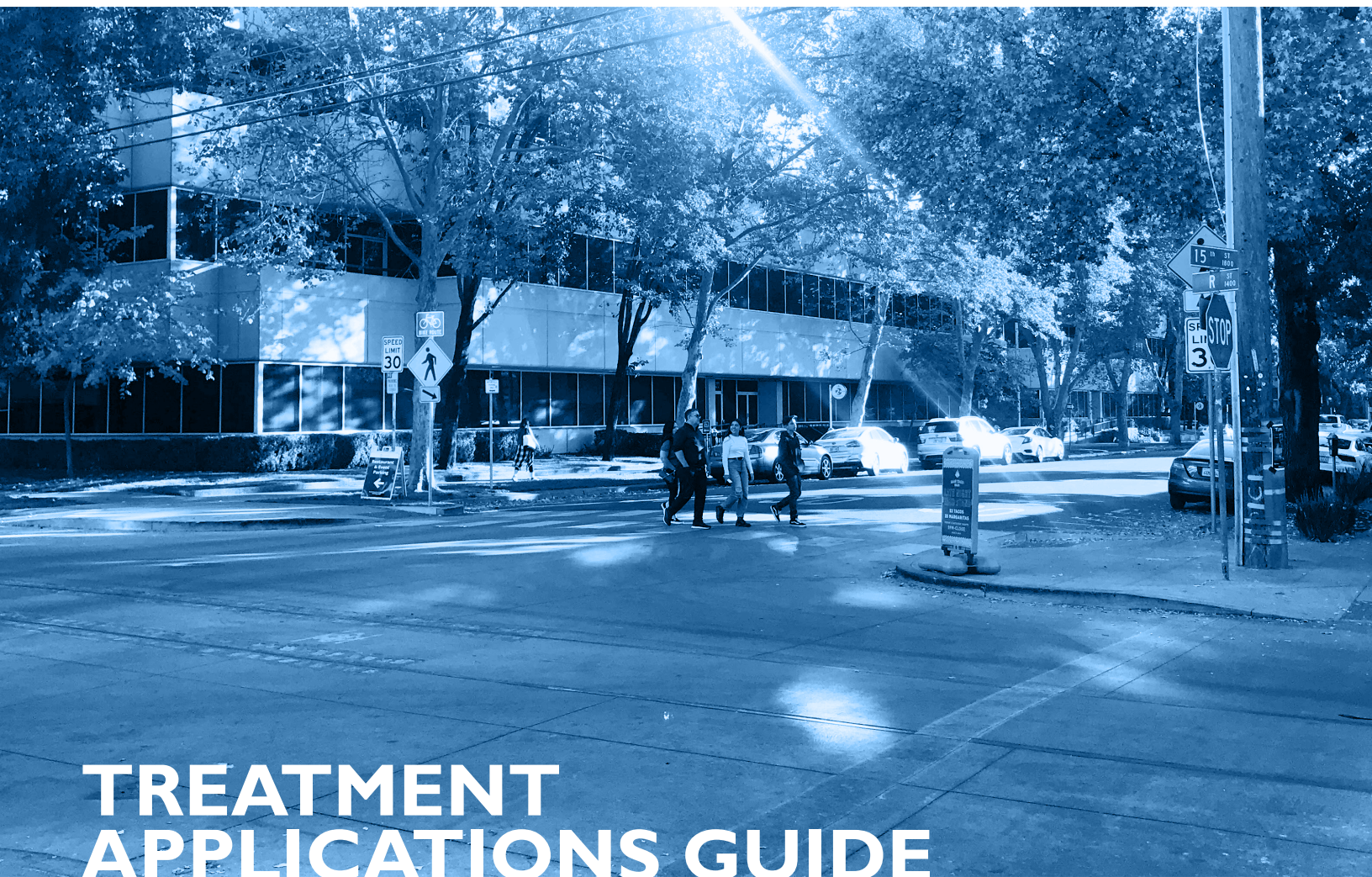


2021

PEDESTRIAN CROSSING GUIDELINES



TREATMENT APPLICATIONS GUIDE



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I.0 INTRODUCTION

The *2021 Pedestrian Crossing Guidelines Treatment Applications Guide* provides additional design and implementation guidance to help City staff select pedestrian crossing treatments for new marked crosswalks or to enhance existing marked crosswalks in combination with the guidance provided in the City of Sacramento *2021 Pedestrian Crossing Guidelines*. The initial consideration of countermeasures should be done using the 2021 Pedestrian Crossing Guidelines' Application of Pedestrian Crossing Treatments by Location Type table, presented in Table 1 on Page 2. This table represents a summary of the 2021 research and best practices related to pedestrian crossing treatments and has been adapted from the Federal Highway Administration (FHWA) *Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations* (2018). The recommendations from the FHWA guide have been adapted to fit the unique characteristics of pedestrian crossings in the City of Sacramento.

In the following section (Section 2.0 Primary Treatments), treatment-specific application guidance for the primary treatments identified in the *2021 Pedestrian Crossing Guidelines* is provided. This guidance is adapted from the Federal Highway Administration (FHWA) *Field Guide for Selecting Countermeasures at Uncontrolled Pedestrian Crossing Locations* (FHWA Field Guide) (2018). This guidance has been supplemented with additional guidance and information from City of Sacramento practices, national best practices and research, and the California *Manual on Uniform Traffic Control Devices* (CA MUTCD) MUTCD and Caltrans *Highway Design Manual* (HDM), as appropriate. National best practices were obtained from the following sources:

- National Association of City Transportation Officials (NACTO) *Urban Street Design Guide* (2013)
- FHWA *Field Guide for Selecting Countermeasures at Uncontrolled Pedestrian Crossing Locations* (2018)
- National Cooperative Highway Research Program (NCHRP) *Report 562: Improving Pedestrian Safety at Unsignalized Crossings* (2006)
- NCHRP *Research Report 893: Systemic Pedestrian Safety Analysis* (2018)
- NCHRP *Research Report 841: Development of Crash Modification Factors for Uncontrolled Pedestrian Crossing Treatments* (2017)
- NCHRP *Synthesis 498: Application of Pedestrian Crossing Treatments for Streets and Highways* (2016)

- Peer Agency Guidance review, including:
 - City of Oakland, CA
 - City of San Diego, CA
 - San Francisco, CA
 - Portland, OR
 - North Carolina Department of Transportation

In addition to the detailed guidance on the primary treatments, Section 3.0 Supplemental Treatments provides guidance and information for supplemental treatments that may be considered at a crossing location on a case-by-case basis based on site conditions and context. Finally, Section 4.0 Signalized Intersection Treatments, provides guidance for signalized intersection treatments that may be considered at signalized pedestrian crossing locations on a case-by-case basis.



TABLE I Application of Pedestrian Crossing Treatments by Location Type

| Roadway Configuration | Posted Speed Limit and ADT | | | | | | | | | | | | | | | | | | | | | | | |
|--------------------------------|----------------------------|---|--------|---|--------|---|--------------------------|---|--------|---|--------|---|---------------------|---|--------|---|--------|---|---|---|---|---|---|---|
| | Vehicle ADT <9,000 | | | | | | Vehicle ADT 9,000-15,000 | | | | | | Vehicle ADT >15,000 | | | | | | | | | | | |
| | <30 mph | | 35 mph | | ≥40mph | | <30 mph | | 35 mph | | ≥40mph | | <30 mph | | 35 mph | | ≥40mph | | | | | | | |
| 2 lanes | 1 | 2 | | 1 | 3 | 1 | | 3 | 1 | | | 1 | 3 | 1 | | 3 | 1 | | | 1 | 3 | 1 | | 3 |
| | 4 | 5 | 6 | | 5 | 6 | | 5 | 6 | 4 | 5 | 6 | | 5 | 6 | | 5 | 6 | 4 | 5 | 6 | | 5 | 6 |
| | | | | 7 | 9 | 7 | | 9 | | | 7 | 9 | 7 | | 9 | | 9 | 7 | | 9 | 7 | | 9 | 9 |
| 2 lanes one-way | 1 | | 3 | 1 | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 3 |
| | | 5 | | | 5 | | | 5 | | | 5 | | | 5 | | | 5 | | | 5 | | | 5 | |
| | 7 | | 9 | 7 | 9 | 7 | | 9 | 7 | | 9 | 7 | | 9 | 7 | | 9 | 7 | | 9 | 7 | | 9 | 9 |
| 3 lanes with raised median | 1 | 2 | 3 | 1 | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 3 |
| | 4 | 5 | | | 5 | | | 5 | | 4 | 5 | | | 5 | | | 5 | | 4 | 5 | | | 5 | |
| | | | | 7 | 9 | 7 | | 9 | 7 | | 9 | 7 | | 9 | 7 | | 9 | 7 | | 9 | 7 | | 9 | 9 |
| 3 lanes without raised median | 1 | 2 | 3 | 1 | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 3 |
| | 4 | 5 | 6 | | 5 | 6 | | 5 | 6 | 4 | 5 | 6 | | 5 | 6 | | 5 | 6 | 4 | 5 | 6 | | 5 | 6 |
| | | | 9 | 7 | 9 | 7 | | 9 | 7 | | 9 | 7 | | 9 | 7 | | 9 | 7 | | 9 | 7 | | 9 | 9 |
| 3 lanes one-way | 1 | | 3 | 1 | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 3 |
| | | 5 | | | 5 | | | 5 | | | 5 | | | 5 | | | 5 | | | 5 | | | 5 | |
| | 7 | 8 | 9 | 7 | 8 | 9 | 7 | 8 | 9 | 7 | 8 | 9 | 7 | 8 | 9 | 7 | 8 | 9 | 7 | 8 | 9 | 7 | 8 | 9 |
| 4+ lanes with raised median | 1 | | 3 | 1 | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 3 |
| | | 5 | | | 5 | | | 5 | | | 5 | | | 5 | | | 5 | | | 5 | | | 5 | |
| | 7 | 8 | 9 | 7 | 8 | 9 | 7 | 8 | 9 | | 8 | 9 | 7 | 8 | 9 | | 8 | 9 | 7 | 8 | 9 | | 8 | 9 |
| 4+ lanes without raised median | 1 | | 3 | 1 | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 1 | | 3 | 3 |
| | | 5 | 6 | | 5 | 6 | | 5 | 6 | | 5 | 6 | | 5 | 6 | | 5 | 6 | | 5 | 6 | | 5 | 6 |
| | 7 | 8 | 9 | 7 | 8 | 9 | | 8 | 9 | | 8 | 9 | 7 | 8 | 9 | | 8 | 9 | 7 | 8 | 9 | | 8 | 9 |

