured as 6+ ft wide lanes on lower-speed, lower-volume streets with one lane in each direction.

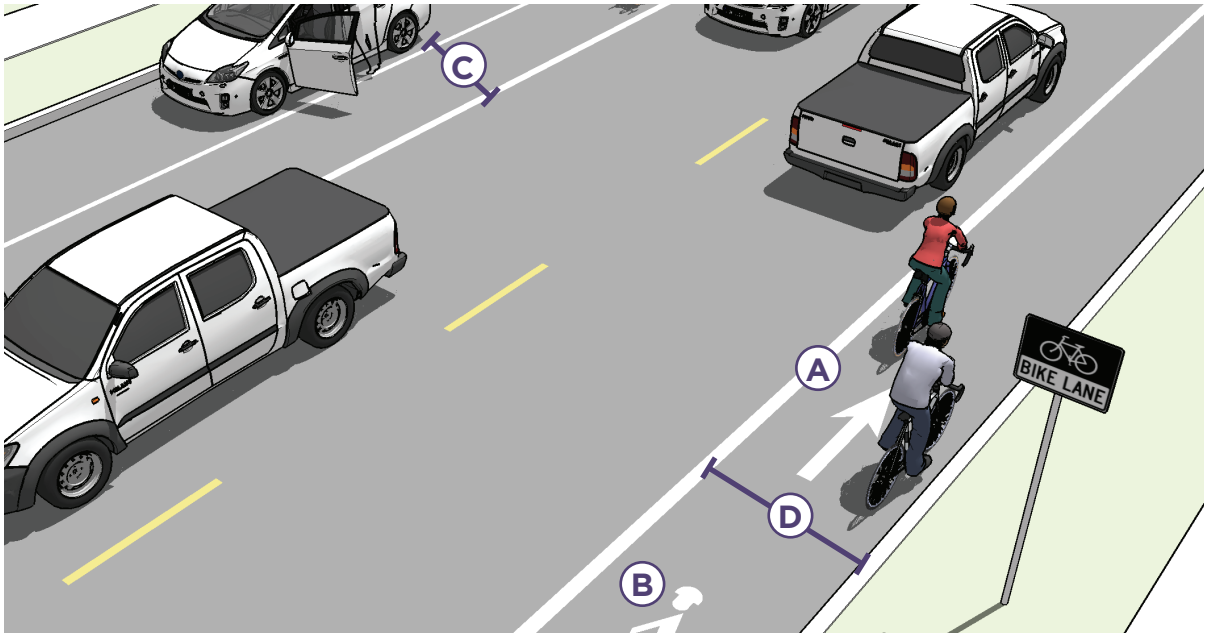
DESIGN FEATURES

(A) Mark inside line with 6" stripe. (CaMUTCD) Mark 4" parking lane line or "Ts".[1]

(B) Include a bicycle lane marking (CaMUTCD Figure 9C-3) at the beginning of blocks and at regular intervals along the route (every 500 ft minimum) (CaMUTCD 9C.04).

(C) 6 ft width preferred adjacent to on-street parking (5 ft min.).

(D) 5–6 ft preferred adjacent to curb and gutter (4 ft min.) or 4 ft more than the gutter pan width.



1 Studies have shown that marking the parking lane encourages people to park closer to the curb. FHWA. Bicycle Countermeasure Selection System. 2006.

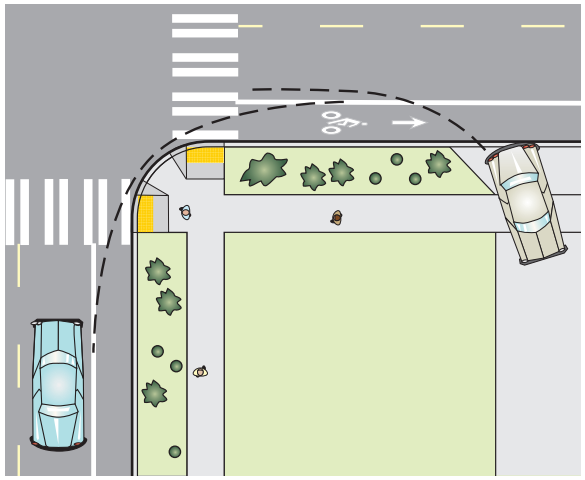
ADDITIONAL BIKE LANE DESIGN

- On high speed streets (≥ 40 mph) the minimum bike lane should be 6 ft.
- On streets where bicyclists passing each other is to be expected, where high volumes of bicyclists are present, or where added comfort is desired, consider providing extra wide bike lanes up to 7 ft wide, or configure as a buffered bicycle lane.
- It may be desirable to reduce the width of general purpose travel lanes in order to add or widen bicycle lanes.
- On multi-lane and/or high speed streets, the most appropriate bicycle facility to provide for user comfort may be buffered bicycle lanes or physically separated bicycle lanes.
- On roadways with existing Class II bike lanes, the City should consider revising vehicle lane width to enlarge or buffer bike facilities where appropriate as part of other roadway projects.

MANHOLE COVERS AND GRATES

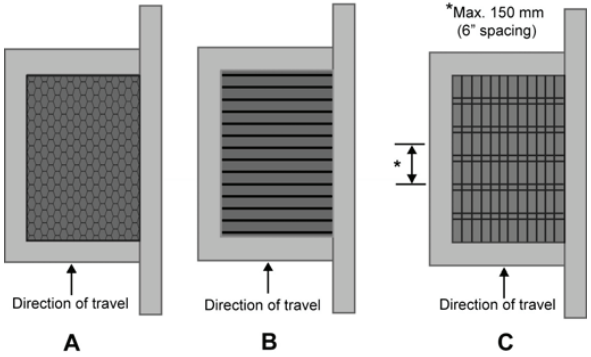
- Manhole surfaces should be manufactured with a shallow surface texture in the form of a tight, nonlinear pattern
- If manholes or other utility access boxes are to be located in bike lanes within 50 ft of intersections or within 20 ft of driveways or other bicycle access points, special manufactured permanent nonstick surfaces will be required to ensure a controlled travel surface for cyclists breaking or turning.
- Manholes, drainage grates, or other obstacles should be set flush with the paved roadway. Roadway surface inconsistencies pose a threat to safe riding conditions for bicyclists. Construction of manholes, access panels or other drainage elements will be constructed with no variation in the surface. The maximum allowable tolerance in vertical roadway surface will be 1/4 of an inch.

Place Bike Lane Symbols to Reduce Wear



Bike lane word, symbol, and/or arrow markings (MUTCD Figure 9C-3) shall be placed outside of the motor vehicle tread path in order to minimize wear from the motor vehicle path. **(NACTO 2012)**

Drainage Grates



Utility infrastructure, such as manholes, water valve covers, and drain inlets within the roadway can present significant hazards to bicyclists, potentially causing a collision. Every effort should be made to avoid placing hazards within the likely travel path of bicyclists on new roadway construction.

BUFFERED BIKE LANES

Buffered bike lanes are conventional bicycle lanes paired with a designated buffer space, separating the bicycle lane from the adjacent motor vehicle travel lane and/or parking lane.

TYPICAL APPLICATION

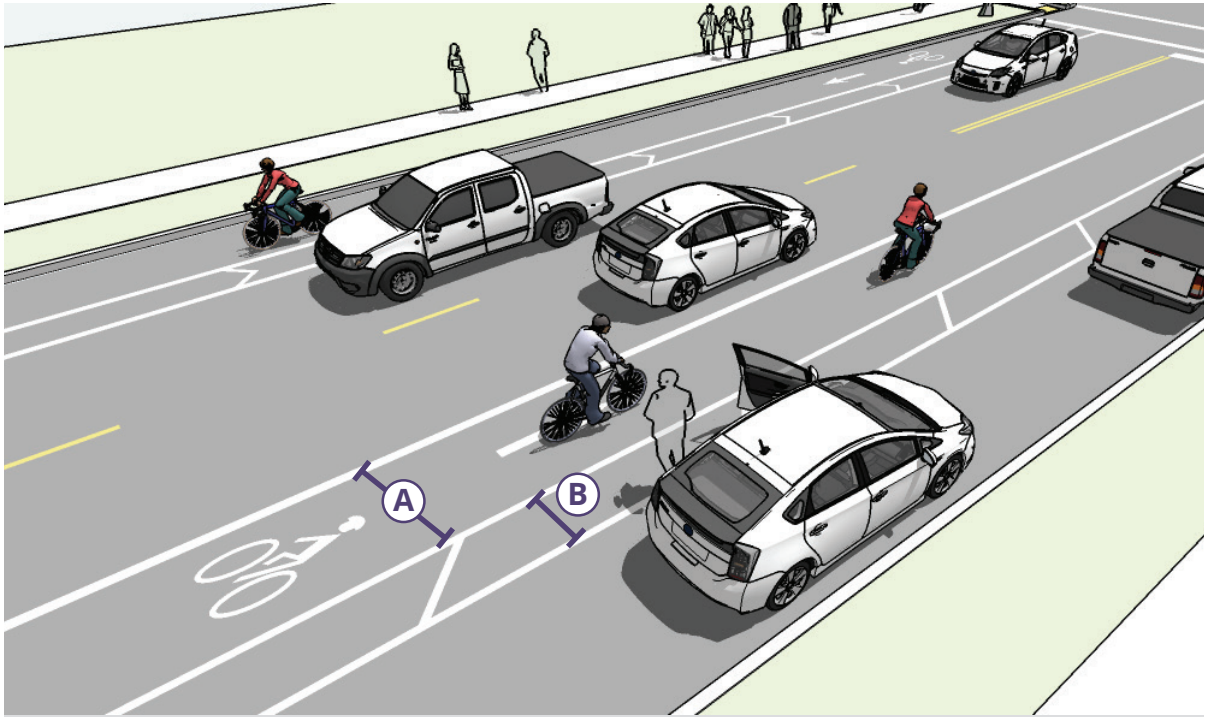
- Anywhere a conventional bike lane is being considered.
- On streets with high speeds and high volumes or high truck volumes.
- On streets with extra lanes or lane width.
- Appropriate for skilled adult riders on most streets.

DESIGN FEATURES

(A) The minimum bicycle travel area (not including buffer) is 5 feet wide.

(B) Buffers should be at least 2 feet wide. If buffer area is 4 feet or wider, white chevron or diagonal markings should be used. (CAMUTCD 9C-104)

- For clarity at driveways or minor street crossings, consider a dotted line.
- There is no standard for whether the buffer is configured on the parking side, the travel side, or a combination of both.



ADDITIONAL INFORMATION

- Color may be used within the lane to discourage motorists from entering the buffered lane.
- A study of buffered bicycle lanes found that, in order to make the facilities successful, there needs to also be driver education, improved signage and proper pavement markings.[1]
- On multi-lane streets with high vehicles speeds, the most appropriate bicycle facility to provide for user comfort may be physically separated bike lanes.
- NCHRP Report #766 recommends, when space in limited, installing a buffer space between the parking lane and bicycle lane where on-street parking is permitted rather than between the bicycle lane and vehicle travel lane.[2]

Buffered Bicycle Lane

The use of pavement markings delineates space for cyclists to ride in a comfortable facility.

Buffered Bicycle Lane

The use of pavement markings delineates space for cyclists to ride in a comfortable facility.

1 Monsere, C.; McNeil, N.; and Dill, J., "Evaluation of Innovative Bicycle Facilities: SW Broadway Cycle Track and SW Stark/Oak Street Buffered Bike Lanes. Final Report" (2011).Urban Studies and Planning Faculty Publications and Presentations.

2 National Cooperative Highway Research Program. Report #766: Recommended Bicycle Lane Widths for Various Roadway Characteristics.

COLORED BICYCLE LANES

Colored pavement within a bicycle lane may be used to increase the visibility of the bicycle facility, raise awareness of the potential to encounter bicyclists and reinforce priority of bicyclists in conflict areas.

TYPICAL APPLICATION

- Within a weaving or conflict area to identify the potential for bicyclist and motorist interactions and assert bicyclist priority.
- Across intersections, driveways and Stop or Yield-controlled cross-streets.

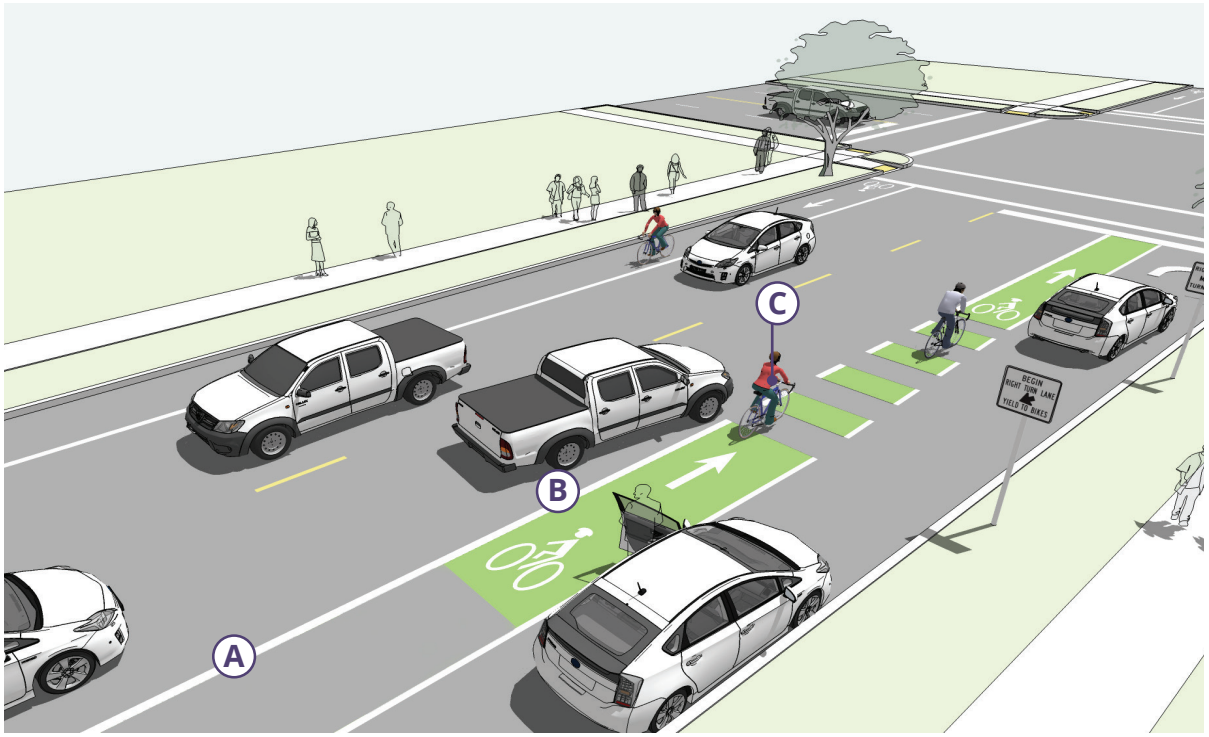
DESIGN FEATURES

(A) Typical white bike lanes (solid or dotted 6" stripe) are used to outline the green colored pavement.

