# Appendix D – Best Practices Toolkit

This document outlines guidelines for the design of walking facilities in Napa County. Safe, walkable streets are a vital aspect of the pedestrian environment, and they enhance the health of communities. Well-designed walking spaces should be comfortable for all residents – of all ages and abilities – to enjoy.

## Creating a Walkable Network

A well-connected pedestrian network is a vital component of livable communities, which thrive on multimodal travel for all roadway users, regardless of age or ability. Multimodal travel incorporates the needs of not just motor vehicles in roadway design, but the needs of pedestrians, bicyclists, and transit users as well. The primary goal of the Best Practices Toolkit is to assist in creating streets Countywide that accommodate pedestrians through a set of recommended practices that enhance walkability. These practices are rooted in the larger concepts of Complete Streets and Traffic Calming, explained below.

### *Complete Streets*

Complete streets accommodate safe access for all users, including pedestrians, bicyclists, transit riders, and motorists. A complete street is designed to make it easy for users of all ages and abilities to travel across and along the street. Complete street practices improve the pedestrian realm when properly integrated with the adjacent land use context, because they encourage the design of streets with well-connected and comfortable sidewalks, traffic calming measures to manage vehicle speeds and enhanced pedestrian crossings. Though the level of accommodation of all modes will vary in different land use contexts, incomplete streets—those designed primarily for automobile access—can be a barrier in any neighborhood, particularly for people with disabilities, older adults, and children.

### *Traffic Calming Best Practices*

Traffic calming includes a suite of treatments designed to encourage safe, pedestrian-oriented speeds. Universal considerations for traffic calming along a pedestrian network can reduce the need for substantial and costly safety improvements in the future, such as large road diets or roundabouts. Considering the relationship between the design speed of a roadway and the desired speed, especially in the context of downtown locations and school zones, is an important first step to designing for a pedestrian-friendly environment. Examples of proactive traffic calming treatments include reduced lane widths, chicanes, and reduced curb radii. Reduced speeds from traffic calming can increase a driver's field of focus and attention to pedestrians that may be walking along or across the street. Additional design guidance is available on NACTO's website at: http://nacto.org/publication/urban-street-design-guide/intersection-design-elements/visibility-sight-distance/ and in the *Treatment Guidelines* section. .

# The Pedestrian Realm

The pedestrian realm consists of walkways, pedestrian crossings, and open public spaces. The quality of the pedestrian realm has two components: accessibility and comfort.

These design guidelines will help each jurisdiction make decisions about the preferred application of pedestrian treatments in the following areas:

- Streets and Sidewalks
- Pathways/Trails
- Accessibility
- Crosswalk Guidelines for Uncontrolled and Controlled Crossings

The pedestrian enhancements described throughout these guidelines provide street design best practice guidance, which can enhance the safety, convenience, and mobility for pedestrians.

## *Streets and Sidewalks*

Streets and sidewalks should support the activities and pedestrian levels along the street. Streets should be well-connected to ensure that destinations are within walking distance and wide enough to support the expected pedestrian volumes.

### Sidewalk Zones

The application of sidewalks varies throughout Napa County. In some jurisdictions and within the unincorporated County where sidewalks may be cost-prohibitive and/or conflict with the desired rural character of the area, lower-cost alternatives should be considered as discussed below. Other more urban areas of the County include sidewalks that are built to specified minimum widths found in the standard street cross-sections for the jurisdiction where they are located and may vary depending on land use. **Table D-4** of the *Treatment Guidelines* section below provides guidelines on the design of organized sidewalk zones that meet walking demand and provide comfort to users.

### Alternatives to Sidewalks

While many of the guidelines outlined here are appropriate in downtown or more urbanized locations, many of the roadways throughout the County are rural, especially in unincorporated areas, and some of the sidewalk guidelines are either not feasible or not a contextual fit. In these instances, pedestrian facilities (where warranted) can be provided through the use of paved multi-use shoulders, unpaved shoulders or pathways. The feasibility of most of these treatments will depend on available right-of-way and should be evaluated when certain general criteria are met, discussed below under *Considerations for Sidewalk and Shoulder Installation*. For additional design guidance on paved multi-use shoulders, see **Table D-10** of the *Treatment Guidelines* section. For design

guidance on pathways and trails, including materials that have been tested in rural settings for ADA applications, refer to the Pathways/Trails section below.

### *Considerations for Sidewalk and Shoulder Installation*

Many rural roadways present engineering and cost challenges for pedestrian facilities due to steep terrain or narrow right-of-way. As such, a three step process for determining applicable facility types and locations is recommended: (1) collect contextual data, (2) evaluate data versus thresholds, and (3) select facility type.

Context

The appropriate location for pedestrian facilities, especially in rural contexts such as the unincorporated areas of Napa County, depends on several factors related to the potential for pedestrian demand including presence of pedestrian-oriented land uses (such as retail, schools or parks), presence of transit, and/or observed pedestrian volumes. More importantly, sidewalks are a documented safety countermeasure[12], and therefore should first be prioritized in locations where pedestrian-vehicle collisions have been recorded with a "walking along the roadway" crash type or there are reported safety concerns, independent of land use or other factors. In cases with no pedestrian demand and no documented safety concerns (reported or anecdotal), designated pedestrian facilities may not be required in a rural context.

Thresholds and Facility Selection

If pedestrian facilities are merited based on the contextual factors, the type of facility is determined based on the land use, vehicle volumes, and density of development. **Table D-1** below, developed for the FHWA, Office of Safety as part of the Pedestrian Safety Guide and Countermeasure Selection System, should be used as a resource to determine the appropriate type of pedestrian facility for the corridor.

While the table is intended to assist in the evaluation of existing conditions, future volumes and housing densities should also be considered to determine whether right-of-way should be preserved or secured in anticipation of sidewalks being warranted under a future condition.

**TABLE D-1:**
**RECOMMENDED GUIDELINES FOR NEW SIDEWALK/WALKWAY INSTALLATION**

| Volume and Housing Density Thresholds by Land Use | Minimum and Preferred Sidewalk/Walkway Treatment |
|---|---|
| **Rural** | |
| Roadways with < 400 ADT | Shoulders preferred, with minimum of 3 ft. |

[12] Zegeer, Charles V., Dan Nabors, Peter Lagerwey, "Pedestrian Safety Guide and Countermeasure Selection System", http://www.pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=1

| TABLE D-1:<br>RECOMMENDED GUIDELINES FOR NEW SIDEWALK/WALKWAY INSTALLATION | |
|---|---|
| **Volume and Housing Density Thresholds by Land Use** | **Minimum and Preferred Sidewalk/Walkway Treatment** |
| Roadways with 400 to 2,000 ADT | 5-ft shoulders preferred, minimum of 4 ft required. |
| **Rural / Suburban** | |
| Roadways with ADT > 2,000 and less than 1 dwelling unit (d.u.) / acre | Off-street facility preferred (sidewalks or side paths[1]).<br><br>Minimum of 6-ft shoulders required. Paved shoulders are preferred to unpaved shoulders to provide an all-weather surface. |
| ***Note: In rural settings, greater width shoulders (up to 8 to 10 feet) are desired along high-speed roadways, particularly with a large number of trucks.*** | |
| Roadways with 1 to 4 d.u. / acre | Sidewalks on both sides required unless side path provided. |
| **Suburban / Urban Residential** | |
| Non-Local Streets (i.e. major arterials, collectors, and minor arterials) | Sidewalks on both sides required. |
| Local streets with less than 1 d.u. / acre | Sidewalks on both sides preferred. Minimum of 5-ft shoulders required. |
| Local streets with 1 to 4 d.u. / acre | Both sides preferred.<br><br>Second side recommended if density becomes greater than 4 d.u. / acre or if schools, bus stops, etc. are added. |
| Local streets with more than 4 d.u. / acre | Sidewalks on both sides required. |
| **Urban Commercial** | |
| ***All Commercial Urban Streets*** | Sidewalks on both sides required. |
| **Industrial** | |
| ***All Streets in Industrial Areas*** | Sidewalks on both sides preferred. Minimum of 5-ft shoulders required. |

[1] Side path is a pathway separated from the travel way; an off-street pathway. It may be paved or unpaved, and is separated from the roadway by a grass or landscape strip without curbing.

Source: Zegeer, Charles V., Dan Nabors, Peter Lagerwey. "*Recommended Guidelines/Priorities for Sidewalks and Walkways*," Pedestrian Safety Guide and Countermeasure Selection System, August 2013.

## *Pathways/Trails*

Pedestrian pathways, which include paved multi-use trails as well as informal, unpaved trails, are an asset to Napa County. They increase pedestrian connectivity and satisfy pedestrian desire lines that are otherwise not accommodated by pedestrian facilities. The design of a trail segment should accommodate users walking in both directions when possible. A pathway can be direct, especially when providing a useful connection between two pedestrian generators, or if the primary purpose is recreational they can meander and take advantage of natural landscape features such as creeks and open space. Perhaps the most important consideration for pedestrian safety in the design of trails is crossing locations. Refer to the Crosswalk Guidelines of this Appendix for applicable treatments based on locational context.

## Unpaved Pathway/Trail Accessibility

Trails and unpaved pathways/shoulders should provide access to pedestrians of all abilities. According to the *Best Practices Design Guide for Designing Sidewalks and Trails for Access*, a guidebook published by the FHWA, the surface material for a trail should be firm and stable to satisfy accessibility requirements. Many natural materials can provide a firm and stable surface, as shown in **Table D-2** below. Slip resistance is also desirable although not always achievable. More information on accessible trail design is available in Chapter 15 of the FHWA guidebook, Recreational Trail Design, which can be viewed at the following link: http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalk2/pdf/16chapter15.pdf.

**TABLE D-2: FIRMNESS, STABILITY, AND SLIP RESISTANCE FOR A VARIETY OF COMMON TRAIL SURFACING MATERIALS**

| Surface Material | Firmness | Stability | Slip Resistance (dry conditions) |
|---|---|---|---|
| **Asphalt** | **Firm** | **Stable** | **Slip resistant** |
| **Concrete** | **Firm** | **Stable** | **Slip resistant*** |
| **Soil with Stabilizer** | **Firm** | **Stable** | **Slip resistant** |
| **Packed Soil without Stabilizer** | **Firm** | **Stable** | Not slip resistant |
| Soil with High Organic Content | Soft | Unstable | Not slip resistant |
| **Crushed rock (3/4" minus) with Stabilizer** | **Firm** | **Stable** | **Slip resistant** |
| **Crushed rock without Stabilizer** | **Firm** | **Stable** | Not slip resistant |
| **Wood Planks** | **Firm** | **Stable** | **Slip resistant** |
| Engineered Wood Fibers that comply with ASTM F1951 | Moderately firm | Moderately stable | Not slip resistant |
| Grass or Vegetative Ground Cover | Moderately firm | Moderately stable | Not slip resistant |
| Engineered Wood Fibers that do not comply with ASTM F1951 | Soft | Unstable | Not slip resistant |
| Wood Chips (bark, cedar, generic) | Moderately firm to soft | Moderately stable to unstable | Not slip resistant |
| Pea Gravel or 1-1/2" Minus Aggregate | Soft | Unstable | Not slip resistant |
| Sand | Soft | Unstable | Not slip resistant |

* A broom finish significantly improves the slip resistance of concrete.

Source: Designing Sidewalks and Trails for Access, Part II of II: *Best Practices Design Guide*, FHWA, 2001 http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalk2/pdf.cfm

## Accessibility

The United States Access Board published proposed accessibility guidelines for pedestrian facilities in the public right-of-way in 2011 which have yet to be adopted formally into law. The most recent information can be found on the Board's website at www.access-board.gov/prowac/. These guidelines represent best practices and should be referenced when constructing new curb ramps and sidewalks to ensure accessibility for users of all abilities. FHWA

has also published *Designing Sidewalks and Trails for Access*, which includes guidance for designing accessible sidewalks and curb ramps. Relevant sections include Chapter 4 *Sidewalk Corridors*, Chapter 5 *Driveway Crossings* and Chapter 7 *Curb Ramps*. A summary of key specifications is included below in **Table D-3.** Additional guidance for surveying curb ramps can be found in the ADA Best Practices Toolkit for State and Local Governments, published by the United States Department of Justice, at https://www.ada.gov/pcatoolkit/app1curbramps.htm.

**TABLE D-3: ACCESSIBILITY GUIDANCE FOR SIDEWALKS AND CURB RAMPS**

| | |
|---|---|
| **Sidewalks** | |
| **Maximum running slope** | 5%[1] |
| **Maximum cross-slope** | 2% |
| **Minimum clear width at obstructions** | 3 feet |
| **Minimum clear height at obstructions (includes signs placed on sidewalk)** | 7 feet |
| **Surface** | Firm, stable and slip resistant |
| **Minimum vertical changes in elevation** | 0.25 inches |
| *Note: Level landings should be provided at the back of sloped driveways to prevent abrupt changes in cross-slopes and accommodate wheelchairs* | |
| **Curb Ramps** | |
| **Maximum ramp slope** | 8.33% |
| **Maximum gutter slope** | 5% |
| **Minimum ramp width** | 36 inches; 48 inches desired |
| **Minimum landing width** | 48 inches |
| **Maximum flare slope** | 10% |
| **Maximum cross slope** | 2% |
| **Detectable warning width** | 24 inches |
| *Note: Abrupt changes in elevation at the top or bottom of a curb ramp should be avoided. Two separate curb ramps should be provided at corners when possible, one for each crosswalk, to provide directional guidance to vision-impaired pedestrians.* | |

1: Except where the grade of the existing street exceeds 5%. Level landings should be provided at regular intervals in these cases.

