

Appendix

Countermeasure Toolbox

This toolbox presents safety countermeasures covering engineering, education, enforcement, emergency services, and emerging technology. Considerations for equitable implementation of these countermeasures are also noted throughout the chapter.

The safety strategies in this chapter also cover the five elements of a Safe System, as shown in the figure below. California is in the process of adopting the Safe System approach and a focus on equity as part of its Strategic Highway Safety Plan.

This plan's focus on the E's of traffic safety, as well as the Safe System approach and an emphasis on equity helps to provide alignment with current LRSP guidelines, but also sets the City of Pacifica up for success in recognition of emerging safety best practices.



5 E's of Traffic Safety

The following toolbox presents countermeasures that cover the 5 E's of traffic safety: Engineering, Education, Enforcement, Emergency Services, and Emerging Technology.

SAFE SYSTEM ELEMENTS

Making a commitment to zero deaths means addressing every aspect of crash risks through the five elements of a Safe System, shown below. These layers of protection and shared responsibility promote a holistic approach to safety across the entire transportation system. The key focus of the Safe System approach is to reduce death and serious injuries through design that accommodates human mistakes and injury tolerances.



Safe Road Users

The Safe System approach addresses the safety of all road users, including those who walk, bike, drive, ride transit, and travel by other modes.



Safe Vehicles

Vehicles are designed and regulated to minimize the occurrence and severity of collisions using safety measures that incorporate the latest technology.



Safe Speeds

Humans are unlikely to survive high-speed crashes. Reducing speeds can accommodate human injury tolerances in three ways: reducing impact forces, providing additional time for drivers to stop, and improving visibility.



Safe Roads

Designing to accommodate human mistakes and injury tolerances can greatly reduce the severity of crashes that do occur. Examples include physically separating people traveling at different speeds, providing dedicated times for different users to move through a space, and alerting users to hazards and other road users.



Post-Crash Care

When a person is injured in a collision, they rely on emergency first responders to quickly locate them, stabilize their injury, and transport them to medical facilities. Post-crash care also includes forensic analysis at the crash site, traffic incident management, and other activities.

Figure 1
Safe System Elements

Source: Fehr & Peers for FHWA



Summary of Countermeasures

- ✔ Local Road Safety Manual (LRSM) Countermeasure

LIGHTING

- ✔ Intersection Lighting
- ✔ Segment Lighting

CONTROL

- ✔ All-Way Stop Control
- ✔ Install Roundabout
- ✔ Install Signal

REMOVE/SHIELD OBJECTS

- ✔ Guardrail
- ✔ Impact Attenuators

GEOMETRIC MODIFICATIONS

- ✔ Directional Median Opening to Restrict Left Turns
- Intersection Reconstruction
- Lane Narrowing
- ✔ Median Barrier
- ✔ Raised Median/Access Control and Turn Restrictions
- Right Turn Slip Lane
- ✔ Road Diet
- ✔ Widen Shoulder

SIGNAL MODIFICATIONS

- ✔ Advance Dilemma Zone Detection
- ✔ Extend Yellow and All Red Time
- ✔ Flashing Beacon as Advance Warning
- ✔ Improve Signal Timing
- ✔ Protected Left Turns
- ✔ Retroreflective Borders on Signals
- Shorten Cycle Length
- ✔ Signal interconnectivity and Coordination
- ✔ Supplemental Signal Heads

Summary of Countermeasures

✔ Local Road Safety Manual (LRSM) Countermeasure

OPERATION/WARNING

- Centerline Hardening
- ✔ Curve Advance Warning Sign
- ✔ Chevron Signs on Horizontal Curves
- ✔ Daylight Intersection
- ✔ Delineators
Also: Reflectors, Object Markers
- ✔ Dynamic Speed Warning Signs (Curves)
- ✔ Edgeline Rumble Strips/Stripes
- ✔ Painted Centerline and Raised Pavement Markers
Speed Feedback Sign
Speed Legends on Pavement at Neighborhood Entries
- ✔ Striping through Intersection
Red Light Camera
Update Markings on Speed Humps
- ✔ Upgrade Intersection Pavement Markings
- ✔ Upgrade to Larger or Install Additional Warning Signs

PEDESTRIAN AND BICYCLE

- ✔ Advance Stop Bar
- ✔ Curb Extensions
Green Conflict Striping
- ✔ High-Visibility Crosswalk
- ✔ Leading Pedestrian Interval and Pedestrian Recall
- ✔ Pedestrian Hybrid Beacon
- ✔ Raised Crosswalk
- ✔ Raised Median/Refuge Island
- ✔ Rectangular Rapid Flashing Beacon
- ✔ Separated Bike Lanes
- ✔ Uncontrolled Pedestrian Crossings with Enhanced Safety Features

What You'll See in This Toolbox



Local Roadway Safety Manual


Many of these countermeasures are recommended for the 10 emphasis areas included in this report. Most of the countermeasures are included in the 2020 Caltrans Local Roadway Safety Manual (LRSM) and can be advantageous for use in Caltrans Highway Safety Improvement Program (HSIP) grant funding applications. The toolbox identifies a Caltrans-approved Crash Reduction Factor (CRF), the expected life of the project, the federal funding eligibility, the systemic opportunity for countermeasure implementation, and applicable collision type (e.g., all modes, bicycle and pedestrian collisions only, etc.) as outlined in the LRSM. The higher the CRF, the greater the expected reduction in collisions. There are many effective safety countermeasures beyond those listed in the LRSM, and several are included in this toolbox.

Countermeasure Icon

Countermeasure Title

Key Issues Most Relevant to Countermeasure

Countermeasure Description



Intersection Lighting ✔

NIGHTTIME
NO STREETLIGHTS

Adding Intersection Lighting at the intersection and on its approaches, improves the safety of an intersection during nighttime conditions by (1) making drivers more aware of the surroundings at an intersection, which improves drivers' perception-reaction times, (2) enhancing drivers' available sight distances, and (3) improving the visibility of non-motorists. Intersection lighting is of particular benefit to non-motorized users as lighting not only helps them navigate the intersection, but also helps drivers see them better.

CRF 40%

CRASH TYPE 🚶 🚲 🚗 NIGHT

Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Opportunity	Medium

LRSM ID S01/NS01

LRSM Countermeasure

Blue Box indicates whether the countermeasure is identified in the LRSP.

Applicable to LRSM Countermeasures

Crash Reduction Factor

Mode(s) this Countermeasure Affects

🌙 NIGHT

Indicates Reductions in Nighttime Crashes

Countermeasure Details

LRSM Countermeasure Code



Intersection Lighting ✓

NIGHTTIME NO STREETLIGHTS

Adding Intersection Lighting at the intersection and on its approaches, improves the safety of an intersection during nighttime conditions by (1) making drivers more aware of the surroundings at an intersection, which improves drivers' perception-reaction times, (2) enhancing drivers' available sight distances, and (3) improving the visibility of non-motorists. Intersection lighting is of particular benefit to non-motorized users as lighting not only helps them navigate the intersection, but also helps drivers see them better.