(B) In exclusive use areas, color application should be solid green.

(C) In weaving or turning conflict areas, preferred striping is dashed, to match the bicycle lane line extensions.

- The colored surface should be skid resistant and retro-reflective. (CAMUTCD 9C.02.02)



ON-STREET BIKE LANES WITH DIAGONAL PARKING

In certain areas with high parking demand such as urban commercial areas, diagonal parking can be used to increase parking supply. Vehicle parking can be available as front-in or back-in diagonal parking, although back-in is preferred.

TYPICAL APPLICATION

- Urbanized, commercial areas in a downtown or town center area.
- Areas with high demand for on-street parking.
- Back-in diagonal parking improves sight distances between drivers and bicyclists when compared to conventional head-in diagonal parking. Back-in parking is best paired with a dedicated bicycle lane.
- Conventional front-in diagonal parking is not compatible or recommended with the provision of bike lanes, as drivers backing out of conventional diagonal parking have limited visibility of approaching bicyclists. Under these conditions, shared lane markings should be used to guide bicyclists away from reversing automobiles.

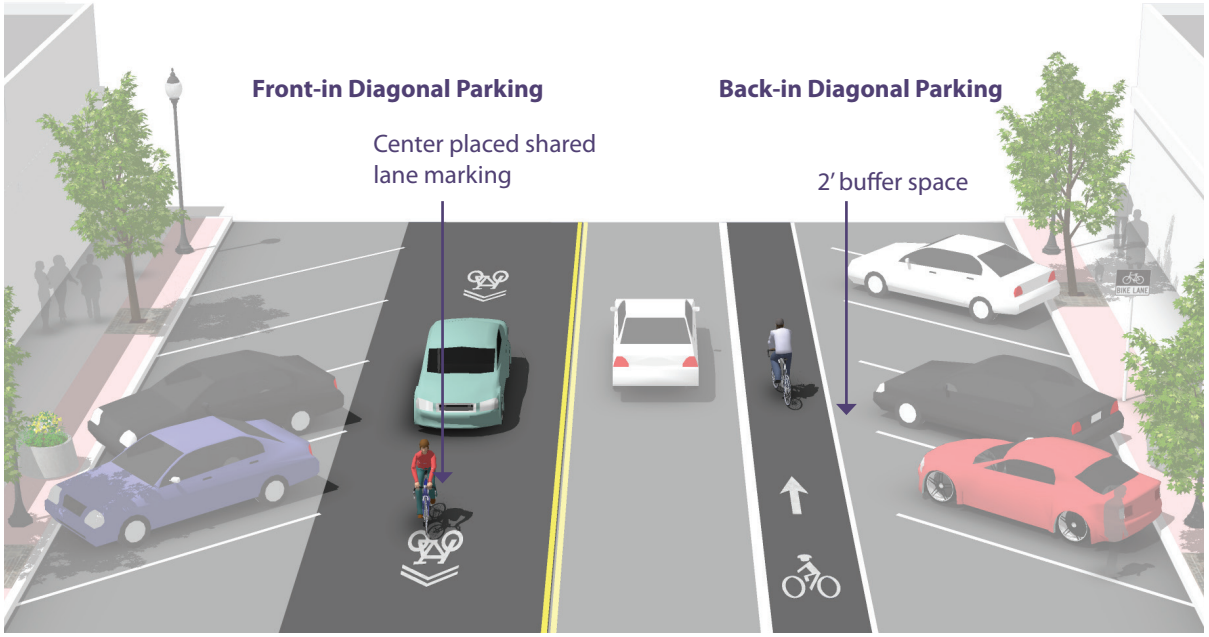
DESIGN FEATURES

Front-in Diagonal Parking

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

Back-in Diagonal Parking

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



SEPARATED BIKE LANES

Separated bicycle lanes are on-street bikeway facilities that are separated from vehicle traffic. Separation for protected bicycle lanes is provided through physical barriers between the bike lane and the vehicular travel lane. These barriers can include bollards, parking, planter strips, extruded curbs, or on-street parking.

TYPICAL APPLICATION

- Along streets on which conventional bicycle lanes would cause many bicyclists to feel stress because of factors such as multiple lanes, high bicycle volumes, high motor traffic volumes (9,000-30,000 ADT), higher traffic speeds (25+ mph), high incidence of double parking, higher truck traffic (10% of total ADT) and high parking turnover.
- Street retrofit projects with limited funds for relocating curbs and drainage.
- Streets for which conflicts at intersections can be effectively mitigated using parking lane setbacks, bicycle markings through the intersection, and other signalized intersection treatments.
- Appropriate for most riders on most streets.

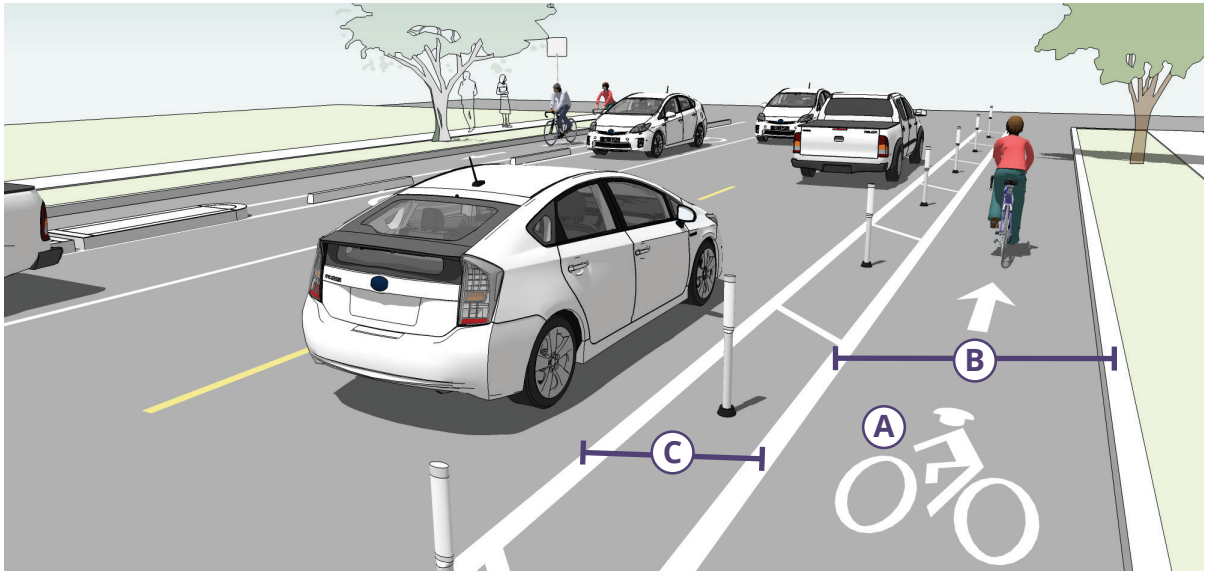
DESIGN FEATURES

(A) Pavement markings, symbols and/or arrow markings must be placed at the beginning of the separated bike lane and at intervals along the facility (CaMUTCD 9C.04).

(B) 7 ft width preferred (5 ft minimum).

(C) 2-3 ft minimum buffer width adjacent to parking. 18 inch minimum adjacent to travel lanes (NACTO, 2012). Channelizing devices should be placed in the buffer area.

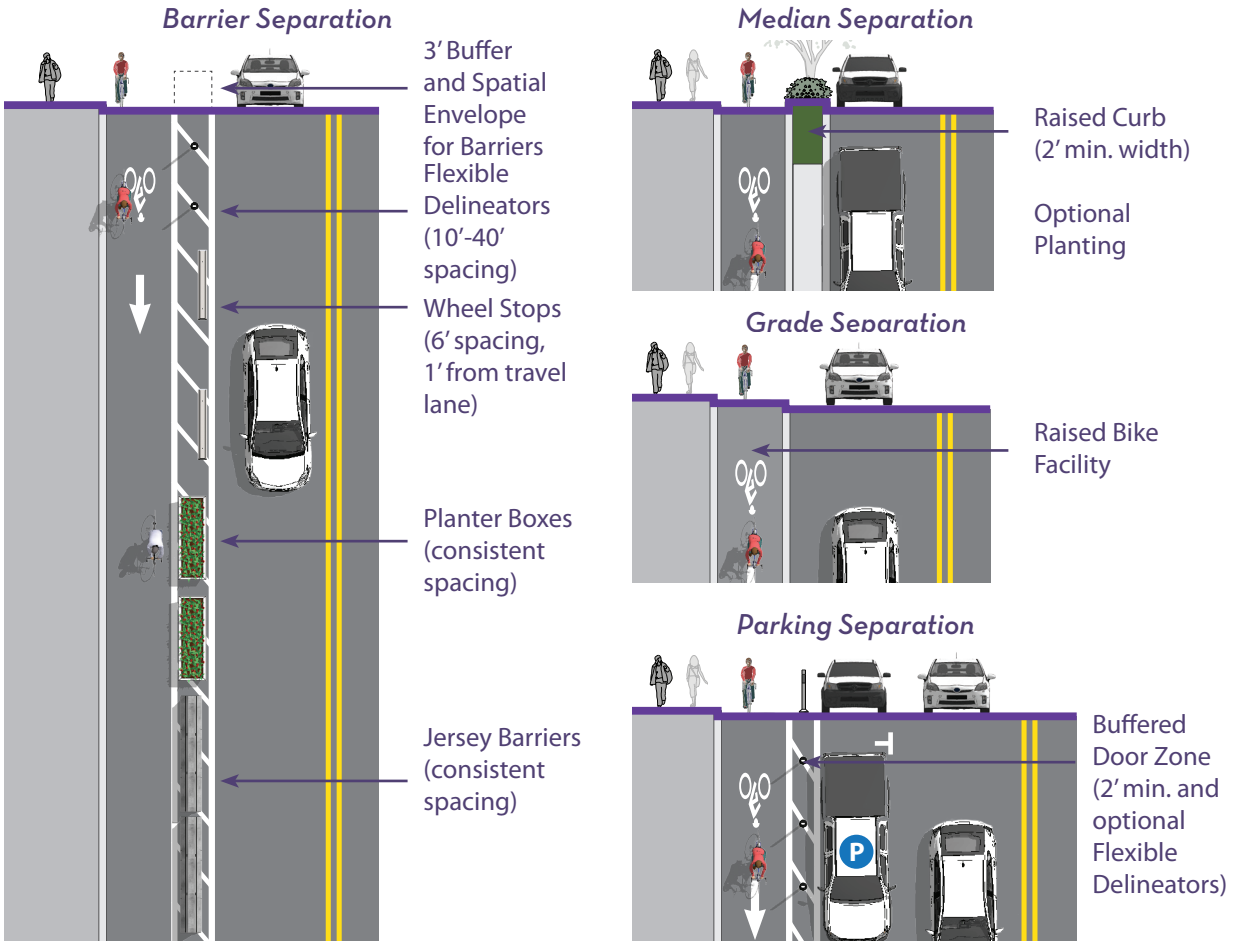
- If buffer area is 4 ft or wider, white chevron or diagonal markings should be used.
- Separated bike lanes using these barrier elements typically share the same elevation as adjacent travel lanes, but the bike lane could also be raised above street level, either below or equivalent to sidewalk level.



SEPARATION METHODS

Separated bikeways may use a variety of vertical elements to physically separate the bikeway from adjacent travel lanes. Barriers may be robust constructed elements such as curbs, or may be more interim in nature, such as flexible delineator posts.

BIKEWAY SEPARATION METHODS



TWO-WAY SEPARATED BIKE LANES

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

TYPICAL APPLICATION

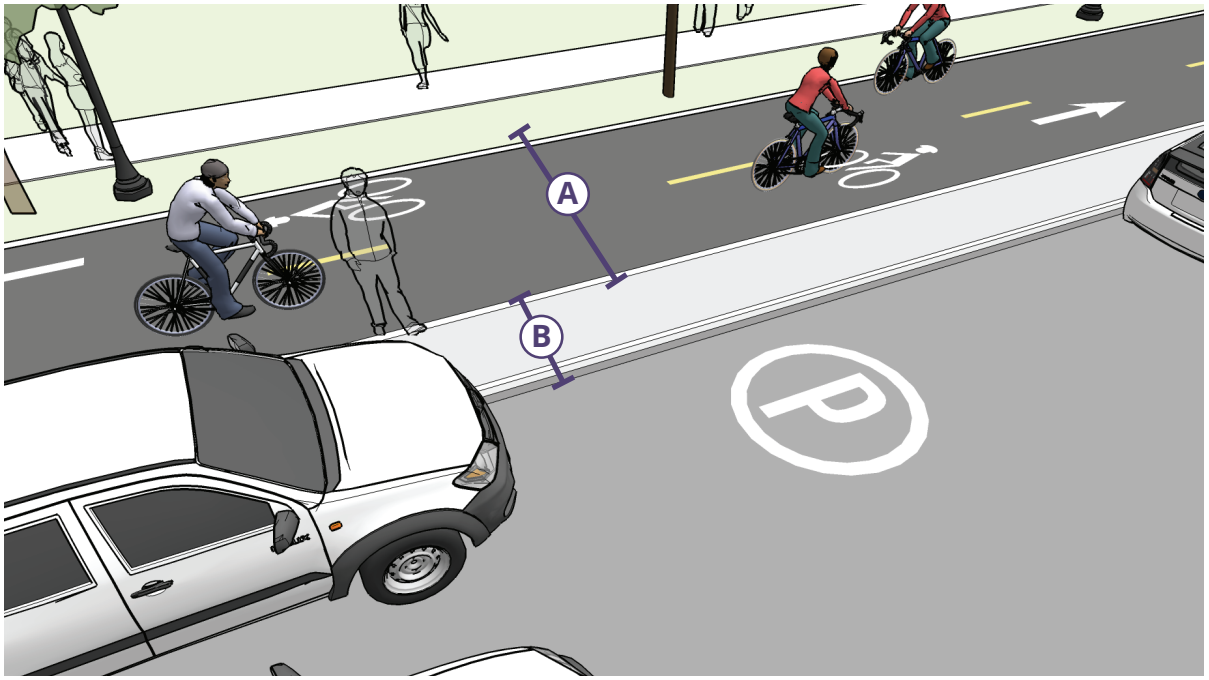
- Works best on the left side of one-way streets.
- Streets with high motor vehicle volumes and/or speeds.
- Streets with high bicycle volumes.
- Streets with a high incidence of wrong-way bicycle riding.
- Streets with few conflicts such as driveways or cross-streets on one side of the street.
- Streets that connect to shared use paths.