Source: Designing Sidewalks and Trails for Access, Part II of II: *Best Practices Design Guide*, FHWA, 2001 http://www.fhwa.dot.gov/environment/bicycle_pedestrian/publications/sidewalk2/pdf.cfm

*Accessible Elements of a Curb Ramp*

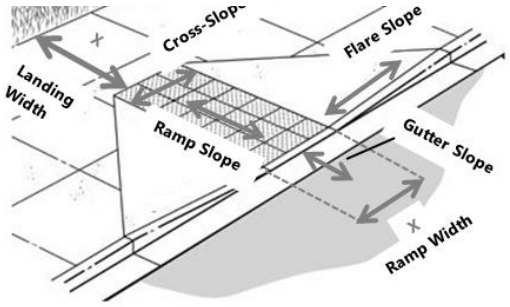



*Image Source: https://www.ada.gov/pcatoolkit/app1curbramps.htm; Annotations: Fehr & Peers 2016*

*Accessible Elements of a Sidewalk*

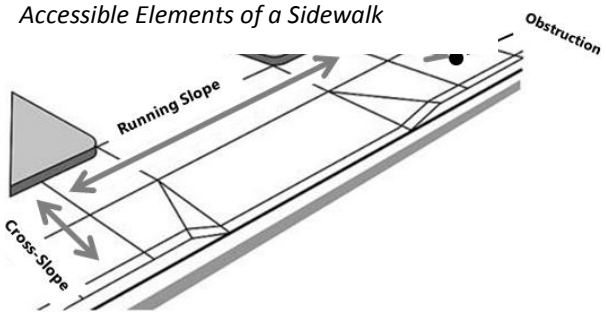
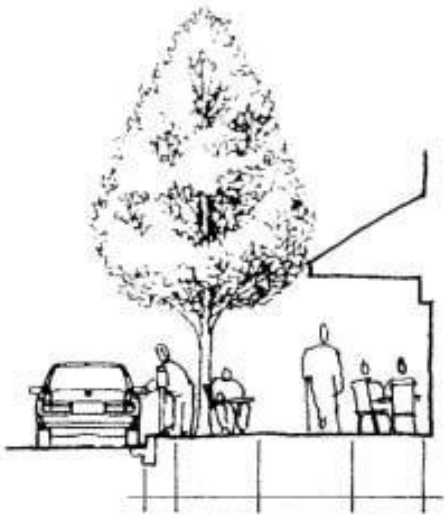



*Image Source: http://www.ite.org/css/online/DWUT08.html; Annotations: Fehr & Peers 2016*

## Additional Treatment Guidelines

**Table D-4: Sidewalk Zones and Corners**

| Description |
| --- |
| The sidewalk zone is the portion of the street right-of-way between the curb and building front. Within this zone, four distinct areas serve different organizational purposes. |
| **Design Example** |
|  <br>E Fu T Fr<br><br>  <br><br>E = Edge Fu = Furnishings T = Throughway Fr = Frontage |
| **Design Summary** |
| Where right-of-way allows, sidewalks should be separated from vehicle lanes by a landscaped buffer. In addition to separating pedestrians from vehicle traffic, landscape buffers provide space for driveway curb cuts and reduce cross-slopes on sidewalks.<br><br>Wider sidewalks can accommodate more pedestrians and further buffer pedestrians from vehicles. In busy pedestrian areas such as downtowns and school areas, sidewalks wider than 6’ should be considered. These sidewalks could include wider landscaped buffers, a pedestrian pathway, and/or vegetative strips along the building face. Elements such as street furniture, newspaper racks, bicycle parking racks, and trash bins should be kept in the furniture zone and should not impede a straight travel path along the sidewalk. Additionally, “meandering” sidewalks, as opposed to straight sidewalks, should be avoided since they are inconvenient for pedestrians and are challenging for disabled users. |

- Edge/Curb Zone is the transition between the sidewalk and the road.
- Furnishing/Landscape Zone acts as a buffer between the curb and throughway zone. This is the areas where trees should be planted and benches should be located. Any sidewalk amenities should be located within this area and should not interfere with the throughway zone. Streets with higher speeds should have larger furnishing zones.
- Throughway Zone provides enough space for pedestrians to travel.
- Frontage Zone borders the building façade or fence. The primary purpose of this zone is to create a buffer between pedestrians walking in the throughway zone from people entering and exiting buildings. It provides opportunities for shops to place signs, planters, or chairs that do not encroach into the throughway zone.

Some zones are more important in specific settings; for example, most residential streets will not include a frontage zone and will only include a furnishing/landscape zone on streets with higher speeds.

These guidelines are nationally supported, and more information is available on the NACTO website: http://nacto.org/publication/urban-street-design-guide/street-design-elements/sidewalks/

Pedestrian Area at Corners

Corners must be functional and must accommodate those waiting to cross the street, those traveling along the sidewalk, and those who stop to congregate on the corner. The greater the number of expected pedestrians, the larger the pedestrian area should be. Other considerations sometimes erode the amount of usable space and hence the functionality of corners. Several strategies exist for expanding the pedestrian area at corners. Small corner radii generally provide the most usable space and the shortest crossing distances for pedestrians. Designers may also consider curb extensions, right-of-way acquisition, public easements across private property to expand the pedestrian area.

The pedestrian area should be clear of obstructions, especially in the triangle created by extending the property lines to the face of curb. Where existing obstructions such as utility poles or newspaper racks are removed, they should not be relocated such that they obstruct a pedestrian's line of travel.

The general rule for choosing a corner radius should be to choose the smallest possible, acknowledging that each location has a unique set of factors that determines the appropriate radius. Small corner radii improve comfort, and create a more enjoyable walking environment because they create more usable space for pedestrians at the corner. They improve safety because they slow vehicle speeds and shorten the crossing distance for pedestrians and improve sightlines. Smaller corner radii are also beneficial for street sweeping operations.

The County may choose to recommend specific corner radii based on roadway classification, presence of curbside parking and heavy truck or transit traffic.

*Image Sources: Valley Transportation Authority Pedestrian Technical Guidelines; Chula Vista Pedestrian Master Plan; Fehr & Peers*

**Table D-5: Pedestrian Wayfinding**

| Description |
| --- |
| A pedestrian wayfinding system provides consistent and user-friendly information about distances and routes to and from major transit centers and popular destinations, making these places easier to connect to, and encouraging people to make short trips on foot. Signs that explain pedestrian directions and summarize route distances make for a more enjoyable and comfortable walking experience. Wayfinding is an essential aspect of street infrastructure which makes pedestrians a priority within the streetscape and enhances the character of the street. |
| **Design Example** |
| Wayfinding (Napa and Yountville examples)<br>  <br>  |
| **Design Summary** |
| Wayfinding signage should cater to both vehicles and pedestrians, particularly in districts with high levels of walking activity. Signs and routes that direct pedestrians to specific destinations are key to providing adequate wayfinding for pedestrians. |

*Image Source: lajollalight.com (left); Fehr & Peers (right)*

**Table D-6: Pedestrian-Scale Lighting**

| Description |
| --- |
| Pedestrian-scale lighting improves pedestrian visibility and the perception of safety and comfort while walking. Well-lit pedestrian facilities are more inviting, and function well for pedestrians after sunset. |
| **Design Example** |
| Pedestrian-scale Lighting (South San Francisco and Calistoga)<br>   |
| **Design Example** |
| Pedestrian-scale lighting provides a better-lit environment for pedestrians while improving visibility for motorists. Sidewalks with frequent nighttime pedestrian activity particularly in the downtown area should have pedestrian lighting. All crosswalks should have pedestrian-scale lighting. Pedestrians tend to observe more details of the street environment since they travel at a slower pace than vehicles, and thus pedestrian-scale lighting should have shorter light poles and shorter spacing between posts. A height of 12- 20 feet is common for pedestrian lighting. The level of lighting should reflect the location and level of pedestrian activity. Pedestrian visibility needs and a desire in rural areas for starlit sky views can require tradeoffs in lighting decisions. Lighting requirement decisions in these situations should be documented for consistent implementation. |

*Image Source: Fehr & Peers and Seattle.gov*

**Table D-7: High-Quality Street Furniture**

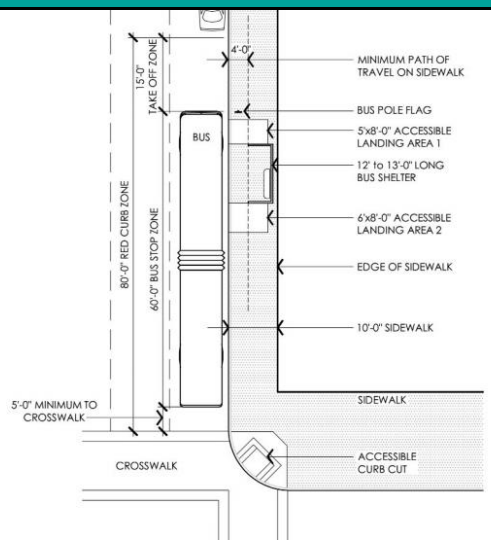
| Description |
| --- |
| High-quality street furniture provides pedestrians with inviting places to rest, and clearly defines the furnishings zone of a sidewalk. Street furniture enhances the streetscape with consistent design character, can protect landscape features, and formalizes waiting areas such as bus stops and street corners. |
| **Design Example** |
|   |
| **Design Summary** |
| Street furniture is normally placed on a sidewalk in the Frontage Zone to provide comfort for pedestrians and enhance place making within the pedestrian realm. Street furniture makes pedestrians feel welcome, but should not conflict with the pedestrian travel path. Street furniture can include benches, specially designed newspaper racks, fountains, special garbage/recycling containers, etc. |

**Table D-8: Bus Stop Accessibility**

## Description

The specific location and design of a bus stop within the right-of-way and pedestrian facilities are important for bus operations and accessibility. The best bus stops are operationally safe and efficient for both buses and passengers. The stop should be located to cause the minimum interference with pedestrian, bicycle and other vehicle movements. Bus stops should be located adjacent to the street curb in most cases, or at a bus bulb along busy transit routes or at transit centers and hubs. Minimum sidewalk and clearance is required for ADA accessibility. Ideally, bus stops also include a bus shelter for protection from sun or rain, and other amenities; at minimum they should include a bus stop pole and ADA compliant bench.

## Design Example





*Bus shelter with bench at back of sidewalk, leaving adequate ADA compliant clearance at curb.*
*Image Source: www.actransit.org, napavalleyregister.com*

## Design Summary

Bus stops must be long enough for the buses that use them so the buses do not hang into the travel lane when pulling in to the bus stop. Buses must stop flush with the curb to provide ADA compliant access to passengers with disabilities. Bus stop dimensions should be coordinated with the appropriate transit agencies.

ADA Accessibility Guidelines (ADAAG) specifies that the paved boarding/alighting area must be at least eight feet deep from the curb and five feet along the curb. ADAAG also requires a minimum path of travel (sidewalk) clear of obstructions to and from this boarding area at least three feet wide. Many cities use four feet or even six feet as their standard.

In most cases bus shelters should be placed at the back of the sidewalk in order to maintain pedestrian travel and meet ADA path of travel requirements. Exceptions are made and placement must consider security and line of sight at intersections and driveways.

Concrete bus pads can be used at bus stop locations to prevent and minimize pavement wear and maintain level grade at locations with heavy bus traffic.

These guidelines are nationally supported, and more information is available on the NACTO website: http://nacto.org/publication/urban-street-design-guide/street-design-elements/transit-streets/bus-stops/

**Table D-9: Pedestrian Accommodations at Interchanges**

| Description |
| --- |
| The Institute of Transportation Engineers (ITE) has drafted a new recommended practice: *Recommended Design Guidelines to Accommodate Pedestrians and Bicycles at Interchanges*. These guidelines provide best practices in accommodation of all modes through interchanges to enhance pedestrian and bicycle safety, connect pedestrian and bicycle facilities efficiently with surrounding land uses, and provide a consistent message. Napa County communities should follow guidance presented in this guide when designing or modifying interchanges. Guiding principles for pedestrians facilities include:<br><br>• Provide pedestrian facilities to safely and efficiently accommodate pedestrians.<br>• Design ramp geometries in ways that encourage slower vehicle speeds until past the pedestrian crosswalk (as illustrated in the design example below).<br>• Locate the crosswalk at the location with the best visibility and before the point where vehicles begin to accelerate (as illustrated in the design example below).<br>• Crosswalks should be designed to be as short as possible, but without deviating excessively from pedestrian desire lines. For long crosswalks, median pedestrian islands should be considered, as they can improve signal timing while making a long crossing less daunting for pedestrians.<br>• Crosswalk Policies developed by each jurisdiction can be used to select appropriate crossing treatments. Treatments range from standard tools such as traffic signal and median pedestrian islands to advanced devices such as the High-Intensity Activated Crosswalk beacon (HAWK or Hybrid) and the rectangular rapid flashing beacon (RRFB). |

