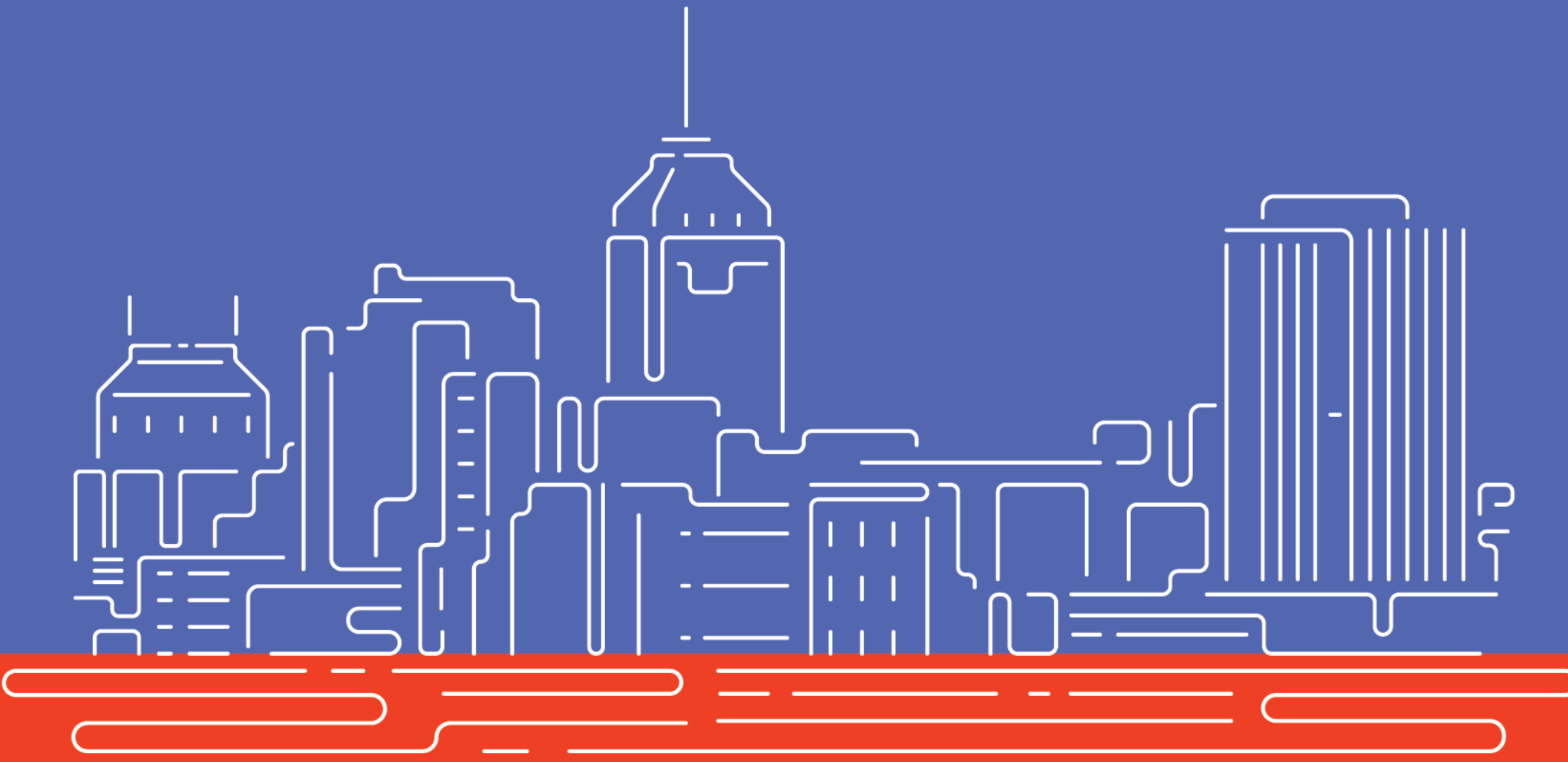
Major Streets Traffic Calming Toolkit



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INTRODUCTION

The City of Fresno is working to improve street safety amid rising crash-related fatalities and injuries. This is particularly true on major streets (arterials, major collectors) where higher speeds, wider streets, and greater traffic volumes increase the prevalence of severe collisions. This *Major Streets Traffic Calming Toolbox* can also be interpreted as an *Arterial and Collector Speed Management Toolbox*. It identifies context-appropriate countermeasures for improving street safety and reducing the likelihood of crashes, specifically along arterials and collectors. This toolbox provides a range of countermeasures that address common safety challenges on the city's major streets. This toolkit responds to Fresno's existing conditions and crash history by focusing on proven safety measures that respond to common crash types on major streets in Fresno.

The City of Fresno's General Plan[1] defines arterials and collectors as follows:

Facility Type	Typical Configuration	Primary Purpose	Access Characteristics
Super-Arterial	Four- to six-lane divided roadway with median separation	Moves high volumes of multi-modal traffic between major generators and across subregions	Very limited access. Select right-in/right-out access points between major intersections; limited partial median openings (max one per half-mile). No left turns allowed out of local streets or properties.
Arterial	Four- to six-lane divided roadway with median separation	Moves traffic within and between neighborhoods and provides connections to freeways and expressways	Somewhat limited access to adjacent properties. Major intersections allow full movements; selected local street intersections may allow left turns where appropriately designed and spaced.
Collector	Two- to four-lane undivided roadway (typically without median; often includes center two-way left-turn lane)	Connects local streets to arterials and serves neighborhood traffic generators while providing property access	Local street intersections and driveway access permitted consistent with City standards. Typically allows two-way left-turn access via center turn lane.