Treatments:

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

Selection Guidance:

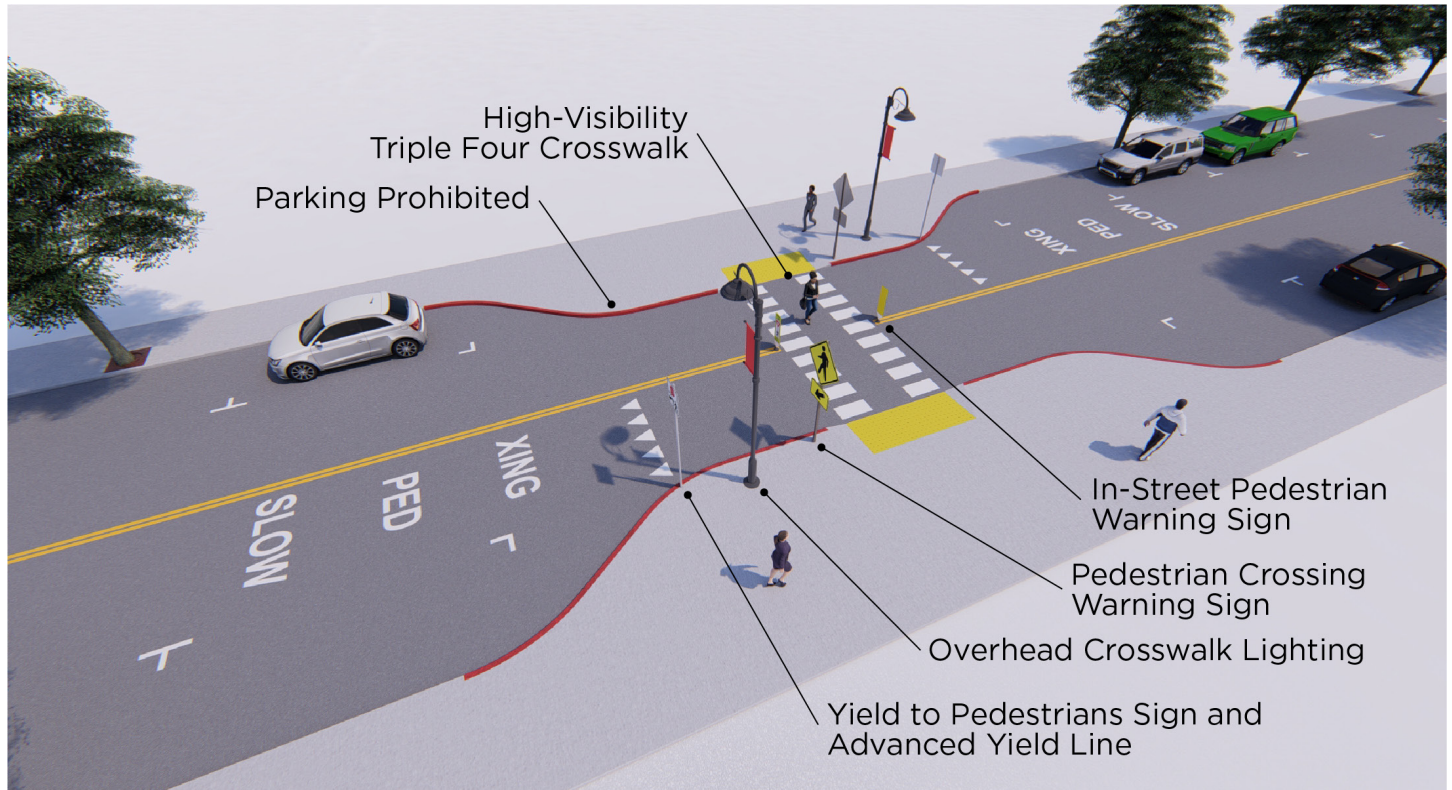
- #: treatments that are candidates for the location type
- #**: treatments shown as a bold number within a darkened box should always be considered, but are not mandated or required.
- #** (with black outline): treatments shown as a bold number in a darkened box with a black outline are crosswalk visibility enhancements that should always occur in conjunction with other identified treatments.
- ** Note: The PHB and RRFB are not installed at the same crossing location

Source: Adapted from FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations (July 2018)

2.0 PRIMARY TREATMENTS

2.1 Crosswalk Visibility Enhancements

FIGURE 1 Example Crosswalk Visibility Improvements #1



Source: FHWA, *Field Guide for Selecting Countermeasures at Uncontrolled Pedestrians Crossings Locations*, 2018.

DEFINITION

This group of treatments includes high-visibility crosswalk markings, improved nighttime lighting, advance or in-street warning signage, curb extensions, and parking restrictions. These features may be used in combination to indicate preferred locations for people to cross, to increase visibility of the crossing location, and to help reinforce the driver requirement to yield the right-of-way to pedestrians at crossing locations.

ROADWAY AND SITE INFORMATION

Established midblock or intersection uncontrolled crossing locations should be consistent with the *2021 Pedestrian Crossing Guidelines* ‘basic’ treatments and additional guidance recommendations. To reduce the risk of crashes involving pedestrians at an uncontrolled marked crosswalk, on-street parking restrictions and curb extensions should also be considered for implementation with the marked crossing.

Per the FHWA Field Guide, on roadways with 4 or more lanes and more than 9,000 vehicles per day, the risk for pedestrian crashes could increase if marked crosswalks are not combined with other treatments, such as refuge islands or Pedestrian Hybrid Beacons.

The FHWA Field Guide recommends consideration of adding advance Yield Here To (Stop Here For) Pedestrians sign and yield (stop) line if the roadway(s) are described by one of the following sets of conditions:

- Any ADT + 4 or more lanes (with or without a raised median) + any speed limit
- Any ADT + any number of lanes + ≥ 35 mph speed limit

CONSIDERATIONS

Crosswalk visibility enhancements are most needed when the following are observed at the site:

- Drivers not yielding to pedestrians in crosswalks
- Inadequate conspicuity/visibility of the crosswalk and/or crossing pedestrian
- Noted conflicts at crossing locations

ADDITIONAL INSTALLATION AND DESIGN GUIDANCE

CROSSWALK MARKINGS

- High-visibility crosswalks may include a variety of crosswalk striping designs, such as ladder, continental, or bar pairs.
- High-visibility markings may be supplemented with the pedestrian crossing warning signs (sign W11-2 in the MUTCD¹) on each approach to the crosswalk.
- See MUTCD Section 2C.50² for more information about Non-Vehicular Warning Signs and Section 3B.18 for more information about crosswalk markings.
- Adjacent bus stops should be placed downstream of the crosswalk and not on the crosswalk approach.
- Sufficient sight distance should be provided for vehicles and pedestrians.
- In school zones, yellow pavement markings should be used.

OVERHEAD LIGHTING

- Overhead lights should be placed in advance of uncontrolled crossings on both approaches to illuminate the front of the pedestrian and avoid creating a silhouette.
- Consider placing the light fixtures 10 to 15 feet in advance of the crosswalk on both sides of the street.

ADVANCE YIELD HERE TO PEDESTRIANS SIGN AND YIELD LINE

- The stop line or “shark’s teeth” yield line is placed 20 to 50 feet in advance of a marked crosswalk to indicate where vehicles are required to stop or yield in compliance with the accompanying Yield Here To Pedestrians sign.

¹ <https://dot.ca.gov/programs/traffic-operations/camutcd>

² <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap2c-rev3-a11y.pdf>

- Stop Here for Pedestrians signs should only be used where the law specifically requires that a driver must stop for a pedestrian in a crosswalk. Otherwise, Yield Here for Pedestrians signs should be used with shark’s teeth pavement markings.
- See MUTCD Section 2B.11³ for more information about Yield Here To (Stop Here For) Pedestrians signs and Section 3B.16⁴ for more information about stop and yield lines.

IN-STREET OR OVERHEAD PEDESTRIAN CROSSING SIGN

- The In-Street Pedestrian Crossing sign (sign R1-6 or R1-6b in the CA MUTCD) can be placed on the center line, on a lane line, or in conjunction with a median/refuge island.
- The In-Street Pedestrian Crossing sign shall not be post-mounted on the left-hand or right-hand side of the roadway.
- Consider maintenance and prompt replacement of damaged in-street (and other) signs.
- If used, the Overhead Pedestrian Crossing sign shall be placed over the roadway at the crosswalk location.
- See CA MUTCD Section 2B.12⁵ for more information about In-Street or Overhead Pedestrian Crossing signs.

Refer to the FHWA Crosswalk Visibility Enhancements Tech Sheet⁶ for more information about this set of treatments.