**Design Example**

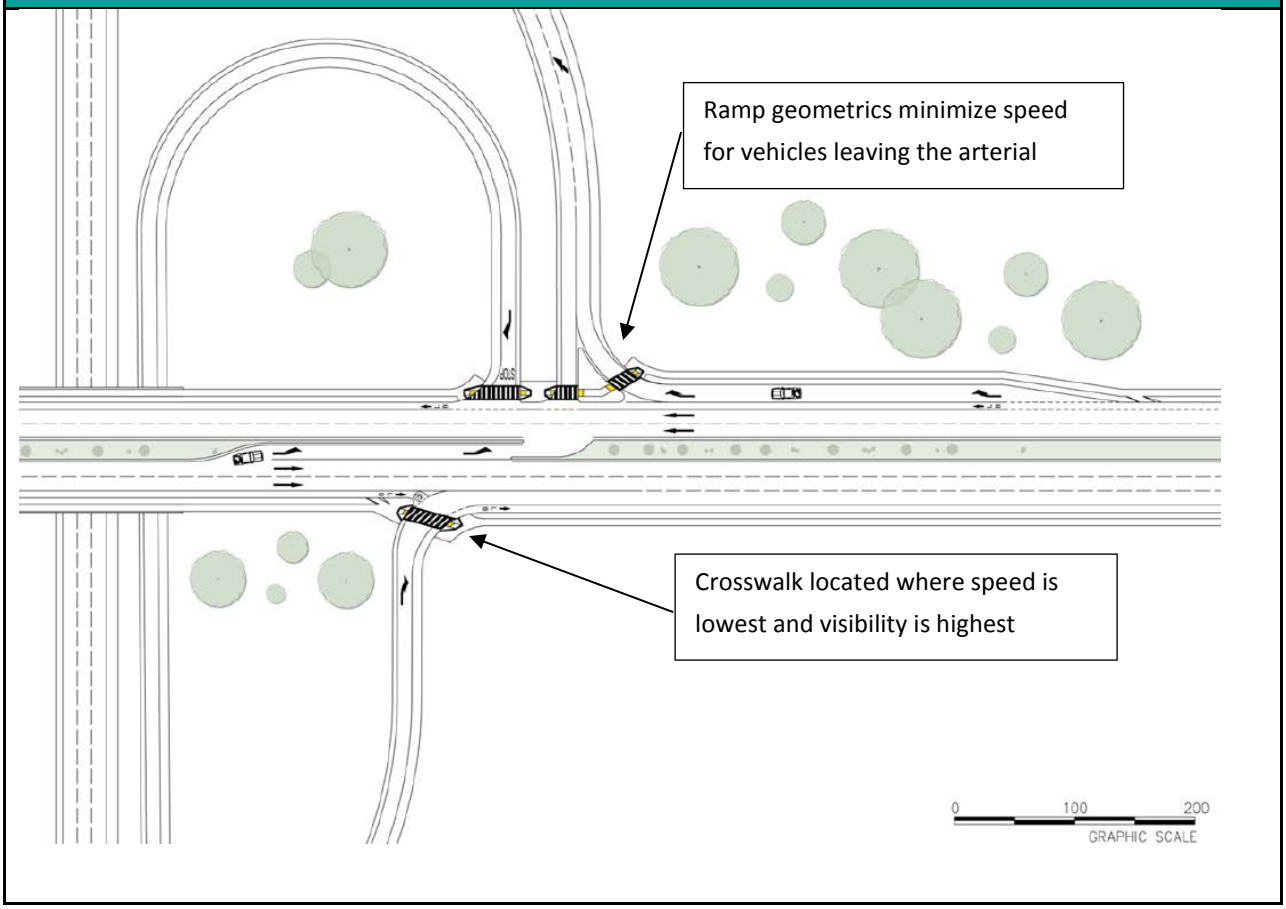
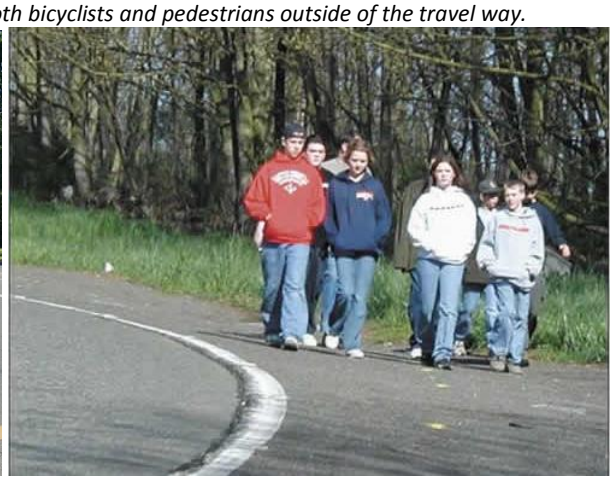



*Image Source: ITE Recommended Practice: Design Guidelines to Accommodate Pedestrians and Bicyclists at Interchanges.*

**Table D-10: Multi-Use Shoulders (Paved or Unpaved)**

| Description |
| --- |
| Where sidewalks are not feasible, a multi-use shoulder can improve the pedestrian experience, providing a space for bicyclists and pedestrians adjacent to the travel lane. Where feasible and especially when speeds or truck volumes are high, eight to ten-foot shoulders in each direction provides ample space for both bicyclists and pedestrians to get to their destinations and a higher level of pedestrian comfort. Guidance for minimum shoulder widths are provided in Table D-1. |
| **Design Example** |
| Wide shoulders<br>*Eight to ten foot paved shoulders can provide space for both bicyclists and pedestrians outside of the travel way.*<br>   |

Enhanced Walkways

*Enhanced multi-use shoulders are particularly appropriate where dedicated space is desired in rural contexts, such as in school-adjacent neighborhoods.*

*Existing - roadways with no sidewalks or designated walkways*

*Edgelines added*

*Edgelines and stamped, colorized asphalt added*

*Image Sources: FHWA (first), City of Walnut Creek Design Guidelines, Fehr & Peers (second)*

# Crosswalk Guidelines


## Introduction

These Crosswalk Guidelines are aimed at improving pedestrian safety and enhancing pedestrian mobility. A comprehensive pedestrian safety strategy contains a three-pronged approach of engineering, enforcement, and education programs. This document focuses on engineering elements, such as pedestrian crossing treatments and intersection design.

This document describes the function of crosswalks and their legal context in the California Vehicle Code. It discusses the advantages and disadvantages of marked crosswalks and summarizes research in the United States focused on pedestrian safety and marked crosswalks. It provides a summary of best practices related to numerous pedestrian treatments, including geometric, signage and striping, and signal hardware or operational measures.

The purpose of these Guidelines is to enable the City to respond to crosswalk requests in a manner that improves pedestrian accessibility and maintains public safety. It provides information to be used when making decisions about where standard crosswalks (two, parallel white stripes) can be marked; where crosswalks with special treatments, such as high-visibility crosswalks, flashing beacons and other special features, should be employed; and where crosswalks will not be marked due to volume, speed, or sight distance considerations.

# Crosswalk Fundamentals

Pedestrian crossing and right-of-way laws vary state to state, and are often a source of driver or pedestrian uncertainty and confusion for when crossing is legal. This section outlines the types of crosswalks, where crossing the street is legal in California, and guidance for identifying locations for marked crosswalks.

## Types of Crosswalks

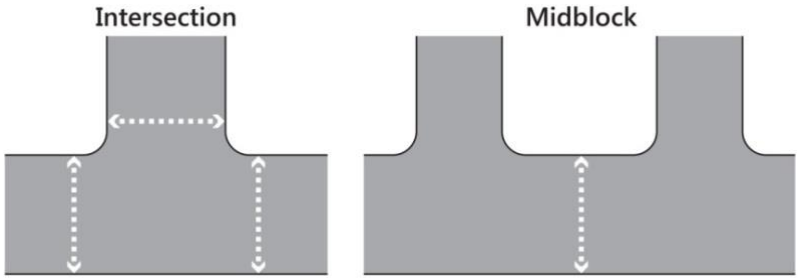
Crosswalks are primarily classified by three characteristics:

1. Whether they are marked (demarcated with striping on the street) or unmarked (no striping)
2. Whether they are controlled (by a traffic signal or stop-sign) or uncontrolled (with no intersection control)
3. Whether they are located at an intersection (where two streets meet) or mid-block (between intersections)

The following section outlines where crossing the street is legal in California. It also discusses key safety research regarding crosswalk markings and locational context..

## Where Is Crossing the Street Legal?

In California, a legal crosswalk exists where a sidewalk meets a street, regardless of whether the crosswalk is marked (i.e., with or without striping to denote the crosswalk). Pedestrians may legally cross any street except at unmarked locations between immediately adjacent signalized




crossings, or where crossing is expressly prohibited. Marked crosswalks reinforce the location and legitimacy of a pedestrian crossing and clarify pedestrian right-of-way at midblock locations.

These legal statues are contained in the California Vehicle Code (CVC) as follows:

- Section 275 defines a legal crosswalk as:
  - That portion of a roadway included within the prolongation or connection of the boundary lines of sidewalks at intersections where the intersecting roadways meet at approximately right angles, except the prolongation of such lines from an alley across a street.

- Any portion of a roadway distinctly indicated for pedestrian crossing by lines or other markings on the surface.

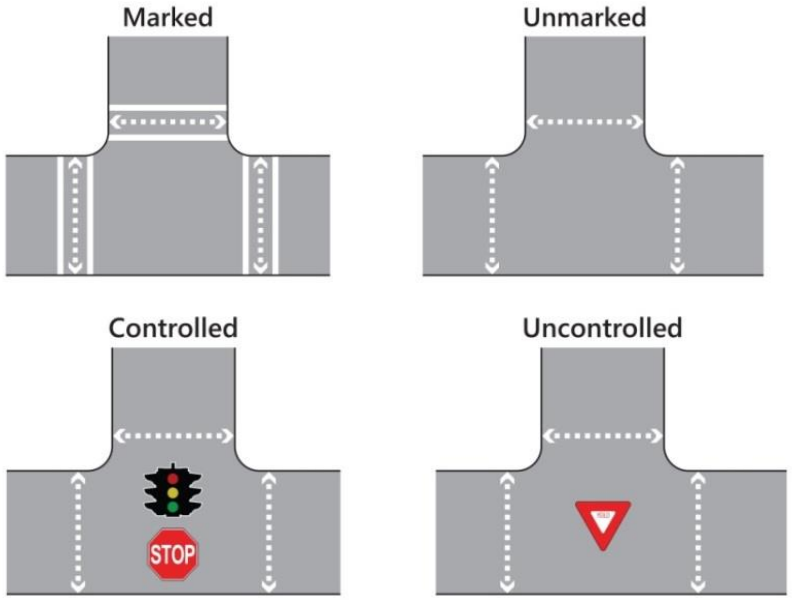
- Section 21950 describes right-of-way at a crosswalk:
  - The driver of a marked vehicle shall yield the right-of-way to a pedestrian crossing the roadway within any marked crosswalk or within any unmarked crosswalk at an intersection.
- Section 21955 describes where pedestrians may *not* cross a street:
  - Between adjacent intersections controlled by traffic control signal devices or by police officers, pedestrians shall not cross the roadway at any place except in a crosswalk.

## Why Mark Crosswalks?

Sidewalks and crosswalks are essential links within a pedestrian network. Whether commuting, running an errand, exercising, or wandering, pedestrians will need safe and convenient crossing opportunities to reach their destinations. A marked crosswalk has three (3) primary functions:

1) To create reasonable expectations where pedestrians may cross a roadway
2) To improve predictability of pedestrian actions and movement
3) To channel pedestrians to designated crossing locations (often selected for their optimal sight distance)

### *Advantages of Marked Crosswalks*




Marked crosswalks offer the following advantages:

- They help pedestrians find their way across complex intersections
- They can designate the shortest path
- They can direct pedestrians to locations of best sight distance
- They assure pedestrians of their legal right to cross a roadway at an intersection or mid-block crossing

This last bullet point is important. The *California Vehicle Code* gives the right-of-way to pedestrians at any marked or unmarked crosswalk (as noted above), although the law is not always obeyed by road users,

including both drivers and pedestrians. Drivers often fail to yield the right-of-way without the visual cue of a marked crosswalk. Pedestrians also do not always know the right-of-way law, and will either wait for a gap in traffic, or assert their right-of-way by stepping into the roadway.

## Steps to Identify Candidate Locations for Marked Crosswalks at Uncontrolled Locations

Identifying candidate locations for marked crosswalks involves two steps.

The first step is to locate the places people would like to cross the street. These locations are called *pedestrian desire lines*, which represent the most desirable, and typically most direct, places that people want to cross a street. Pedestrian desire lines are influenced by elements of the roadway network, such as transit stops, and nearby land uses (homes, hotels, schools, parks, trails, commercial centers, wineries, etc.). This information provides a basis for identifying pedestrian crossing improvement areas and prioritizing such improvements, thereby creating a convenient, connected, and continuous walking environment.

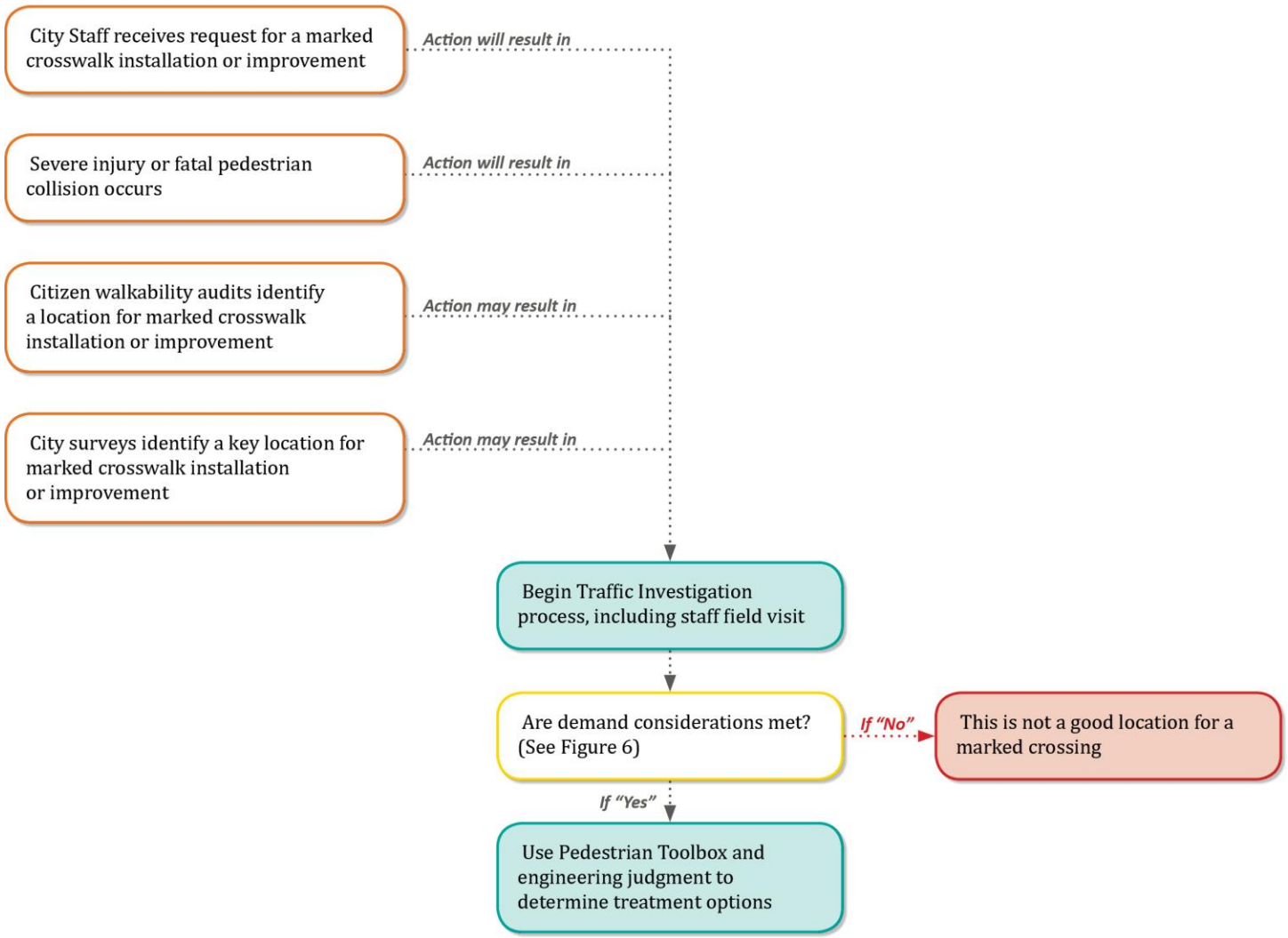
The second step is to identify where people can cross safely. The primary consideration in this step is adequate stopping sight distance.