DESIGN FEATURES

(A) 12 foot operating width preferred (10 ft minimum) width for two-way facility. In constrained an 8 foot minimum operating width may be considered.

(B) Adjacent to on-street parking a 3 foot minimum width channelized buffer or island shall be provided to accommodate opening doors.

- Separation may be narrower than 5 foot if physical barrier separation is present.



ADDITIONAL INFORMATION

- Two-way bikeways introduce additional complexities at intersections and drivways. Additional signalization and signs may be necessary to manage conflicts.
- Separated bikeway buffers and barriers are covered in the CAMUTCD as preferential lane markings (section 3D.01) and channelizing devices, including flexible delineators (section 3H.01). Curbs may be used as a channeling device, see the section on islands (section 3I.01).
- A two-way separated bikeway on a one-way street should be located on the left side where possible.
- A two-way separated bikeway may be configured at street level or as a raised separated bicycle lane with vertical separation from the adjacent travel lane.
- Two-way separated bikeways should ideally be placed along streets with long blocks and few driveways or mid-block access points for motor vehicles.
- Consult Caltrans DIB 89; Class IV Bikeway Guidance for more information.

Two-Way Separated Bicycle Lanes

A two-way facility can accommodate cyclists in two directions of travel.

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An example of bikeway intersection crossing markings in Minneapolis, MN.

BICYCLE FACILITIES AT INTERSECTIONS

SECTION 5

BIKE BOULEVARD CROSSING TREATMENTS

Treatments at minor and major roadway intersections are designed to improve the visibility of a bicycle boulevard, raise awareness of motorists on the cross-street that they are likely to encounter bicyclists, and enhance safety for all road users. Traffic diversion treatments reduce motor vehicle volumes by completely or partially restricting through traffic on a bicycle boulevard.

TYPICAL APPLICATION

- On the bicycle boulevard, the majority of intersections with minor roadways should stop-control cross traffic to minimize bicyclist delay. This will maximize bicycling efficiency. Stop signs increase bicycling time and energy expenditure, frequently leading to non-compliance by bicyclists and motorists, and/or use of other less desirable routes. Bicycle boulevards should have fewer stops or delays than other local streets.
- At major intersections, treatments are designed to improve visibility and encourage motorists to stop for pedestrians; with engineering judgment, many of the same treatments are appropriate for use along bicycle boulevards.

DESIGN FEATURES

MINOR INTERSECTIONS

(A) Traffic circles are a type of horizontal traffic calming that can be used at minor street intersections. Traffic circles reduce conflict potential and severity while providing traffic calming to the corridor.

(B) If a stop sign is present on the bicycle boulevard, a second stop bar for bicyclists can be placed closer to the centerline of the cross street than the motorists' stop bar to increase the visibility of bicyclists waiting to cross the street.

(C) Curb extensions can be used to move bicyclists closer to the centerline to improve visibility and encourage motorists to let them cross.

MAJOR INTERSECTIONS

(D) Bike boxes increase bicyclist visibility to motorists and reduce the danger of right "hooks" by providing a space for bicyclists to wait at signalized intersections.

(E) Median islands provided at uncontrolled intersections of bicycle boulevards and major streets allow bicyclists to cross one direction of traffic at a time as gaps in traffic occur.

(F) Hybrid beacons, active warning beacons and bicycle signals can facilitate bicyclists crossing a busy street on which cross-traffic does not stop.

Traffic Circles

Bicycle Forward Stop Bar

MINOR INTERSECTIONS

Curb Extension

Stop Signs on Cross-Street

Bike Box

Hybrid Beacon (HAWK)

MAJOR INTERSECTIONS

Median Island


Rectangular Rapid Flash Beacon (RRFB)

BIKE LANES AT INTERSECTIONS

The appropriate treatment at right turn only lanes is to introduce an added turn lane to the outside of the bicycle lane. The area where people driving must weave across the bicycle lane should be marked with dotted lines to identify the potential conflict areas. Where there isn't room for a conventional bicycle lane and turn lane a combined bike lane/turn lane creates a shared lane where bicyclists can ride and turning motor vehicles yield to through traveling bicyclists. The combined bicycle lane/turn lane places shared lane markings within a right turn only lane.

TYPICAL APPLICATION

ADDED RIGHT TURN LANES

- Streets with right-turn lanes and right side bike lanes.
- Streets with left-turn lanes and left side bike lanes.

COMBINED BIKE LANE/TURN LANE

- Most appropriate in areas with lower posted speeds (30 MPH or less) and with lower traffic volumes (10,000 ADT or less).
- May not be appropriate for high speed arterials or intersections with long right turn lanes.
- May not be appropriate for intersections with large percentages of right-turning heavy vehicles.

DESIGN FEATURES

ADDED RIGHT TURN LANES

Ⓐ Mark inside line with 6" stripe.

Ⓑ Continue existing bike lane width; standard width of 5 to 6 ft (4 ft in constrained locations).

Ⓒ A "Begin Right Turn Lane Yield To Bikes" (CaMUTCD R4-4) signs indicates that motorists should yield to bicyclists through the conflict area.

Ⓓ Consider using colored in the conflict areas to promote visibility of the dashed weaving area.

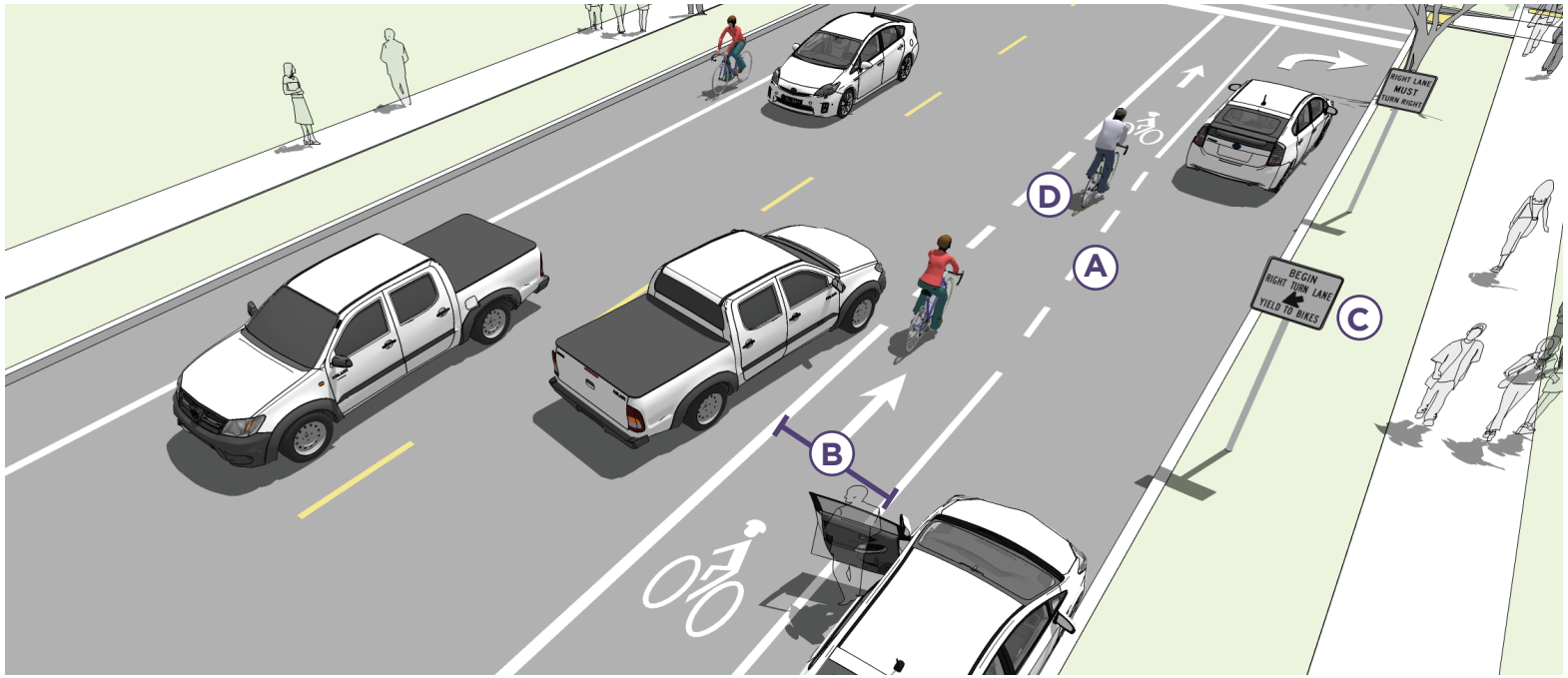
COMBINED BIKE LANE/TURN LANE

Ⓐ Maximum shared turn lane width is 13 ft; narrower is preferable (NACTO, 2012).

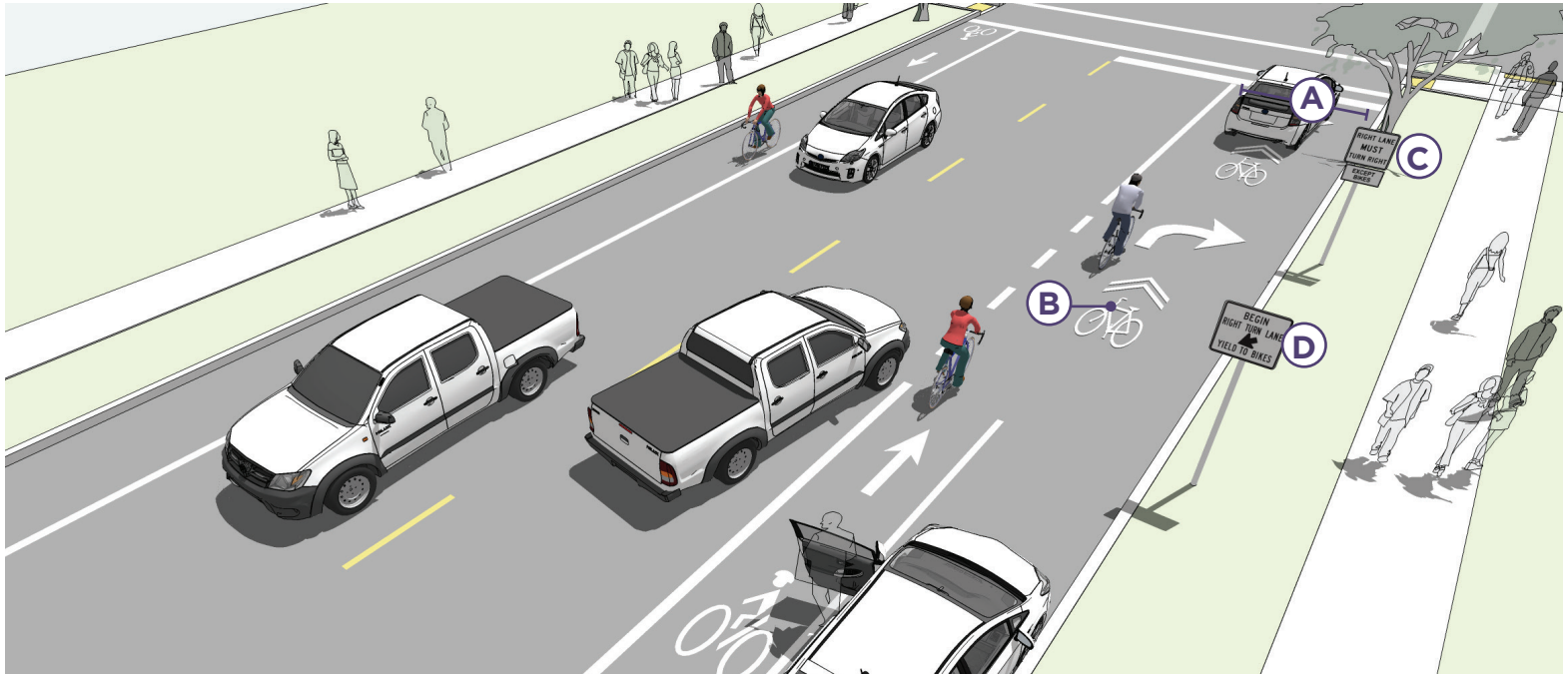
Ⓑ Shared Lane Markings should indicate preferred positioning of bicyclists within the combine lane.

Ⓒ A "Right Lane Must Turn Right" (CaMUTCD R3-7R) sign with an "EXCEPT BIKES" plaque may be needed to permit through bicyclists to use a right turn lane.

Ⓓ Use "Begin Right Turn Lane Yield To Bikes" signage (CaMUTCD R4-4) to indicate that motorists should yield to bicyclists through the conflict area.



ADDED RIGHT TURN LANE



COMBINED BIKE LANE / TURN LANE

SEPARATED BIKE LANES AT INTERSECTIONS

At intersections, separated bike lanes can be designed multiple ways. Typically, a bend in or bend out design approach is appropriate.

TYPICAL APPLICATION

BEND IN

- Bikeways separated by a visually intensive buffer or on-street parking.
- Where it is desirable to create a curb extension at intersections to reduce pedestrian crossing distance.
- Where space is not available to bend-out the bikeway prior to the intersection.

BEND OUT

- Streets with separated bikeway protected by wide buffer or on-street parking.
- Where two separated bikeways intersect and two-stage left-turn movements must be provided for bicycle riders.
- Helps reduce conflicts between right-turning motorists and bicycle riders by reducing turning speeds and providing space for vehicles to queue out of the way of through traffic and before the separated bikeway.
- Where it is desirable to create a safety island at intersections to reduce pedestrian crossing distance.

DESIGN FEATURES

BEND IN

(A) At least 20 ft prior to an intersection, provide between 20 – 40 ft of length to shift the bikeway closer to motor vehicle traffic.

(B) Where the separated bikeway uses parked cars within the buffer zone, parking must be prohibited at the start of the transition.

- Place a "Turning Vehicles Yield to Bikes" sign (modified MUTCD R10-15) prior to the intersection.
- Optional - Provide a narrow buffer with vertical delineators between the travel and lane and bikeway to increase comfort for bicycle riders and slow driver turning speed.