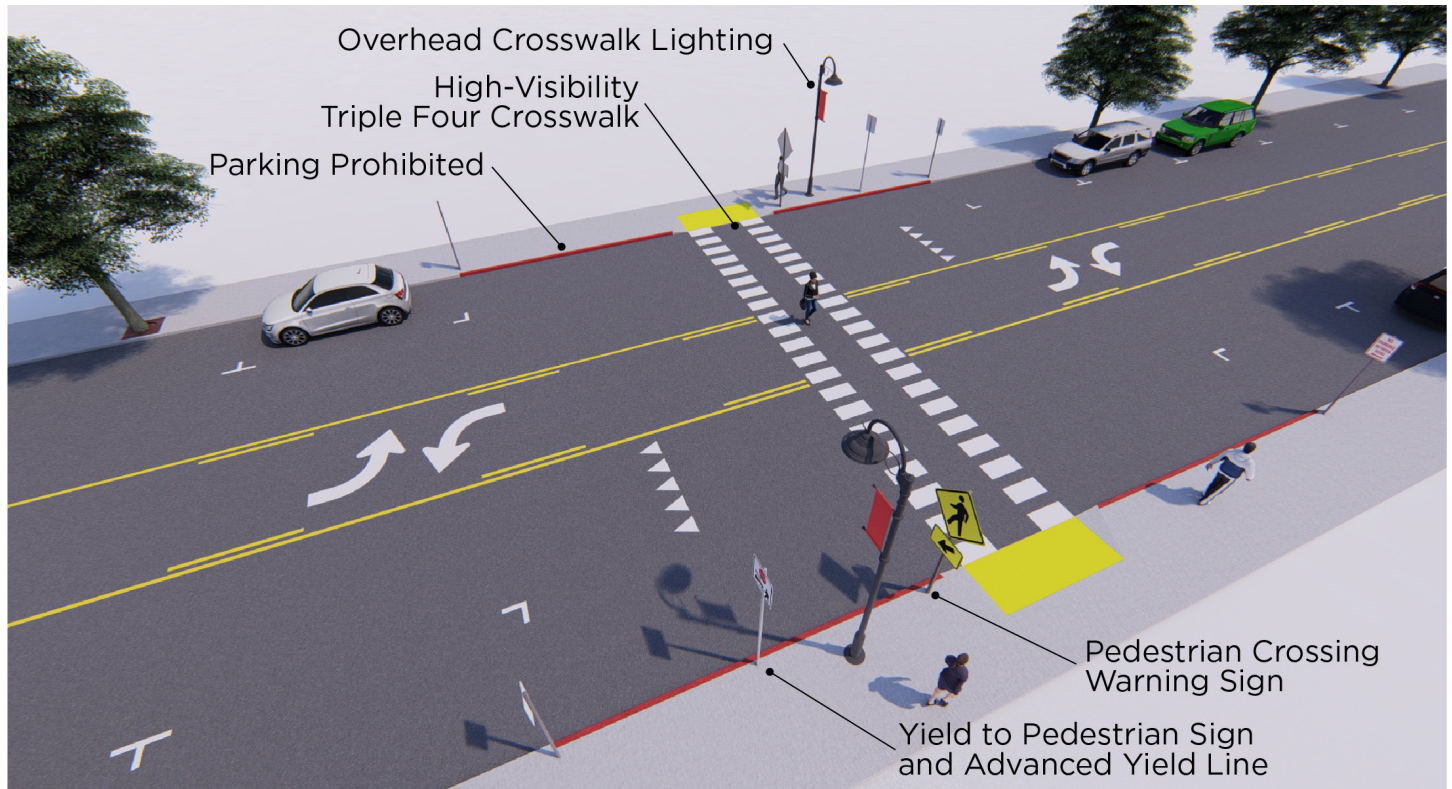
³ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap2b-rev4-a11y.pdf>

⁴ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap3b-rev3-a11y.pdf>

⁵ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap2b-rev4-a11y.pdf>

⁶ https://safety.fhwa.dot.gov/ped_bike/step/docs/TechSheet_VizEnhancemt_508compliant.pdf

FIGURE 2 Example Crosswalk Visibility Improvements #2



Source: FHWA, 2018.

PARKING RESTRICTIONS

- Parking restrictions can include the removal of parking space markings or the installation of “no parking” signs or pavement markings.
- The minimum setback for parking restrictions is 20 feet in advance of the crosswalk where speeds are 25 mph or less, and 30 feet in advance of the crosswalk where speeds are between 26 and 35 mph.
- Adequate visibility for motorists is considered through a clear sight triangle based on required stopping sight distance of approaching motorists.
- The City Traffic Engineer may consider variations to the guidelines recommended on a case-by-case basis depending on overall context of the crossing location such as roadway and traffic conditions (number of lanes, traffic volume, and speed); area type (downtown / central business districts, suburban areas, etc.); required and available sight distance; reported crash history involving pedestrian related crashes; etc.

CURB EXTENSIONS

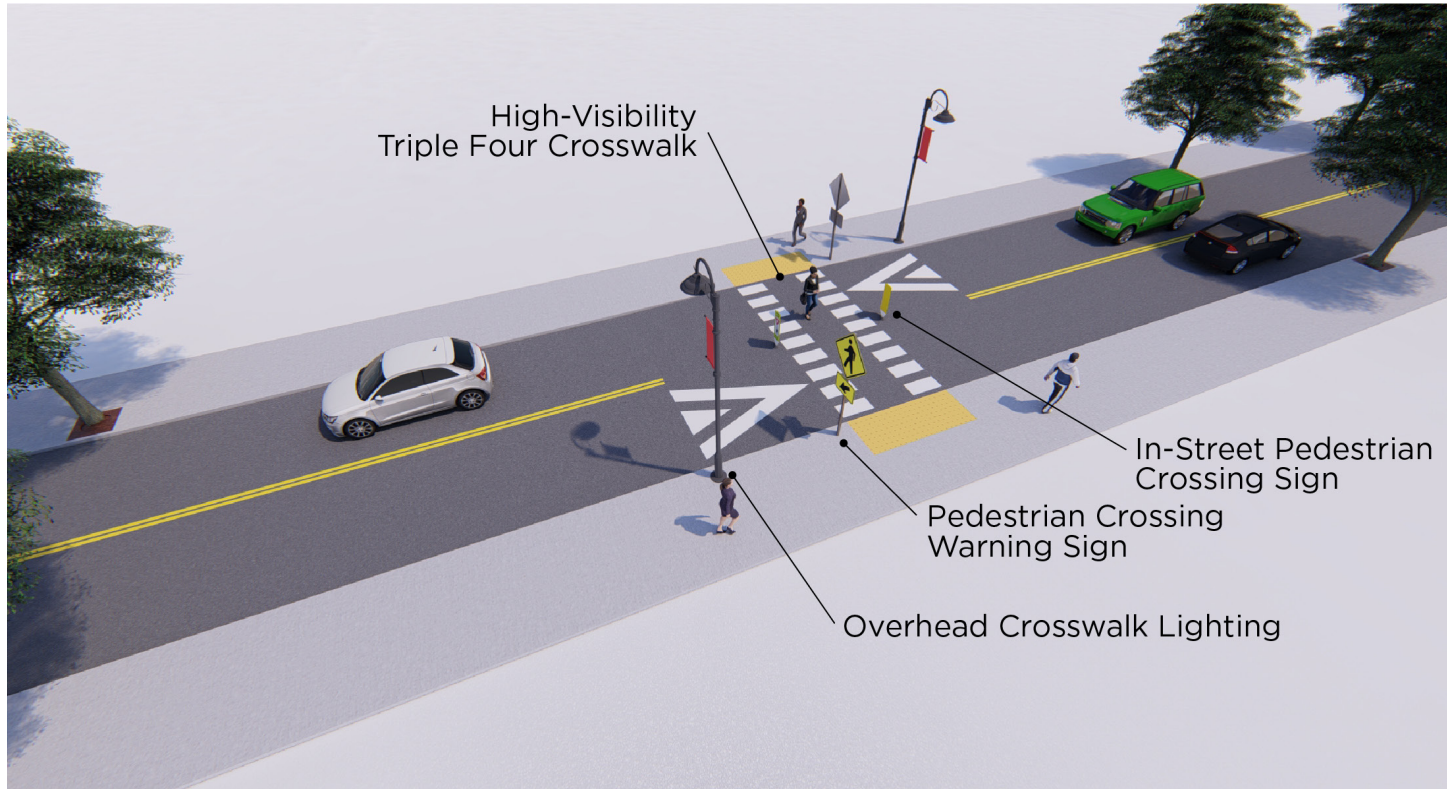
- Curb extensions can be installed at intersections or mid-block to extend the curb and pedestrian space further into the roadway, shortening the exposure crossing distance for pedestrians.
- Curb extensions must not extend into travel lanes and should not block bicycle lanes.
- Curb extensions should be constructed to accommodate ADA requirements.

Refer to the FHWA Crosswalk Visibility Enhancements Tech Sheet⁷ for more information about this set of treatments.

⁷ https://safety.fhwa.dot.gov/ped_bike/step/docs/TechSheet_VizEnhancemt_508compliant.pdf

2.2 Raised Crosswalk

FIGURE 3 Example Raised Crosswalk



Source: FHWA, *Field Guide for Selecting Countermeasures at Uncontrolled Pedestrians Crossings Locations*, 2018.

DEFINITION

Raised crosswalks are ramped speed tables spanning the entire width of the roadway, often placed at midblock crossing locations.

ROADWAY AND SITE INFORMATION

Per the FHWA Field Guide, this treatment is best suited for 2 or 3 lane roadways also described by the following conditions:

- ADT < 9,000 + ≤ 30 mph speed limit

CONSIDERATIONS

This treatment may help address the following:

- Inadequate conspicuity/visibility of the crosswalk and/or crossing pedestrian
- Excessive vehicle speed

ADDITIONAL INSTALLATION AND DESIGN GUIDANCE

- Raised crosswalks may be installed with curb extensions and on-street parking.
- Raised crosswalks may also be used at intersections, particularly at the entrance of the minor street.

- Raised crosswalks should be flush with the height of the sidewalk.
- The crosswalk table is typically at least 10 feet wide and designed to allow the front and rear wheels of a passenger vehicle to be on top of the table at the same time.
- Detectable warnings (truncated domes) and curb ramps should be installed at the street edge for pedestrians with impaired vision.
- Raised crossings are generally avoided on arterial streets and primary routes for heavy trucks, bus transit, and emergency response vehicles.
- Consider storm water drainage in the design of the raised crosswalk.
- See MUTCD Section 3B.25⁸ for information about Speed Hump Markings and other markings that can be used with raised crosswalks.