[1] See City of Fresno General Plan section 4.3 Roadways and Automobiles for more information on street classification.
Fresno General Plan

HOW TO USE THE TOOLKIT

City staff are encouraged to use this document as guidance when evaluating safety interventions, acknowledging that each location is unique and that solutions should be supported by engineering judgment. This guide can be used as a complement to the City's current traffic calming practices on neighborhood streets through the Neighborhood Traffic Calming Program.

The countermeasures are organized into four categories; however, countermeasures may correspond to more than one category:

1. Travel Lanes
   Includes countermeasures that focus on design and operational improvements to lane configurations to enhance safety and mobility.
2. Intersections and Crossings
   Includes countermeasures that address design and operational improvements at intersections, which are critical due to the number of street users, movements, interactions, and decisions at these locations.
3. Speed Management
   Includes countermeasures that focus on reducing motorists' speeds, as excessive speeds significantly increase the likelihood and severity of crashes.
4. Signs and Signals
   Includes countermeasures that relate to regulatory, warning, and traffic control devices that guide the behavior of streets users.

In the Toolbox, each countermeasure is organized as follows:

Countermeasure

Description

Provides a brief depiction of the measure or measures.

Safety Benefits

Lists all the potential safety benefits that, when implemented, the countermeasure could provide.

Target Crash Types

Identifies crash types the countermeasure targets, including:

- **Head-on** is a crash that happens when two motorists travelling in opposite directions collide front to front.
- **Intersection-related** is a crash that happens at an intersection, usually related to turning maneuvers, motorists failing to yield, or motorists running through red lights.
- **Lighting conditions-related** is a crash that happens when lighting conditions related to time of day or the weather affect the visibility of the street, leading to a collision.
- **Pedestrian involved and/or bicyclist involved** is a crash where a pedestrian or a bicyclist is involved in the collision.
- **Rear end** is when a motorist crashes into the back of another vehicle.
- **Roadway or lane departure** is a crash that happens when a motorist swerves out of the travel lane and collides with another vehicle or with an object.
- **Side impact** is when a motorist crashes into the side of another vehicle.
- **Speeding-related** is a crash that happens as a result of a motorist travelling above the posted speed limit.

Crash Reduction

Refers to Crash Modification Factors (CMF) used by the Federal Highway Administration (FHWA) to provide a quantitative measure of the expected change in the number of crashes resulting from the implementation of the countermeasure. When referring specifically to the estimated percentage decrease of crashes, the FHWA calls it 'Crash Reduction Factors (CRF). The FHWA determines the factors by historical data and analysis of past interventions, but not all countermeasures have been researched, analyzed, and assigned a CMF.

In the state of California, Caltrans has prioritized a small number of CRFs and has linked them to applications for grants with the aim of establishing an accurate comparison between projects. The Toolbox identifies these CRFs through the reference "(CT)" at the end of the factor.

Considerations and Applicability

Outlines where the countermeasure is most effective and what factors should be considered during implementation. The section describes suitable locations based on traffic patterns and context while addressing design constraints and maintenance needs, and identifies potential impacts, tradeoffs, and conflicts that may arise as a result of implementation

Feasibility

Provides a threshold of the countermeasure's implementation cost represented as a graphic scale from low to high. Shaded circles indicate where the countermeasure falls within the scale. If more than one circle is shaded it indicates the cost falls within a range.

This section also provides infromation on funding opportunities for planning and implementing the countermeasures, including federal, state, and local grant programs.

Resources

Includes federal manuals, design guidelines, and research that refer to the countermeasure.

Coordinating Speed Management with Emergency Management Vehicles

Performance and System Level Considerations

Emergency response time is a critical performance measure for transportation networks. Delays in emergency vehicle travel can negatively affect outcomes for fire suppression, emergency medical services (EMS), and law enforcement response. Research and publicly available resources suggest strategies to balance the tradeoffs of traffic calming measures, emergency response times, vehicle sizes, and reliability.

Key considerations for emergency services travel and reliability include:

- **Network effects:** Countermeasures that introduce additional delay or deflection should be evaluated in the context of emergency response routes.
- **Temporal patterns:** Peak travel demands can compound emergency response delay; designs should account for variability in travel times.
- **Performance measures:** Emergency response time reliability can be incorporated into project evaluation criteria alongside safety and mobility metrics.

Design Impacts on Emergency Vehicles

Physical speed management features and roadway geometries implemented to reduce vehicle speeds and improve safety outcomes can affect larger vehicles, including fire apparatus and ambulances, by creating additional delay, vehicle handling challenges, or potential for equipment wear. Federal guidance specifically highlights the need to balance the safety benefits of geometric treatments with potential impacts on emergency mobility:

- The Federal Highway Administration's *Traffic Calming ePrimer* documents that geometric measures that create deflection are effective at lowering vehicle speeds but *must be designed to maintain emergency vehicle access*.[2] Design variants such as speed cushions, mountable curbing, or provision of bypass lanes are common design strategies to maintain access while preserving safety benefits.
- Professional safety organizations, including the Insurance Institute for Highway Safety (IIHS), emphasize that physical traffic calming treatments are effective at reducing speeds and crashes, but that coordination with emergency service providers is a recommended best practice to ensure operational compatibility.[3]

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[2] FHWA Speed Management / Traffic Calming ePrimer — addresses traffic calming effects on speeds and the need for design consideration for emergency vehicles. https://highways.dot.gov/safety/speed-management/traffic-calming-eprimer

[3] Insurance Institute for Highway Safety (IIHS), *Traffic Calming* Topic Page — describes safety benefits of traffic calming and best practices. https://www.iihs.org/topics/traffic-calming

Emergency vehicle compatibility should not be assumed; instead, treatment design should explicitly account for vehicle dimensions, turning radii, and operational characteristics of local fire and EMS fleets. Early engagement with emergency service providers can help identify preferred design treatments and mitigation options that reduce delay without compromising safety.