Advantages:

- Motorists on a side street can see bicycles and vehicles in a similar field of vision
- Requires less space than bend out

Disadvantages:

- Parking spaces close to intersection may be lost
- Bicyclists may perceive less separation due to proximity of through vehicles

BEND OUT

(A) Setback bicycle crossing of 16.5 ft allows one passenger car to queue while yielding. Smaller setback distance is possible in slow-speed, space constrained conditions. A reduced separation width as low as 6.5 ft may be used in low-speed environments.

(B) Corner safety island with a 15-20 ft corner radius slows motor vehicles. Larger radius designs may be possible with a deeper setback, a protected signal phase, or small mountable aprons. Two-stage turning boxes are provided for queuing bicyclists adjacent to corner islands.

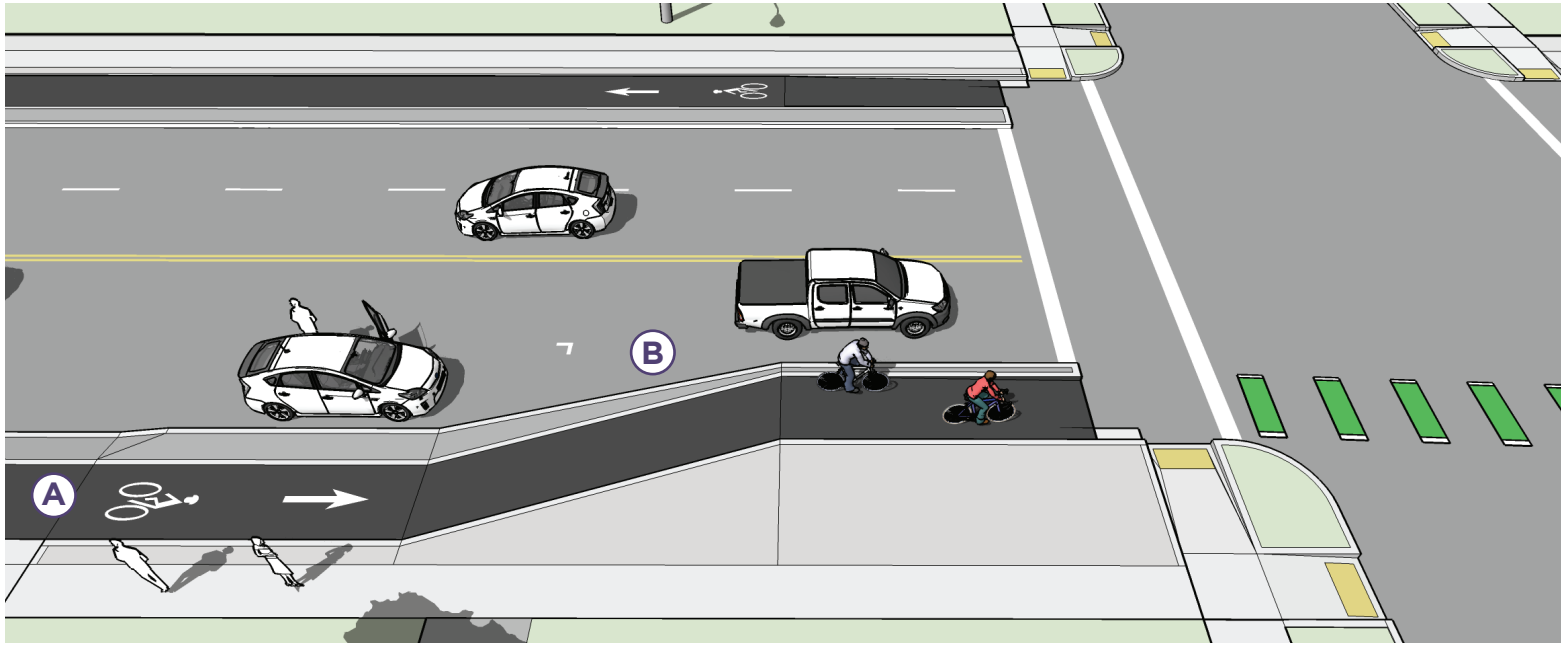
(C) Intersection crossing markings should be used.

Advantages:

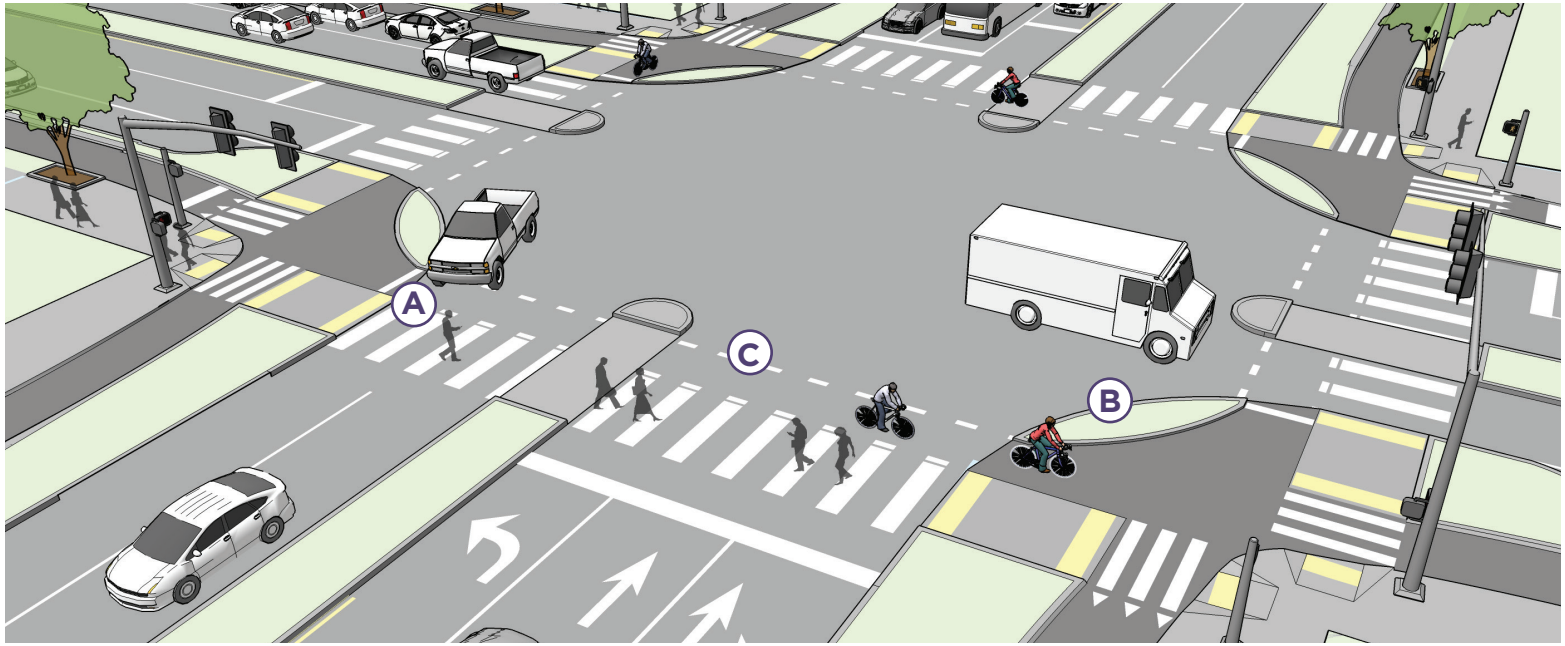
- Allows vehicle traffic turning across separated bike lane to queue out of the way of through traffic.
- Allows a queuing location for cyclists wanting to turn left.

Disadvantages:

- Requires more space
- Less familiar design



BEND IN



BEND OUT

SEPARATED BIKE LANES AT TRANSIT STOPS

A bicycle transit bypass is a channelized lane for bicyclists designed to provide a path for bicyclists to pass stopped transit vehicles, and clarify interactions between passengers and bicyclists.

This is particularly helpful on corridors with high volumes of transit vehicles and bicyclists, where "leapfroging" may occur, and on protected bike lane corridors where maintaining physical separation is important to maintain user comfort.

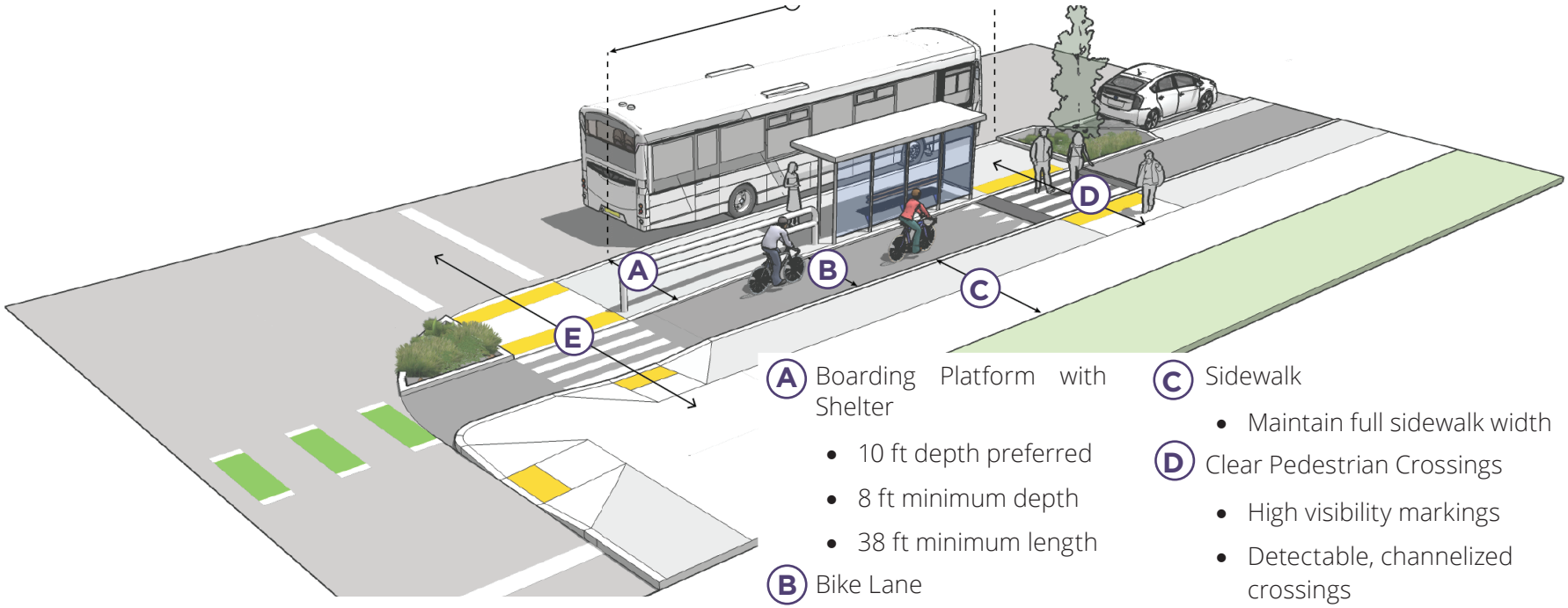
TYPICAL APPLICATION

- Routes where bike lanes or protected bike lanes and transit operations overlap.
- Transit island should be wide enough to accommodate mobility devices.
- Transit island stops to maximize usable space for transit riders, bicyclists and pedestrians.

DESIGN FEATURES

- Pedestrian refuge islands shorten crossing distance for pedestrians.
- Pedestrian ramp into crosswalk with ADA compliant ramps.
- Direct pedestrians to crossing locations to consolidate potential conflict points.
- At high volume stops, provide room for waiting and loading with shelters and seating.
- Make it clear that bicyclists yield to pedestrians with signage and yield lines to clarify expectation.
- 6 foot minimum width bypass lane.
- Transit island should be wide enough to hold all waiting transit riders.
- Consider elevating the bike bypass lane 3-4 inches from the adjacent roadway to reduce the height of curbfaces. A curb < 3" in height will minimize conflict with bicycle pedals and maximize ridable space.

Seattle, Washington



A Boarding Platform with Shelter

- 10 ft depth preferred
- 8 ft minimum depth
- 38 ft minimum length

B Bike Lane

- 7 ft width preferred
- 4 ft minimum width

C Sidewalk

- Maintain full sidewalk width

D Clear Pedestrian Crossings

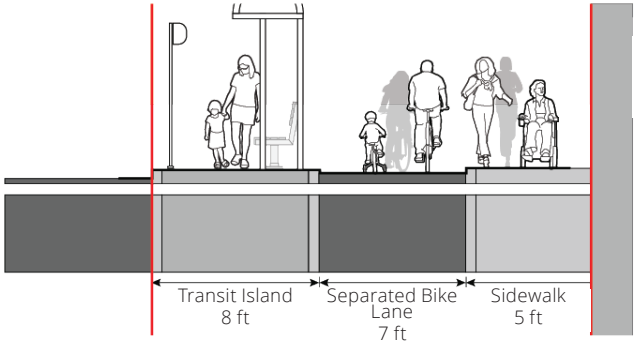
- High visibility markings
- Detectable, channelized crossings

E Intersection Integration

- For near or far-side stops
- Bus stops should be placed after the intersection

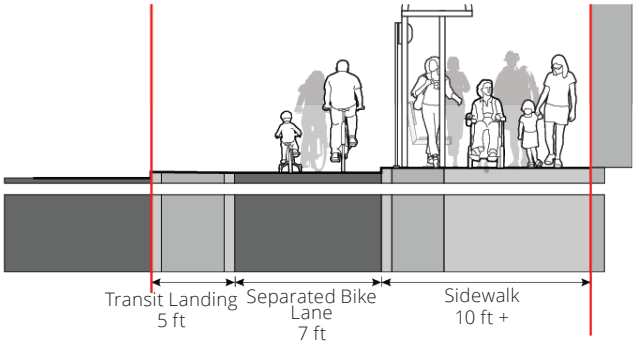
BUS STOP CONFIGURATION OPTIONS

Preferred configuration varies by bus stop volume, street activity, and available right of way.



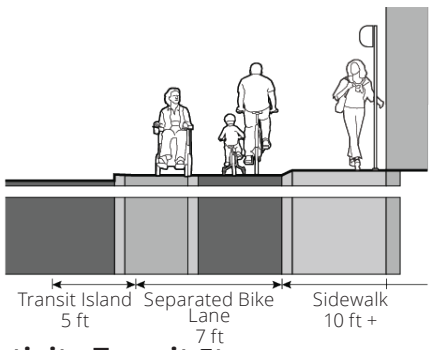
High Activity Transit Stop

Not appropriate with high activity land uses immediately adjacent



Lower Activity Transit Stop

Low on/off volume and/or highly active street frontages



Low Activity Transit Stop

Low on/off volume and inactive street frontage

BIKE BOX

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

TYPICAL APPLICATION

- At potential areas of conflict between bicyclists and turning vehicles, such as a right or left turn locations.
- At signalized intersections with high bicycle and/or vehicle volumes.
- Where a bike boulevard, bike lane, or separated bike lane meets an intersection.