Once candidate locations are identified, an engineering evaluation should be conducted to determine if a marked crosswalk should be installed at an uncontrolled or mid-block location, and if so, what visibility enhancements should be included in the design. Crossings should be marked where all of the following occur:

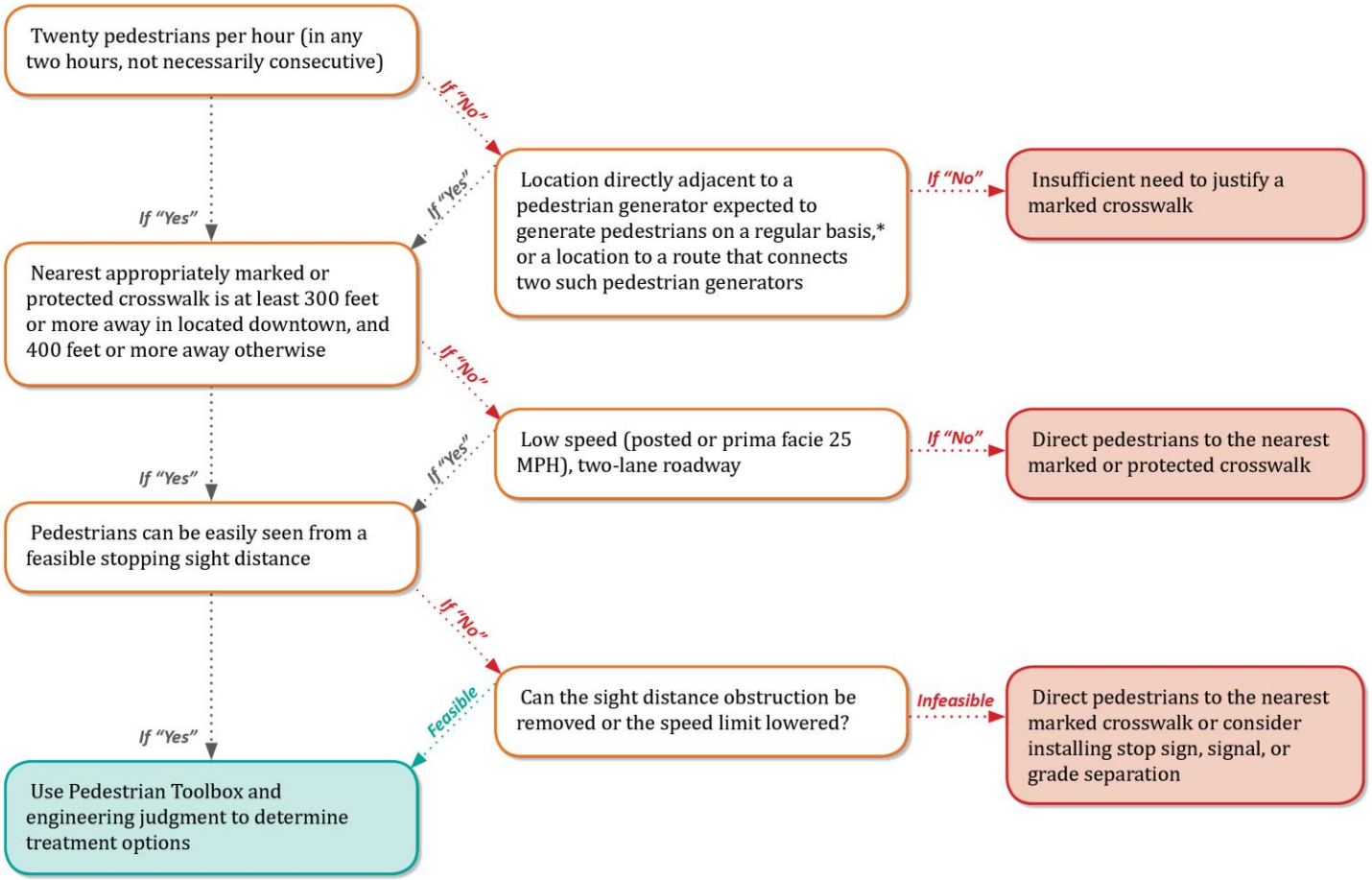
- Sufficient demand exists to justify the installation of a crosswalk
- Sufficient sight distance as measured by stopping sight distance calculations exists and/or sight distance will be improved prior to crosswalk marking
- Safety considerations do not preclude a crosswalk

**Figures A-1** and **A-2** describe the overall procedures from the moment City staff receives a request for a new marked crosswalk (or considers removing an existing marked crosswalk) to the installation of the treatment. As described, the first steps to determine the appropriate location and treatment for the crosswalk include a staff field visit.

Figure A-1: Uncontrolled Marked Crosswalk Placement



## Figure A-2: Feasibility Analysis for Treatments at Uncontrolled Locations




* ***Note:*** *Where a marked crosswalk is not necessary based on Figure A-2, other treatment options are available. These include traffic calming measures, such as speeds tables and speed humps; curb extensions and refuges to narrow the roadway, speed feedback signs, and similar treatments to help reducing crossing distances and slow speeds. These engineering treatments are described in the following pages. In addition to engineering treatments, education and enforcement programs should be considered.*

***Example pedestrian generators:*** *School, Hotel, restaurant, winery, park, bus stop, or hospital. For locations without pedestrian counts, consider whether location is directly adjacent to one of these generators a pedestrian generator such as a school, hotel, restaurant, winery, park, bus stop, or hospital and is expected to generate pedestrians on a regular basis, or is located on a route that connects two such pedestrian generators.*

# Uncontrolled Crossing Enhancement Toolbox

This section presents best practices for the installation of marked crosswalks at uncontrolled intersections and mid-block locations. Uncontrolled crossings require additional consideration during planning and design as drivers must recognize the pedestrian and yield accordingly. Thus, providing appropriate enhancements to improve the visibility and safety of pedestrians crossing the street at an uncontrolled location is critical.

## Crosswalk Safety Research

Several studies of pedestrian safety at uncontrolled crossings have been completed, from which conflicting research has at times emerged. Studies conducted in San Diego in the 1970s showed that pedestrian collision risk at marked, uncontrolled crosswalks was greater than at unmarked crossings. This led many cities to remove marked crosswalks, as they were suspected of providing a false sense of security that drivers would yield to pedestrians in the crosswalk. However, a more recent study[13] by the Federal Highway Administration (FHWA) comprehensively reviewed crossing safety at 1,000 marked and 1,000 matched unmarked crosswalks in 30 U.S. cities, controlling for site context factors. The study concluded that site factors related to pedestrian-involved collisions included pedestrian average daily traffic (ADT), vehicle ADT, number of lanes, median type, and the region of the U.S. At uncontrolled locations on two-lane roads and multi-lane roads with ADT below 12,000 vehicles, FHWA found that the presence of a marked crosswalk alone, compared with an unmarked crosswalk, made no statistically significant difference in the pedestrian crash rate. However, on multi-lane roads with an ADT of greater than 12,000 vehicles (without a raised median) and 15,000 vehicles (with a raised median) the presence of a marked crosswalk without other improvements was associated with a statistically significant higher rate of pedestrian collisions compared to sites with an unmarked crosswalk. These findings are summarized in Table X.

FHWA stressed that the results of the study should not encourage decision makers to simply remove (or fail to install) marked crosswalks. Rather, the

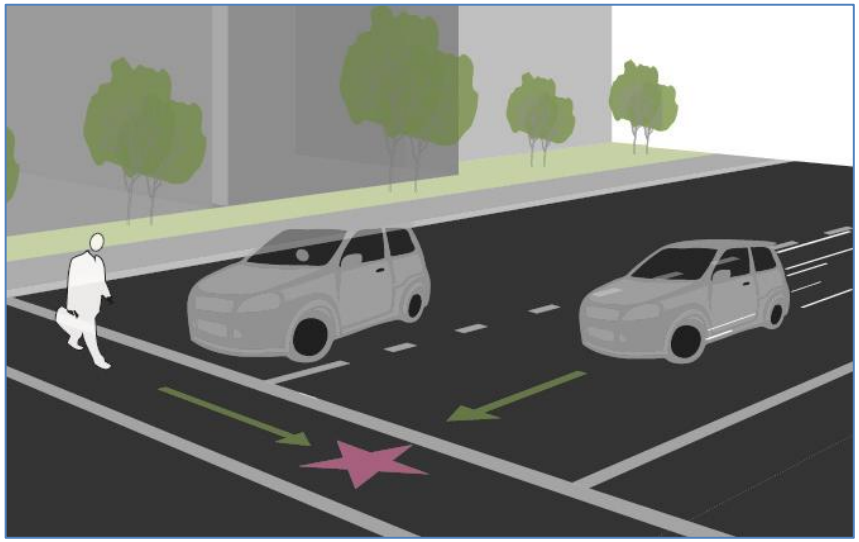
### Mid-Block Crossings

Crosswalks can be marked at intersections and mid-block points. Mid-block crossings play an important role for pedestrian access; without mid-block crossing locations, pedestrians may face the undesirable choice to detour to a controlled crossing location, detour to an intersection where crossing is legal even if not controlled, or cross illegally (if the midblock crossing is between two signalized intersections). Where signals are spaced far apart (generally more than 600-800 feet), pedestrians may have to detour several minutes to a controlled crossing location. Pedestrians are more likely to wait for a gap in traffic and cross at an unmarked location, rather than travel a distance out of their way to find a marked crosswalk. Mid-block crossings also offer an important safety consideration: fewer potential conflict points between pedestrians and motorists.

[13] Zeeger, C., J. Stewart, and H. Huang. *Safety Effects of Marked Versus Unmarked Crosswalks at Uncontrolled Locations*. Publication FHWA-RD-01-142, FHWA, U.S. Department of Transportation, 2001.

study suggested adding crosswalk enhancements to the marked crosswalks to balance mobility needs with safety needs. These improvements include providing raised medians on multi-lane roads, installing traffic and pedestrian signals where warranted, adding curb extensions, providing adequate lighting, and designing intersections with tighter turn radii.

In the FHWA study, about 70 percent of the pedestrian crashes occurred at marked crosswalks on multi-lane roads. Of the pedestrian crashes at marked crosswalks, 17.6 percent were classified as multiple-threat collisions. Multiple-threat collisions occur as one car slows down to allow pedestrians to cross, but a second car approaching from behind in the adjacent lane may not see the pedestrian, as illustrated in the image to the right. The slowing vehicle blocks the sight line of both the pedestrian and the second motorist, leading to the pedestrian-vehicle collision. Multi-lane roadways are therefore not well-served by unmarked or marked crosswalks alone. At these sites, the study concluded, engineers should consider countermeasures that provide additional safety to pedestrians and alert motorists to upcoming crosswalks. These countermeasures include advanced yield lines with corresponding signs informing motorists where to yield. Other more substantial measures may also be considered, such as signalization, warning beacons, illumination, or raised medians.



*Multiple threat conflicts on multi-lane roadways occur where a vehicle yielding to a pedestrian inhibits sight lines to another oncoming vehicle.*

Table 1. Recommendations for installing marked crosswalks and other needed pedestrian improvements at uncontrolled locations.*

| Roadway Type (Number of Travel Lanes and Median Type) | Vehicle ADT ≤ 9,000 | | | Vehicle ADT >9000 to 12,000 | | | Vehicle ADT >12,000 - 15,000 | | | Vehicle ADT > 15,000 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Speed Limit** | | | | | | | | | | | |
| | ≤ 30 mi/h | 35 mi/h | 40 mi/h | ≤ 30 mi/h | 35 mi/h | 40 mi/h | ≤ 30 mi/h | 35 mi/h | 40 mi/h | ≤ 30 mi/h | 35 mi/h | 40 mi/h |
| 2 Lanes | C | C | P | C | C | P | C | C | N | C | P | N |
| 3 Lanes | C | C | P | C | P | P | P | P | N | P | N | N |
| Multi-Lane (4 or More Lanes) With Raised Median*** | C | C | P | C | P | N | P | P | N | N | N | N |
| Multi-Lane (4 or More Lanes) Without Raised Median | C | P | N | P | P | N | N | N | N | N | N | N |

* These guidelines include intersection and midblock locations with no traffic signals or stop signs on the approach to the crossing. They do not apply to school crossings. A two-way center turn lane is not considered a median. Crosswalks should not be installed at locations that could present an increased safety risk to pedestrians, such as where there is poor sight distance, complex or confusing designs, a substantial volume of heavy trucks, or other dangers, without first providing adequate design features and/or traffic control devices. Adding crosswalks alone **will not** make crossings safer, nor will they necessarily result in more vehicles stopping for pedestrians. Whether or not marked crosswalks are installed, it is important to consider other pedestrian facility enhancements (e.g., raised median, traffic signal, roadway narrowing, enhanced overhead lighting, traffic-calming measures, curb extensions), as needed, to improve the safety of the crossing. **These are general recommendations; good engineering judgment should be used in individual cases for deciding where to install crosswalks.**

** Where the speed limit exceeds 40 mi/h (64.4 km/h) marked crosswalks alone should not be used at unsignalized locations.