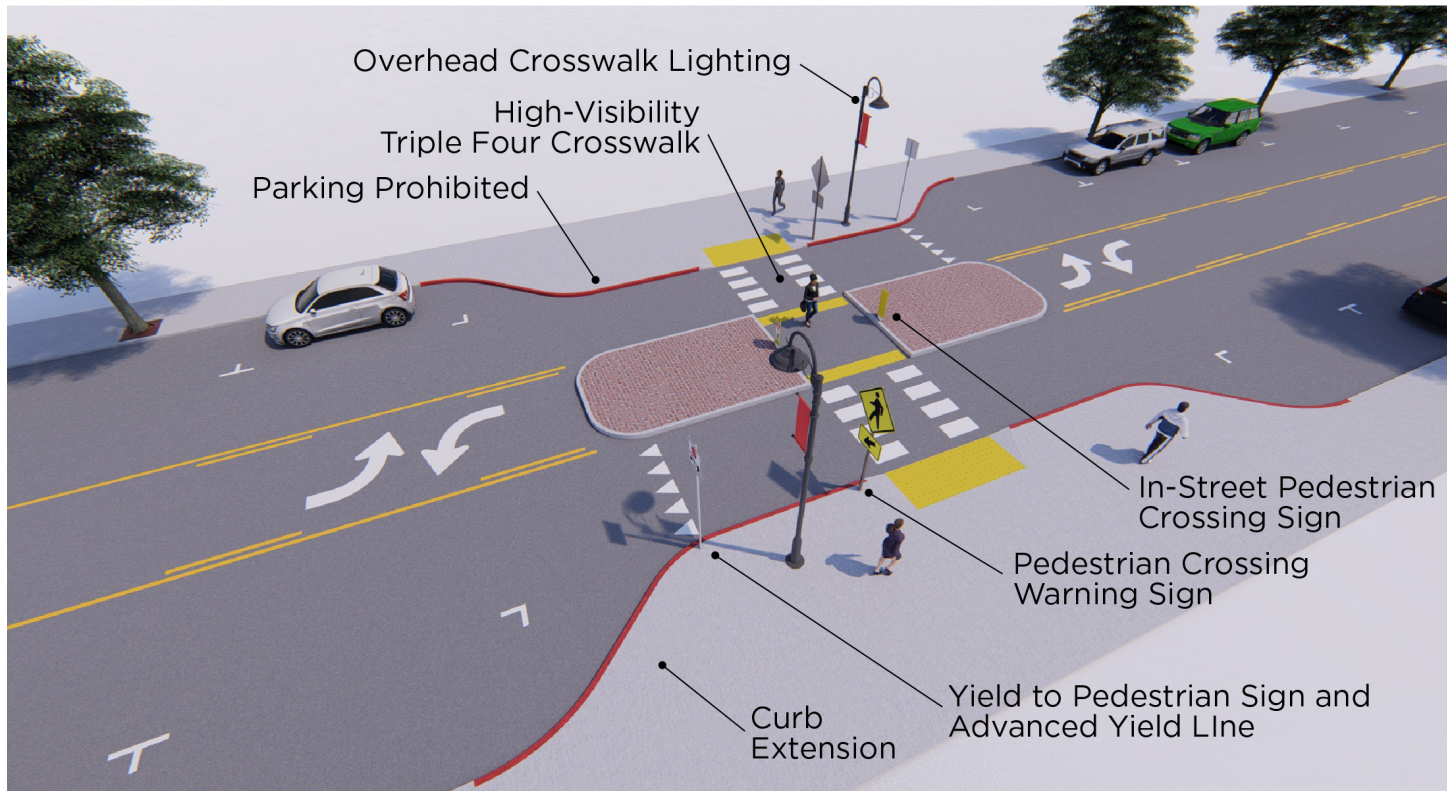
Refer to the FHWA Raised Crosswalks Tech Sheet for more information about this treatment⁹.

⁸ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap3b-rev3-a11y.pdf>

⁹ https://safety.fhwa.dot.gov/ped_bike/step/docs/techSheet_RaisedCW2018.pdf

2.3 Pedestrian Refuge Island

FIGURE 4 Example Pedestrian Refuge Island



Source: FHWA, *Field Guide for Selecting Countermeasures at Uncontrolled Pedestrian Crossings Locations*, 2018.

DEFINITION

A pedestrian refuge island is a median with a refuge area that is intended to help protect pedestrians who are crossing the road. This treatment is sometimes referred to as a crossing island or pedestrian island.

ROADWAY AND SITE INFORMATION

Consider this treatment for established pedestrian crossings at 2 or 3 lane roadways without a raised median.

Per the FHWA Field Guide, this treatment should strongly be considered if the roadway(s) are described by one of the following sets of conditions:

- ADT $\geq 9,000$ + 4 or more lanes without a raised median + any speed limit
- Any ADT + 4 or more lanes without a raised median + ≥ 35 mph speed limit

CONSIDERATIONS

This treatment may be most effective where the following are observed at the site:

- Inadequate conspicuity/visibility of the crosswalk and/or crossing pedestrian
- Excessive vehicle speed
- Lack of pedestrian separation from traffic during long crossings

ADDITIONAL INSTALLATION AND DESIGN GUIDANCE

- Consideration should be given to creating a two-stage crossing. The island can encourage pedestrians to cross one direction of traffic at a time and look towards oncoming traffic before completing the second part of the crossing.
- Pedestrian refuge islands should be at least 6 feet wide (preferably 8 feet) and of adequate length to allow the anticipated number of pedestrians to stand and wait for gaps in traffic before crossing. Pedestrian islands at least 4 feet wide may be considered on a case-by-case basis when site conditions do not allow a 6-foot wide island.
- The cut-through of the island must include detectable warnings if island width is at least 6 feet.
- Refuge islands should be illuminated or highlighted with streetlights, signs, and/or reflectors to ensure that they are visible to motorists.
- See MUTCD Section 3B¹⁰ for more information about the following for refuge islands:
 - Section 3B.10 - Approach Markings for Obstructions
 - Section 3B.18 - Crosswalk Markings
 - Section 3B.23 - Curb Markings
- If applicable, evaluate the impact of the island on bicycle facility design.
- The design, and installation of the raised island should evaluate the impact on left turn movements to or from the side street.

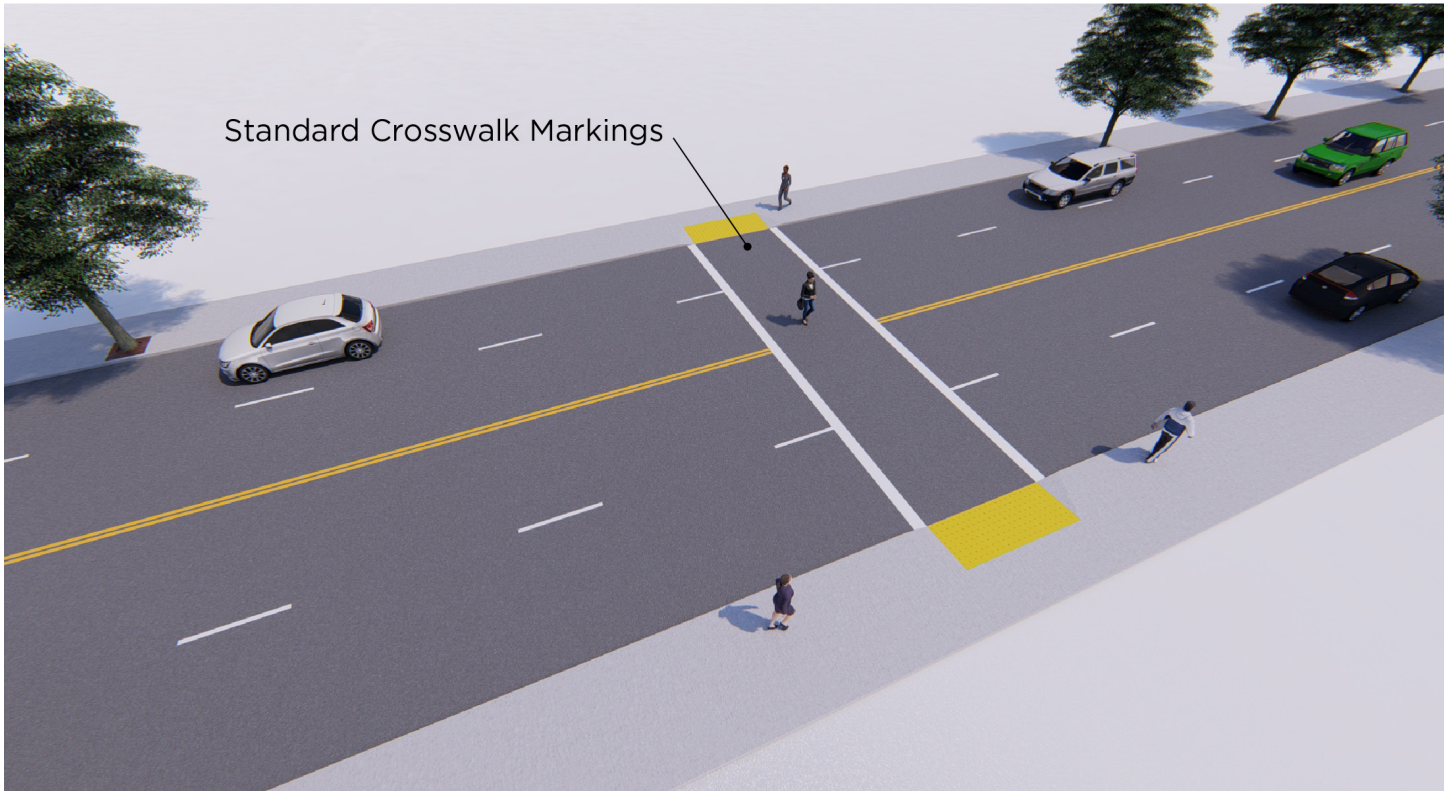
Refer to the FHWA Pedestrian Refuge Island Tech Sheet for more information about this treatment¹¹.