CRF **40%**
 CRASH TYPE NIGHT

Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Opportunity	Medium

LRS ID **S01/NS01**



Segment Lighting ✓

NIGHTTIME NO STREETLIGHTS

Providing **segment lighting** improves safety during nighttime conditions by making drivers more aware of the surroundings, which improves drivers' perception-reaction times; enhancing drivers' available sight distances to perceive roadway characteristic in advance of the change; and improving non-motorist's visibility and navigation.

CRF **35%**
 CRASH TYPE NIGHT

Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Opportunity	Medium

LRS ID **R01**

LIGHTING

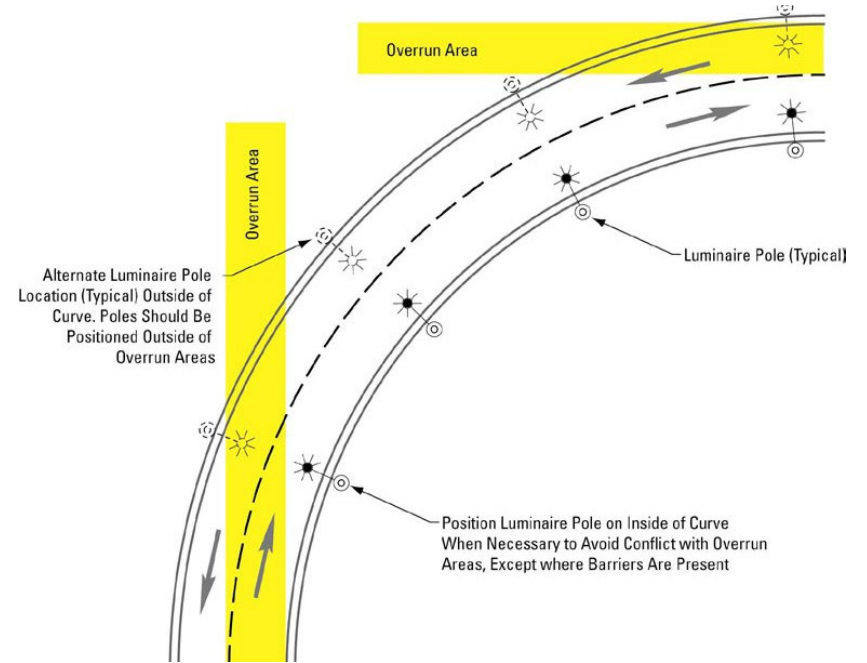
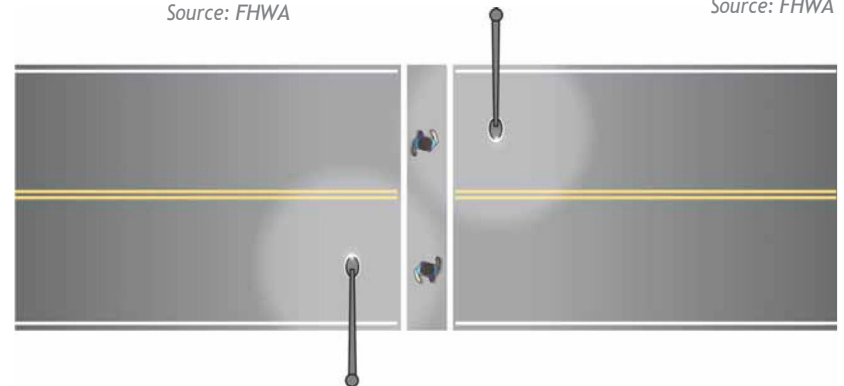


Figure 2
 Guidance for Lighting on Curves
 Source: FHWA

Figure 3 Guidance for Lighting at Midblock Crosswalks
 Source: FHWA



CONTROL



All-Way Stop Control ✓

BROADSIDE

An **all-way stop-controlled intersection** requires all vehicles to stop before crossing the flow of traffic. Traffic signals have the potential to reduce the most severe type crashes but will likely cause an increase in the need for motorists, bicyclists, and pedestrians on a side-street stop-controlled intersection to cross free-flowing lanes of traffic, which reduces the risk of collision. An "All-Way Stop" sign should be placed under stop signs at all-way stop-controlled intersections as required by the California Manual on Uniform Traffic Control Devices (MUTCD).

CRF **50%**

CRASH TYPE LEFT-TURN ANGLE

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	High

LRSM ID **NS02**



Install Signal ✓

MAJOR UNSIGNALIZED INTERSECTION

BROADSIDE

Traffic signals at intersections control the flow of traffic. Traffic signals have the potential to reduce the most severe type crashes but will likely cause an increase in the need for motorists, bicyclists, and pedestrians on a side-street stop-controlled intersection to cross free-flowing lanes of traffic, which reduces the risk of collision. A reduction in overall injury severity is likely the largest benefit of traffic signal installation.

CRF **30%**

CRASH TYPE

Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Opportunity	Low

LRSM ID **NS03**



Install Roundabout ✓

MAJOR UNSIGNALIZED INTERSECTION

BROADSIDE

A **roundabout** is a type of circular intersection in which road traffic is permitted to flow in one direction around a central island, and priority is typically given to traffic already in the junction. The types of conflicts that occur at roundabouts are different from those occurring at conventional intersections; namely, conflicts from crossing and left-turn movements are not present in a roundabout. The geometry of a roundabout keeps the range of vehicle speed narrow, which helps reduce the severity of crashes when they do occur. Pedestrians only have to cross one direction of traffic at a time at roundabouts, thus reducing their potential for conflicts. See CA MUTCD Chapter 3C for details.

CRF **VARIES**

CRASH TYPE

Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Opportunity	Low

LRSM ID **S16/NS04/NS05**



Guardrail ✔

HIT OBJECT

Guardrail redirects a vehicle away from embankment slopes or fixed objects and dissipates the energy of an errant vehicle. Guardrail is installed to reduce the severity of lane departure crashes. However, guardrail can reduce crash severity only for those conditions where striking the guardrail is less severe than going down an embankment or striking a fixed object.

CRF **25%**

CRASH TYPE FIXED OBJECT RUN-OFF ROAD

Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Opportunity	High

LRSM ID R04



Impact Attenuators ✔

HIT OBJECT

Impact attenuators bring an errant vehicle to a more-controlled stop or redirect the vehicle away from a rigid object. Impact attenuators are typically used to shield rigid roadside objects such as concrete barrier ends, steel guardrail ends and bridge pillars from oncoming automobiles. Attenuators should only be installed where it is impractical for the objects to be removed.