**C =** **Candidate sites for marked crosswalks**. Marked crosswalks must be installed carefully and selectively. Before installing new marked crosswalks, an engineering study is needed to determine whether the location is suitable for a marked crosswalk. For an engineering study, a site review may be sufficient at some locations, while a more in-depth study of pedestrian volume, vehicle speed, sight distance, vehicle mix, etc. may be needed at other sites. It is recommended that a minimum of 20 pedestrian crossings per peak hour (or 15 or more elderly and/or child pedestrians) exist at a location before placing a high priority on the installation of a marked crosswalk alone.

**P =** **Possible increase in pedestrian crash risk may occur if crosswalks are added without other pedestrian facility enhancements.** These locations should be closely monitored and enhanced with other pedestrian crossing improvements, if necessary, before adding a marked crosswalk.

**N =** **Marked crosswalks alone are insufficient, since pedestrian crash risk may be increased due to providing marked crosswalks alone. Consider using other treatments, such as traffic-calming treatments, traffic signals with pedestrian signals where warranted, or other substantial crossing improvement to improve crossing safety for pedestrians.**

*** The raised median or crossing island must be at least 4 ft (1.2 m) wide and 6 ft (1.8 m) long to adequately serve as a refuge area for pedestrians in accordance with MUTCD and American Association of State Highway and Transportation Officials (AASHTO) guidelines.

With these studies as a backdrop, these Guidelines outline a decision making process to identify appropriate treatments for uncontrolled locations and presents a variety of treatment options to mitigate safety, visibility, or operational concerns at specific locations.

## Treatment Selection

At uncontrolled locations, a marked crosswalk with striping alone may not provide adequate visibility to the pedestrian crossing, especially at high volume, high speed, or multi-lane crossings. Enhancements should be considered for installation to supplement crosswalk striping. Appropriate treatments should be identified based on:

- Site characteristics: presence of pedestrian desire lines, available sight distance and visibility, lighting
- Geometric configuration of the roadway: number of vehicle travel lanes and presence of curb extensions or median refuge islands
- Travel data: 85$^{th}$ percentile speeds, posted speed limits, and average daily traffic (ADT) volumes.

Marked crosswalks alone should not be installed on multi-lane streets (two or more lanes per direction; three or more lanes total) under the following conditions[14]:

- Speeds of greater than 40 miles per hour
- Average daily traffic volumes (ADT) greater than 12,000 without a raised median or pedestrian refuge island
- Average daily traffic volumes (ADT) greater than 15,000 with a raised median or pedestrian refuge island

Locations with speeds and ADT volumes below these thresholds may also warrant enhancements. The Uncontrolled Treatment Toolbox outlines considerations for the use of enhancements in various contexts as summarized in **Table D-11**. This Toolbox may be used to identify potential treatments at a candidate uncontrolled crosswalk location based on the results of **Figures A-1** and **A-2**.

A calculation of Pedestrian Level of Service forms the basis for the treatment identification. Pedestrian Level of Service is the average delay experienced by pedestrians as they are waiting to cross the street. Expected motorist compliance is another other key variable for treatment identification. Compliance is based on field observations and engineering judgment. It is meant to reflect typical motorist responses to pedestrians attempting to cross the street. If drivers are likely to stop for a pedestrian, the compliance is rated "high." If drivers rarely stop for pedestrians, compliance is "low." The compliance rate should be assumed to be low for all locations where the speed limit is greater than 30 MPH. **Table 5** summarizes the appropriate treatments based on level of enhancement needed (with the most significant enhancement required with the worst LOS and compliance rates).

[14] California MUTCD, Section 3B. 18.

**TABLE D-11:**
**APPLICATION OF ENHANCED TREATMENTS FOR UNCONTROLLED LOCATIONS**

| Pedestrian Level of Service | Expected Motorist Compliance | | |
|---|---|---|---|
| | **Low (or Speed >30 mph)** | **Moderate** | **High** |
| LOS A-D (average delay up to 30 seconds) | ***LEVEL 3*** 2 lane road: In-pavement flashers, overhead flashing beacons Multi-lane road: RRFB *Plus LEVELS 1 and 2* | ***LEVEL 2*** Curb Extensions, Bus Bulb, Reduced Curb Radii, Staggered Pedestrian Refuge *Plus LEVEL 1* | ***LEVEL 1*** High Visibility Crosswalk Markings, Advanced Yield Lines, Advance Signage |
| LOS E-F (average delay greater than 30 seconds) | ***LEVEL 4*** Pedestrian Hybrid Beacon, RRFB, or Direct Pedestrians to Nearest Safe Crossing *Plus LEVELS 1 and 2* | ***LEVEL 3*** 2 lane road: In-pavement flashers, overhead flashing beacons Multi-lane road: RRFB *Plus LEVELS 1 and 2* | ***LEVEL 2*** Curb Extensions, Reduced Curb Radii, Staggered Pedestrian Refuge *Plus LEVEL 1* |

Notes: A pedestrian refuge island (median) is recommended for consideration in all scenarios with more than 2 lanes of traffic.

Level 1 represents a minor intervention, appropriate for situations with lower speeds and traffic volumes and high driver yielding rates. Higher levels represent more significant interventions. Treatments should be combined with higher level treatments added to lower level treatments (i.e., flashing beacons with curb extensions). Additional funding sources should be identified as needed for these enhancements. Failing to provide an enhanced crosswalk when needed and/or removing a marked crosswalk should be an option of last resort.

## Treatment Options

The following tables described preferred pedestrian safety treatments for uncontrolled locations with different roadway characteristics:

- **Table D-12: Geometric Treatments**
- **Table D-13: Striping and Signage**
- **Table D-14: Signal Hardware and Operational Measures**

Within each table, devices are categorized in three levels based on the level of safety concern they are meant to address: Level 1 (all cases), Level 2 (enhancements), and Level 3 (advanced enhancements). Categories of improvements are cumulative; for example, a Level 2 device should also include appropriate Level 1 devices.

**TABLE D-12:**
**UNCONTROLLED CROSSINGS: GEOMETRIC TREATMENTS**

| Treatment | Description | Level | Estimated Cost |
|---|---|---|---|
| **2-1. Fewer Travel Lanes ("Road Diet")**<br>  <br><br>*Image Source: Fehr & Peers* | Fewer travel lanes decrease roadway width and crosswalk length, reduce speeds, reduce left-turn and rear-end collisions, and often eliminate the multiple-threat collision. It takes an average pedestrian almost four seconds to cross each additional travel lane. Therefore, reducing the number of travel lanes minimizes the amount of time that pedestrians are in the crosswalk. More travel lanes than necessary can also increase vehicle travel speeds; research has shown that the severity of pedestrian collisions increases with vehicle travel speed. Where fewer travel lanes are not possible, travel lanes can be narrowed to as little as nine feet, especially left- and right-turn pockets. | **Level 1** | $20/LF<br>(Includes removal of existing pavement markings and repainting. Assumes existing curbs remain as is) |

| TABLE D-12:<br>UNCONTROLLED CROSSINGS: GEOMETRIC TREATMENTS | | | |
|---|---|---|---|
| **Treatment** | **Description** | **Level** | **Estimated Cost** |
| **2-2. Removal of Sight-Distance Obstructions**<br>  <br>*Image Source: Fehr & Peers* | If objects impede sight-distance, this may result in an unsafe condition where motorists and pedestrians are unable to see each other. Items such as parked cars, signage, landscaping, fencing, and street furniture should be placed in a location that will not obstruct sight distance. | **Level 1** | $150/EA<br><br>(Item removed is anticipated to be no larger than a sign and post) |

| TABLE D-12: UNCONTROLLED CROSSINGS: GEOMETRIC TREATMENTS | | | |
|---|---|---|---|
| **Treatment** | **Description** | **Level** | **Estimated Cost** |
| **2-3. Pedestrian Refuge Island**<br><br>  <br><br>*Image Source: Fehr & Peers* | Raised islands are placed in the center of the roadway separating opposing lanes of traffic with cutouts or ramps for accessibility along the pedestrian path. Median refuge islands are recommended where right-of-way allows and conditions warrant. Studies show medians are one of the most important safety enhancements available for crosswalks. They simplify complicated multi-lane crossings by breaking the crossings/conflicts into two stages. | **Level 1** | $130/LF<br><br>(New curb and new concrete barrier. Assumes 6 foot median) |

| TABLE D-12:<br>UNCONTROLLED CROSSINGS: GEOMETRIC TREATMENTS | | | |
|---|---|---|---|
| **Treatment** | **Description** | **Level** | **Estimated Cost** |
| **2-4. Curb Extensions**<br>  <br>*Image Source: Fehr & Peers* | Curb extensions extend the curb and sidewalks further into the roadway, shortening the length of the crosswalk. They act as a traffic calming device by narrowing the effective width of the roadway and slowing turning speeds. Because they extend into the roadway, often past parallel-parked vehicles, they improve visibility for pedestrians. The also provide space for street furniture, landscaping, bicycle parking, and signs and signal poles. Curb extensions can be constructed with reduced curb radii and to accommodate ADA improvements, such as directional curb ramps. | **Level 1** | $140/LF<br>(Curb, sidewalk, removal of existing curb, new bollards, does not include curb ramps) |

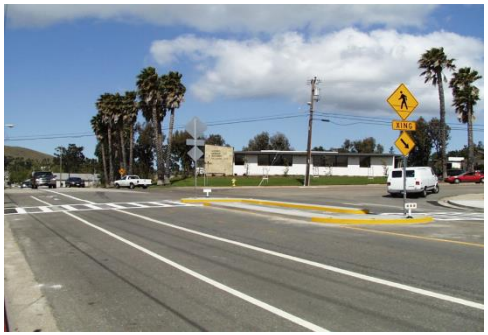
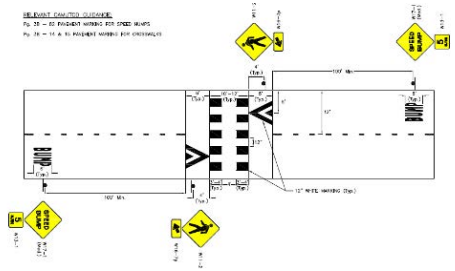
| TABLE D-12:<br>UNCONTROLLED CROSSINGS: GEOMETRIC TREATMENTS | | | |
|---|---|---|---|
| **Treatment** | **Description** | **Level** | **Estimated Cost** |
| **2-5. Split Pedestrian Crossover (SPXO)**<br>  <br>*Image Source: Fehr & Peers* | This measure is similar to traditional median refuge islands; the difference is that the crosswalks in the roadway are staggered such that a pedestrian crosses half of the street and then walks toward traffic to reach the second half of the crosswalk. This measure must be designed for accessibility by including rails and truncated domes to direct sight-impaired pedestrians along the path of travel. | **Level 1**<br><br>Note: see Table 11 for a Pedestrian Signal | $130/LF<br><br>(Same materials as 6-3) |
| **2-6. Raised Crosswalk**<br>  <br>*Image Source: Fehr & Peers* | Raised crosswalks are speed tables (flat-topped speed humps) outfitted with crosswalk markings and signage, providing pedestrians with a level street crossing. By raising the level of the crossing, vehicles drive more slowly through the crosswalk and pedestrians are more visible to approaching motorists. | **Level 2** | $18,000/EA |

**TABLE D-12:**
**UNCONTROLLED CROSSINGS: GEOMETRIC TREATMENTS**

| Treatment | Description | Level | Estimated Cost |
|---|---|---|---|
| **2-7. Pedestrian Overpass/Underpass**<br>  <br>*Image Source: Fehr & Peers* | This measure consists of a pedestrian or pedestrian/bicycle overpass or underpass of a roadway. It provides complete separation from motor vehicle traffic, normally where no other pedestrian facility is available, and connects off-road trails and paths across major barriers. Overpasses and underpasses should be used as a measure of last resort because of their cost and barriers to their effective/efficient use, with topographical and desire line considerations influencing their design. The cost of an undercrossing compared to an overcrossing can vary depending on multiple factors. On a busy roadway, an undercrossing will likely be more expensive than an overcrossing because of construction staging costs, and undercrossings can vary in cost depending on the presence of underground utilities and groundwater. The cost of either improvement will increase depending on desired aesthetics. | **Level 3** | $300/SF |

Source: Fehr & Peers, 2014.