¹⁰ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap3b-rev3-a11y.pdf>

¹¹ https://safety.fhwa.dot.gov/ped_bike/step/docs/techSheet_PedRefugeIsland2018.pdf

2.4 Road Diet

FIGURE 5 Example Roadway Before Road Diet



Source: FHWA, *Field Guide for Selecting Countermeasures at Uncontrolled Pedestrians Crossings Locations*, 2018.

DEFINITION

A Road Diet is a roadway reconfiguration resulting in a reduction in the number of travel lanes, which is usually achieved by converting a four-lane undivided road to three lanes. The space gained by eliminating lanes is typically used for other uses and travel modes.

Road diets can reduce the risk of crashes involving pedestrians by:

- decreasing vehicle travel lanes for pedestrians to cross, therefore reducing the “multiple threat” conditions for pedestrians;
- providing room for a pedestrian refuge island;
- improving safety for bicyclists when bike lanes are added (such lanes also create buffer space between pedestrians and vehicles);
- reducing rear-end and sideswipe crashes; and,
- improving speed limit compliance and decreasing crash severity when crashes do occur.

ROADWAY AND SITE INFORMATION

Per the FHWA Field Guide:

- Consider this treatment for roadways with four or more lanes without a raised median.
- Typically, Road Diets are considered for roadways with current and future average daily traffic (ADT) equal to or less than about 20,000.

CONSIDERATION

This treatment may help address the following:

- Conflicts at crossing locations
- Excessive vehicle speeds
- Lack of pedestrian separation from traffic during long crossings

FIGURE 6 Example Roadway After Road Diet



Source: FHWA, *Field Guide for Selecting Countermeasures at Uncontrolled Pedestrians Crossings Locations*, 2018.

ADDITIONAL INSTALLATION AND DESIGN GUIDELINES

- Driveway density, transit routes, the number and design of intersections along the corridor, as well as operational characteristics are some considerations to be evaluated before deciding to implement a road diet.
- The FHWA Road Diet Informational Guide identifies a range of additional design considerations for road diets, including:
 - Vehicle speed
 - Level of Service (LOS)
 - Quality of Service
 - Operation and volume of pedestrians, bicyclists, transit, and freight
 - Peak hour and peak direction traffic flow
 - Vehicle turning volumes and patterns
 - Frequency of stopping and slow-moving vehicles
 - Presence of parallel roadways

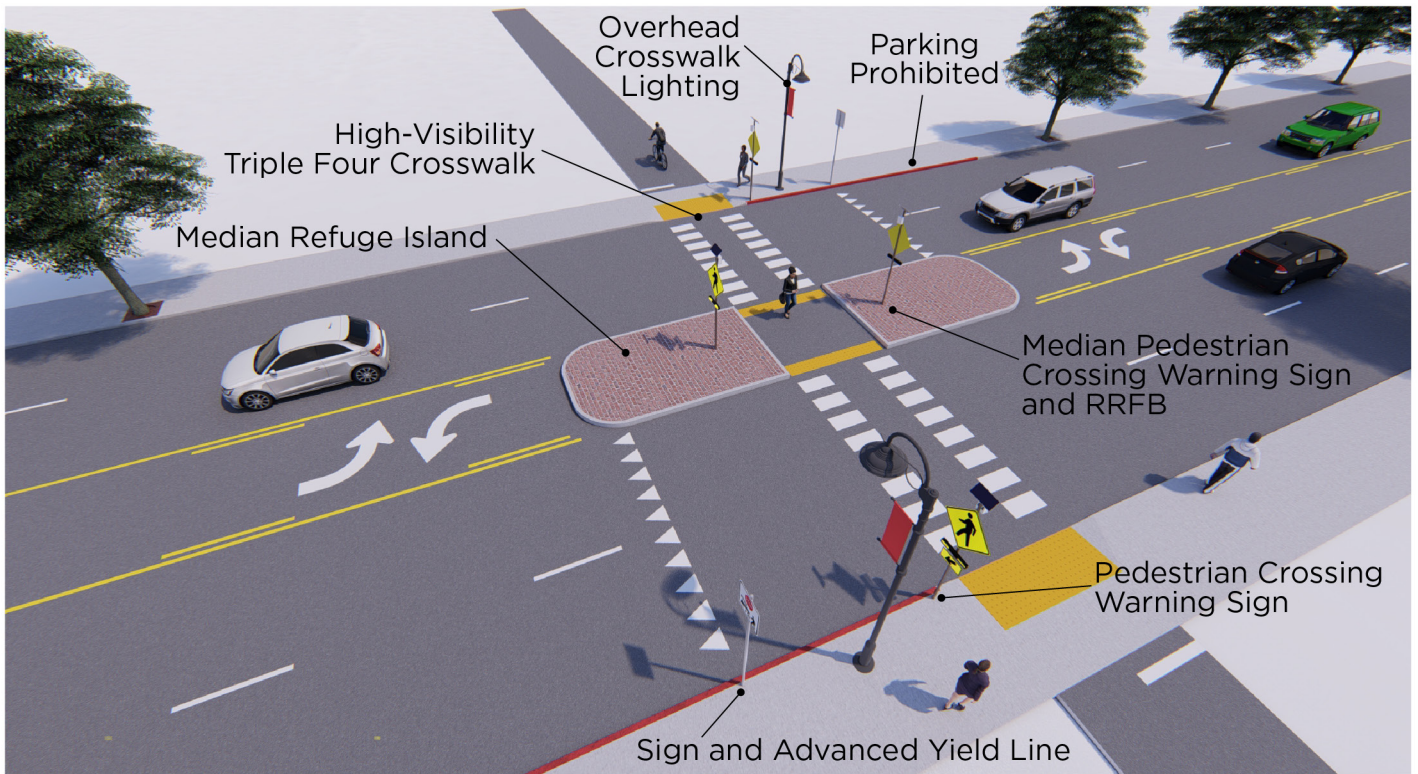
- Where fewer travel lanes are not possible, narrower lanes may be considered, especially left- and right-turn pockets. Narrower travel lanes decrease pedestrian crossing exposure by reducing the unprotected crosswalk length.

Refer to the FHWA Road Diet Tech Sheet for more information about this treatment¹².

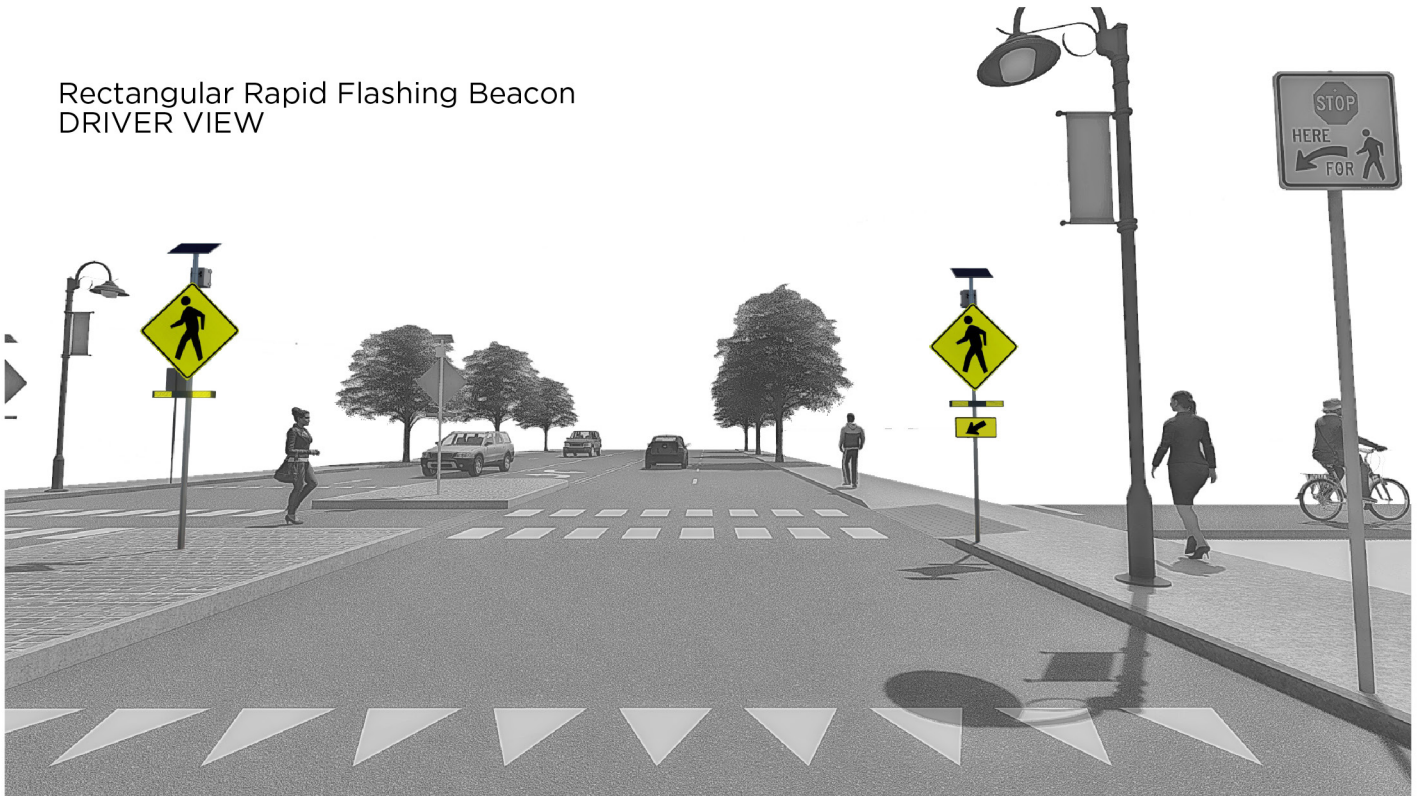
¹² https://safety.fhwa.dot.gov/ped_bike/step/docs/techSheet_RoadDiet2018.pdf

2.5 Rectangular Rapid Flashing Beacon

FIGURE 7 Example Rectangular Rapid Flashing Beacon



Rectangular Rapid Flashing Beacon
DRIVER VIEW



Source: FHWA, *Field Guide for Selecting Countermeasures at Uncontrolled Pedestrians Crossings Locations*, 2018.