CRF **25%**

CRASH TYPE FIXED OBJECT RUN-OFF ROAD

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	High

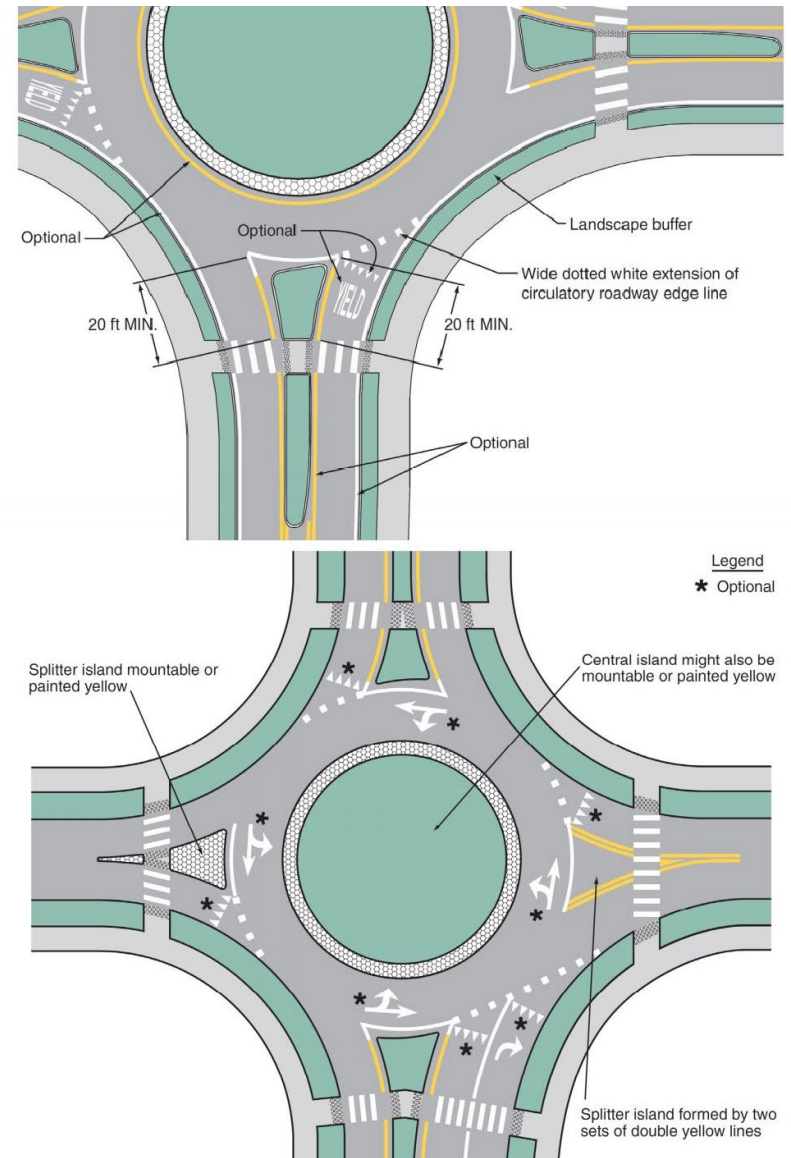
LRSM ID R05

Figure 4
Examples Markings for
One-Lane Roundabouts

Source: CA MUTCD



REMOVE/ SHIELD OBSTACLES



GEOMETRIC MODIFICATIONS



Directional Median Opening to Restrict Left Turns ✓

IMPROPER TURNING BROADSIDE

MAJOR UNSIGNALIZED INTERSECTIONS

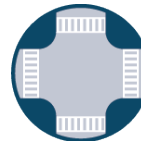
A **directional median opening** restricts specific turning movements, such as allowing a left-turn from a major street but not from a minor street. A directional median opening to restrict left turns improves safety by reducing the number of conflict points.

CRF **50%**

CRASH TYPE

Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Opportunity	Medium

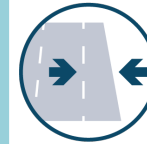
LRSM ID **S14/NS15**



Intersection Reconstruction

SIGNALIZED INTERSECTIONS

Irregular intersections can be overbuilt and confusing, presenting safety hazards to all users. "**Squaring up**" an intersection as close to 90 degrees as possible involves major intersection reconstruction to provide better visibility for all road users, reducing high speed turns and reducing pedestrian crossing length.



Lane Narrowing

UNSAFE SPEED

Lane narrowing reduces lane widths to encourage motorists to travel at slower speeds. Lane Narrowing improves safety by lowering the risk of collision among bicyclists, pedestrians, and other motorists.

GEOMETRIC MODIFICATIONS



Median Barrier ✓

PEDESTRIAN CROSSING OUTSIDE CROSSWALK

This strategy is designed to prevent head-on collisions by providing a barrier between opposing lanes of traffic. The variety of **median barriers** available makes it easier to choose a site-specific solution. The main advantage is the reduction of the severity of the crashes. Median Barriers can also be used at locations to discourage pedestrian crossings where a safe crossing cannot be provided.

CRF **25%/35%**

CRASH TYPE **HEAD-ON**

Expected Life (Years)	20
Federal Funding Eligibility	100%/90%
Systemic Opportunity	Medium/Low

LRSM ID **R03/S13PB**



Raised Median/Access Control and Turn Restrictions ✓

IMPROPER TURNING BROADSIDE

MAJOR UNSIGNALIZED INTERSECTIONS

Access control and turn restrictions balances traffic safety and efficiency with reasonable property access. Installing a raised median can restrict turning movements and reduce head-on collisions by number of vehicles that cross the centerline.