Operational Countermeasures and Mitigations

In addition to geometric design features, operational countermeasures can mitigate potential negative impacts on emergency response. For example, *traffic signal priority and preemption* systems allow emergency vehicles to influence signal timing, reducing delay at signalized intersections and improving travel time reliability for responders. These systems are referenced in national signal control guidance and have been documented in public signal design manuals.[4]

Other operational strategies that should be considered in conjunction with physical countermeasures include:

- Coordination of signal timing along key emergency routes.
- Use of real-time traveler information and routing for emergency vehicles.
- Detection and priority systems for emergency responders.

Implications for Countermeasure Applicability

Incorporating emergency response considerations into countermeasure evaluation and selection supports a more balanced and context-sensitive application of traffic safety treatments. Countermeasure selection and implementation should include:

- Identifying locations where emergency vehicle responsiveness is a critical performance factor.
- Evaluating geometric and speed management measures and their potential impact on emergency travel times.
- Engaging fire, EMS, and law enforcement agencies early in the planning and design phases to identify concerns and mitigation strategies.
- Considering operational enhancements such as traffic signal priority as part of the countermeasure suite.

These considerations help ensure that countermeasure recommendations not only improve safety and traffic operations for the public but also support essential emergency services.

[4] Traffic Signal Preemption (public overview) — explains priority signal control for emergency vehicles. https://en.wikipedia.org/wiki/Traffic_signal_preemption

Medians and Pedestrian Islands

Travel Lanes

Description

Medians are raised or street level areas that separate opposing traffic.

Pedestrian islands are designated refuge spaces in the middle of the crosswalk where people can wait and safely cross the street in two stages.

Considerations and Applicability

- Ensure that the street section is wide enough to include a median and still have the lanes' widths within regulations.
- Ensure access and flow management by aligning the median gaps with intersections, driveways, and turning lanes.
- Coordinate with the Fire Department and School Districts to ensure that emergency vehicle, school bus, and public transit access can be maintained.
- Make the pedestrian islands between 4 feet and 8 feet wide to ensure pedestrian safety and comfort.

Recommended:

- Implement medians on multilane streets and streets with traffic volumes over 9,000 vehicles per day.
- Implement pedestrian islands at mid-block crossings.
- Implement pedestrian islands in zones with a high number of pedestrians or vulnerable street users, including near schools, hospitals, and senior living centers.

Safety Benefits	Feasibility
Medians help organize opposing traffic flows and calm speeds, enhancing visibility and predictability of motorists' movements. Pedestrian islands enhance safety by reducing pedestrian exposure to traffic and providing a refuge when crossing. **Targets:** • Head-on crashes • Intersection-related crashes • Lane departure crashes • Pedestrian-involved crashes • Side impact crashes	**Cost Range**  **Grants | Funding** Active Transportation Program (ATP) Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Safe Streets and Roads for All (SS4A) California Office of Traffic Safety Grants (OTS) Local Streets and Roads Program (LSRP) Solutions for Congested Corridors Program Surface Transportation Block Grant Program (STBG) Highway Safety Improvement Program (HSIP)
Crash Reduction	**Resources**
25% Reduction in all crash types when installing a raised median on approaches. (CT) **45%** Reduction in pedestrian crashes when installing a raised median and pedestrian island at unsignalized intersections. (CT)	FHWA Proven Safety Countermeasures Pedsafe Guide GDCI Global Street Design Guide California Local Roadway Safety Manual

Narrow Travel Lanes

Travel Lanes

Description

Travel lanes typically range in width from 9 feet to 12 feet based on the street's function and context; narrow lanes are considered those between 9 feet and 10 feet. Nine-foot travel lanes are only feasible where striping, mountable features, or operational treatments are provided to accommodate larger vehicles such as emergency responders and transit vehicles. Narrow lanes help manage speeds and can free up space to accommodate infrastructure needs or other street users.

Considerations and Applicability

- Ensure that lane widths align with local regulations.
- Coordinate with the Fire Department and School Districts to ensure that emergency vehicle, school bus, and public transit access can be maintained.

Recommended:

- Implement narrow travel lanes on streets with lower posted speed limits or with low traffic volumes.
- Implement in dense urban and/or residential areas.
- Implement in areas with a high volume of people walking and/or biking.

Not recommended:

- Implementation is not recommended on streets with regular transit service or freight traffic.

Safety Benefits	Feasibility
Narrow travel lanes enhance road safety by encouraging slower motorists' speeds which reduces the likelihood and severity of crashes. **Targets:** • Pedestrian or bicyclist involved crashes • Speed-related crashes	**Cost Range**  **Grants | Funding** California Office of Traffic Safety Grants (OTS) Local Streets and Roads Program (LSRP) Solutions for Congested Corridors Program Caltrans Sustainable Transportation Planning Grant Congestion Mitigation and Air Quality Improvement Program Surface Transportation Block Grant Program (STBG) Highway Safety Improvement Program (HSIP)
Crash Reduction	**Resources**
24% Reduction in all crash types when converting 12 foot lanes to 11 foot lanes. **42%** Reduction in all crash types when converting 12 foot lanes to 10 foot lanes.	FHWA Safety Countermeasures NACTO Urban Street Design Guide GDCI Global Street Design Guide

Road Diet

Travel Lanes

Description

A road diet is a street reconfiguration that usually involves reducing travel lane widths or eliminating travel lanes, resulting in fewer travel lanes and often the space to accommodate other modes. The redesign encourages slower speeds and allows for the safe integration of different street users.