| TABLE D-13:<br>UNCONTROLLED CROSSINGS: STRIPING AND SIGNAGE | | | |
|---|---|---|---|
| **Treatment** | **Description** | **Level** | **Estimated Cost** |
| **3-1. High Visibility Markings**<br>  <br>*Image Source: Fehr & Peers* | All uncontrolled marked crosswalks should feature high-visibility markings. Various striping patterns are available. At trail crossings, such as at the Vine Trail, a triple-four crossing with bicycle stencils in the middle to denote a shared crosswalk for bicyclist s and pedestrians should be considered. | **Level 1** | $6/Foot |

| TABLE D-13:<br>UNCONTROLLED CROSSINGS: STRIPING AND SIGNAGE | | | |
|---|---|---|---|
| **Treatment** | **Description** | **Level** | **Estimated Cost** |
| **3-2. Advanced Yield Line**<br>  <br>*Image Source: Fehr & Peers* | Advanced yield lines, often referred to as "sharks teeth", should be striped at all marked, uncontrolled crosswalks on multi-lane roadways. They should be placed 20-30 feet in front of the crosswalk. Their intention is to identify where vehicles should stop when yielding to a pedestrian to maintain adequate sight lines. These are typically use on multi-lane roadways but could be considered on two-lane roadways were driver encroachment and yielding are a concern. They should be used with the "Yield Here to Pedestrians" sign. | **Level 1** | $100/EA |

| TABLE D-13: UNCONTROLLED CROSSINGS: STRIPING AND SIGNAGE | | | |
|---|---|---|---|
| **Treatment** | **Description** | **Level** | **Estimated Cost** |
| **3-3. Advanced Warning Signs**<br>  <br>*Image Source: Fehr & Peers* | High-visibility yellow or fluorescent-yellow-green (FYG) signs are posted at crossings to increase the visibility of a pedestrian crossing. | **Level 1** | $1,000/EA |

| TABLE D-13:<br>UNCONTROLLED CROSSINGS: STRIPING AND SIGNAGE | | | |
|---|---|---|---|
| **Treatment** | **Description** | **Level** | **Estimated Cost** |
| **3-4. In-Street Pedestrian Crossing Sign**<br><br>  <br><br><br>*Image Source: FHWA* | This measure involves posting regulatory pedestrian signage on lane edge lines and/or road centerlines. The in-street pedestrian crossing sign may be used to remind road users of laws regarding right-of-way at an uncontrolled pedestrian crossing. They can be installed on medians and may also be temporary signs, placed by school crossing guards during school hours. | **Level 1** | $400/EA |

Source: Fehr & Peers, 2014.

| TABLE D-14: UNCONTROLLED CROSSINGS: BEACON, LIGHTING, AND SIGNAL TREATMENTS | | | |
|---|---|---|---|
| **Treatment** | **Description** | **Level** | **Estimated Cost** |
| **4-1. Pedestrian-Scale Lighting**<br>  <br>*Image source: www.ci.mil.wi.us* | Pedestrian-scale lighting improves visibility along a pedestrian's path and across driveways. It also improves visibility at pedestrian/vehicle conflict points in crosswalks. | **Level 1** | $10,000 per light assuming light every 100 feet |

| TABLE D-14:<br>UNCONTROLLED CROSSINGS: BEACON, LIGHTING, AND SIGNAL TREATMENTS | | | |
|---|---|---|---|
| **Treatment** | **Description** | **Level** | **Estimated Cost** |
| **4-2. Flashing Beacon**<br>  <br>*Image Source: Fehr & Peers* | Flashing amber lights are installed on overhead or post-mounted signs, in advance of the crosswalk or at the crosswalk's entrance. Full-time flashing beacons are not recommended; flashing beacons are most effective when they are activated by the crosswalk user (they should rest on dark). By resting on dark, they can also be solar powered. | **Level 2** | $20,000/EA |

**TABLE D-14:**
**UNCONTROLLED CROSSINGS: BEACON, LIGHTING, AND SIGNAL TREATMENTS**

| Treatment | Description | Level | Estimated Cost |
|---|---|---|---|
| **4-3. Rectangular Rapid Flashing Beacon (RRFB)**<br>  <br>*Image Source: Fehr & Peers* | The RRFB is an enhancement of the flashing beacon that replaced the traditional slow flashing incandescent lamps with rapid flashing LED lamps. The RRFB may be push-button activated or activated with passive detection. This treatment was approved for use in California via Interim Approval IA-11-83 in 2011. Any installations should be reported to Caltrans for documentation, but do not require pre-approval for experimentation. | **Level 2** | $20,000/EA |

| TABLE D-14:<br>UNCONTROLLED CROSSINGS: BEACON, LIGHTING, AND SIGNAL TREATMENTS | | | |
|---|---|---|---|
| **Treatment** | **Description** | **Level** | **Estimated Cost** |
| **4-4. Pedestrian Hybrid Beacon (PHB)**<br><br>  <br><br><br>*Image Source: FHWA* | The PHB is a pedestrian-activated beacon that is a combination of a beacon flasher and a traffic control signal. When actuated, the PHB displays a yellow (warning) indication followed by a solid red indication. During the pedestrian clearance interval, the driver sees a flashing red "wig-wag" pattern until the clearance interval has ended and the beacon goes dark. The device is included in the 2012 California MUTCD for use at midblock locations. | **Level 3** | $80,000/EA |

**TABLE D-14:**
**UNCONTROLLED CROSSINGS: BEACON, LIGHTING, AND SIGNAL TREATMENTS**

| Treatment | Description | Level | Estimated Cost |
|---|---|---|---|
| **4-5. Pedestrian Signal**<br>  <br>*Image Source: Fehr & Peers* | A pedestrian signal is a conventional traffic control device with warrants for use based on the MUTCD. The pedestrian warrants were revised with the 2009 Federal and 2012 California MUTCD. | **Level 4** | $250,000/EA |

Source: Fehr & Peers, 2013.

# Controlled Crosswalk Treatment Toolbox

Controlled crosswalks are located at stop-controlled or signalized intersections. Generally, these crossings do not need enhancements beyond standard crosswalk markings (two parallel lines), as the traffic signal or stop-sign controls allocation of right-of-way. However, in some cases, such as in the Downtown, at skewed intersections, or near schools, the City may consider providing enhanced crossings or signal adjustments to create a sense of place or improved aesthetics, or to improve visibility or safety. This chapter presents preferred and enhanced measures for pedestrian treatments at controlled locations to:

- Improve the visibility of pedestrians to motorists and vice-versa
- Communicate to motorists and pedestrians who has the right-of-way
- Accommodate vulnerable populations such as the disabled, children, and the elderly
- Reduce conflicts between pedestrians and vehicles
- Reduce vehicular speeds at locations with potential pedestrian conflicts

All treatments identified in this chapter are required or allowed by the standards and specifications in the *California Manual on Uniform Traffic Control Devices* (CA MUTCD).

## Universal Considerations

The following treatments are identified as the basic pedestrian crossing improvements to be provided at all stop-controlled and signalized intersections. New controlled intersections should be designed with these treatments included; existing controlled intersections that require retrofits may be prioritized and upgraded as funds become available. These treatments are based on recommended best practices in pedestrian safety:[15]

- Mark crosswalks on all legs of the intersection
- Provide advanced stop bars with each crosswalk
- Minimize the number of vehicle traffic lanes pedestrians must cross
- Provide median refuge islands and thumbnails, as width and path of turn maneuvers allow
- Remove sight-distance obstructions
- Provide directional curb ramps for each crosswalk (e.g., two per corner)
- Eliminate free right-turn slip lanes, where feasible, and mitigate for pedestrian safety (slowing speeds) where they remain
- Locate bus stops on the far-side of the intersection (or in front of mid-block crossings)
- Minimize cycle lengths

[15] See America Walks *Signalized Intersection Enhancements that Benefit Pedestrians* http://americawalks.org/wp-content/upload/America-Walks-Signalized-Intersection-Enhancement-Report-Updated-8.16.2012.pdf (2012).

- Reduce prevalence or eliminate permitted signal phasing where pedestrian crossings exist
- Provide pedestrian signal heads for all crossings at signalized intersections
- Provide adequate pedestrian clearance intervals (crossing time) at signalized intersections
- Consider benefits of a roundabout (stop controlled or signalized locations) or signalization (stop controlled locations) for all users

## Signalized Crossing Enhancements

To create a transparent and consistent decision making framework, four issue-specific flow charts follow a multi-step process to determine an enhanced treatment "match" for the signalized intersection characteristics.

**CHART A:**

Actuated Signals Pedestrian Option Flow Chart

Use this flow chart whenever traffic signal actuation is used at the study intersection.

**CHART B:**

Left-Turns on Two-Way Streets Pedestrian Options Flow Chart

Use this flow chart for new and retrofit signal installations, and where a conflict between pedestrians and left turning vehicles is observed/ apparent from collision data.

**CHART C:**

Right Turns on Two-Way Streets or Left Turns on One-Way Streets Pedestrian Options Flow Chart

Use this flow chart for new and retrofit signal installations, and where a conflict between pedestrians and right turning vehicles (or left turning on one-way streets) is observed/ apparent from collision data.

**CHART D:**

Pedestrian Scramble Flow Chart

Use this flow chart to supplement Chart B and Chart C as directed.

Intersection type and pedestrian conflict characteristics form the basis for completing Charts A, B, and C, and the applicable charts are then completed using existing and/or proposed intersection characteristics such as lane configurations, location along transit priority corridor, pedestrian and vehicle volumes, and signal phasing.

The first step of the left or right turn conflict flow charts is to determine if the pedestrian to vehicle conflict volume levels meet minimum pedestrian scramble considerations, which could lead to completion of the pedestrian scramble test (Chart D) or continuation on the original flow chart (Chart B or Chart C). If the scramble flow chart is completed and passed (*with operations analysis performed*), a pedestrian scramble phase is the recommended treatment. If the scramble flow chart is not completed, the inputs listed above will lead to identification of various pedestrian treatments as resolution to the specified conflicts.

Flow Chart A that is completed for all actuated signals recommends different signal timing pedestrian recall treatments based on the signal's location, such as a downtown location.

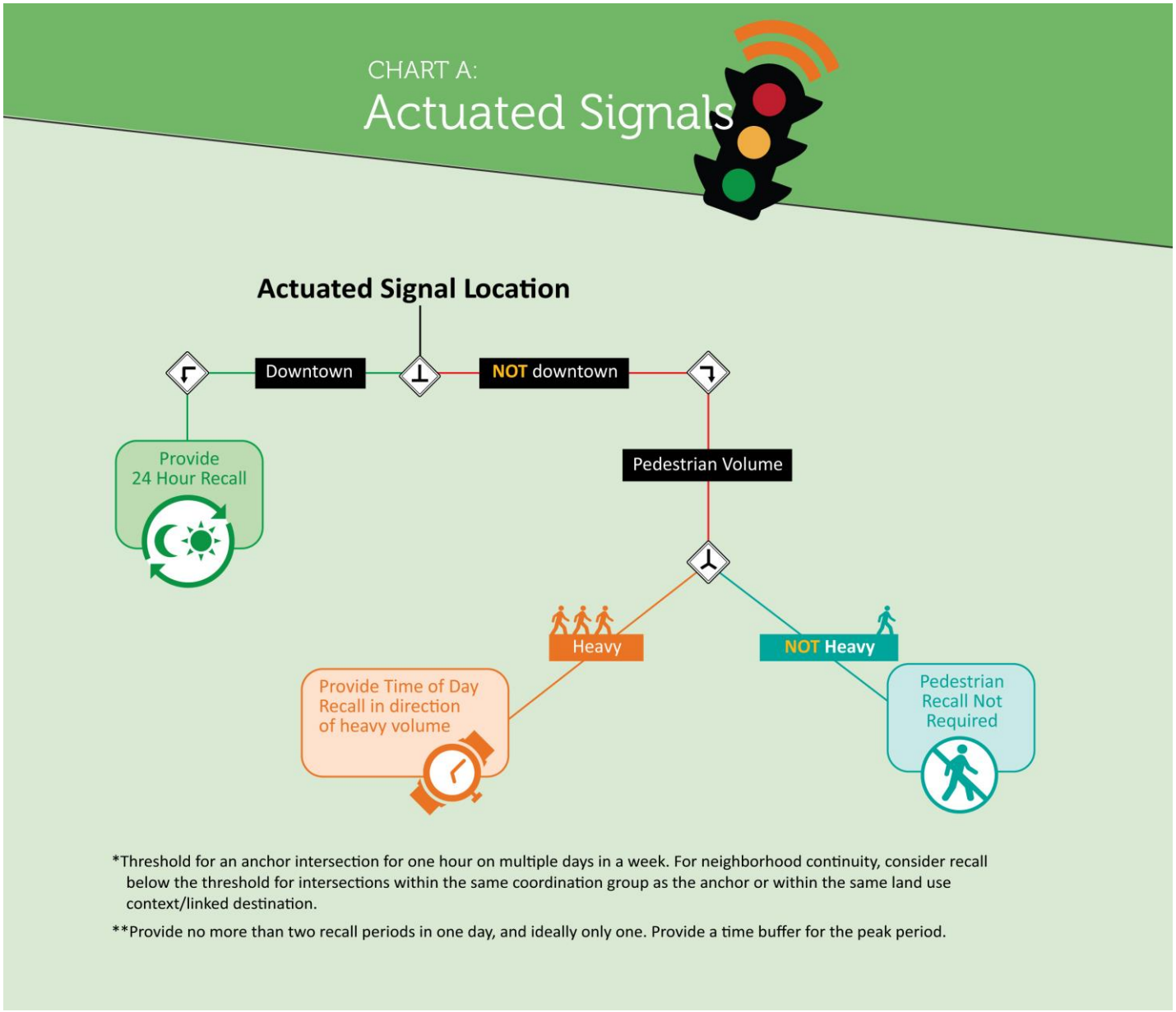


CHART A:
Actuated Signals
Actuated Signal Location
Downtown
NOT downtown
Provide
24 Hour Recall
Pedestrian Volume
Heavy
NOT Heavy
Provide Time of Day
Recall in direction
of heavy volume
Pedestrian
Recall Not
Required
*Threshold for an anchor intersection for one hour on multiple days in a week. For neighborhood continuity, consider recall below the threshold for intersections within the same coordination group as the anchor or within the same land use context/linked destination.
**Provide no more than two recall periods in one day, and ideally only one. Provide a time buffer for the peak period.