CRF **25%**

CRASH TYPE

Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Opportunity	Medium

LRSM ID **R08**



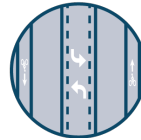
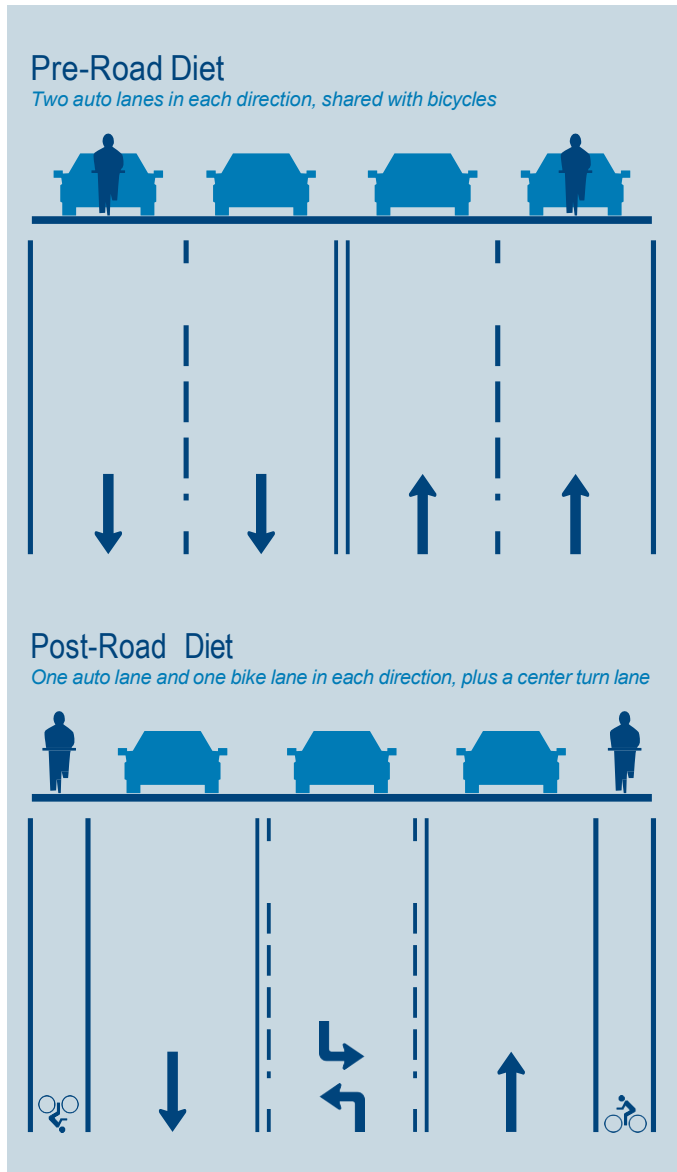
Right Turn Slip Lane

SIGNALIZED INTERSECTIONS

A **right turn slip lane** is a traffic lane provided at an intersection to allow vehicles to turn right without actually entering it and interfering with through traffic. Where the main intersection is controlled by traffic signals, a slip lane is often controlled by yield or stop sign. Slip lanes should be designed with safe speeds and pedestrian safety in mind, providing high-visibility crosswalks and enhanced pedestrian crossing signage, ensuring pedestrian visibility to drivers through crosswalk placement, and reducing turning radii to support safe turning speeds.

GEOMETRIC MODIFICATIONS

Figure 5
Typical Road Diet Configuration
 Source: Fehr & Peers



Road Diet ✓

UNSAFE SPEED

A **road diet** reduces roadway space dedicated to vehicle travel lanes to create room for bicycle facilities, wider sidewalks, or center turn lanes. A Road Diet improves safety by reducing vehicle speeds and creating designated space for all road users. FHWA advises that streets with 20,000 ADT or less may be good candidates for road diets, though road diets have been implemented successfully on roadways with higher traffic volumes in urban settings.

CRF **30%**

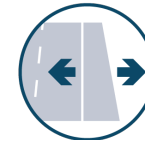
CRASH TYPE

Expected Life (Years) **20**

Federal Funding Eligibility **90%**

Systemic Opportunity **Medium**

LRSM ID **R14**



Widen Shoulder ✓

PEDESTRIAN IN ROAD

Widened and paved shoulders, which may also include flattening the slopes along the sides of the roadway, create a separated space for bicyclists and also provide motor vehicle safety benefits, such as space for inoperable vehicles to pull out of the travel lane.

CRF **30%**

CRASH TYPE **FIXED OBJECT** **RUN-OFF ROAD** **SIDE-SWIPE**

Expected Life (Years) **20**

Federal Funding Eligibility **90%**

Systemic Opportunity **Medium**

LRSM ID **R15**

SIGNAL MODIFICATIONS



Advance Dilemma-Zone Detection ✓

SIGNALIZED INTERSECTION BROADSIDE

An **advanced dilemma-zone detection** system minimizes the number of vehicles the intersection traffic control signal system exposes to an intersection-approach dilemma zone. This is accomplished by adjusting the start time of the yellow-signal phase either earlier or later, based on observed vehicle locations and speeds.

CRF **40%**

CRASH TYPE

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	High

LRS ID **S04**



Extend Yellow and All Red Time ✓

SIGNALIZED INTERSECTION BROADSIDE

Extending yellow and all red time increases the time allotted for the yellow and red lights during a signal phase. Extending yellow and red time improves safety by allowing drivers and bicyclists to safely cross through a signalized intersection before conflicting traffic movements are permitted to enter the intersection. See CA MUTCD Section 4D.26 for more detail.

CRF **15%**

CRASH TYPE

Expected Life (Years)	10
Federal Funding Eligibility	50%
Systemic Opportunity	Very High

LRS ID **S03**



Flashing Beacon as Advance Warning ✓

SIGNALIZED INTERSECTION

A **flashing beacon as advance warning** is a blinking light with signage to notify motorists of an upcoming intersection or crosswalk. A Flashing Beacon improves safety by providing motorists more time to be aware of and slow down for an intersection or yield to pedestrians crossing a crosswalk.

CRF **30%**

CRASH TYPE REAR-END ANGLE

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	Medium

LRS ID **S10**

SIGNAL MODIFICATIONS



Improve Signal Timing ✓

SIGNALIZED INTERSECTION

Certain timing, phasing, and control strategies can produce multiple safety benefits. **Signalization improvements** may include adding phases, lengthening clearance intervals, eliminating or restricting higher-risk movements, and coordinating signals at multiple locations.

CRF **15%**

CRASH TYPE 

Expected Life (Years)	10
Federal Funding Eligibility	50%
Systemic Opportunity	Very High

LRSM ID **S03**



Protected Left Turns ✓

SIGNALIZED INTERSECTION

BROADSIDE

A **protected left turn** can be implemented at signalized intersections (with existing left turns pockets) that currently have a permissive left-turn or no left-turn protection that have a high frequency of angle crashes involving left turning, opposing through vehicles, and non-motorized road users. Left turns are widely recognized as the highest-risk movements at signalized intersections. Providing protected left-turn phases for signalized intersections significantly improve the safety for left-turn maneuvers by removing the need for the drivers to navigate through gaps in oncoming/opposing through vehicles.

CRF **30%**

CRASH TYPE 

Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Opportunity	High

LRSM ID **S07**



Retroreflective Borders on Signals ✓

SIGNALIZED INTERSECTION

BROADSIDE

NIGHTTIME

Retroreflective borders enhance the visibility of traffic signals for aging and color vision impaired drivers enabling them to understand which signal indication is illuminated. Retroreflective borders may also alert drivers to signalized intersections during periods of power outages when the signals would otherwise be dark, and non-reflective signal heads and backplates would not be visible.