Considerations and Applicability

- Ensure widths align with local regulations.
- Coordinate with the Fire Department and School Districts to ensure that emergency vehicle, school bus, and public transit access can be maintained.
- Include bike lanes where needed and feasible.

Recommended:

- Implement on streets with excess roadway capacity.
- Implement on multi-lane streets.
- Implement in areas with high pedestrian/or bicyclist volumes.
- Implement where there is a need for dedicated left-turn lanes.

Not recommended:

- Implementation is not recommended on streets with an ADT of 10,000 or above.

Safety Benefits

Road diets enhance road safety by encouraging slower motorists' speeds, defining motorists' maneuvers, shortening pedestrian crossings, and minimizing conflicts between street users.

Targets:

- Intersection-related crashes
- Pedestrian and bicyclist involved crashes

Feasibility

Cost Range

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Grants | Funding

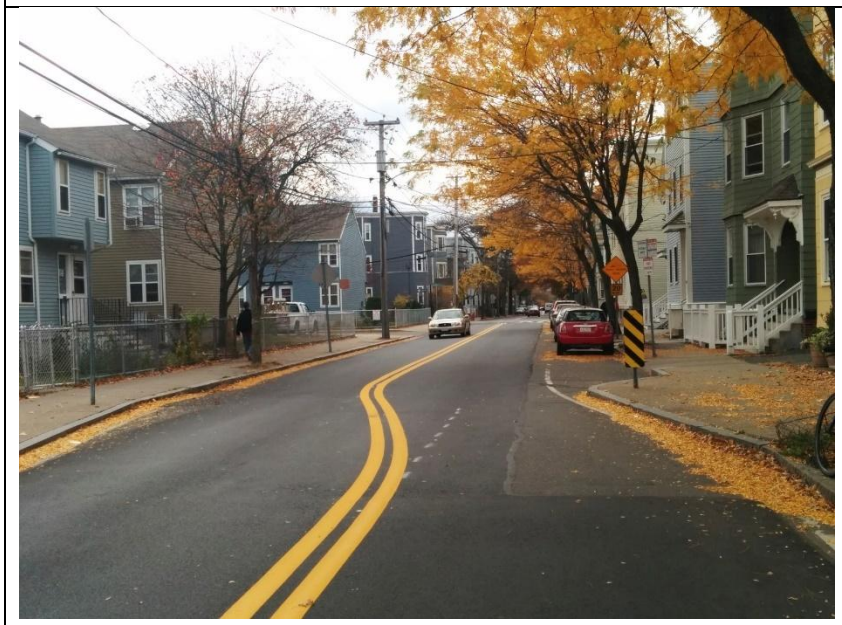
Active Transportation Program (ATP)
Better Utilizing Investments to Leverage Development (BUILD)
Safe Streets and Roads for All (SS4A)

• Rear-end crashes • Speed-related crashes	California Office of Traffic Safety Grants (OTS) Local Streets and Roads Program (LSRP) Solutions for Congested Corridors Program Surface Transportation Block Grant Program (STBG) Clean California Local Grant Highway Safety Improvement Program (HSIP)
Crash Reduction	Resources
35% Reduction in all crash types when converting or replacing vehicle lanes with left-turn and bike lanes. (CT)	FHWA Road Diet Desk Reference FHWA Proven Safety Countermeasures NMDOT Design Manual California Local Roadway Safety Manual

Chicanes

Travel Lanes

Description



Chicanes are horizontal deflections which use a series of alternating curb extensions placed mid-block that guide motorists into multiple lane shifts and increase motorists' awareness and reduce speeds.

Considerations and Applicability

- Consider drainage needs when implementing chicanes.
- Make sure the street width allows for chicanes.
- Consider the impact of the reduction in parking spaces.
- Utilize the gained space to incorporate landscaping elements.
- Identify emergency vehicle needs.
- Ensure chicanes are visible to motorists.

Recommended:

- Implement on residential streets.
- Implement on downtown streets
- Implement in school zones and near parks.

Not recommended:

- Implementation is not recommended on truck routes and transit corridors.
- Implementation is not recommended on streets with more than one travel lane in each direction.

Safety Benefits	Feasibility
Chicanes encourage safer driving behavior by reducing straight-line acceleration and increasing motorist awareness enhancing motorist and pedestrian safety. **Targets:** • Pedestrian and bicyclist involved crashes • Speed-related crashes	**Cost Range**  **Grants | Funding** Active Transportation Program (ATP) Rebuilding American Infrastructure with Sustainability and Equity (RAISE) Safe Streets and Roads for All (SS4A) California Office of Traffic Safety Grants (OTS) Local Streets and Roads Program (LSRP) Solutions for Congested Corridors Program Surface Transportation Block Grant Program (STBG) Clean California Local Grant
Crash Reduction	**Resources**
While the FHWA CMF Clearinghouse does not list a treatment-specific CMF labeled *chicane*, the Clearinghouse does include CMFs for *traffic calming* treatments incorporating horizontal deflection. For example, an approximate 33% reduction in crashes is documented for traffic calming treatments on urban minor collectors (FHWA CMF Clearinghouse, CMF ID 131), demonstrating measurable crash reduction associated with physical speed management measures.	NACTO Urban Street Design Guide Pedsafe Guide GDCI Global Street Design Guide California Local Roadway Safety Manual FHWA Speed Management Crash Modification Factors Clearinghouse

Roundabout

Intersections and Crossings

Description

A roundabout is a circular intersection that eliminates stop signs and signals and relies on the motorists who are entering the intersection to yield to the traffic already inside. Motorists travel counterclockwise around a center island at slower speeds, improving traffic flow and road safety.