DEFINITION

A Rectangular Rapid Flashing Beacon (RRFB) is a pedestrian-actuated conspicuity enhancement used in combination with a pedestrian, school, or trail crossing warning sign to improve safety at uncontrolled, marked crosswalks. The device includes two rectangular-shaped yellow indications, each with an LED-array-based light source, that flash with high frequency when activated.

ROADWAY AND SITE INFORMATION

Per the FHWA Field Guide, this treatment should be considered if the roadway(s) are described by one of the following sets of conditions:

- ADT $\leq 15,000$ + 2 lanes or 3 lanes (with a raised median) + ≥ 40 mph speed limit
- ADT 9,000–15,000 + 3 or more lanes (with or without median) + ≥ 35 mph speed limit

The FHWA Field Guide suggest strongly considering a PHB instead of an RRFB for the following:

- ADT 9,000–15,000 + 3 lanes (without raised median) or more lanes + ≥ 40 mph speed limit

CONSIDERATIONS

This treatment may help address the following:

- Noted conflicts at crossing locations
- Inadequate conspicuity/visibility of the crosswalk and/or crossing pedestrian
- Lack of pedestrian separation from traffic for long crossing distances

ADDITIONAL INSTALLATION AND DESIGN GUIDANCE

- The RRFB is not currently included in the MUTCD. FHWA has issued interim approval for the optional use of the RRFB (Interim Approval 2I or IA-2I)¹³. California has requested and received statewide permission to use the RRFB.
- IA-2I provides additional information about the conditions of use, including dimensions, placement, accessibility features, and flashing requirements. IA-2I does not provide guidance or criteria based on number of lanes, speed, or traffic volumes.
- RRFBs are placed on both ends of a crosswalk. If the crosswalk contains a pedestrian refuge island or other type of median, an RRFB should be placed to the right of the crosswalk and on the median (instead of the left side of the crosswalk).
- An RRFB shall only be used to supplement the following warning signs, located at or immediately adjacent to an uncontrolled marked crosswalk:
 - Post-mounted W11-2, S1-1, or W11-15 crossing warning sign with a (W16-7P) plaque; OR
 - An overhead-mounted W11-2, S1-1, or W11-15 crossing warning sign.
- See MUTCD Section 2C.50 Non-Vehicular Warning Signs¹⁴ and Section 7B.08 School Sign (S1-1)¹⁵ for more information about signs that may be used with an RRFB.
- The RRFB may be pushbutton activated or activated with passive detection.
- For locations with obstructed visibility for side-mounted RRFB treatment, a median-mounted RRFB treatment shall be considered. For locations where a median island RRFB treatment is not feasible, or there are more than two lanes in a direction, other appropriate treatments, such as a PHB shall be considered.
- RRFBs may be considered for mounting overhead consistent with FHWA's Interpretation Letter regarding RRFB Overhead Mounting¹⁶.

Refer to the FHWA Road Diet Tech Sheet for more information about this treatment¹⁷.

¹³ https://mutcd.fhwa.dot.gov/resources/interim_approval/ia2i/index.htm

¹⁴ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap2c-rev3-a11y.pdf>

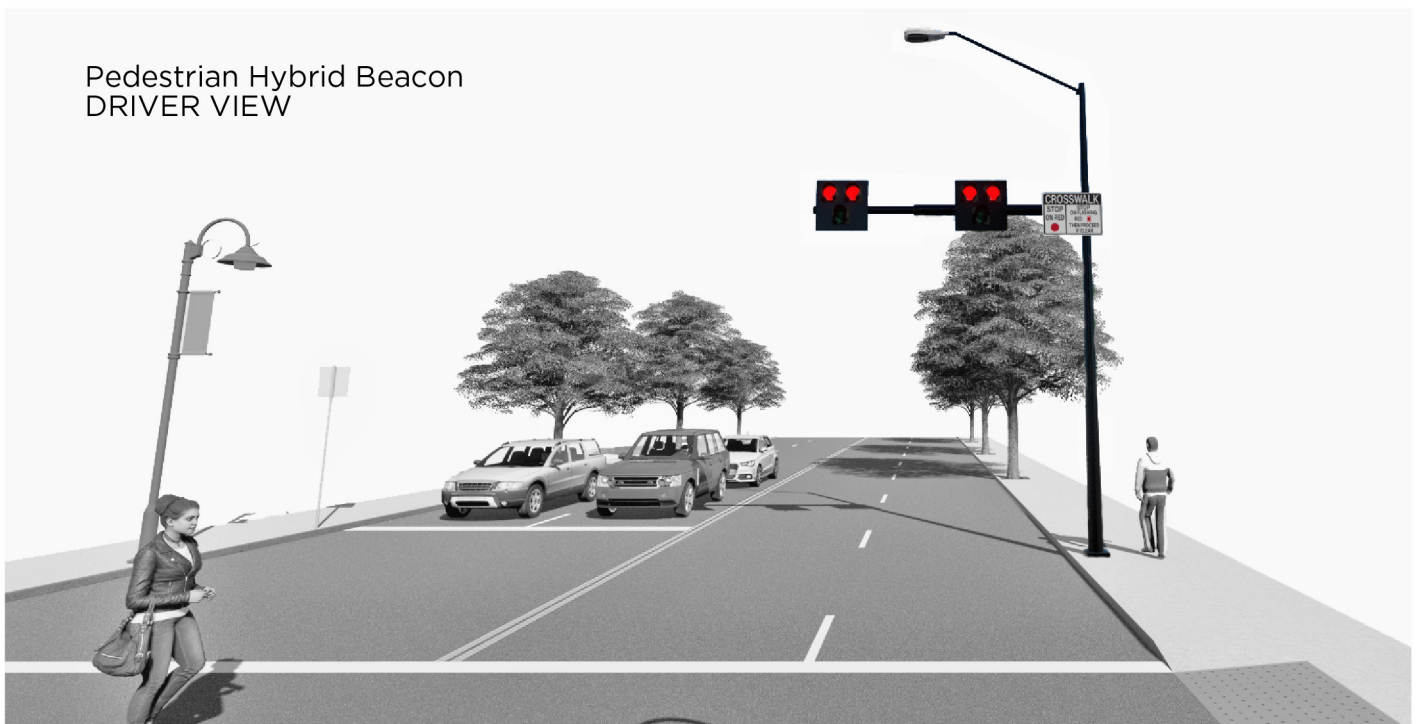
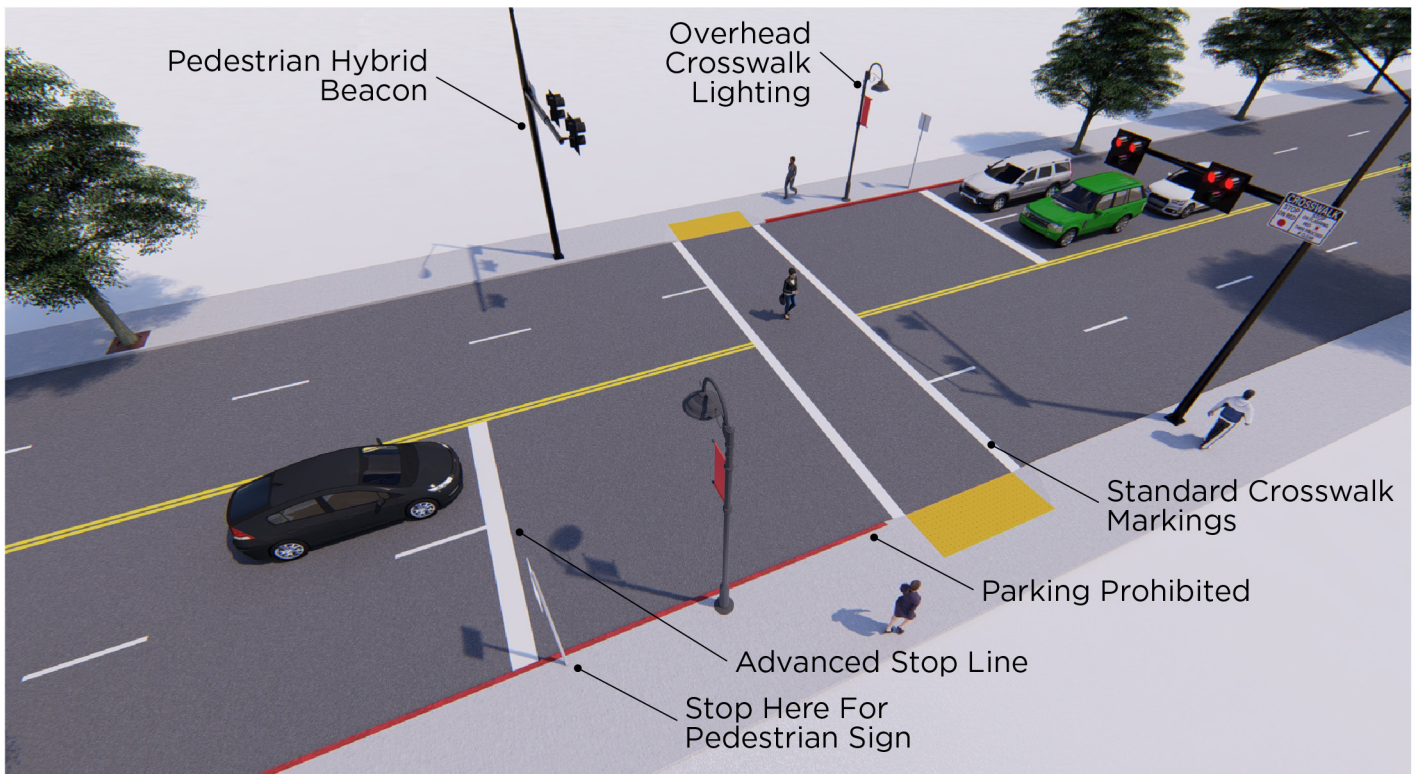
¹⁵ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap7b-a11y.pdf>

¹⁶ http://mutcd.fhwa.dot.gov/resources/interpretations/4_376.htm

¹⁷ https://safety.fhwa.dot.gov/ped_bike/step/docs/techSheet_RRFB_2018.pdf

2.6 Pedestrian Hybrid Beacon

FIGURE 8 Example Pedestrian Hybrid Beacon



Source: FHWA, Field Guide for Selecting Countermeasures at Uncontrolled Pedestrians Crossings Locations, 2018.