CRF **15%**

CRASH TYPE  REAR-END ANGLE

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	Very High

LRSM ID **S02**

SIGNAL MODIFICATIONS



Shorten Cycle Length

SIGNALIZED INTERSECTION

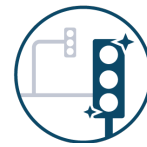
Traffic signal cycle lengths have a significant impact on the quality of the urban realm and consequently, the opportunities for bicyclists, pedestrians, and transit vehicles to operate safely along a corridor. Long signal cycles, compounded over multiple intersections, can make crossing a street or walking even a short distance prohibitive and frustrating. Short cycle lengths of 60–90 seconds are ideal for urban areas.



Signal Interconnectivity and Coordination ✓

SIGNALIZED INTERSECTION UNSAFE SPEED

Certain timing, phasing, and control strategies can produce multiple safety benefits. Sometimes capacity improvements come along with the safety improvements and other times adverse effects on delay or capacity occur. The emphasis of improving **signal coordination** for this countermeasure is to provide an opportunity for slow speed signal coordination.



Supplemental Signal Heads ✓

SIGNALIZED INTERSECTION

Additional signal heads allow drivers to anticipate signal changes farther away from intersections. Supplemental traffic signals may be placed on the near side of an intersection, far-left, far-right, or very high.

CRF **15%**

CRASH TYPE REAR-END ANGLE

Expected Life (Years)	10
Federal Funding Eligibility	50%
Systemic Opportunity	Very High

LRSM ID **S03**

CRF **15%**

CRASH TYPE REAR-END ANGLE

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	Very High

LRSM ID **S02**

OPERATION / WARNING



Centerline Hardening

IMPROPER TURNING

Centerline hardening is a technique to make intersections safer by encouraging drivers to make left turns at slower speeds and encourage safe turning behavior. Bollards and rubber curbs are used to block the diagonal path through the intersection, modifying the turning angle of the vehicle, and increasing visibility of pedestrians in the crosswalk for drivers.



Curve Advance Warning Sign ✓

CURVES

A **curve advance warning sign** notifies drivers of an approaching curve and may include an advisory speed limit as drivers navigate around the curve. This warning sign is ideally combined with other infrastructure that alerts drivers of the curve, such as chevron signs, delineators, and flashing beacons. A curve advance warning sign improves safety by giving drivers additional time to slow down for the curve.

CRF **25%**

CRASH TYPE RUN-OFF ROAD

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	Very High

LRSM ID **R24**



Chevron Signs on Horizontal Curves ✓

CURVES

Post-mounted chevrons are intended to warn drivers of an approaching curve and provide tracking information and guidance to the drivers. They can be beneficial on roadways that have an unacceptable level of crashes on relatively sharp curves during periods of light and darkness.

CRF **40%**

CRASH TYPE RUN-OFF ROAD

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	Very High

LRSM ID **R23**

OPERATION / WARNING



Daylight Intersection ✓

BROADSIDE VICTIMS UNDER 19

To “daylight” an intersection is to clear sight lines between pedestrian crossings and oncoming cars, usually by creating no-parking zones at the curbs in front of crosswalks at that intersection. By removing sight distance restrictions (e.g., vegetation, parked vehicles, signs, buildings) from the sight triangles at stop or yield-controlled intersection approaches, drivers will be able see approaching vehicles on the main line, without obstruction and therefore make better decisions about entering the intersection safely

CRF 20%

CRASH TYPE

Expected Life (Years)	10
Federal Funding Eligibility	90%
Systemic Opportunity	High

LRSM ID NS11



Delineators ✓

Also: Reflectors, Object Markers

HIT OBJECT CURVES

NIGHTTIME

Delineators, reflectors and object markers are intended to warn drivers of an approaching curve or fixed object that cannot easily be removed. They are generally less costly than Chevron Signs as they don't require posts to place along the roadside, avoiding an additional object with which an errant vehicle can crash into. See CA MUTCD Section 3F for more details.

CRF 15%

CRASH TYPE

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	Very High

LRSM ID R27



Dynamic Speed Warning Signs (Curves) ✓

CURVES

A **dynamic speed warning sign** notifies drivers of their current speed, usually followed by a reminder of the posted speed limit. A Speed Feedback Sign improves safety by providing a cue for drivers to check their speed and slow down, if necessary. This countermeasure is applicable on curvilinear roadways that have an unacceptable level of crashes due to excessive speeds on relatively sharp curves. This countermeasure does not apply to Radar Speed Feedback Signs, which do not have a nationally accepted crash reduction factor.

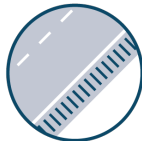
CRF 30%

CRASH TYPE

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	High

LRSM ID R26

OPERATION / WARNING



Edgeline Rumble Strips ✓

HIT OBJECT

NIGHTTIME

UNDER THE INFLUENCE

Rumble strips can be installed along the edge line or center line to address roadway departure and head-on crashes caused by distracted, drowsy, or otherwise inattentive drivers who drift from their lane. See CA MUTCD Section 3J for more details.

Note that these have the potential to cause noise.

CRF **15%**

CRASH TYPE



RUN-OFF ROAD

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	High

LRSM ID **R31**



Painted Centerline and Raised Pavement Markers ✓

NIGHTTIME

A **raised pavement marker** is a small device attached to the road and used as a positioning guide for drivers. These markers, along with **painted centerlines** can assist drivers in understanding the limits of travel lanes and the roadway. New pavement marking products tend to be more durable, are allweather, more visible, and have a higher retroreflectivity than traditional pavement markings. See CA MUTCD Section 3B.01 and 3B.11-14 for additional detail.

CRF **25%**

CRASH TYPE



RUN-OFF ROAD

HEAD-ON

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	Very High

LRSM ID **R28**



Speed Feedback Sign

UNSAFE SPEED

A **speed feedback sign** notifies drivers of their current speed, usually followed by a reminder of the posted speed limit. A Speed Feedback Sign improves safety by providing a cue for drivers to check their speed and slow down, if necessary.

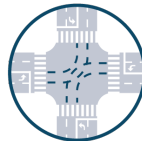
OPERATION / WARNING



Speed Legends on Pavement at Neighborhood Entries

UNSAFE SPEED

Speed legends are numerals painted on the roadway indicating the current speed limit in miles per hour. They are usually placed near speed limit signposts.



Striping through Intersection ✓

SIGNALIZED INTERSECTION

Adding clear **striping through the intersection** can guide motorists through complex intersections. Intersections where the lane designations are not clearly visible to approaching motorists and/or intersections noted as being complex and experiencing crashes that could be attributed to a driver's unsuccessful attempt to navigate the intersection can benefit from this treatment.



Red Light Camera

SIGNALIZED INTERSECTION

BROADSIDE

A **red light camera** enforces traffic signal compliance by capturing the image of a vehicle that has entered an intersection in spite of the traffic signal indicating red. The automatic photographic evidence is used by authorities to enforce traffic laws and issue traffic violation tickets.