Speed calming features like channelized approaches and curvature design must be incorporated to ensure low travel speeds of 30 mph.

Considerations and Applicability

- Ensure that there is enough space for the central island and the entry and exit lanes.
- Incorporate adequate designs for pedestrians and bicyclists, such as setback pedestrian crosswalks.
- Add destination signage at the entry and exit points.
- Incorporate splitter islands or road markings to organize flows.
- Include speed signage and design features to slow down motorists approaching the intersection.
- Consider that this type of intersection may be challenging for people with visual disabilities.
- Coordinate with the Fire Department and School Districts to ensure that emergency vehicle, school bus, and public transit access can be accommodated.

Recommended:

- Implement at intersections with moderate to high traffic volumes.
- Implement at intersections with a history of left-turn crashes.
- Implement in urban, suburban, and rural areas.

Not recommended:

- Implementation is not recommended on streets with high-speed limits.
- Implementation is not recommended at intersections with unbalanced traffic volumes.
- Implementation is not recommended at locations with high pedestrian volumes.

Safety Benefits	Feasibility
Roundabouts reduce conflict points and encourage slower speeds, decreasing the likelihood of severe crashes. They can also improve pedestrian safety by providing shorter crossing distances and pedestrian islands when designed and implemented properly. **Targets:** • Intersection-related crashes • Pedestrian-involved crashes • Side impact crashes	**Cost Range**  **Grants | Funding** Surface Transportation Block Grant (STBG) Highway Safety Improvement Program (HSIP) Safe Streets and Roads for All (SS4A) Local Streets and Roads Program (LSRP)
Crash Reduction	**Resources**
82% Reduction in all crash types when converting a stop-controlled intersection into a single-lane roundabout. **35% - 67%** Reduction in all crash types when converting a signalized intersection into a roundabout. (CT) **12%-78%** Reduction in left-turn crashes when converting an intersection into a roundabout. (CT)	FHWA Roundabouts with Pedestrians and Bicycles FHWA Roundabouts: An Informational Guide Pedsafe Guide FHWA Proven Safety Countermeasures California Local Roadway Safety Manual

Protected Intersection

Intersections and Crossings

Description

A protected intersection incorporates infrastructure like corner islands and signal elements that prioritize the safety and traffic of pedestrians and bicyclists.

Considerations and Applicability

- Ensure that adequate space is available for the redesign of the intersection.
- Consider that traffic flow may be affected.
- Coordinate with the Fire Department and School Districts to ensure that emergency vehicle, school bus, and public transit access can be maintained.

Recommended:

- Implement in urban and suburban areas
- Implement at locations with a high number of pedestrians and bicyclists.
- Implement on transit corridors

Not recommended:

- Implementation is not recommended in rural or low-density urban areas.
- Implementation is not recommended in intersections with limited space.

Safety Benefits

Protected intersections reduce collision risks by enhancing visibility and reducing conflicts between street users through clear separation of flows and crossing areas.

Targets:

- Intersection-related crashes
- Pedestrian and bicyclist involved crashes

Feasibility

Cost Range

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Grants | Funding

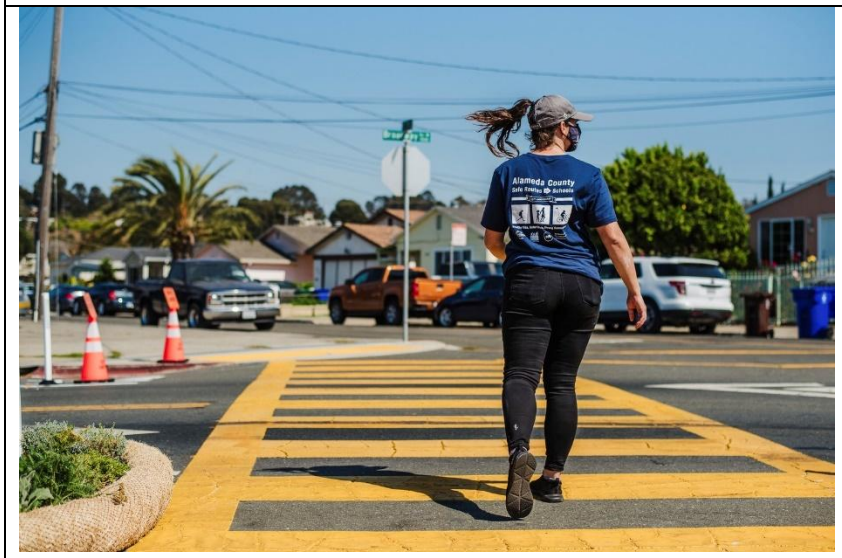
Active Transportation Program (ATP)
Safe Streets and Roads for All (SS4A)
Highway Safety Improvement Programs (HSIP)
California Office of Traffic Safety Grants (OTS)
Local Streets and Roads Program (LSRP)

Crash Reduction	Resources
59% Reduction in bicyclist-involved injury crashes at intersections when installing cycle tracks, bike lanes, or on-street cycling.	Caltrans Pedestrian Safety Countermeasures Toolbox NACTO Urban Street Design Guide MASSDOT Separated Bike Lane Planning and Design Guide

Crosswalk Visibility Enhancements

Intersections and Crossings

Description



Crosswalk visibility enhancements are design and marking improvements that make pedestrian crossings more noticeable to all street users. This approach includes:

High visibility markings using reflective and durable paint.
Advanced warning signs alerting motorists to upcoming crosswalks.
Overhead lighting enhancing visibility at intersections.
Rectangular Rapid Flashing Beacons (RRFB) providing active warning crosswalk beacons to motorists.