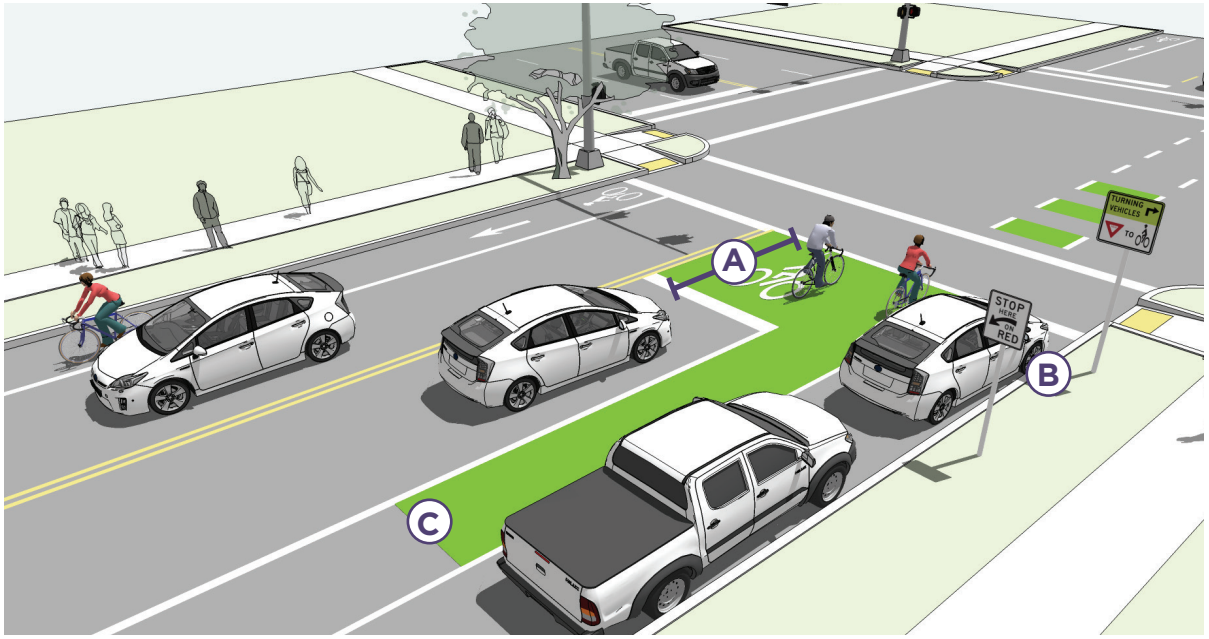
DESIGN FEATURES

(A) 14 ft minimum depth from back of crosswalk to motor vehicle stop bar (NACTO, 2012).

(B) A "No Turn on Red" (MUTCD R10-11) sign shall be installed overhead to prevent vehicles from entering the Bike Box. A "Stop Here on Red" (CaMUTCD R10-6) sign should be post mounted at the stop line to reinforce observance of the stop line.

(C) A 50 ft ingress lane should be used to provide access to the box.

- Use of green colored pavement is optional.



TWO STAGE TURN BOX

Two- stage turn boxes offer bicyclists a safe way to make turns at multi-lane signalized intersections from a separated or conventional bike lane. On physically separated bike lanes, bicyclists are often unable to merge into traffic to turn due to physical separation, making the provision of two-stage turn boxes critical.

TYPICAL APPLICATION

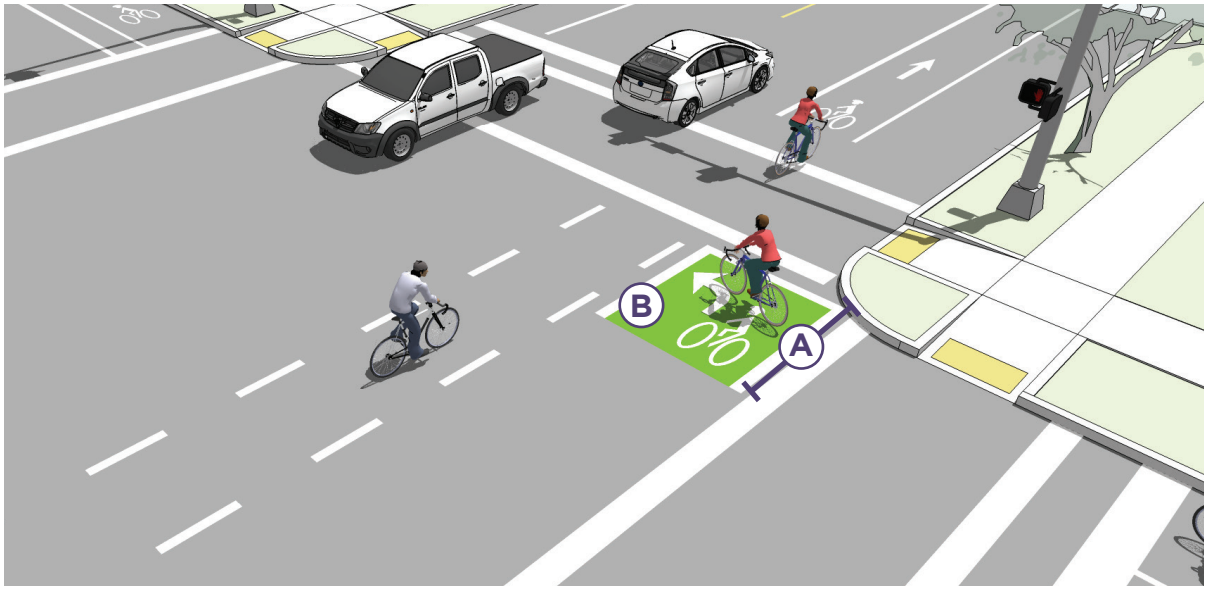
- Streets with high vehicle speeds and/or traffic volumes.
- At intersections locations of multi-lane roads with signalized intersections.
- At signalized intersections with a high number of bicyclists making a left turn from a right side facility.
- Where a cyclist is crossing a multi-lane signalized intersection from a bike lane or separated bike lane.

DESIGN FEATURES

- The two-stage turn box shall be placed in a protected area. Typically this is within the shadow of an on-street parking lane or separated bike lane buffer area and should be placed in front of the crosswalk to avoid conflict with pedestrians.

(A) 8 ft x 6 ft preferred depth of bicycle storage area (6 ft x 3 ft minimum).

(B) Bicycle stencil and turn arrow pavement markings shall be used to indicate proper bicycle direction and positioning (NACTO, 2012).



INTERSECTION CROSSING MARKINGS

Bicycle pavement markings through intersections guide bicyclists on a safe and direct path through the intersection and provide a clear boundary between the paths of through bicyclists and vehicles in the adjacent lane.

TYPICAL APPLICATION

- Streets with conventional, buffered, or separated bike lanes.
- At direct paths through intersections.
- Streets with high volumes of adjacent traffic.
- Where potential conflicts exist between through bicyclist and adjacent traffic.

DESIGN FEATURES

- Intersection markings should be the same width and in line with leading bike lane.
- (A) Dotted lines should be a minimum of 6 inches wide and 4 ft long, spaced every 12 ft.
- All markings should be white, skid resistant and retro reflective (MUTCD 9C.02.02).
- (B) Green pavement markings may also be used.

BICYCLE DETECTION AND ACTUATION

Bicycle detection and actuation devices are used to ensure convenient and safe street crossings for cyclists. Various technologies and systems are available.

TYPICAL APPLICATION

- Where a bicycle facility must cross an arterial street.
- Where high volumes of bicycle traffic is anticipated.

DESIGN FEATURES

PUSH BUTTON ACTUATION

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

LOOP DETECTORS

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

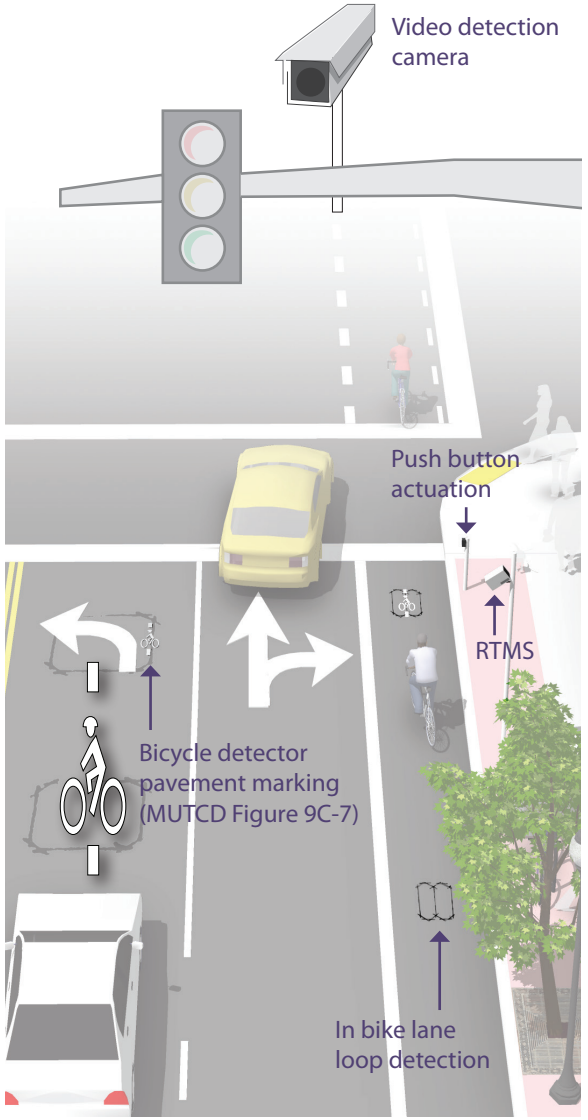
Loops that are sensitive enough to detect bicycles should be supplemented with pavement markings to instruct bicyclists how to trip them.

VIDEO DETECTION CAMERAS

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

REMOTE TRAFFIC MICROWAVE SENSOR DETECTION (RTMS)

RTMS is a system which uses frequency modulated continuous wave radio signals to detect objects in the roadway. This method marks the detected object with a time code to determine its distance from the sensor. The RTMS system is unaffected by temperature and lighting, which can affect standard video detection. RTMS system costs range from $5,000-15,000 per intersection, depending on the unit and corridor.



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Trails can be enjoyed by people walking, biking, jogging, and riding horses.

TRAILS

SECTION 6

TRAIL DESIGN PRACTICES

Trails can provide a desirable facility, particularly for recreation, and users of all skill levels preferring separation from traffic. Trails should generally provide directional travel opportunities not provided by existing roadways.

TYPICAL APPLICATION

- In abandoned rail corridors (commonly referred to as Rails-to-Trails or Rail-Trails).
- In active rail corridors, trails can be built adjacent to active railroads (referred to as Rails-with-Trails).
- In utility corridors, such as powerline and sewer corridors.
- In waterway corridors, such as along canals, drainage ditches, and beaches.
- Within roadway right-of-way.

DESIGN FEATURES

Width

- 10 feet is the recommended width for trails. A separate track (5' minimum) can be provided for pedestrian use. 8 feet is recommended width for low traffic trails.
- 8 feet is the minimum width allowed for a two-way bicycle trail and is allowed for neighborhood accessways or places with limited space and for limited lengths.
- A 2 foot or greater shoulder on both sides of the trail should be provided. An additional foot of lateral clearance (total of 3') is required by the MUTCD for the installation of signage or other furnishings.
- Clearance to overhead obstructions should be 8 feet minimum, with 10 feet recommended.

Centerline Striping

- On trails with heavy peak hour and/or seasonal volumes, the use of a center line stripe may help organize pathway traffic. When striping is desired/required, use a 4 inch dashed yellow centerline stripe with 4 inch solid white edge lines.
- Solid centerlines can be provided on tight or blind corners, and on the approaches to roadway crossings.

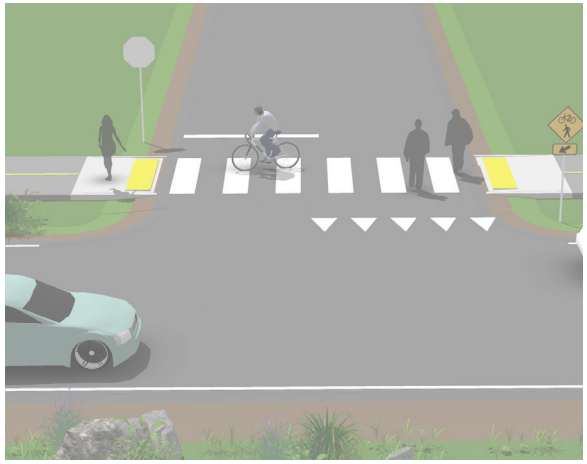
Bollards

- Use of bollards should be avoided when possible. If bollards are used at intersections and access points, they should be colored brightly and/or supplemented with reflective materials to be visible at night.

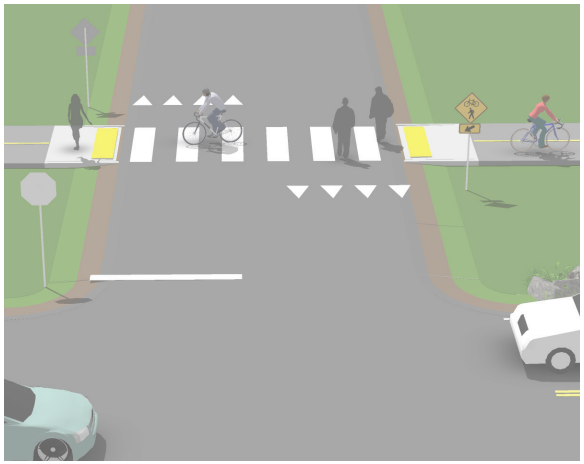
TRAILS ALONG ROADWAYS

Trails within road right-of-way, also called sidepaths, are a type of path that run adjacent to a street and are for both bicycle and pedestrian travel. Because of operational concerns it is generally preferable to place trails within independent rights-of-way away from roadways. However, there are situations where existing roads provide the only corridors available.

Adjacent Crossing - A separation of 6 feet emphasizes the conspicuity of riders at the approach to the crossing.



Setback Crossing - A set back of 25 feet separates the trail crossing from merging/ turning movements that may be competing for a driver's attention.