CRF **10%**

CRASH TYPE



WET

NIGHT

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	Very High

LRSM ID **S09**

OPERATION / WARNING



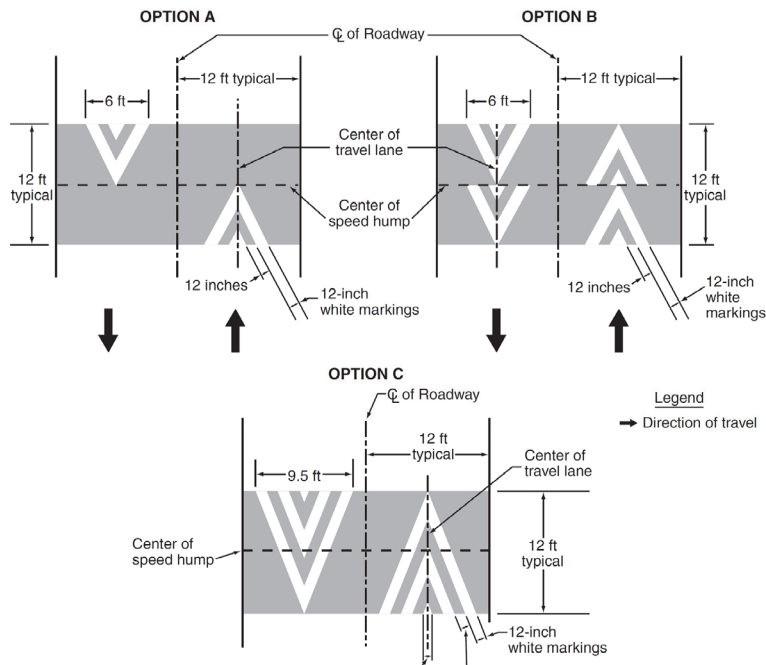
Update Markings on Speed Humps

UNSAFE SPEED

Speed humps are the common name for traffic calming devices that use vertical deflection to slow motor-vehicle traffic in order to improve safety conditions. Refreshed markings on speed humps can help to bring drivers' awareness to their location. See Section 3B.25 of the CA MUTCD for more information.

Figure 6
Pavement Markings for Speed Humps without Crosswalks

Source: CA MUTCD



Upgrade Intersection Pavement Markings

BROADSIDE

MAJOR UNSIGNALIZED INTERSECTIONS

Upgrading intersection pavement markings can include "Stop Ahead" markings and the addition of centerlines and stop bars. Upgrading intersection pavement markings improve safety by increasing the visibility of intersections for drivers approaching and at the intersection.

CRF 25%

CRASH TYPE

Expected Life (Years) 10

Federal Funding Eligibility 100%

Systemic Opportunity Very High

LRSM ID NS07



Upgrade to Larger or Install Additional Warning Signs

BROADSIDE

MAJOR UNSIGNALIZED INTERSECTIONS

Upgrading to larger warning signs replaces existing signs with physically larger signs with larger warning information. Installing additional warning signs can help bring awareness to an intersection. These enhancements improve safety by increasing visibility of the information provided.

CRF 15%

CRASH TYPE

Expected Life (Years) 10

Federal Funding Eligibility 100%

Systemic Opportunity Very High

LRSM ID NS06

PEDESTRIAN & BICYCLE



Advance Stop Bar ✓

SIGNALIZED INTERSECTION

An **advance stop bar** is a horizontal stripe painted ahead of the crosswalk at stop signs and signals to indicate where drivers should stop. An advanced stop bar improves safety by reducing instances of vehicles encroaching on the crosswalk. Creating a wider stop bar or setting the stop bar further back may be appropriate for locations with known crosswalk encroachment issues. See CA MUTCD Section 3B.16 for more information.

CRF **15%**

CRASH TYPE

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	Very High

LRSM ID **S20PB**



Curb Extensions ✓

PEDESTRIANS CROSSING OUTSIDE CROSSWALK

UNSAFE SPEED SCHOOLS VICTIMS UNDER 19

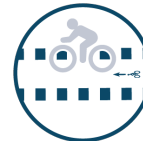
A **curb extension** is a traffic calming measure which widens the sidewalk for a short distance to enhance the pedestrian crossing. This reduces the crossing distance and allowing pedestrians and drivers to see each other when parked vehicles would otherwise block visibility.

CRF **35%**

CRASH TYPE

Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Opportunity	Medium

LRSM ID **S20PB**



Green Conflict Striping

BROADSIDE

Green conflict striping is green markings painted in a dashed pattern on bike lanes approaching an intersection and/or going through an intersection. Green conflict striping improves safety by increasing the visibility bicyclists and identifying potential conflict points so bicyclists and motorists use caution when traveling toward and through an intersection.

PEDESTRIAN & BICYCLE



High-Visibility Crosswalk ✓

PEDESTRIANS CROSSING OUTSIDE CROSSWALK

A **high-visibility crosswalk** has a striped pattern with markings made of high-visibility material, such as thermoplastic tape, instead of paint. A high-visibility crosswalk improves safety with a clearly marked pedestrian crossing so motorists exercise caution and yield to pedestrians. The crash reduction factor noted here only applies to locations currently without a marked crosswalk, but High-Visibility Crosswalk upgrades can be implemented globally at existing marked crosswalks. See further information on crosswalks later in this document, and Section 3B.18 of the CA MUTCD for more detail.

CRF **25%**

CRASH TYPE

Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Opportunity	High

LRSM ID **S18PB**



Install Sidewalk ✓

PEDESTRIAN IN ROAD

Installing Sidewalks provides a separated and continuous facility for people to walk along the roadway. Adding sidewalks improves safety by minimizing collisions with pedestrians walking in the road.

CRF **80%**

CRASH TYPE

Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Opportunity	Medium

LRSM ID **R34PB**



Leading Pedestrian Interval and Pedestrian Recall ✓

SIGNALIZED INTERSECTION

At intersection locations that have a high volume of turning vehicle and have high pedestrian vs. vehicle crashes, a **leading pedestrian interval** gives pedestrians the opportunity to enter an intersection 3 - 7 seconds before vehicles are given a green indication. With this head start, pedestrians can better establish their presence in the crosswalk before vehicles have priority to turn left or right. **Pedestrian recall** timing automatically provides a pedestrian crossing phase, without having to press the pedestrian call button.