Considerations and Applicability

- Take into consideration speed limits when choosing intervention type.
- Assess pedestrian volumes at crosswalks.
- Ensure regular maintenance at crosswalks.
- If possible, follow a systematic approach to enhance predictability.

Recommended:

- Implement at mid-block crossings and unsignalized crossings.
- Implement at intersections with a high volume of pedestrians, like school zones or near transit stops.
- Implement in areas with poor visibility.

Not recommended:

- Implementation is not recommended in areas with low pedestrian activity or volumes.
- Implementation is not recommended on high-speed streets without additional safety measures.

Safety Benefits	Feasibility
Improve pedestrian safety by increasing motorists' awareness and predictability of crosswalk locations. **Targets:** • Pedestrian-involved crashes • Intersection-related crashes • Lighting-related crashes	**Cost Range**  **Grants | Funding** Active Transportation Program (ATP) Safe Streets and Roads for All (SS4A) Highway Safety Improvement Programs (HSIP) California Office of Traffic Safety Grants (OTS) Local Streets and Roads Program (LSRP)
Crash Reduction	**Resources**
35% Reduction in pedestrian-involved crashes when installing or upgrading a high-visibility crosswalk at unsignalized intersections. **CMF ID 9017 • 42%** Reduction in pedestrian-involved crashes when implementing advance yield or stop markings and signs. **CMF ID 1786 • 37%** Reduction in all crash types when installing a pedestrian crossing with signs, ramps, and extensions. **30%** Reduction in all crash types when installing advanced flashing beacons at intersections. (CT) **35%** Reduction in pedestrian-involved crashes when installing RRFB. (CT) **25%** Reduction in all crash types when upgrading pavement markings at unsignalized intersections. (CT) **40%** Reduction in all nighttime crashes when adding lighting at intersections. (CT)	FHWA Proven Safety Countermeasures Pedsafe Guide Manual on Uniform Traffic Control Devices (MUTCD) NCHRP 926 Guidance to Improve Pedestrian and Bicyclist Safety at Intersections California Local Roadway Safety Manual

Corner Redesign

Intersections and Crossings

Description

Corner redesign measures modify intersections by reducing curb radii and/or adding curb extensions. A curb extension is a sidewalk extension that narrows the roadway at intersections or mid-block crossings.

These measures shorten the crossing distance for pedestrians, reduce motorists' turning speeds, and improve visibility between motorists and pedestrians.

Considerations and Applicability

- Coordinate with the Fire Department, School Districts, and public to ensure curb radii are design to accommodate large-vehicle turning movements.
- Allow for adequate water drainage when implementing curb extensions.
- Consider bicyclist circulation when implementing curb extensions.
- A width of 6 feet is suggested for curb extensions.

Recommended:

- Implement at urban and suburban intersections with high pedestrian activity and volumes.
- Implement at locations with frequent turning conflicts.
- Implement in school zones

Not recommended:

- Curb extension implementation is not recommended on streets without an on-street parking lane.

Safety Benefits	Feasibility
Corner redesign improves safety by reducing motorists' speeds, improving visibility and reducing pedestrians' exposure to vehicles. This measure helps reduce conflicts between motorists and pedestrians and bicyclists. Targets: • Intersection-related crashes • Pedestrian and bicyclist involved crashes	**Cost Range**  **Grants | Funding** Active Transportation Program (ATP) Safe Streets and Roads for All (SS4A) Highway Safety Improvement Programs (HSIP) California Office of Traffic Safety Grants (OTS) Local Streets and Roads Program (LSRP) Community Development Block Grant (CDBG)
Crash Reduction	**Resources**
35% Reduction in all pedestrian-involved crashes when installing a pedestrian crossing with signs, ramps, and curb extensions (CT)	Pedsafe Guide NCHRP 926 Guidance to Improve Pedestrian and Bicyclist Safety at Intersections FHWA Traffic Calming ePrimer, Module 3, Part 2 AASHTO Guide for the Planning, Design, and Operation of Pedestrian Facilities

Slip Lane Treatment

Intersections and Crossings

Description

Slip lanes are channelized dedicated right-turn lanes that allow motorists to turn without stopping.

Treatments include traffic calming measures and pedestrian-centered interventions to make the intersection safer. Slip lanes may also be eliminated to create a tighter and more controlled intersection.

Considerations and Applicability

- Assess the impact on vehicle capacity and flow when removing the slip lane.
- Reclaim gained space from the lane closure with green infrastructure or amenities.
- When implementing pedestrian-focused measures, add advance sign warnings to increase motorists' awareness.

Recommended:

- Implement at intersections where right turns pose a risk to pedestrians.
- Implement at urban and suburban intersections with a high volume of pedestrians, including school zones, transit hubs, and commercial areas.

Not recommended:

- Implementation is not recommended on major freight or emergency routes.
- Lane closures are not recommended at locations where there is a high number of turning vehicles.