DEFINITION

A Pedestrian Hybrid Beacon (PHB) is a hybrid beacon used to control traffic and reverts to all dark until a pedestrian activates it via pushbutton or other form of detection. When activated, the beacon displays a sequence of flashing and solid lights that indicate when pedestrians should cross and when it is legal for drivers to proceed.

ROADWAY AND SITE INFORMATION

Per the FHWA Field Guide, this treatment should be considered if the roadway(s) are described by one of the following sets of conditions:

- ADT \geq 15,000 + 4 or more lanes + any speed limit
- ADT \geq 9,000 + 3 or more lanes (with or without median) + \geq 35 mph speed limit
- Any ADT + any number of lanes + \geq 40 mph speed limit

CONSIDERATIONS

This treatment may help address the following:

- Drivers not yielding to pedestrians in crosswalks
- Noted conflicts at crossing locations

ADDITIONAL INSTALLATION AND DESIGN GUIDELINES

- A PHB should only be installed in conjunction with a marked crosswalk and pedestrian countdown signals.
- A pedestrian hybrid beacon may be considered for installation to facilitate pedestrian crossings at a location that does not meet traffic signal warrants, or at a location that meets traffic signal warrants under MUTCD Sections 4C.05 (Warrant 4, Pedestrian Volume) and/or 4C.06 (Warrant 5, School Crossing)¹⁸ but a decision is made to not install a traffic control signal.
- For roadways with speeds of 35 mph or less, see MUTCD Figure 4F-1¹⁹. For roadways speeds greater than 35 mph, see MUTCD Figure 4F-2. These charts compare crosswalk length, approximate vehicles per hour (VPH, including both approaches), and pedestrians per hour (PPH). The MUTCD recommends installation of a PHB where these conditions meet minimum criteria.
- The PHB should be installed at least 100 feet from side streets or driveways that are controlled by STOP or YIELD signs.
- Parking should be prohibited, and other sight obstructions should be removed at least 100 feet in advance of and at least 20 feet beyond the marked crosswalk and PHB.
- The PHB should be coordinated if within a signal system.
- Review the MUTCD Part 4F¹⁸ for more information about the design and operation of the beacon face and the installation of optional signage.

Refer to the PHB Tech Sheet for more information about this treatment²⁰.

¹⁸ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap4c-rev1-a11y.pdf>

¹⁹ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap4f-rev2-a11y.pdf>

²⁰ https://safety.fhwa.dot.gov/ped_bike/step/resources/docs/fhwasa18064.pdf

3.0 SUPPLEMENTAL TREATMENTS

3.1 Tighter Curb Radii

Tighter curb radii reduce right-turning vehicle speeds at an intersection by forcing sharper turns. Reduced corner radii also shorten crossing distances for pedestrians. Tighter turn radii may be considered for:

- Intersections with average right-turn speeds above 15 miles per hour and where pedestrian volumes are greater than 20 pedestrians per hour.
- Intersections with a documented crash history of right-turning vehicle and pedestrian conflicts.

The primary benefits of smaller curb-return radii to pedestrians include:

- increasing motorist visibility of pedestrians waiting to cross the street;
- reducing pedestrian crossing distance (which also benefits vehicles with a shorter cycle length at signalized intersections) and exposure to traffic;
- providing the shortest accessible route for disabled persons; and,
- reducing speed of turning vehicles and severity of the crashes if they occur.

Curb-return radii should be designed to reflect the “effective” turning radius of the corner. The effective turning radius considers the wheel tracking of the design vehicle utilizing the width of parking and bicycle lanes. Use of the effective turning radii allows a smaller curb-return radius while retaining the ability to accommodate larger design vehicles. Tighter turn radii should be balanced with the need to provide convenient turning movements for larger vehicles (e.g., using a truck turning template on the intersection) to consider vehicle speeds and pedestrian crossing safety.

3.2 Textured Pavement

Textured paving treatments (e.g., stamped asphalt or concrete) may send a visual cue to motorists about the function of a street. They can also create an aesthetic enhancement of a street and be used to delineate separate space for pedestrians or bicyclists.

The City may allow the use of textured pavement in the crosswalk and/or intersection as long as:

- the textured pavement treatment is consistent with FHWA guidelines;
- the crosswalk markings are consistent with the *2021 Pedestrian Crossing Guidelines*; and,
- there is a provision/agreement in place for funding for maintenance and/or replacement of the textured pavement.

3.3 Locate Transit Stops on the Far Side of the Intersection

Buses at near side transit stops and heavy vehicles obstruct the visibility of side-mounted treatments (such as RRFBs) making overhead placement of the devices an option to be considered. When possible, the transit stop should be located to the far side of the intersection.

At intersections, far-side placement is generally preferred; however, location selection should be done on a case-by-case basis. Placing bus stops on the near side of intersections or crosswalks may block the pedestrians’ view of approaching traffic and approaching motorists may be unable to stop in time when a pedestrian steps from in front of a stopped bus to cross vehicle travel lanes.

Locating stops on the far side of an intersection encourages pedestrians to cross the street behind the bus where they are more visible to approaching traffic, reduces delay for buses, and minimizes conflicts between buses and right turning motor vehicles. For Class IV separated bike lanes, far side stops should be coordinated with the transit agency to identify any concerns related to floating transit islands and/or stopping in the vehicle lane.

3.4 Flashing Warning Beacon

Typical uses of flashing beacons include obstructions in or immediately adjacent to the roadway, supplemental to advance warning signs, at mid-block crosswalks, and at intersections where a warning is appropriate.

Several studies have shown that intermittent (typically activated using a manual pushbutton or automated sensor) flashing beacons provide a more effective response from motorists than continuously flashing beacons

Standard beacons should only be used as supplemental treatments. Flashing warning beacons can be installed overhead or post-mounted on the roadside either in advance of the crosswalk or at the crosswalk to increase visibility of a pedestrian crossing.

The design and installation of flashing warning beacons shall comply with the requirements of CA MUTCD Chapter 4L²¹.

²¹ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap4l-1y.pdf>

3.5 Improved Right-Turn Slip-Lane Design

Right-turn slip lanes should be designed to:

- slow turning vehicles;
- allow drivers and pedestrians to easily see each other;
- reduce pedestrian exposure in the roadway;
- reduce the complexity of an intersection by breaking it into manageable parts; and,
- allow drivers to see oncoming traffic as they merge into the receiving roadway.

Drivers are often looking to their left to merge into cross-street traffic and are not always attentive to the presence of pedestrians when turning right.

See ITE's *Recommended Practice - Designing Walkable Urban Thoroughfares: A Context Sensitive Approach*²² for more detailed design guidance. This guidance can be used to retrofit existing right-turn slip-lane designs as part of maintenance projects or address pedestrian safety when new slip-lanes are in design.

3.6 Traffic Calming Measures

Installing traffic-calming measures may be appropriate on certain streets to slow vehicle speeds and/or reduce cut-through traffic. Traffic-calming measures include raised crossings (raised crosswalks, raised intersections), street narrowing measures (chicanes, slow points, "skinny street" designs), and intersection designs (traffic mini circles, diagonal diverters).

Some traffic-calming measures are better suited to local or neighborhood streets than to collector or arterial streets.

²² <https://www.ite.org/pub/?id=E1CFF43C-2354-D714-51D9-D82B39D4DBAD>

3.7 Pedestrian-Activated Flashing (Embedded LED) Warning Sign

Similar to a typical warning sign, pedestrian-activated flashing warning signs are intended to increase motorist awareness of a pedestrian in a crosswalk. The sign includes embedded Light Emitting Diodes (LED) within the sign border that illuminate when activated. The sign may be pushbutton activated or activated with passive detection. Embedded LED units enhance visibility and recognition of signs to drivers, especially under low-light or low-visibility conditions.

Light Emitting Diode (LED) units may be used in the border of a STOP or warning sign to improve the conspicuity of the sign. If flashed, all LED units shall flash simultaneously. The uniformity of the sign design shall be maintained without any decrease in visibility, legibility, or driver comprehension during either daytime or nighttime conditions.

See CA MUTCD Section 2A.07²³ states for more guidance.

3.8 Raised Intersection

Raised intersections are similar to raised crosswalks but raise the entire intersection footprint flush with the sidewalk. The raised intersection helps to manage speeds and can assist in encouraging motorists yielding to pedestrians crossing at the intersection. Bollards or other vertical elements should be installed at the edge of the raised intersection to prevent motorists from entering the sidewalk/pedestrian space.

3.9 Protected Intersection

Protected intersections are an intersection design that provides a physically separated space for bicyclists up until the intersection. Corner islands are used to extend the bicycle lane as far as possible into the intersection and tighten the corner's turn radius. This intersection design provide shorter crossings for pedestrians and can improve sightlines and reduce vehicle turning-related conflicts for bicyclists and pedestrians.