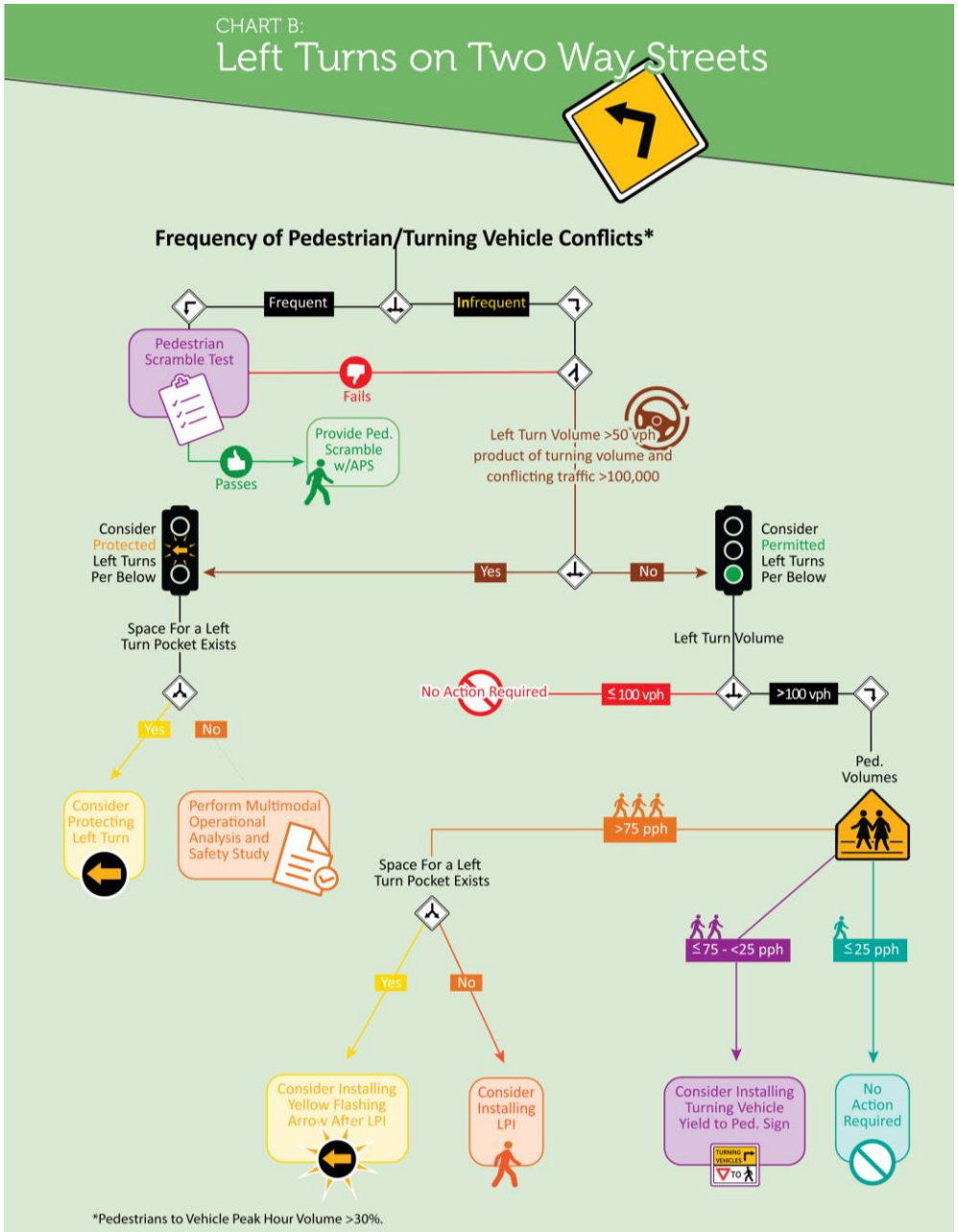


CHART B:
Left Turns on Two Way Streets
Frequency of Pedestrian/Turning Vehicle Conflicts*
Frequent
Infrequent
Pedestrian Scramble Test
Fails
Passes
Provide Ped. Scramble w/APS
Left Turn Volume >50 vph product of turning volume and conflicting traffic >100,000
Consider Protected Left Turns Per Below
Yes
No
Consider Permitted Left Turns Per Below
Space For a Left Turn Pocket Exists
Left Turn Volume
No Action Required
≤100 vph
>100 vph
Yes
No
Ped. Volumes
Consider Protecting Left Turn
Perform Multimodal Operational Analysis and Safety Study
>75 pph
Space For a Left Turn Pocket Exists
≤75 - <25 pph
≤25 pph
Yes
No
Consider Installing Yellow Flashing Arrow After LPI
Consider Installing LPI
Consider Installing Turning Vehicle Yield to Ped. Sign
No Action Required
*Pedestrians to Vehicle Peak Hour Volume >30%.

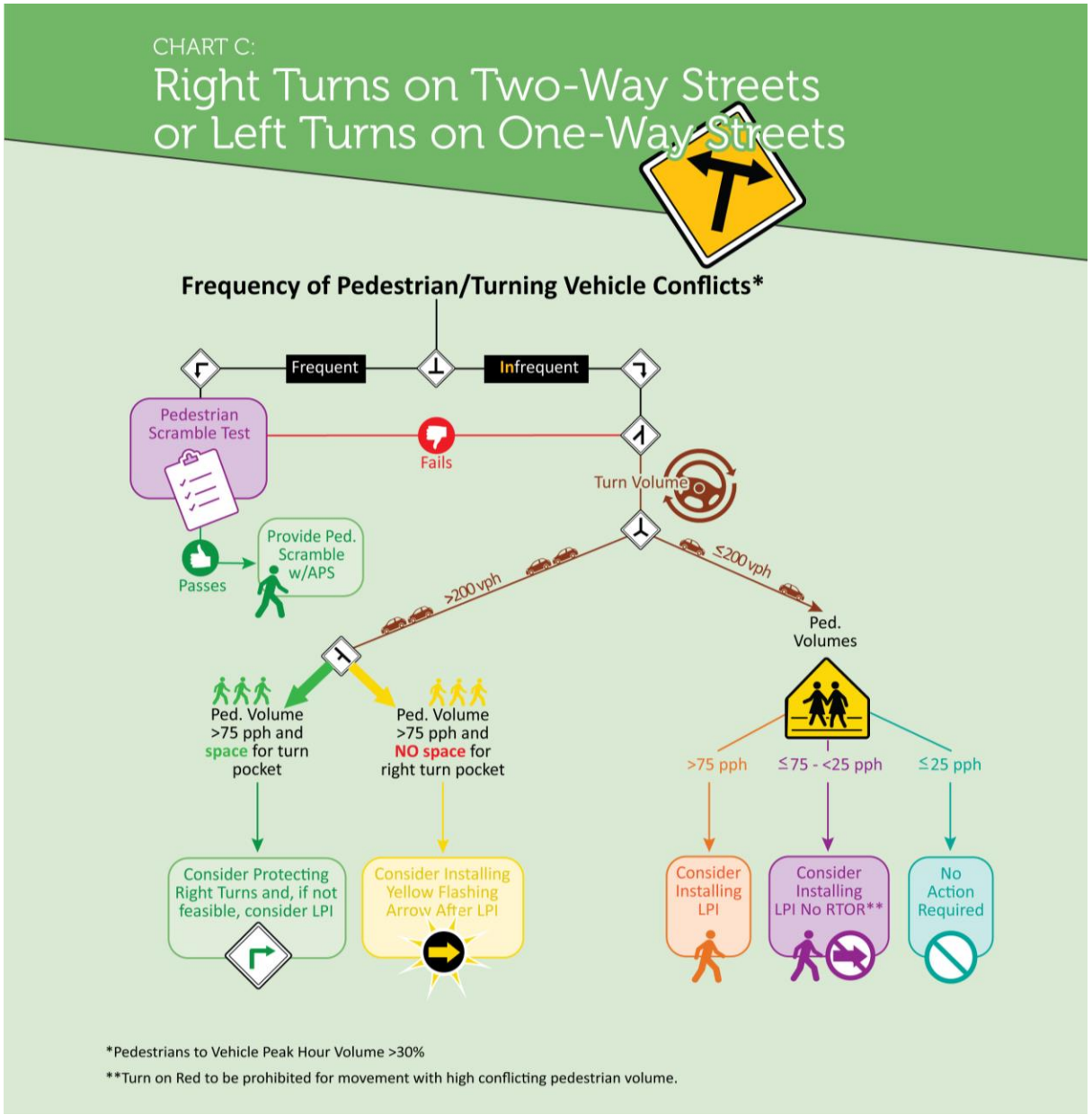


CHART C:
Right Turns on Two-Way Streets
or Left Turns on One-Way Streets
Frequency of Pedestrian/Turning Vehicle Conflicts*
Frequent
Infrequent
Pedestrian Scramble Test
Fails
Turn Volume
Passes
Provide Ped. Scramble w/APS
>200 vph
≤200 vph
Ped. Volumes
Ped. Volume >75 pph and space for turn pocket
Ped. Volume >75 pph and NO space for right turn pocket
>75 pph
≤75 - <25 pph
≤25 pph
Consider Protecting Right Turns and, if not feasible, consider LPI
Consider Installing Yellow Flashing Arrow After LPI
Consider Installing LPI
Consider Installing LPI No RTOR**
No Action Required
*Pedestrians to Vehicle Peak Hour Volume >30%
**Turn on Red to be prohibited for movement with high conflicting pedestrian volume.


CHART D:
Pedestrian Scramble
Should a Pedestrian Scramble Be Installed?
Does the intersection have a history of pedestrian/vehicle collisions and/or is an intersection of two one-way streets?
Yes
Is the intersection located along a major transit corridor?
No
Yes
No
Can the diagonal crossing distance be less than 100 feet?
No
Yes
Can the cycle length be less than 100 seconds?
No
Yes
Perform multimodal operations analysis to consider a pedestrian scramble for all pedestrian phases.
Do NOT
Install Scramble

## Flow Chart Footnotes

1. Time of Day Recall
   - One surveyed city does only 24 hour recall
   - Two surveyed cities run pedestrian recall only during the day or p eak hours when pedestrian volumes are higher.

2. Pedestrian Scramble with Accessible Pedestrian Signals (APS)
   - In three cities surveyed, used at intersections with complex geom etry or two one-way street intersections with high pedestrian volumes.

3. Turn volume for protected left
   - CA MUTCD section 4D.19

4. Left Turn Volume
   - AASHTO section 12.1.1

5. Pedestrian Volume
   - MUTCD section 4C.05 (pedestrian signalize intersection warrant) a nd 4F.01 (pedestrian hybrid beacon warrant)

6. Right Turn Volume
   - CA MUTCD section 4D.07

7. Flashing Arrow Leading Pedestrian Interval (LPI) with APS
   - Used by one city surveyed to provide a balance between the delay of a protected left and the safety benefits of a protected left. Re quires a turn pocket.

8. LPI with APS
   - Six cities surveyed have implemented LPIs at specific intersections , usually dependent on complaints/requests, collision history, and /or high vehicle turning and pedestrian volumes.

The following tables describe the preferred and optional enhanced pedestrian safety treatments that may be used for controlled locations:

- **Table A-5: Geometric Treatments**
- **Table A-6: Striping and Signage**
- **Table A-7: Signal Hardware and Operational Measures**

| TABLE D-15:<br>CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS | |
|---|---|
| **Treatment** | **Description** |
| **5-1. Fewer Travel Lanes ("Road Diet")**<br>  <br><br>*Image Source: Fehr & Peers* | Fewer travel lanes decrease roadway width and crosswalk length, reduce speeds, reduce left-turn and rear-end collisions, and often eliminate the multiple-threat collision. An average pedestrian takes almost four seconds to cross each additional travel lane. Therefore, reducing the number of travel lanes minimizes the amount of time that pedestrians are in the crosswalk. More travel lanes than necessary can also increase vehicle travel speeds; research has shown that the severity of pedestrian collisions increases with vehicle travel speed. Where fewer travel lanes are not possible, travel lanes can be narrowed to as little as nine feet, especially left- and right-turn pockets. |

| TABLE D-15:<br>CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS | |
|---|---|
| **Treatment** | **Description** |
| **5-2. Pedestrian Refuge Island with "Thumbnail"**<br><br>  <br><br>*Image Source: Fehr & Peers* | Median pedestrian islands provide a refuge for pedestrians to stand if they do not have sufficient time to cross a street. They can be enhanced with median pedestrian push buttons at signalized crossings. Median islands can be installed throughout a corridor or only at specific crosswalks. |

| TABLE D-15:<br>CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS | |
|---|---|
| **Treatment** | **Description** |
| **5-3. Removal of Sight-Distance Obstructions**<br><br>  <br><br>*Image Source: Fehr & Peers* | If objects impede sight-distance, an unsafe condition may arise where motorists and pedestrians are unable to see each other. Items such as parked cards, signage, landscaping, fencing, and street furniture should be placed in a location that will not obstruct sight-distance. |

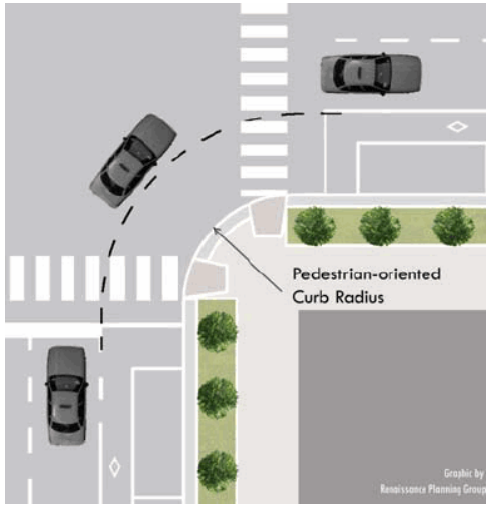
| TABLE D-15:<br>CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS | |
|---|---|
| **Treatment** | **Description** |
| **5-4. Directional Curb Ramps with Truncated Domes**<br><br>  <br><br>*Image Source: Fehr & Peers* | Curb ramps offer wheelchair access to/from the sidewalk and crosswalk. Truncated domes, or tactile strips, warn blind pedestrians that they are about to enter a crosswalk. The best practice for curb ramps is to install two per corner so that each ramp points directly into the crosswalk and to the curb ramp at the other side of the street. Corner bulbouts can be used to increase the amount of space available for directional curb ramps. |