TYPICAL APPLICATION

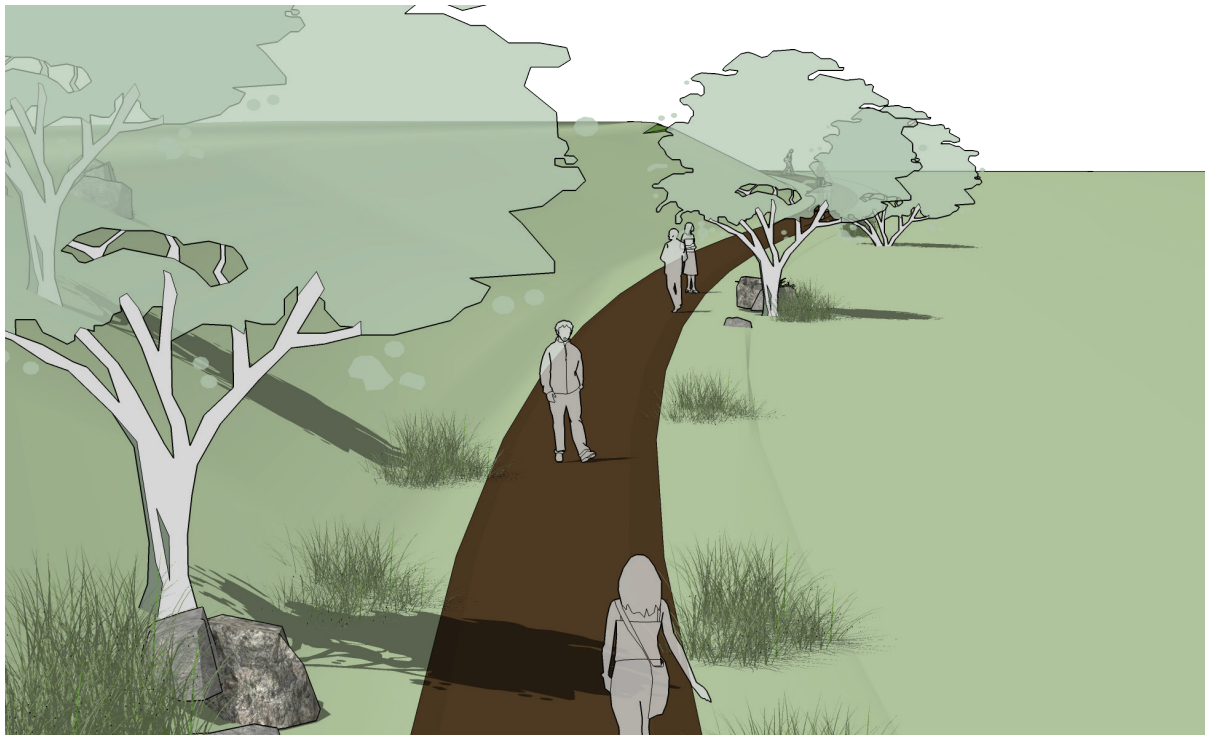
- Along one or both sides of roadways
- To reduce potential conflicts in some situations, it may be better to place one-way trials on both sides of the street.

DESIGN FEATURES

- Guidance should follow that for general design practices of trails.
- A high number of driveway crossings and intersections create potential conflicts with turning traffic. Consider alternatives to trails on streets with a high frequency of intersections or heavily used driveways.
- Where a trail terminates special consideration should be given to transitions so as not to encourage unsafe wrong-way riding by bicyclists.
- Crossing design should emphasize visibility of users and clarity of expected yielding behavior. Crossings may be STOP or YIELD controlled depending on sight lines and bicycle motor vehicle volumes and speeds.

NATURAL SURFACE TRAILS

Sometimes referred to as footpaths or hiking trails, natural surface trails are used along corridors that are environmentally-sensitive but can support bare earth or boardwalk trails.



TYPICAL APPLICATION

- Natural surface trails are a low-impact solution and found in areas with limited development or where a more primitive experience is desired.
- Provide recreational opportunities for walking, jogging and riding.

DESIGN FEATURES

- Trails can vary in width from 18 inches to 6 feet or greater; vertical clearance should be maintained at 9 feet above grade.
- Base preparation varies from machine-worked surfaces to those worn only by usage.
- Trail surface can be made of dirt, rock, soil, forest litter, or other native materials. Some trails use crushed stone (a.k.a. "crush and run") that contains about 4 percent fines by weight, and compacts with use.
- Provide positive drainage for trail tread without extensive removal of existing vegetation; maximum slope is five percent (typical).

EQUESTRIAN TRAILS

All trails identified as multi-use are open to equestrians, in addition to pedestrians, cyclists and other non-motorized users. Multi-use trails may be designed to have a single tread for all users or multiple treads to separate uses that might conflict.

TYPICAL APPLICATION

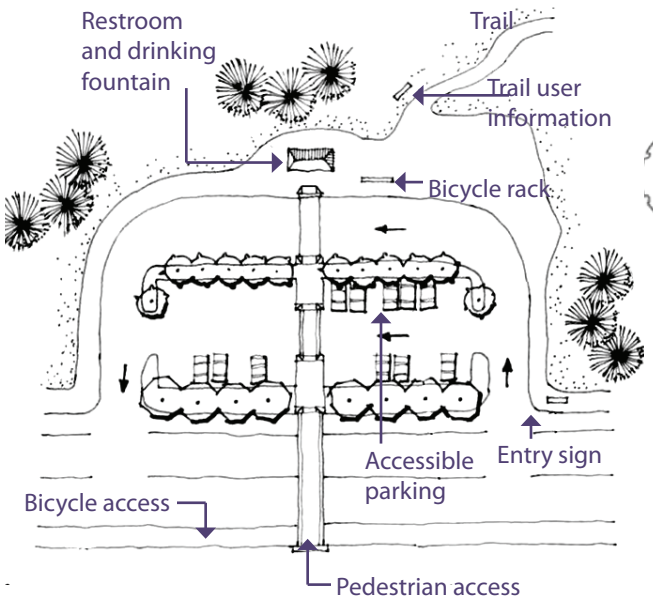
- Pedestrians and equestrians are often compatible as they both use unpaved surfaces at relatively slow speeds.
- Bicyclists and horses may have conflicts. Road cyclists prefer a hard, smooth surface which is not ideal for horses. The faster speed of cyclists and natural flight reaction of horses may cause conflicts.

DESIGN FEATURES

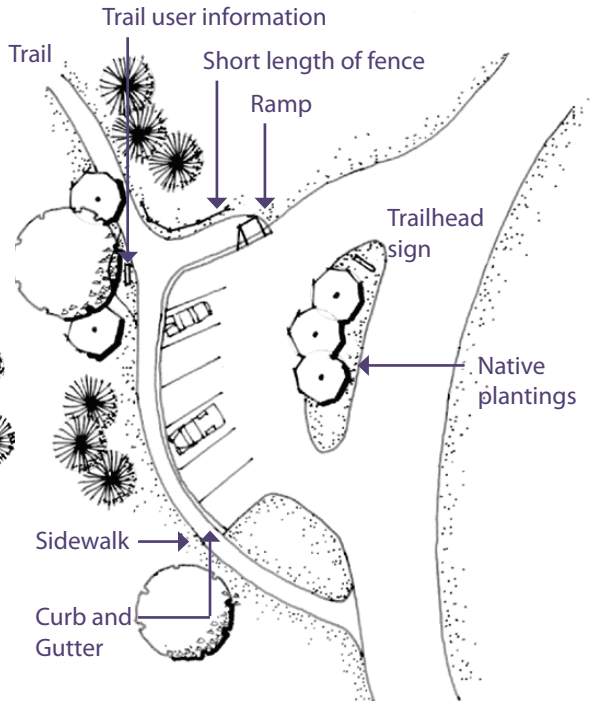
- Minimum width of 1.5 feet of tread width and 5 feet of horizontal clear width to accommodate horse and rider.
- Preferred width of 6 feet of tread and 3 foot shoulders (12 feet total).
- Grade: 0-10% preferred, with 20% acceptable for spans shorter than 50 yards.
- Preferred separation includes vegetated buffers, elevation changes, or distinctive surfaces suitable to each user group. In corridors where space is limited, shared use facilities may be provided.
- Refer to pages 14-15 of this guide for additional information.

TRAILHEADS

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



Major Trailhead



Minor Trailhead

TYPICAL APPLICATION

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

DESIGN FEATURES

- Trailheads should be distributed throughout the trail system at key nodes, vistas, and other significant locations.
- If equestrians are expected, provide :
- equestrian-specific wayfinding and signage
- water sources (not troughs)
- manure bins
- mounting blocks or boulders
- spacious, level, and pull-thru design horse trailer parking with gravel

TRAIL AMENITIES

Trail amenities provide services for trail users that increase comfort and usability of a trail. Amenities may include, but are not limited to, warning signs, drinking fountains, benches, lighting, restrooms, and landscaping.

TYPICAL APPLICATION

- At and along trails

DESIGN FEATURES

WARNING SIGNS

Warning signs should advise trail users as to user hierarchy, Signs to caution trail users about unexpected conditions or potential hazards.

DRINKING FOUNTAINS & BENCHES

Drinking fountains increase comfort by ensuring trail users have access to clean water. Drinking fountains may be installed every 0.5 mile to one mile, depending on trail usage.

If equestrians are expected, provide a water source for horses along the trail (not a trough).

Benches also increase comfort by providing a place for trail users to rest. Increase frequency of seating where there is high demand or where there is heavy use by seniors and people with disabilities

LIGHTING

Pedestrian/cyclist scale lighting improves visibility and safety for trail users. Pedestrian scale lighting is characterized by short light poles (around 15 feet high), close spacing, low levels of illumination (except at crossings), and the use of LED lamps to produce good color rendition, long service life and high energy efficiency.

Lamp fixtures should be at height of about 12-14 feet, and poles should be spaced approximately 25-50 feet apart depending on the intensity of lights.

RESTROOMS

Restrooms are typically located at trail heads, with signage indicating restroom location.

LANDSCAPING

Landscaping adjacent to trails should be maintained to ensure it does not impede on the trail clear zone.

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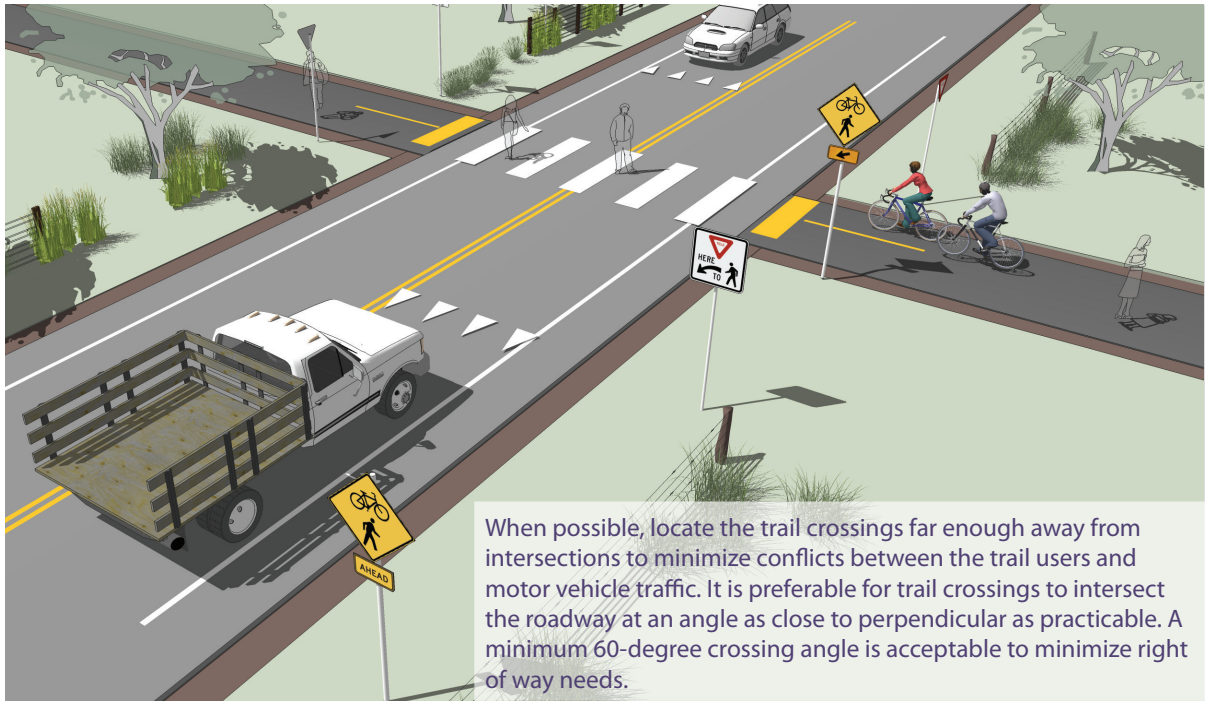
Trail crossings should be safe and comfortable for all trail users.

TRAIL INTERSECTION TREATMENTS

SECTION 7

MARKED CROSSING

A marked/unsignalized crossing typically consists of a marked crossing area, signage, and other markings to slow or stop traffic. The approach to designing crossings at mid-block locations depends on an evaluation of vehicular traffic, line of sight, pathway traffic, use patterns, vehicle speed, road type, road width, and other safety issues such as proximity to major attractions.



When possible, locate the trail crossings far enough away from intersections to minimize conflicts between the trail users and motor vehicle traffic. It is preferable for trail crossings to intersect the roadway at an angle as close to perpendicular as practicable. A minimum 60-degree crossing angle is acceptable to minimize right of way needs.