²³ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap2a-rev1-a11y.pdf>

4.0 SIGNALIZED INTERSECTION TREATMENTS

The following treatments address pedestrian crossings at signalized intersections. When selecting treatments to signalized intersections, the following signalization principles from the NACTO Urban Street Design Guide should be considered:

- Shorten signal cycle lengths to increase turnover to minimize delay, reduce wait times, and create crossing opportunities at closer intervals.
- Avoid adding multiple turn lanes and increasing turn phase intervals – do one or the other, but not both.
- Keep the number of signal phases to a minimum and consider turn restrictions.
- Time signals to the speed you intend traffic to go to discourage speeding, especially on one-way streets.
- Adjust timing for peak and off-peak volumes to meet different activity levels throughout the day.
- Used fixed versus actuated signals to increase predictability and provide consistent pedestrian crossing opportunities.

4.1 Shorter Cycle Lengths

Long cycle lengths at signalized intersections result in long pedestrian wait times to cross a street. These long wait times can make crossing a street or walking even a short distance prohibitive and frustrating, discouraging walking and separating destinations. 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.

In general, shorter cycle lengths and longer walk intervals provide better service to pedestrians and encourage better signal compliance. Cycle lengths of 60 to 90 seconds are ideal. The length of the crossing and presence of elderly pedestrians or children should be considered when using shorter cycle lengths. Other efforts to shorten the crossing distance may complement shorter cycle lengths to address these issues.

4.2 Longer Crossing Times

Longer crossing times at crosswalks improve the likelihood that pedestrians are able to cross the street within the allotted time.

Longer crossing times may apply at:

- Signalized intersections where pedestrian crossing times are inadequate for pedestrian volumes
- Locations with a documented crash history of pedestrians frequently crossing against the signal

Longer crossing times can also be used to help manage vehicle speeds along a corridor.

See CA MUTCD Chapter 4E²⁴ states for more detailed guidance and requirements.

4.3 Pushbuttons or Passive Pedestrian Detectors

Pedestrian pushbuttons are detectors intended to provide pedestrians with the ability to activate a pedestrian signal and reassure pedestrians that they will receive a crossing indication. Pushbuttons have been shown to increase crossing compliance with the walk phase and reduce the number of pedestrians trapped in the roadway after a crossing phase.

Pushbuttons should be designed and installed for maximum convenience, conspicuity, and communication for pedestrians. Pushbuttons are not required at locations where pedestrian signal intervals are automatically activated for every signal cycle. Automatic pedestrian signal intervals are preferred at locations with significant and/or consistent pedestrian activity.

Pedestrian signals may be equipped with passive detectors instead of pushbuttons. Passive detection devices register the presence of a pedestrian in a position indicative of a desire to cross, without requiring the pedestrian to push a button. Some passive detection devices are capable of tracking the progress of a pedestrian as the pedestrian crosses the roadway for the purpose of extending or shortening the duration of certain pedestrian timing intervals.

Refer to Section 4E.08 of the CA MUTCD²³ for specific guidance on the location and other requirements related to pushbuttons at traffic signals.

²⁴ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap4e-rev1-a11y.pdf>

4.4 Pedestrian Countdown Signal

Pedestrian countdown signals give pedestrians “Walk” and “Don’t Walk” signals to inform them how long they have to cross the street. Pedestrian countdown signals are required for pedestrian signal heads when the pedestrian change interval is more than 7 seconds to inform pedestrians of the number of seconds remaining in the pedestrian change interval.

Fewer pedestrians cross the street late in the countdown as compared to signal heads with only the Flashing Don’t Walk light. Where they are installed, pushbuttons to activate the pedestrian signal should be easily accessible by pedestrians, wheelchair users, and bicyclists for each crossing.

Pedestrian countdown signals are particularly useful to pedestrians at longer distance crossings, so pedestrians know how much time remains before the signal changes. Countdown signals may be useful where crash or conflict patterns indicate pedestrians cross frequently against the signal.

CA MUTCD Section 4E.07²³ contains more information on design guidance.

4.5 Extended Pushbutton

Some pedestrians may need extra time to cross a street. Traffic signals can be programmed to increase crossing time by pressing the pushbutton longer.

This treatment should be considered where pedestrians must cross long distances at the intersection and/or near schools, hospitals, senior facilities, or other pedestrian generators where pedestrians may be expected to at times need additional time to cross the intersection.

CA MUTCD Section 4E.06 and 4E.08²⁵ contains further guidance.

4.6 Pedestrian Recall

Pedestrian recall gives pedestrians a “Walk” signal at every cycle. No pushbutton or detection is necessary since a “Walk” signal will always be given.

Pedestrian recalls may be considered in areas with high levels of pedestrian activity.

4.7 No Turn On Red Restrictions

Mounted signs eliminate the right of motorists to make a right turn at a red light. These prohibitions can be used full-time or under restricted time intervals. Restrictions should be considered where:

- Exclusive pedestrian phases or high pedestrian volumes are present.
- There is inadequate sight distance for pedestrians and vehicles to see each other – inadequate sight distance means insufficient stopping sight distance for motorists and/or pedestrians that do not have sufficient line of sight to judge a safe gap to cross based on prevailing vehicle speeds.
- Geometric or operational characteristics may result in unexpected conflicts.
- The traffic signal has school or railroad crossings.
- The traffic signal has three or more phases.

No turn on red restriction can also be considered for left turning movements, i.e. No Left-Turn-on-Red (from a one-way street to one-way street).

Additionally, a “blank out” turn restriction sign can be used instead of the conventional “No Right Turn on Red” signs. The “blank out” turn restriction sign displays either the NO TURN ON RED legend or the No Right Turn symbol or word message, as appropriate, only at certain times during the day or during one or more portion(s) of a particular cycle of the traffic signal. “Blank out” turn restriction signs have been found to be more effective than conventional “No Right Turn on Red” signs. Furthermore, the conventional “No Right Turn on Red” signs that specify time-of-day restrictions may be confusing to motorists.

See CA MUTCD, Section 2B.54²⁴ for more guidance.

²⁵ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap2b-rev4-a11y.pdf>

4.8 Protected Left-Turn

Protected left-turn phasing adjusts the traffic signal phasing to allow left-turning vehicles a dedicated phase or portion of a phase (protected versus protected/permissive) left-turn phase instead of a permissive phase turning across opposing traffic. Implementing protected left turn phasing can reduce conflicts with pedestrians crossing parallel to vehicle traffic by separating pedestrian crossings and left turns across the crosswalk into separate phases.

Protected left-turn phasing may be considered under the following conditions:

- Signalized intersections where left-turning vehicle-pedestrian crashes are frequent.
- Signalized intersections where left-turning vehicles and pedestrians have frequent conflicts.

Refer to CA MUTCD Section 4D.19²⁶ for additional protected left-turn phasing guidance.

4.9 Leading Pedestrian Interval

A leading pedestrian interval (LPI) advances the “Walk” signal for 3 to 7 seconds while vehicles continue to receive a red light to give crossing pedestrians a “head start”. Intervals of up to 10 seconds may be appropriate where pedestrian volumes are high and/or the crossing distance is long.

LPIs improve the visibility of pedestrians and give them priority by allowing them to enter the crosswalk before vehicles start moving. As a result, LPIs can help reduce conflicts with pedestrians and vehicles turning across the crosswalk. LPIs typically require adjustments to existing signal timing that are relatively low-cost compared to other treatments. A leading bicycle interval can be implemented with an LPI where a bikeway on the through movement conflicts with turning traffic to help prevent right hook crashes.

Leading Pedestrian Intervals may apply at the following locations:

- Intersections where frequent turning vehicle movements make pedestrian crossing movements uncomfortable.
- Intersections with a documented history of turning movement-related vehicle-pedestrian crashes.

See CA MUTCD Section 4E.06²⁷ for more guidance.

²⁶ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap4d-rev2-a11y.pdf>

²⁷ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap4e-rev1-a11y.pdf>

4.10 Accessible Pedestrian Signals

Accessible pedestrian signals (APS) and detectors provide information, in non-visual formats (such as audible tones, speech messages, and/or vibrating surfaces) to improve accessibility for pedestrians who have visual disabilities.

APS detectors must address a demonstrated need in the form of a request from an individual or group that would use the audible signal. See CA MUTCD Section 4E.09 through 4E.13²⁸ for more information and design guidance on accessible pedestrian signals.

The City’s current practice is that the new signalized intersections should be provided with the necessary hardware for installation of APS based on the future requests. For existing signalized intersections, the City’s current practice is to retrofit the signal with APS if there is a request for the same from an individual or group.

4.11 Animated Eyes Pedestrian Pushbutton

Animated eyes pedestrian signals feature eyes that look from side to side when a “Walk” signal is given. The signals remind pedestrians to look for turning vehicles before proceeding into the crosswalk.

CA MUTCD Section 4E.04²⁷ contains design guidance on animated eyes pushbuttons.

4.12 Pedestrian Scramble Intersection

A pedestrian scramble intersection operates by providing an exclusive pedestrian crossing phase to a signal-controlled intersection that allows pedestrians to cross in any direction, including diagonally, at the same time while all vehicles are stopped at a red signal. This treatment may be effective where there is high crossing demand for diagonal crossing movements or there are frequent conflicts with turning vehicles.

²⁸ <https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/ca-mutcd/camutcd2014-chap4e-rev1-a11y.pdf>

5.0 CONCLUSION

The treatments presented in this guidance represent the pedestrian crossing treatments that the City of Sacramento has implemented or identified for potential future implementation at pedestrian crossings. The City of Sacramento's practice is to use traffic control devices that are approved for use in California. With advancement in engineering practice and technology, new treatments and devices may become available in the future. The City Traffic Engineer may approve the use of such treatments and devices, as determined appropriate. As these treatments are approved, they may be added to the Treatment Applications Guide or otherwise documented by City staff for consideration in future crosswalk marking and/or crosswalk enhancement evaluations.