**TABLE D-15:**
**CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS**

| Treatment | Description |
|---|---|
| **5-5. Right-Turn Lane Design**<br><br>  <br><br>*Image Source: Fehr & Peers* | Free right-turns allow vehicles to turn right at high speeds. Since the vehicles are not typically controlled by the traffic signal in this circumstance, crosswalks across the turn lanes are usually uncontrolled crosswalks. Controlled right-turn movements are preferable for pedestrians because they require a vehicle to stop on red before turning right. Where "pork-chop" islands that channelize right-turns are necessary to provide acceptable turning radii, raised crosswalks are a pedestrian enhancement. Other options include signalizing the crossing (especially if it is multi-lane) and designing the "pork-chop" for slower speeds and better visibility of pedestrians. |

| TABLE D-15:<br>CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS | |
|---|---|
| **Treatment** | **Description** |
| **5-6. Far-Side Bus Stops**<br><br>  <br><br>*Image Source: Fehr & Peers* | Far-side bus stops allow pedestrians to cross behind the bus, improving pedestrian visibility. Far side bus stops also enhance transit operations by providing a guaranteed merging opportunity for buses. Exceptions for far-side bus stops include considerations for bus routing, sufficient sidewalk area, and conflicts with parking, land uses, or driveways. |

| TABLE D-15:<br>CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS | |
|---|---|
| **Treatment** | **Description** |
| **5-7. Curb Extensions**<br><br>  <br><br>*Image Source: Fehr & Peers* | Curb extensions extend the curb and sidewalks farther into the roadway, shortening the length of the crosswalk. They act as a traffic calming device by narrowing the effective width of the roadway and slowing turning speeds. Because they extend into the roadway, often past parallel-parked vehicles, they improve visibility for pedestrians. The also provide space for street furniture, landscaping, bicycle parking, and signs and signal poles. Curb extensions can be constructed to accommodate ADA improvements, such as directional curb ramps. |

| TABLE D-15:<br>CONTROLLED INTERSECTIONS: GEOMETRIC TREATMENTS | |
|---|---|
| **Treatment** | **Description** |
| **5-8. Reduced Turn Radius**<br><br>  <br><br><br>*Image Source: AARP* | Vehicles travel faster through turns with a large radius. Reducing the radius of a corner is an effective way of reducing vehicle speeds. In suburban environments, turn radii generally do not need to exceed 30 feet. In urban environments turn radii can be 10 feet or less, especially where the meeting of one-way streets prohibits turning movements. Where on-street parking is permitted and/or bicycle lanes are present on one or both streets, consideration for further reductions of radii should occur acknowledging that the effective radius is increased with on-street parking. Corner curb radii on multi-lane streets should acknowledge that trucks turning right can turn into two lanes. |

| TABLE D-16:<br>CONTROLLED INTERSECTIONS: STRIPING AND SIGNAGE | |
|---|---|
| **Treatment** | **Description** |
| **6-1. Marked Crosswalks**<br><br>  <br><br>*Image Source: Google Maps* | Marking a crosswalk across all approaches of an intersection improves pedestrian accessibility. At a four-way intersection, a closed crosswalk forces pedestrians to cross via three crosswalks instead of one. Crosswalks on all approaches can often be accommodated without a significant impact to traffic signal operations.<br><br>At controlled trail crossings, high-visibility triple-four trail crossings with bicycle legends in the middle should be considered to indicate a shared crossing space for bicyclists and pedestrians. |

| TABLE D-16:<br>CONTROLLED INTERSECTIONS: STRIPING AND SIGNAGE | |
|---|---|
| **Treatment** | **Description** |
| **6-2. Advanced Stop Bar**<br><br>  <br><br>*Image Source: Fehr & Peers* | Advanced stop bars are placed five to seven feet in front of crosswalks. They keep vehicles from encroaching into the crosswalk when stopped at a red signal or stop sign. |

| TABLE D-16:<br>CONTROLLED INTERSECTIONS: STRIPING AND SIGNAGE | |
|---|---|
| **Treatment** | **Description** |
| **6-3. High Visibility Markings**<br><br>  <br><br>*Image Source: Fehr & Peers* | High-visibility crosswalks at controlled locations are appropriate in areas with high pedestrian volumes, at crosswalks with skewed geometries, or near sensitive land uses (such as schools). |

| TABLE D-16:<br>CONTROLLED INTERSECTIONS: STRIPING AND SIGNAGE | |
|---|---|
| **Treatment** | **Description** |
| **6-4. Textured Pavement or Colored Crosswalks**<br><br>  <br><br>*Image Source: Fehr & Peers* | Textured pavement can be used in crosswalks or in intersections as an aesthetic enhancement. Because of its texture, it may also calm traffic by slowing vehicles before they cross an intersection. It can also make crosswalks more visible. Textured pavement can be made of brick or, alternatively, both concrete and asphalt can be stamped to look like brick or stone. At controlled locations, standard crosswalk striping should be provided in addition to the textured pavement. A smooth, non-slip surface is preferable. |

| TABLE D-17:<br>CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES | |
|---|---|
| **Treatment** | **Description** |
| **7-1. Adequate Crossing Times**<br>  <br>*Image Source: Fehr & Peers* | The 2012 California MUTCD requires a walking speed of 3.5 feet per second be assumed to determine crossing times as a default minimum (4.0 feet per second was previously the guidance). A speed slower than 3.5 feet per second can be used where slower pedestrians routinely use the crosswalk, such as locations near schools, hospitals, or senior centers. |

**TABLE D-17:**
**CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES**

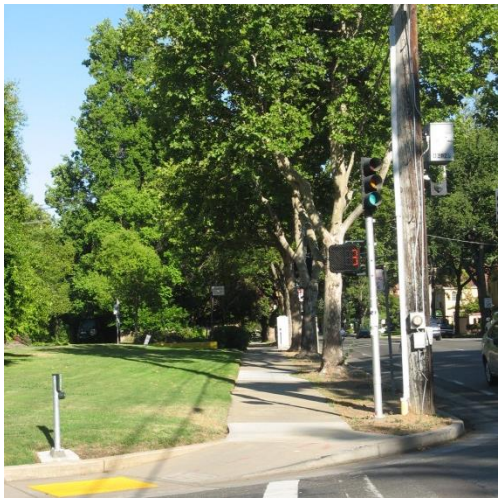
| Treatment | Description |
|---|---|
| **7-2. Pedestrian Countdown Signal**<br>  <br>*Image Source: Fehr & Peers* | Pedestrian countdown signals give pedestrians "Walk" and "Don't Walk" signals with a second-by-second countdown for each phase. Research suggests that pedestrians are more likely to obey the "Don't Walk" signal when delivered using a countdown signal. The device has been shown to enhance safety for all road users. The 2012 California MUTCD requires that all new pedestrian signals be countdown signals. |

**TABLE D-17:**
**CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES**

| Treatment | Description |
|---|---|
| **7-3. Pedestrian Signals and Push Buttons**<br>  <br><br>*Image Source: Fehr & Peers* | Mounting push buttons for different crosswalks on one pole can be confusing for blind pedestrians. Push buttons should be separated by ten feet and placed within five feet of each curb ramp, one per crosswalk. At long crosswalks (≥60 feet) with a median refuge island, push buttons can be placed in the median for pedestrians who may not be able to cross the entire crosswalk in one cycle length. In areas with high pedestrian volumes, eliminating pedestrian push buttons and providing a pedestrian phase in every cycle, can enhance walkability (and signal compliance). |

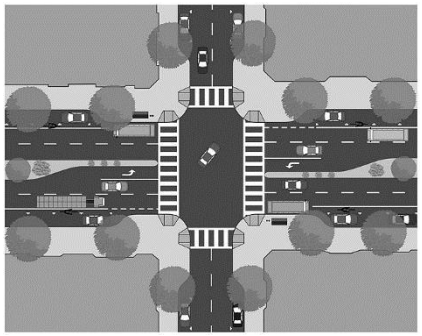
| TABLE D-17:<br>CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES | |
|---|---|
| **Treatment** | **Description** |
| **7-4. Short Cycle Lengths**<br>  <br>*Image Source: Institute of Transportation Engineers* | Long cycle lengths at signalized intersections result in long pedestrian wait times to cross a street. By shortening an intersection's cycle length, pedestrians do not have to wait as long to cross after pushing the button to request a "Walk" signal. |

**TABLE D-17:**
**CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES**

| Treatment | Description |
|---|---|
| **7-5. Protected Left-Turns**<br>  <br>*Image Source: Fehr & Peers* | Where permitted left-turns are allowed, denoted by a "Left Turn Yield on Green" sign, left-turning vehicles can conflict with pedestrians in the crosswalk. By making the left-turn protected, so that it is allowed only with a green arrow, the "Walk" signal at a crosswalk occurs at the same time that through- and right-turning vehicles in the same direction receive a green light. This reduces the risk of left-turning vehicle conflicts with the opposing crosswalk; since left-turns typically occur at a higher speed than right-turns, collisions of increased severity can be avoided by protecting left-turns. |

| TABLE D-17:<br>CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES | |
|---|---|
| **Treatment** | **Description** |
| **7-6. Accessible Pedestrian Signals**<br>  <br>*Image Source: Fehr & Peers* | Accessible pedestrian signals (APS) and detectors provide information, such as "Walk" indications and direction of crossing, in non-visual formats to improve accessibility for blind pedestrians. Audible options for accessible pedestrian signals include audible tones and speech messages. Vibrotactile push-buttons are effective options that alleviate the impacts of noise created by audible pedestrian signals. They are also accessible to deaf pedestrians. APS should always be provided when two push buttons are located on one pole and where persons with disabilities are expected frequently at a crossing. At other locations, APS is currently a best practice, but is expected to become a requirement when the proposed rulemaking of the *Public Rights of Way Accessibility Guidelines* (PROWAG) is finalized. |

| TABLE D-17:<br>CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES | |
|---|---|
| **Treatment** | **Description** |
| **7-7. Pedestrian Recall**<br>  <br>*Image Source: Fehr & Peers* | Pedestrian recall gives pedestrians a "Walk" signal at every cycle. No push-button or detection is necessary since a "Walk" signal will always be given. Pedestrian recalls are useful in areas with high levels of pedestrian activity. They demonstrate that an intersection is meant to serve both vehicles and pedestrians. In general, pedestrian recall should be used if pedestrians actuate a "Walk" signal 75 percent of the time during three or more hours per day. Recall can be used 24-hours a day or during peak hours for pedestrians (in which case push buttons should continue to be provided). |
| **7-8. No Right Turn on Red**<br>  <br>*Image Source: FHWA* | When attempting to turn right on red, motorists must look left to see if the road is clear; motorists often do not look right before turning and may not see pedestrians to their right. Restricting right turns on red can reduce conflicts between vehicles and pedestrians. "Blank out" turn restriction signs (see 11-9 below) are more effective than conventional "No Right Turn on Red" signs. "No Right Turn on Red" signs that specify time-of-day restrictions or "When Pedestrians are Present" are confusing to motorists and are often disregarded. |

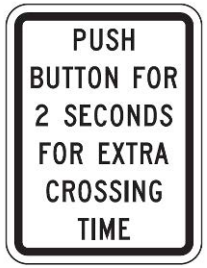
| TABLE D-17:<br>CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES | |
|---|---|
| **Treatment** | **Description** |
| **7-9. Blank-Out Turn Restriction LED Sign**<br>  <br><br>*Image Source: Fehr & Peers* | The ubiquity of conventional turn restriction signs, usually for no right turn on red, contributes to their disregard by motorists. Blank out turn restriction signs activate only when the specified movement is prohibited. The LED sign is also very visible. |

**TABLE D-17:**
**CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES**

| Treatment | Description |
|---|---|
| **7-10. Animated Eyes**<br>  <br>*Image Source: Fehr & Peers* | Animated eyes pedestrian signals feature eyes that move from side to side when a "Walk" signal is given. The signals remind pedestrians to look for turning vehicles before proceeding into the crosswalk. Research has indicated that animated eyes pedestrian signals reduce conflicts between vehicles and pedestrians. |

| TABLE D-17:<br>CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES | |
|---|---|
| **Treatment** | **Description** |
| **7-11. Leading Pedestrian Interval (LPI)**<br>  <br>*Image Source: Fehr & Peers* | A leading pedestrian interval (LPI) advances the "Walk" signal for a few seconds while through-vehicles continue to receive a red indication. By allowing pedestrians to get a head start into the crosswalk, it can reduce conflicts between pedestrians and turning vehicles. The 2012 California MUTCD recommends that LPIs be at least three seconds in duration. Right-turn on red restrictions may be needed with LPIs are installed in locations with lower pedestrian volumes. |

**TABLE D-17:**
**CONTROLLED INTERSECTIONS: SIGNAL HARDWARE AND OPERATIONAL MEASURES**

| Treatment | Description |
|---|---|
| **7-12. Push Button for Extended Crossing Time**<br>  <br><br>*Image Source: FHWA* | Some pedestrians may need extra time to safely cross a street. Traffic signals can be retrofitted to provide pedestrians with increased crossing time by extending the duration of a pushbutton press. |

Source: Fehr & Peers, 2014.