TYPICAL APPLICATION

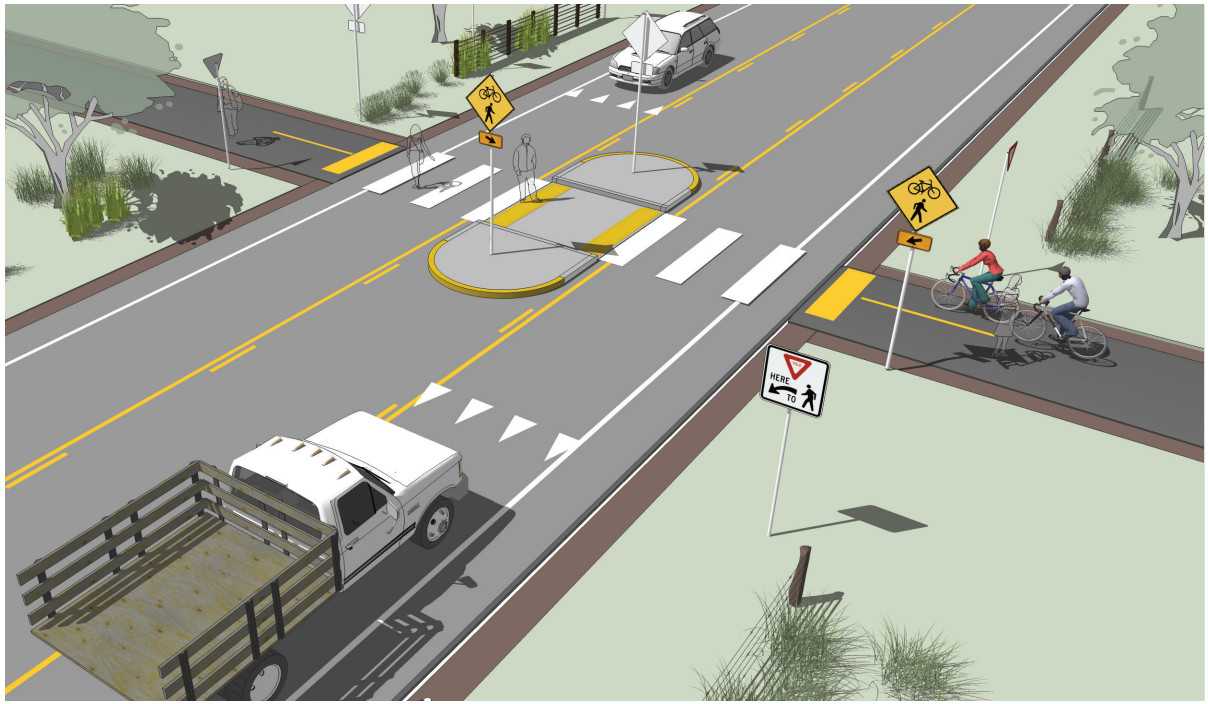
- Maximum Traffic Volumes
  - ≤9,000-12,000 Average Daily Traffic (ADT) volume
- Maximum travel speed of 35 MPH
- Minimum Sight Lines
  - 25 MPH zone: 155 ft
  - 35 MPH zone: 250 ft
  - 45 MPH zone: 360 ft

DESIGN FEATURES

- On roadways with low to moderate traffic volumes (<12,000 ADT) and a need to control traffic speeds, a raised crosswalk may be the most appropriate crossing design to improve pedestrian visibility and safety.

MEDIAN CROSSING

On roadways with higher volumes, higher speeds and multi-lanes of vehicular traffic, a median crossing is preferred. A median refuge island can improve user safety by providing pedestrians and bicyclists space to perform the safe crossing of one side of the street at a time.



TYPICAL APPLICATION

- Maximum Traffic Volumes
  - Up to 15,000 ADT on two-lane roads, preferably with a median
  - Up to 12,000 ADT on four-lane roads with median

DESIGN FEATURES

- Unsignalized crossings of multi-lane arterials over 15,000 ADT may be possible with features such as sufficient crossing gaps (more than 60 per hour), median refuges, and/or active warning devices like rectangular rapid flash beacons or in-pavement flashers, and excellent sight distance. For more information see the discussion of active warning beacons.

ACTIVE WARNING BEACONS

Active enhanced crossings are unsignalized crossings with additional treatments designed to increase motor vehicle yielding compliance on multi-lane or high volume roadways. These enhancements include pathway user or sensor actuated warning beacons, Rectangular Rapid Flash Beacons (RRFB) shown below, or Pedestrian Hybrid Beacons.

TYPICAL APPLICATION

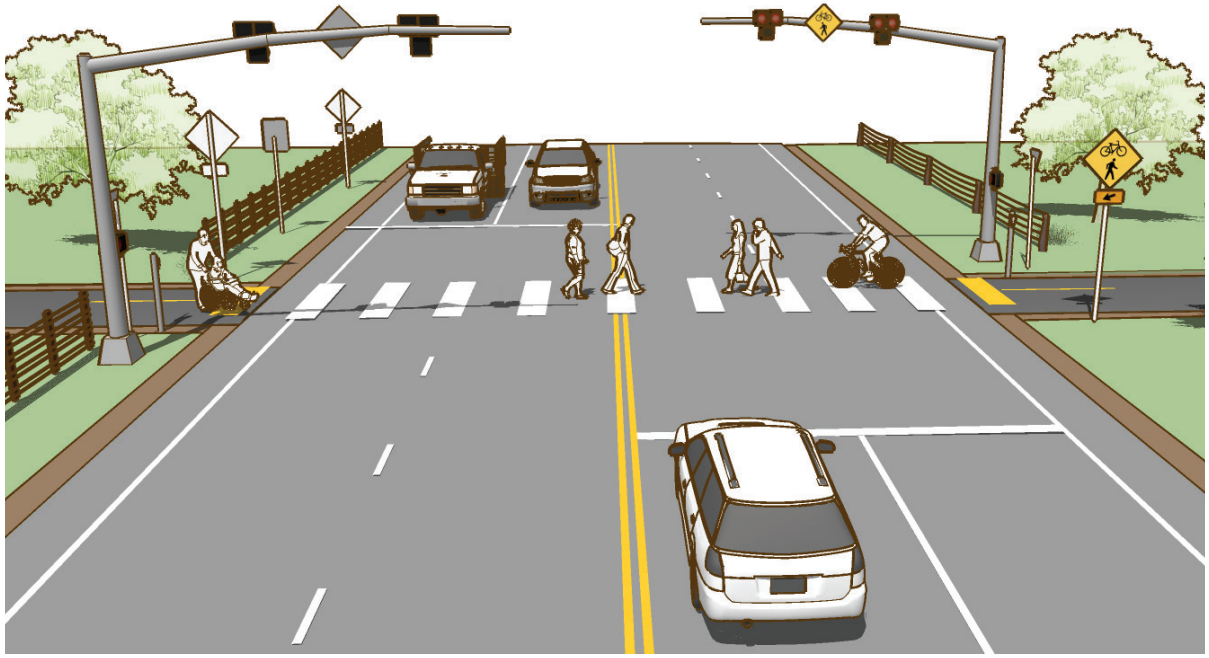
- Guidance for marked/unsignalized crossings applies.
- Warning beacons shall not be used at crosswalks controlled by YIELD signs, STOP signs, or traffic control signals.
- Warning beacons shall initiate operation based on user actuation and shall cease operation at a predetermined time after the user actuation or, with passive detection, after the user clears the crosswalk.

DESIGN FEATURES

- RRFBs are user actuated lights that supplement warning signs at unsignalized intersections or mid-block crossings.
- If equestrians are expected, provide an equestrian height actuation button.

PEDESTRIAN HYBRID BEACONS

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



TYPICAL APPLICATION

- Used to improve non-motorized crossings of major streets in locations where side-street volumes do not support installation of a conventional traffic signal.
- Hybrid beacons may also be used at mid-block crossing locations.

DESIGN FEATURES

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

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

ROUTE USERS TO SIGNALIZED CROSSING

Trail crossings within approximately 400 feet of an existing signalized intersection with pedestrian crosswalks are typically diverted to the signalized intersection to avoid traffic operation problems when located so close to an existing signal.

TYPICAL APPLICATION

- For this restriction to be effective, barriers and signing may be needed to direct path users to the signalized crossing. If no pedestrian crossing exists at the signal, modifications should be made.
- Trail crossings should not be provided within approximately 400 ft of an existing signalized intersection. If possible, route trail directly to the signal.

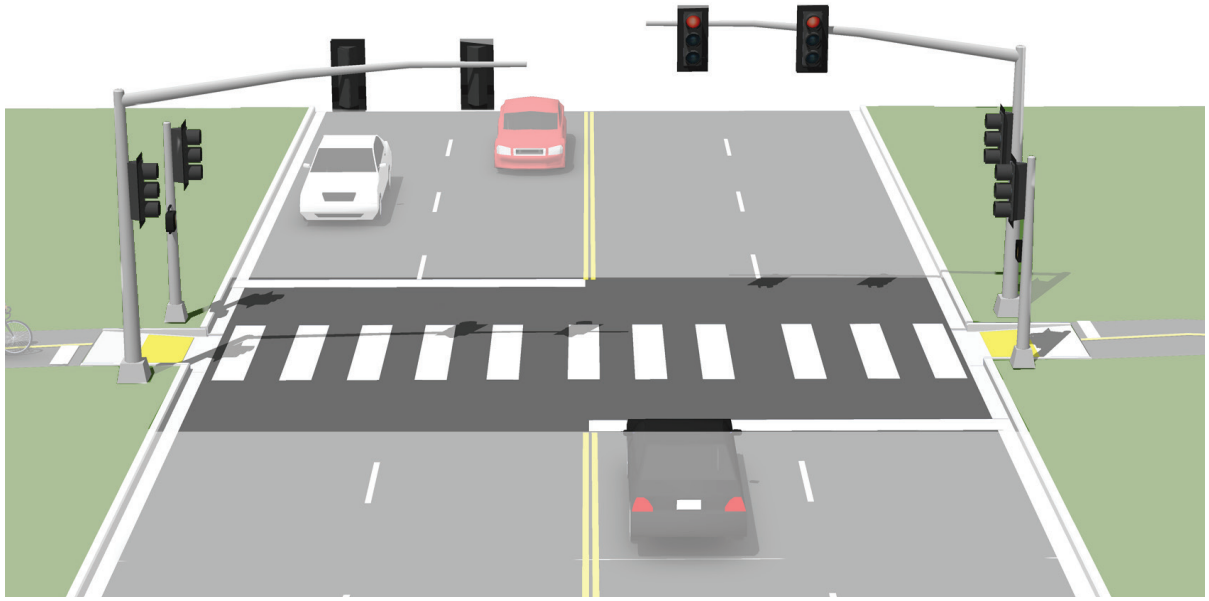
DESIGN FEATURES

- In the US, the minimum distance a marked crossing can be from an existing signalized intersection varies from approximately 250 to 660 feet.
- Engineering judgment and the context of the location should be taken into account when choosing the appropriate allowable setback. Pedestrians are particularly sensitive to out of direction travel and undesired mid-block crossing may become prevalent if the distance is too great.

FULL TRAFFIC SIGNAL CROSSING

Signalized crossings provide the most protection for crossing trail users through the use of a red-signal indication to stop conflicting motor vehicle traffic.

A full traffic signal installation treats the trail crossing as a conventional 4-way intersection and provides standard red-yellow-green traffic signal heads for all legs of the intersection.



TYPICAL APPLICATION

Full traffic signal installations must meet MUTCD pedestrian, school or modified warrants. Additional guidance for signalized crossings:

- Located more than 300 feet from an existing signalized intersection
- Roadway travel speeds of 40 MPH and above
- Roadway ADT exceeds 15,000 vehicles

DESIGN FEATURES

- Trail signals are normally activated by push buttons but may also be triggered by embedded loop, infrared, microwave or video detectors. The maximum delay for activation of the signal should be two minutes, with minimum crossing times determined by the width of the street.
- Each crossing requires additional review by a registered engineer.

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Bike amenities make it easier and more convenient to bicycle for daily trips.

BIKEWAY SIGNING & AMENITIES

SECTION 8

WAYFINDING SIGN TYPES

The ability to navigate through a city is informed by landmarks, natural features, and other visual cues. Signs throughout the city should indicate to bicyclists the direction of travel, the locations of destinations and the travel time/distance to those destinations. A bicycle wayfinding system consists of comprehensive signing and/or pavement markings to guide bicyclists to their destinations along preferred bicycle routes.

TYPICAL APPLICATION

- Wayfinding signs will increase users' comfort and accessibility to the bicycle network.
- Signage can serve both wayfinding and safety purposes including:
- Helping to familiarize users with the 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 people who are not frequent bicyclists (e.g., "interested but concerned" bicyclists)

DESIGN FEATURES

(A) Confirmation signs indicate to bicyclists that they are on a designated bikeway. Make motorists aware of the bicycle route. Can include destinations and distance/time but do not include arrows.

(B) Turn signs indicate where a bikeway turns from one street onto another street. These can be used with pavement markings and include destinations and arrows.

(C) Decisions signs indicate the junction of two or more bikeways and inform bicyclists of the designated bike route to access key destinations. These include destinations, arrows and distances. Travel times are optional but recommended.

D11-1c

D11-1/D1-3a

D1-1

WAYFINDING SIGN PLACEMENT

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

TYPICAL APPLICATION

CONFIRMATION SIGNS

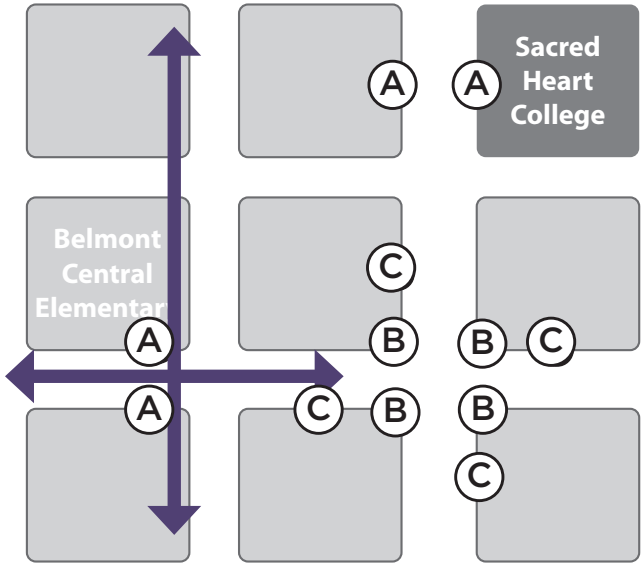
- Placed every ¼ to ½ mile on off-street facilities and every 2 to 3 blocks along on-street bicycle facilities, unless another type of sign is used (e.g., within 150 ft of a turn or decision sign).
- Should be placed soon after turns to confirm destination(s). Pavement markings can also act as confirmation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

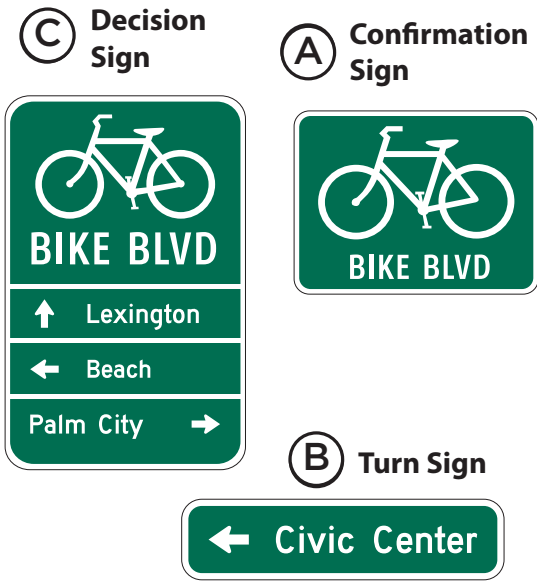
TURN SIGNS

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

DECISION SIGNS

- Near-side of intersections in advance of a junction with another bicycle route.
- Along a route to indicate a nearby destination.