Safety Benefits	Feasibility
Slip lane treatments and closures enhance safety by reducing turning speeds, improving sightlines, and eliminating conflicts between motorists and pedestrians and bicyclists. **Targets:** • Intersection-related crashes • Pedestrian-involved crashes	**Cost Range**  **Grants | Funding** Safe Streets and Roads for All (SS4A) Highway Safety Improvement Programs (HSIP) California Office of Traffic Safety Grants (OTS) Clean California Local Grant Program
Crash Reduction	**Resources**
A crash reduction factor has not been determined for this countermeasure.	Caltrans Pedestrian Safety Countermeasures Toolbox LADOT Vision Zero Toolkit FHWA Countermeasures Pedsafe Guide

Context-Sensitive Speed Limits

Speed Management

Description

Context-sensitive speed limits adjust speed regulations based on the surrounding environment, street classification and function, and street user needs. Catered speed limits differ from statutory speed limits on a case-by-case basis.

Applicability and Considerations

- Accompany the new speed limits with traffic calming measures or adequate enforcement.

Recommended:

- Implement in urban and residential areas.
- Implement in school zones and near parks.

Not recommended:

- Implementation is not recommended on freeways.
- Implementation is not recommended on rural streets with low pedestrian and bicyclist activity.

Safety Benefits	Feasibility
Context-sensitive speed limits enhance safety by reducing motorists' speeds and crash risk and severity. **Targets:** • Speed-related crashes	**Cost Range**  **Grants | Funding** Active Transportation Program (ATP) Safe Streets and Roads for All (SS4A) Highway Safety Improvement Programs (HSIP) California Office of Traffic Safety Grants (OTS) Local Streets and Roads Program (LSRP) Measure C Regional Transportation Program
Crash Reduction	**Resources**
40% Reduction in fatal and serious injury crashes on rural streets when setting the speed limit 5 mph below the engineering study recommendation. **34%** Reduction in all crash types when installing variable speed limits on principal arterials. **65%** Reduction in rear-end crashes when installing variable speed limits on principal arterials.	FHWA Proven Safety Countermeasures FHWA Safe System Approach for Speed Management

Speed Limit Signs and Markings

Speed Management

Description

Signs and markings provide clear, visible guidance on posted speed limits helping regulate motorists' speeds. Signs are installed at regular intervals and sign size depends on the function of the street and its speed.

Pavement markings can reinforce speed regulations by painting the posted speed limit on the street surface. Markings are usually considered in critical areas or where there is a high volume of pedestrians.

Signs and pavement markings are complementary and serve as reminders to motorists to travel at the posted speed limit.

Considerations and Applicability

- Ensure sign and marking placement is visible.
- Use reflective materials and proper sizing.
- Align signs and markings with local regulations.
- Install signs and markings at regular intervals.
- Provide regular maintenance.

Recommended:

- Implement at street entry points.
- Implement at transition zones where the speed limit changes.
- Implement at curves.
- Implement in areas with high pedestrian and/or bicyclist volumes.
- Implement on multimodal corridors.

Safety Benefits	Feasibility
Speed limit signs and markings reinforce safe driving behavior and improve compliance with speed limits, reducing motorists' speeds and reducing crashes and/or their severity. **Targets:** • Speed-related crashes	**Cost Range**  **Grants | Funding** Highway Safety Improvement Program (HSIP) Measure C Funding Active Transportation Program (ATP)
Crash Reduction	**Resources**
A crash reduction factor has not yet been associated with in-roadway speed pavement markings or static speed limit signs.	FHWA Speed Management Toolkit FHWA Proven Safety Countermeasures NCHRP Posted Speed Limit Setting Procedure and Tool California Local Roadway Safety Manual

Speed Feedback Signs

Speed Management

Description

Speed feedback signs are permanent or portable electronic displays that show motorists their speed in real-time.

Considerations and Applicability

- Install the signs where motorists have enough time to react and adjust their speeds before reaching critical areas.
- Ensure sign visibility in all lighting and weather conditions.
- Accompany with speed limit signs, pavement markings, calming measures, and/or enforcement.

Recommended:

- Implement in transition zones and school zones.
- Implement in work zones.
- Implement on downhill segments.

Not recommended:

- Implementation is not recommended in areas with poor visibility.

Safety Benefits

Speed feedback signs increase motorists' awareness and helps maintain speed limits, reducing the risk of crashes.

Targets:

- Speed-related crashes

Feasibility

Cost Range

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Grants | Funding

Highway Safety Improvement Program (HSIP)
Measure C Funding
Active Transportation Program (ATP)
Community Development Block Grant (CDBG)

Crash Reduction	Resources
34% Reduction in all crash types when installing variable speed limit system where posted speed limits change in real time according to traffic and/or weather conditions. **51%** Reduction in fatal and serious injury crashes when installing variable speed limit system where posted speed limits change in real time according to traffic and/or weather conditions. **65%** Reduction in rear-end crashes when installing variable speed limit system where posted speed limits change in real time according to traffic and/or weather conditions. **7%** Reduction in all crash types when implementing feedback indicator signs at high crash rate curve sites with identified speeding problems.	FHWA Proven Safety Countermeasures NHTSA Countermeasures That Work Pedsafe Guide California Local Roadway Safety Manual

Optical Speed Bars

Speed Management

Description

Optical speed bars are pavement markings designed to create the visual illusion that a motorist is traveling faster than they actually are to potentially reduce their speed. They consist of a series of narrow parallel lines placed perpendicular to the direction of travel, where the spacing between them decreases as a motorist drives over them.

Considerations and Applicability

- Consider installing vertical deflections like humps where needed.
- Avoid overusing the speed bars as it can reduce effectiveness.
- Provide regular maintenance.

Recommended:

- Implement at transition zones and in school zones.
- Implement at approaches to high-risk intersections.
- Implement at approaches to curves.
- Implement on narrow streets.