CRF **60%**

CRASH TYPE

Expected Life (Years)	10
Federal Funding Eligibility	100%
Systemic Opportunity	High

LRSM ID **S21PB**

PEDESTRIAN & BICYCLE



Pedestrian Hybrid Beacon ✓

PEDESTRIAN CROSSING OUTSIDE CROSSWALK

MIDBLOCK MAJOR UNSIGNALIZED INTERSECTION

Pedestrian hybrid beacon (PHB), also known as a HAWK, is a flashing light that is activated by a pedestrian pushing a button or some other form of detection. A PHB is used at unsignalized intersections or mid-block crosswalks to notify oncoming motorists to stop with a series of red and yellow lights. Unlike a traffic signal, the PHB rests in dark until a pedestrian activates it via pushbutton or other form of detection. See CA MUTCD Section 4F for more detail.

CRF **55%**

CRASH TYPE

Expected Life (Years)	20
Federal Funding Eligibility	100%
Systemic Opportunity	Low

LRSM ID **NS23PB**



Raised Crosswalk ✓

PEDESTRIAN CROSSING OUTSIDE CROSSWALK

SCHOOLS VICTIMS UNDER 19

Raised crosswalks are ramped speed tables spanning the entire width of the roadway, often placed at midblock crossing locations. The crosswalk is demarcated with paint and/or special paving materials. These crosswalks act as traffic-calming measures that allow the pedestrian to cross at grade with the sidewalk. A Raised Crosswalk improves safety by increasing crosswalk and pedestrian visibility and slowing down motorists.

CRF **35%**

CRASH TYPE

Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Opportunity	Medium

LRSM ID **R36PB**



Raised Median/Refuge Island ✓

PEDESTRIAN CROSSING OUTSIDE CROSSWALK

4-5 LANE ROADS WITH 40+ MPH SPEEDS

A **raised median/refuge island**, is raised curb in the center of the roadway that can restrict certain turning movements and provide a place for pedestrians to wait if they are unable to finish crossing the intersection. A Raised Median improves safety by reducing the number of potential conflict points with designated zones for vehicles to turn, and a pedestrian refuge island improves safety by reducing the exposure time for pedestrians crossing the intersection.

CRF **45%**

CRASH TYPE

Expected Life (Years)	20
Federal Funding Eligibility	90%
Systemic Opportunity	Medium

LRSM ID **NS19PB**

PEDESTRIAN & BICYCLE



Rectangular Rapid Flashing Beacon ✓

PEDESTRIAN CROSSING OUTSIDE CROSSWALK

SCHOOLS

A **rectangular rapid flashing beacon (RRFB)** is a pedestrian-activated flashing light with additional signage to alert motorists of a pedestrian crossing. An RRFB improves safety by increasing the visibility of marked crosswalks and provides motorists a cue to slow down and yield to pedestrians.

CRF **35%**

CRASH TYPE 

Expected Life (Years)	20
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Federal Funding Eligibility	100%
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Systemic Opportunity	Medium
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LRSM ID **NS22PB**



Separated Bike Lanes ✓

WRONG SIDE OF ROAD (BICYCLE)

A **separated bike lane** provides dedicated street space, typically adjacent to outer vehicle travel lanes, with separation from vehicle traffic, designated lane markings, pavement legends, and signage. Bike lanes improve safety by reducing conflicts between bicycles and vehicles on the road and by creating a road-narrowing effect with buffers or vertical barriers, which may reduce vehicle speeds.

CRF **45%**

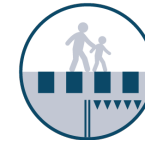
CRASH TYPE 

Expected Life (Years)	20
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Federal Funding Eligibility	90%
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Systemic Opportunity	High
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LRSM ID **R33PB**



Uncontrolled Pedestrian Crossings with Enhanced Safety Features ✓

PEDESTRIANS CROSSING OUTSIDE CROSSWALK

SCHOOLS

COMMERCIAL AREAS

An **uncontrolled pedestrian crossing** at an intersection or on a segment provides a formalized location for people to cross the street, reducing the risk of people crossing outside crosswalks where drivers are not expecting them. Crosswalk striping, signs, and other enhanced safety features alert drivers that there may be a pedestrian crossing. See further information on crosswalks later in this document for more detail.

CRF **35%**

CRASH TYPE 

Expected Life (Years)	20
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Federal Funding Eligibility	90%
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Systemic Opportunity	Medium
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LRSM ID **R35PB**



Widen Sidewalk

PEDESTRIAN IN ROAD

Widening sidewalks provides a more comfortable space for pedestrians, particularly in locations with high volumes of pedestrians, and provides space to accommodate people in wheelchairs. Widening sidewalks improves safety by minimizing collisions with pedestrians walking in the road.



Raised Crosswalk



Curb Extension

PEDESTRIAN & BICYCLE

KEY

- 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)*

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

ENGINEERING

CROSSWALK POLICY BEST PRACTICES

Uncontrolled pedestrian crossings occur where sidewalks or designated walkways intersect a road at a location where no tra2c control (e.g., tra2c signal or stop sign) exists. This crossing type occurs at intersections (marked or unmarked)

and at mid-block locations (where they must be marked). Research has demonstrated the importance of marking uncontrolled crossings to facilitate access to key destinations while ensuring that additional safety treatments are applied at these locations if they have higher traffic speeds and volumes. The **FHWA Guide for Improving Pedestrian Safety at Uncontrolled Crossing Locations** proposes

countermeasures based on road conditions, crash causes, and pedestrian safety issues. Figure 21 summarizes recommendations from the guide, includes a comprehensive matrix and list of FHWA-approved pedestrian crash countermeasures suggested for application at uncontrolled crossing locations per roadway and traffic features.

		POSTED SPEED LIMIT AND AADT								
		Vehicle AADT <9,000			Vehicle AADT 9,000-15,000			Vehicle AADT >15,000		
Roadway Configuration		≤30 mph	35mph	≥40mph	≤30 mph	35mph	≥40mph	≤30 mph	35mph	≥40mph
2 lanes 1 lane in each direction		1 2	1	1	1	1	1	1	1	1
		4 5 6	5 6	5 6	4 5 6	5 6	5 6	4 5 6	5 6	5 6
3 lanes WITH RAISED MEDIAN 1 lane in each direction		1 2 3	1 3	1 3	1 3	1 3	1 3	1 3	1 3	1 3
		4 5	5	5	4 5	5	5	4 5	5	5
3 lanes WITHOUT RAISED MEDIAN 1 lane in each direction with a two-way left-turn lane		1 2 3	1 3	1 3	1 3	1 3	1 3	1 3	1 3	1 3
		4 5 6	5 6	5 6	4 5 6	5 6	5 6	4 5 6	5 6	5 6
4+ lanes WITH RAISED MEDIAN 2 or more lanes in each direction		1 3	1 3	1 3	1 3	1 3	1 3	1 3	1 3	1 3
		5 6	5 6	5 6	5 6	5 6	5 6	5 6	5 6	5 6
4+ lanes WITHOUT RAISED MEDIAN 2 or more lanes in each direction		1 3	1 3	1 3	1 3	1 3	1 3	1 3	1 3	1 3
		5 6	5 6	5 6	5 6	5 6	5 6	5 6	5 6	5 6



Figure 7
Application of
Pedestrian Crash
Countermeasures by
Roadway Features
Source: FHWA

Signifies that the countermeasure is a candidate treatment at a marked uncontrolled crossing location
The absence of a number (#) signifies that the countermeasure is generally not an appropriate treatment, but exceptions may be considered following engineering judgment.