SAFETY & WARNING SIGNS

Signs may be used to raise awareness of the presence of bikes on the roadway beyond that of the conventional "Bike Route" sign. These 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.

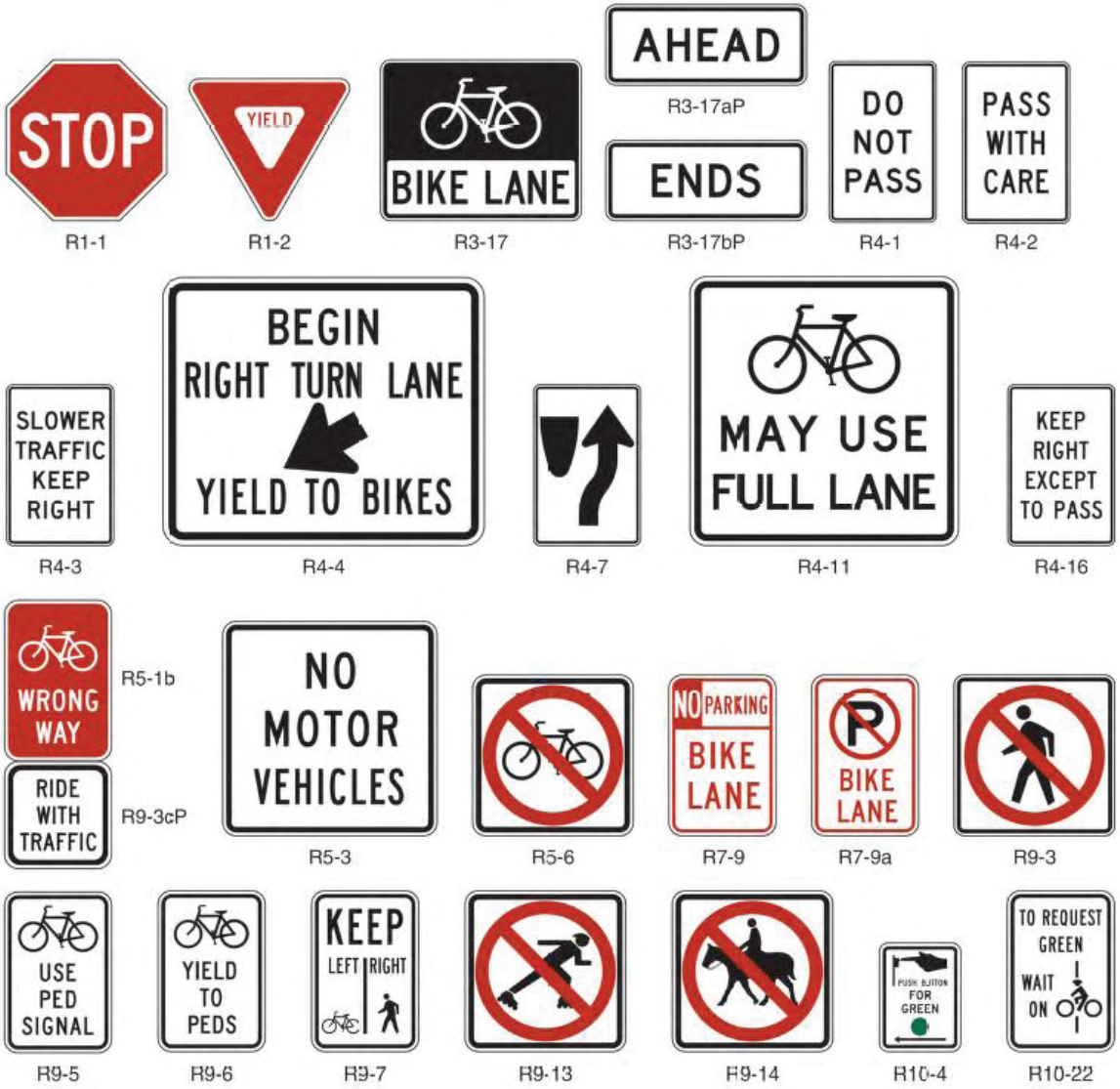
TYPICAL APPLICATION

- In higher speed contexts, a bicycle warning sign (W11-1) paired with a legend plaque reading "ON ROADWAY" may clarify to motor vehicle drivers to expect bicyclists.
- In relatively dense areas, "Bikes May Use Full Lane" (BMUFL) (R4-11) signs encourage bicyclists to take the lane when the lane is too narrow. They typically work best when placed near activity centers such as schools, shopping centers and other destinations that attract bicycle traffic.
- The "SHARE THE ROAD" (W16-1P) plaque is discouraged for use due to a lack of shared understanding among road users.
- In California, the state-specific "PASS Bicycle (symbol) 3FT MIN" symbol (R117) can be used to remind motorists to provide adequate space when passing.
- Regulatory and warning signs as set forth in the CAMUTCD, are designed to indicate the traffic laws and regulations of the road and provide warning of specific roadway conditions to reduce the likelihood of motor vehicle, bicycle and pedestrian-involved crashes and injury.

DESIGN FEATURES

- Use with travel lanes less than 14 feet wide, which are too narrow for safe passing within the lane.
- Signs should be placed at regular intervals along routes with no designated bicycle facilities.
- Dedicated bicycle facilities are recommended for roadways with speed limits above 35 mph where the need for bicycle access exists.
- Regulatory signage specific to bicycle and pedestrian travel are typically rectangular in shape with a white background and a black border. Bicycle and/or pedestrian warning signage is yellow or fluorescent yellow-green with a black border, and diamond -shaped. Consult CAMUTCD Chapter 2 for more information regarding design, size, placement of regulatory and warning signage.
- Monitor signs along bikeways for vandalism, graffiti, and normal wear and replace signs in the bikeway network as needed.

MUTCD FIGURE 9B-2. REGULATORY SIGNS & PLAQUES FOR BICYCLE FACILITIES



CAMUTCD FIGURE 9B-2 (CA). CALIFORNIA REGULATORY SIGNS FOR BICYCLE FACILITIES

R44A (CA)

R44B (CA)

R81A (CA)

R81B (CA)

R44C (CA)

R81 (CA)

R117 (CA)

R118 (CA)

BIKE PARKING

Bicyclists expect a safe, convenient place to secure their bicycle when they reach their destination. This may be short-term parking of two hours or less, or long-term parking for employees, students, residents, and commuters.

TYPICAL APPLICATION

Bicycle parking facilities shall be located in highly visible well-lighted areas. In order to maximize security, whenever possible short-term bicycle parking facilities shall be located in areas highly visible from the street and from the interior of the building they serve (i.e., placed adjacent to windows).

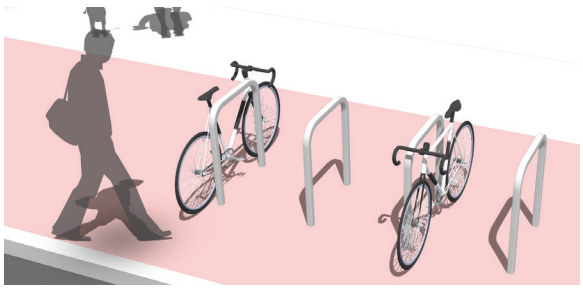
DESIGN FEATURES

- All bicycle facilities shall provide a minimum 4 ft aisle to allow for unobstructed access to the designated bicycle parking area.
- Bicycle parking facilities should be securely anchored so they cannot be easily removed and shall be of sufficient strength and design to resist vandalism and theft.

BIKE RACKS

- Bike racks should provide a minimum of two points of contact, such as a staple rack (or inverted U rack). Wave racks are not recommended.
- 2 ft minimum from the curb face to avoid 'dooring.'
- 4 ft between racks to provide maneuvering room.
- Locate close to destinations; 50 ft maximum distance from main building entrance.
- Minimum clear distance of 6 ft should be provided between the bicycle rack and the property line.
- Bike racks should be placed 2 ft minimum (3 ft preferred) from a building or wall.

PERPENDICULAR BIKE RACKS

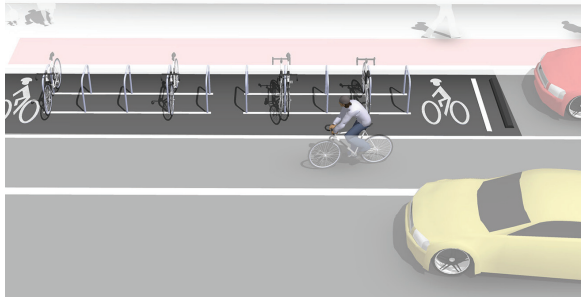


BIKE CORRALS

- Bicyclists should have an entrance width from the roadway of 5-6 ft for on-street corrals.
- Can be used with parallel or angled parking.
- Parking stalls adjacent to curb extensions

For additional information on bike parking, reference Essentials of Bike Parking by the Associate of Pedestrian and Bicycle Professionals

BIKE CORRAL



BIKE ACCESS ON STAIRS

Stairways can provide useful and important connections for cyclists and can be safe and convenient, if properly designed. Bike channels on stairs, also referred to as "runnels", are small channels along a stairway that allows cyclists to roll a bike up or down the stairway.

TYPICAL APPLICATION

- Where the geography creates a steep slope.
- Where sufficient space isn't available to accommodate required ramps slopes and resting areas.
- Where street right of way isn't available to build a tunnel.
- To access transit stations.

DESIGN FEATURES

Five key design elements must be used to ensure that runnels are safe and useful to cyclists:

- Low stair slope: Dutch standards call for a 25% slope for stairs with runnels; conveyor belts can be used to help pull the bike
- Transition: the runnel should extend the entire stairway; otherwise, when ascending, bike must be lifted. When descending, the bike will abruptly drop off runnel
- Runnel Profile: a curved, U or V profile rather than flat to help hold the wheel, while helping to maintain control and balance
- Adequate setbacks: 6.5 inch set back from wall or handrail is necessary
- Usable: Stairs should be usable by people walking up and down the stairs. Stairs should have runnels on both sides or a central runnel with two profiles.
- The runnel should be physically separated from the steps/travel way, either through grade-separation or the outside edge of the side-running railings to prevent from posing a trip-hazard and maintaining a detectable surface/edge.

BIKE ACCESS ON TRANSIT

Safe and easy access to transit stations and secure bicycle parking facilities is necessary to encourage commuters to access transit via bicycle. Bicycling to transit reduces the need to provide expensive and space consuming car parking spaces.

DESIGN FEATURES

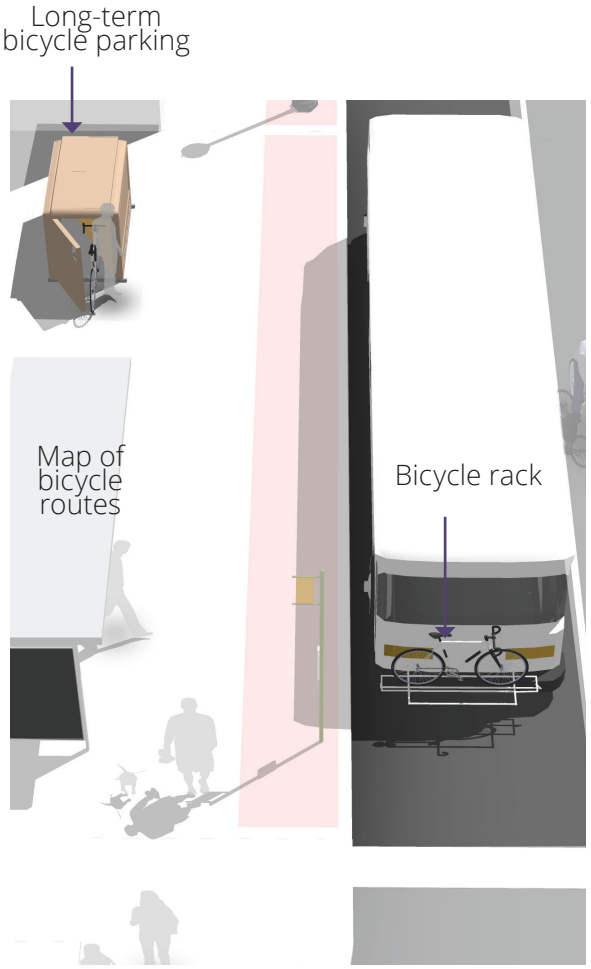
Many people who ride to a transit stop will want to bring their bicycle with them on the transit portion of their trip, so buses and other transit vehicles should be equipped accordingly.

ACCESS

- Provide direct and convenient access to transit stations and stops from the bicycle and pedestrian networks.
- Provide maps at major stops and stations showing nearby bicycle routes.
- Provide wayfinding signage and pavement markings from the bicycle network to transit stations.
- Ensure that connecting bikeways offer proper bicycle actuation and detection.

BICYCLE PARKING

- The route from bicycle parking locations to station/stop platforms should be well-lit and visible.
- Signing should note the location of bicycle parking, rules for use, and instructions as needed.
- Provide safe and secure long-term parking such as bicycle lockers at transit hubs. Parking should be easy to use and well maintained.



MAINTENANCE

Regular bicycle facility maintenance includes sweeping, maintaining a smooth roadway, ensuring that the gutter-to-pavement transition remains relatively flush, and installing bicycle-friendly drainage grates. Pavement overlays are a good opportunity to improve bicycle facilities. The following recommendations provide a menu of options to consider to enhance a maintenance regimen.

SWEEPING

- Establish a seasonal sweeping schedule that prioritizes roadways with major bicycle routes.
- Sweep walkways and bikeways whenever there is an accumulation of debris on the facility.
- In curbed sections, sweepers should pick up debris; on open shoulders, debris can be swept onto gravel shoulders.

SIGNAGE

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

ROADWAY SURFACE

- Maintain a smooth pothole-free surface.
- Ensure that on new roadway construction, the finished surface on bikeways does not vary more than ¼".
- Maintain pavement so ridge buildup does not occur at the gutter-to-pavement transition or adjacent to railway crossings.

PAVEMENT OVERLAYS

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

DRAINAGE GRATES

- Require all new drainage grates be bicycle-friendly, including grates that have horizontal slats.
- Create a program to inventory all existing drainage grates, and replace hazardous grates as necessary.

GUTTER TO PAVEMENT TRANSITION

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

LANDSCAPING

- Ensure plants do not impede bike passage.
- After major damage incidents, remove fallen trees or other debris from bikeways as quickly as possible.