Not recommended:

- Implementation is not recommended where there are no lane lines.

Safety Benefits	**Feasibility**
Optical speed bars improve safety by encouraging motorists to reduce their speeds. **Targets:** • Speed-related crashes • Rear-end crashes	**Cost Range**  **Grants | Funding** Highway Safety Improvement Program (HSIP) Measure C Funding Active Transportation Program (ATP)
Crash Reduction	**Resources**
A crash reduction factor has not yet been established for optical speed bars.	Speed Management Toolbox for Rural Communities FHWA Low Cost Treatments for Horizontal Curve Safety NCHRP Speed Reduction Techniques for Rural High-to-Low Speed Transitions

Advanced Stop Lines

Signs and Signals

Description

Advanced stop lines are pavement markings placed ahead of the standard distance from the crosswalks, usually 4 feet before the crosswalk.

This measure may be accompanied by a bike-box, which is a dedicated space at intersections for bicyclists to wait during the stop phase, making them more visible to motorists.

Considerations and Applicability

- Do not place more than 4 feet away from the crosswalk as motorists might not comply.
- Effectiveness of advance stop lines depends on motorist compliance.
- Advance stop lines work best as part of a systemic approach for high-visibility crosswalks.
- Accompany with a bike-box at signalized intersections.

Recommended:

- Implement in areas with a high number of pedestrians and bicyclists.
- Implement at intersections with frequent turning movements.

Not recommended:

- Implementation is not recommended on street sections without traffic control.

Safety Benefits	Feasibility
Advanced stop lines improve visibility of pedestrians and reduce conflicts between motorists and vulnerable street users. **Targets:** • Pedestrian-involved crashes	**Cost Range**  **Grants | Funding** Highway Safety Improvement Program (HSIP) Measure C Funding Active Transportation Program (ATP)
Crash Reduction	**Resources**
15% Reduction in pedestrian and/or bicyclist involved crashes when installing an advance stop bar before a crosswalk. (CT)	Pedsafe Guide Caltrans Pedestrian Safety Countermeasures Toolkit FHWA Step Studio California Local Roadway Safety Manual

Protected Left Turns

Signs and Signals

Description

A protected left turn is an exclusive signal phase that allows left-turning motorists to proceed with a green arrow, while all other traffic and pedestrians are stopped.

Considerations and Applicability

- Implementing a protected left turn could increase the signal cycle length.
- The wait time for pedestrians and bicyclists could increase.
- Additional signal heads and detection systems may be required.

Recommended:

- Implement in locations with high left-turn volumes.
- Implement at intersection with a history of left-turn crashes and/or conflicts.
- Implement on streets with multiple oncoming traffic lanes.
- Implement at intersections with limited visibility.

Not recommended:

- Implementation is not recommended at intersections with low vehicle volumes.
- Implementation is not recommended on corridors with coordinated signal timing needs.

Safety Benefits	Feasibility
Protected left turns eliminate conflicts between turning motorists and other street users, reducing crash risks at intersections. **Targets:** • Intersection-related crashes • Side impact crashes	**Cost Range**  **Grants | Funding** Highway Safety Improvement Program (HSIP) Measure C Funding Caltrans Statewide Traffic Safety Program (STSP) Active Transportation Program (ATP) Safe Streets and Roads for All (SS4A) Community Development Block Grant (CDBG)
Crash Reduction	**Resources**
28% Reduction in all crash types when providing a left-turn lane on one major-street approach. **48%** Reduction in all crash types when providing a left-turn lane on both major-street approaches. **42%** Reduction in left-turn related crashes when changing left-turn signals from permitted to protected only during certain times of day. **55%** Reduction in all crash types when installing a left-turn lane and phase where there was none before. (CT) **30%** Reduction in all crash types when providing a left-turn phase in an existing left-turn lane. (CT)	California Local Roadway Safety Manual

High Visibility Pavement Markings

Signs and Signals

Description

High visibility pavement markings are roadway markings used to delineate space and improve visibility for all street users, especially in the dark and in adverse weather conditions. These can be:

Reflective pavement markings which use paint that is brighter and more durable than standard paint.
Raised pavement markers (RMPs) which are small reflective devices that mark lane boundaries or other specific areas.

Considerations and Applicability

- Provide regular maintenance.
- Ensure alignment with MUTCD standards.

Recommended:

- Implement at crosswalks in areas with high-pedestrian volumes.
- Implement at intersections with frequent conflicts.
- Implement in contexts with weather conditions that affect visibility.
- Implement in rural areas with poor lighting.

Not recommended:

- Implementation is not recommended on streets subject to frequent resurfacing.
- Implementation is not recommended on streets with low traffic volumes.

Safety Benefits	Feasibility
High visibility pavement markings reduce the risk of crashes related to poor visibility by enhancing lane definition and guiding street users through specific areas. **Targets:** • Pedestrian-involved crashes • Lane departure crashes • Nighttime crashes • Intersection-related crashes	**Cost Range**  **Grants | Funding** Highway Safety Improvement Program (HSIP) Measure C Funding Active Transportation Program (ATP) Safe Streets and Roads for All (SS4A)
Crash Reduction	**Resources**
24% Reduction in nighttime crashes in rural areas when implementing reflective pavement markings. **10%** Reduction in fatal and injury related crashes when applying thermoplastic markings in rural areas. **15%** Reduction in all crash types when installing delineators, reflectors and/or object markers when approaching a curve or fixed object. (CT)	FHWA Guidelines for the Use of Raised Pavement Markers FHWA Proven Countermeasures