■ Signifies that the countermeasure should always be considered, but not mandated or required, based upon engineering judgment at a marked uncontrolled crossing location
◊ Signifies that crosswalk visibility enhancements should always occur in conjunction with other identified countermeasures

DEMAND CONSIDERATIONS FOR CROSSWALKS

Uncontrolled and mid should be identified marking if there is a crosswalk. Figure for deciding if a c Engineering judgment be used to select 1 for a marked, uncon Enhanced treatments and signing should uncontrolled locati facing page.

Should a crosswalk be installed?

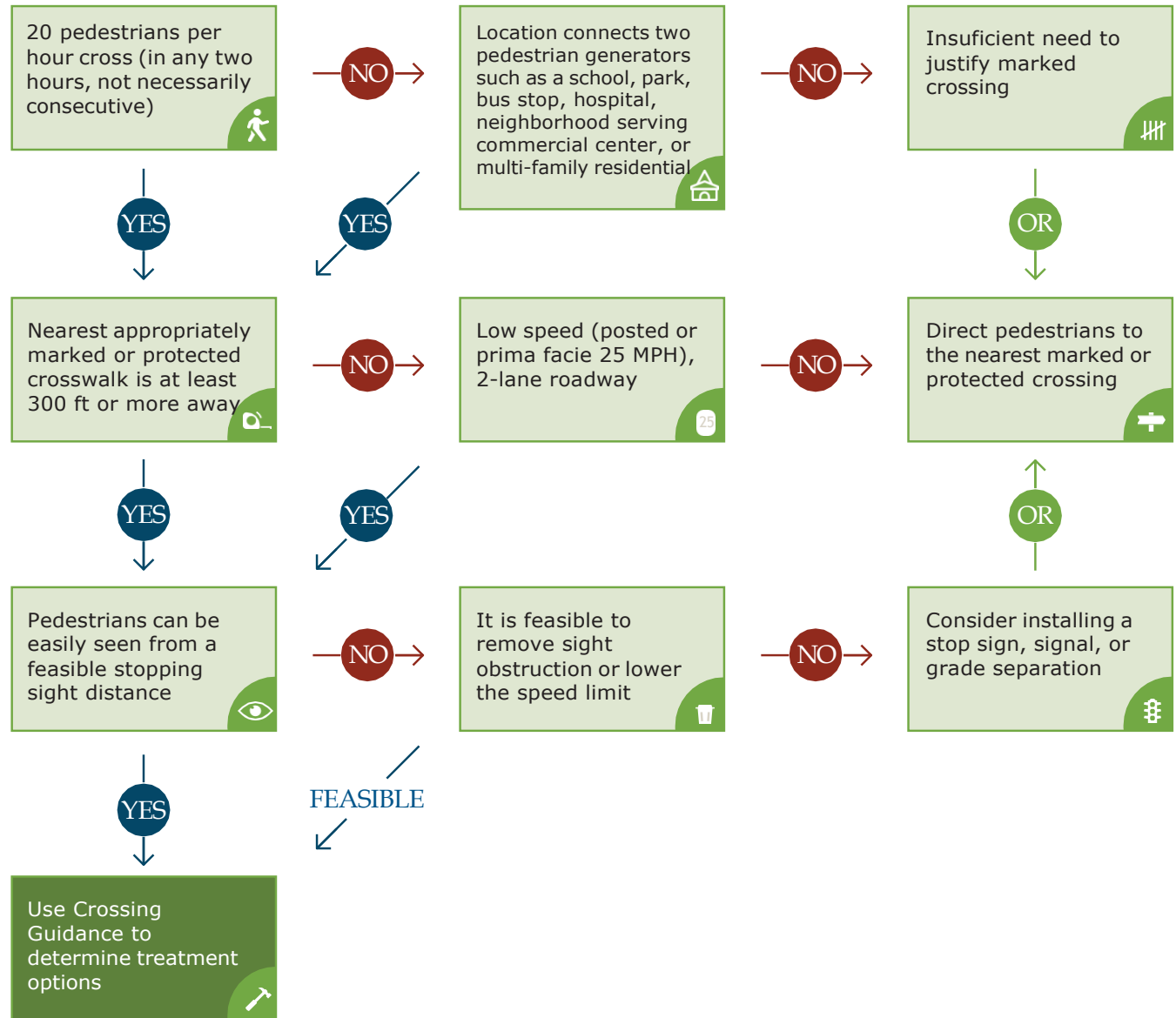


Figure 8
 Samples of Decision Tree
 for Marking Crosswalks
 Source: Fehr & Peers

ENGINEERING

CROSSWALK MARKINGS

Crosswalk markings help driver know where to expect pedestrians, and provide guidance for pedestrians crossing the roadway by defining and delineating paths on approaches to uncontrolled and mid-block locations. The use of high visibility striping is appropriate at both uncontrolled crossing locations, and signalized locations as traffic volumes, speeds, and vehicle-pedestrian conflicts require. There are several treatments for high visibility markings, including the continental and triple-four (also called double continental) markings, shown in Figure 02. Pacifica could choose a preferred style to use, so it is consistently applied. Pacifica may also want to adopt a policy of using high visibility markings at

all marked crosswalks, when intersection upgrades occur.

Continental striping is often chosen to communicate sensitive pedestrian crossing areas as the designated high visibility tool. Research shows that continental crosswalk markings are more visible to drivers at night than parallel line markings (1). Crosswalks with longitudinal lines parallel to traffic flow allow drivers to see the marked crosswalk from a greater distance, when compared with standard markings. This increased visibility distance gives drivers more time to safely stop for a pedestrian waiting to cross.

Additional resources:

(1) Fitzpatrick, K., S. Chrysler, V. Iragavarapu, and E.S. Park. Detection Distances to Crosswalk Markings: Transverse Lines, Continental Markings, and Bar Pairs. Transportation Research Record: Journal of the Transportation Research Board, No. 2250. Transportation Research Board of the National Academies, Washington, DC, 2011.

→
Figure 9
Crosswalk Marking
Examples

- Triple-four markings include two dashed lines on the outside with a clear space in the center to direct pedestrian traffic, and are often enhanced with outer rows of raised pavement markers. They may be less costly to install and maintain as they require less paint than a standard high visibility crosswalk.

